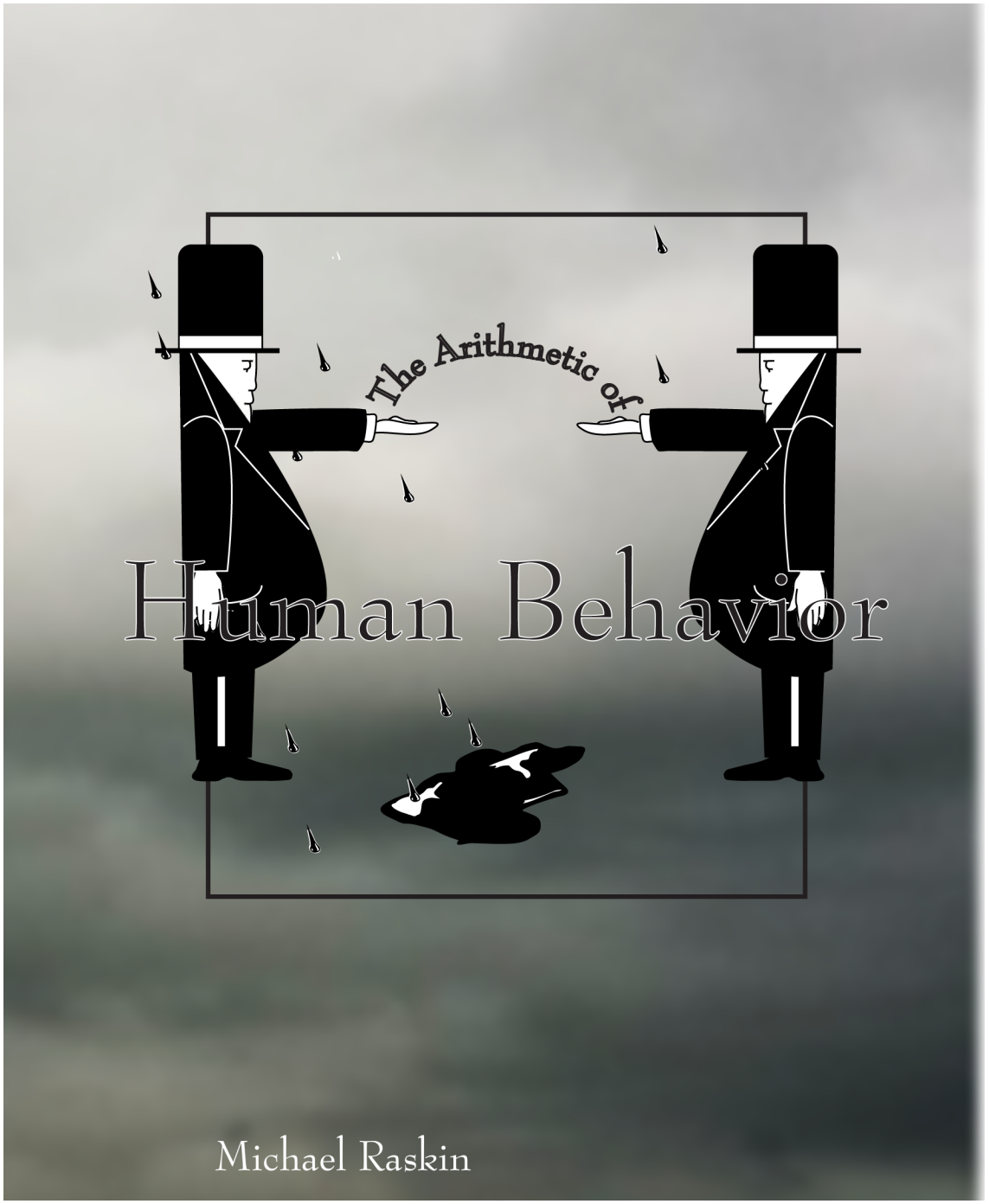
The Arithmetic of
Human Behavior
Michael Raskin

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A Veritec Solutions Book

August, 2011

Whether materialistically or spiritualistically minded, philosophers have always aimed at cleaning up the litter with which the world apparently is filled. They have substituted economical and orderly conceptions for the first sensible tangle; and whether these were morally elevated or only intellectually neat, they were at any rate always aesthetically pure and definite, and aimed at ascribing to the world something clear and intellectual in the way of inner structure. As compared with all these rationalizing pictures, the pluralistic empiricism which I profess offers but a sorry appearance. It is a turbid, muddled, gothic sort of an affair, without a sweeping outline and with little pictorial nobility. Those of you who are accustomed to the classical constructions of reality may be excused if your first reaction upon it be absolute contempt—a shrug of the shoulders as if such ideas were unworthy of explicit refutation. But one must have lived some time with a system to appreciate its merits.

William James (The Pluralistic Universe)

All the pleasure of life is in general ideas. But all the use of life is in specific solutions.

Oliver Wendell Holmes (letter to Elmer Gertz)

I mean the method of reducing the explanation of natural phenomena to the smallest possible number of primitive natural laws; and, in mathematics, of unifying the treatment of different topics by using a generalization. Philosophers constantly see the method of science before their eyes, and are irresistibly tempted to ask and answer questions in the way science does. This tendency is the real source of metaphysics, and leads the philosopher into complete darkness.

Ludwig Wittgenstein (The Blue Book)

Here's to the heart that's wise enough to know when its better off broken.

Dave Van Ronk (Last Call)

Introduction

Social scientists are often criticized for leaving out much of what makes us human, but they have their reasons. If we hope to get at what is really going on, they argue, we have to cut away the incidental, disclose the underlying consistencies, and from that identify more basic structures, forces, and mechanisms. Leaving things out isn't only an analytic tactic forced on us by the complexity of the human world, it is central to a scientific approach.

It's a good argument given its assumptions, but what if the patterns of human behavior we observe do not stem from underlying consistencies? What if the underlying consistencies, like the rules of a game of chess or computer hardware, just allow a wide variety of ways things can happen? In that case explanations are not restricted to consistencies leading to consistencies. Reliable patterns of behavior can arise because there are many ways the same thing can happen: inconsistent ways to reach consistent results. In this case behaviors are explained by the sum of the probabilities of the diverse ways they happen, and a science looking to tease out consistencies leading to consistencies is an exercise in misdirection.

Mathematically, the idea of different and even improbable inputs leading to a probable output is not problematic. It is simply the effect of a disjunction under uncertainty. But are disjunctions a plausible mechanism for explaining much of the human world?

Consider, for a start, how much ordinary observation, as well as scientific studies, find different motivations and histories leading to the same behaviors; or that linking multiple inputs to one output, which is generally hard to do in the physical world, is quite easy to do when the linkages are in the mind, so disjunctions can be an efficient way to produce consistent outcomes; or that disjunctive mechanisms explain how our diverse and inconsistent selves can produce consistent patterns of behavior without hypothesizing unseen underlying forces or taking recourse in high levels of abstraction. But the most compelling argument that disjunctions are pervasive in the human world is that, once we know what to look for, we can see that they are hidden in plain sight, and all but universal.

An example is the easiest way to see how this works. There are numerous reasons why people don't leave their jobs. A quick ten: the job seems secure, starting a new job is stressful, they have friends at work, the boss is not too bad, the commute is short, the salary is good enough, jobs

they'd rather have require training they can't afford, the company provides subsidized daycare, the work is interesting, the health benefits are good. The ten generate 1024 combinations of reasons, each combination a reason, some better some worse, to stay on the job. For most people there will be a number of combinations that will keep them on the job. Consider someone who might stay if the boss is a pain, but the work is interesting, and the benefits are good; that person might also stay if the work is dull as long as the daycare is available and the job is secure; and further, that individual might also stay if the commute is short and friends work there, at least until they can afford training for a better job; and so forth—quite different combinations, but as long as one of them holds the person stays. The probability of that person staying on the job, then, is the probability of combinations A *or* B *or* C *or* … *or* N. In short, a disjunction.

Similar examples are easily found. Just list conditions that can influence the likelihood of a behavior. Odds are that they can produce that behavior in various combinations, so there is a disjunction. When we know what to look for, it becomes harder to find examples of reliable behaviors where disjunctions are not involved than when they are.

Once these disjunctive mechanisms are recognized we are faced with the possibility that the great intellectual apparatus associated with science and rationality is not well suited to making sense of the human world. Conventional foci – commonalities, central tendencies, distinguishing signal from noise, parsimonious and unifying theories and models, abstracting to general concepts and covering laws, theory testing, generalizability – might as well have been designed to overlook human disjunctions. Reduction to basic principles is not a powerful strategy if those principles (like the rules of chess) just tell us that things can happen in lots of different ways. A competition of ideas is not appropriate when many of the 'competing' ideas can be valid, 'cooperating,' parts of the disjunction.

In terms of basic logic, we are trying to understand disjunctive (A *or* B *or* C...) phenomena with conjunctive (A *and* B *and* C...) reasoning: a mismatch between the logic of the phenomena and the logic of our explanations. This is a poor foundation for a rational enterprise.

The practical problem is that we cannot readily replace conjunctive understandings with disjunctive ones. Our minds are not built to handle the myriad possibilities, probability estimates, calculations, and data handling that explanations depending on sums of probabilities require. We can handle this with the aid of computers, if we have the data and analytic tools designed to work with disjunctions, but this is only a practical solution if we can invest the resources required. For the most part we will have to rely on reasoning that is inadequate if not misleading: more conjunctive than disjunctive. But we can apply heuristics and strategies that improve how reasoning is interpreted, compensate for its distortions and limits, and take advantage of information conventional reasoning discounts.

This book is divided into four main sections. The first makes the argument for the role and pervasiveness of disjunctive mechanisms in the human world, it's basic arithmetic, and how we distort evidence and logic to make conjunctive thinking appear credible. The second looks at practical strategies we can, and sometimes do, employ to cope with disjunctive mechanisms we cannot adequately grasp. These strategies utilize the predictive power of correlations between commonalities in a disjunction's inputs and an output. More generally, however, they seek useful actions by capitalizing on disjunctive mechanisms. The third section presents a statistical approach to analyzing disjunctive human mechanisms, called Disjunctive Mapping, with a worked example. Analyses are based on computing the sums of the probabilities of the various ways outcomes occur, and measuring the influence of individual factors in the contexts of each of those ways. (An appendix provides JMP scripts for those who might want to try it.) The fourth, a conclusion, steps back from the particulars of the arguments to try to get a sense of where they leave us.

Part 1

Mechanisms

Mentality

The human world is different from other natural phenomena after all, although there is nothing mystical or beyond the reach of science about it. It is different because human behaviors are responses to information rather than direct reactions to physical forces. Information, unlike physical forces, does not force things. Input-output connections are made in the mind and are as diverse and changeable as the minds that contain them. On one hand this produces uncertainty, but on the other it allows the human world to utilize mechanisms that play a lesser, if any role at all, in other natural phenomena.

Unlike the physical world that the natural sciences have generally studied, the human world does not respond directly to physical forces. It responds to information—and much of what we respond to does not exist except as information. I do not, for example, own a car unless I and/or other people think I do; I am not married or divorced unless I and/or other people think I am; music is not beautiful unless I and/or other people think so; I am not a citizen of the United States unless I and/or other people think so, and so on. We exist in a world defined by information, by what is in our minds.

The result is that relationships and properties, like the minds that contain them, are diverse and malleable. In input-output terms: *A* can lead to different *B's*, and different *A's* can lead to the same *B*. These linkages are apt to vary across people, circumstances, and time. Unlike physical forces, psychological and social forces do not force things.

In his 1984 Reith lectures, John Searle argues that the mental character of psychological and social phenomena create a radical discontinuity between the social and physical sciences.

> For a large number of social and psychological phenomena the concept that names the phenomena is itself a constituent of the phenomenon. In order for something to count as a marriage ceremony or a trade union, or property or money or even a war or revolution people involved in these activities have to have certain appropriate thoughts. In general, they have to think that's what it is. So, for example, in order to get married or buy

> property you and other people have to think that that is what you are doing. Now this feature is crucial to social phenomena. But there is nothing like it in the biological and physical sciences. Something can be tree or a plant, or some person can have tuberculosis even if no one thinks: 'Here's a tree, or a plant, or a case of tuberculosis', and even if no one thinks about it at all.[1]

This passage is on the way to arguing that the social sciences must be sciences of *intentionality*. Our argument starts in the same place but goes in a different direction. It is that "the intrinsically mental character of social and psychological phenomena" (Searle, p. 84) allows the human world to be built with mechanisms that would be both implausible and inefficient—that would hardly make sense—in a world that is purely physical.[2] These mechanisms create a second 'radical discontinuity' between the physical and social sciences.

It takes a little arithmetic, however, to see how how this works.

Combinations, Uncertainty, and Disjunctions

> **These mechanisms are disjunctive, based on our mental ability to link multiple inputs to one output. These inputs are likely to be various mixes of conditions, each mix representing one way the output can come about. A large number of mixes are possible from the combinations of a relatively small set of conditions. The result is that reliable outputs can be explained by diverse and unreliable inputs—the sum of the probabilities of these various ways an output can happen determines its**

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[1] John Searle, *Minds, Brains, and Science* (Cambridge: Harvard University Press, 1984, p. 78). Searle also argues that there cannot be any strict 'bridge principles,' from physical states to mental ones because there are no physical limits on what entities like 'money,' 'married,' and so forth are connected to.

[2] Searle defined *intentionality* as "the feature by which our mental states are directed at, or about, or are of objects or and states of affairs other than themselves." 'Intentionality' refers to beliefs, desires, hopes, fears, love, hate, disgust, shame, pride, irritation, amusement, and all of those mental states (whether conscious or unconscious) that refer to, or are about, the world apart from our mind." (p. 16) Others have used a similar starting point, the mental character of psychological and social phenomena, to argue toward different points, including the impossibility of behavioral or social sciences. For example, in reviewing *The Age of Fallibility: The Consequences of the War on Terror,* by George Soros, John Gray explains Soros's amendment to Popper's notion of fallibility, "Social objects are not like stars or stones, which exist independently of how humans think about them. This introduces an element of uncertainty in to our view of the world that makes us even more prone to error than Popper believed: we can never have objective knowledge of society, if only because our shifting beliefs are continuously changing it." Gray notes similar concerns by philosophers such as Ludwig Wittgenstein and Peter Winch, hermeneutic theorists such as Alfred Schutz and Charles Taylor, and sociologists such as Anthony Giddens. But the issue here is not mentality or uncertainty in themselves, and no implication is taken suggesting the impossibility of behavioral and social sciences, rather, the issue is that these sciences (and common sense) must account for the mechanisms that mentality makes possible. As we will see, these mechanisms not only create uncertainty, but also reduce it.

probability. Disjunctive explanations, grounded equally in everyday observation and the mathematics of probabilities, offer a general model of human behavior that embraces rather than struggles with uncertainty, diversity, large numbers of conditions, and the individuality of our minds.

Consider a few of the conditions that affect the likelihood of getting married (given the opportunity): love, friendship, money, security, lust, status, wanting children, getting away from home, escaping loneliness, a lack of anything better to do, parental pressure, and everyone else is doing it. While someone may get married with only one of these conditions in play, it is more likely to be a combination.

Taken singly and together these dozen conditions form 4096 different combinations, and while some conditions are likely to play a role more often or have more influence than others, every combination is, potentially, a reason to get married. For example, one reason for getting married is the combination of love, money, security, status, and having children, but none of the rest. Another example is the combination of lust, friendship, security, children, escaping loneliness, and nothing better to do, but none of the rest. While there must be eligible people who wouldn't get married for any of the thousands of reasons made from these combinations, and there might be some who would only get married for all of them, most people are apt to find a variety of these reasons compelling. For some it might be just a few and for others hundreds or more—and if not from this list, from another and more complete one.

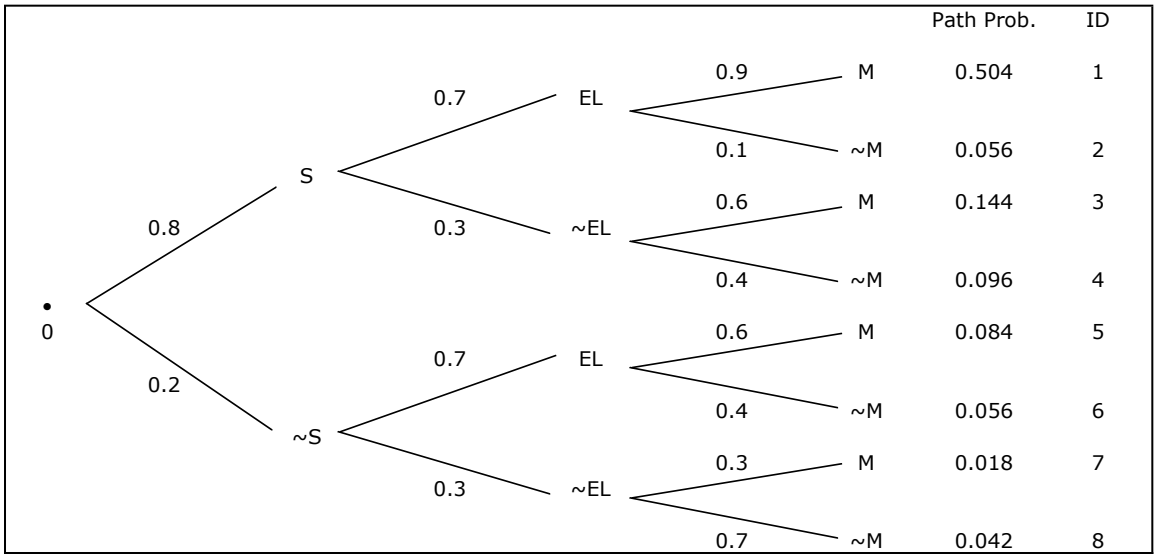
That we can respond in the same way (getting married) in response to so many different combinations of input is a property of mentality. These conditions are largely states of mind—feelings, beliefs, thoughts, concepts and so on—and the mind can link them to any action it chooses, wisely or foolishly. Physical objects are not so easily linked up (and presumably are not worried about wisdom).

Figure 1.1 is a simplified version of the situation we have been describing. It has only two of the twelve conditions and therefore only four combinations forming reasons to get married. These four will stand in for the 4096. These conditions, having taken two more or less at random, are Security and Escaping loneliness, along with their complements (what is true if the condition is false). The resulting four combinations serving as reasons to get married are:

1. Security and Escaping Loneliness
2. Security and not Escaping Loneliness
3. Not security and Escaping Loneliness
4. Not security and not Escaping Loneliness

Each combination leads to one of two outcomes, marriage, or no marriage, so there are eight possibilities in all (instead of 4096). The diagram, a conventional probability tree, shows the eight paths that result. Probabilities are assigned for the purposes of exploring the example, and for sake of simplicity, treated as independent.

Figure 1.1 A Probability Tree Showing the Combinations of Two Reasons



A path running from left to right represents each possibility. For example, Path 6 represents the combination of not Security (~S) and Escaping Loneliness (EL) not leading to marriage. The probabilities along the paths are the likelihood that conditions will be present and lastly, of marriage (M) occurring (or not) given those conditions. The probabilities on the far right are the probabilities of the paths, that is, the probability of a particular combination of reasons and outcome.

Or, to say this in more substantive terms, the probabilities of S, EL, and their complements represents the situation, the likelihood of these reasons being involved or not involved in the

choice to get married; the probability of M is the probability of getting married given those conditions, for an individual that would be how they react to them; and the path probability is the probability of marriage given those conditions and the response to them.

Path probabilities are the product of the probabilities of the conditions along it. The probability of Path 1, for example, is

$$P(S) \times P(EL|S) \times P(M|S \ \& \ EL) = .8 \times .7 \times .9 = .504$$

Since marriage can happen in any of the ways shown by the four paths that lead to marriage, its probability is the probability that any of those paths—Path 1, or Path 3, or Path 5, or Path 7 occur—which (since they are mutually exclusive) is the sum of the path probabilities.

$$P(\text{Path 1}) + P(\text{Path 3}) + P(\text{Path 5}) + P(\text{Path 7}) = .504 + .144 + .084 + .018 = .75$$

The result in this simplified example is that marriage, with a probability of .75, is fairly likely even though the highest probability way it happens only has a probability of .5. It is the sum of the probabilities of diverse ways that marriage can happen that explains its likelihood. In a more realistic tree, with hundreds or thousands of paths, quite probable outputs could arise from the sums of the probabilities of quite improbable inputs. In short, in the human world reliable outputs can be explained by unreliable inputs. Strong castles can be built on shifting sands. More conventional understandings and methods, which look for input-output consistencies, are apt to miss what is happening.

The logic of this mechanism is disjunctive, based on asserting that the outcome arises from *A or B or C or… or N*. This is in contrast to the more conventional explanatory logic, which is conjunctive, based on asserting that the outcome arises from *A and B and C and…and N*.

Although disjunctions can be created by multiple chances to do the same thing—try and try again—note that the paths here represent genuinely different ways to produce the same outcome. The psychology of a marriage that arises from motivations of security and escaping loneliness, is not the psychology of marriage arising from the motivation of security by itself, nor is it the psychology of a marriage arising from the motivation of escaping loneliness by itself, nor is it the psychology of a marriage when neither security or escaping loneliness are involved. These

are different psychologies, an understanding of one is not an understanding of another, and predictions valid for one may not be valid for another.

That the paths represent different psychologies suggests how much the more complete example, which explains marriage with more than four thousand paths, can accommodate a wide variety of people and situations. Each person gets, in effect, to select from the combinations available the ones that happen to apply. Thus an environment that makes marriage likely for a diverse population would be expected to provide a matching variety of combinations, and would be effective in promoting marriage to the degree that those combinations were numerous and probable. This, a somewhat all things to all people quality, is a mathematical basis for explaining an enduring institution or practice in a diverse and changing world.

It is also much of why the reliable features of individuals and society, and even more, how they are created, are hard to understand. In a disjunctive human system they do not arise from a core consistency, but from interchangeable (with respect to a specific outcome) effects of diverse conditions.

The argument for these disjunctive mechanisms—a disjunction of many ways to the same end created by a multiplicity of combinations of conditions—can also be made by considering the difficulty in explaining human behavior in the absence of such a mechanism. Table 1.1 shows the maximum probabilities of paths with from two to twenty conditions, where the condition's average probability runs from .7 to .995. It illustrates how difficult it is to produce a viable explanation based on a consistent set of inputs, that is, for a single path, one way something happens, to account for even moderately high probability outcomes.

If we wish, for example, to explain a behavior whose probability is just .57 with a single path of eleven uncertain conditions, their average probability must be at least .95. While many conditions affecting human behavior are that probable, or even more probable, many are not. But the issue is not only that high probability behaviors may be hard to find, it is the uniformity required. A path's probability cannot be higher than the probability of its least probable element. For this reason, in a single path explanation, every one of the conditions must be close to the probability shown in the table. Such uniformity is too stringent a requirement for explaining

most human behaviors. Consider the range of probabilities likely among the conditions in marriage example, as well as that these probabilities are likely to vary across circumstances. (Additional examples are given in the next section, ranging from going to a movie, through holding a particular job, to going to war.) The explanatory weakness of individual paths gives us little alternative but explanations that build on the contributions of multiple paths.

Table 1.1 Path Probabilities[3]

	.995	.99	.97	.95	.93	.90	.85	.80	.75	.70
2	.990	.980	.941	.903	.865	.810	.723	.640	.563	.490
3	.985	.970	.913	.857	.804	.729	.614	.512	.422	.343
4	.980	.961	.885	.815	.748	.656	.522	.410	.316	.240
5	.975	.951	.859	.774	.696	.590	.444	.328	.237	.168
6	.970	.941	.833	.735	.647	.531	.377	.262	.178	.118
7	.966	.932	.808	.698	.602	.478	.321	.210	.133	.082
8	.961	.923	.784	.663	.560	.430	.272	.168	.100	.058
9	.956	.914	.760	.630	.520	.387	.232	.134	.075	.040
10	.951	.904	.737	.599	.484	.349	.197	.107	.056	.028
11	.946	.895	.715	.569	.450	.314	.167	.086	.042	.020
12	.942	.886	.694	.540	.419	.282	.142	.069	.032	.014
13	.937	.878	.673	.513	.389	.254	.121	.055	.024	.010
14	.932	.869	.653	.488	.362	.229	.103	.044	.018	.007
15	.928	.860	.633	.463	.337	.206	.087	.035	.013	.005
16	.923	.851	.614	.440	.313	.185	.074	.028	.010	.003
17	.918	.843	.596	.418	.291	.167	.063	.023	.008	.002
18	.914	.835	.578	.397	.271	.150	.054	.018	.006	.002
19	.909	.826	.561	.377	.252	.135	.046	.014	.004	.001
20	.905	.818	.544	.358	.234	.122	.039	.012	.003	.001

Although we have only sketched in its features and used a simple model, the key virtues of disjunctive understandings of human behavior have been suggested. Disjunctive understandings, grounded equally in everyday observation and the mathematics of probabilities, offer a general model of human behavior that embraces rather than struggles with uncertainty, diversity, large numbers of conditions, and the individuality of our minds. It has no difficulty with behaviors that are produced by different and shifting reasons across time and circumstances, and they are more than at home in a world in large part defined by mental constructs (‘mentality’ in Searle’s terms). In short, disjunctive understandings offer a mathematically sound general model that fits the human world very well.

[3] The probability calculations throughout this book, unless otherwise stated, are conditioned on other factors in the path. Doing so simplifies the discussion without requiring the factors to be assumed independent.

The Disjunction Exercise

We have used marriage as an example of a phenomenon best explained by a disjunctive model, but it should be apparent that the same case could be made for a wide variety of other psychosocial phenomena. This is, in some ways, familiar territory. A disjunctive view is implicit in the recognition that we do things for a variety of reasons and these reasons can be combined in a variety of ways. And if we want to see how broadly this view applies, a simple exercise will suggest an answer. List the variety of conditions that can influence the likelihood of a behavior. A disjunction is present if there is more than one combination where there is some likelihood that the behavior will result. The difficulty, once this exercise is tried, is finding human behaviors where people have some freedom of action but do not have disjunctive roots.

Table 1.2 provides a few examples.

Table 1.2

Behavior	Possible Reasons Leading to Behavior
Going to a movie	Friends have asked you to go Read a good review of the movie Do not want to stay at home “Everyone else” is seeing it Having a free pass that will soon expire Like the cast
Keeping a job	The pay is adequate Colleagues are pleasant The commute is easy No better alternatives are available Have time to attend to personal needs Reason to get out of the house The work is interesting The work provides a sense of satisfaction

Going to war	Fulfilling treaty obligations Responding to an attack Gaining an advantage over domestic political rivals Maintaining control of foreign markets Ideological convictions Establish country as a first rate military power Improving (a leader's) self-image Maintaining current balance of power

Just as in the marriage example, in each of these cases a number of combinations of the reasons listed can lead to the outcome, and if a full list of conditions was made, this could be a very large number of combinations.

The reasons mentioned in these examples are all familiar parts of conventional and sometimes competing explanations. But they are understood here as creating a variety of possibly improbable paths to the same behavior, and that it is the sum of the path probabilities that explains that behavior.

Instead of finding the diversity and unreliability of human inputs an obstacle to explanation, with disjunctive explanations, we find that the diversity of reasons and unreliable inputs are the explanation.

Efficiency and Robustness

Why such complication? The possibility of creating reliable outputs from diverse and unreliable inputs, and the efficiency with which mentality can create the disjunctions required, provides adaptive forces a powerful alternative to relying on creating uniform and reliable behaviors. Further, when diverse ways are utilized they are apt to yield more robust solutions than a single way when circumstance changes. So it is not surprising that the human world should rely on disjunctions. What may be more of a surprise is how our limited recognition of how thoroughly and consequentially disjunctive mechanisms are woven into the fabric of our world. Part of the reason for this lack of recognition is that conventional versions of rational thinking are not as logical as we suppose.

Why would the human world be organized in this complicated way? Why do the same thing in many ways when it can be done in one? Wouldn't one best way make more sense? The simple answer is something like, because we can—or less cavalierly, because, given human mental capabilities, disjunctive mechanisms are an effective adaptation.

There are two ways to produce reliable outputs using unreliable inputs: either minimize unreliability by altering the inputs or being selective in their use, or capitalize on the likelihood that one of a number of ways to produce the output will occur. With physical mechanisms, reducing unreliability in the inputs is generally the most efficient method of obtaining reliability. We have a long history of success in making reliable devices by insuring that their components are reliable under normal operating conditions. (And a long history of sciences that have succeeded by finding structures built on reliable behaviors in nature.) In the physical world, capitalizing on disjunctive arrangements, which requires maintaining duplicates, monitoring performance, and some method of relatively seamless switching, tends to be expensive. For that reason it is largely reserved for critical applications such as redundant aircraft control systems or emergency hospital power supplies.

In the human world, however, we have not had similar success with minimizing unreliability, especially in the longer term. Our techniques for minimizing unreliability in human behavior, such as rewards, punishments, education, training, social and economic pressures, ethical and moral codes, and coercion, along with selection mechanisms such as grading, certification, and hiring and firing, are useful, often powerful, but not consistently effective. So, while some behaviors are very reliable—for instance, in the all the years I have been going to my local grocery I have never seen a cashier reject appropriate payment—many behaviors are neither so reliable nor readily made so reliable. Compared to machines, the mechanisms of the human world are apt to face relationships and properties whose probabilities are lower and more variable.

But in the human world, disjunctive arrangements can be made of reasons for doing things that tap nothing more in the way of resources than the mental capacity to do something for more than one reason, and draw on the all but ready-made combinations inherent in the multiplicity of reasons we do things. In contrast to a more mechanically driven world, disjunctive mechanisms

can be had, in effect, on the cheap. So cheap that it is hard, given how easily we do the same thing for different reasons and the presence of so many combinations to provide those different reasons, to see how disjunctions can be avoided.

Evolutionary logic is the logic of what survives, regardless of whether the evolutions is physical or social. When survival depends on consistencies we would expect adaptive pressures to push us towards whatever produces consistencies. The forces that have powerful uniformity creating effects, however, tend to come apart. Consider, for example, the uniformity creating effects of the struggle for survival in a marginal economy; the coercion and social pressures of totalitarian states and other rigid organizations; powerful incentives such as opportunities for rapid acquisition of wealth in a speculative boom; or high morale and closely knit groups. As people succeed in improving the economy or circumstances improve; as the rigidity of a social system is subverted when people discover ways to avoid its strictures and corrupt its powers towards their own ends; as the economic boom plays out; as the closely knit group unravels or morale takes a downswing when other interests and affections intrude, the uniformity creating forces which drove behavior lose much of their potency. In short, as powerful as these forces can be, they are difficult to sustain and are apt to only be effective for a limited time and in particular circumstances. For a cultural pattern, a social institution, or a personal characteristic to persist across time and circumstances, its survival is apt to be better explained by how it capitalizes upon, rather than fights, our diverse, unreliable, and changeable nature.

Reasoning About Human Behavior

If logic were taken seriously, its ambiguity when facing uncertainty would be a clear sign of its limitations when reasoning about human behavior. But we have tricks that make it seem like we're being rigorously logical while avoiding its actual, uninformative, implications. The key to many of these tricks is reasoning as if uncertain statements were true—such as when using best guesses, generalizations, and abstractions that we know do not hold in every case—and then adding the caveat that the conclusion should be understood as to the best of our knowledge, or in general, or an approximation. Logic cannot justify this caveat, as becomes evident when we supplement logic with probability theory.

Instead, it shows just how far these tricks, as well as conventional methods of analysis, can take us from reality. By dodging the implications of uncertainty, these same tricks and methods obscure the power of disjunctions to create strong conclusions given uncertain premises.

Logic

Explaining human behaviors in terms of the diverse ways they can happen, and the probability of behaviors by the sum of those diverse ways, goes against the grain. In part this is due to how we distort logic, and the explanations these distortions appear to support.

Logic is not sufficient to sort out the effects of uncertainty. As L.J. Savage commented, "[I]t is obvious as many have pointed out, that the implications of what is ordinarily called logic are meager indeed when uncertainty is to be faced." (The Foundations of Statistics, 1954) In practice, however, we tend to overlook this limitation.

Consider the following examples.

Example 1.1

The premises are,

A usually occurs,

B usually occurs,

If *A* and *B* occur, *X* usually occurs

What follows from these premises? Logic cannot justify concluding that *X* usually occurs. It can justify concluding something along the lines of *X* sometimes occurs, but that would hardly be informative. Even if X were to always occur whenever A and B both occur, we could not conclude that *X* usually occurs.

Example 1.2

The premises are,

A usually occurs,

B usually occurs,

C usually occurs,

If *A* and *B* and *C* occur, *X* usually occurs

A fourth premise has been added. Logic cannot determine whether the three premises in Example 1 or the four in Example 2 make the better case. There is nothing in logic to indicate that the number of premises should make any difference at all. The effect is so strong, however, that an extended argument with a convincing conclusion could be weaker than a shorter argument with similarly credible premises but a comparatively unconvincing conclusion.

These two examples illustrate logic's inability to evaluate either the effects of the degree of uncertainty or the number of premises in conjunctions.

Example 1.3

The premises are,

A usually does not occur,

B usually does not occur,

If *A* or *B* or both occur, *X* usually occurs[4]

Logic does not suggest that the third example (1.3) could make a better case for *X* than the first two examples. It offers no way to gauge the comparison. This example illustrates logic's insensitivity, not only to the number and uncertainty of premises, but also to the effects of disjunctions under uncertainty—and from that, to recognizing the role of disjunctive mechanisms in the human world.

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[4] See the section on *Probabilities* below to see how these examples play out. The examples were suggested by a passage in Hubert M. Blalock, Jr. *Causal Inference in Nonexperimental Research*, The University of North Carolina Press, Chapel Hill, 1961, 1964. 'If A occurs B will usually occur,' it would be extremely difficult to develop deductive systems that go very far beyond commonsense. For example it would not necessarily be correct to assert, 'If A then usually B, and if B then usually C; therefore if A then usually C.' The alternative, 'If A then sometimes C' might be more sensible, but it would hardly be very enlightening. (p. 45) Blalock, a sociologist, argues for a more deductively powerful approach, along the lines of economics, which is achieved by dealing in abstractions. We go quite the opposite way.

The Suppositional Maneuver

If we were strictly logical we would recognize logic's ambiguities and blind spots. When applied to human behavior, sound logic would be associated with hesitant, weak, hedged, and tentative reasoning. Yet we tend to treat logic as if it were the high road to informative, definitive conclusions. How do we mange to grant such an uninformative and ambiguous tool this reputation? The answer, not surprisingly, is by sleight-of-hand and a bit of bad faith.

A key move is to take quantifiers out of the logic of the argument while drawing conclusions (although they still might be stated) and put them into caveats about how it is interpreted.[5] We might think of this as reasoning from our best guesses, closest approximations, basic or underlying forces, or some amalgam of notions along these lines. In any case, we draw the conclusions that would follow if our premises were true, putting off consideration of their uncertainty to how we interpret the conclusions.

So, faced with the uncertain premises in Example 1 we would remove the 'usually's,' and say,

Example 1.1a

A occurs,

B occurs,

If *A* and *B* occur, *X* occurs

We can then conclude, with unquestionable logic, that *X* occurs. We get similarly definite results with the other two examples,

Example 1.2a

A occurs,

B occurs,

[5] In logic, terms like 'usually' or 'rarely' are called quantifiers, even though they do not specify a numeric quantity. Note that we would be dealing with quantifiers even if we believed that human behavior is wholly lawful and we know the laws, as long as in practice, perhaps due to unmeasured, unknown, or uncontrolled influences, behavior remains unpredictable.

C occurs,

If *A* and *B* and *C* occur, *X* occurs

Clearly, *X* occurs.

Example 1.3a

A does not occur,

B does not occur,

If *A* or *B* or both occur, *X* occurs

Clearly, X does not occur.[6]

Then comes the interpretation. To account for uncertainty—the missing quantifiers—we say something along the lines of: the conclusion is only a best guess, closest approximation, most plausible conclusion, most credible judgment, an expectation, a tendency, the best we can do given our current understandings, the central issues, what would happen under ideal conditions, the result of basic forces, and so on. These are mostly mild caveats, at least as much justification as warning. Some of these interpretation claim that we are getting to the heart of the matter; all are slanted toward accepting the conclusion. Using these caveats we recognize uncertainty, the quantifiers, while not letting them undermine the apparent clarity and power of logic.

Justifications for reasoning in this fashion are easily found. We do not know the truth so we have to work with the closest approximations we have. Plato, with a flair for dramatic imagery, makes this case,

> I think, Socrates, as presumably you do yourself, that in this life it is either altogether beyond our powers, or at least very difficult, to attain certain knowledge about matters such as these. And yet a man would be a coward if he did not try with all his might to refute every argument about them, refusing to give up before he has worn himself out by examining them from all sides. For he must do one of two things: either he must learn, or discover, the truth about these matters, or if that is beyond his powers, he must take whatever human doctrine seems to him to be the best, and to offer the hardest resistance to refutation; and, embarking upon it as upon a raft, he must sail upon it

[6] More precisely, X does not occur as a logical consequence of *A* or *B* occurring. Other factor might lead to X, but they are outside of the argument.

through life in the midst of dangers, unless and until he can embark upon some stronger vessel.[7]

This all sounds sensible, open minded, and even necessary—to say nothing of courageous. What other choice do we have in an uncertain world where decisions have to be made? But when applied to human behavior it is a recipe for self-deception. What we are doing is making a suppositional argument—supposing that best guesses, tendencies, closest approximations, theoretical constructs, etc. are true and drawing their implications—and only then, after the reasoning is complete, admitting that the suppositions might not hold. It is a smooth move: we get to reason as if under certainty, gaining all its simplicity, forcefulness, and definitive results—all of logic's weakness and ambiguities under uncertainty gone—without denying uncertainty. Uncertainty's effects disappear even as we admit its presence. We call this sleight of hand the *suppositional maneuver*.

Probabilities

If we explore the previous example's conclusions with probability calculations we can see how readily the suppositional maneuver misleads. Returning to Example 1.1 and translating 'usually' as, a probability of .7, we go from,

Example 1.1c

A usually occurs,

B usually occurs, and

If *A* and *B* occur, *X* usually occurs

to (substituting a probability of .7 for the quantifier 'usually,')

$P(A) = .7$

$P(B) = .7$

$P(X|A \text{ and } B) = .7$

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7 *Phaedo*. Simmias is speaking. The translation here is the one used by Popper as the motto for a essay titled, *The Demarcation of Science and Metaphysics*, reprinted in, Karl R. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge*. New York: Harper and Row, 1968, p. 252)

The probability of *X* occurring is,

$$P(X) = P(A)\ P(B)\ P(X|A \text{ and } B) = .7 \times .7 \times .7 = .34$$

So, in this example, and contrary to the suppositional conclusions reached above, which says that *X* will occur, we find *X*'s probability is barely over 1/3. In words, we would have to conclude that *X* usually does not occur—even though *A* and *B* usually occur and *X* usually occurs if *A* and *B* occur.[8]

The suppositional maneuver is also misleading when comparing the three and four premise examples. Again translating 'usually' to a probability of .7, the probability of the four premise argument is,

Example 1.2c

$$P(X) = P(A)\ P(B)\ P(C)\ P(X|A \text{ and } B \text{ and } C) = .7 \times .7 \times .7 \times .7 = .24$$

which makes the four premises argument weaker than the three. The suppositional argument is unable to distinguish between the two.

Turning to the last example we see this suppositional maneuver missing the potential of disjunctions. (Using 1 - .7 = .3 for a probability of 'not usually.')

$P(A) = .3,$

$P(B) = .3,$

$P(X|A \text{ or } B) = .7$

and the calculation,

$$P(X) = (P(A) + P(B) - P(A)\ P(B))\ P(X|A \text{ or } B) = ((.3 + .3) - (.3 \times 3)) \times .7 = .36$$

Thus the disjunctive argument is the strongest of the three examples although the suppositional maneuver condemns it as the weakest, since it is the only one that claims that *X* will not occur.

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[8] Even if *X* always occurs when *A* and *B* occur, we would find that *X* usually does not occur, as we would have, $P(X) = P(A)\ P(B)\ P(X|A \text{ and } B) = .7 \times .7 = .49$

These results illustrate a few points. First, that the suppositional conclusion is not necessarily a best guess, in the sense of representing the most likely outcome. The best guess in all three examples is that X will not occur, a conclusion reached by only one of the examples, and as it happens, the one with the strongest argument. The best guess should be that something other than X will happen (true around two thirds of the time). This is important because we often base our reasoning on assertions that we believe are likely to prove true—a probability of at least .5—and assume that any conclusion that follows from these assertions is also likely to prove true. This is far from being a safe assumption.

A second point, one that follows from the last comment, is that we cannot reliably test the validity of suppositional arguments by checking that every premise is credible, and the conclusion is credible given those premises. It is all too easy for these claims to be true while the argument is not credible at all. For example, a historian can carefully build a case about the information various political and military leaders had, what happened in meetings, what their preconceptions were, what limits were imposed by the bureaucracies and internal politics, and so forth prior to a war, and every assertion might be credible, consistent with the evidence available and what else is known about the people and institutions. If we work through the historian's argument step by step we come away convinced at every point. Yet a conclusion which requires that all those well constructed claims are true, and is very strong if all those claims are all true, can easily be a very weak conclusion, since in all likelihood one or more of those claims are false.[9]

This point is worth underlining: even if our premises and reasoning is credible we shouldn't be surprised if the conclusion is not credible.

Third, in the examples, if X occurs reliably, the conjunction of A and B cannot account for it. Say, for example, X usually occurs, with a probability of .7. In Example 1, however, even though A and B usually occur, and X usually occurs if they occur, X only occurs about a third of the time. So there is a gap between what A and B can account for, and how frequently X occurs. The

[9] This is not an argument about the value of good historical research, only that we should recognize that the form of argument it often relies upon, one that supposes all its claims are true. Such a form allows plausible, nuanced, and evidence based account, rather than strong conclusions. But this is still much more than we usually have. See *Using Descriptive Realism* and *Narrative History, Fiction, and Social Science* below.

general point, given the discussion of the requirement for uniformly high probabilities in inputs, is we should suspicious of single path explanations of reliable behaviors.

Fourth, nothing in reasoning based on the suppositional maneuver allows either detecting the accumulations of uncertainty that underlie the points just made, or that disjunctive reasoning has just the opposite qualities. If anything disjunctive reasoning seems a weak—maybe this or maybe that—form of argument. While using disjunctive reasoning is not a simple matter, as we will see, the suppositional maneuver leaves us blind to its possibilities.

The conventional concerns of inductive logic, whether, and with what degree of confidence a conclusion can be said to follow from the premises, considered only the last step in the logical chain. This makes the conventional study of inductive of limited value when it comes to reasoning about human behavior. When reasoning with fallible premises the relationship between the premises and the conclusion may be the least problematic part of our arguments.

The examples are illustrative, their numbers chosen to allow using simple examples. Examples with a different number of premises and different probabilities will, of course, produce different results. Short arguments with uniformly low levels of uncertainty will show small effects, and the suppositional maneuver will be correspondingly less misleading. Longer arguments with higher and less uniform levels of uncertainty will show larger effects, and the suppositional maneuver will be correspondingly more misleading. We should not expect the suppositional maneuver to be equally misleading in all instances, and as we will see, this is an important practical consideration (see Part 2, *Qualitative Solutions: Reasoning and Strategy*).[10] But as shown in Table 1.1, uncertainty begins to take a toll on arguments at fairly low levels of uncertainty and numbers of uncertain premises—so this is far from being a 'purely academic' or 'merely technical' concern.

Conjunction vs. Disjunction

The tricks we use to discount logic's ambiguity under uncertainty create the illusion that the human world can be understood in conjunctive terms. Sustaining

10 The most obvious case is reasoning premised on a few highly reliable behaviors—the everyday routines such as going to work, preparing meals, dressing, and so forth. In stable times these are the stuff of everyday practical thinking, and serve us well. But less reliable conclusions are also useful, if properly used.

that illusion, we discount disjunctive explanations as equivocal (maybe this or maybe that...), lacking parsimony (must have missed the unifying factors), lacking the boldness of good thought, and a consequence of carelessly defining the outcome. In short, for the most part, disjunction is not treated as an adequate mode of explanation.

In spite of our efforts to overlook their implications we are not blind to the uncertainty, diversity, and changeability that arise from mentality. Rather, the point is that the ways we tend to reason undermine our ability to think through to their implications. At every mental turning, the ways we think guide us to strip away uncertainty, diversity, and changeability; they hide both the weakness of conjunctive logic and the strength of disjunctive logic. By the time we have drawn conclusions we have set aside the very information and logic we need to make sense of human behavior. Then it tells us that this reasoning and these conclusions are not only the best we can do, but also represent sound scientific practices.

As much as this leads to errors in particular arguments, the more egregious error may be that we misunderstand the basic mechanisms of human behavior, and then develop tactics and strategies to influence future behavior based on these misconceptions. An explanation with credible premises and an equally credible conclusion is likely to be taken at face value—reasoning that the premises are generally true and that the conclusion occurs so reliably because they are generally true—when the conclusion could have such a high reliability is that the conclusion can also happen in other ways as well. In short, there must be a disjunction but conjunctive mechanisms are given credit for what disjunctive mechanism produce. This is the most fundamental of illusions produced by suppositional reasoning's sleight of hand: that we can explain the disjunctive human world using conjunctive logic.

The preference for conjunctive explanation and bias against disjunctive explanation, however, is far from being a product of the suppositional maneuver alone. Disjunction, although as much a part of formal logic as conjunction, is not treated as an equal when formulating explanations. Explanations relying on disjunctive logic seem overly complicated, making us suspicious that there are unifying conditions that we have missed. Additionally, they violate the scientific ideal of parsimony. Explanations appear equivocal, as if we were saying, 'It works this way, but also that way, and this other way too,' suggesting a slippery unwillingness to stick by

one's principles, to have firm beliefs, to propose bold hypotheses, to believe in something. We seem inclined to see disjunctions as symptoms of careless thinking, believing, as Hume put it, that "The same cause always produces the same effect, and the same effect never arises but from the same cause." When this principle does not apply we tend to think that the problem is the inadequacy of our understandings. As Cohen and Nagel argue, we would expect that "when a plurality of causes is asserted for an effect, the effect is not analyzed very carefully." Bertrand Russell makes a similar argument, noting that a plurality of causes, "results only from conceiving the effect vaguely and the cause precisely and widely."[11] It is as if disjunctive explanations were not explanations at all, rather stopgaps to be discarded once we sort things out properly.[12]

Disjunctions Are Not Just Multiple Causes

> **It is easy to mistake disjunctive explanations of human behavior as just saying that there are multiple conditions or that human behavior is overdetermined. Under uncertainty, however, disjunctive logic allows unreliable inputs to generate reliable outputs. This explains a great deal that neither of the former concepts make clear. And neither addresses how disjunctions arise from mentality and the numerous combinations created by multiple conditions, weaving them deep into the fabric of the human world.**

It is commonplace in the social sciences, as well as in everyday thought, to admit the complexity of causation in human behavior—that many conditions are involved. This is a wholly conjunctive formulation. A less prevalent but still common recognition is that human events can be overdetermined, a term from psychoanalysis meaning that a behavior can arise from multiple

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[11] These passages are quoted in Mario Bunge, *Causality and Modern Science*, Third Revised Edition, New York, Dover Publications Inc. 1959-79, p. 123. Bunge defends the possibility of multiple disjunctive causes, but sees it as an unsatisfactory state, worth avoiding if at all possible. "We may accept disjunctive plurality of causes or effects; but, whenever possible, we should attempt to explain such multiple connections in terms of further, eventually non-causal, terms. (p. 124). By non-causal terms Bunge means the conditions in which the phenomena occurs. In social science terms this would be a contingency model. These, however, would hardly be practical since each path represents its own set of contingencies, and it assumes away the possibility that there are different causal mechanisms at work on different paths, which, given mentality, will often be the case.

[12] Piatteli-Palmarini goes so far as saying that "[i]n real life, none of us *ever* spontaneously formulates a disjunctive hypothesis." (Massimo Piatteli-Palmarini, *Inevitable Illusions:How Mistake of Reason Rule our Minds* (New York: John Wiley and Sons, 1994), 177.) This seems overstated, whenever we recognize that the same behavior can arise for different reasons we have at least implicitly formulated a disjunctive hypothesis, but he has a point. Disjunction does not seem a comfortable mode of thought. See, also, the original he cites in that passage, Jerome S. Bruner, Jacqueline J Goodnow, and George A. Austin, *A Study of Thinking* (Transaction Publishers: New Brunswick and London, 1986) Chapter 6. Originally published by, John Wiley and Sons, 1956. Their conclusions were somewhat narrower than Piatteli-Palmarini's.

causes, any one of which could explain it. But as this is usually applied, the idea is that all the causes are present, even though any one of them would do. This is still a conjunctive formulation although the possibility of a disjunction is implied by the notion that different causes can lead to the same outcome. It is not until we get, not only to the idea that there is more than one way something can happen, but that under uncertainty these multiple ways explain why something happens as reliably as it does, that we have reached a disjunctive explanation of human behavior. This is not so commonplace.

And, it is only when we add in how diverse mentality and the numerous combinations that arise from what might be a small set of conditions allows the formation of these disjunctions, and then how thoroughly, and necessarily, they are woven into human events, that we get to the disjunctive explanation of human behavior at the core of this essay.

Ambiguity

> **In practice, when an argument cites a number of conditions in support of its conclusion, it is rarely clear about how the relationship between those conditions and the conclusion should be understood. If the conclusion follows if all the conditions are true, it is a conjunctive explanation. If the conclusion follows when various combinations of some of the conditions are true, it is a disjunctive explanation. Since we do not pay attention to the difference it makes, we do not give this distinction much attention, and do not specify what combinations can lead to the conclusion. Thus our arguments tend to be ambiguous on a critical dimension. The apparent default, since most arguments claim all their premises and the conclusions that follows from them are at least credible, is the conjunctive version. In any case, recognizing the ambiguity and that the same premises can be understood as forming a disjunction, does not lead to a obvious resolution. The reason is that, as a practical matter, disjunctive arguments can be near impossible to evaluate, because of the large numbers of combinations that arise from even a few uncertain premises and their complements, and because of our ignorance of the implications and probabilities of those combinations. Once we recognize the ambiguity, then, we see that practical evaluation of arguments that once appeared straightforward may be well beyond our capabilities. This suggests that we will need a different way to think about what constitutes good, or at least, useful, reasoning.**

Some years ago, in a conversation with friends, I made an argument that the (then) President would reject a treaty proposal, citing a dozen or so conditions that would all mitigate against his

signing, and by implication, that no other conditions were likely to be relevant. My analysis was accepted by others in the discussion as a coherent way to address the question even if they disagreed with my conclusion. But when I thought about it later I realized that I could have reached my conclusion if only some of my premises were true. So while it seemed that I have made one argument, one where all my premises were true, if I looked at what I actually believed I had actually made, or meant, many arguments. In each some my premises were true and others false but the conclusion still held. On one hand this meant that my argument could withstand criticism that pointed to the weakness of some of its premises, if there were combinations made of the remaining premises that still made a good case for the conclusion. So it was a stronger argument than I had presented. On the other hand, once I admitted that my argument included premises that might be false but the conclusion could still hold, I had also admitted that didn't know what I was claiming: just specifying my claim would take laying out all the arguments to see which led to the conclusion. Not only was this impractical, given the numbers involved, it was also clear that I didn't have a very good idea about the effects of many of the combinations of premises I would have to evaluate, especially since it would require that I consider the effects of the complements of the premises that may be false.

What if the President's cabinet, whose key members I supposed would support him, were divided. Who would be on each side, and how much would they influence his decision? What specific positions would they take instead (there are many different ways to oppose)? What if major allies, who I had supposed were mildly against the treaty although they had taken no public stand, were for it but in a watered down form that the President could accept. What if public sentiment in districts where the upcoming election could go either way shifted to being solidly for it? And so on. While none of these possibilities, all complements of my premises, struck me as very likely, I understood that the probability that one of them, or some possibility I hadn't thought of, would happen was still high. If, as a quick glance at Table 1.1 shows, I was 95% confident that all of my dozen premises were true, there was still a 46% (one minus the probability, .54. that all the premises are true) chance that at least one of them was false. That is, nearly half the time, and did I really think there was only a one in twenty chance that they could be wrong? If I was only 80% confident (still a far higher probability than studies of political

pundits indicates is likely, see *Short Conjunctive Arguments Premised on Near Certainties*) there would be a 93% chance that at least one of my premises was false. And as binomial probability calculations show, the probability of more than one error was also substantial: the likelihood of at least two premises proving false is 72%, at least three, 44%, and at least four, 20%.

None of this meant my argument was threatened. It could turn out that many of the premises contained in the complements of my initial premises did not make much difference, so the argument deserved much the same confidence regardless—perhaps because some other premises were sufficient to minimize their effects. The political advantages of opposing the treaty and maintaining his public posture could overwhelm arguments by his advisors and allies, or the President didn't listen to them anyway, and so forth. It could even turn out that some possibilities in the complements would improve my argument. The crucial point, rather, was that I didn't know. I couldn't evaluate my own argument. I didn't even know what other arguments my argument implied (because I had not worked out what the complements contained and all their feasible combinations) and even if I did, I was in no position to gauge their effects (as this would take knowing all their probabilities and making the appropriate calculations). Yet, because there was a good chance that one of more of my premises would prove false, I had very good reason to believe that one of these other arguments would prove true.

So I had started out by making what seemed like a cogent, reasonably well informed argument which, if not wholly convincing, made a plausible case, and ended up realizing that I had no idea if my case was plausible or not—and the same applied to the arguments made contrary to mine. All the arguments were clearly stronger than a strict conjunctive interpretation requiring that all their premises were true would allow, but this did not suggest they were very strong, unless their premises were nearly infallible. Otherwise, the arguments were all at the mercy of unstated and unrecognized arguments formed from some of the premises and some of their complements, whose effects were well beyond our grasp.

As in this example, when thinking about human behavior we rarely consider whether the conditions we are considering have a conjunctive or disjunction relationship to the outcome in question. We generally think in conjunctive terms, and leave it at that. The question doesn't arise. This leaves a deep and largely unacknowledged ambiguity at the heart of our thinking, and it is

not one, generally speaking, that is easily resolved.

The point of recognizing this ambiguity and the difficulties of resolving it is not, as we will see in the discussions in *Qualitative Solutions: Reasoning and Strategy*, and *Doing the Arithmetic,* that reasoning under uncertainty about disjunctive human phenomena is hopeless, but rather that doing it effectively is quite a different matter than books on logic, and our everyday and social science practices, lead us to believe.

The Competition and Cooperation of Ideas

> **Thinking in disjunctive terms diminishes the role of a competition of ideas. The primacy given to a competition of ideas does not fit well with disjunctive explanations, where the relationship between ideas is as much one of cooperation that competition. Such a competition creates a forced, arbitrary choice of one among many, so that the correct explanation, a disjunction of the many, is never considered.**

It has become something of a cliché that scientific theories do not fail simply because evidence mounts up against them, or their logic shows questionable and even dubious leaps. Theories stand until toppled by another that is judged superior. This idea has become popular in the social sciences as a justification for holding onto theories in spite of disconfirming evidence and logical lapses, by saying, if usually at greater length and with more polished phrases, 'See, the natural sciences do it too.'[13] Pointing out even obvious foibles is, therefore, not sufficient to falsify a theory—if you can offer nothing better. As the sociologist Christopher Jencks commented, '[Y]ou can't lick a dumb theory with no theory.'[14]

A narrower idea working in the same direction, which I learned as a graduate student, is that a successful challenge to an interpretation of an experiment or study requires more than showing that the research is in some way flawed—all research is flawed in one way or another—it requires showing that a plausible rival hypothesis left open by that flaw.

But from a conjunctive perspective a disjunctive theory seems like no theory at all, so how

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[13]Often the reference is to *The Structure of Scientific Revolutions*, Thomas S. Kuhn, Second Edition Enlarged, Chicago, The University of Chicago Press, Dover Publications Inc. 1962-70. Whether this view is a fair interpretation of Kuhn is another matter, but not one at issue here.

[14] Quoted in and interview in the *Boston Phoenix*, February 20 - 26, 2004

can it be a plausible rival? Instead, as we have seen, it seems like an admission either that the universal and important conditions have not been found, or that the effects have been carelessly defined. Disjunctive competitors are ruled out before the competition begins. What remains is pitting sufficient reliability conjunctive explanations against one another—suggesting an endless controversy of inadequate explanations.

In addition, there are various standards by which theories are evaluated, such as scope, fruitfulness, predictive power, logical structure, verisimilitude, and consistency with other theories and methods, and these standards do not speak with a unified voice. When, as is likely to be the case, no theories are fully convincing when judged by the more empirical tests (concerning verisimilitude or predictive power), the competition is likely to be fought out using other standards. In this sort of contest the most abstract theory you can get away with has substantial advantages: by virtue of the scope it possesses by treating a wide range of different behaviors as one, the logical force it possesses by collapsing of diversity allows into simple and invariant structures, and the opportunity for a consistency with other abstract ideas allowed by mutually weak empirical moorings.

So, for example, defenders of rational choice theory (an expansion of economic theory into political science and elsewhere), while conceding much of it's weakness in accounting for empirical events, argue that no theories are all that strong anyway, and that rational choice is the only theory currently available that has such broad scope, logical power, and fruitful implications. And, of course, it cannot be discarded until a better one comes along.[15]

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15 See, *The Rational Choice Controversy,* edited by Jeffrey Friedman (Yale University Press, New Haven and London,1996). The book is a collection of essays in response to *Pathologies of Rational Choice* by Donald Green and Ian Shapiro. ... They quote what Kenneth A. Shepsle said he heard as the first law of wing-walking in a philosophy of science course, "Don't let go of something until you have something else to hold on to." Their reply is that, "Shepsle's appeal to the first law of wing walking would be easier to take seriously if one could develop a degree of confidence that the aircraft in question were indeed airborne."(p. 256)

In Green and Shapiro's essay in Friedman they argue against the pursuit of universal theories as incapable of handling the variety of human behaviors, but nevertheless stay within the theory testing, competition of ideas framework that is ill-suited to disjunctive phenomena, even though they do not expect that the results will always be definitive. Their hope is for a number of theories with less scope but greater explanatory power. This commitment is particularly clear in Shapiro's collection of essays, *The Flight from Reality in the Human Sciences* (Princeton University Press, Princeton and Oxford, 2005) which while critical of the universalist impulse fully embraces a conventional statistical and experimental framework, as well as the conjunctive construction of theories. See the section on *Social Science* below.

None of this would flow from disjunctive analyses. From a disjunctive explanatory perspective the competition of ideas looks like manufacturing a controversy out of explanations that are, in fact, more likely to be mutually supportive. *Individually inadequate explanations does not prevent the possibility of their collective adequacy.* Rational choice, for example, is one explanation of our behavior, one way we might do things, but far from the only one. These different explanations of behavior, at least the ones that aren't wholly fanciful, are not competitors but different ways things happen. Once viewed as parts of a larger disjunctive framework seeming competitors can come together to form an adequate explanation. *It also raises the possibility, since we are no longer looking for explanations which, individually, have the power and universality to win competitions, that the knowledge we already have about human behavior might be better than it looks.*

Explanation

When compared to their role in conventional explanations of human behavior, the premises of disjunctive explanations carry a lighter burden. They only have to be true some of the time. This allows everyday understandings that are inadequate in conjunctive explanations to prove adequate in disjunctive ones. This suggests that we understand ourselves better than we think: the pressing problem is more how we use what we know and less what we know.

In the introduction to *Explanation and Human Action*, A. R. Louch argues,

> In daily life we succeed in accounting for our actions without recourse to general theories or statistical regularities. When we appeal to wants, plans, schemes, desires, intentions, and purposes we render our actions intelligible to ourselves and to our everyday auditors. … When we say that a man seeks food because he is hungry, or kills his father because he has been cut out of the will, or equally when we say that men band together in economic or political enterprises and religious and social ceremonies because of their beliefs, needs, or roles, we are offering explanations of cases which do not require the support of general or theoretical statements.[16]

But this misses the commonplace: there are general statements, even theories if you like, that do support these cases—and everyday understandings would not be credible without them.

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[16] A. R. Louch, *Explanation and Human Action*, University of California Press, Berkeley and Los Angles, 1969, p. 1. Louche is working towards arguing against the possibility of a social science. We go in the opposite direction, but question whether current practices are a sensible way to go about it.

One is that hungry people usually seek food. Another is that people sometimes take revenge on those who hurt them. These broad generalizations are often narrowed with conditional (or 'boundary') statements. For example, hungry people are more likely to seek food when they like the food available, and less likely to seek food when they are being pursued by something that thinks that they're food; or, people are more likely to take revenge when they think they can get away with it and less likely to take revenge when social norms are against it. These general statements are all common knowledge, and all describe tendencies.

Commonplace generalizations of this sort provide the underlying coherence of everyday understandings, of journalistic and historical accounts, and naturalistic fiction. They distinguish what does from what does not appear to make sense. In this role, as trivial as they may be, they seem to serve us well.

So, what's wrong with them? If we are attempting to explain human behavior using conjunctive reasoning they are too numerous, too uncertain, allow too many possibilities, and explanations based upon them often have an ad hoc quality.[17] But, as we have seen, information of this sort is wholly adequate for building disjunctive explanations under uncertainty—more a cooperation of ideas than a competition—so these are not crucial failings. Note, also, that common sense explanations often have the credibility of corresponding to observation, while our ways of reasoning about human behavior rarely correspond to the dictates of logic and probability theory. Where should our suspicions be directed?

Moreover, accurate generalizations about human behavior should describe tendencies. Given mentality, we should not expect people to react uniformly. We should be able to explain how the human world works as the logical result of tendency relationships. That is, we should be able to explain its consistencies by the effects of its inconsistencies. This cannot be done with conjunctive thinking.

This line of argument suggests that the main obstacle to explaining human behavior is not so much our limited understandings of human behavior as our habit of attempting to explain it using

[17] Ad hoc reasoning, however, can prove reliable. As Louch points out, there are often specific behaviors—what particular people will do in particular circumstances—that are far more certain than the general principle that explains those behaviors—which is not the expected relationship between supposedly lawful general statements, the pure relationship, and actual behaviors, which are subject to other influences.

conjunctive logic without properly accounting for uncertainty. In short, and as the previous section suggests, *the problem appears to be less what we know than how we think about what we know*.[18]

The Fundamental Error

Thinking about disjunctive phenomena in conjunctive terms.

Streetlights and Drunks

There is the story about a drunk who drops his keys in the dark, but searches for them under a streetlight because that's where he can see clearly. Like him, we search where the light of reasoning shines brightest (where certainty is approached and conjunctive logic is appropriate) even though the understandings of the human world we seek can't be found there.

The drunk presumably never thinks to justify his method. We maintain a state of denial to justify ours. To make the way we reason about human behavior look plausible we have had to overlook the nature of mentality and the mechanisms it supports; dodge both logic's ambiguity under uncertainty and the clarifying implications of probability theory by reasoning as if under certainty; treat what straightforward observation would see as disjunctive in conjunctive terms; tolerate sciences whose descriptions of human behavior are unlike other sciences' descriptions in their own domains, in that they often have less informative detail than is available in non-scientific thinking.

Add all this to our usual mental tricks—our hodgepodge of inductive fallacies, judgmental biases, selective uses of evidence, outright lies, sheer carelessness, reliance on dubious authorities, and bad faith in general—and we outdo the drunk. He, at least, knows the keys are lost. By comparison, we are in the habit of thinking we have found them, or are just about to, or say so even if we privately suspect otherwise.

And in the morning the drunk wakes up sober...

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[18] In the end this is an empirical question, which is why I use the word 'suggests" to introduce it. The point is that we have long believed that the main difficulty is what we don't understand, while there is, at the least, an equally strong case that the difficulty is how we misuse our understandings.

Attempts to fully apply a disjunctive explanatory framework to human behavior are apt to exceed our mental capacities for retaining information and calculation. In Parts Two and Three we will explore qualitative and quantitative solutions. Qualitative solutions are strategies that compensate for our limited abilities to trace the implications of our understandings, staying within the boundaries of what we can do mentally, individually or collectively. The quantitative solution is, in effect, a statistical method that builds a map of the disjunctions and draws inferences from that map, in a manner roughly parallel to inferential statistics, but in a framework that differs from conventional statistics, in that it is not constrained by ideals like seeking conjunctive consistencies, parsimony, getting to the heart of the matter, or the competition of ideas. It requires a computer to handle the quantities of data and computations that go beyond our mental capabilities.

As a practical matter, moving from a conjunctive to a disjunctive explanatory framework under uncertainty is difficult. It asks us to build explanations in an unaccustomed and uncomfortable manner, use information we are accustomed to discounting, and it also takes us to a level of complication and technicality that we are, for the most part, ill prepared to handle. As we have seen, disjunctive human mechanisms can easily contain thousands of combinations of conditions. Fully modeling them would require probability assignments for every event in every combination and path probability calculations. This is not the kind of subject matter we can work through in our minds. In this sense, that of the sheer overwhelming of mental capabilities once we try to pursue the implications of our understandings, we cannot think rationally about human behavior. It is beyond us and it is an illusion to think otherwise.

There are two directions we can go from here, which roughly divide into qualitative and quantitative approaches. On the qualitative side we are looking for ways to work within our limitations. For the most part the methods we explore are things we already do—it would be surprising if we had not evolved practical ways to cope with disjunctive mechanisms. But because of the fundamental error of thinking about disjunctive phenomena in conjunctive terms and the devices we use to make that thinking seem credible, we often fail to understand these practices—why what we are doing works. As a result we are less likely to do them when, where, or as well as we could. On the quantitative side we take advantage of recent computer

technology—while our minds cannot hold all the information and perform the computations required to draw correct inferences about uncertain disjunctive system, computers can. The main features of a program designed to analyze disjunctive systems under uncertainty are outlined and discussed. While many of its measures have similar purpose as those in conventional statistics, measuring the effect of variables and making predictions, it does not build models or define functional relationships, but rather maps the various paths in a disjunction and sums their effects in various combinations that represent the influence of conditions and sets of conditions. Because of the shift to disjunctive explanations, ideas and methods that have seemed integral to making sense of natural phenomena are set aside: these include seeking consistencies, parsimony, and the competition of ideas. The quantitative methods are discussed after the qualitative, to allow placing what they offer in a context of practical strategies.

Part 2

Qualitative Solutions: Reasoning and Strategy

The Foundations of Useful Reasoning

With the exception of times when adequate data collection and computing resources can be applied, we can seek or try to create situations where our limited knowledge and mental abilities are sufficient—a matter of matching of objectives and capabilities. In practice, this means working in niches where conjunctive reasoning will prove useable—where we can get away with it.

Short Conjunctive Arguments Premised on Near Certainties

> **For the most part, as a practical matter, we cannot avoid using conjunctive reasoning even if we are aware of its distortions and deficiencies. The question is, when and how can we get away with it? One answer is to minimize its liabilities by restricting arguments to a small number of nearly certain premises. Uncertainty has little opportunity to accumulate, and within its limits, conjunctive reasoning can produce sensible understandings as well as reliable conclusions. In practice, this largely amounts to restricting reasoning to practical arrangements based on routines. Although this reasoning is apt to be simple, nevertheless, some people are likely to be much better at it than others—not because of their greater intellectual powers so much as characteristics like unusual abilities to notice and keep in mind what others do not, not accepting conventional notions that do not correspond to experience (as the current line goes, believing our lying eyes), access to privileged information or at least information that is not general knowledge (in some cases, via statistical competence); and better use of evidence about probabilities than is typical. In addition, some people are better than others at creating situations where behavior is likely to be more reliable, such as by the use of authority, charisma, and loyalty, again broadening the realm of effective conjunctive reasoning. Aspects of personality and position may be more important in making good use of this approach to reasoning than intelligence, at least as the term is usually employed.**

There are a large number of nearly certain behaviors. Most people show up for work every day, for example, and behaviors like salespeople's willingness to sell a product when proper payment is offered are so reliable that the term "invariable" almost applies. People spend much

of their time behaving in predictable ways. They are more or less law abiding—within the conventions of their peers. They work, eat, travel, sleep, and are social in their usual ways, and do what is necessary to try to keep things that way. Everyday activities depends on this predictability, and we are all familiar with mechanisms that maintain it: social and economic constraints, habits, inclinations towards conformity, ties of friendship and loyalty, strict codes of behavior and morality, coercion, and so forth. In addition, institutions, social organizations, and conceivably, even cultures can also behave reliably (in the sense that members have high probability of certain attributes and responses), often for similar reasons. While the reasons for the reliable behaviors are presumably disjunctive, within limits the reliability of these behaviors allow them to be used to premise effective conjunctive reasoning.[19]

Conjunctive reasoning, restricted to highly reliable behaviors and a limited number of premises, can lead to reliable predictions.[20] The reliability of this reasoning goes some way in explaining the utility of simple conjunctive thinking in the conduct of everyday life: the reasoning stays within the narrow band where uncertainty does not seriously threaten conclusions or allow disjunctions to play a significant role.[21] Note that within the limits of short conjunctive arguments premised on near certainties, the suppositional maneuver is not misleading. We can reason as if the premises were certain, and caveats along the lines of warnings that conclusions are best guesses and so forth are appropriate.

Although there is little that is apt to be subtle or difficult in the logic of these arguments, these arguments are not necessarily obvious. We pay attention selectively and often carelessly; we miss a lot that we are capable of noticing. Some reliable behaviors might be missed because they are so common we never pay attention to them; some reliable behaviors might be missed

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[19] There is a risk that in not recognizing the role played by disjunctions in making these conjunctive arguments viable, of generalizing to where those disjunctions are weaker or non-existent, or, unknowingly taking actions that undermine the underlying disjunction. See the discussion in *Strategy* below.

[20] The reasoning behind these predictions might be sound: the conclusions justified by the premises and the premises trustworthy. Or, the the reasoning can be spurious: the conclusions justified in part or whole by unstated trustworthy premises highly correlated to the stated ones. In either case there is a small number of reliable premises.

[21] Especially since in many reliable everyday arrangements, if things do not work out as expected fallbacks are easily found. If this store is out of what we are looking for, another is likely to have it in stock, or it will be restocked soon; if X does not show up for work Y may be able to take X's place for a few days, or the work can be postponed; and so on. So, although our reasoning may not explicitly take these fallbacks into account, the social mechanisms it addresses often contain disjunctions which reduce the need for wholly trustworthy conclusions..

because we think we already know what is going on; some reliable behaviors might be missed because we refuse to admit to them; some reliable behaviors may be missed because they occur too infrequently to pick up the connections, and so on. And even if we do notice reliable behaviors, they may not come to mind when we are trying to think through a problem or issue—especially under social and time pressure, in the heady rush to a desired conclusion, or when thinking is channeled along different lines by preconceptions about what behaviors are and are not reliable.

In addition to what we miss in plain sight, there are habits and routines we do not know about because they are outside of our experience, whether because they are secret, obscured by conventions, hidden by clouds of irrelevancies, or simply going on somewhere else. This includes many criminal and corrupt practices, but also much that is unconventional, clandestine, antisocial, embarrassing, risks legal liability, only known to the trade, and much of how people live that is different from ourselves but we never found out.

Finally, we are generally poor judges of probability, in particular tending to overestimate the probabilities of behaviors that are representative of what we consider typical, or are available to ready recall.[22] Evidence of our insensitivity to the low probability of assertions is provided by studies of political pundits and experts, whose predictions tend to hover around the .5 level, yet are taken as providing good reasons to expect an outcome, and used to premise further reasoning.[23] This is not surprising, in part, because the way we judge the credibility of premises tends to rely on standards—such as the beliefs of our peers, the judgment of authorities, consistency with beliefs we treat as well established—that are only indirectly connected to

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[22] Representativeness and Availability are two well documents cognitive biases. See …

[23] *Brill's Content,* a magazine published from 1998 to 2001, tracked the predictive accuracy of a selection of well known television political commentators. They were rarely out of the .4 to .6 range. Phillip E. Tetlock's more extensive and systematic study, *Expert Political Judgment* (Princeton University Press, Princeton and Oxford, 2005), comes to a similar conclusion looking at a much wider range of experts.

measuring or estimating an assertion's probability, and possibly not connected at all.[24] And as George Orwell commented, "To see what is in front of one's nose needs a constant struggle."[25]

So, an advantage goes to people who are unusually good at noticing and keeping in mind what others do not; have the independence and presence of mind to be less entrapped by conventions, social pressures, and time constraints; have a wide range of experience and access to privileged information (and in some cases, statistical competence); are less given to overconfidence about what easily comes to mind, and use more direct evidence of probability than is typical. They have a better chance at coming up with good short conjunctive arguments premised on near certainties. This suggests that qualities usually thought of as aspects of personality rather than intelligence (taken as an ability to think logically) are the ones at a premium when it comes to being unusually good at this sort of reasoning. These aspects of personality are, to use Isaiah Berlin's dichotomy, more the virtues of the fox than the hedgehog —the fox knows many things but the hedgehog knows one big thing—in their attention to local detail and variety versus larger trends and basic underlying forces that may not have a sufficiently reliable effect in particular cases, if at all.[26,27] They may also be more the virtues of the imaginative, seeing multiple possibilities, than the clever, whose focus is apt to be on making a powerful best guess case.

Carrying the idea that some people are in a better position to make short conjunctive arguments premised on near certainties than others a couple of steps further, however, we can go in another direction. Consider people who are in positions of authority, whether granted freely or coerced, or whose personalities are charismatic, forceful, and so forth. They are unusually able to

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[24] Note that premises may describe aggregates as well as the individual behaviors. We can, for example, make a premise that the majority of Republican party members oppose unrestricted access to abortion; or that around half of individuals with an alcoholic parent become alcoholics, or that Japan rank's nineteenth in average per capita ice cream consumption, and so on. The probability of the these premises is measured, not by the rate they describe, but the certainty about whether that rate (at an acceptable level of precision) is accurate.

[25] I came across this quote as the motto to Andrew Sullivan's blog, *The Daily Dish*.

[26] There is some empirical support for the Fox's advantage. In Tetlock's study of political judgment a central argument is that foxes are the more reliable forecasters, partly attributed to their abandonment of parsimony and their willingness to use ad hoc reasoning. See, in particular, Chapter 3,

[27] Note that probabilities are not typically reported in social science statistics, which often deal in continuous variables, and which tend to rely on other measures of effect size.

influence behavior and in doing so make it more predictable. Thus they live in a world relatively favorable to short conjunctive arguments premised on near certainties, as compared to people in the same circumstances but without these advantages. Behavior becomes more predictable than usual in response to them. Or, consider people living in a society with rigid conventions, they will find it a world relatively conducive to this form of reasoning, at least in matters dependent on outward appearances. Hedgehogs and the clever have the advantage here, although in their narrowness and liking for strong general statements they might be poor at understanding why.

As this suggests, people are not just passive, accidental, recipients of these advantages. We can select or modify environments to make them more suited to our mental capabilities. The means are familiar. Getting things organized is, in effect, a way to make each person's role predictable, as are training programs. Hiring people with a proven track record is, in effect, selecting people who's performance is predictable. Commitment to a moral or ethical code is, in effect, a way to limit the range of likely behaviors. Firing or excluding people who you cannot depend on reduces unpredictability, and so on. Much in our conventions and culture serves to make the world more suitable for thinking that relies on short conjunctive arguments premised on near certainties, even if that is not how we usually think of the consequences these activities.

The discussion of how personality and social organization rather than analytic capability are keys to successful reasoning about human behavior opens a theme that will run through the discussion of practical strategies: that the obstacles to improving practical reasoning about human behavior are more a matter of suitable individual and social capabilities, strategies, unusual or privileged knowledge, and an ability to shape one's human environment rather than knowledge of principles or powerful applications of logic.

There is also the crucial matter of not disturbing, or even supporting, the disjunctions that produce the reliable behaviors short arguments premised on near certainties require. On this, see the discussion of Incrementalism in *Using Descriptive Realism* below.

Note that the idea here is only that these personal and social qualities increase the reliability of some behaviors, and expand the range of reliable behaviors, not that they guarantee the

possibility of sound short conjunctive arguments premised on near certainties. These qualities just make the reasoning more likely to be viable and applied in useful places.

Sometimes, the word 'wisdom,' or at least the idea of a wise person, seems be about the qualities of a person—something about who they are rather than the depth of their knowledge or how well they think—that leads them to unusually reliable perceptions or appropriate actions. We can see that some of the requirements for successful conjunctive reasoning about human behavior leads in exactly that direction. But wisdom is not as suitable a description of others who may also be successful in using conjunctive reasoning, such as those whose position, authority, charisma, ability to intimidate, or insider knowledge provides local environments with highly predictable behaviors and observable routines, and thus have unusual opportunities for sound conjunctive reasoning.

Lastly, if the reasoning is sound, it supports correctly diagnosing failures. In the everyday world where we repeatedly rely on short arguments premised on near certainties for practical arrangements, sooner or later they will prove wrong—even if in each instance the odds are highly in their conclusion's favor. Sometimes this will just be the consequence of the uncertain connection between conditions and outcomes, but at other times it will be because the conditions leading to the outcome, being uncertain themselves, were not present. If we are correct when we say A, B, and C usually leads to X, and X does not happen, it is worth checking whether A, B, and C were present. This sets up the framework to for an accurately targeted try and try again disjunction. If, for instance, B did not happen, time to try B again, or find another way to do what B did.

In this case short arguments premised on near certainties can be used to create a well focused disjunction, and thereby produce more reliable results than the confidence in original argument permits.

Commonalities, Explanation, and Prediction

> **When dealing with conjunctive phenomena it makes sense to seek common elements in the inputs, since elements of the input that are not consistently present cannot explain a consistent output. If the same method is applied to disjunctive**

phenomena, however, it misses the explanatory boat since disjunctions do not depend on consistent inputs. Nevertheless, commonalities are apt to be present to some extent in the various input combinations that form the disjunction, and if present can be correlated with the outcome. This can allow them to serve as useful predictors. But at the same time it produces an illusion, since conjunctive thinking will lead us to give the commonalities credit for what is actually the effects of a disjunction—even if the commonalities are of little consequence on their own.

Seeking to explain behaviors that arise from multiple and diverse influences, a conjunctive orientation leads us to seeking commonalities, parsimony, and reductive understandings.[28] Thus we look for a few conditions that are consistently present and that can be treated as largely sufficient for understanding a behavior. The introduction to Frank H. Knight's 1921 classic in economic theory, *Risk, Uncertainty, and Profi*t, puts a high gloss on this process,

> The very conception of an exact science involves abstraction; its ideal is analytic treatment, and analysis and abstraction are virtual synonyms. We have given us the task of reducing to order a complex mass of interrelated changes, which is to say, of analyzing them into uniformities of sequence or behavior, called laws, and the isolation of the different elementary sequences for separate study.
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> …The value of the method depends on the fact that in large groups of problem situations certain elements are common and are not merely present in each single case, but in addition are both few in number and important enough largely to dominate the situations. The laws of these few elements, therefore, enable us to reach an approximation to the law of the situation as a whole. They give us a statement of what "tends" to hold true or "would" hold true under "ideal" conditions, meaning merely in a situation where the numerous and variable but less important "other things" which our laws do not take into account were entirely absent.
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> ...And while such laws never accurately hold good in any particular case, because they are incomplete, not including all the elements in the case, yet they enable us to deal with practical problems intelligently because they are approximately true and we know how to discount their incompleteness. Only by such approximations, reached by dealing analytically with the more important and universal aspects of phenomena, could we

[28] Reduction is used here to mean explanation by the properties and relationships of more basic components, it does not imply oversimplification.

> ever have attained any intelligent conception of the behavior of masses of matter in motion and secured our present marvelous mastery over the forces of nature.[29]

The method Knight outlines, if grandiose sounding by contemporary standards, is not only associated with science. It is central to everyday notions of 'getting to the heart of the matter,' 'separating the wheat from the chaff,' 'dealing with the essentials.' 'cutting to the chase,' and alike. It's what's expected of answers to questions like, 'Basically, what's going on here?' In addition, it plays to our desire to keep things clear and simple.

But disjunctive phenomena do not depend upon what Knight takes as given: that "certain elements are common and are not merely present in each single case, but in addition are both few in number and important enough largely to dominate the situations." In disjunctive phenomena reliable outcomes can be the product of a number of combinations with no common elements, and with no combination dominant. There may be nothing that is 'basically what is going on' except the shared outcome.

Nevertheless, if we approach disjunctive human phenomena guided by this method, there are innumerable situations where it seems to work. The reason is that commonalities are common. Some reasons for behaviors—reflecting shared concerns, interests, beliefs, conventions, circumstances, understandings, methods, goals, pressures, fears, and so forth—show up more often than others. Also, we create conventions and institutions that address these matters, and so, in effect, build the commonalities in.

For example, say that the commonalities for accepting a job offer are good salary, an adequate health plan, and the prospect of continuing employment. These reflect widely shared concerns and employment is an institution that addresses them. However, the commonalities are only a part of what leads to accepting an offer. In one instance an offer is accepted because of the

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[29] Frank H. Knight, *Risk, Uncertainty, and Profit*, Chicago, Chicago University Press, 1971 (original 1921) These passages are from the Introductory section. Contemporary social scientists are apt to use more modest terms while pursing the same logic of inquiry and analysis, but not always. Naomi Klien, writing in the Washingto Post, April 19, 2009, quotes Lawrence Summers as saying, "The laws of economics are like the laws of engineering," he said. "One set of laws works everywhere."

Contemporary social scientists are also apt to be less explicit about the assumptions underlying their methods, the assumptions have become the ocean social science swims in.

Although much of the criticism of social science and the sciences in general in the humanities stems from a recognition that human behavior arises from mentality—the beginnings of the path we have gone down—it uses it to argue against the possibility of rationality, rather than to argue that we are going about it the wrong way.

commonalities in combination with good child care facilities, that the job would look good on a resume, and high status. In a second instance an offer is accepted because of the commonalities and good promotion opportunities, friends working there, and that it was the spouse's preference. In a third an offer is accepted because of the commonalities in combination with that the job would look good on a resume, that the work is interesting, and that parent's would approve. And so on. As long as the commonalities tend to occur in the combinations that lead to accepting a job offer but not in combinations that lead to tending to reject it, they can serve as predictors even though they do not account for the behavior.

Note that, by themselves, the commonalities may have very little influence. Consider that jobs that only offer the commonalities of good salary, an adequate health plan, and the prospect of continuing employment have to compete with jobs that offer the commonalities, and a selection of additional conditions drawn from the disjunction that contains the commonalities—such as good child care facilities, looking good on a resume, high status, good promotion opportunities, friends working there, spouse's preference, interesting work, and so on, where offers by competitors are superior. Why accept less when you can get more?

An employer thinking that the commonalities explain why people accept job offers, and who therefore pays no attention to maintaining the disjunction that provides other elements in the combinations, is depending on the having the good fortune that the disjunction will stay in place. If that employer somehow insured that their offers contained only those common conditions, they would have a hard time recruiting employees. This may seem an example of obvious foolishness but it is exactly what economists do when policy is determined by model based on (real or supposed) common features of market systems, what political analysts do when they talk about durable national interests, what psychologists do when they talk about the evolutionary sources of human nature, what sociologists do when attempting to explain behavior by social class, and so forth. The point is not that the commonalities each identifies are false—in the sense of being less common than they claim, although they might be—but that they explain less than our conjunctive predispositions and the commonalities' predictive power, as limited as it sometimes is, suggests.

In other words, the commonalities are weaker influences than they seem, and in acting on our mistaken understandings of their effects we take the same sort of risk the foolish seeming employer takes, that the disjunction which makes the commonalities seem powerful won't be there when we need it—and even that, in our ignorance, we will act in ways that undermine it. (See the discussion in *Strategy: Using Descriptive Realism*, below.)

Commonalities competing with commonalities plus idiographic conditions is the systematic result of a very human inclination: to try to find or create something of what one wants in every situation. Because of this inclination few customs and institutions serve a single purpose—at least not for long, and in spite of our intentions. Just as a job not only provides an income but also opportunities for socializing, accomplishment, status seeking, getting your parents off your back, pilfering office supplies, and so forth, we bring to most situations a range of desires and habits and try to find ways to satisfy and accommodate them. Given time, ingenuity, and the wide and diverse range of human desires, most anything can be turned to serve a variety of purposes—and it is all the various ways we manage to make use of our customs and institutions that make them valuable and enduring.

Thus the presence and power of idiographic conditions is a fundamental result of the ways we construct our world. Commonalities in competition with commonalities plus idiographic conditions, and losing that competition, is what should be expected. For this reason the commonalities will have limited influence if acting on their own, although they may still be good predictors.

Given this, the strongest causal role we should expect commonalities to play is as a rough, under uncertainty, version of being logically necessary but not sufficient—in the way an adequate income is often or even generally a necessary part of a job offer but is not sufficient to insure that the offer will be accepted. That commonalities are likely to play only a rough version of necessary is easy to see: desperate people will take less than an adequate income as better than nothing; more comfortably situated people will take less because they can afford to, in light of other benefits, such as interesting work; misinformed and self-deceiving people will take less by mistake; members of multi-income households will take less because it is the total income that must be adequate; and so forth.

Necessary but not sufficient is only definitive in a negative sense. A necessary condition tells you that something won't happen but not when it will. An under uncertainty version of necessary is not definitive but remains informative.

In schematic form, the structure that enables predicting the effects of a disjunction using conjunctive logic based on commonalities looks something like this:

Table 2.1

Case	Common Conditions	Idiographic Conditions	Predicted Outcome Holds
1	A B C	G H P Q R X...	Yes
2	A B C	E F I N P R ...	No
3	A B C	F K M N P X...	Yes
4	B	O P R T V W...	No
5	A B C	D E G I K P...	Yes
6	AC	G J K P R W...	No
...N	etc.	etc.	etc.

Each row represents a single case. If this represented the job offer example, row one would represent the common conditions good salary, an adequate health plan, and the prospect of continuing employment, and the mix of idiosyncratic ones reflecting an individual's and local situationally driven concerns, such as pleasant work, convenient location, interesting work, and high job status; for another these might be liberal vacation policy, friends work there, enhances resume, and convenient location, and so forth. The correlation between the common conditions and the outcome allows making predictions, but, as we have seen, it is the complete combination that explains the outcome. The commonalities, by themselves, may explain very even when they are good predictors. The idiographic conditions, which may explain a great deal, are largely invisible to conjunctive, especially rigorously conjunctive, modes of analysis.

On one hand this structure is an open invitation to unchecked, or at least, uncheckable, theorizing. Any of the commonalties or any combination of the commonalities can be used to make a somewhat convincing case, empirical tests included, if considered without looking at

alternative explanations.[30] On the other hand if there are no commonalities there could still be a strong causal system with no input-output correlations, that is, one which would escape comprehension when reasoning conjunctively—and if we are sufficiently committed to conventional rigorous techniques, even detection.

Prediction and Explanation

> **The distortions created by conjunctive reasoning applied to disjunctive phenomena come home to roost when correlations between commonalities and outcomes are used as evidence in support of explanations. Conventional behavioral and social science uses of statistics and experimentation, seeking input-output consistencies, reinforce this error. This allies rigorous methods of social science with other means of self-deception, such as the suppositional maneuver and ideals like explaining the most with the least, which only make sense when applied to conjunctive phenomena. The issue here is not the correlations or the relationships shown in experiments themselves, but how they are interpreted. Concern with verisimilitude can provide some balance to misreading predictive and experimentally demonstrated relationships, and as we will see, supports practical problem solving.**

In an influential essay some thirty years later, Knight's student, Milton Friedman, argued against worrying about apparently unrealistic assumptions in social sciences. Part of his argument is that,

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[30] And we are talented at avoiding looking at alternative explanations.

This discussion puts us some distance from scientific realism, to which we are otherwise generally sympathetic, in its interpretation of prediction and more generally, in its confidence in methods grounded in conjunctive reasoning and its associated ideals.

Jarrett Leplin (1984, p.1 - 2) lists "characteristic realist claims," with the caveat that "no majority of which, even subjected to reasonable qualification, is likely to be endorsed by any avowed realist." They nevertheless give the flavor of the realist position. If, however, we take this list seriously, only the sixth, eight, and tenth entries are clearly consistent with the arguments made here, and even that is a something of a stretch. So perhaps the sympathy is mostly about a shared confidence that empirical work can be genuinely referential.

- The best current scientific theories are at least approximately true.
- The central terms of the best current theories are genuinely referential.
- The approximate truth of a scientific theory is sufficient explanation of its predictive success.
- The (approximate) truth of a scientific theory is the only possible explanation of its predictive success.
- A scientific theory may be approximately true even if inferentially unsuccessful.
- The history of at least the mature sciences shows progressive approximation to a true account of the physical world.
- The theoretical claims of scientific theories are to be read literally, and so read are definitively true or false.
- Scientific theories make genuine, existential claims.
- The predictive success of a theory is evidence for the referential success of its central terms.
- Science aims at a literally true account of the physical world, and its success is to be reckoned by its progress toward achieving this aim.

See *Prediction and Explanation* below.

> Truly important and significant hypotheses will be found to have "assumptions" that are wildly inaccurate description descriptive representations of reality, and, in general, more significant security, the more realistic the assumptions (in this sense). The reason is simple. A hypothesis is important if it "explains" much by little, that is, if it abstracts common and crucial elements from the massive complex and detailed circumstances surrounding the phenomena to be explained and permits valid predictions on the basis of them alone. To be important, therefore, a hypothesis must be descriptively false in its assumptions; it takes account of, and accounts for, none of the many other attendant circumstances, since its very success shows them to be irrelevant for the phenomena to be explained.
>
> To put this point less paradoxically, the relevant question to ask about the "assumptions" of a theory is not whether they are descriptively "realistic," for they never are, but whether they are sufficiently good approximations for the purpose in hand. And this question can be answered only by seeing whether the theory works, which means whether it yields sufficiently accurate predictions. The two supposedly independent tests thus reduced to one test.[31]

In this Friedman is largely walking in Knight's footsteps, but with the additional point that prediction is a sufficient test to weed out assumptions that do not belong in an explanation. Verisimilitude need not be an separate concern. And for phenomena that can be treated conjunctively he has a point. If there is only one way things happen (or we revise our definitions until each way something can happen can be treated separately, although this is only a practical possibility if there are not very many ways) then prediction from commonalities is sufficient to weed out conditions that are irrelevant. Irrelevant conditions will not show a consistent connection to the outcome and spurious relationships can be exposed by controls and testing them against more accurate rival hypotheses (assuming they are less than perfectly correlated). This is a conventional understanding of scientific methods.

But if the predictive power of the commonalities arises from a disjunction, the same method is apt to produce perverse results: weeding out relevant conditions (the idiographic conditions in Table 2.1) and accepting spurious relationships. More accurate hypotheses are ruled out of contention by the inconsistent relationships that constitute a disjunction.

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[31] Friedman, Milton, *The Methodology of Positive Economics*, in Essays in Positive Economics, The University of Chicago Press, Chicago and London, 1953, p. 14 - 15.

Conventional use of statistics reinforces the inclination to read commonalities with good predictive relationships as explanatory—as they are concerned with identifying and defining reliable relationships between inputs and outputs. In a regression model, for example, predictor variables are dropped from the model if their unique (not correlated with other variables) relationship is not correlated at greater than chance levels with the predicted variable. In other words, predictors are dropped unless a sufficiently consistent and distinctive relationship is observed. Applied to data with a few strong predictors (common conditions) and a large number of other variables that showed up more or less randomly (idiographic conditions), especially if in relatively small numbers, regression will be likely to show that the common conditions are the only variables that count—that is, that explain any of the outcome's variance. We generally would interpret this as indicating that only the commonalities have any effect, at least for the population as a whole. In this, statistical methods are only doing what they are designed to do—identify consistencies in a noisy environment—but by doing what they are designed to do, disjunctions, even if they are the correct explanation, are systematically overlooked as noise.

Experimental methods take a different approach to systematically overlooking disjunctions. By using experimental controls that, as much as possible, exclude the influence of any but the experimental conditions, the disjunction has been pushed aside before the test has even begun. And since those conditions are no longer in competition with combinations containing more reasons for a behavior, they are likely to appear more powerful than they are in natural settings. Thus we entirely miss that the experimental variables act as parts of combinations, not alone, and that the question we should be answering to understand their effects concerns their contributions to the combinations they are likely to be part of, not their isolated effects.

In both cases the methods support the confusion of common and in some cases, more or less necessary, conditions, with ones that explain a phenomena. In statistics the variance explained measures the predictive power of the combinations including the commonalities, but only the commonalities will be sufficiently consistent to remain in the model. In experiments the disjunction is removed so only the commonalities (or variables selected for other reasons) chosen as experimental variables are available to take the credit. Neither offers the means to clarify the situation and both reinforce our misconceptions.

They are inappropriate tools for sorting out disjunctive phenomena. I think the current cliche would have it that our rational and scientific traditions and methods are ingredients in a 'perfect storm' of ways to fool ourselves—the discounting of mentality, the end-runs around logic we use to handle uncertainty, biases against disjunctive explanations, limited cognitive capacity, the successes of the natural sciences grounded in its use of conjunctive reasoning, essentialism, desires for clarity, certainty, and gaining a secure basis for decisions and moral judgments, the advantages of simple and forceful explanations in advocacy, habits of relying on affirmative evidence, and so forth, all come together with social science methods that give credit to commonalties for the effects of disjunctions. The only shelter from this storm within conjunctive reasoning, as we will see, is exactly what Friedman is arguing against: a concern with verisimilitude. He argues that this concern is rarely fruitful,

> Such a theory cannot be tested by comparing its "assumptions" directly with "reality." Indeed, there is no meaningful way in which this can be done. Complete "realism" is clearly unattainable, and the question whether a theory is realistic enough can be settled only by seeing whether it yields predictions that are good enough for the purpose in hand or that are better than predictions from alternate theories. Yet the belief that a theory can be tested by the realism of its assumptions independently of the accuracy of its predictions is widespread and the source of much of the perennial criticism of economic theory is unrealistic. Such criticism is largely irrelevant, and, in consequence, most attempts to reform economic theory that it is stimulated have been unsuccessful. (ibid, p 41)

But his standard is prediction using conjunctive models, that is, where the competition is for the best performing unrealistic explanation, so failed reforms aimed at realism are hardly surprising. The importance of verisimilitude, when relying on conjunctive reasoning about disjunctive human systems, and given the uncertainties associated with the conditions and relationships verisimilitude invokes, is not in establishing strong predictive relationships (short of the type of analysis discussed in Part Three). Instead it is as providing guides to more effective strategies given the dangers of relying on explanations that are right for the wrong reasons (the

commonalities alone), and as checks on false clarity. We pick up on this theme in *Using Descriptive Realism* below.[32]

Recourse to Abstraction

As if we were not confused enough by commonalities in disjunctions, we use abstractions to create commonalities from disparate elements. The price is a blurring of useful distinctions, ones that would identify reasons for different outcome probabilities.

When reliable behaviors arise from disjunctions without pronounced commonalities, thus offering no predictors to enable conjunctive reasoning to be right for the wrongs reasons, we still have a way to make conjunctive arguments that seem sound. We can take recourse to abstractions: lumping together influences on behavior which are likely to lead to different outcomes, and lumping together different outcomes as well, Returning to the initial marriage example, let us say that the need for love, friendship, and wanting children were not sufficiently probable, taken individually, to serve as commonalities in a conjunctive argument. We can create a common condition by by lumping them together, say, as all representing the need for affection, and give that as a reason for marriage. Instant commonality! It sounds sensible. But unless the probability of the outcome is the same regardless of which of the three conditions hold, and there are no other substantive differences of interest in the effects of the three conditions, this is a bookkeeping trick—calling different things by the same, or at least a more general, name—and a loss of information by blurring useful distinctions.

Morality

Moral judgments are made via our understanding of the reasons for behaviors, of why people do what they do, which allows us to attribute responsibility. If these understanding are systematically flawed then our ability to make fair moral judgments is flawed as well.

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[32] We have used statements by two Chicago economists to characterize a general approach to research in the social sciences. One reason is their clarity, even if it arises from an excess of confidence (although Knight can be defended for his enthusiasm since the ideas had not yet been put to many tests) leading economists to taking what other fields are more likely to treat as guidelines as rigorous strictures. Another reason, perhaps, is that the greater role of formal models in economics, with their attendant lack of realism, has pushed economists to defend their practices more vigorously. Offense as the best defense. But the logic of what they do is the logic of social and natural sciences as well. and that is the issue. This logic does not work well when applied to disjunctive phenomena.

How we explain human events not only guides how we make predictions, it shapes how we feel about people and events and our moral judgments. Explanations of behavior influence where we attribute responsibility, what behaviors we value and want to support, what we consider a threat, and so forth. If our explanations are flawed—as conjunctive understandings of disjunctive phenomena are apt to be even when they are predictively powerful—then these judgments, feelings, and beliefs are apt to be flawed as well, and our morality will be misapplied. The issue here is not the content of any particular morality but whether we can apply moral judgments fairly when our understandings of the reasons for behavior—the motivations, choices, pressures, and so forth—are systematically misleading. In short, although we often claim explanations of behavior and morality are independent realms, in application they are inextricably intertwined, since we apply the morality via our explanations of events, and for this reason relying on conjunctive understandings threatens the competence of moral judgment.

Strategy

Using Descriptive Realism

Descriptive realism contains information that conjunctive reasoning, premised on consistencies between commonalities and outcomes, discounts and discards. The information can used as signs of emerging problems and opportunities that conjunctive reasoning will miss. The signs are ambiguous, so the actions indicated are not definitive solutions but processes—including investigations, early and small interventions that keep options open, monitoring, and preserving the capabilities to take these and other actions. Much of this is seen in the strategy of Incrementalism, although Incrementalism does not derive from considerations of the mismatch of conjunctive reasoning and disjunctive human phenomena.

Descriptive realism is a bridge, a somewhat shaky one but that's the only kind there can be, between conjunctive reasoning and disjunctive realities. It retains information that conjunctive reasoning about human behavior discounts—by our habit of exaggerating logic's power under uncertainty and methods that attribute the effects of both commonalities and ideographic conditions to commonalities alone. While it cannot be used to correct that thinking, since that cannot be done without abandoning conjunctive reasoning, it can be used to point the way toward more robust courses of action and tempering our judgments. Consider a few examples.

In the Fall of 2008 the former Chair of the Federal Reserve Board, who had presided over the build-up to the financial collapse, testified at a congressional hearing,

> "I made a mistake in presuming that the self-interests of organizations, specifically banks and others, were such as that they were best capable of protecting their own shareholders and their equity in the firms," Mr. Greenspan said.
>
> ....Mr. Waxman pressed the former Fed chair to clarify his words. "In other words, you found that your view of the world, your ideology, was not right, it was not working," Mr. Waxman said.
>
> "Absolutely, precisely," Mr. Greenspan replied. "You know, that's precisely the reason I was shocked, because I have been going for 40 years or more with very considerable evidence that it was working exceptionally well." [33]

Mr. Greenspan got it wrong when using the same models he had been getting it more or less right with for so many years. This type of error is exactly we should expect from thinking you are right for the right reasons when you are right for the wrong reasons, and the conditions in the right reasons, the overlooked disjunction, change. Things go along just as you'd expect, and then, without adequate warning because you were looking elsewhere, they don't.

Note that this is not what you'd expect if, as Knight as many other social scientists would have it when explaining errors, that the models are approximately true but incomplete. That is, that the key condition's and dynamics are adequately represented. Unanticipated variations occur due to secondary influences. In that case, as long as the key conditions hold, in this case institutional self-interest, the model should have held. If, however, the model's predictive success is due to correlations with commonalities that explain very little by themselves, then that these 'key' conditions hold is a much weaker assurance. Complete collapse is entirely possible since most of the reasons for the behavior are not in the model in the first place. Once the underlying disjunction has changed, reasoning based on variables and dynamics in the model, no matter how fine it seems, is besides the point. The endogenous turns out to be exogenous.

There are, however, likely to be visible signs that something is wrong—if we are not blinded by treating commonalities as if they were causes. In this case there were, close in, a housing

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[33] Alan Greenspan, testimony to the House Oversight and Government Reform Committee, Oct. 23, 2008, as reported by Kevin Drum for the Mother Jones magazine blog.

bubble and a proliferation of dubious, opaque, and highly leveraged financial instruments; in recent years major scandals where regulation was inadequate (Savings and Loan, Junk Bond, and Enron); and since the 1980's, a growing anything goes, grab the money while you can, business culture. See, for example, Liar's Poker by Michael Lewis, a best seller published in 1989.[34] The prudent self-interested behaviors that Mr. Greenspan attributed to self-interest alone were more likely the product of a disjunction whose combinations consisted of self-interest *and*, among other things, a business culture that frowned upon risky loans and innovative, complex, financial instruments; where jobs which were understood more as following conventional practices than aggressively increasing revenue; where people attracted to investment banking were of cautious dispositions; where regulatory measures prohibited some risky practices, or at least made them more difficult to pursue; where the long term viability of a firm was given greater weight relative to short term profits; where promotions and remuneration were more dependent on pleasing the boss and the appearance of rectitude than on spectacular increases in revenue; and where making money was more closely associated with producing and selling goods rather than manipulating money and government. And so on. Even without explicitly thinking in disjunctive terms, a great deal of information was available. The forces for prudence were visibly, even dramatically, slackening. This could be and was noticed.

The conditions just listed are the kind of social, cultural, and political factors economists sometimes point to after the fact—when things do not go as expected and they go outside their models in search of explanations. In short, they turn to the descriptive realism their model's systematically avoid to explain their model's failures, treating them as shocks from outside the system. What this second-guessing typically misses, however, is that these external factors are not the explanation of how things go wrong, and otherwise irrelevant or set aside as givens, but central to the explanation of how things went right in the first place. Commonalities like self-

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34 Although at the time he thought the madness could not continue. Writing during the 2008 financial crisis he comments: I thought I was writing a period piece about the 1980s in America. Not for a moment did I suspect that the financial 1980s would last two full decades longer or that the difference in degree between Wall Street and ordinary life would swell into a difference in kind. I expected readers of the future to be outraged that back in 1986, the C.E.O. of Salomon Brothers, John Gutfreund, was paid $3.1 million; I expected them to gape in horror when I reported that one of our traders, Howie Rubin, had moved to Merrill Lynch, where he lost $250 million; I assumed they'd be shocked to learn that a Wall Street C.E.O. had only the vaguest idea of the risks his traders were running. What I didn't expect was that any future reader would look on my experience and say, "How quaint." *The End*, Michael Lewis, www.portfolio.com, November 11, 2008,

interest, are only a part, and possibly only a small if more or less necessary part, of the mechanism. Once the full mechanism is in consideration, policy prescriptions that ignore so much take on a risky air.

When Mr. Greenspan talks about there being an flaw in his model, he is probably on the wrong track. The error was not a flaw, something that at least in principle can be corrected without much alteration of the rest of the model—an ill chosen parameter value, a crucial variable missing, or an incorrectly specified function. The greater error was that the model itself was of the wrong logical type—a conjunctive model of a disjunctive phenomena. All corrections to such models can do is formulate a new set of right for the wrong reason rules that appears to fit and predicts the current situation better, and hope that it proves durable.

Note that the error here is not oversimplification—all models simplify and whether in any case it is oversimplification depends on how the model is being used. The error we are talking about is the mismatch of the logic of the model and the phenomena. A category error: treating a disjunctive phenomena as a conjunctive one. Not understanding the nature of what had been modeled or why the model worked while it did, he did not understand what could be expected from it, or the need to pay closer attention to what the model excluded: both the excluded conditions and the disjucntive nature of the phenomena that made the excluded conditions more important than his model would show.

The question is how, given our limited capabilities when facing disjunctive phenomena, should this greater realism be used?

Mr. Greenspan could not have just ‘read the signs’ and fixed the problem. The signs were ambiguous. But he could have used them to take early and relatively minor actions that could prevent later breakdowns if they were on the way. If the signs were taken as reasons to investigate, to look closely at lending practices, the information being concealed by the new financial instruments, leverage ratios, rating agency practices—all places where the effects of a lack of prudence would be manifest—there would have been better grounds to oppose some of the deregulation, and better justification for proposing regulations. As it is, few seem to have realized how highly leveraged and interdependent the financial markets had become and so did

not see the full dangers in a housing bubble collapse, even if they admitted there was danger at all. (Some did, but it took a lot of access and digging on their part, see the Lewis article cited above for an example.) In any case, the signs, which only indicated a shifting of probabilities, did not lead directly to policy prescriptions so much as a need for information, which, in turn, may lead to prescriptions or exploratory actions.

None of this requires thinking in disjunctive terms, but none of it will happen if we accept strong predictive relationships based on commonalities as a valid description of how the human world works, and justification for treating seemingly non-predictive variables as irrelevant. If you already have the answers, why ask questions?

Investigation is far from the only way to use signs descriptive realism provides. For a second example we will jump from the world of finance to my son's daycare. His teacher, compared to parents who relied upon one or two methods to control situations, whether coaxing, time-outs, verbal disapproval, physical punishment, removal of privileges, serious talkings-to, or bribery, seemed to almost dance among an unlimited and gentler set. She could intervene earlier because of the lightness of most of her interventions, depending much more on distracting the child from what they were up to than immediately correcting it. She might start a game, ask for help with something, tell a joke or story, ask for their opinion, launch a conversation, and so forth. Her repertoire seemed endless, none of it provoking confrontations and contests of will. If she did not achieve the desired effect she had not closed off the chance to try again, and having such a large repertoire, she always seemed to have something else to try.

The teacher's method, although only sketched in here, was based on following the signs, but in this example investigatory and even prescriptive aspects were secondary. She didn't need more information, she just needed to know that an intervention might be needed. The interventions were already at hand. The actions she took were light enough that if trouble was not brewing, no harm was done. If there was trouble brewing and she didn't manage to head it off with her initial intervention, she had more on tap from a large and inventive supply, and her initial action had not undermined the possibility of further interventions. It was never a process of diagnosis and prescription—analysis to identify the nature of the problem and matching it

with an appropriate remedy. It was much more a well designed and executed process of trial and error.

A third example is an explicit strategy. In *A Strategy of Decision*[35] and earlier works, Charles E. Lindblom outlined a strategy he called *Disjointed Incrementalism*, which he described as what policy makers actually do, not every time, but rather a set of effective and widely used methods.[36]

Lindblom argues that Incrementalism is well adapted to the actual conditions under which difficult decisions are made, including: uncertainty about consequences, limited resources and time for analysis, the inseparability of fact and value, and disagreements over values. This is a broader argument than we are considering. For the purposes here, what is of interest is how many of the prescriptions increase the likelihood of getting away with conjunctive reasoning that is right for the wrong reasons, as well as right for right reasons, in a disjunctive world.

The heart of incrementalism is a prescription to consider only those policy choices which differ incrementally from the existing state of society. Lindblom's distinction between a change small enough to be considered incremental and one too large, is "the difference, as it is sometimes put, between structural changes and changes within a given structure." For our

[35] A Strategy of Decision: Policy Evaluation as a Social Process, David Braybrooke & Charles E. Lindblom,

[36] I studied with Charles Lindblom in graduate school—to my great benefit. He was, however, wary of the quantitative directions I had begun exploring, fearing, I suspect, that I was one more somewhat promising graduate student about to be lost the lures of cleverness and equations—instead of trying to make useful sense of the world.

purposes we can read that as staying within the bounds of predictable relationships—minimizing disruption to the underlying disjunctions that allow conjunctive reasoning to work.[37]

A second prescription, the adjustment of objectives to policies—to adapt ends to means—guides reasoning toward taking advantage of existing routines and connections. Beginning with means rather than ends directs us toward demonstrated routines and connections, where conjunctive reasoning can operate. If we begin with ends we are free to call on relationships whose probability has not been demonstrated and whose plausibility arises from conjunctive understandings, leading us into untrustworthy territory. In addition, like the restriction to incremental changes, adapting ends to means minimizes disruption of existing disjunctions.

The number of uncertain premises and their degree of uncertainty is restricted by incrementalism's prescription to limit consideration to only a few consequences of any proposed policy. A highway designer, to mention an example given, need not consider the effects on social mobility. This intentional shortsightedness constricts both subject areas and how far consequences are projected in time. Lindblom is explicit that the consequences ignored by incremental decision makers include important consequences; the question is how to deal with them effectively. Instead of trying to construct arguments with long chains of premises—such as those required to associate highway construction with social mobility—the issues are confronted as they come up, when there is less uncertainty about what those consequences might be and more incentives to deal with them. (This is not to ignore the risks of short-sightedness but to

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[37] Lindblom shies away from hinging the definition of a small (he also uses the term marginal) change on the notion of structure because he is "not confident that the difference between structural changes and infrastructural changes can be established objectively." As a substitute he offers a distinction based on "the converging view that rests on widespread agreement concerning what is or is not important change." (p.64) After pointing out how people may differ on what they understand as a small change, Lindblom goes on to argue, "But the notion of small is not as subjective and personal as this conclusion implies, for in any society there develops a strong tendency toward convergence in estimates of what changes are important or unimportant. The convergence is of a particular kind that gives the judgment of "importance" an objective quality. Convergence develops for two reasons: because, while people favor (or disfavor) contrary things, they make issues of the same topics and because they tend to agree on which factors are important for theoretical explanations of change." This does not strike me as an adequate solution, both because I am less confident in the convergence and because even if the convergence exists it need not correctly define the difference between small and large changes—50 million Frenchmen and numerous others can be wrong. But the terms does not have to be well defined, for practical purposes all the definition has to do is point decision makers to where they should be using their judgment. A more important concern from a disjunctive point of view is that while an incremental approach protects underlying disjunctions, as an overarching principle it slights the possibility of creating them, and thereby producing new, or new reasons for, reliable behaviors. The quote is from David Braybrooke & Charles E. Lindblom, *A Strategy of Decision,* New York, The Free Press, 1970, 1963, p. 62-63. Lindblom was the primary author of chapters two through six, which details the strategy and from which this is taken, and is, as far as I know, the originator of the term "Incrementalism."

argue that attempting to foresee the unforeseeable is the pursuit of a hopeless ideal. Instead, what is needed, are mechanisms capable of dealing with consequences as they occur. See the Serial and Remedial prescriptions below.)

Another facet of incrementalism shifts much of the burden of decision making from reasoning to social process. This shift is a familiar social device: when we put something up to a vote the decision has been transferred from the dictates of evidence and logic (if there were such things when reasoning under uncertainty) or a decision making authority to the preferences of voters, which may or may not consider the arguments or address them logically. We also see reason supplanted by social process in decisions that arise from peer pressure, the weight of authority, groupthink, and so on. What incrementalism looks for, however, is a social process that is remedial, exploratory, and serial. Remedial in the sense that it aims at alleviating ills as they come to notice rather than reaching for visions of good—such ends rather than means visions are asking too much of reasoning. It is exploratory in the sense that the effort at alleviation does not have to work because it is also serial, in the sense that the process follows the maxim, 'If at first you don't succeed, try, try again.' Thus the incremental process creates a disjunction (multiple ways to reach an end), targeted at the problem at hand by its remedial, exploratory, and serial commitments.

This try and try again logic is also in Nassim Nicholas Taleb's recent discussion of strategies that take advantage of uncertainty by looking for situations, such as investments, where the cost of investing is low but the payoff for success, even if improbable, is very high. A lot of cheap investments, mostly losers but with one or a few bigs wins, and you're profitable.[38]

This use of disjunctions is even true of Incrementalism's prescription that value agreement should not be pursued—all that is required is agreement on outcomes (generally short range, such as agreement on building a school even though the school's supporters have very different views on education)—which also utilizes disjunctions. It capitalizes on many reasons for the same behavior by getting the obstacle of value agreement out of the way.

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[38] Taleb, Nassim Nicholas, *The Black Swan*, Random House, New York, 2007. See the comment on predicting Black Swans in *Paying Attention to the Improbable* in Part 3.

Taken together Incrementalism's prescriptions reduce the need to be right, whether for the right reasons or the wrong ones, by being remedial, exploratory, serial, and relying on social process for decisions, including avoiding letting decisions hinge on values where agreement is unlikely. At the same time they increase the likelihood that we will be right, if often for the wrong reasons, by restricting options to ones that are incremental, short-sighted, and adapt ends to means. These restrictions enhance the likelihood that we can find fairly predictable relationships. Although Incrementalism is a decision making strategy it is not concerned about the logic of choice. Its emphasis is on what you do to improve the odds of making good choices, leaving making the choice up to our everyday reasoning (aided at times and in limited ways by social science) and social processes.

Everyday reasoning, while it lets descriptive realism into its conjunctive formulations, is careless about predictive relationships and getting facts right, is inconsistent about the conditions it treats as worthy of consideration, tends to rely on on a biased selection of anecdotes and overemphasize current issues, draws conclusions using inadequate and often contradictory evidence, and everyday reasoners tend to run in packs—although they are not the only ones. This is only a partial list of its prominent flaws. Yet incrementalism can make use of everyday reasoning's inconsistency to the extent that it allows it to be responsive. It does not require correct understandings, although it is likely to do better without fanciful or deranged ones, so much as indications—signs that processes need be undertaken rather than understanding of what is going on. In this, it is like my son's daycare teaching methods.[39]

What incrementalism cannot do without, at least in democratic states, is fairly trustworthy, trusted, competent, and effective institutions. Polices cannot be remedial, exploratory, and serial if institutions are not trusted to try and try again. Decision making by social process is likely to

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[39] There is an enormous decision making literature, ranging from formal mathematical techniques to examining psychological mechanisms and group processes that undermine or support effective decision making. Generally, however, the emphasis is on improving the quality of decisions, or understanding how they are made, rather than, as in the three examples, adopting a broader view of problem solving as a strategy in which actual decision making, the evaluating information and applying decision rules or techniques, may well be among the least problematic aspects. In *Usable Knowledge*, with David K. Cohen (Yale University Press, New Haven and London, 1979), and later, on his own, in Inquiry and Change (Yale University Press, New Haven and London, 1990) Lindblom does come at the issue of the value of the social sciences and inquiry into social issues more directly. To my eye he informatively circles around the issues but cannot get at them clearly, since the conjunctive logic we use to evaluate information we collect is never directly questioned.

become increasingly vulnerable to demagoguery with its demands for value agreement. It is hard to accept a process that adapts ends to means when the means available seem inappropriate, inefficient, corrupt, or weak.

Making a World A Safer Place for Reasoning about Human Behavior

> **To some extent reliable behaviors can be produced intentionally. Many of the mechanisms are familiar—employment, socialization by schools and religious institutions, intimidation, and so forth. Although these mechanisms depend on disjunctions to produce the behaviors they capitalize upon, they do not require disjunctive reasoning to operate. Their effects can be larger than Incrementalism allows, although these effects may not be sustainable.**

In the late 1940's Herbert A. Simon (1965) pointed to the peculiar contractual relationship implied by employment: not simply that the employee will perform a specified task for payment, but that the employee will do what the employee is told to do. Reliable behaviors on demand—tailored to fit. The employee is expected to be obedient, within limits, although these limits range from all but indistinguishable from slavery to where the obedience is clearly consensual and entails mutual obligations between employer and employee. In addition, selection mechanisms are at work: when the peculiar contractual relationship does not produces the desired results, people can be fired, or moved to other jobs.[40] Employment can be used to create a range of reliable behaviors, more or less on demand, often with great success—which provide suitable material for conjunctive reasoning.

The viability of the peculiar contract, of course, is likely to have a disjunctive foundation. People agree to it for a variety of reasons in various combinations, as we saw in the discussion of why people accept job offers. But as noted there, we do not have to understand these reasons to

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[40] Selection is a way of capitalizing on uncertain processes. For example, as Malcolm Gladwell (*Annals of Education,* The New Yorker, December 15, 2008) argues, starting with the example of quarterbacks in professional football but aiming the problem of selecting teachers, that their performance cannot be predicted from their records: either as college players, or for teachers, prior education. The solution in both cases is to recruit a large pool but only retain those who prove effective in the professional game and in classes. This is a version of the try and try again disjunction, done simultaneously, and operated using conjunctive reasoning.

Selection mechanisms based on performance are common—probation periods for new employees, periodic performance evaluations, sales quotas, voting once a candidate has been in office, grades at educational institutions, and so on.

use them. Instead, we have to be in a situation where they are already present and we manage to avoid undermining them.

The employment contract, of course, is only one means of obtaining reliable behaviors on demand. Various social institutions—such as schools, families, and community and religious organizations—can be seen, among many effects they have, as playing a similar role. This is clear when we talk about socialization, training, learning to be a responsible member of society, and so forth. And in all these cases, their effectiveness depends on a web of influences built of obligation, trust, expectations, social pressures, fears, desires, loyalties, rewards, punishments, control of information, and so on, in various combinations many of which have the same effect—that is, a disjunction. These social institutions success in creating the intended reliable behaviors, as with the employment contract, does not, however, depend on understanding the disjunctions that make them possible so much as upon employing strategies that utilize, create, and maintain them.

These changes can go well beyond what might be considered incremental. Perhaps the most obvious example of creating disjunctions that allow larger than incremental changes can be seen in times of crisis, such as the mobilization of people and resources that can occur in times of war. Patriotism, peer pressure, perceptions of a shared threat, trust in leadership, sanctions against dissent, a sense of working together, shared goals, shaming, controlling information, rewarding and punishing behaviors, creating in-groups, scapegoating, physical coercion and threats of violence, etc., in various combinations all serve to increase the probability of selected behaviors (including the probability that behaviors won't happen).[41]

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[41] The argument is not that these mobilizations and other large but successful changes, however they may be portrayed afterwards in light of their accomplishments, are efficient. Instead they are filled with foolish decisions, doing things for the sake of seeming to do things, major set-backs, corrections, redoing things, using people who are unprepared and tools that are unsuitable, profiteering and other forms of corruption, and so forth. And there is a great deal that, as the cliche goes, is never the same again—behaviors that were once reliable that are not reliable any longer. In the case of the domestic effects of World War II in the United States, the changing role of women in the work force and in the armed service themselves, the migrations to industrial and shipping centers, the mixing in military units of people from different regions, all created lasting changes. Against all the inefficiency, however, is a more general willingness to try and try again and to solve problems that comes with high morale, the belief that success is crucial, a sense of purpose and a shared, we're all this together spirit, trust in authority, and so forth. This is not a necessarily as benign process as phrases like high morale and a sense of shared purpose might suggest. High morale and a sense of shared purpose can be built on self-righteousness, scapegoating, selfishness, resentment, and so on. But benign or not, routines and disjunctions with more or less necessary but not sufficient predictors are created, and allow a using conjunctive reasoning to manage the process.

We have strategies, like incrementalism, that are designed to take advantage of existing capabilities without putting those capabilities at risk, or asking more of us than we can generally accomplish; and we have strategies that push further but put more at risk and make greater demands, which tends to make them disruptive, costly, and unsustainable but potentially effective in the short term.

Reasoning as an Interactive Process

> **Human behavior and institutions can be modified, and often are, in ways that make them more (or less) amenable to our limited reasoning capabilities. The path to more powerful reasoning, at least a significant portion of it, is social change, large and small.**

Putting the themes of the last sections together we see that the way we generally reason about human behavior is highly misleading outside of a narrow if important range of applications, although sometimes we get away with it, at least for awhile. The question, since we cannot expect to get disjunctive things right, is how to use such flawed reasoning effectively—and for that we find, not surprisingly, that our everyday life is full of strategies and mechanisms that seemed designed for just that task. We have adapted to our limited capabilities, but haven't adequately recognized what we have done.

In short, the power of conjunctive reasoning greatly depends on the creation and maintenance of disjunctions containing common conditions. This, in turn, is a product of the characteristics of individuals and society. And these characteristics can be influenced by familiar (and unfamiliar) methods of influence, socialization, and organizing. So the path to more powerful reasoning, at least a significant portion of it, is social change, large and small.

It might even be said that we attempt to build a world, although largely constructed with disjunctive mechanisms and structures, that can be understood using conjunctive reasoning—as an adaptation to our limited mental capacity and ability to gather information. But this is too bloodless a way of saying it. In part the creation of a comprehensible world is the product of affection, loyalty, a willingness to work toward shared goals, implicit and explicit social contracts, moral and ethical behaviors, and habits that arise from such things. But it is also the

product of manipulation and coercion, of lies and appeals to fear and hate, of forced starvation, torture, and killing. While one side of achieving a comprehensible world is founded on mutual adjustment, cooperation, and even kindness, the other side has as its ultimate logic, that the only wholly predictable person is a virtual automaton. Both ways of making the world more comprehensible are widely employed.

Narrative History, Fiction, and Social Science

> **Narrative historical and fictional accounts tend to describe the human world in conjunctive terms, but because they are generally describing one way something happens, there is no intrinsic conflict between them and disjunctive thinking about human behavior. Both can contribute to supporting strategies based on descriptive realism. The Social Sciences, however, while often recognizing disjunctive features of the human world, largely attempts to handle them with conjunctive tools. So among the three it is only one in direct conflict with a disjunctive analysis of human behavior. A social science that fully accommodates disjunctive understandings would allow reconciling the insights of the humanities and the sciences.**

Consistencies in human behavior arise, in a disjunctive system, because there are many ways something can happen and one of them is likely to occur. Taken individually, each of these ways is a conjunction. A disjunction is made when there is some probability any of a number of them will happen. A narrative historical account can be understood as describing one of these conjunctions, a single sequence of events, the one that appears to have happened. In principle, then, there is no inherent conflict between the reportorial objectives of historical accounts and a disjunctive understanding of the human world. Historical accounts describe one of the ways things can happen.

As such our concerns are with its practical limitations. Much of the information required to fully explore how human events happen is inaccessible. The information is, or was, in people's minds. It went unobserved or unreported. We may not understand what was influencing the people involved, or even who was involved—which is not to say it could't be understood, just that it wasn't—and so did not consider or investigate relevant factors. And so on. Still, we can strive towards the most plausible interpretation of the information available. One way it could have happened even if not, clearly, the way it did happen.

This takes us an answer to the perennial question: What is the practical value of studying history? Historical accounts can be used in the same way we use other sources of descriptive realism. Having at least the possibility of being more rigorous and thorough in their search for and use of evidence than is typical, and tending to go outside what most people know from their own and peers' experiences, they can be especially valuable. In short, the study of history has the potential to give us a better idea of what to watch for when looking for the diverse and ambiguous signs that guide the descriptive realism strategies discussed earlier.

The trick is to value this contribution for what it is, and not try to turn it into more deductively powerful lessons. There madness (and perhaps tenure) lies.

Fiction can overcome some of the practical limitations of historical studies, since it can invent what goes on in people's minds and supply every relevant event. In this sense fiction can achieve greater realism than a scrupulous historical account. It allows weaving together what we know must go on but cannot observe with what could be observed if the events in the story had actually occurred. But the only tests of this realism, since evidence cannot be brought directly to bear, is judgments about the credibility of its characters and situations.

We can ask the same question about fiction's practical value that we ask about histories. In addition to answers about it's value as entertainment (something that some historical accounts can claim as well), fiction, especially by its delving into realms that can only be reached by going well beyond what can be observed, the answer is much the same as that of historical accounts. For the purpose of the strategies using descriptive realism one is not necessarily more useful than the other. It comes down to cases.

Of the three types of accounts of human behavior under discussion in this section—narrative history, fiction, and social science—only the social sciences have traditions and ambitions that directly conflict with a disjunctive understanding of human behavior. Narrative history and fiction's traditions and ambitions, their focus on particular sequences of events and stories, largely aim them at aspects of the human world that can be described conjunctively. But the social sciences, in their attempt to explain various phenomena—patterns of behavior, characteristics of individuals and groups, predictable relationships—attempts to deal disjunctive

phenomena in largely conjunctive terms. Of the three, then, only the social sciences are inherently at odds with a disjunctive understanding of the human world.

The social sciences, however, do not always follow these traditions and practices with an easy mind. There is, among some social scientists, as Daniel Little describes it,[42]

> ...doubt about the availability of strong universal laws among social phenomena; attention to the multiple pathways and structural alternatives that exist in large-scale historical development; awareness of the deep heterogeneity of social processes and influences—in time and place; attention to the substantial degree of contingency that exists in historical change; attention to the plasticity of social organizations and institutions; and attempts at bridging between micro- and macro-level social processes.

The question is what to do about these doubts, and the answer has largely been to try to limit the universalist ambition but hold onto the rest of a conjunctive approach.[43] Little goes on to list some of responses in sociology, including,

> ...**comparative historical sociology**. The core of the approach is a concern for large historical structures embodied in different social settings, and a conviction that we can discover historical causes by comparing in detail the unfolding of some important historical processes in different social settings… concrete **causal social mechanisms**... emphasize social variability, path-dependence, and a methodology emphasizing the discovery of specific social mechanisms that combine in novel ways in different historical circumstances... abandonment of the ideal of discovering regular historical patterns… in favor of specific historical trajectories in specific settings...**case study methodology**… we can examine single instances, and the events and conditions that led up to them, in order to discern some of the causal mechanisms that were instrumental in bringing the event about… **new institutionalism** has made the point very convincingly that the specific rules that constitute a given institution make a substantial difference to the behavior of persons subject to the institution—and this has

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42 Daniel Little, *Agents, Structures, and Social Contingency: New Thinking About the Foundations of the Social Sciences*, a lecture given at Tsinghua, available as a PDF at www.changingsociety.org.

Little own position is probably more radical than most social scientists would accept, including those he discusses—making sharp distinctions where they might see less problematic differences of degree. In the lecture's conclusion, he says, "The social world is not a system of law-governed processes; it is instead a mix of different sorts of institutions, forms of human behavior, natural and environmental constraints, and contingent events. The entities that make up the social world at a given time and place have no particular ontological stability; they do not fall into "natural kinds"; and there is no reason to expect deep similarity across a number of ostensibly similar institutions – states, for example, or labor unions. So the rule for the social world is—heterogeneity, contingency, and plasticity. And the metaphysics associated with our thinking about the natural world—laws of nature; common, unchanging structures; and predictable processes of change—do not provide appropriate metaphors for our understandings and expectations of the social world; nor do they suggest the right kinds of social science theories and constructs."

43 There are, of course, exceptions. One is agent-based simulations.

> major social consequences… the **cultural turn** in social research. Social scientists and historians have come to recognize the irreducibly "cultural" nature of social behavior. Human beings construct their worlds and their actions around a set of understandings, values, and identities that are variable from place to place, and that make a difference in large social outcomes [emphasis in original]

What Little describes is conventional social science writ small. Multiple explanations, yes, but each in its own contingent pocket for use one at a time. (This is suggested by phrases like, "specific historical trajectories in specific settings," "discern some of the causal mechanisms," "specific rules that constitute a given institution make a substantial difference to the behavior of persons subject to the institution," and "a set of understandings, values, and identities that are variable from place to place, and that make a difference in large social outcomes." All of these phrases point to finding consistencies within—contingent upon—specific contexts. Once the contingencies in which each understanding applies is established, we can apply the right explanation at the right time. In short, in spite of having multiple explanations we are still thinking in largely conjunctive terms—by narrowing its focus to where one explanation can be used at a time.

We can find a similar turning away from universalist ambitions is at the core of the arguments such as those by Donald P. Green and Ian Shapiro (see footnote 15), both political scientists, against the universalist ambitions of rational choice theory.

> Rational choice theorists are not the first to believe that the way to place the study of politics on the secure path of a science is to embrace a new paradigm, outlook, approach, or general theory. At different times systems theorists, structural–functionalists, and Marxist, among others, have all harbored comparable theoretical ambitions. Although it is always possible that an architectonic effort of this sort will bear fruit, the history of accumulated failures leaves us skeptical. In our view, advances in political science are more likely to come at the level of the hypothesis or middle–level generalizations than at that of the grand theory or or paradigmatic innovation, and the energy that is poured into developing new theories and paradigms, translating the existing stock of knowledge into them, and defending them against all comers, would be better spent on problem–driven research. As we've sought to establish in the preceding pages this stance is not borne of any particular animus towards theorizing.

> Rather, it rests on the pragmatic judgment that empirically sustainable general theories about politics are unlikely to be formulated in any other way. [44]

But a less universalist, contingency based, problem-driven retention of conjunctive thinking is less a solution than a way of avoiding the worst excesses of a flawed method. Its narrowing of scope should allow finding more powerfully predictive relationships than a wider one, but this social science writ small is based on the same basic error as more universalist social science writ large: using conjunctive models to try to understand disjunctive phenomena. As such it leads to the same types of misapprehensions and errors we have been discussing throughout this essay. It is not a fully coherent way of thinking about the human world.

Social sciences based on disjunctive explanations would not introduce these misapprehensions and errors, and would allow a mutually supportive reconciliation between the humanities and the social sciences. The diversity and detail the humanities often champion, in history and fiction, would no longer be in conflict with rigor of a scientific approach. Their accounts of diverse actors and sequences of events would simply be descriptions of one of the ways things can happen, understood as part of a larger disjunction. Part 3 of this essay will show that the basic quantitative and conceptual foundations of such a social science are straightforward.

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[44] *Reflectons On Our Critics*, Donald P. Green and Ian Shapiro in *The Rational Choice Controversy*, Jeffrey Friedman, Yale University Press, New Haven and London, 1996, pp. 270.

Part 3

A Quantitative Solution: Doing the Arithmetic

As we have seen, much of the great intellectual apparatus associated with rationality and science is not well adapted to the study of the disjunctive human systems that mentality makes possible. Conventional foci—commonalities, central tendencies, distinguishing signal from noise, parsimonious and unifying models, abstracting to covering laws, theory testing—might as well have been designed to overlook human disjunctions. Reduction to basic principles is not a powerful strategy if those principles just tell us that things can happen in lots of different ways. (Knowing the rules of chess, for example, tells us very little about how any game will actually proceed. Its basic principles—the rules—instead of representing a profound knowledge of the game represents a trivial one.)[45] A competition of ideas is not appropriate when many of those ideas can be a part of the correct explanation of a phenomena. Clear categories are a poor way to capture the variety of human characteristics and relationships that arise from mentality. An emphasis on discovery is hardly to the point if the troublesome issue is less how to explain behavior than determining what explanations imply.

It turns out that for the most part we can set this apparatus aside. Doing so greatly simplifies the nature of the quantitative analysis. Once we think in terms of human behavior's reliance on disjunctive mechanisms to generate predictability out of uncertainty, and that these disjunctions are largely built from the numerous combinations that arise from a relatively small number of conditions, quantitative analysis, now able to go directly at what is going on, is simplified. This is not to say that the computational requirements aren't substantial, or that the behaviors are not in themselves complicated, but that what is being computed, compared to conventional approaches, is more straightforward and concrete.

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45 Similarly, understanding the logic of a computer's hardware provides very limited information about what programs will be run on it, or even the logic of the software. These analogies illustrate why the the power of reduction is not a matter of whether there are basic principles underlying behavior—there must be in a coherent world—but to what extent and in what ways knowing them is likely to be informative.

The idea, then, is that we can get at the questions we generally want to answer—what makes a difference and by how much—without the complicated, often ambiguous, and even arcane apparatus of conventional statistics, and without the conceptual muddles created by imposing conjunctive thinking on disjunctive phenomena. We suspect that much of the difficulty in applying and interpreting conventional statistics, and its growing mathematical complexity, stems from the mismatch between the logic of their models and the logic of the phenomena.

Basic Concepts in Disjunctive Mapping

Maps Not Models

> **The variety of ways an outcome can happen can be described as a set of paths. Taken together the set of paths can be thought of as a map: various ways to get to an outcome. Because the paths are independent of one another each can have its own logic: in the same way as taking highways, staying on side roads, traveling down a river by motor boat or raft, taking the train, flying by aircraft, blimp, or helicopter, and so on have their own logic. Models, by contrast, do not have that freedom and for the most part are not seeking it, as they are looking for unifying logics that covers as much as possible. Using a map, the task of analysis is to answer questions by looking up the various paths that are relevant, measuring and summing their effects. Using a model, the task of analysis is to represent the key dynamics, and reason from that information.**

We can describe the conditions that lead to human behaviors—motivations, habits, events, beliefs, conventions, feelings, influences, perceptions, social pressures, circumstances and so forth—quite simply as paths (or streams of inputs leading to an output). For example, a sequence or combination of three input events, A, B, and C, leading to an output behavior X.

$$A \;\; B \;\; C \rightarrow X$$

If there is uncertainty associated with the output, that is, if it could have more than one outcome, we would need at least two X's. One (X_1) would represent when X occurs and the other (X_2) when X does not.

$$A \;\; B \;\; C \rightarrow X_1, X_2$$

If there is uncertainty about both the inputs and the outcomes we could represent it with a stack of paths, one for each combination of inputs.[46]

$A_1 \quad B_1 \quad C_1 \rightarrow X_1, X_2$

$A_1 \quad B_1 \quad C_2 \rightarrow X_1, X_2$

$A_1 \quad B_2 \quad C_1 \rightarrow X_1, X_2$

$A_1 \quad B_2 \quad C_0 \rightarrow X_1, X_2$

$A_2 \quad B_1 \quad C_1 \rightarrow X_1, X_2$

$A_2 \quad B_1 \quad C_2 \rightarrow X_1, X_2$

$A_2 \quad B_2 \quad C_1 \rightarrow X_1, X_2$

$A_2 \quad B_2 \quad C_2 \rightarrow X_1, X_2$

We can think of a listing of ways to go from the inputs of human behavior to its outputs as a map—or at least as a stack of path maps.

A map shows various ways to get from here to there. There is no difficulty if each of the paths has its own logic, passing through different locations and using different means of conveyance—go through the mountain pass, follow the river valley, take the coastal route but avoid the marshes, take the scenic highways, take the train, take the ferry, fly. But models have to find or impose a limited number of underlying logics, only one if possible. Thus models are a poor fit when there are multiple underlying logics and diverse factors from one instance to another, as there can easily be when behaviors arise from various combinations of reasons. Maps simply show what is there.

In conjunctive but noisy phenomena we would expect one path to account for most of X_1's probability, with trace amounts on other paths. The analytic task would be, first of all, to define that path: its principles (rules) or functional form, and the variables involved. Having done so, that path can serve as a model for whole system—a viable approximation (just as those in the tradition that Knight exemplifies would expect). We would then use the model as a stand in for

[46] To keep the example simple each input (like the output) has only two states, they either happen or they don't. The Map can be constructed with any number of input and output states for each input and output variable, and any number of inputs and outputs.

the entire system, with more or less caution depending on the quality of the fit and our confidence in having captured the underlying forces or patterns.

In a disjunctive world we we would expect X_1's probability to be distributed among the paths, with no expectations about its concentration. The analytic task would be, first, to identify the conditions and paths (combinations) that contribute to that outcome and measure their contributions. The result is not a model, but rather, reference materials. We can look up which paths contain the strongest input-output relationships, which occur most frequently, what roles individual conditions play across paths, what conditions are on influential paths, what the probability of an outcome is given a set of paths, and so forth. No model is required or appropriate, as there is no core logic or narrow set of critical conditions to capture. Analysis is a matter of looking up their effects by selecting conditions and paths and performing the appropriate calculations.

Categories Not Continua

> **The map is a logical rather than a mathematical representation, based on propositions rather than functions. As such, it deals in categories not continua. This is especially appropriate for data representing information humans respond to, as we tend to interpret continua in categorical terms—such as middle class income referring to a range, and poor a different range, and so on. Using categories can add information by describing how the data is chunked into categories.**

The Map is a logical rather than a mathematical representation of behavior. Its path by path structure is along the lines of, 'If *A* and *B* and *C*, then *Y*,' rather than, y = *f*x. Propositions rather than functions. These propositions are assigned probabilities computed from data.

Logical propositions, however, are categorical, while much of the information we have about human behavior, such as information on income, price, rates of literacy, percentages of religious affiliation, scales measuring attributes such as intelligence or depression, consumer preference, and so forth are measured on continuous scales. Points on a continuous scale do not have a probability—only segments of the scale do. So, when used in a logical model a variable like income would have to be divided into segments, such as ranges of dollar amounts that represent

substantive classifications, such as poor, middle class, and rich income levels, although finer distinctions will often be required.[47]

In statistics converting legitimate continuous variables into categorical variables is considered throwing away information on finer gradations and distances between measures. But because we are dealing with human responses, we can gain information instead. Since George Miller's classic 1956 paper, *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information,* there have been a series of demonstrations that we break (or chunk) continua into a rather limited number of categories, and that there are cognitive limitations that force such strategies upon us.[48] The tendency to stereotype, to create dichotomies, to consider only a few options when making decisions, and so forth, seems to be more than just a bad habit or satisficing. Thus a model of human behavior that tracks how one thing leads to another, if it works from continua, is using a surrogate for the information that actually influences responses—the categorical interpretations we impose on continua. Conversion allows adding this information.[49] For this reason, generally speaking, human behavior should be more effectively modeled by categories than continua.[50] The necessity of using categories is more a feature than a bug.

The choice of categories, and more generally the degree to which conditions should be aggregated or disaggregated, depends on whether there is information to be gained. If it makes a significance difference to the probability of an outcome to divide an event, we learn something

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[47] Note that categories are often ordered on some dimension, such as social class, income, intelligence, military rank, and so forth.

[48] Miller, George. A. (1956) The magical number seven, plus or minus two: Some limits on our capacity for processing information, Psychological Review, 63, 81-97.

[49] There is no difficulty in using multiple interpretations of a single continua—converting one continua into many sets of factors—thus capturing different categorizations that people use. Unlike covariance based statistics, correlated measures are neither hard to interpret, nor do they create mathematical problems.

[50] When applied outside of human behavior, probability mapping may still be appropriate when phenomena can be handled categorically and have a disjunctive structure, medical diagnostics and epidemiological studies are potential examples.

by doing so [51] (The Disjunctive Mapping method discussed below provides support for finding the most informative level of aggregation.)[52,53]

Having argued for using categories we should note that logistic regression can be used to build models using using continuous input variables and discrete output variables to obtain probabilities of outcomes, each model representing a single path in a Map. Although single path modeling should be simpler than building regressions for more encompassing phenomena, using regression to create paths in a map is apt to greatly increase the effort required to construct a map. For the substantive reasons just discussed, the expected increment in the map's accuracy and utility may not be worth the effort.[54]

Variables and Missing Information

> **The values (alternative conditions) of the categorical variables describe all possible outcomes of a state of the world, using catch-all categories, like 'Other' if necessary to fill the gaps. This allows analysis to explore how much of an outcome's probability arises from unknown conditions.**

Disjunctive Mapping's variables are composed of conditions (the variable's categories, its values) that fully describe the possibilities of a state of the world. That is, in the situation in question one of them will occur. While it will sometimes be possible to define all the conditions with specific categories, such as when people are classified into age groups, there will often be a number of cases where there is either no information available or no suitable category, often characterized as Not Applicable, Other, or left blank (Unknown). In Disjunctive Mapping

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[51] 'Significance,' of course, can be a first rate weasel word. If it indicates statistical significance, it refers to a seemingly clear line that is, unfortunately, predicated on a somewhat arbitrary number representing what has been customarily treated as an acceptably low probability that an observed difference occurred by chance, and which depends not only on the difference but the size of the sample. If it refers to practical or clinical significance, we have to answer a *how much is enough* question. What difference is enough to make a difference worth noticing? While this can be a difficult question to answer, when working in probabilities rather than measures of explained variance, at least we are not faced with interpreting dimensionless numbers measuring the change in predictability if a variable or variables is added or removed from a model. A probability can be interpreted straightforwardly as a percentage, and when appropriate, one that allows direct application of expected value frameworks.

[52] The current implementation of Disjunctive Mapping uses recursive partitioning to segment variables when other segmenting criteria are lacking or need to be be tested. Future versions will test segmentations within the program.

[53] Note that 'variables' as used in Behavior Mapping does not imply that the categorical elements a variable contains are substantively connected beyond being alternative possibilities. The terms 'sample space' and 'universe' as used in probability theory would be more appropriate if they were not so awkward in non-technical usage.

[54] This capability is not implemented.

categories along these lines insure that all variable account for all the possibilities. These can be important categories for analysis. There are outcome probabilities for the paths where these space holder categories are present just like any other path, so they be treated as conditions representing a lack of more specific information, and as such can identify paths where those outcome probabilities may be poorly accounted for by the information and understandings available. The sum of the probabilities of these paths provides a rough measure of what we might call ignorance, since we can specify the probability of the paths but not the some of the condition on the paths.

Commonalities Are Not the Basis for Explanations

> **Disjunctions do not require commonalities to produce reliable outcomes. Disjunctive Mapping does, however, measure commonality's effect when they are present, and this measure is likely to be more informative than conventional statistics, which attribute the effects of the complete disjunction to its commonalities. Knowledge of commonalities can have important practical uses as predictors and may represent effective levers on the overall disjunctive system.**

The explanation of predictable and reliable behaviors is the sum of the probability of different paths. These paths need not contain common conditions at all, and if they do contain commonalities, they need not have substantial effects. However, DM recognizes commonalities when they are present, and provides tools to show the contexts (combinations of conditions) in which they have effects. Compared to conjunctive explanations that require commonalities to find the consistencies they require, DM is unbiased.

Conventional statistics, relying on measures of explained variance, exaggerate the power of commonalities by attributing to them what is actually the product of the disjunctions that contain them. (See *Prediction and Explanation* above) Thus we would tend to think of conventional measures as likely overestimates of the commonality's effects.

That commonalities are not necessary for explanations of reliable behavior, nor necessarily reflections of underlying forces (See *Explanation* above), and that we tend to exaggerate their effects, in no way denies that if commonalities have similar effects on a number of paths they

can be of great practical importance as an efficient way to predict or manipulate diverse combinations.[55] It is only to say that we misunderstand why.

More a Cooperation than a Competition of Ideas

> **The probability of an outcome is the sum of the probabilities of the paths that lead to it, and each path is an explanation of a way the outcome occurs. The differing explanations can be thought of as cooperating to explain the outcome. A competition to find the best explanation would only identify the path (or paths subsumed by an abstraction) that is currently the most probable ways to reach an outcome.**

Since each of the paths in a disjunction may each have its own explanation, a number of explanations are true for any outcome—although each is true only some of the time. It takes many if not all of them, however, to explain an outcome's probability. Thus the explanations might be said to cooperate.

Explanations can compete on a path level (the path, after all, are conjunctions). But the winner of the competition gets a much smaller prize than when explaining a mechanism that is conjunctive throughout. All the winner has done is explain one part of a disjunction, perhaps just a single path, and possibly not a very large part—even if it is the path with the highest probability of reaching the outcome.

Also, as we have seen, when maximizing universality is no longer a key criteria for good explanations, good explanations of human behavior no longer seem as elusive. So considerations of the limited value of finding a winner, along with, as we have seen, good reason to suspect that a lack of adequate explanations is not what makes thinking about human behavior so difficult, gives theory testing a low priority.

Parsimony Is Not an Analytic Ideal

Since a disjunctive explanation works via the proliferation of ways something can happen, holding parsimony as an ideal is an invitation to misrepresentation. This is not simply a matter of

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[55] When reliable behaviors are understood as the product of disjunctions, commonalities are more likely to be seen as the product of ways we make our world more manageable than the products of underlying forces.

oversimplification, but of distorting the central causal mechanism, which arises from that proliferation.

Investigate Outcomes Not Relationships

Human behavioral phenomena are not one thing, but many, consisting of the diverse ways an outcome occurs—and different instances of a phenomena are apt to contain both different conditions and different relationships. So to have a coherent target for investigation, it has to be the outcome. The inputs are all over the place. This implies that asking questions which implicitly unify a phenomena—such as asking for a theory of conflict resolution, consumer preferences, religious belief, nationalism, and so on—is less than fully coherent.

Interpreting Conditions and Paths

> **Statistics works with measures of states and things, and if the states and things being measured are not the same on relevant dimensions, meaning is drained out of the analysis. In ordinary language, context and modifiers allow shades of meaning, but conventional quantitative analysis must strive towards variables that stand on their own, interactions and contingencies conflict with parsimony and universality, and the program of identifying coherent basic forces. Disjunctive mapping, with no interest in parsimony or universality, provides a distinctive context for every condition: the path it is on. Thus the path, not the condition (a state of a categorical variable), can be thought of as the smallest well-defined unit.**

Everyday understandings use context: a knowledge of motivations, circumstances, personal characteristics, and so forth that allows us to interpret—rightly or wrongly—what we observe. In any case, a single behavior can signify very different things. There are many reasons for a person getting angry, getting a B+ in calculus, signing a contract, becoming an elementary school teacher, treating another person with courtesy or contempt, voting for the Republican candidate for Governor, deciding another nation's armaments represent a threat, professing belief in a political or religious doctrine, buying a pickup truck, and so on. This not a necessarily a problem

for ordinary language, which can use modifiers and describe contexts.[56,57] But it is an issue in conventional quantitative empirical analysis. Whatever the heavy math that might be applied once data has been collected, analysis relies on the assumption that its categories adequately represent, for the purposes of the analysis, comparable entities. To the degree that whatever is counted or measured is not comparable on relevant dimensions the analysis loses meaning.[58]

This problem, however, is not built into the map. Each condition is embedded in a path, which defines its context. Just as an condition's probability is understood as (potentially) conditioned by the conditions that precede it on a path, so a condition's content is understood as (potentially) conditioned by those preceding conditions, and its effect on the probability of the outcome conditioned by subsequent conditions as well. So just as in ordinary language each condition is set in a defining context. The limits on definitions are also similar: the information available to define that context and our willingness to consider it.

In principle, this makes the path, rather than the condition or the variable (since their content can vary by context), the smallest well-defined, or one might even say, coherent unit.[59]

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[56] The point that a single behavior can indicate a wide variety antecedent reasons is central to John Searles's argument that Behaviorism, with its prohibition against considering mental states (we carry the effects of antecedents in our minds), does not make sense. See …

[57] Context setting is not just a matter of providing descriptive information. Context is also provided by information about the purposes of a description, allowing intelligent choices about what other information is relevant and how the description should be interpreted. We would, for example, bring a very different understanding to the term 'insane' when used as an off-hand comment intended to dismiss an opinion, and as part of a medical judgment determining someone's fitness to go to trial.

58 Terms in conventional analysis are understood as defined by relevant commonalities rather than by what Wittgenstein called 'family resemblance,' which, in requiring context to point to which of the potentially shared qualities are relevant in a particular usage, would be closer to the expectation in Disjunctive Mapping.

59 Except in the unlikely case when the are no dependencies between the elements. We have abandoned the ideal that terms are supposed to have only one meaning, and a clear one at that. This is not a loss, just a way to find clarity where it actually resides. Clarity is available at the level of paths—if they are well constructed. This is congruent with a point we made earlier, that it is the combinations (path) not the common factors that account for behavior — these common factors may be many different things so we should not be using them to explain matters, The analysis and synthesis, reduction, tradition, however, is to search for small coherent units and build explanations from them. In DM shows this procedure is not appropriate, we look for coherence at a high level.
There is no practical problem with using nominal definitions—as long as you know what you are doing.

Narratives rather than Basic Forces and Structures as the Central Explanatory Metaphor

Each path represents a description of one way an outcome can occur. Each could be told as a story, or history: a narrative whose it-happened-this-way-this-time sense derives from the kind of everyday understandings discussed in *Part One: Explanation*. In that discussion we noted that once an outcome has multiple explanations, individual explanations do not have to account for a great deal. So narratives we would dismiss as insufficiently general for conjunctive explanations can be entirely adequate when part of a Map. Also, as we also noted at the close of Part One, a correspondence between narratives and individual paths reconciles understandings associated more with the humanities with those of the social sciences without loss of nuance and variety on one side of logical rigor and empiricism on the other.

Understanding Conditions by their Effects on Paths

> **Since conditions are understood in the context of their paths, it follows that measures of condition effects should be measures of their effects in that context, and that we would expect a condition to have different effects on different paths. The measure of a condition's effects is the difference in outcome probabilities between the paths on which a condition or combination of conditions is present and those where that condition or combination is absent.**

Given the ambiguity of conditions outside of the context provided by paths (or more generally, a narrative or other ways to establish a context), and that we would expect conditions to have different effects depending on their paths (context), a condition's influence is understood and measured at the path level. This produces intuitively accessible measures of effect. A condition's effect is measured by the difference in outcomes probabilities when it is present and when it is absent, on otherwise identical paths or sets of paths. The comparison is cleanest if the paths are otherwise identical. As a practical matter, however, we may have to rely on similar combinations. There is, in general, no free-standing, contextless, definition of a condition's effects, nor should there be.

Probabilities as the Measure of Effect Size

Working with categorical variables, the primary practical question is likelihood. Is it going to happen? Under uncertainty that question becomes, How likely is it? Probabilities address these questions with an easily calculated number that can be understood as a percentage.

The Disjunctive Mapping Program

The Map

> **The map is simply a listing of all the paths formed by combinations of conditions, with associated statistics. In short, it describes the disjunction narrative by narrative.**

The Map produced by the DM program consists of one row for each path, and one column for each input variable: the basic layout shown above in *Maps Not Models*. To the right of the variables are the output columns, listed by conditions. An input variable has only one column regardless of the number of conditions, since only one conditions occurs in any combination. An output variable has as many columns as it has conditions, since any of the outputs can occur given a set of inputs. Looking at any row we see the contents of a path and its outcomes. The paths and their outcomes, taken together, along with a few basic statistics, map the disjunction.

We will follow an example comparing two junior high school programs, one currently in use and the other incorporating proposed revisions, using standardized test scores.[60] The study randomly assigned 400 students to the two programs, 303 remained in the study, with almost all of the drop outs from the current program. The test scores were divided into three categories, High, Medium, and Low. The study also collected data on school quality, administrative support for the curricula, and each student's grade and sex. The study's purpose was selecting the program that produces the most students with High test scores.

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[60] The data is from a real study but it was not about educational programs, and it used different categories.

The Map constructed from the study's results has 77 rows, each representing one combination of the input variables (only the combinations that occur in the data are included). The first 30 rows are shown below, sorted by path frequency, the DM program's default setting. Each path represents one way an outcome might happen, the Map shows all the ways an outcome can happen recorded in the data.

Figure 3.1

Curriculum Study Map

	Route	Curriculu	Grade	School	Admin	Sex	High	Med	Low	N	route probability	route potential	route contributio	%route contribution
1	7FemaleBToleratesGood	B	7	Good	Toler...	Fe...	10	10	4	24	0.079	0.417	0.033	8.696
2	7MaleBToleratesGood	B	7	Good	Toler...	Male	7	8	2	17	0.056	0.412	0.023	6.087
3	7MaleBUnderminesGood	B	7	Good	Unde...	Male	5	9	2	16	0.053	0.313	0.017	4.348
4	7MaleAUnderminesPoor	A	7	Poor	Unde...	Male	1	9	1	11	0.036	0.091	0.003	0.870
5	7MaleBUnderminesPoor	B	7	Poor	Unde...	Male	3	4	4	11	0.036	0.273	0.010	2.609
6	7FemaleBUnderminesGood	B	7	Good	Unde...	Fe...	4	5	0	9	0.030	0.444	0.013	3.478
7	8MaleAUnderminesPoor	A	8	Poor	Unde...	Male	2	6	1	9	0.030	0.222	0.007	1.739
8	7MaleBSupportGood	B	7	Good	Supp...	Male	7	1	0	8	0.026	0.875	0.023	6.087
9	9FemaleBToleratesGood	B	9	Good	Toler...	Fe...	4	2	1	7	0.023	0.571	0.013	3.478
10	8FemaleAUnderminesPoor	A	8	Poor	Unde...	Fe...	2	5	0	7	0.023	0.286	0.007	1.739
11	7FemaleBUnderminesPoor	B	7	Poor	Unde...	Fe...	0	6	1	7	0.023	0.000	0.000	0.000
12	9FemaleBSupportGood	B	9	Good	Supp...	Fe...	6	0	0	6	0.020	1.000	0.020	5.217
13	9MaleBToleratesGood	B	9	Good	Toler...	Male	3	2	1	6	0.020	0.500	0.010	2.609
14	7FemaleAToleratesGood	A	7	Good	Toler...	Fe...	2	3	1	6	0.020	0.333	0.007	1.739
15	7FemaleBUnderminesAve...	B	7	Average	Unde...	Fe...	1	5	0	6	0.020	0.167	0.003	0.870
16	7MaleAToleratesPoor	A	7	Poor	Toler...	Male	2	2	2	6	0.020	0.333	0.007	1.739
17	7MaleBToleratesPoor	B	7	Poor	Toler...	Male	1	4	0	5	0.017	0.200	0.003	0.870
18	7MaleBToleratesAverage	B	7	Average	Toler...	Male	2	3	0	5	0.017	0.400	0.007	1.739
19	8FemaleAToleratesPoor	A	8	Poor	Toler...	Fe...	2	2	1	5	0.017	0.400	0.007	1.739
20	7MaleBUnderminesAverage	B	7	Average	Unde...	Male	0	4	1	5	0.017	0.000	0.000	0.000
21	9MaleBSupportGood	B	9	Good	Supp...	Male	5	0	0	5	0.017	1.000	0.017	4.348
22	7MaleASupportGood	A	7	Good	Supp...	Male	5	0	0	5	0.017	1.000	0.017	4.348
23	7FemaleAUnderminesPoor	A	7	Poor	Unde...	Fe...	0	3	2	5	0.017	0.000	0.000	0.000
24	9MaleBUnderminesGood	B	9	Good	Unde...	Male	1	2	1	4	0.013	0.250	0.003	0.870
25	8MaleAToleratesPoor	A	8	Poor	Toler...	Male	0	3	1	4	0.013	0.000	0.000	0.000
26	7MaleAUnderminesAverage	A	7	Average	Unde...	Male	1	3	0	4	0.013	0.250	0.003	0.870
27	8FemaleBUnderminesPoor	B	8	Poor	Unde...	Fe...	0	3	1	4	0.013	0.000	0.000	0.000
28	7MaleAUnderminesGood	A	7	Good	Unde...	Male	0	3	1	4	0.013	0.000	0.000	0.000
29	7FemaleBSupportGood	B	7	Good	Supp...	Fe...	3	0	1	4	0.013	0.750	0.010	2.609
30	7FemaleAUnderminesGood	A	7	Good	Unde...	Fe...	0	4	0	4	0.013	0.000	0.000	0.000

The analytic problem is how do we extract useful information without collapsing the diversity of paths it contains, or denying its disjunctive structure, and thereby throwing away potentially valuable information.

Basic Statistics

The map is analyzed using three basic statistics. Path Probability, Path Potential, and Path Contribution (measured in two ways). Path Probability is simply the

probability of the path regardless of outcome Path Potential is the probability of the outcome accounted for by the path. Path Contribution is the probability that the path will occur and the outcome will occur (Path Probability x Path Potential), also shown as the percentage of the outcome's probability the path accounts for.

The Map contains four calculated columns for each outcome (for reasons of space and keeping the example used below simple, the columns for only one outcome are shown). These statistics, all straightforward, are the basis for drawing inferences about the effects of paths and conditions in the disjunction.

The *Path Probability* of Path i is defined as the probability that path i occurs, a relative frequency:

$$N_i / \sum N$$

Where N_i is the number of instances of path i, and the summation is taken over all paths. This is simply the probability that a path will occur, regardless of the outcome.

The *Path Potential* of Path i is the probability of the outcome of interest given the path:

$$(\text{Frequency of Outcome of interest on Path i})/N_i$$

Path potential measures the strength of the relationship between the conditions on a given path and an outcome, as a probability.

The *Path Contribution* for Path i is the probability of outcome of interest accounted for by the path, relative to all possible paths:

$$(\text{Path Potential})_i * (\text{Path Probability})_i$$

Path contribution combines path potential with path probability, producing a measure of the extent that a path plays a role in the probability of the outcome, which depends on both the strength and frequency of a relationship. It is expressed in two ways: as the probability that the

conditions on the path and an outcome will occur, or the same probability as a percentage of the outcome's total probability.

Once you have the Map and these measures, data analysis is quite straightforward and flexible.

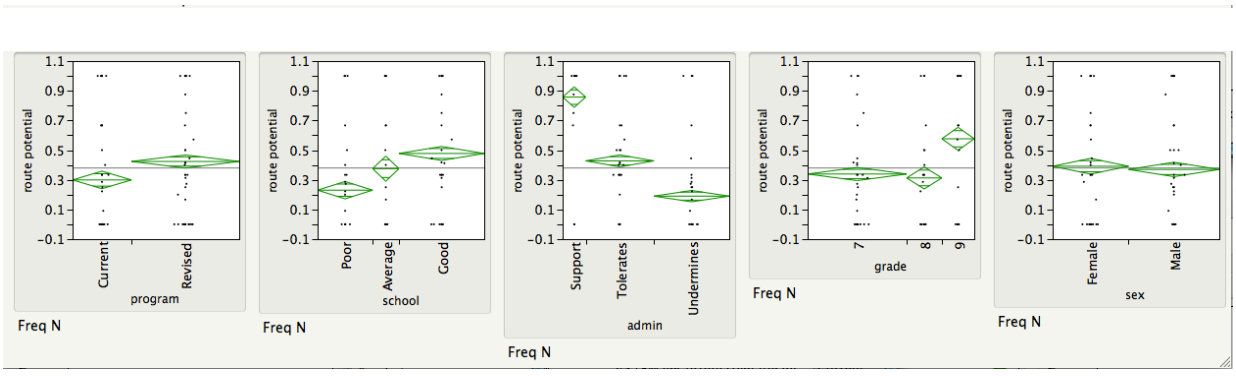
Influence

Influence uses path potential to measure of the effect of condition on the probability of an outcome. The measure is calculated as the weighted average of path potential across selected paths. By looking at different selections of paths it can address a wide variety of questions, showing how much a condition or conditions influences an outcome and how that degree of influence compares to what else might happen.

The way this works is easiest to see with an example. The charts in Figure 3.2 show the influence of all the conditions in the map, variable by variable, the left most chart showing the influence of the current and revised programs and continuing on to the variables in the study. It is a picture of the quantitative effects of the variables on the probability of the outcome, given the combinations found in the data, and including statistical control for sampling error. (The charts show the results of an ANOVA applied to data structured by the Map and using Path Potential as the response variable. Computation of the means and confidence intervals is weighted by path frequency, N.)

Figure 3.2

Influence on All Paths



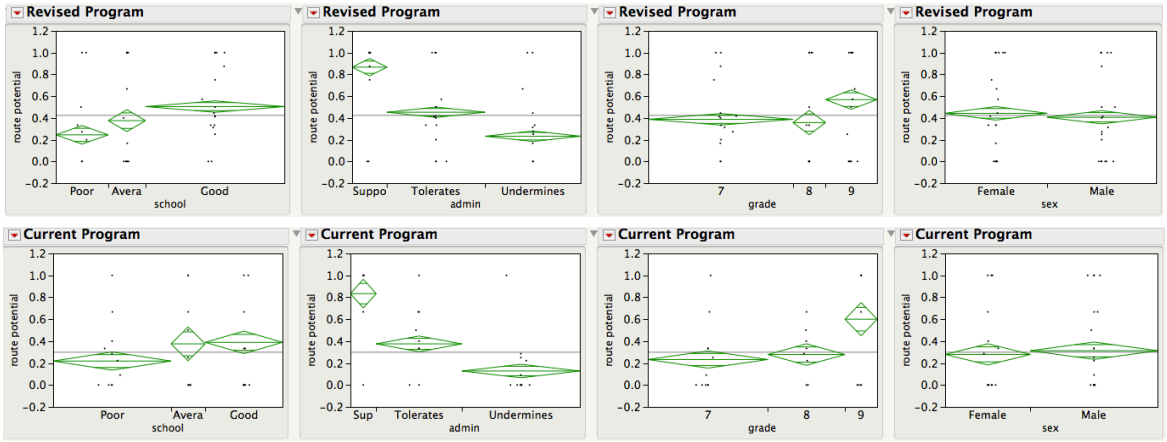
Reading the charts: The probability of a high score is shown by the center line in the diamonds. The diamond's vertical dimension represents a 95% confidence interval (this value is adjustable). The diamond's horizontal dimension shows the proportion of the sample in each category. The comparison lines near the top and bottom of the diamonds test whether the difference in the means is statistically significant. If the comparison lines in one diamond are closer to the mean of another than their own, the difference is not significant. The dot plots is jittered (slightly scattered) to reveal points overlapping points.

A quick inspection of the chart shows that the revised program's high score probability is about .42 while the current program's is around .3; that these estimates are sufficiently precise to take seriously; and that the difference is statistically significant. To the extent that we trust the quality of the sample, the finding is that the revised system has an advantage over the current system. In addition it shows us that some other conditions have a major, even larger, effect on the outcome than the differences in the programs.

To get a more thorough picture of the program's effects, and the roles played by the other conditions in each of these programs, we can compare the paths for the revised and current programs. The charts in Figure 3.3 compares the paths containing the revised program with those containing the current program. This process of choosing relevant paths to answer the question at hand and computing condition influence is central to analysis of the Maps.

Figure 3.3

Influence on Current and Revised Program Paths



A quick inspection of the diamonds tells us that both the quality of schools and the degree of administrative support have larger effects than the difference between the programs (which we have seen is .12); that the programs have the same high score probability in 7th and 8th grade, then it jumps upward in 9th grade; that the student's sex makes little if any difference; and that the current program has the same effect in average and good schools but the revised program does better in good schools than average ones. In addition, we can see that for the most part the revised program shifts all the probabilities upward by very roughly .12, which suggests that the difference in high score probability between the programs is not due to the effects of other variables, as the conditions in those variable have maintained their relationships (relative positions) with one another. But this rough similarity of patterns contains two important exceptions. One is that the effect of a supportive administration is both large, and of similar magnitude in both programs. A second exception is that the revised program only strongly outperforms the current one in good schools. Finally, we can see a possible explanation of the high subject drop out rate in the current program, which contains a higher proportion of poor schools and of tolerating or undermining administrations, suggesting that better schools or individuals tended to abandon the current program. This differential drop out does not, however, account for the revised program's gains, since gains across the same groups, such as good schools, show a positive effect from the revised program.

This is a lot of information from a very easily performed and compactly presented analysis—and while the interpretation depends, as it usually does in analysis, on thoughtful consideration it does not require technical knowledge. (A minimal understanding of statistical significance is sufficient: only that its lack indicates a risk, at the specified level, that the observed difference is a product of chance.) The point is not that this information could not be gotten in others ways, but that it could not be gotten so easily, and with such limited technical proficiency. (Precise numbers for influence levels, confidence intervals, and sample size are available in ANOVA tables. For the most part, however, the graphics tell the story and exact numbers would represent misplaced precision.)

Prediction

Predictions are made by selecting all paths containing input variables expected to be present, and using the grand mean (the gray line in the influence charts) as the predicted probability of the output. Examination of the influence charts allows discarding variables that have little effect, enlarging the set of paths included in the prediction set and increasing the generality (to this larger set of paths) and precision of the predicted probability.

It makes sense to talk about 'probability accounted for' as a parallel to the familiar 'variance accounted for' in conventional statistics. But there is an important distinction. Variance accounted for is a measure of reduction in prediction errors compared to an alternate model. When interpreting measures of variance accounted for we have to follow a logical path from the evidence of reduced prediction errors given the set of predictors used, to the substantive effect we infer. This path is obscured by the signal and noise distinction that only recognizes commonalities, so it arbitrarily discards some information. Probability accounted for is a more direct measure of substantive effects, being the contribution to the likelihood of an outcome instead of to the power of a prediction model, and by having no bias based on signal and noise distinctions.

Leverage

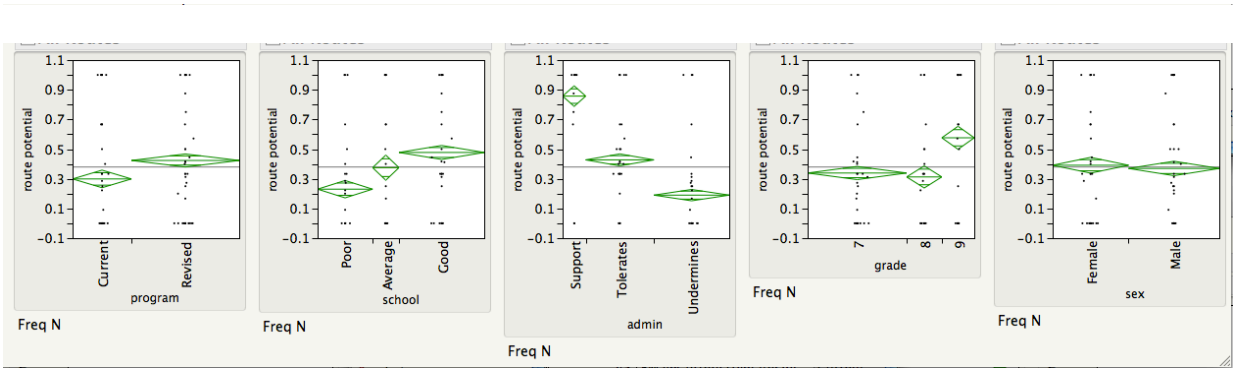
When dealing with practical problems we are looking for levers, a condition or conditions whose probability we can alter, and which have a substantial effect on the system over all. Something that makes a difference. Influence is a measure of what makes a difference, and how much of a difference it makes. Whether this can be translated into leverage depends on whether the potential levers, the conditions, Influence identifies can be utilized in practice.

Note that reasons for the lever's effects might be substantially different from path to path—which we would expect in a disjunction built from combinations of human reasons for doing things—but we don't have to know these numerous reasons to use them. Also note that there can be disjunctions with no levers, not even potential ones, if there are no conditions that have a large effect across a number of paths. In a disjunction commonalities are of practical more than explanatory importance.

Figure 3.2 showed the influence of conditions on all Paths in the map, suggesting which might have the greatest leverage regardless of program. Returning to those charts with the question of leverage in mind, we see that school quality and administrative support are more influential than program, which raises the question of whether the focus should be on those variables.

Figure 3.2 (revisited)

Influence on All Paths

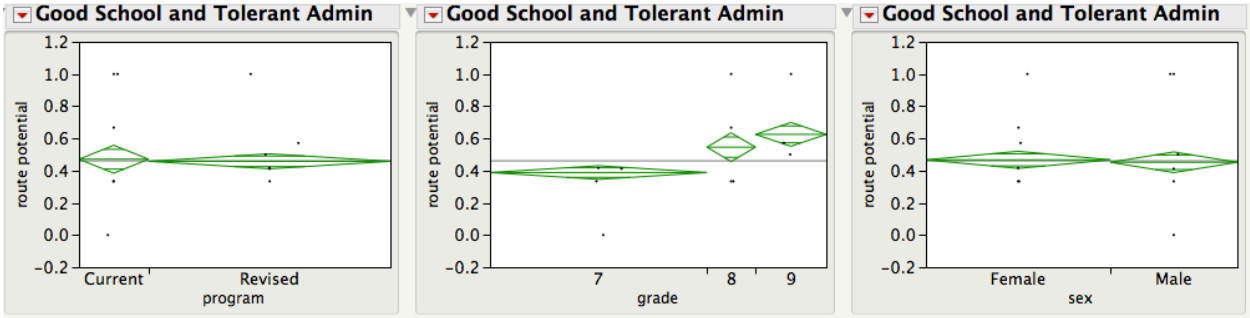


The most powerful candidate for use as a positive lever, although it was observed in a small number of cases, is a supportive administration. Whether it can serve as a lever depends on whether the school system can increase the supportiveness of school administrations with the resources available to it, sufficiently to the desired increase in high scoring students. This question is partially one of possibility, of whether the school can change administrator' behavior to being supportive (if there are so few maybe there's a reason there are so few), partially one of whether it would be the best use of resources, and partially whether it would be more broadly effective.

Selecting paths that address a question and computing influence to see how each variable affects the outcome on those paths can be applied to multiple as well individual conditions. We can ask, for example, what if the school system could increase the number of good schools with tolerant administrators. The reasoning might be that these are relatively common, compared to the more powerful effects of supportive administrators, so we have more confidence that the school system can produce them. The result shown in Figure 3.4.

Figure 3.4

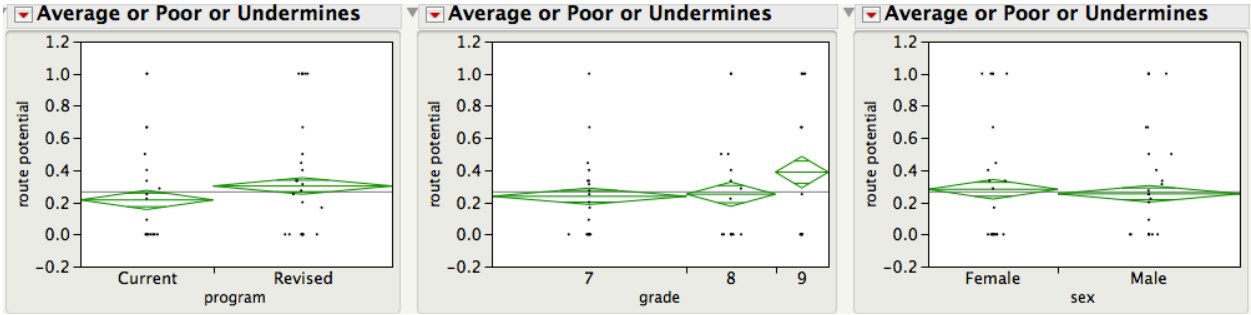
Influence on Good School and Tolerant Administrator Paths



Compared with the current program, this is an increase from .3 to .46, a greater increase than we saw for the revised program, although the effects diminish in the lower grades. In 7th grade the gain is only around .01. The gain is the same regardless of whether the current or revised program is used, so if this approach is adopted the only reason to use the revised program would be for its effect in the schools that were average or poor or had undermining administrators.

Figure 3.5

Influence on Average or Poor or Undermines Paths



The charts, however, do show that the revised program raises the probability of a high test score from about .21 to .3 on average, poor, and undermines paths. Whether the focus should be on high scores in those schools, however, is a question worth considering. Analyses could be run

using the path potential for medium, or medium and high scores rather than high scores alone to get an idea of the potential.

High and Wide Clusters

We are often concerned with identifying a set of factors that are associated with—cluster around—an outcome. In Disjunctive Mapping terms, that would be common conditions on paths with high path potential or contribution. These clusters can be identified by selecting paths with high path potential or contribution numbers, and noting the influential and frequently occurring conditions on those paths. In short, diamonds that are both high and wide (and handsome?).

A Cascade of Maps

If we were only interested in comparing the current and revised programs, the study would have served its purpose and be complete as it stands. However, since the Map showed that other conditions have more powerful effects on producing high test scores, one follow-up question we might want to pursue is what appears to lead to the more influential conditions, such as Supportive Administration. Each Map describe the paths to one set of destinations, the Map's outcomes. So this question would require a new Map. We might collect data on things like administrator's backgrounds such as years on the job, years teaching (if any), degrees and certificates, other work experience; measures of job performance like reviews by superiors, evaluations by peers, teachers, students, and community members; the presence of incentives such as performance based pay, professional recognition (awards and events to recognize service); relationships with school boards and community groups (measured by questionnaire responses and records of joint initiative and disputes); school resources such as funding per student, experience of teachers, ranking of school (good, medium, poor), number of previous initiatives and their success; and so on. The resulting Map would then show the probabilities of an administrator being supportive under a variety of conditions. The conditions that are influential, individually or in combinations, would be potential levers in creating supportive administrators.

This is just a two step cascade but it easily could go further, the more we include in Maps the more we might have further questions to pursue. The expectation of a cascade of analyses

suggests an approach to research more akin to that of a detective (at least a fictional one) who who is developing leads than a researcher who is attempting to develop a comprehensive understanding or model, and that expectation is consistent with what we would expect exploring disjunctive systems: there is no informative comprehensive view, only the particular ways it has been organized to product particular outcomes.

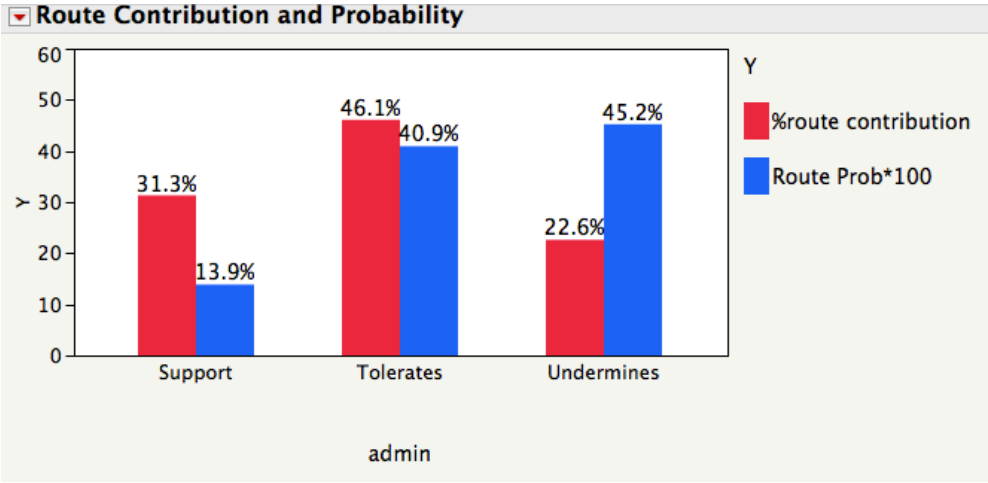
Description Using Path Contribution

For the most part Path Contribution, the product of path potential and path probability, serves as a descriptive statistic. (For most exploratory and inferential purposes we would generally use one or both of its components separately.) Path Contribution measures how much effect that input has on the disjunction, given the input's probability and potential, so it is how the conditions happen to play out in this particular disjunction, or any selection of paths from it. The sum of the path contribution is the probability of the outcome, the gray line in the influence charts for the Map or a subset of the Map (the grand mean of path potential and path probability).

A useful way to visualize Path Contribution is by comparing an input's Path Contribution percentage to its Path Probability (multiplied by one hundred to give them matching scales). In effect, a ratio of the input's impact if all its conditions had the same influence to their actual influence. For example, in Figure 3.6 we can see that the power of Administrative Support in this disjunction. Paths containing it account for nearly a third of high scores even though their probability is less than 15%.

Figure 3.6

Path Contribution for Administrative Support



Paying Attention to the Improbable

Maps will often contain improbable path with strong effects—high path potentials but low contributions—that are nearly invisible to conventional methods. They occur so rarely that they are lost in the noise, and even if observed, are anomalies that models cannot predict. And we are predisposed to discount them by our focus on the typical, average, and characteristic, that is central to the suppositional maneuver and conjunctive reasoning in the face of diverse observations in general. As Nassim Nicholas Taleb argues in *The Black Swan*, we systematically discount their importance.[61] He also argues that improbable events are by their nature unpredictable, but by treating disjunctive phenomena with appropriate tools, they may be more predictable than currently seems possible.

Some things are, of course, unpredictable—arising not only from diverse conditions but from conditions that are not under consideration because no one has thought of them or there is no reliable data to go on. But Disjunctive Mapping does retain information on diverse and improbable but powerful sets of conditions, rather than subsuming them in a model, thus allowing access to them. (Black Swans would be low probability, high potential, paths.) It would

[61] Cited earlier. Taleb, Nassim Nicholas, *The Black Swan*, Random House, New York, 2007

be possible, for example, to track a situation, such as in financial markets, using a wide range of information from standard financial indicators to the incentives built into tax law and renumeration policies, regulatory changes, content analyses of commentators, and so on. Then we could look for when the current or an anticipated situation matches, or looks like it might match, one or more improbable paths with a high path potential. This might allow improved forecasting of major changes in trend lines, for example, conceivably even a boom or crash.

Disjunctive Mapping as a Demonstration

> **DM shows that that a rigorous and informative analysis of disjunctive behavior is viable and straightforward—and can be done without falling back on or struggling to adapt ill-fitting conjunctive methods.**

Disjunctive Mapping shows that core functions of conventional social science statistical methods—identifying influences and measuring their effects—are available within a disjunctive analytic framework. It does this, answering *what makes a difference and by how much* questions without relying on most of the great intellectual apparatus associated with rationality and science —central tendencies, distinguishing signal from noise, parsimonious and unifying models, abstracting to covering laws, theory testing, reduction to basic forces, strict categories, discovery of new principles, or a competition of ideas—all tacitly aimed at conjunctive phenomena. Commonalities do play a role, but they are understood as defining practical (leverage and prediction) opportunities, are not assumed to be powerful causal agents even if they create those opportunities, are not assumed to work the same way across paths, and are not a necessary part of explanations. Our view is that once we have set the conjunctive apparatus aside we can see the human world more clearly, and that the social sciences are undermined by granting that apparatus the central role it currently plays.

The conventional apparatus sees much of human diversity and uncertainty as obscuring human behavior's basic nature. Disjunctive Mapping, by contrast, sees much of the conventional apparatus as obscuring human behavior's basic nature.

Also, as we noted earlier, setting the conventional apparatus aside greatly simplifies the nature of the quantitative analysis of human behavior. The simplification is not due to

sophisticated technical innovations but rather a rethinking of how human behavior should be described for the purposes of analysis, and given that description, what should be measured. Once we grant that the human world greatly relies on disjunctive mechanisms to produce predictability from uncertainty, and that the disjunctions are largely built from the numerous combinations that arise from a relatively small number of often identifiable conditions, we can go straight at what is going on.

As we have seen in this outline of Disjunctive Mapping, this getting straight at it is largely a matter of finding and analyzing the effects of paths and conditions. And this, in turn, is largely a matter of organizing the data and defining measures. The analysis does requires a great deal more arithmetic than we are likely to be able to do without computers, but is otherwise accessible. The measures outlined here, however, are not intended as a complete analytic tool kit, only enough to show that what is needed to create one is readily at hand.

Conventional methods can work toward noticing the diverse ways things happen but this is not the same as recognizing the role of disjunctions, and even in this limited arena conventional methods have to struggle against their own implicit purposes. Instead of looking for the different ways outcomes happen they have to tease them out with methods designed to find what unifies. This teasing out has become increasingly possible using contemporary statistical and graphical methods. But as long as methods rely on explanation through commonalities in conditions, functional forms, and conjunctive reasoning, and prize parsimony and unifying theory, they are working at cross purposes with themselves when facing disjunctive phenomena—pushing through a back door while the front door stands wide open.

Part 4

A Wise But Broken Heart

Our systematic misunderstanding of ourselves stems, in part, from technical errors. But if we correct them, instead of finding that a more secure attachment to evidence and logic leads us to a world that can be captured in elegant and powerful ideas, we discover that we are projected into a world where elegant thinking and the hope for powerful formulations dissolve in accumulations of uncertainty and disjunctive complications. Instead of the promise of an easier time of it as the reward for tracing the implications of evidence and logic, where practical tasks that were once difficult become easy and new possibilities emerge in an unending stream, we have, at least by comparison, the promise of a ceaseless, slogging struggle, although a more effective and less self deceptive one.

This essay began with four quotes, the first from William James. Its closing lines ran,

> *As compared with all these rationalizing pictures, the pluralistic empiricism which I profess offers but a sorry appearance. It is a turbid, muddled, gothic sort of an affair, without a sweeping outline and with little pictorial nobility. Those of you who are accustomed to the classical constructions of reality may be excused if your first reaction upon it be absolute contempt—a shrug of the shoulders as if such ideas were unworthy of explicit refutation. But one must have lived some time with a system to appreciate its merits.*

The story we have been telling—the failure to recognize how mentality makes disjunctive mechanisms a central feature of the human world by allowing it to build stable structures on uncertain foundations; the ways we have misused logic and notions of rationality that avoid facing those mechanisms squarely; the semi-illusory world we have created by discounting verisimilitude/descriptive realism in favor of simpler and deductively stronger systems of generalizations and abstractions; which, in turn, depends on getting away with being right for the wrong reasons via correlations of commonalities with outcome; the coping strategies we only fitfully apply, in part because we don't understand why they work; and a quantitative method that allows facing uncertain disjunctive human systems squarely and rigorously, but at a substantial cost in data collection and computation—may seem a sorry one. It is a story about living in world of cleverly devised illusions and half-truths, and of the necessity of struggle rather than the

promise of solutions. But this story partially driven by technical errors, even if ones reinforced by psychological and social dispositions. In principle, at least, technical errors can be fixed.

The technical fixes are not, in themselves, difficult to understand, or even, taken one at a time, controversial.[62] Disjunctive logic and probability theory are well established, and at the level required, neither is hard to grasp. The psychological and social concepts likely to be invoked are numerous but largely familiar, if perhaps disappointingly pedestrian. By comparison the technical and substantive demands of the transition to the natural sciences were much greater. But then we come, in James's words, although referring to a different pluralistic vision, to his "turbid, muddled, gothic sort of an affair." Instead of finding that a stronger attachment to evidence and logic leads us to a world that can be captured in elegant and powerful ideas, we discover that we are projected into a world where elegant thinking and the hope for powerful formulations dissolve in accumulations of uncertainty and disjunctive complications. Instead of the promise of an easier time of it as the reward for tracing the implications of evidence and logic, where practical tasks that were once difficult become easy and new possibilities emerge in an unending stream, we have, at least by comparison with that vision, the promise of a ceaseless, slogging struggle. In short, more like what we already do, if with the hope of doing it better.

James suggests that if you live in this turbid, muddled, gothic mental habitat for awhile its merits can grow on you. There is a straightforwardness in being able to explain the human world by the effects of mentality, diversity, and uncertainty instead of in spite of them. It is good to know the insights that in everyday life seem to explain what we see might actually do so (when placed in a disjunctive framework). And there is protection from the seemingly hard-headed arguments that use various tricks to avoid the implications of uncertainty and diversity and thereby make it seem that conjunctive explanations are sufficient to account for observed

[62] There is some controversy concerning interpreting probabilities as applying to specific events, or at least doing so by a subjective interpretation, although this controversy has been superseded by its wide acceptance in practice. The interpretation used here relies on relative frequencies as a measure of probability, only venturing away from this view by interpreting those probabilities as applying to individual events—as a measure of confidence that they will occur (which is not necessarily a degree of belief, but that is another story).

behavior.[63] (James called the people who made such arguments, tender-minded, for their unwillingness to face messy reality.) These tricks would no longer fool us, or at least not fool us so easily. In short, we would have a better idea of what sound reasoning about human behavior requires, and the limited realms in which its conclusions can be treated as reliable. (Among other things, this would undermine much of what passes for serious discussion of public policy and politics, doing great harm to the entertainment industry.) This should be liberating. In addition we gain a more straightforward approach to quantitative analysis than provided by conventional methods. And we gain a great deal of practical utility in recognizing the value and logic of strategies that recognize and capitalize upon rather than ignore and undermine disjunctions, and so make better use of the information and powers of reasoning available to us.

But we are not as sanguine as James that living there for awhile will lead to appreciating its merits. The price, measured against familiar expectations, is high. The range of opportunities to make powerful arguments—to justify choices about how to live, about political beliefs and policies, and even moral positions in so far as they include claims about the causes and consequences of human behavior—may seem intolerably narrowed.

Francis Bacon wrote,

> Doth any man doubt, that if there were taken out of men's minds, vain opinions, flattering hopes, false valuations, imaginations as one would, and the like, but it would leave the minds, of a number of men, poor shrunken things, full of melancholy and indisposition, and unpleasing to themselves. (Of Truth, from *The Essays or Counsels, Civil and Moral*, 1597-1625)

So, with this narrowed mental world in mind, we close by returning to the final quote from the beginning of the book, from Dave Van Ronk's song, *Last Call*,

"Here to the heart that's wise enough to know when its better off broken."

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[63] These tricks, as we have seen, include reasoning from best guesses and other suppositional maneuvers, supplanting diverse particulars with unifying but uninformative abstractions and generalizations, ignoring the effects of accumulating uncertainty, discounting disjunctive explanations as inadequate for failing to find a more fundamental unity, assuming that the understandings we already have of human behavior are inadequate because they cannot be used to construct powerful conjunctive explanations, and assuming when conjunctive explanations prove inadequate that a superior conjunctive explanations should be sought.

Appendix A

Building Disjunctive Maps in JMP

Building the Map.

1. Create the Map from a data base.

The scripts build the Map used in the School Program comparison example from a flat data file containing records for the 303 students in the study. The concatenate and tabulate steps are easily done in JMP without use of the scripts, although they are provided. Making new columns for path probability, path potential and path contribution, however, would be tedious without them.

```
//STEP 1: Create Path column. (The data table must be
the front window.) This step concatenates the input
variables into a single variable used to define the
paths when the Map is built.

new column( "path", formula (:program || :school
|| :administration || :grade || :sex));

//STEP 2: Tabulate to build a Map from the data table.
(The data table must be the front window.)

Tabulate(
    Show Chart( 1 ),
    Show Control Panel( 0 ),
    Order by count of grouping columns( 1 ),
    Add Table(
        Column Table( Grouping Columns( :scores ) ),
        Column Table( Statistics( N ) ),
        Row Table(
            Grouping Columns(
                :path,
                :program,
                :school,
                :administration,
                :grade,
```

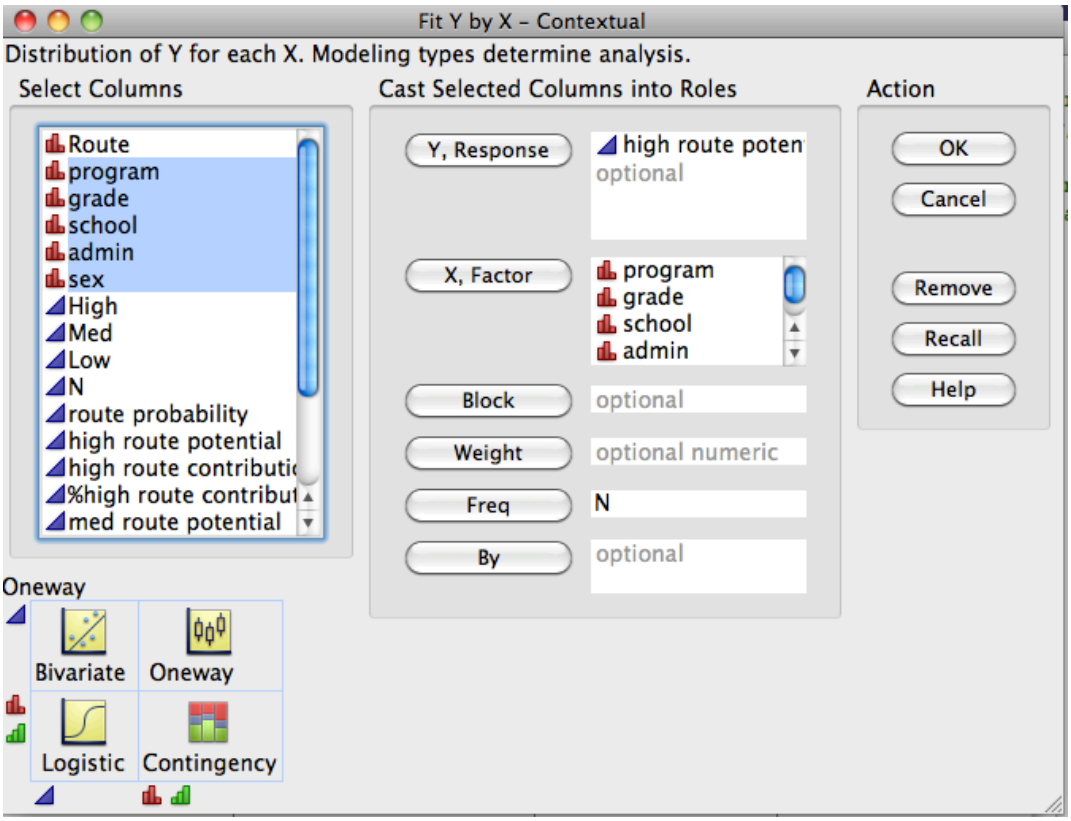
```
                    :sex
                )
            )
        )
);


/* STEP 3: ADD CALCULATED COLUMNS. Adds Path
Probability, Path Potential, Path Contribution, and
Path Contribution % columns for output variables. Since
the Score variable has three values (high, med, low)
the score specific columns must be run for each value.
The script shown is for the high value and includes the
path probability column which applies to the path prior
to the outcome so only needs to be run once. The
following three columns are rerun for med and low
(using Find and Replace All to quickly change the names
—crude, I know).*/

New Column( "path probability",
        Numeric,
        Continuous,
        Format( "Fixed Dec", 10, 3 ),
        Formula( :N / Col Sum( :N ),Evalformula)
        );
    New Column( "high path potential",
        Numeric,
        Continuous,
        Format( "Fixed Dec", 10, 3 ),
        Formula( :high / :N ),Evalformula
    );
    New Column( "high path contribution",
        Numeric,
        Continuous,
        Format( "Fixed Dec", 10, 3 ),
        Formula( :path probability * :high path
        potential ),Evalformula
    );
```

```
    New Column( "%high path contribution",
        Numeric,
        Continuous,
        Format( "Fixed Dec", 10, 3 ),
        Formula( (:path probability * :high path
        potential * 100 ),Evalformula
    )
);
```

2. Analyze the Map

STEP 4: Calculate Influence using Fit Y by X. Note that Frequency is N.

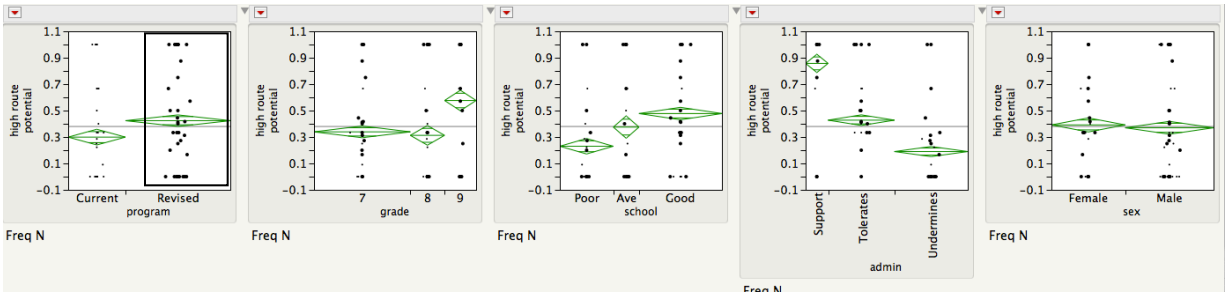
The example shown is for the entire map. The defaults (set in preference) are set to jitter the dots and create mean diamonds



Selection

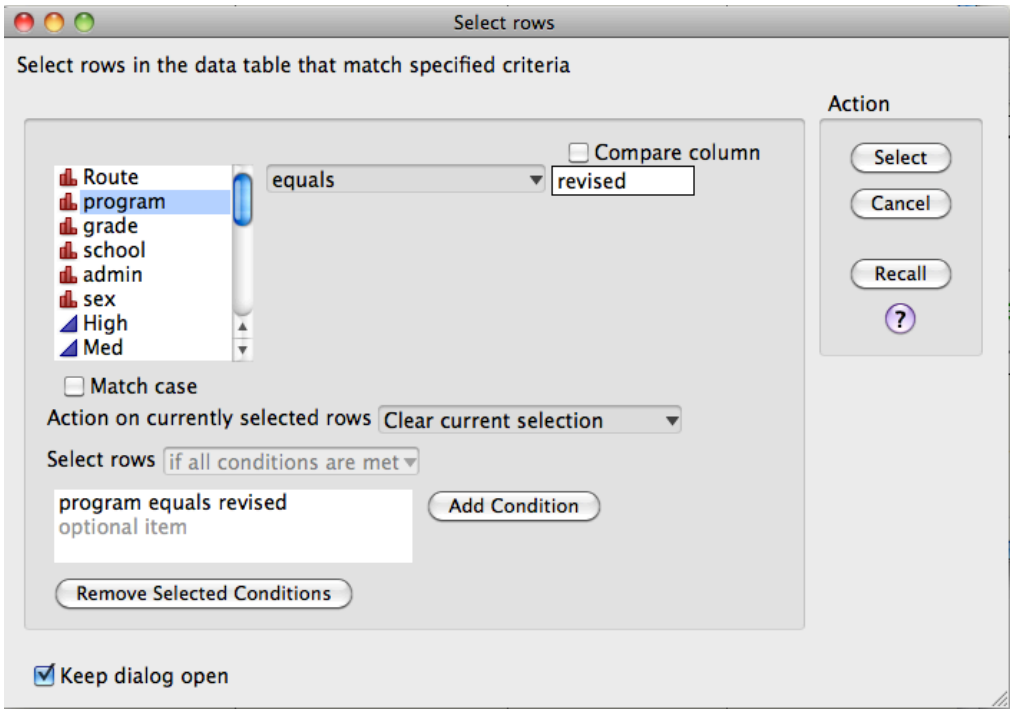
The analysis, as discussed in the text, proceeds by selecting subsets of the Map. This can be done within JMP in a few ways. Depending on the analysis selection might be of the union or intersection of subsets of the data.

Following the example in the text, we wished to run the influence analyses to compare the revised and current programs, we could select the points in the chart for the entire data set.

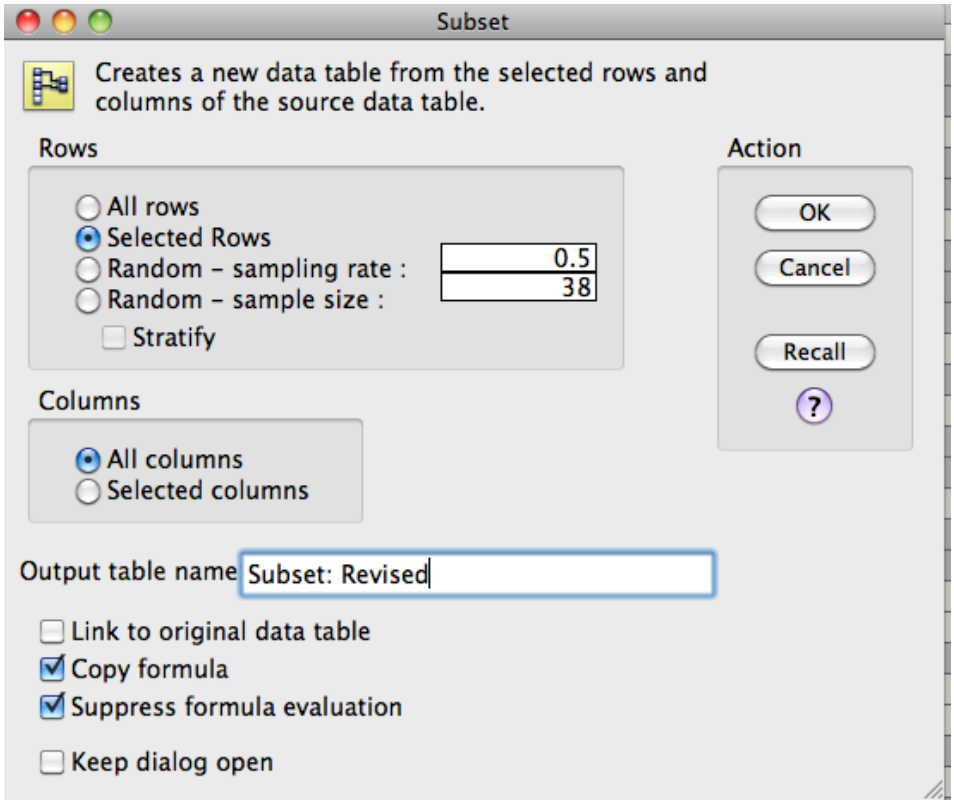


This will select the paths in the Map. (Note the interactive JMP feature, showing the distribution of selected points across the other charts.)

Alternatively, selections can be made using the Select Where command (in the Rows menu or pull down). Checking the Keep dialog open box speeds up doing and revising analyses. The Select Rows option just above the conditions box in the lower left allows global AND and OR based selections.



Given the selection, Influence charts can be made from the data table by excluding unselected rows, using Invert Selection and Exclude/Hide commands, or by making a Subset Table. Since Subset Tables are sometimes useful for other analyses, making subset tables is generally preferred.



Factor Influence charts for the Revised Program can then be made using this table (it must be in front) in the same way as shown above for the Influence chart for the entire data set. An interface to populate and run these scripts, and to calculate and rank the influence of all possible combinations, is currently being developed.

Acknowledgements

More than anything else, this book represents one voice from a more than thirty year long conversation with Brad Honoroff. If he ever gets time, the other voice may be heard as well. Disjunctive Mapping would have never happened if it weren't for Warren Lieberman's interest and support, as a friend and through Veritec Solutions.

Mike Gordon, at Veritec Solutions, did the programming for first Disjunctive Mapping applications and in the process helped clarify its structure. At Veritec Solutions I benefitted from and enjoyed conversations with most everyone, but Tamara Dieck, Gillian Lam, Warren Lieberman, John Middlekauf, and Jim Mullin deserve particular mention.

When first exploring these ideas as a graduate student I received great assistance and support from John Bassler, Garry Brewer, J. Richard Hackman, Madeline Heilman, Don Kinder, Charles Lindblom, John Miller, Dennis Perkins, Janet Weiss, Gerrit Wolff, and Douglas Yates at Yale, and although it has gotten to be a very long time ago, I still feel the gratitude. As I do for fellow graduate students, particularly Anat Admati, Bruce Blair, John Chapman, Art Estey, Mike Evanisko, Rick Guzzo, Rosalee Hermens, Carol Schreiber, and Warren Lieberman, for the friendly, thoughtful, and invigorating environment they created.

Pierre Shevenell and Sheila O'Connell have undoubtedly influenced my thinking and one day, perhaps, I'll figure out what they have done. Larry Hartenian and Robert Smith, historian and sociologist, have not only read and commented on various versions of these ideas over the years, but have put up with my talking about them when we should have been concentrating on nothing but the beers in front of us. Richard Gonci keeps trying to think of some way to make me marketable, which goes to show he's still something of a dreamer. Jacopo Madaro gets it. My family, Paula and Jake, have been kind enough to treat my dogged commitment to working on this stuff without showing signs that it worries them, and for this and many other reasons, I owe them more than I can ever say.

Some passages in this book appeared in a modified form in a paper by Warren Lieberman, Jim Mullin, and myself, published in the *Journal of Revenue and Pricing Management*, Vol. 10, 2, 112–118 & Vol, 10, 3, 211–230 (2011)

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