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Change in the Decision Sciences

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Sommaire

A common type of change in science occurs as theorists generalize a model of a phenomenon by removing some idealizations of the model. This type of change occurs in the decision sciences and also in the normative branch of the decision sciences that treats rational choice. After presenting a general account of model generalization, the paper illustrates generalization of models in normative decision theory. The principal illustration generalizes a standard model of rational choice by removing the idealization that deliberation has no cost.

Key-words: decision; deliberation; idealization; model; rationality

1 – Introduction

Science changes, among other ways, by generalizing the models it constructs. A scientific model of a phenomenon typically involves idealizations, and relaxing the model's idealizations, when feasible, generalizes the model. The decision sciences construct both descriptive models that target actual choices and normative models that target rational choices. This paper explicates change in normative models of choice as the models remove idealizations. It applies the analysis of normative models in Weirich (2015).

Section 2 advances an account of models and their generalizations. Section 3 illustrates the account's application to normative decision theory using standard models of rational choice. Section 4 presents another illustration using a novel generalization of a standard model of rational choice that removes the standard model's idealization about deliberation costs. Because this generalization is novel, its presentation requires some groundwork, including an examination of types of utility. Section 5 heads off some possible misunderstandings of the new model. Section 6 summarizes the paper's characterization of a type of change in the decision sciences.

Change by generalizing models is just one type of change in normative decision theory, and generalizing models by removing idealizations is just one type of generalization. I treat removal of idealizations because the literature on rational choice does not adequately characterize this type of change. Articulating methods of improving normative models of rational choice benefits decision theory.

2 – Models

A set of conditions on a possible world characterizes a model, according to a sense explicated by Sugden (2002). Assuming that the conditions do not specify a possible world, the model itself is either a possible world incompletely described by the conditions, or the set of possible worlds that meet the conditions, a set completely described by the conditions.

A model typically adopts idealizations to control for some factors that affect the phenomenon it treats. The idealizations hold in the model and not in the actual world. In contrast, general principles governing the phenomenon hold in both the model and in the actual world. The model's idealizations control the operation of these principles. The model uses the idealizations to exhibit in a controlled setting the effect of some factors on the target phenomenon. Generalizing the model by relaxing idealizations accommodates additional factors that affect the phenomenon. Relaxing an idealization removes a control on some factors affecting the phenomenon and allows them to vary. For example, a familiar model of an ideal gas formulates the relationship between the gas's pressure and volume using Boyle's law, $P_1V_1 = P_2V_2$, under the idealization that the gas's temperature is constant. A generalization of the model dispenses with the assumption of constant temperature and replaces Boyle's law with the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$. Removing the idealization removes the original model's control of temperature.[1]

A model selects for study some factors affecting a phenomenon. For example, a model of an ideal gas may select volume's effect on pressure. Although relaxing idealizations may change the effect some factors have on the phenomenon the model targets, a well-constructed model uses idealizations that do not change the effect the selected factors have on the phenomenon. As a result, both the original model and its generalization display the effect of the selected factors on the phenomenon. Even though additional factors affect the phenomenon in the generalized model, the effect on the phenomenon of the factors that the original model selects is constant. For example, a model may select a variable and study its effect on the target phenomenon given various idealizations. A generalization of the model may relax an idealization that controls the effect of a second variable on the target phenomenon. A change in the first variable may produce a tenden-

1 - Fowler (1997, 3) observes that a model arises from idealizations that may be removed later to achieve a more general, realistic model. Mäki (2002, 10–12) holds that a model's idealizations commonly control for explanatory factors by removing those factors or holding them constant, as in controlled experiments.

cy for the target phenomenon to change in both the original model and in the generalized model, even though in the generalized model the target phenomenon depends on the value of the second variable as well as the value of the first variable. In a model of an ideal gas that uses Boyle's law and then generalizes using the combined gas law, increasing volume tends to decrease pressure in both the original model and also in its generalization, although this tendency may be countered in the generalized model by the tendency of increasing temperature to increase pressure. A principle common to the two models is increasing volume's tendency to decrease pressure.

Complete generalization of a model, with removal of all idealizations, is an elusive scientific goal. A completely generalized model's characterization, independent of special assumptions, specifies the set of all possible worlds, including the actual world, meeting general principles governing the target phenomenon. To shed light on the target phenomenon, less general models that rely on idealizations identify factors that operate in the models, as they do in the actual world, to produce the target phenomenon.

The following sections present some models of rational choice. Relaxing idealizations of the models illustrates generalization of a model in the decision sciences. The sections provide a characterization of a type of change in the decision sciences that yields progress toward realism.

3 – Information

A model in normative decision theory typically adopts idealizations about agents and their decision problems and then formulates standards of rationality for the agents' choices.[2] A common model, using several idealizations, claims that a rational choice maximizes utility.

A preliminary version of the common model assumes that an agent is cognitively ideal, fully informed, and faces a decision problem with a finite, Archimedean set of options to which the agent can assign a precise utility that evaluates an option comprehensively according to the agent's evaluation of the option's world, that is, the possible world that would be realized if the option were realized, a world the model assumes exists. In this preliminary model, an agent's maximizing utility amounts to the agent's maximizing informed utility, that is, adopting an option whose world, as represented by a proposition that for every feature of a world that the agent cares about specifies whether the world has that feature, receives a utility at least as great as the utility of any other option's world.

In the model a rational choice maximizes utility. This feature is normative and does not hold as a matter of definition. The model does not define rationality as utility maximization. It uses rationality in its ordinary, nontechnical sense of reasonableness, according to which an irrational choice is blameworthy. Its normative claims depend on fundamental normative principles. Also, its normative claims may fail without the model's assumptions about the abilities and circumstances of agents and the features of the decision problems they face. For example, if an agent's decision problem has no option of maximum utility, then the agent has a good excuse for not maximizing utility, and a failure to maximize is not irrational.

Normative decision theory advances by relaxing the preliminary model's idealization that an agent is fully informed, while retaining the other idealizations. Instead of assuming that the agent is certain of the world that would be realized if an option were realized, a more general model assumes only that the agent assigns a probability to each world that might be the option's world. Then a rational choice maximizes expected utility. It adopts an option such that the expected utility of the option's world is at least as great as the expected utility of any other option's world. That is, the probability-weighted average of the utilities of the possible worlds that might be the option's world is at least as great as the analogous probability-weighted average for any other option. Relaxing the idealization of complete information generalizes the preliminary model so that it accommodates cases in which an agent's information is incomplete as well as cases in which it is complete.

The generalized model takes an option's utility to equal its expected utility. An option's expected utility given complete information is just the utility of the option's world, so the generalized model extends the preliminary model's account of an option's utility. The generalized model changes the preliminary model by extending principles of utility without altering the decision principle that requires utility maximization. The preliminary model and its generalization for incomplete information share the principle that a rational choice maximizes utility. This principle is part of the preliminary model of a rational choice by a completely informed agent and also part of the generalized model of a rational choice by an agent who may be incompletely informed.

A model of rational choice advances principles of rational choice under its assumptions about agents and their decision problems. Some models attribute ideal cognitive powers to agents. Whether people have the cognitive powers of agents in the model is an empirical question; whether the model's principles of rational choice govern agents with these powers is a normative, *a priori* matter. A normative model constructed to advance claims about rational choice succeeds or fails depending on whether its principles of rational choice have the support of fundamental principles of rationality. The success of the preliminary model and also its generalization is an *a priori*, not an *a posteriori*, matter because the preliminary model and its generalization have the main objective of advancing normative, *a priori* principles. These normative models use *a priori* principles of rationality to classify choices, and make assumptions about agents, their circum-

2 - Colyvan (2013) describes normative models of rational choice.

stances, and their decision problems to simplify formulation of principles of rational choice. An *a priori* principle of rationality that holds in all worlds may have assumptions that the worlds of a model meet but that the actual world does not meet. The principle may state that, given the conditions that characterize the model, rational choices satisfy certain requirements, such as utility maximization, even if in the actual world the requirements for a rational choice are more complex because the model's conditions are not met.

A normative model of choice may partially explain the rationality of a choice in the real world by describing the operation of some factors that affect the choice's rationality. The model partially explains the rationality of a choice by describing how some factors, such as utility maximization, play a role in settling its rationality. Utility maximization, along with the rationality of the utility assignment and the abilities and situation of the agent, fully explain the rationality of a choice in the actual world. A model may precisely describe the role of utility maximization in a controlled setting but not describe the operation of other factors explaining a choice's rationality in the actual world. The model explains partially the rationality of a choice in the real world by fully explaining the rationality of a choice in the model using factors that contribute to the explanation of the rationality of a choice in the actual world. The partial explanation assumes that the factors that explain the rationality of a choice in the model operate the same way in the real world but are joined by other factors affecting the rationality of the choice. Utility maximization affects the rationality of a choice in the real world together with other factors concerning the rationality of the utility assignment and the ability of the agent to maximize utility in the circumstances of the agent's decision problem. A choice that does not maximize utility is irrational in the real world unless circumstances create good excuses, as they often do. In the model, idealizations prevent such excuses.

Generalizing a model of rational choice to accommodate incomplete information relies on familiar principles concerning an option's expected utility. The next illustration of a model's generalization examines an agent's means of evaluating an option. The generalization uses some novel principles concerning an option's evaluation that require a detailed presentation.

4 – Evaluation

A standard model in normative decision theory supposes that an agent is cognitively ideal so that the agent may effortlessly evaluate each option's world to assign it a utility. Relaxing the idealization that an agent is cognitively ideal generalizes the model. The generalized model extends principles of rational choice to agents who can effortlessly assign an option a utility only if the option's evaluation processes a number of considerations smaller than some limit. In the generalized model, a rational agent, for efficiency, evaluates an option by evaluating, not the option's world, but the part of an option's world that distinguishes it from other options' worlds. For example, the agent may put aside events in the option's world that occur prior to the agent's current decision problem. These events occur in every option's world and do not distinguish the options' worlds. An efficient, general evaluation of options reviews only events that distinguish the options' worlds.

Peterson (2009) offers a good account of decision principles. Some decision principles demand certain procedures for making decisions, for example, the principle to reflect before making an important decision. Other principles require that a decision meet certain substantive conditions, such as maximizing utility. In ideal conditions, a rational agent in a decision problem not only realizes an option that maximizes utility but also efficiently resolves the decision problem.

I treat evaluation of decisions rather than procedures for making decisions. However, the evaluation of decisions considers an agent's abilities and circumstances. It does not require a decision that maximizes utility if an agent cannot identify such a decision, or if the decision problem's significance does not justify the effort of identifying such a decision. Efficient cost-free procedures for identifying options of maximum utility extend the requirement of utility maximization to agents who without these procedures pay a cost for identifying options that maximize utility, a cost that a decision problem may not justify. Even if a choice's rationality does not require following efficient procedures for identifying options of maximum utility, the availability of these procedures removes an excuse for not realizing an option of maximum utility. Their availability raises standards of rationality for an agent's choice. Cognitive limits affect not only rationality's demands concerning decision procedures but also rationality's substantive demands on decisions.

This section begins with the previous section's model for informed choice and then generalizes the model to handle a cognitive limit on processing considerations during an option's evaluation and also simultaneously generalizes the model to handle incomplete information, applying the principle of expected utility. The generalized model retains idealizations of the preliminary model except for the idealization of limitless processing of considerations; in particular, it retains the idealization that an agent has the cognitive capacity required for cost-free identification of considerations relevant to evaluation of options. The generalized model that accommodates limits on effortless processing of considerations to evaluate options needs: first, a way of characterizing the considerations that distinguish options' worlds; second, a type of utility that evaluates just the distinguishing features of an option's world; and, third, a justification for selecting an option according to evaluations of options that consider just the distinguishing features of options' worlds.

4.1 An Option's Consequences

The events that distinguish an option's world are those that occur if the option were realized but do not occur given every option. According to Gibbard and Harper (1981), these events are the option's consequences. An event is an option's *consequence* if and only if it would occur if the option were realized but can be prevented by realizing another option. An option's consequences in this sense exclude past events and also future events that no option can influence. An option's consequences stand in a type of causal relation to the option, but are not the same as the option's effects, because, for instance, an option is a consequence of itself but is not an effect of itself.

4.2 Types of Utility

According to causal decision theory, which I assume, an option's comprehensive utility is a probability-weighted average of the utilities of the worlds that might be the option's world if the option were realized.[3] In Section 3's model of rational choice generalized for incomplete information but retaining other idealizations of the preliminary model, the probability-weight for a world that might be the option's world is the probability that if the option were realized, the world would be realized. For the sake of efficiency, causal decision theory may replace an option's comprehensive utility with another type of utility that focuses on the option's consequences. It may do this both for models of informed choice and for models of incompletely informed choice.

A type of utility applied to an option has an evaluative scope specifying the considerations that the evaluation appraises. An option's *comprehensive* utility, a widely-used type of utility, evaluates an option by evaluating the option's world; the scope of its evaluation is comprehensive. Being comprehensive ensures it does not omit any feature of an option's world that is relevant to the option's evaluation in a decision problem. An option's evaluation according to its consequences needs a type of utility with narrower evaluative scope than comprehensive utility. Comprehensive utility, even if applied to just an option's consequences evaluates the world in which the option's consequences obtain, and so evaluates the option's world, not just the option's consequences.

An alternative type of utility that evaluates an option by evaluating just the option's consequences I call "causal utility." Its narrower evaluative scope makes it contrast with comprehensive utility, which evaluates an option by considering all that holds given the option. The definition of causal utility uses another type of utility, *intrinsic utility*, which has a very narrow evaluative scope. Intrinsic utility evaluates a possible event by considering only the *a priori* implications of the event's occurrence. The *causal utility* of an option is the intrinsic utility of its consequences, and, given incomplete information, the expected intrinsic-utility of its consequences. Defined this way, an option's causal utility surveys only the option's consequences, as intended. In cases of incomplete information, an option's causal utility equals the option's expected causal utility computed using the option's consequences in the worlds that might be the option's world.

4.3 Justification of Rankings

A justification of using options' causal utilities to rank the options shows that the ranking of options according to their causal utilities is the same as their ranking according to their comprehensive utilities. To show this, a justification may demonstrate, in the case of complete information, that the comprehensive utility of an option is a sum of the option's causal utility and the intrinsic utility of events in the option's world that are not its consequences. Then it may establish that the second factor is the same for all options, so that an option's rank according to the first factor, that is, its causal utility, is the same as its rank according to the sum of the first factor and the second factor, that is, its comprehensive utility. The following paragraphs provide this two-step demonstration.

The first step establishes that an option's comprehensive utility sums the option's causal utility and the intrinsic utility other events in the option's world. It uses a similar summation principle for intrinsic utilities.

Intrinsic utilities express intrinsic attitudes of desire, aversion, or indifference. An agent's intrinsic attitude is *basic* if and only if none of the agent's other intrinsic attitudes are among the agent's reasons for it. Because the reasons for a basic intrinsic attitude are independent of the reasons for other attitudes, its realization has the same intrinsic utility no matter what other events occur. In an option's world, the relevant events are realizations of basic intrinsic attitudes, and so I take the option's consequences and other events in the option's world to be events of this type. The intrinsic utility of a set of events, an evaluation of the *a priori* implications of the set's realization, equals the sum of the intrinsic utilities of realizations of basic intrinsic attitudes that the set's realization entails. This additivity is a fundamental principle of intrinsic utility that Weirich (2015, Chap. 3) explicates. Because of this additivity, the intrinsic utility of an option's world is the sum of the intrinsic utility of the option's consequences and the intrinsic utility of the other events in the option's world.[4]

A bridge principle connects comprehensive and intrinsic utility; the comprehensive utility of an option's world equals the intrinsic utility of the option's world, as both types of utility consider all relevant events in the option's world. Also, an option's causal utility is by definition the intrinsic utility of the option's consequences. Hence, the summation principle for intrinsic utilities establishes that

> (1) an option's comprehensive utility equals its causal utility plus the intrinsic utility of events in the option's world besides its consequences.

3 - Joyce (1999) argues for causal decision theory.

4 - In a rational ideal agent, a basic intrinsic desire is equivalent to a basic intrinsic preference for the realization of the desire as opposed to its non-realization. Krantz et al. (1971, Chap. 6) present methods of conjoint measurement that may use the independence of basic intrinsic preferences to establish a representation theorem for intrinsic utility. According to the theorem, given standard axioms for preferences among worlds and the independence of basic intrinsic preferences, the intrinsic utility of a world equals the sum of the intrinsic utilities of the basic intrinsic desires that the world realizes. The representation theorem shows the possibility of using preferences among worlds to measure intrinsic utilities, but does not yield a definition of intrinsic utility.

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Next, observe that for all the options, the same events, except the options' consequences, occur in the options' worlds. This follows from Section 4.1's definition of an option's consequences. Because all options are alike in their non-consequences and because intrinsic utility evaluates events by evaluating their *a priori* implications,

(2) for all options, the intrinsic utilities of their non-consequences are the same.

Points (1) and (2) are the two steps of the demonstration that the beginning of the section outlined. They justify ranking options according to their causal utilities. The options' ranking according to their causal utilities is the same as their ranking according to their comprehensive utilities.

To illustrate the type of simplification that evaluation by causal utility achieves, imagine this case. John considers whether to exercise. John is wise and remains wise whatever he decides about exercise. His being wise is unavoidable. However, he remains healthy if and only if he exercises. Health is a consequence of exercise. John cares only about being healthy and being wise. He has a basic intrinsic desire for each. The comprehensive utilities of his options to exercise or not are, respectively, the intrinsic utility of the world in which he exercises and the intrinsic utility of the world in which he does not exercise. Also, a world's intrinsic utility sums the intrinsic utilities of the objects of the basic intrinsic desires it realizes. Letting E stand for John's exercising, $\sim E$ stand for his not exercising, U stand for comprehensive utility, and IU stand for intrinsic utility, the following equations state the options' comprehensive utilities.[5]

$$U(E) = IU(H \,\&\, W) = IU(H) + IU(W)$$
$$U(\sim E) = IU(\sim H \,\&\, W) = IU(\sim H) + IU(W)$$

The causal utilities of John's options evaluate just the consequences of his options. Letting CU stand for causal utility, the next pair of equations states the options' causal utilities.

$$CU(E) = IU(H)$$
$$CU(\sim E) = IU(\sim H)$$

The options' comprehensive utilities involve a common factor, $IU(W)$, that their causal utilities drop. Dropping the common factor does not affect comparisons of options: $CU(E) > CU(\sim E)$ if and only if $U(E) > U(\sim E)$. The ranking of John's exercising and of John's not exercising according to causal utility is the same as the ranking of these options according to comprehensive utility.

The justification of ranking options accord to their causal utilities extends straightforwardly to ranking options according to their expected causal-utilities in the case of incomplete information.

5 – Objections and Replies

According to a type of separability, which Broome (1991, Chap. 4) explicates, an event is *separable* from other events if its utility is the same no matter how other events are fixed. The summation principle for intrinsic utilities entails this type of separability for the intrinsic utility of an option's consequences. More precisely, it entails that the combination of an option's consequences is separable from the other events in the option's world, with respect to intrinsic utility, given the agent's rationality and the absence of cognitive limits, aside from the limit on an evaluation's cost-free processing of considerations. Is the combination of an option's consequences in the option's world in fact separable from the other events in the option's world? Such separability requires that the intrinsic utility of the option's consequences be independent of events in the option's past. However, in some cases it seems that past events affect the intrinsic utility of an option's consequences. This raises an objection to evaluation of options by their causal utilities, and a reply must defend the separability of an option's consequences.

Suppose that I want to be the first king of Antarctica. This can happen only if the continent has had no king in the past. Only then does my becoming king now make me the first king. Given this, are the consequences of my becoming king separable from past events? Suppose that I have complete information about the option's world. I use knowledge of the past to characterize future events. In particular, I use knowledge of the existence of any past king of Antarctica to settle whether my now becoming king is my becoming the first king. If I know the continent has not had a king before, I know that my becoming its king now is my becoming its first king. My becoming its first king is then a consequence of my becoming its king now. An option's evaluation may focus on its consequences even if the past plays a role in characterizing its consequences.

Note that the separability of an option's consequences from other events in an option's world requires only that the intrinsic utility of the option's consequences be the same for any way of fixing the other events that is *a priori* compatible with the option's consequences. Hence, if becoming the first king of Antarctica is a consequence of my becoming its king now, then the consequences' separability from past events requires a constant intrinsic utility for the consequences as past events change in ways *a priori* compatible with the consequences. The utility of the consequences need not be constant for changes in the past, such as introduction of a past king of Antarctica, that prevent the occurrence of the consequence that I become its first king.

Given incomplete information, I use my knowledge of the past to characterize future prospects and their probabilities; for each world that might be the option's world, I use past events in the world to characterize the consequences in the world of the option's realization. Then I maximize expected utility considering just the consequences of options. In general, although the past plays a role in characterizing an option's consequences, once they have been characterized, they are separable from other events. Rationality, in

5 - IU(~H) equals the intrinsic utility of not realizing any basic intrinsic desires. It need not equal the strength of a basic intrinsic aversion to not being healthy. In the example, John has no basic intrinsic aversions.

fact, requires this type of separability for an agent who is almost cognitively ideal, as in the model of Section 4. Because intrinsic utilities evaluate events using only their *a priori* implications, the intrinsic utility of an option's consequences is the same regardless of the other events in the option's world. The separability that the summation principle implies stands confirmed. Therefore, an option's evaluation may justifiably use the option's causal utility.

Another objection to Section 4's justification of evaluation by causal utility targets the definition of a basic intrinsic desire. An intrinsic desire obtains considering only the *a priori* implications of the object of desire. A basic intrinsic desire, according to the definition stated, does not have as a reason another intrinsic desire. Is this definition of a basic intrinsic desire faithful to intuitions about basic intrinsic desires? Satisfying a desire to see my son do well may also satisfy a desire for pleasure. Suppose both desires are basic intrinsic desires. Does the definition of a basic intrinsic desire accommodate this possibility? Pleasure is a reason for wanting that my son do well. Does the definition of a basic intrinsic desire therefore disqualify my desire that my son do well, contrary to intuition, because another intrinsic desire, the desire for pleasure, is a reason for the desire?

No, the case does not create a problem for the definition. An agent may have both an intrinsic desire and an extrinsic desire that some event occur. I may have an extrinsic desire that my son do well in addition to an intrinsic desire that he do well. I desire that my son do well because of its *a priori* implications; hence this desire is intrinsic. Also, I desire that my son do well because his doing well brings me pleasure; hence this desire is extrinsic. The intrinsic desire for pleasure grounds the extrinsic desire that my son do well, but not the intrinsic desire that he do well. The intrinsic desire that he do well considers only the *a priori* implications of satisfaction of the desire, and the desire's satisfaction does not entail pleasure. Pleasure is a consequence, but not an *a priori* implication, of my son's doing well. The intrinsic desire that my son do well may, therefore, be a basic intrinsic desire not grounded in any other intrinsic desire. Because the intrinsic desire for pleasure is not a reason for my intrinsic desire that my son do well, the latter may qualify as a basic intrinsic desire. Only the extrinsic desire that my son do well is grounded in the intrinsic desire for the pleasure his flourishing brings. The definition of a basic intrinsic desire therefore does not clash with intuition in this case.

6 – Conclusion

The previous sections presented some models of rational choice. Section 3 presented a standard model for expected-utility maximization and then relaxed idealizations about information. Section 4 generalized the standard model by relaxing an idealization about deliberation costs. Section 5 defended this generalization.

Relaxing the idealizations of full information and of limitless, cost-free processing of considerations illustrates a method of generalizing models in normative decision theory that exemplifies a common type of change in science. Initial idealizations simplify a model's treatment of a phenomenon, and succeeding models generalize by relaxing idealizations. The result is greater realism. This characterization of a type of change in normative decision theory advances the decision sciences.

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