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Models of multi-attribute decision-making: implications for institutional analysis and design

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MAX PLANCK SOCIETY



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Models of Multi-Attribute Decision-Making. Implications for Institutional Analysis and Design*

Christoph Engel

Abstract

Institutions are governance tools. They are useful only if they impact on behaviour: of citizens, and of those administering the legal system. Models of behaviour are therefore crucial for institutional analysis and design. In light of this, this paper draws lessons for institutional analysis and design resulting from the models of multi-attribute decision-making assembled in this special issue. That way, it contributes to assessing the external validity of these models with respect to one well-defined, and practically highly relevant, domain.

Keywords: multi-attribute decision-making, recognition heuristic, parallel constraint satisfaction, sequential evidence accumulation, exemplars, external validity of behavioural models, standard of proof, jury decision-making, story telling model

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Introduction

In modern societies, institutions are typically not inherited from the past. They do not emerge from continuous social interaction. Rather they are purposefully designed. This trend in institutional evolution is epitomised by the law. The constitution empowers parliament to make new law at any point in time. Institutional designers must be able to say why the new intervention into freedom or property is necessary. The intervention may aim at preventing natural catastrophe. Yet these days, most institutions aim at curing perceived social ills, resulting from the socially disruptive behaviour of some individuals. At any rate, whatever their goal, institutions can only be effective if they impact on behaviour.

Consequently, an institutional analyst wants to know: what is the effect of a certain institution on behavior? For instance: will consumer behavior change if the law requires advertisements to be more informative? If the analyst also wants to assess the performance of the institution, the research question becomes more entangled. First, the purpose of intervention must be defined. In the example, advertising might be regulated to enhance allocative efficiency, to prevent redistribution of wealth from consumers to producers, or to paternalistically help consumers make better choices. Depending on this choice of goal, very different changes in behavior may become desirable. For instance heavy advertising might be a way for the producer to signal its long-term commitment to quality, and thereby to overcome an information asymmetry (Kihlstrom and Riordan 1984). This would enhance efficiency. But those who believe in consumer sovereignty might still find emotional advertising to be undesirable for paternalistic reasons.

Moreover, in reality a new institution hardly ever builds on a clean slate. Other institutions remain in place. The new intervention becomes part of a richer institutional arrangement. In that case, one must be able to say how the new intervention changes behavior, given that it is guided by the newly configured institutional arrangement. Going again back to the example: is there a need for positively requiring a minimum degree of informativeness given that, anyhow, competitors may sue if advertising is “misleading”?

Designing new law differs from analyzing existing law in that it is forward-looking. Given the definition of the respective social problem, the designer predicts the effect of a suggested intervention. Normally, there is more than one institution that should be able to improve the situation. If so, the institutional designer must also comparatively assess the advantages and disadvantages of the conceivable solutions. In other words, the designer must predict how the alternative institutions will impact on the behaviour of those to be governed by them.

Given the complexity of human behavior, the legal order (as a shorthand for those developing and administering the law) cannot exclusively rely on empirics for the purpose. It needs theoretical concepts to ask appropriate questions. If there is time and a manageable methodology, the legal order may be content with asking questions to psychology, and patiently wait for the answer. Yet often, the legal order will have to take action before psychology has come up with a

solid set of findings. In these situations, good psychological theory is a most valuable, albeit of course incomplete, substitute.

In that spirit, it is fortunate that a model pretty close to the one offered by Glöckner & Betsch has already been tested on a question of criminal procedure. However, it is shown in this paper how the remaining models of multi-attribute decision-making are also relevant for the law, although they have not been tested on legal issues as yet. For sure, it would be desirable that such evidence were produced in the future.

There is, of course, a vast literature on “behavioral law and economics” (e.g. Sunstein 2000), and an even older literature on “law and psychology” (e.g. Hastie, Penrod et al. 1983; Sporer, Malpass et al. 1996). In some way or other, this literature has touched upon all the legal applications discussed below. It is not the intention of this paper to supersede, or to survey for that matter, all of these discussions. All this paper sets out to do is to demonstrate the usefulness of the models presented in this special issue for these discussions.

How ought one evaluate the quality of a model? In psychology, this question has haunted math modelers and users of mathematical models from the beginning (Estes 1975). Almost universally, modelers and users alike will agree that any evaluation should take place in the context of multiple competing models, akin to Platt’s strong inference (Platt 1964). As a heuristic, most everyone will also agree that Occam’s Razor should be applied to choosing among the models so that the model “that fits observed data sufficiently well (i.e., descriptive adequacy) in the least complex way (i.e., simplicity) should be preferred” (Myung, Forster et al. 2000:1). By analogy to experimental methodology (see Cook and Campbell 1979), one might understand these two principles as testing a model’s internal validity, or how well a model is able to organize the data at hand. However, this is just one dimension to evaluate a model. Keeping with the analogy to experimental methodology, a model should also generalize to populations and to situations outside of the laboratory. It should also be externally valid.

There is one major difference between internal and external validity. While the norms defining internal validity are universal, external validity can only be assessed with respect to a well-defined application. As the following remarks demonstrate, not only are institutional analysis and design a field of application that differs from others, like the interpretation of art, or the design of products. One must even be more specific, and select individual institutions, or individual social problems, to say how a certain model of multi-attribute decision making can be put to productive legal use.

The Models

Parallel Constraint Satisfaction

In all but one of the papers, institutional analysis and design, let alone the law, is at most a hidden agenda. This is different with the paper by Glöckner and Betsch (see also Glöckner 2008). It

explicitly formulates hypotheses for the theory of institutions. It therefore provides a good starting point for the endeavor. Glöckner and Betsch offer an all-purpose model for multi-attribute decision making. Irrespective of tasks and domains, in inference tasks, decision-makers integrate cue information according to a mathematically specified algorithm. The task is designed as the choice between predefined interpretations. Cues have initial validity, which can be imposed externally, or accumulated in earlier experience with similar tasks. If the task is non-trivial, different cues support different interpretations of the evidence.

In the Glöckner and Betsch model, this conflict is resolved the following way: initial information input informs the automatic system of the conflict. The system uses this information, plus its knowledge about initial cue validities, to engage in what one might metaphorically characterize as competition between interpretations for support. In this competition, the fact that another interpretation also gets some initial support weakens the interpretation. Through multiple iterations, the automatic system devalues some cues, and revalues others, until one interpretation gets enough support to surpass the predetermined threshold for being convincing. Glöckner and Betsch provide evidence that this cognitively taxing mechanism is indeed at work when experimental subjects are asked to make inferences, based on incomplete evidence.

In social reality, the evidence is often incomplete. This is obvious whenever decision-makers do not only have to assess past events, but aim at influencing the future. For, by definition, the future is not fully predictable (more from Engel, 2005). But even if decision-making is exclusively backward looking, the evidence is hardly ever complete. This is epitomized by criminal law. When assessing whether the defendant has committed the crime of which she is accused, the criminal court is exclusively interested in the past. However, even when inflicting the severest sanctions of which the legal order disposes, it is content with finding the defendant guilty "beyond reasonable doubt" (more from U.S. Sentencing Commission Guidelines Manual, 1994). Courts have power to convict defendants although they have pleaded "not guilty". Since the defendant has the constitutional right to be heard in court, at least one cue, that should have sufficiently high initial validity, calls for a different interpretation of the evidence.

Stylized criminal cases have been used in experiments to test a model of information aggregation that is closely related to the one by Glöckner and Betsch. Experimental subjects did indeed inflate the weight of some of the evidence, at the expense of other pieces of evidence. Their automatic system translated the procedural standard "beyond reasonable doubt" into a fairly high threshold for accepting an interpretation. Critically, they reacted to the high standard by strongly changing cue validities in the process of generating their assessment of the case (Simon, Pham et al. 2001; Simon 2004). This finding in support of parallel constraint satisfaction resonates well with the predominant model to organize the data from mock juries. Jurors are said to engage in "narrative reasoning". From the evidence they have heard they try to construct stories. They hold the defendant guilty if the prosecutor has been presenting a coherent story, that is basically backed up and, more importantly, not patently contradicted by the evidence (Hastie, Penrod et al. 1983; Hastie 1993; Kuhn, Weinstock et al. 1994). Parallel constraint satisfaction models provide

a causal explanation for these findings, based on evidence regarding the underlying mental mechanism.

This is important news for the law. While sitting in court and listening to the evidence, as it is presented to them by the prosecutor and by the counsel for the defense, the automatic system of jury members is likely to be busy trying out interpretations. From the Glöckner and Betsch model, the legal order learns that, once they have seen all the evidence, psychologically the evidence will no longer be the same. In an attempt at generating consistency, the automatic system has devaluated some of it, and it has given additional weight to other pieces of evidence.

There are obvious follow-up questions: how effective is the legal order when it tries to impose a standard of proof? Note that the legal order firmly believes this to be effective. For constitutional reasons, the standard is particularly high in criminal justice. It is much weaker in private law disputes. Usually the court has power to find for the plaintiff if only there is "preponderance of the evidence". Moreover, in court procedure the evidence is presented sequentially. How strong is the effect of the order in which this evidence has been presented?

What can legal reformers do with this knowledge? In criminal procedure, the norm is not disputed. The presumption of innocence has to be respected. But is it violated by what we now learn about the automatic system? This knowledge forces the legal order to become normatively more precise. Although this is usually not made explicit, the legal discourse typically implicitly starts from assuming that past events could in principle be fully reconstructed (but see Jackson 1996). If only the legal decision maker had access to all the theoretically available evidence, a one to one reconstruction would be feasible. The fact that the evidence in court is next to never that complete is only due to imperfections. The standard of proof says which degree of imperfection is still acceptable in the respective type of case.

In light of the Glöckner and Betsch model, this is a questionable definition of the normative problem to be solved by evidentiary rules. The critical point is centre stage in the (otherwise competing) tradition in which the Gaissmaier, Schooler and Mata, and the Rieskamp papers are written. When criticizing the Kahneman and Tversky line of research, Gigerenzer and his collaborators have always insisted: the human decision-making apparatus is not made for the artificially certain world of the lab. It is designed such that humans are able to navigate a fundamentally uncertain world (Gigerenzer 1996; Gigerenzer, Todd et al. 1999). This message is only beginning to travel into law (Gigerenzer and Engel 2006).

For the law of evidence, the implication of this shift is straightforward. If one starts from the assumption that a one to one reconstruction of past events is impossible, it no longer is normatively problematic that jury members use their automatic system to make sense of incomplete evidence. On the contrary: this is the best humans can do. Specifically, the automatic system not only has many more cognitive resources than the consciously accessible, deliberate system. It works in parallel, not serially. It is not limited by memory span (Wechsler 1945), to list only the two most important reasons. It also is much better at tackling with conflicting evidence, and in correcting

for missing evidence, precisely since it aims at consistency maximization. There are evidentiary questions for which even better, non-human technology is available. Genetic fingerprinting provides an illustration. Where the advantage of technology is not that evident, those developing procedural rules could call in psychologists to comparatively test the performance of outside technology versus the human automatic system. Based on such findings, facts could be singled out that must be proven by technology. However, for the remaining evidence, the legal order has no reason to shun the consistency maximizing mechanics of the automatic system.

To be sure, this mental mechanism is not foolproof. As work on mock juries has shown, personal ability varies remarkably. Individual jurors differ widely in the mental representations of the inference problem. As a rule, richer representations lead to a normatively more appropriate final assessment (Kuhn, Weinstock et al. 1994). It is therefore not enough for procedural law to give room for consistency maximization. The law should also see to it that jurors are likely to represent the problem appropriately. And there remain, of course, the additional challenges resulting from the fact that jurors decide as a group: the tendency to conformity (Asch 1952), the power of persuasion (Hovland 1953), and the propensity to groupthink (Janis 1972).

The focus of procedural lawyers should shift to different questions: under which, exceptional, circumstances does the automatic system not work that well? More importantly even: by which manipulations is the automatic system most severely misled? In court, two strategic actors meet. Both are professionals, specializing in litigation. Both get a significant premium if they successfully manipulate the jury. Contrary to this, on purpose, jury duty affects the public at large. Consequently, in a typical criminal case, the prosecutor and the counsel for the defendant have much more experience with the situation than the members of the jury. The legal order should be troubled by this asymmetry. Is the automatic system still as reliable if two interested actors with conflicting goals try to mislead it? How well is the automatic system prepared to detect such attempts at manipulation?

Recognition and Fluency Heuristics

The foregoing shows how institutional analysis and design can capitalize on the Glöckner and Betsch model. Let us now say more about boundary conditions. The model is not about criminal procedure. It is not about the reconstruction of past events. It is just about inference tasks. This high level of generality, and this independence from context, makes outside use of the model easy. Compare this to the (partly) competing heuristics model, as used in the Gaissmaier, Schooler and Mata paper. The paper is particularly attractive in that it uses a general-purpose tool, the ACT-R framework (Anderson, Bothell et al. 2004; Schooler and Hertwig 2005), to model heuristics. But, it differs from the Glöckner and Betsch approach in that the object modeled is inference *by specific heuristics*, not inference at large. In the tradition of which this paper is part and parcel, heuristics are not domain specific (for an alternative view see (Engel 2006)), but are task specific. Specifically, the recognition and the fluency heuristics are deemed applicable whenever two conditions hold: in an inference task, the subject does not have easy access to

the normative solution; with respect to at least one cue, the subject can discriminate: while one object is (better) recognized the other is not (as good). Note that those propagating these heuristics claim they are applicable whenever memory allows for discrimination, irrespective of the domain. The paper thus models at two levels: in defining its cognitive object as being inference by recognition, and in using ACT-R to say how this specific cognitive tool works. The specificity inherent in the model almost by definition limits its external validity.

Note that, obviously not by coincidence, both papers have used the very same task. Experimental subjects are asked to assess the size of foreign cities, based on a small number of cues. Those favouring the heuristics model claim: if a subject knows the name of one of the cities (well), and if she does not know the name of the other city (well), that settles it for her. Within the Glöckner and Betsch model, the fact that the subject recognizes one of the names matters for the initial validity of this cue. Of course, the bone of contention between both models is parsimony. The heuristics model claims: people use as little information as ever possible. The constraint satisfaction model claims: people in principle use all the information available. Ultimately, this is an empirical question, to which this paper cannot contribute.

Yet there is a second difference. In and of itself, the model presented in the Gaissmaier, Schooler and Mata paper only speaks to inference tasks where the decision maker is able to discriminate between two interpretations by way of recognition. This may occasionally happen in criminal procedure. An illustration is this. In criminal procedure, the counsel for the defendant often claims: given the uncontested evidence, there could be explanations other than the defendant having committed the crime. The jury has to take such speculations seriously if they “cast reasonable doubt”. Jury members might translate this legal standard into a question in the spirit of the recognition heuristic: have I ever heard of such a course of events? Before this translation is officially accepted by the legal order, one would, of course, need experiments that show whether recognition of entire stories is as reliable a proxy for their probability, as is the recognition of city names for city size (Goldstein and Gigerenzer 1999), or the recognition of brand names for stock performance (Andersson and Rakow 2007).

More importantly, even if one may tell plausible stories about inference by heuristic in criminal courts, such stories must have fairly strict boundary conditions. This limits the external validity of the heuristics model, at least if the user is someone who analyses criminal procedure. An adaptive toolbox model could be the basis for institutional interventions only if the law maker knew all, or at least most of the tools in the box, and when which tool is most likely to be used. The applicability of the parallel constraint satisfaction model is not in the same way constrained. Hence, to use the two metaphors from the Bröder and Newell paper (this issue), the external validity appears higher for "adjustable spanner" than for "adaptive toolbox" models.

Sequential Evidence Accumulation

Yet another paper has direct relevance for judicial procedure. Before the jury, or the judge for that matter, decides whether the alleged facts have been proven to exist, judicial procedure is an exercise in fact finding. Depending on whether the respective procedure is guided by the adversarial or by the inquisitorial principle, it is the parties or the judge who decide which evidence is heard. Hausmann and Läge offer a search model that has a direct analogue in judicial procedure. They claim that individuals neither exhaust the evidence, nor content themselves with learning the single most discriminatory cue. Rather individuals have a level of confidence. They go on checking further cues until the supporting evidence surpasses the level of confidence. If the judge has power to investigate, this is also what happens in court. If this power is reserved to the parties, the judge, and the jury for that matter, are in a directly related situation. Given the evidence they have heard, they must decide whether it is conclusive. This task can be translated into the question: if I had been able to investigate myself, would I have stopped search here?

This is exactly what the already introduced legal concept of the standard of proof is about. As mentioned, it ranges from "beyond reasonable doubt" down to "preponderance of the evidence". The only qualification stems from the fact that courts may not refuse to decide a case. An additional set of rules, called the burden of proof, determines which party loses if the evidence remains inconclusive. The most important follow-up question has already been mentioned. Are institutions able to effectively determine the level of confidence of judicial decision-makers? Specifically: are the jury instructions able to induce this level of confidence in decision-makers who are novices? Do standardized instructions have sufficiently similar effects on all members of the jury, although the jury is meant to represent social and cultural variation in society? Using language that is prominent in the behavioral law and economics discourse: are jury instructions an effective technology for "debiasing through law" (Jolls and Sunstein 2006)?

Findings from the Hausmann and Läge paper even offer first answers to these follow-up questions. In (implicitly) defining their level of confidence, experimental subjects are sensitive to task differences, and personality matters. Unfortunately, it will not be easy to capitalize on this knowledge for making better law. For the level of confidence, the task characteristics and the personality component are all free parameters. The legislator, or those applying a general legal rule, would need to know these parameters in each and every instance. From the abstract model, the institutional designer only learns that there is a lot of variance in the field. Of course, this may just be the essence of decision-making in the face of uncertainty. In that case, further institutions would be needed to make behavior more predictable (Engel 2005). Compare this to the Glöckner and Betsch model. It has not only three, but a potentially unlimited number of free parameters, in that initial cue validities are not determined exogenously. But for improving jury decisions, the legislator need not know these validities. It suffices to understand the abstract mechanism.

Exemplars

Good policymakers are storytellers. They seize the opportunity of a graphic scandal (Markovits and Silverstein 1988) to overcome otherwise insurmountable veto points (Immergut 1992; Tsebelis 2002). In legal procedure, at least the plaintiff must tell a story, which is often countered by the defendant. Judges and jury members have been demonstrated to decide by way of "narrative reasoning". In the face of uncertainty, by mental simulation they sketch scenarios and decide in favour of the most convincing one (Hastie, Penrod et al. 1983; Hastie 1993). Last, but not least, the law's subjects are more sensitive to a graphic story than to the abstract presentation of the same issue, even if the basic structure remains the same. The effect is exploited by firms merchandising their products, and by politicians merchandising their interventions.

Why is that? The Karlsson, Juslin and Olsson paper offers a causal explanation. To make that claim, one must of course scale up from bug shapes to legal cases and political conflicts. One may feel confident to do that since there is solid evidence on the "story model" (see again Hastie, Penrod et al. 1983; Hastie 1993). But ultimately, it would of course have to be shown experimentally that the very same mental mechanisms are indeed at work with stories. Karlsson, Juslin and Olsson show their subjects to be sensitive to the structure of the inference task. If cues are additively linear, the majority of their subjects finds this and uses cue information in isolation. Cue abstraction is also the fallback option if subjects have next to no information about the object of the inference task. However, there is a broad intermediate area. Subjects know at least something. But to their judgement, the validity of one cue is not independent of the co-presence of other cues. In such environments, subjects rely on exemplars stored in memory. By analogy, they use, or they construct stories.

This is important news for institutional analysis. Stories do not matter all over the place. But the law's subjects are likely to make inferences by exemplar if the environment is muddy, yet not totally obscure. This is a situation in which many persons frequently find themselves. Exemplars are retrieved from memory. Understanding the underlying mental mechanism can help design appropriate institutional interventions that aim at protecting, e.g., investors who have been demonstrated to be liable to the "hot hand fallacy" (Gilovich, Vallone et al. 1985): If prices fluctuate modestly, investors track these changes properly. However, when seemingly trends appear, many subjects switch to chasing these trends (Andreassen and Kraus 1990). These observations might justify regulatory intervention.

However, patterned exemplars may have a downside for regulation too. If the large majority of the target population is likely to hold similar exemplars in a domain, behaviour may become sticky. It may be very difficult to change behaviour if this becomes normatively desirable. The powerful exemplar might be in the way of alternative constructions of reality that would make the new social expectation more digestible. A well documented observation from environmental psychology may be brought under this rubric. In travel mode selection, people heavily rely on routines (Aarts and Dijksterhuis 2000; Bamberg, Ajzen et al. 2003). One explanation for this is cognitive: when they want to go from A to B, they do not see this as a problem of travel mode

choice at all. They simply construct it as an instance that triggers using their preferred means of transportation. Note that, in this explanation, the ineffectiveness of institutional intervention would not rest in the opposing will of institutional addressees. The cause of regulatory failure would be entirely cognitive.

Conclusion

All models of multi-attribute decision-making assembled in this special issue have been developed as tools of basic (psychological) science. Basic science has its own driving forces. It often needs lengthy detours. It must artificially simplify problems such that they become tractable. It must invest into the development of new conceptual and empirical tools, even if it is initially unclear how they might ever transcend beyond the discourse of specialists. Therefore if, in this paper, some models have been characterised as being less useful for guiding legal reform, this by no means excludes that they are valuable contributions to the theory of multi-attribute decision-making. However, being practically useless is not a precondition for scientific progress. A model should be preferred if it has as much internal validity as a competing one, but outperforms the other in terms of external validity. All this paper has set out to do is assessing the models on one of these external dimensions.

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