

Mathematical Modeling Issues in Analytical Representations of Human Societies

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Abstract

The application of mathematical models to anthropology has had a long history, with examples as varied in their content as is the field of anthropology. While models borrowed from other disciplines have been effectively applied, these models often do not fully take into account the implications of the cultural aspect of human social systems. A cultural construct provides organization for and representation of the external world. The implications for mathematical modeling of human systems are threefold: modeling of a cultural construct as a symbol system, modeling of the process of instantiation whereby abstract symbols and relations are provided with more concrete content and modeling of the ongoing set of behaviors and relationships of one individual to another.

The application of mathematical models to anthropology has had a long history, with examples as varied in their content as is the field of anthropology (see Read 1996 for a recent overview of the use of mathematical models in anthropology). Anthropologists have made extensive use of mathematical procedures ranging from statistical methods for elucidation patterns in behavior to mathematical representation of the logic of native conceptual systems such as kinship terminologies. Mathematical models and mathematical modeling has been considered by some metaphorically as a tool and by others as a way to extend anthropological or archaeological reasoning. Yet others have decried the use of mathematical, and in particular, statistical and quantitative modeling, as fundamentally in opposition to a humanistic approach to understanding human behavior that must take into account contingency and historical embeddedness and decries universality. For some the power of mathematical models is in providing a metaphorical language for expressing aspects of behavior, while for others mathematical representation of fundamental concepts is a sign of the growing maturity of anthropology as a science. In many cases models are bor-

rowed from sister disciplines that address what appear to be similar issues, such as the application of Optimal Foraging Theory from ecology to hunting strategies in human foraging societies, linear programming to diet choice among hunters and gatherers, or game theory to choices made by Jamaican fishermen. In other cases the models derive from the characteristics and properties of the data being examined or the anthropological arguments being made, such as models of prescriptive marriage systems as found among aboriginal Australian populations.

While models borrowed from other disciplines have been effectively applied, these models often do not fully take into account the implications of the cultural aspect of human social systems. Economic models, for example, typically are based on assumptions of rationality, equal access to all information when economic decisions are being made, assumption of a fixed utility function and do not consider where the utilities themselves come from. For example, the economist Friedman commented "The economist has little to say about the formation of wants..." (1962) and later the economist Becker wrote "Economists generally take 'tastes' as given and ... [assume] that tastes do not change" (1976). Problematic from an anthropological viewpoint is the presumption of a fixed structure within which decision making takes place. The cultural component is critical, for, as noted by Pollak and Watkins (1993) "... accounts that emphasize the unity of culture, viewing culture as a coherent whole, a bundle of practices and values" are "incompatible with the rational actor model" (490).

But what is meant by the cultural component varies widely and ranges from viewing culture as socially learned and transmitted behaviors to culture viewed as made up of abstract symbolic systems with an internal logic giving a symbolic system its structure. If the former then it is the process by which transmission takes place from one person to another that is central to elucidating the role of culture in human behavior. If the latter then culture plays a far-reaching and constructive role with respect to patterns of behavior that cannot be induced simply through observation of behaviors however sophisticated the statistical analysis as the structuring power of culture under this assump-

tion is only partially captured by the process through which behaviors are transmitted from one individual to another or in the range of behaviors that occur. The same situation would arise as occurs with language acquisition. For there to be language acquisition there must be a cognatic process by which a finite corpus of language utterances experienced by a child leads to internalization of an underlying grammar that transcends the specific features of that finite corpus of utterances. Likewise, if culture consists of abstract symbol systems whose form is the consequence of an internal logic, a child learns not just specific instances of the usage of that symbol system but derives from those instances a cognatically based understanding of the internal logic of the symbol system.

In contrast, if culture consists of socially learned and transmitted behaviors then the cognatic aspects of the human brain play a relatively minor role when constructing models of behavior and of social/cultural systems. The cognatic aspect of the brain that is needed in this framework is primarily a decision process by which one either accepts or rejects a behavior as part of one's own repertoire of behaviors. In addition, the decision process under this scenario should be specifiable in terms of a structuring process external to the individual such as natural selection since the decision process for accepting or rejecting behaviors will have direct implication for the (Darwinian) fitness of an individual.

Of these two scenarios for the definition of culture, culture as socially learned and transmitted behaviors appears to be inadequate and lacking in the depth needed to encompass the full range of cultural phenomena. Cultural constructs such as kinship terminologies, for example, cannot be specified simply in terms of behaviors that occur among kin-related individuals since one's kin is a culturally constructed category and determined through the persons to whom one has a determinable kin term relationship. Among the !Kung san, for example, being a non-kin and being a

stranger are synonymous (Marshall 1974:xxxx) and both are potential sources of harm. Social intercourse takes place among the world of kin and one's kin are determined through knowing the kin term relationship of ego to alter. The latter depend upon the kinship terminology having two features: (1) the kin terms constituting a symbolic system structured by a logic or grammar that gives the symbolic systems its particular form and (2) a means, or set of rules, for mapping abstract symbols onto individuals (that is, a mapping from the ideational domain of a kinship terminology as a cultural construct to the phenomenological domain of individuals organized by kin term relationships—or lack of a kin term relationship—linking individuals to one another.

The two parts being identified here—an abstract, conceptual structure and instantiation of that conceptual structure—are not unique to kinship and kinship terminologies but are found, I argue, where ever we find a culturally determined model for the organization of some aspect of human social systems. In effect, we appear to have two ways in which we cognize, represent and make sense of phenomena that impinge on our sensory apparatus. First, there is a level of cognition that we share, to varying degrees, with other organisms. This level would include cognatic modeling that we may do at a non-conscious level that serves to provide an internal organization of external phenomena and to provide the basis upon which behavior takes place. Second, there is a culturally constructed representation of external phenomena that also provide an internal organization for external phenomena, but where the form of the representation arises through formulating an abstract, conceptual structure that provides form and organization for external phenomena in a manner that need not be consistent with the form and patterning of those phenomena as external phenomena; that is, the cultural construct provides a "constructed reality," to use a current, but much abused, phrase. The two parts are shown schematically in Figure 1,

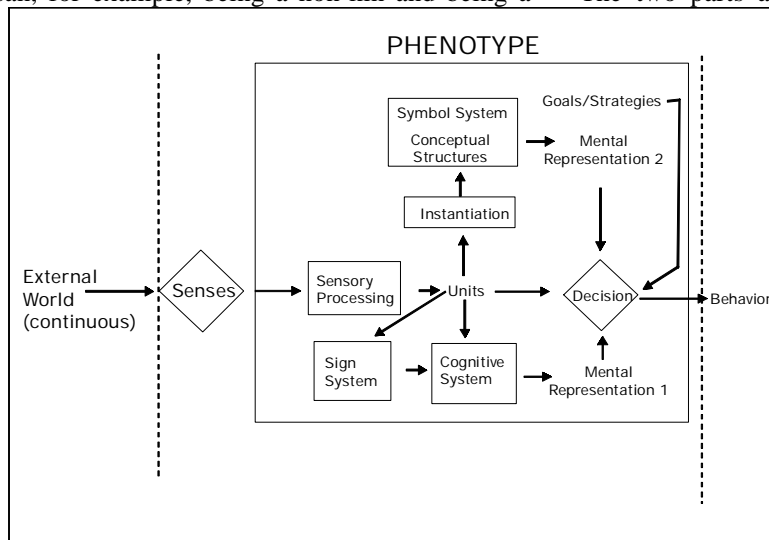


Figure 1: Schematic diagram of the information processing system of an individual consisting of two separate systems: a cognitive system and a symbol system.

where the cognitive system is shared, to one degree or another and produces an organization for and representation of the external world that serves as the basis upon which decision making leading to behavior takes place. A cultural construct is represented by a symbol system and the symbol system also provides an organization and representation of the external world, but one that is not constrained by its degree of concordance with the external world but by its coherence as a conceptual system organized by an internal logic or "grammar."

The implications for mathematical modeling of human systems are threefold. First, modeling of a cultural construct as a symbol system organized by an internal logic or "grammar." Second, modeling of the process of instantiation whereby abstract symbols and

relations are provided with more concrete content. The process of instantiation is not derivable from the form and properties of the cultural construct being instantiated, but has its own logic—what Bourdieu has called the "logic of practice"—and its own dynamic character and time-embeddedness. The latter is a key aspect of instantiation that translate static structure into dynamic social organization. And third there is modeling of the ongoing set of behaviors and relationships of one individual to another, such as the use of networks to identify the actual pattern of interactions of individuals along one or more dimensions deemed to be relevant for the organizational form of the individuals making up a social unit.

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