Cognitive Functional Processing System: Reasoning about Quantitative Relationships

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Introduction

How people acquire or generate rules for combining information for decision-making has long been of interest (Norman, 1974). A cognitive functional processing system is proposed which assesses the relationship between any two variables in the environment by taking the partial derivative of an assumed or known response surface for one variable (A) relative to another (B). The response surface is a general concept that can include stochastic and determinist functions whether correlational or causal. The system is used to reason about the composition and decomposition of functions for combining information to make a single judgment. Brunswik's (1955) Lens Model, Norman Anderson's (1981), Information Integration Theory, and Kenneth Hammond's (1975) Social Judgment Theory are instances of such functions. In this system, decision makers store gradient functions in a matrix as shown in Table 1.

Table 1: Gradient Functions.

	A	**B**	**C**
A	--	f(A,B)	f(A,C)
B	f(B,A)	--	f(C,A)
C	f(C,A)	f(C,B)	--

f(A,B) = + when increases in B lead to increases in A.
f(A,B) = 0 when changes in B do not affect changes in A.
f(A,B) = - when increases in B lead to decreases in A.

When called upon to make subsequent judgments, decision makers generate composition rules from these gradients.

An experiment in which participants used a dynamic map query system to access information about geographic regions was used to investigate relationships learned and inferred between variables.

Experiment

Thirty undergraduates participated in an experiment in which they were asked to find states that satisfied one, two, and three variable range queries using a dynamic map query system (Dang, North, & Shneiderman, 2001). They adjusted sliders which continuously showed the dynamic set of states that met the search criteria.

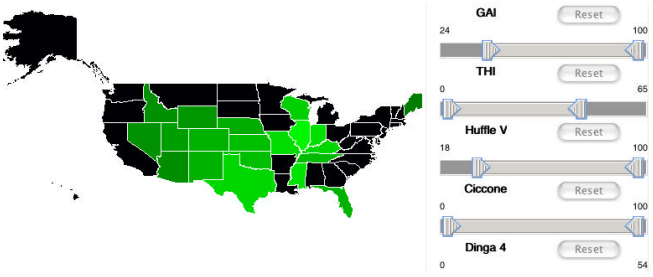

Figure 1: Dynamic Query Interface.

The results showed that participants were able to code the existence and direction of the gradients between the criterion variables; that is, they were aware of the inter-relationships of the search variables. A follow-up experiment was used to demonstrate the ability of the participants to generate new composition rules given the decomposed gradients they had stored from the queries.

Conclusion

The cognitive function processing systems accounts for how people are able to generate information integration rules in novel situations. They re-use previously stored gradients from other decision or search functions.

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