Formalization of the Multi-Resolution Thesis and the Reciprocal Constraints Paradigm for Understanding Social Systems

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1 General Structure of the Reciprocal Constraints Paradigm

The RCP is a methodological approach for thinking about how to develop understanding of social systems, and ultimately provide useable simulations of such. It's value does not lie in precise presecription, but in laying a foundation for fruitful social simulation and an understanding of the implications for theory and models across levels of scale. Figure **??** shows the four primary components of the RCP: a cognitive system, an upward-scaling constraint, a social system, and a downward-scaling constraint. Figure **??** captures the potential for integrating neurophysiolgical considerations when appropriate; these may prove as essential for some social systems.

A central assumption in the RCP is that cognitive systems and definitions of agent behaviors in social systems are representing human information-processing capacities that can be described as mathematical functions. [**?**, **?**][1]. From this assumption we can define a cognitive system as $\psi_{ct} : I_{ct} \rightarrow \psi_{ct}(i)$ where I_{ct} is the set of allowable inputs and $\psi_{ct}(i)$ is the output; social systems, then, have a corresponding agent definition as $\phi_{at} : I_{at} \rightarrow \phi_{at}(i)$ where I_{at} is the set of allowable inputs and $\phi_{at}(i)$ is the output for an agent[2]. Further, we assume that defining social systems and cognitive models as having an abstract set of first principles S and C, repectively such that $s \in S$ and $c \in C$ for ϕ_{at} and ψ_{ct}. Notice that S and C imply somthing about the inputs for both levels of scale as well as each's functional mapping. S and C are theoretical entities that determine what is allowable; these will be defined more precisely below. The interpretation of the upward- and downward-scaling constraints we use is that

[1] This is equivalent to Marr's computational level; we will use Marr's computational, algorithmic, and implementation levels of description[**?**, **?**] throughout this paper.

[2] Social and cognitive systems may define parameters regarding variability among a set of agents; this is not reflected here.

each level of scale *inherits* properties from the adjacent level.[3] We will expand on constraints below.

1.1 Constraints, Inheritance & First Principles

What is a constraint? It means, simply, that some properties of one level of scale are inherited by another level. Thus, the potential power in RCP comes from defining inheritance a notion that is tighly coupled with the first principles C and S. In a sense, it is right to consider inheritance as a way of putting cognitive first principles into social systems and vis versa. Beyond this abstraction, the detials of what inheritance means are quite different, from our perspective, for the upward- and downward-constraints. As we do not have a formalization of the inheritance process, we are left to provide some examples that seem natural to a first approximation; these are not meant to be exhaustive or restrictive.

A primary example in C is the set of allowable algorithms [4] that have some grounding in empirical work in cognitive science and psychology. That is to say, given no new experiments, it might be Not all algorithms that compute ψ_{ct} are equivalent in this regard.

A primary example in S is the Korkmaz work...such that, given a social system S does not allow information from certain branches...in other words the social system affects the allowable inputs in a given unit time.

The empirical argument. A fundamental component of constraints is that they are bound up

The algorithmic considerations; where does this fit in?

1.1.1 Upward-Constraints

The constraints one type of inhieritance from the cognitive to social would be to consider the degree to which ϕ_{at} the s in S compares to C; in other words, to what degree does s respect first principles of human cognition. These are approaches that may not necessitate direct simulation, but would require a disciplined appraoch fo such a comparison.

1.1.2 Downward-Constraints

but by example, many social systems will define information flow among agents as a graph G where $V(G)$ are the agents and $E(G)$ define the information channels among agents.

1.1.3 Automation and Systems of Constraints

The notion of generating a fixed system of constraints that can automate the construction of social systems.

[3] In this treatment, we only have two levels, but this is not necessarily the case.

[4] Issues of computational complexity are a separate but important consideration both in cognitive science and in generative social science that will be considered later or not at all in this paper.