Computational Constraints from Biology

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Even the crudest consideration of neural computation imposes severe constraints on the plausible organizations for cognitive processes. The most obvious constraint is the remarkably small number of sequential time steps involved in intelligent activity, but there are additional constraints imposed by the moderate number (~1011) of units, their limited (< sqrt N) connectivity, and the relative lack of plasticity in adulthood. The exploration of the computational consequences of these constraints has already been fruitful and could become a significant aspect of Cognitive Science.

One consequence of taking these computational constraints seriously is a profound reservation on the ultimate viability of many of the information processing models currently dominating the field. Any paradigm that depends on central control, data structures or symbol manipulation presents the problem of having no obvious reduction to the underlying computational system. Researchers motivated by biological constraints have tended to work on positive results rather than argue paradigms and have been exploiting insights gained through traditional approaches. But it does seem likely that many problems that appear intractable in conventional information processing paradigms will be accessible in a more natural formalism and that cognitive scientists from all domains should examine whether careful consideration of the biological constraint might be timely.

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