Problem Decomposition for Problem Solution

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Techniques for adaptation and learning, and criteria for learnability are issues we have investigated extensively in our theoretically-oriented research. Within this *learning theory* context we have investigated representation of complex systems and informational domains, to establish relationships between behavior and structure. We have sought to determine structural components that would be *necessary* in a behavioral model, and the ways in which components might interact to produce a specified behavioral goal.

In our initial research in inductive inference we sought, and found, perfect behavioral models. The process began with analysis of a complex domain to determine *categories* of behavioral elements. Each category represented a class of elements equivalent with respect to (a congruence defined by) a specific behavioral goal. Each necessary component of a realizing model corresponded to a determined behavioral category.

If only *some* specified behavior could be observed (as is generally the case) a potential model could be inferred from the observed examples, and as more examples became available, the potential model could be refined. Our learning techniques enabled components to be determined *adaptively* with the potential model expanding *monotonically* . As long as the behavioral goal was maintained, there was assurance that with sufficient observations or examples, components of a perfect behavioral model ultimately would be found.

Within the constrained domain of our theoretical research we found a potential behavioral model also could be *adequately* tested to determine whether it might be incorrect. Example behavior defining components of a realizing model also defined relative-complementary examples, and these sets of examples comprised sufficient error-detecting tests. Through iterative *testing-and-correction* of potential behavioral models, we also could determine model components that were perfectly correct. Error-detection and correction thus were included in our perfect learning techniques.

Our theoretical results could be obtained in constrained domains where behaviors could be completely-specified, and where they were finitely-realizable and decidable (to determine if an element is either correct or incorrect). In real-life problems of learning, behaviors are rarely so well-behaved, so that feasible modeling may only be *approximate* modeling. If a complex problem cannot be solved perfectly, it may be possible to solve some of its *sub*problems perfectly, thus approximating an overall correct result. The adaptivity that might achieve a perfect behavioral goal (if possible) is essential to determining better approximations. By decomposing problem domains into subdomains, some with perfectly realizable subgoals, we can find perfect sub-results. The collection of interacting component-results approximate the goal of the greater problem .

We believe our approach to decomposing behavioral domains into categories representable by interacting model components is applicable to many practical areas of agent design. These include determining congregations; designing agent federations; and developing teams of cooperating agents that may solve problems (as needs be) autonomously or interactively. Our error-detection and correction approach has obvious utility in reactive agent design.

We ourselves have applied our theory to the successful modeling of an economic subdomain (to determine best times to buy or sell) and to detection of defects in some deployed e-commerce systems (for maintaining brokerage accounts, and for managing airline reservations), some of which we detail in the references cited below. Since we accept real-life models as approximate, we have no qualms about revising our own models, should we observe behavior that is unexpected and anomalous. Flexibility and revision are important aspectsof learning.

Relevant References by the Author

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