THE NATURE OF AN APPLICATION OF HEURISTIC PROGRAMMING TECHNIQUES

The problem of choosing a reasonable, appropriate, and potentially fruitful application of heuristic programming techniques is a difficult one. This is probably why there are so few application described in the literature. I have not seen the problem explicated anywhere. Here are some considerations that came to mind.

I. Problem Formulation

A. Does there exist, or can there be brought to exist, a generally agreed-upon "best way" to represent the problem domain, D? Is there a representation which is in common use in human problem solving in D? Is there a relatively formal way of describing and creating entities within this representation? i.e., a formal language?

B. Primitives and Combinatorics: Can the generation of potential solutions be conceived as a combinatorial process? (Either as "moves" or "reductions"?) There must be this if we are to fit within the heuristic search paradigm.

C. What is the set of primitives, i.e., solution elements, out of which solutions will be discovered by combination and search?

II. The Knowledge Base: Knowledge is Power. To qualify as an application, nontrivial power is necessary (almost by definition).

A. Does there exist a model of some sort, preferably well-understood and powerful, (a good theory, if you will), on the basis of which pruning can take place, evaluations of search paths can be made, solution candidates evaluated? In other words, is there a powerful semantics behind the symbol manipulation? If not, can such a thing be brought into existence readily?

B. Is there in your environment at least one highly knowledgable, highly motivated, computer-oriented and computationally "sensitive" expert, who can serve as an informant--through whom the knowledge base can be acquired? Intense interdisciplinary interaction will be required. Does he see the payoff? Is there at least one computer scientist around who will meet him halfway and become at least a minor expert in D?
C. Is the universe of facts of D small? Is D almost decoupled from all other possible universes?

III. Problem Difficulty

A. Is the application too difficult at the current state of knowledge? Too simple? Consider, for a typical problem in D, how long does it take a human to solve that typical problem? minute? hour? month? once a lifetime?

B. Ill-structuredness: Is D well-defined enough so that measurements can be made as to how well the programs are doing and where they are deficient...so that reasonable corrective action can be taken?

C. Can progress toward higher levels of performance be made incrementally, or is there a big performance threshold to be overcome?

D. Is the application ill-structured enough to be a heuristic programming application?

IV. Resources: These can be predicted to be relatively large.

A. Ability to obtain major chunks of resources?

B. Ability to sustain resources (money, effort, motivation, knowledgable experts) over long periods of time?

V. A Zoo of Examples: The standards for evaluation of these applications are 1972 standards. My evaluations do not reflect opinions about ultimate practicality, or even the practicality of doing work in the years ahead.

A. Workable Applications

DENDRAL
Chemical Synthesis Planning
Genetics Counseling
Assembly Line Balancing, Job shop scheduling, Warehouse Location and similar combinatorial management science applications
Logistics Planning
Possible difficulties related to:

B. Unworkable Applications
   Predicting Toxic Drug Interactions
   Electrocardiogram analysis
   Clinic Screening and preliminary diagnosis
   Medical Diagnosis
   Modern high-energy physics
   Social Science problems

C. Workable—maybe
   Space Planning
   Design of PC Boards or IC Chips
   Medical Diagnosis in very narrow areas (e.g. glaucoma)
   Semi-automatic Programming a la Floyd
   Semi-automatic debugging
   Fault Diagnosis in Equipment
   Crew Scheduling for Airlines
   Computer-Assisted Instruction
   Control of Scientific and Clinical Instrumentation
   Mass Screening of biological/chemical data
   Analysis of Human Problem Solving Protocols