Research Summary:
Generating Approximate Thermal Models

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In doing design of a physical system it is often useful to reduce the computational cost of evaluating design alternatives by using a range of simulation/analysis models with different degrees of accuracy and computational cost. In the early design stage, we would trade off the accuracy of a model in exchange for its efficiency. In the final design where high degree of accuracy is required, then we switch to an accurate but costly model. We are studying the problem of automatically constructing such models in the domain of heat transfer. This domain is different from most of those studied by AI/Modelling research because both lumped and distributed continuous behavior are involved. The models in this domain range from simple algebraic equations to complex partial differential equations. Our focus is on models to be used by the evaluation step of an iterative parameter design process.

In the heat transfer domain, all models are based on the law of conservation of energy. There is a standard approach to formulating models, and different kinds of energy are well understood. We are developing a system that makes use of this strong domain theory for model generation. The system has three sequential tasks:

- a set of system boundaries, called control volumes, which determine regions of interest, is chosen,
- a set of energy processes that act within and across the boundaries of these regions is selected and instantiated, and
- then the energy processes are transformed into mathematical form and mathematical simplification are used to turn them into mathematical models.

Various kinds of approximations are used in the system, and they take three forms:

- choice of control volume, e.g. lumping regions of the artifact, based on the form of a query and an estimate of how much the parameter of interest varies,
- choice of which energy processes to ignore based on their order of magnitude values, and
- assumption that various material properties do not vary across space or time.

An initial version of our system is described in a paper [Ling and Steinberg, 1992] in this symposium. We are currently implementing our second version for multi-components artifacts.

References


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*This research is part of the Rutgers CAP project, supported by the Defense Advanced Research Projects Agency and the National Aeronautics and Space Administration under NASA grant NAG2-645.