Chapter 5

PPK:
TOWARDS A KERNEL FOR BUILDING PSES

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Abstract
Problem Solving Environments (PSEs) are very high level software environments that provide all the facilities needed for handling some class of problems. It is clear that building PSEs is a costly endeavor both in terms of the person-years required and the diversity of knowledge and expertise required. This paper describes the Purdue PSE Kernel (PPK), a software framework designed to assist in the development of PSEs. PPK assumes a fairly general model of PSEs, where PSEs are viewed as a collection of communicating, cooperating entities. The architecture of PPK is designed to provide the infrastructure needed to build application PSEs that adhere to this model. The model is realized in terms of an electronic notebook for user interaction with the PSE, an object manager for storing problem information, and a software bus for supporting communication between components of the PSE.

Introduction

A Problem Solving Environment (PSE) is a computer system that provides all the computational facilities necessary to solve a target class of problems (Rice and Boisvert, 1996). These features include advanced solution methods, automatic and semiautomatic selection of solution methods, and ways to easily incorporate novel solution methods. Moreover, PSEs use the language of the target class of problems, so users can run them without specialized knowledge of the underlying computer hardware or software. Overall, they create a framework that is all things to all people. They solve simple or complex problems, support rapid prototyping or detailed analysis, and can be used in introductory education or at the frontiers of science. It is obvious that building such software systems is a monumental task (Weerawarana, 1994), thus a solid base infrastructure upon which application scientists can build their PSEs is needed. The Purdue PSE Kernel (PPK) is a software framework (infrastructure) designed to
assist PSE builders in this task. PPK assumes a fairly general model of PSEs, where PSEs are viewed as a collection of communicating, cooperating entities. The architecture of PPK is designed to provide all the infrastructure needed to build application PSEs that adhere to this model. This model is realized in terms of an electronic notebook for user interaction with the PSE, an object manager for storing all the problem and solution components and a software bus for supporting the communication and integration needs of the components of the PSE. An embedded, customizable programming language is provided within the electronic notebook to allow users to "program" a problem solving process by specifying a high level script. This base architecture of PPK is augmented with a set of domain-specific toolkits which provide the required infrastructure in key areas such as symbolic computation, computational intelligence, computational geometry and numeric computation. In addition, a high level composition framework allows users to compose PSE from existing PSE components. In this paper we describe the overall architecture of PPK and a partial prototype that has been completed.

1. PROBLEM SOLVING PROCESS

We consider the problem solving process used when computation is the primary technique for solving some problem, and consider activities both from the user's and the system's viewpoints. In this context, the system is the sum total of all software/hardware which is involved in computationally solving the problem. The process involved can typically be decomposed to the following five stages: declarative problem specification (the user interacts directly with a PSE designed to solve the problem), computational script (the problem specification must be transformed to some solution algorithm which when run will solve the problem), high-level programming language program (the computational script must be executed by either interpreting it or by translating it to some traditional high level programming language), problem solvers (libraries or servers are the components that do the real work for solving the problem, and are invoked from the high level language), OS/networks/utilities (the lowest level is the traditional computing platform on which the problem solvers execute).

2. OVERVIEW OF PPK

The goal of the Purdue PSE Kernel project is to develop a software kernel that can be used to build PSEs that support the problem solving process described above. This goal is realized by the following components:

- PSE architecture: PPK defines and supports a powerful, extendable PSE architecture. All the components of PPK and the resulting PSEs assume and support this architecture.