An Extensible State Machine Pattern for Interactive Applications

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Abstract. The *state design pattern* is the standard object-oriented programming idiom for implementing the state machine logic of interactive applications. While this pattern provides a number of advantages, it does not easily support the creation of extended state machines in subclasses. We describe the *extensible state design pattern*, which augments the traditional state pattern with a few additional constraints that allow subclasses to easily add both new states and new events. Further, we observe that *delimited continuations*, a well-known construct from functional programming languages, supports *state refinement* in subclasses as well as the modular expression of control flow in the presence of interaction. We illustrate our pattern in the context of Java, leveraging its generics to obviate the need for dynamic typecasts and employing a small library that implements delimited continuations. We have used our pattern to simplify and modularize a widely used application written by others.

1 Introduction

Interactive applications are those that repeatedly accept input from and produce output to an external entity. Typically the output produced depends upon the current input along with the current state of the application, and this output may in turn affect the next input. Many common application domains are fundamentally interactive, including servers, user interface programs, and computer games. In addition, more traditional applications often include an interactive component. For example, a program whose behavior is configured by an XML file might interactively parse the file through the event-driven Simple API for XML (SAX) [17].

The logic of an interactive application essentially takes the form of a state machine, and the standard way to implement this logic in an object-oriented (OO) language is with the *state design pattern* [9]. This pattern reifies each state as a distinct class, which has one method for each possible external event. The state machine class maintains a field containing the current state, and all external events are forwarded to the current state to be handled appropriately. Handling an event may result in some output and additionally update the current state.

J. Vitek (Ed.): ECOOP 2008, LNCS 5142, pp. 566–591, 2008.
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