

An Extensible State Machine Pattern for Interactive Applications

Brian Chin and Todd Millstein

Computer Science Department
University of California, Los Angeles
{naerbnic, todd}@cs.ucla.edu

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.

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Table of Contents An Extensible State Machine Pattern For Interactive

1. Understanding the eBook An Extensible State Machine Pattern For Interactive
 - The Rise of Digital Reading An Extensible State Machine Pattern For Interactive
 - Advantages of eBooks Over Traditional Books
2. Identifying An Extensible State Machine Pattern For Interactive
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an An Extensible State Machine Pattern For Interactive
 - User-Friendly Interface
4. Exploring eBook Recommendations from An Extensible State Machine Pattern For Interactive

- Personalized Recommendations
 - An Extensible State Machine Pattern For Interactive User Reviews and Ratings
 - An Extensible State Machine Pattern For Interactive and Bestseller Lists
5. Accessing An Extensible State Machine Pattern For Interactive Free and Paid eBooks
 - An Extensible State Machine Pattern For Interactive Public Domain eBooks
 - An Extensible State Machine Pattern For Interactive eBook Subscription Services
 - An Extensible State Machine Pattern For Interactive Budget-Friendly Options
 6. Navigating An Extensible State Machine Pattern For Interactive eBook Formats
 - ePub, PDF, MOBI, and More
 - An Extensible State Machine Pattern For Interactive Compatibility with Devices
 - An Extensible State Machine Pattern For Interactive Enhanced eBook Features
 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of An Extensible State Machine Pattern For Interactive
 - Highlighting and Note-Taking An Extensible State Machine Pattern For Interactive
 - Interactive Elements An Extensible State Machine Pattern For Interactive
 8. Staying Engaged with An Extensible State Machine Pattern For Interactive
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers An Extensible State Machine Pattern For Interactive
 9. Balancing eBooks and Physical Books An Extensible State Machine Pattern For Interactive
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection An Extensible State Machine Pattern For Interactive
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine An Extensible State Machine Pattern For Interactive
 - Setting Reading Goals An Extensible State Machine Pattern For Interactive
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of An Extensible State Machine Pattern For Interactive

- Fact-Checking eBook Content of An Extensible State Machine Pattern For Interactive
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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