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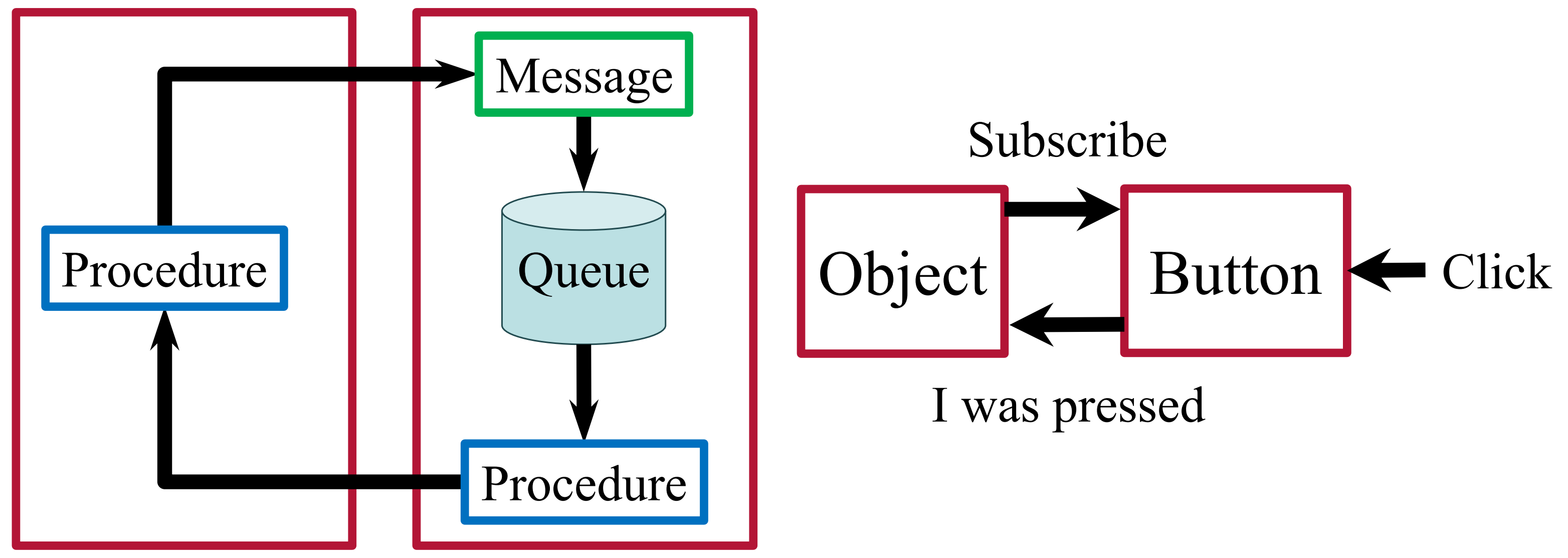
Integrating Event-Driven and Capsule-Oriented Programming

Introduction

Problem
Panini is a capsule-oriented programming model that helps developers take advantage of concurrency [3]. However, it is difficult for developers to use Panini when developing applications with common event-centric components such as user interfaces. There is no way for a capsule to ask another to notify it when something happens, such as a button click.

Solution
An integration of Panini and events would allow developers to more easily design concurrent systems that have event-centric components.



Differences in interaction between capsules (left) and with events (right)

Objectives

This project combines the Panini and event-driven programming models into a single, integrated model respecting Panini's properties that make it easy and safe to use.

Methods

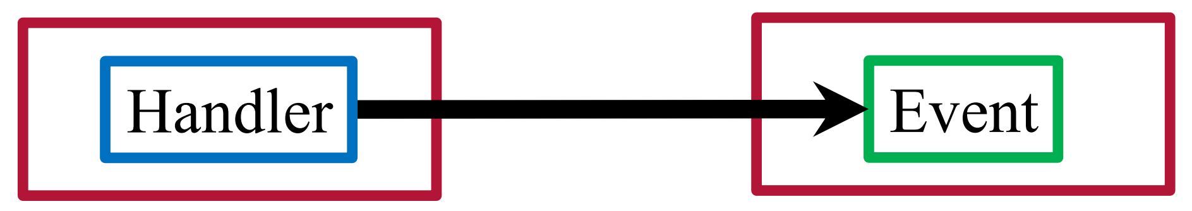
- Implemented event-driven capabilities into @Paninij, an implementation of the Panini model.
- Code is available at: https://github.com/jlmaddox/panini/tree/event
- Examined current literature to see how others have handled the challenges faced during this project

Results

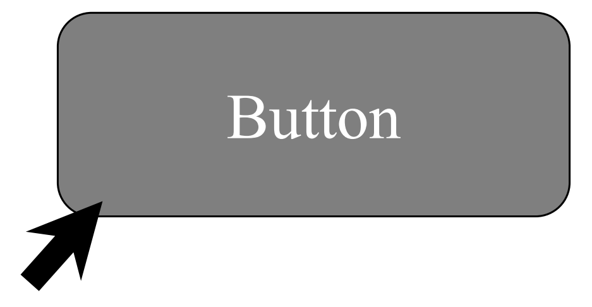
The result is a version of @Paninij with event-driven capabilities.

Capsule Events
- Capsules can contain events, such as a button click
- Capsules can specify some code that handles events occurring

The Model
This is how the integrated model works:

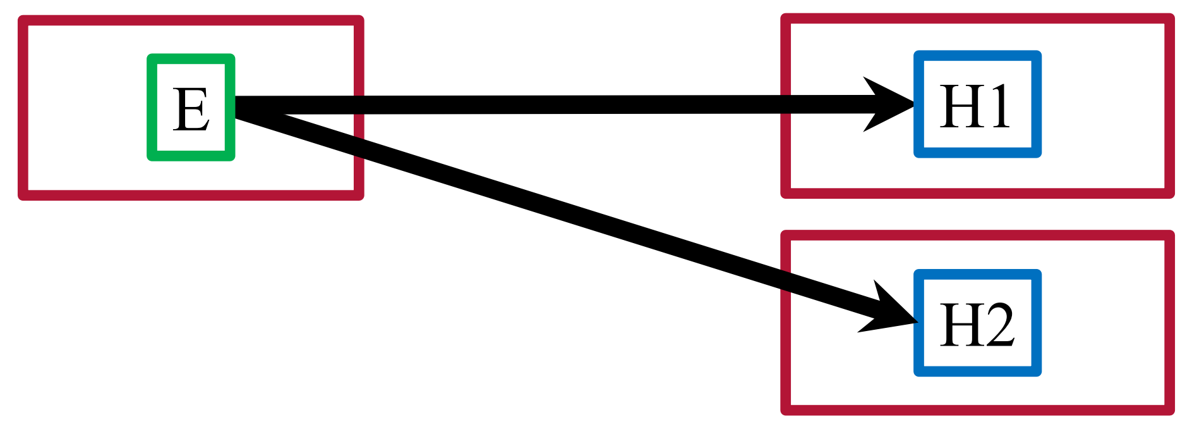


Step 1: At startup, capsules subscribe to the events it is interested in. Multiple capsules can subscribe to a single event.

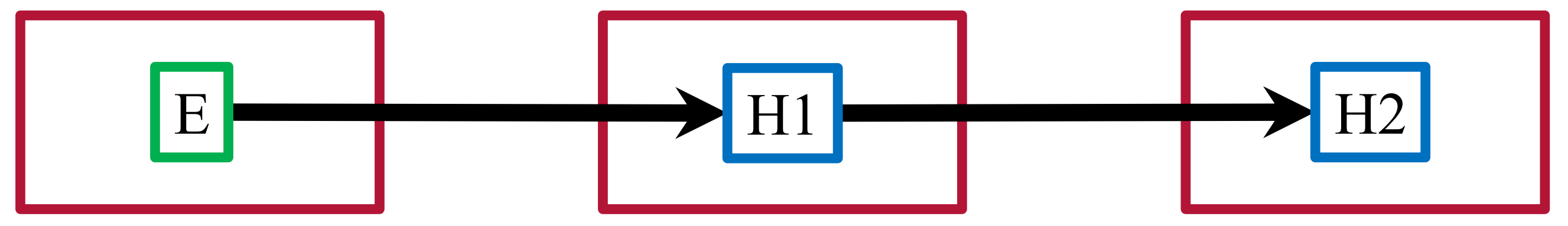


Step 2: The event occurs

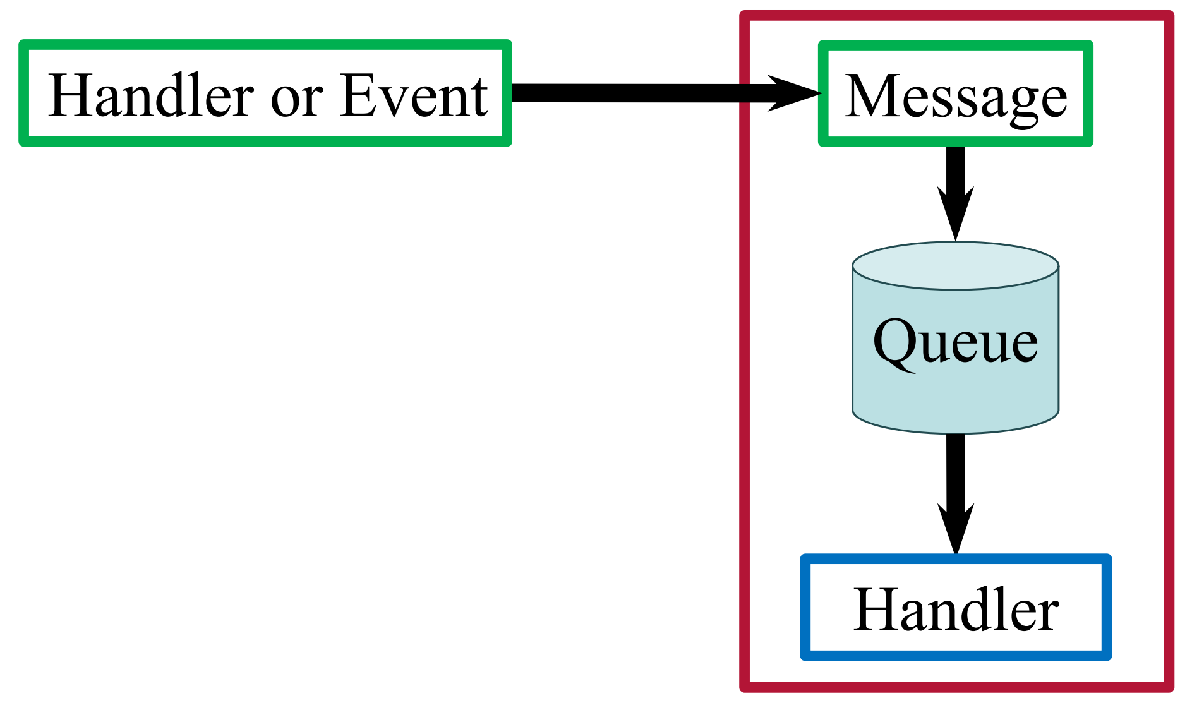
Step 3: One of two things happens, depending on the developer's choice.



Step 3a: Broadcast notification: E is announced and handlers H1 and H2 only read the message. Send the same message to both simultaneously.



Step 3b: Chain notification: E is announced and H1 or H2 may modify the message. Send the message to one and have it pass it on.



Step 4: Notification message arrives at the subscribing capsule

Challenges
- Designing the notification scheme (step 3) to be performant and thread safe
- Deciding how to handle missed event announcements due to capsules with events starting before their subscribers is an unresolved challenge

Conclusion

This honors research project has led to the following findings:
- It is possible to integrate event-driven and capsule-oriented models into a single model to take advantage of both
- The missed announcements problem can be addressed reasonably by for example simply assuming that some might be missed or by requiring all capsules to start up before executing any code or handling messages
- The integrated model allows developers to create concurrent, thread-safe software that contain event-centric components in a clean manner

Reference

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