Introduction: Overview of Patterns & Frameworks (Part 1)

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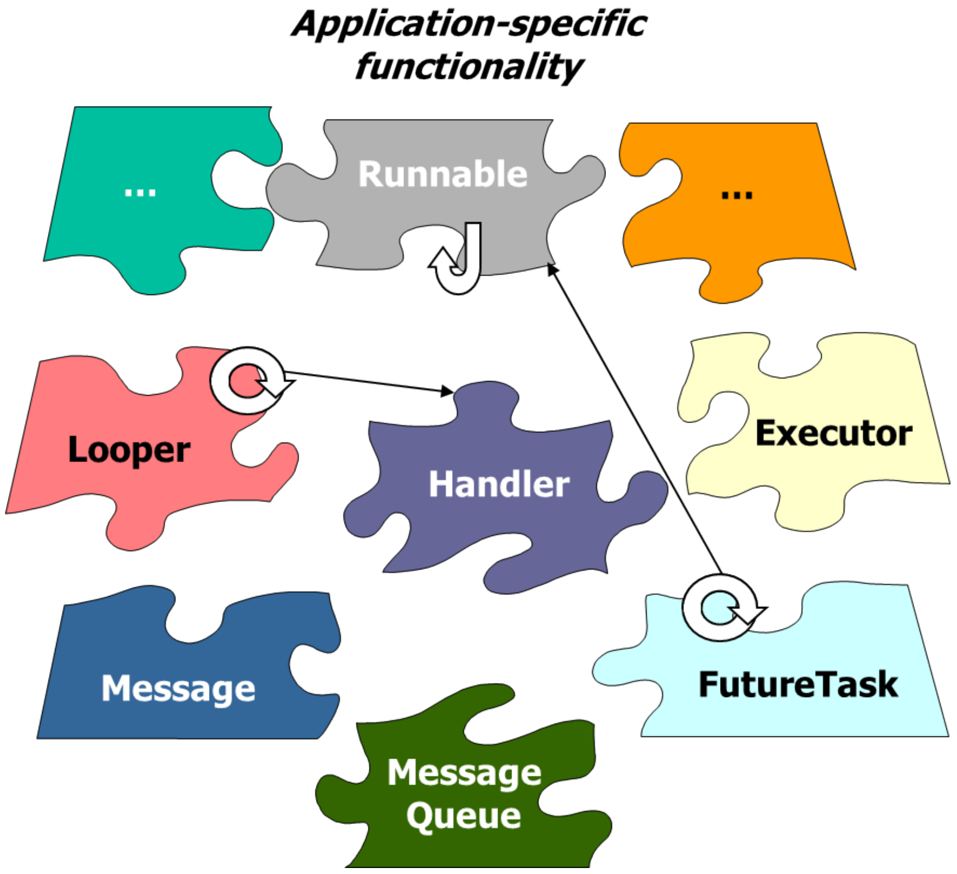
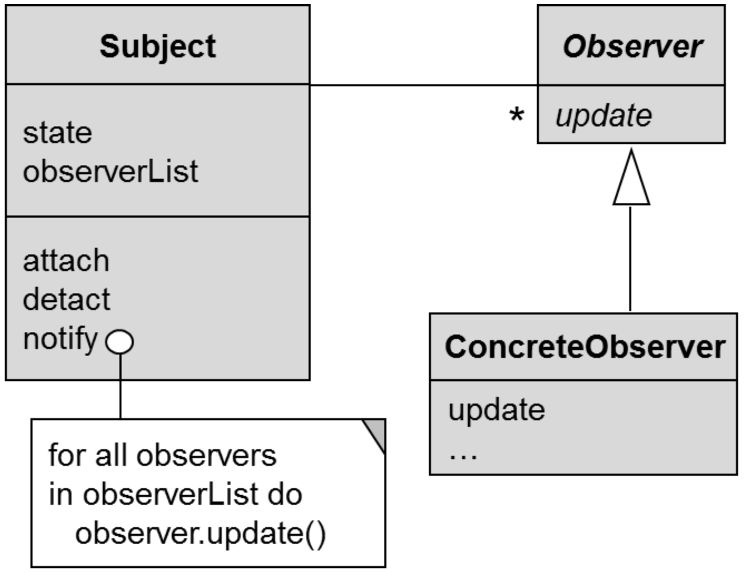
Nashville, Tennessee, USA

Learning Objectives in this Part of the Module

- Understand what *patterns* & *frameworks* are & why they are essential for programming mobile device software

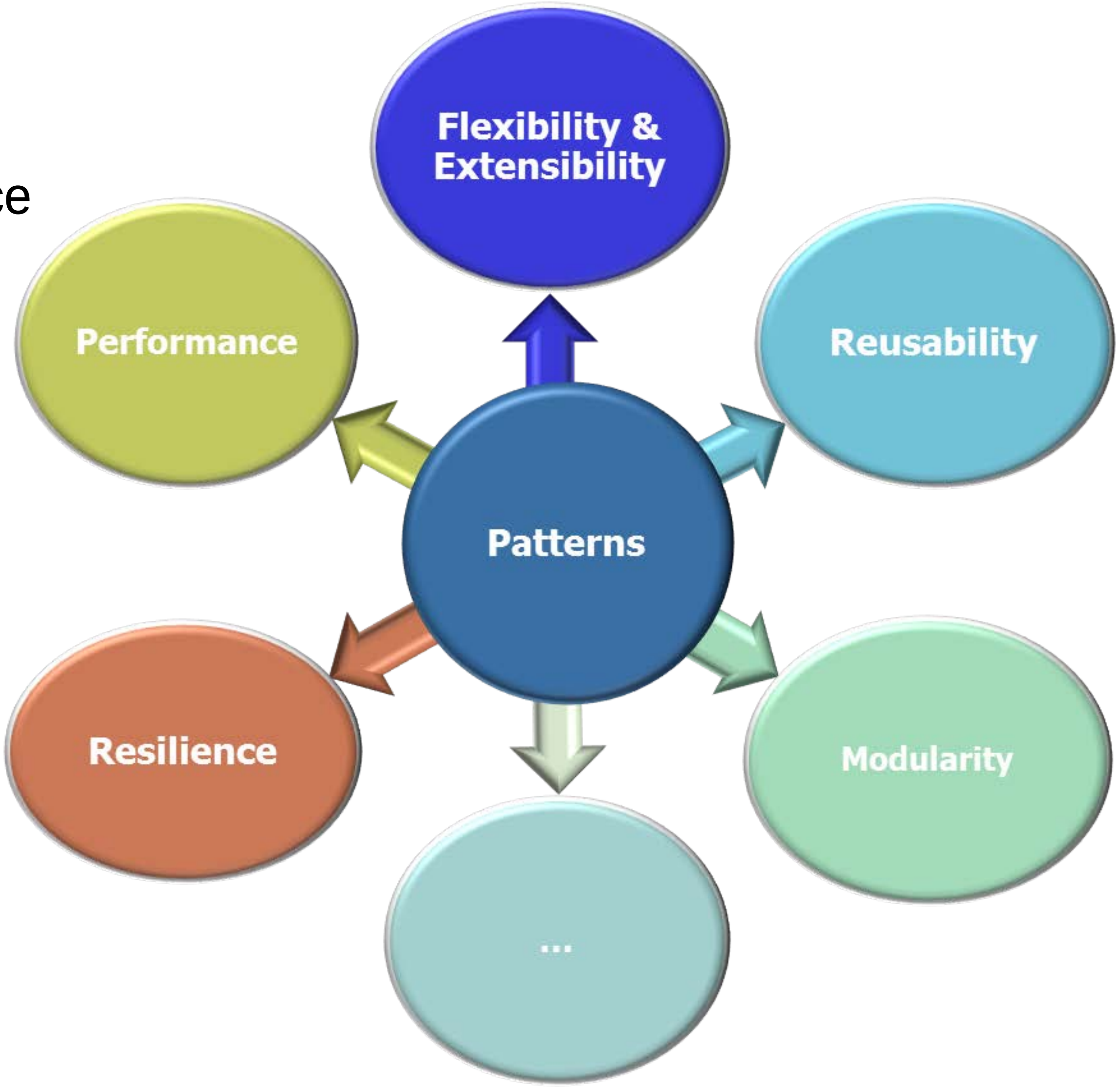




The *Observer* pattern

Motivation for Software Patterns & Frameworks

- Patterns & frameworks leverage proven design & implementation experience to enhance key software quality attributes



www.sei.cmu.edu/architecture/start/reasoning.cfm has more on quality attributes

Leveraging Experience in Other Domains

- Experts perform differently than beginners

Leveraging Experience in Other Domains

- Experts perform differently than beginners
  - Unlike novices, professional athletes, musicians, & dancers move fluidly & effortlessly, without focusing on each individual movement

Leveraging Experience in Other Domains

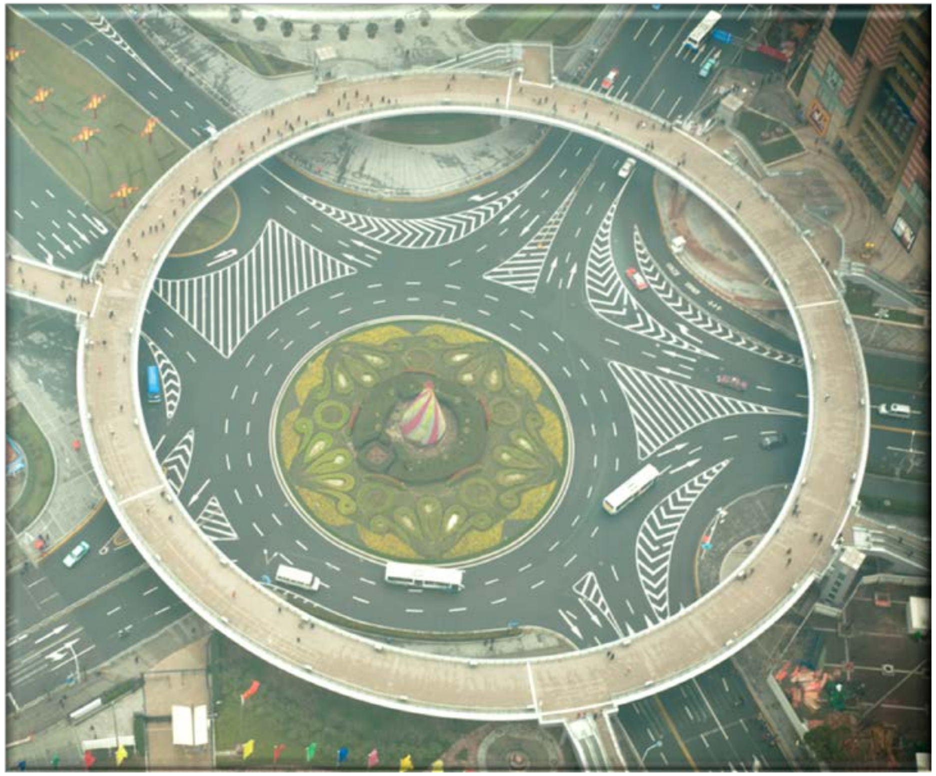
- Experts perform differently than beginners
- When watching experts perform it’s easy to forget how much effort they’ve put into reaching high levels of achievement

Leveraging Experience in Other Domains

- Experts perform differently than beginners
- When watching experts perform it's easy to forget how much effort they've put into reaching high levels of achievement
- Continuous repetition, practice, & mentoring from other experts are crucial to their success

Leveraging Software Experience via Patterns

- Patterns provide reusable solutions to common problems arising within a context



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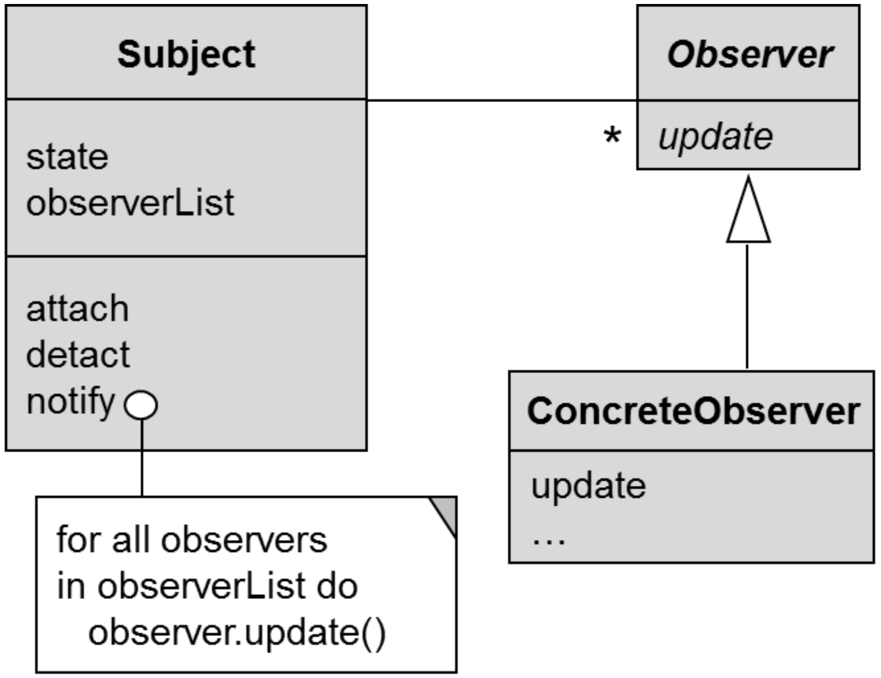
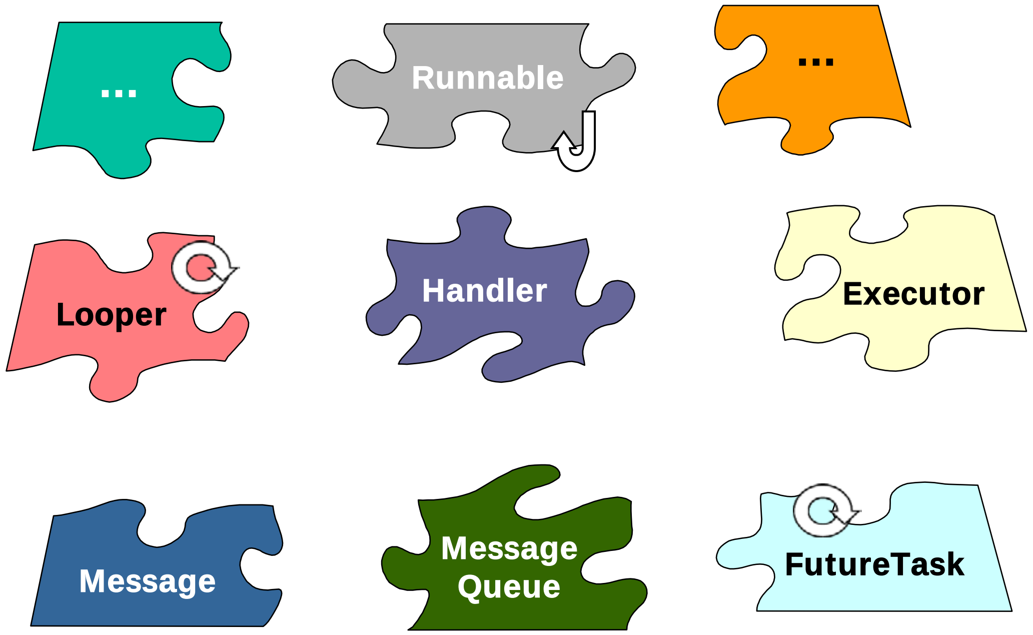


The *Observer* pattern

Patterns provide *design* & *architecture* guidance

Leveraging Software Experience via Frameworks

- A frameworks is an integrated set of components that collaborate to provide a reusable architecture for a family of related applications or services



Frameworks provide *implementation* guidance

Frameworks & Patterns are Synergistic

- Frameworks are concrete realizations of patterns that facilitate direct reuse of detail design & source code

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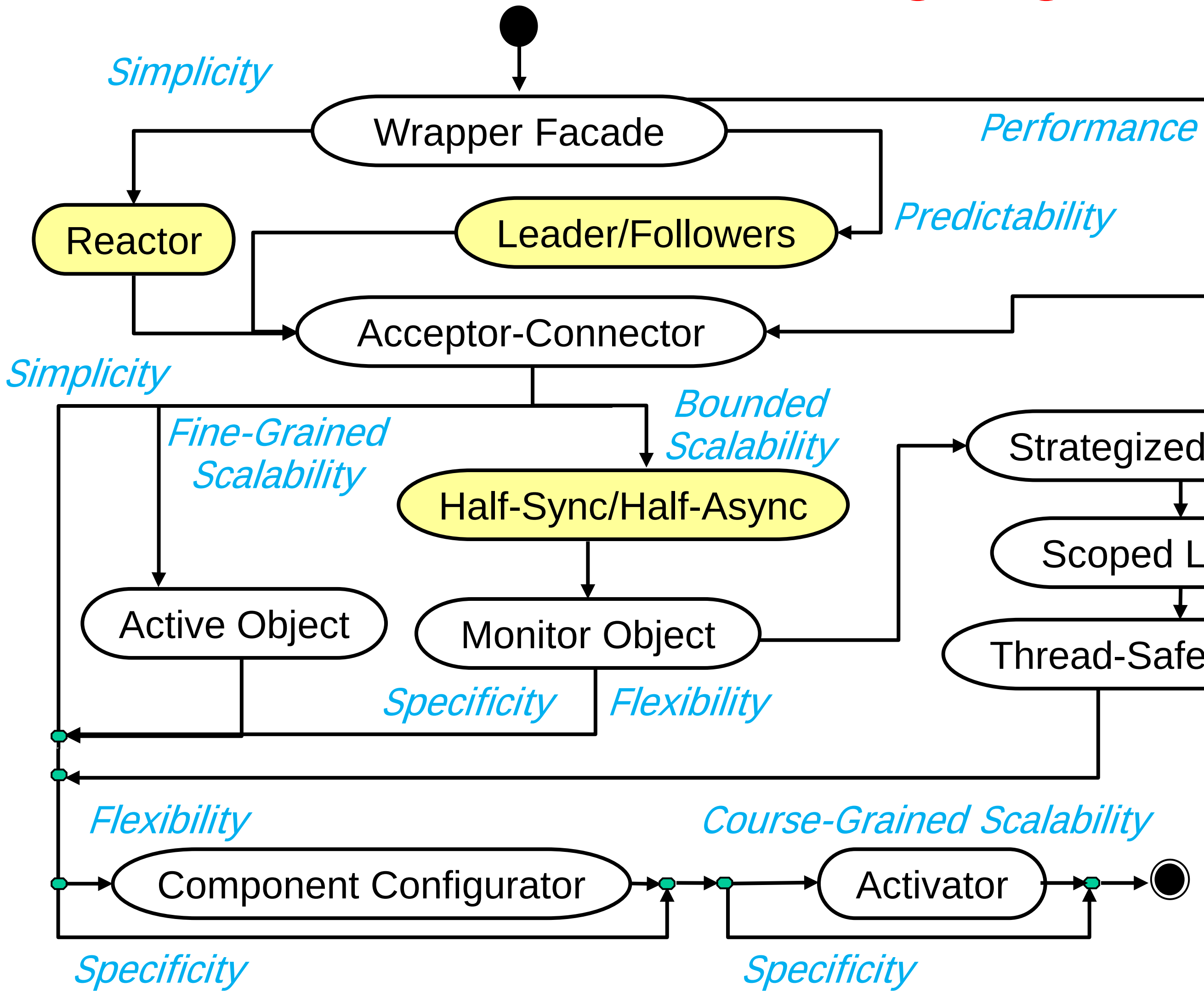
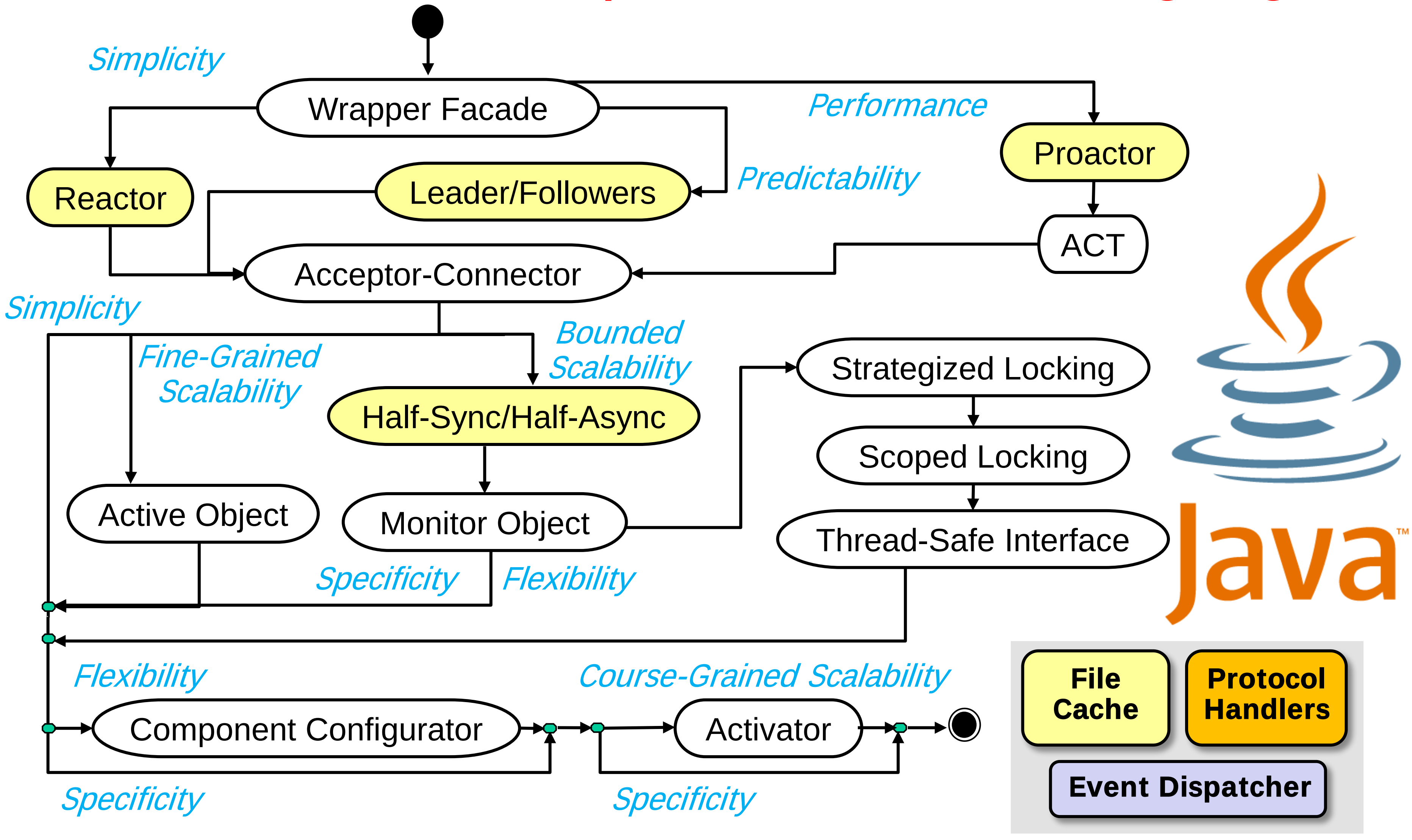
- Frameworks are concrete realizations of patterns that facilitate direct reuse of detail design & source code
- Patterns are abstract descriptions of frameworks that facilitate reuse of software architecture & design knowledge

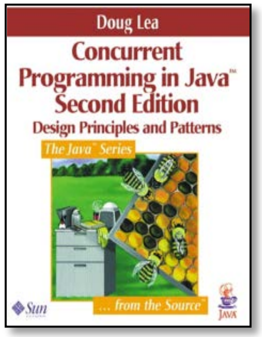
Patterns are Often Language Independent

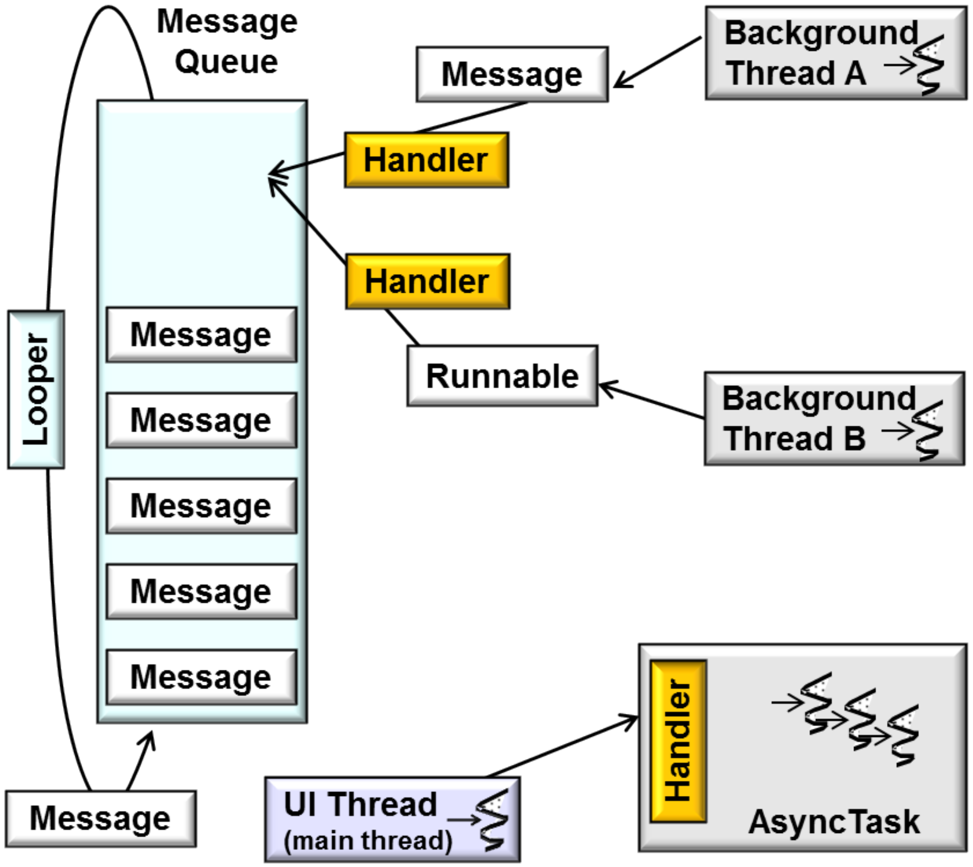


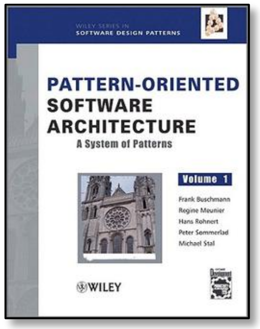
Frameworks are Implemented in a Language



Android Uses Patterns & Frameworks Heavily


Doug Lea
Concurrent Programming in Java Second Edition
Design Principles and Patterns
The Java Series
... from the Source





PATTERN-ORIENTED SOFTWARE ARCHITECTURE
Volume 2
Patterns for Concurrent and Networked Objects
WILEY

Overview of Patterns

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- Present solutions to common problems arising within a context

Electronic Trading

Aerospace & Avionics

Mobile Devices

e-commerce

Automotive

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Overview of Patterns

- Present solutions to common problems arising within a context
- Help resolve key software quality attribute forces

Quality of Service
Quality of Design

Software quality attributes must be balanced & traded-off against various forces

Overview of Patterns

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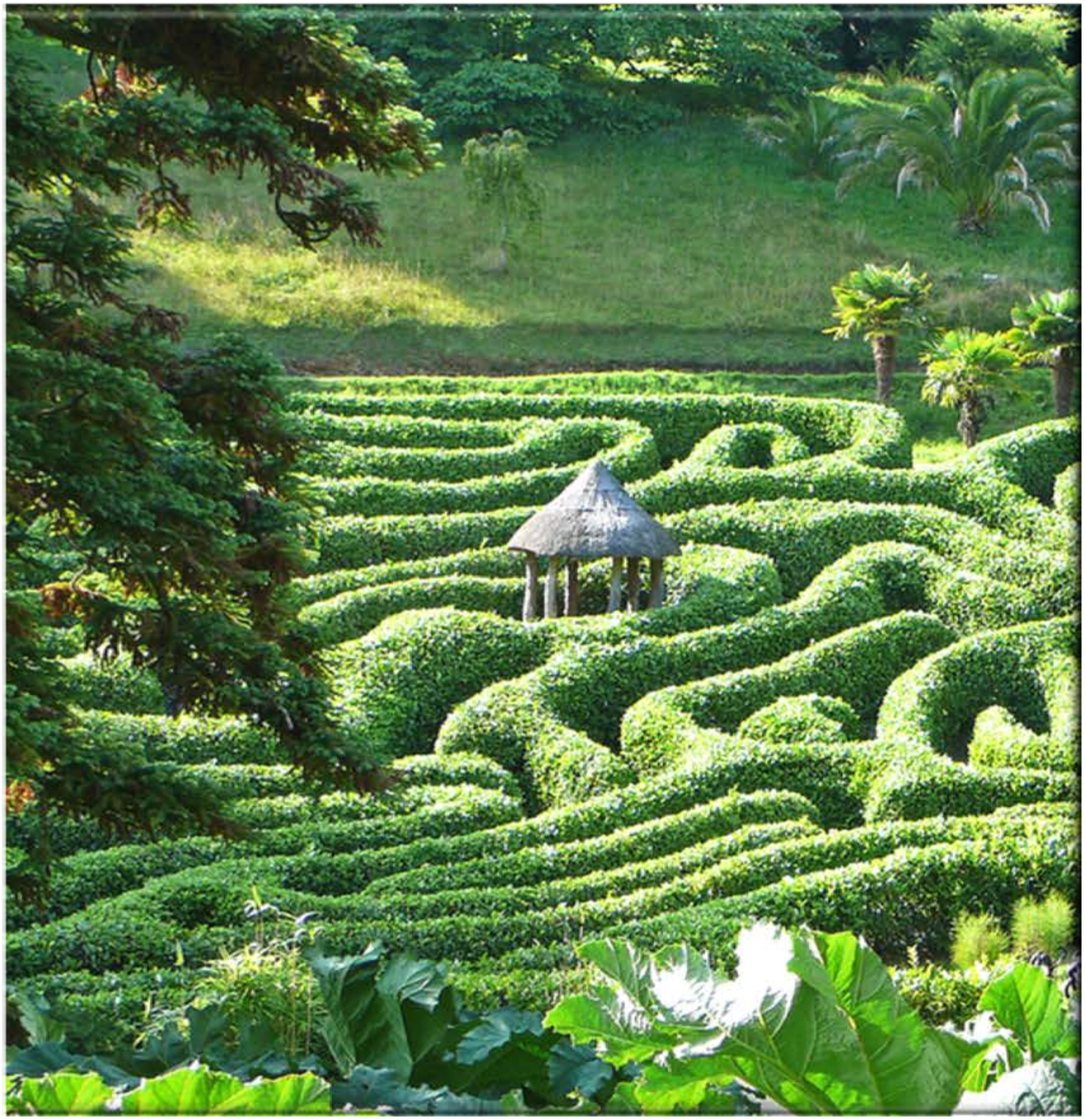

Patterns help developers navigate through trade-offs in domains & design spaces

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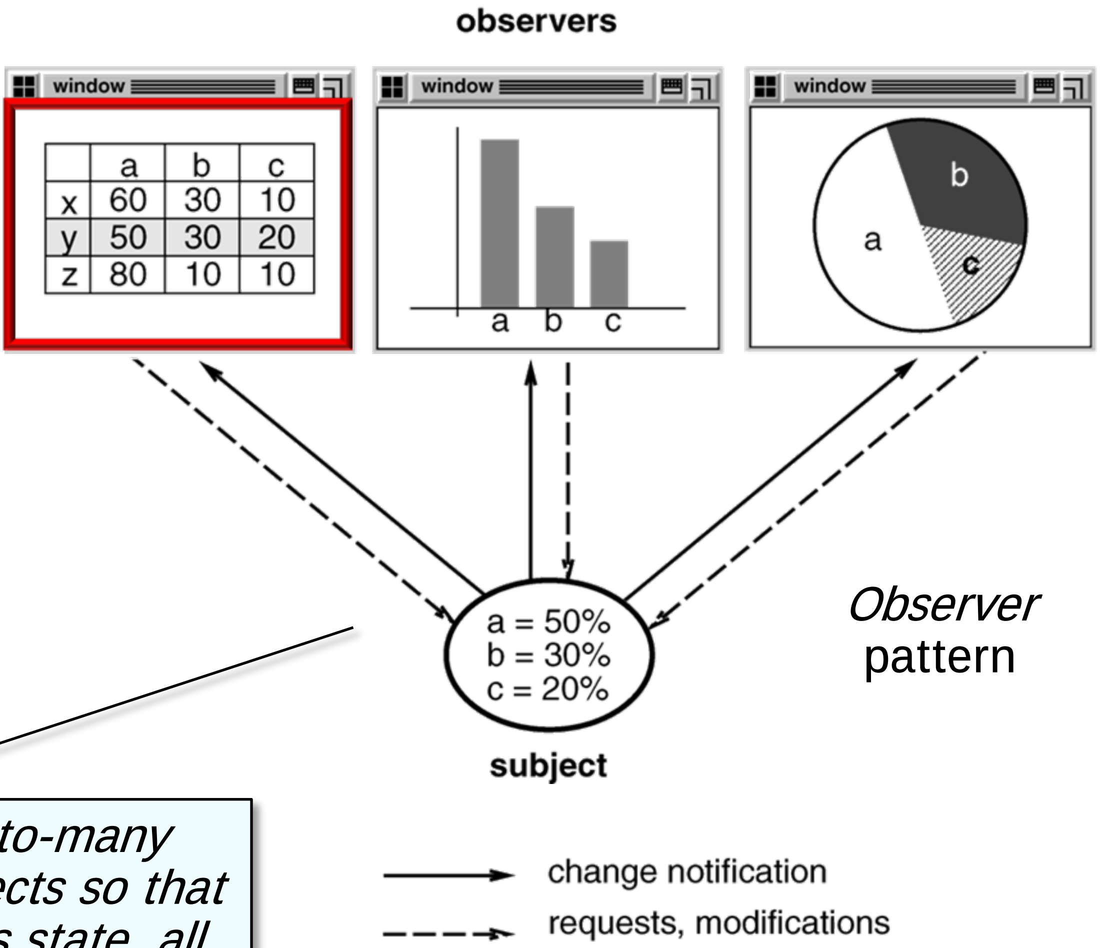
- Capture recurring structures & dynamics among software elements to facilitate reuse of successful designs



***Intent**: "Define a one-to-many dependency between objects so that when one object changes state, all dependents are notified & updated"*

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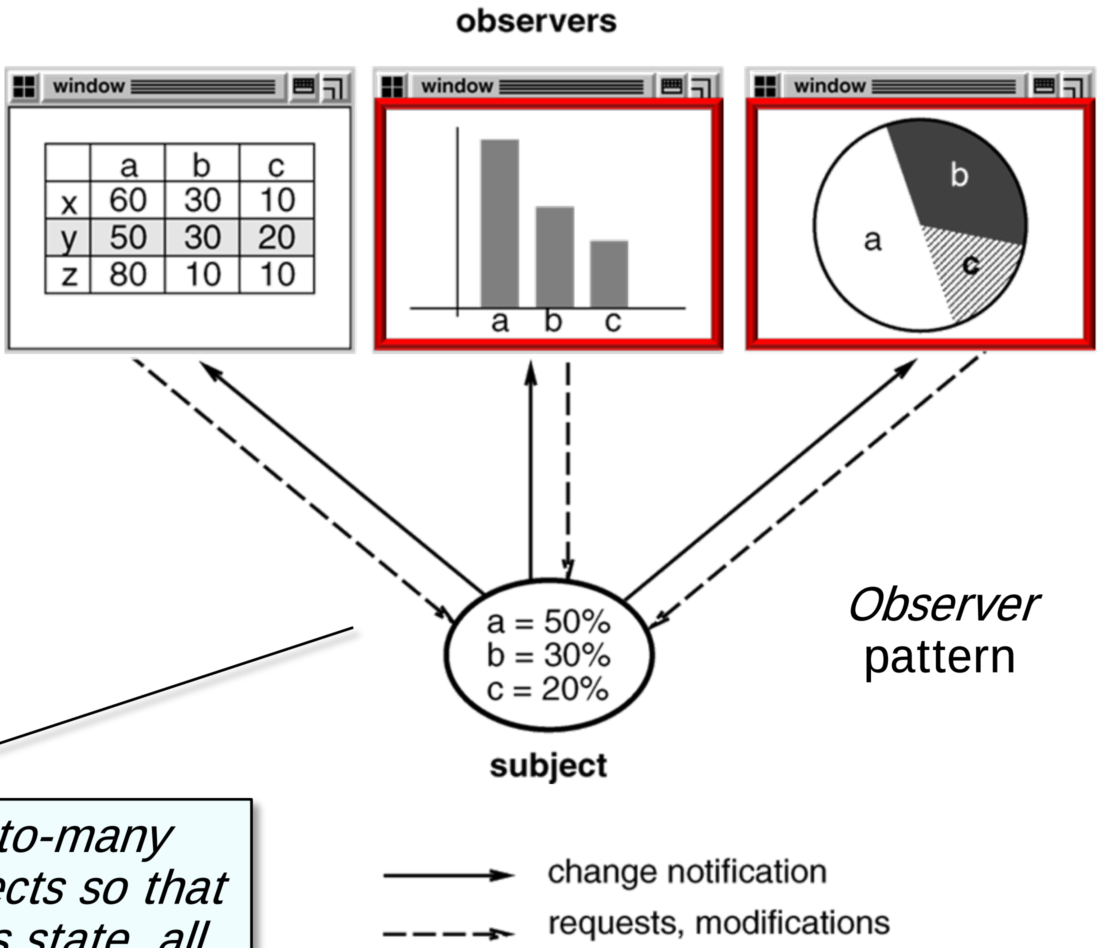

Observer pattern

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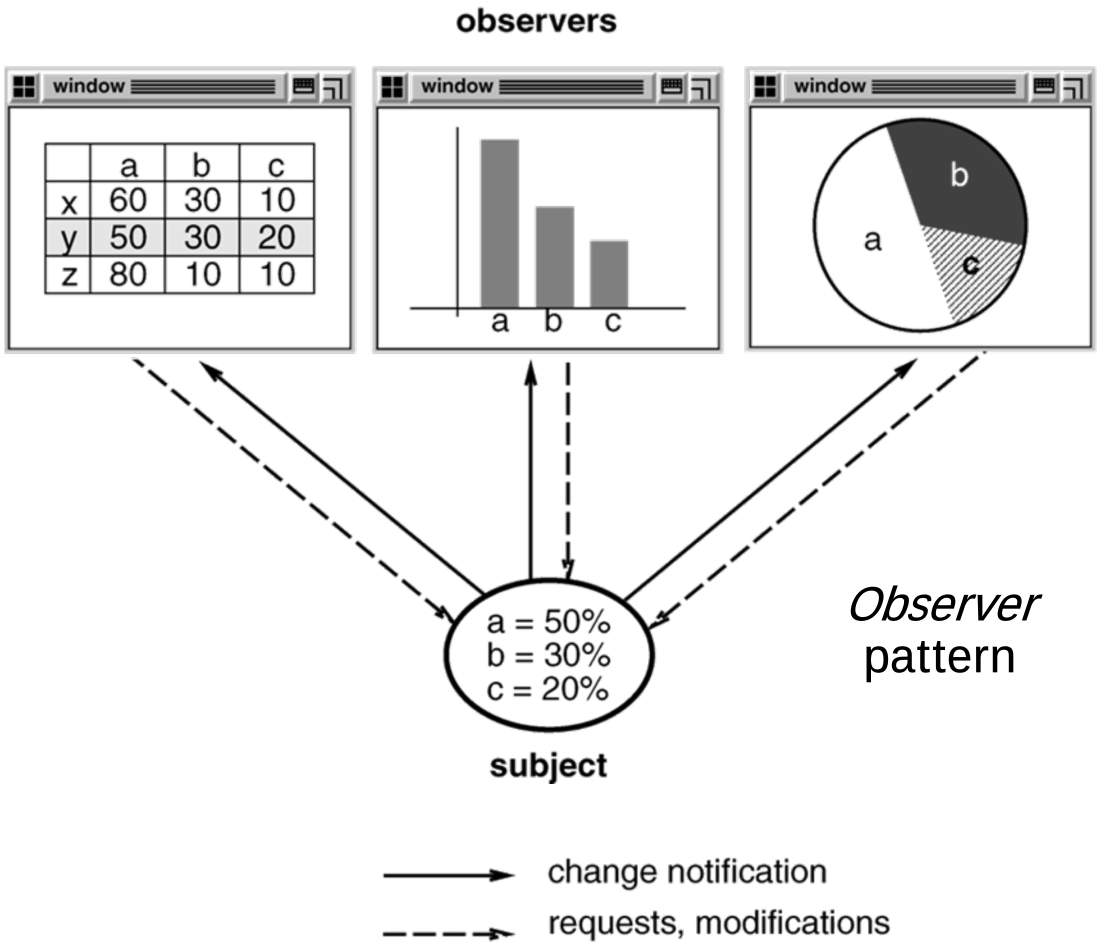

Observer pattern

en.wikipedia.org/wiki/Observer_pattern has more on *Observer*

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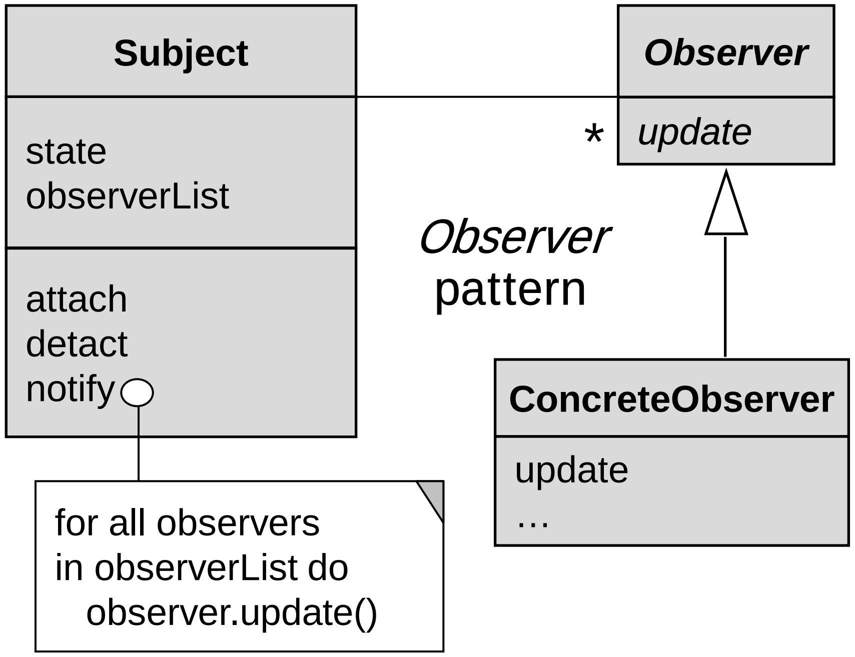

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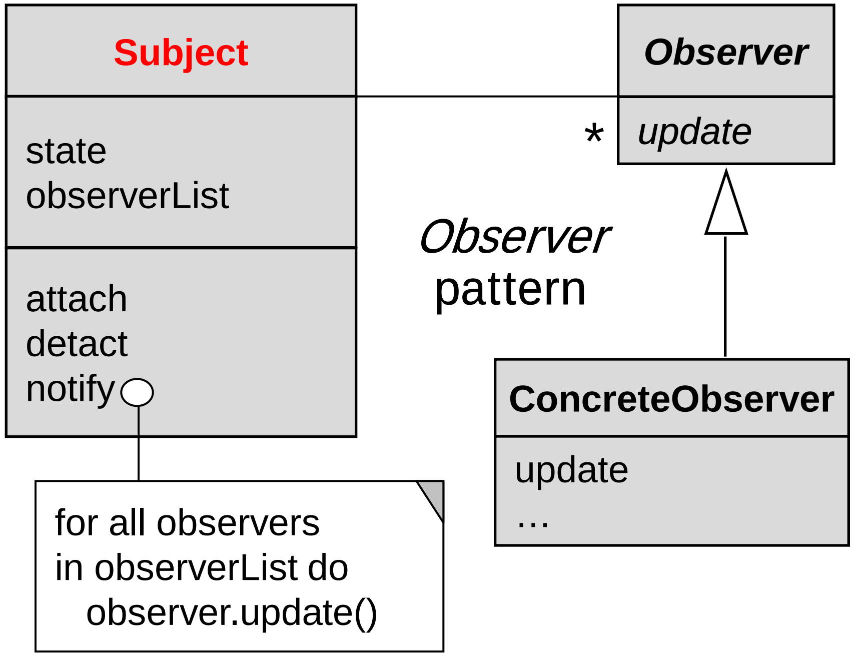

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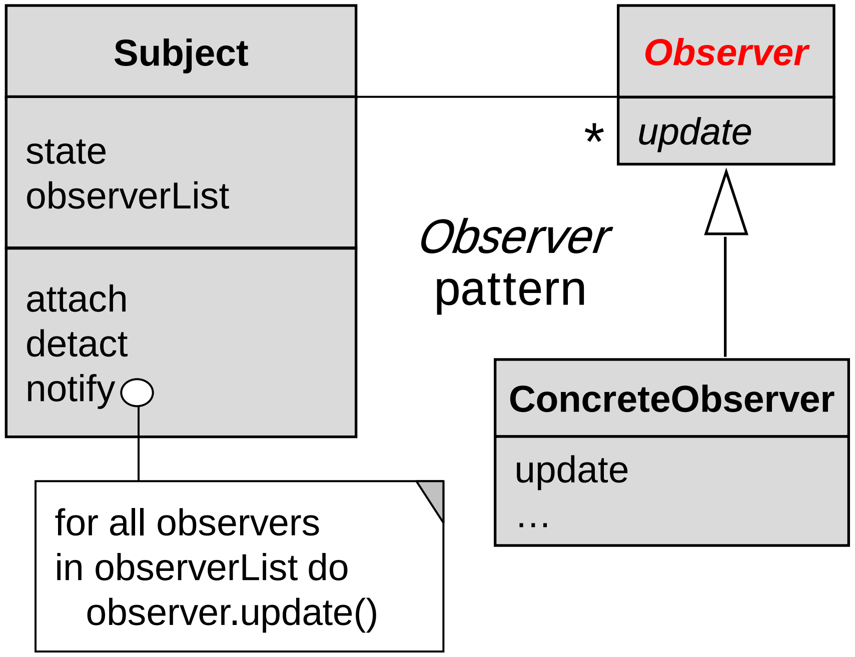

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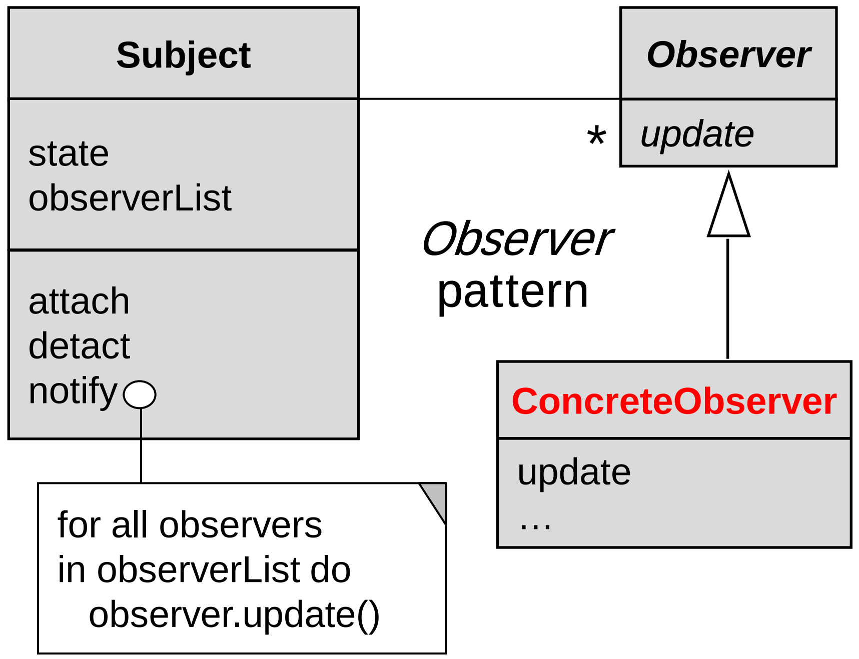

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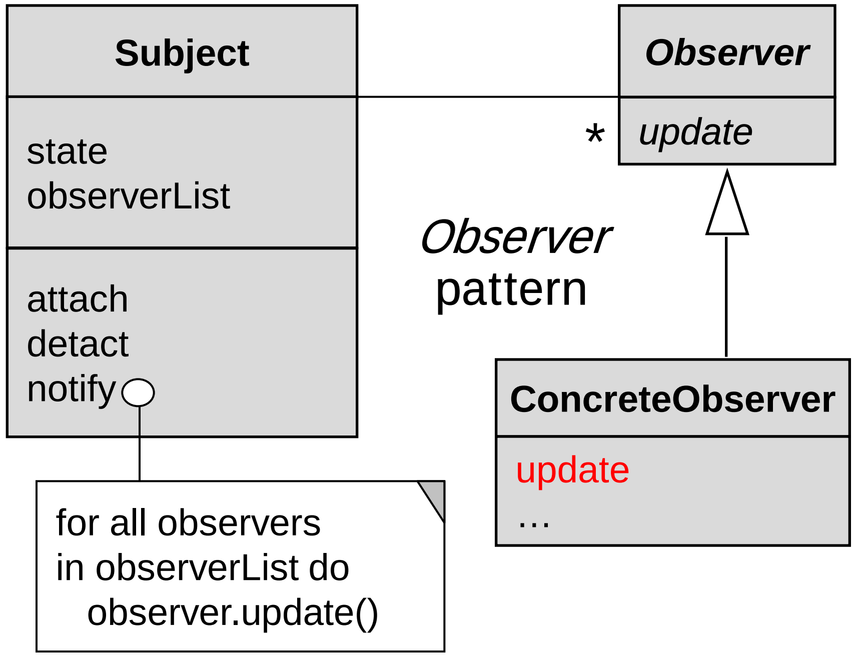

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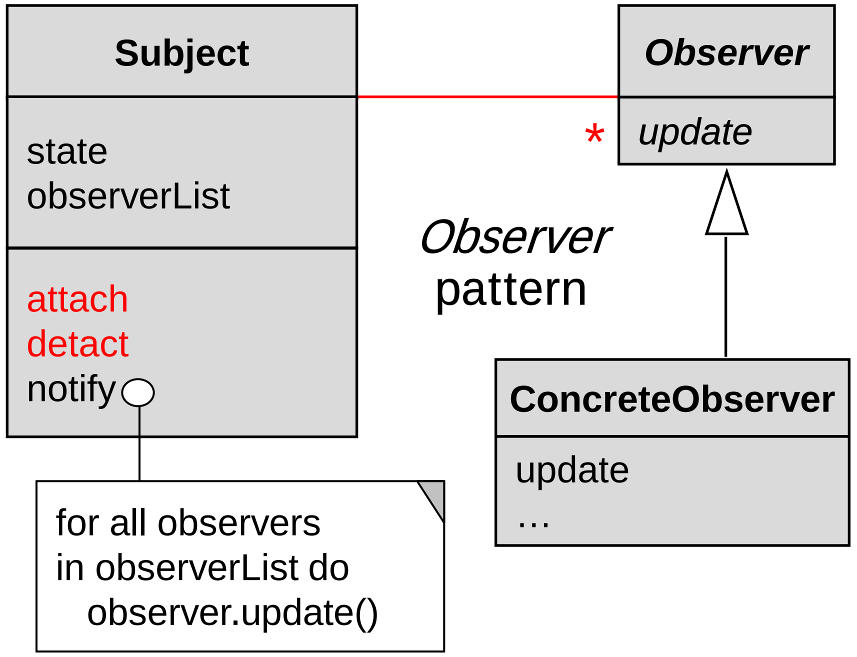

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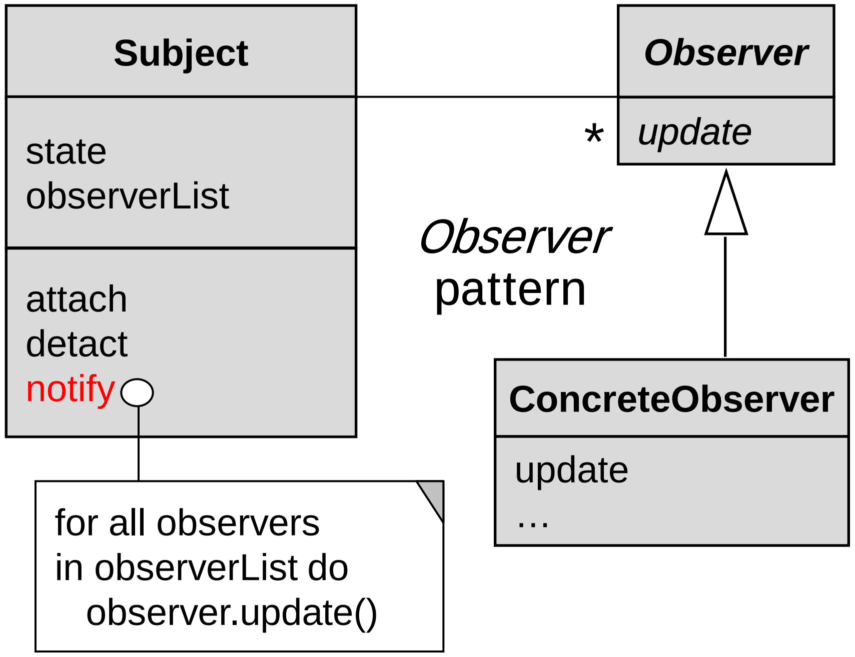

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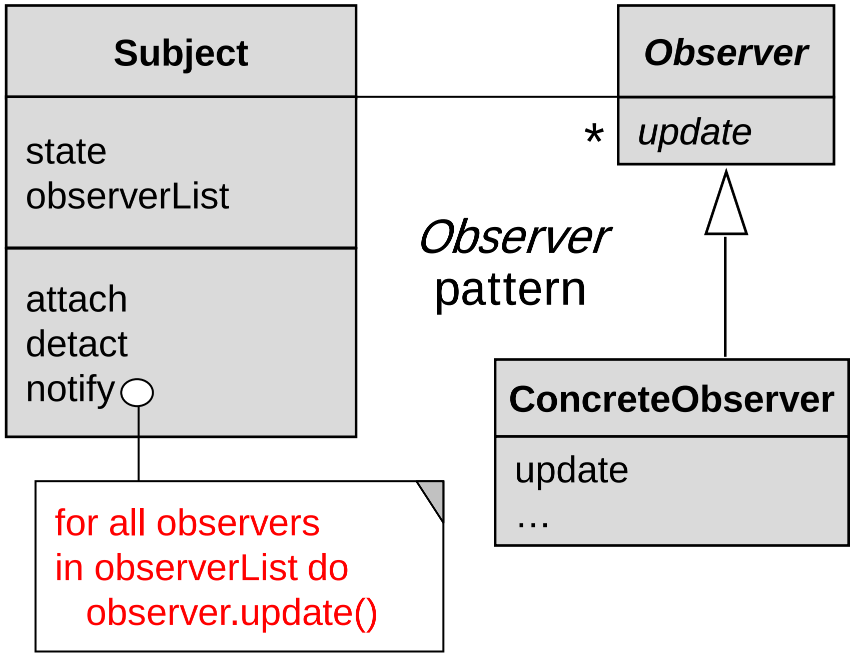

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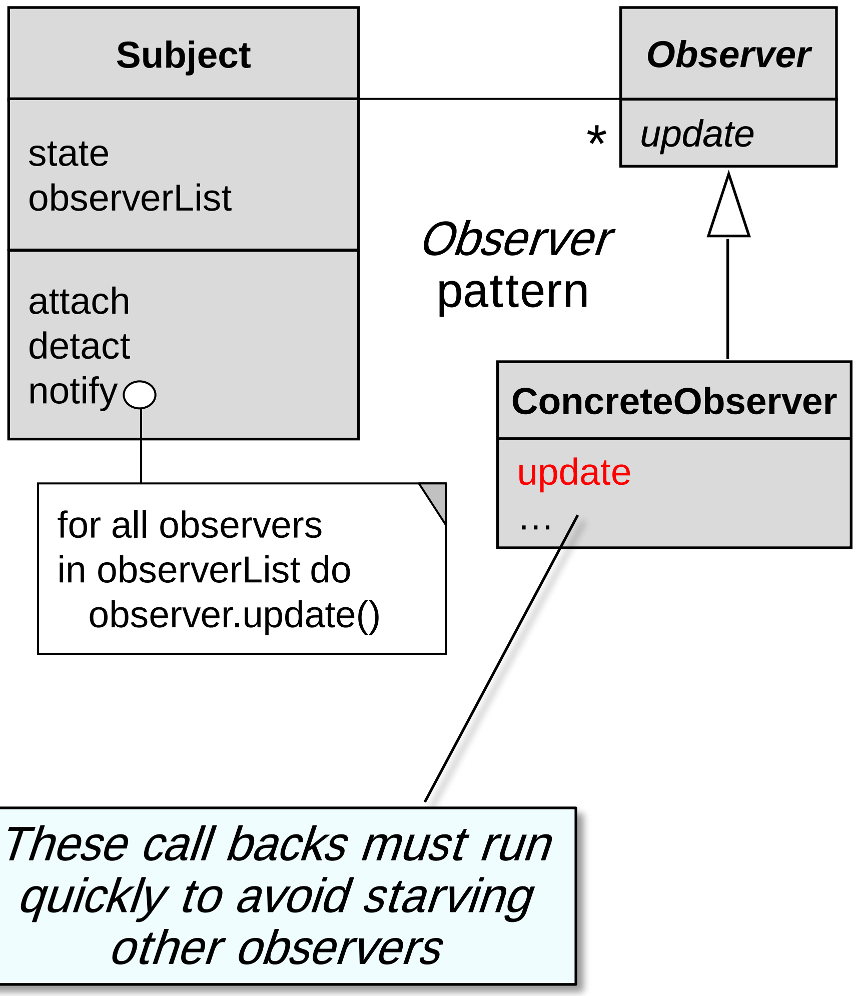

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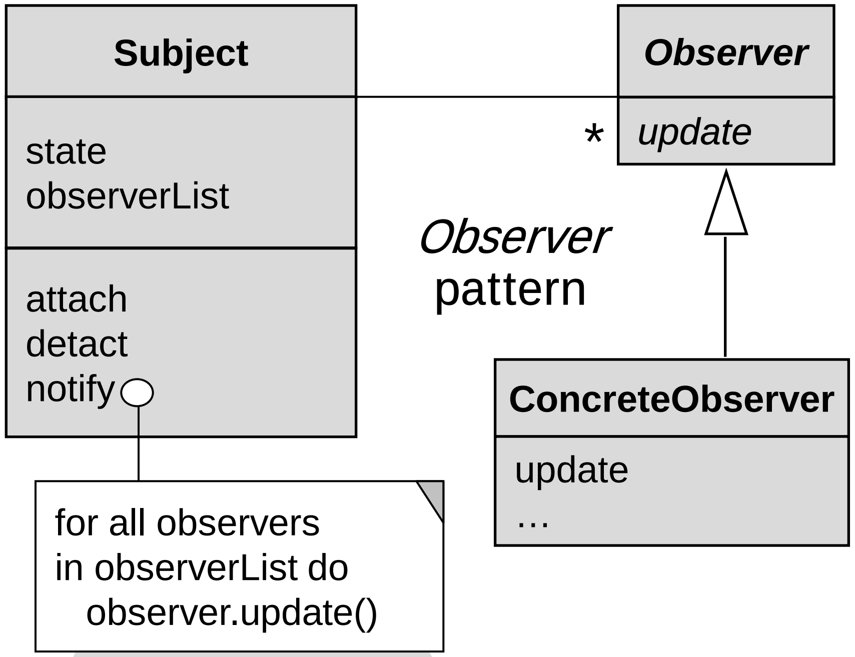

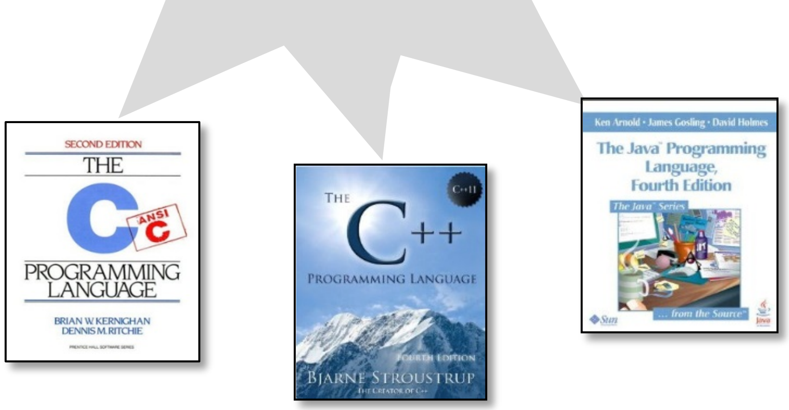
THE C PROGRAMMING LANGUAGE
THE C++ PROGRAMMING LANGUAGE
The Java Programming Language, Fourth Edition

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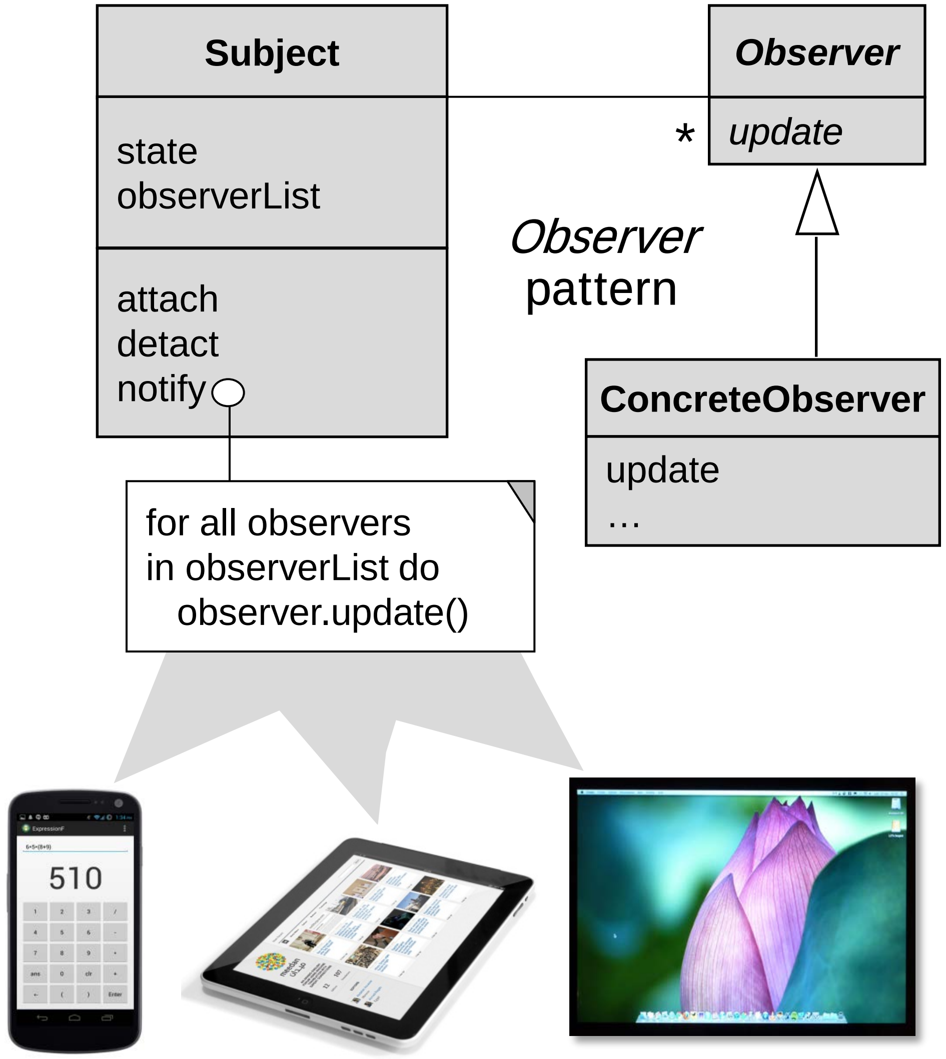

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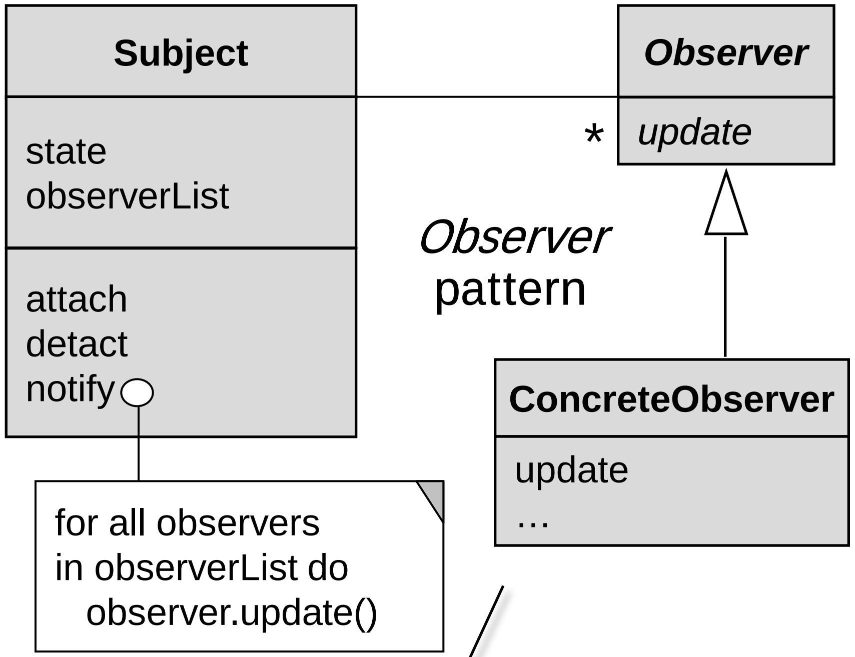

The roles & responsibilities of patterns are largely the same across implementations

Patterns codify & allow reuse of valuable design knowledge

Overview of Patterns

- Present solutions to common problems arising within a context
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- Help augment & “de-risk” mentoring relationships between experts & apprentices

en.wikipedia.org/wiki/Bus_factor has more on getting hit by a bus ;-)

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Bobby Woolf
Pattern-Oriented Software Architecture
Volume 3 Patterns for Resource Management
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Patterns for systems with limited memory
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A Pattern Language for Distributed Object Computing
Volume 4

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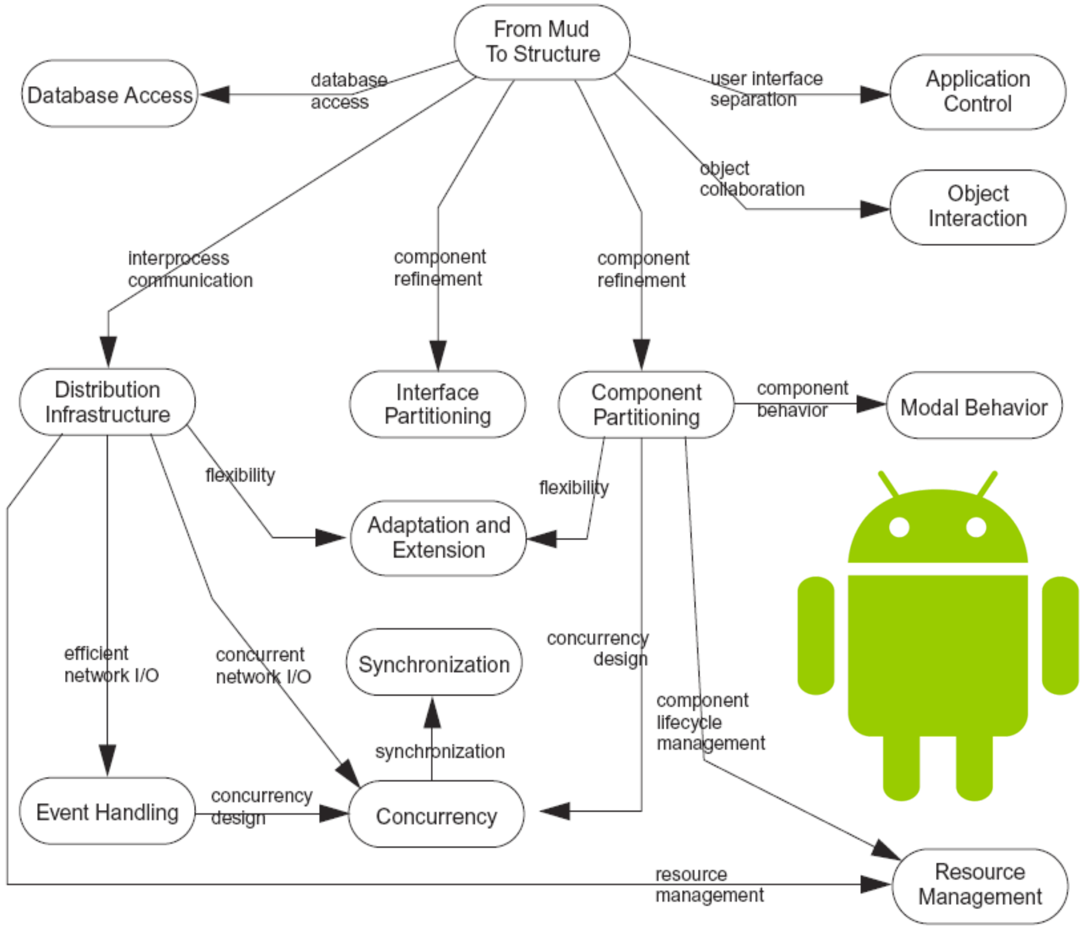
- Many parts of Android are guided by patterns



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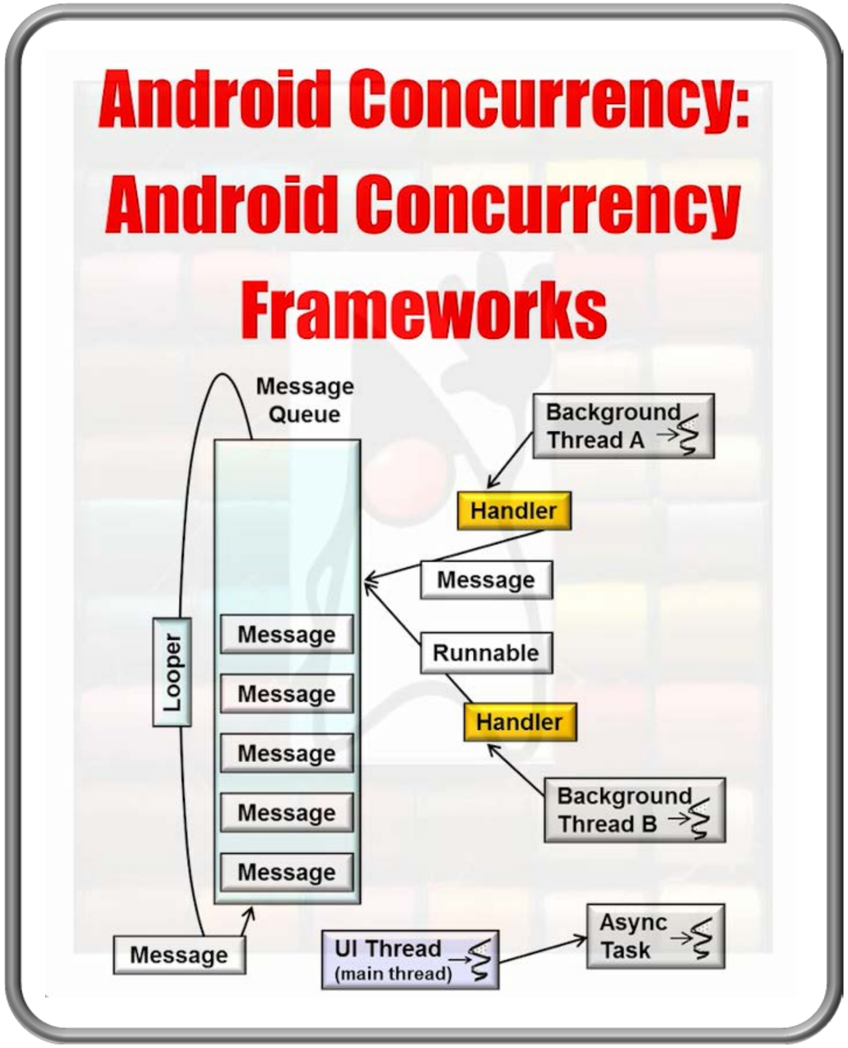
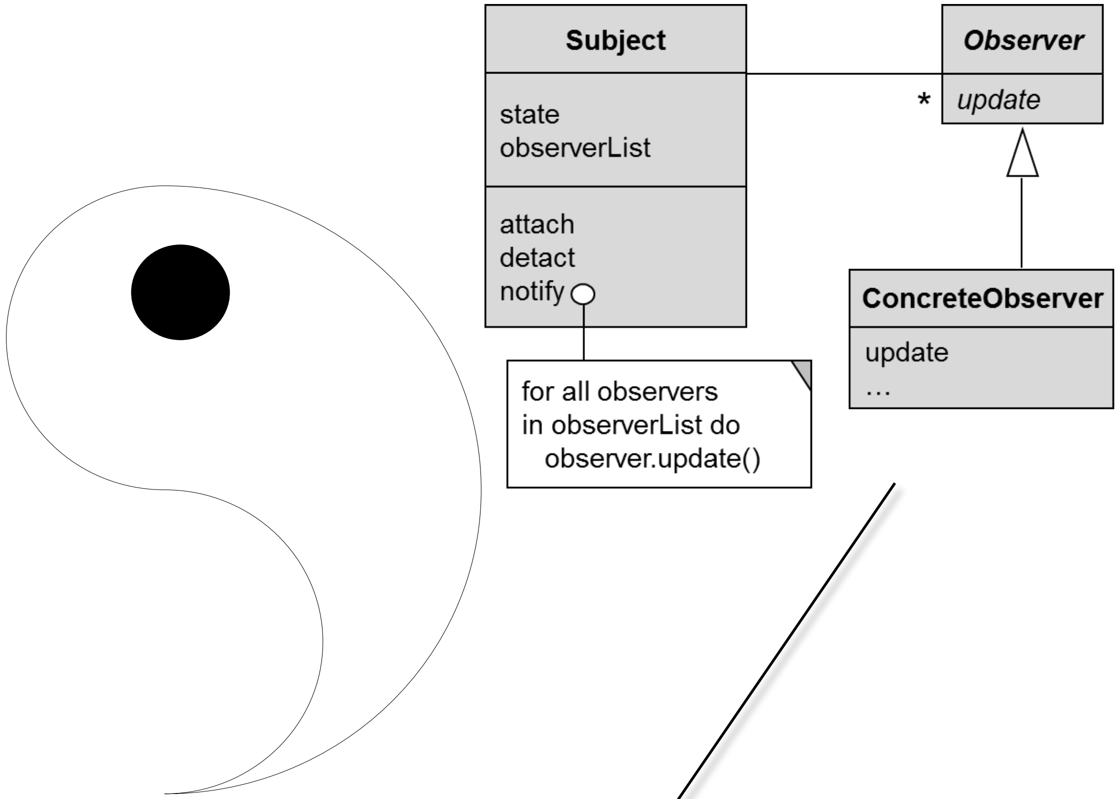


See item #17 at class.coursera.org/posa-002/wiki/FrequentlyAskedQuestions

Overview of Frameworks

Motivation for Frameworks

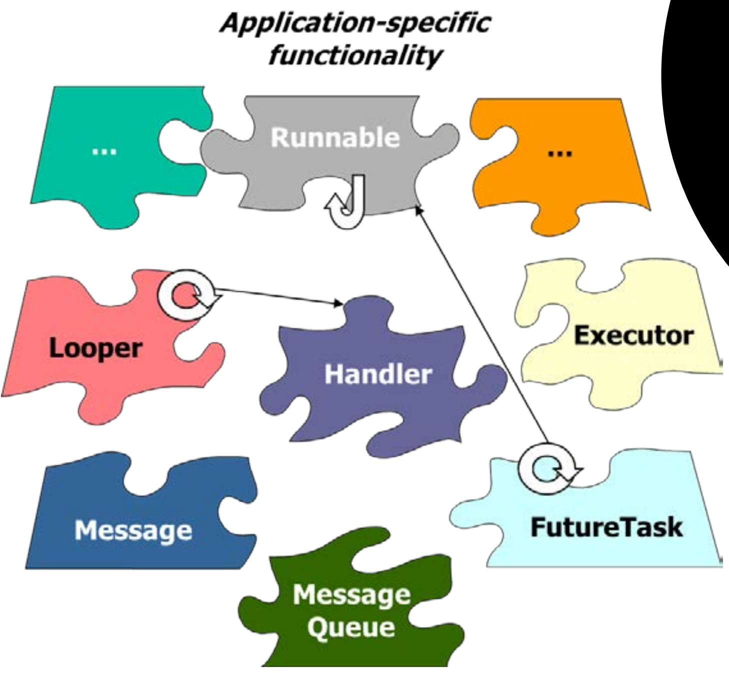


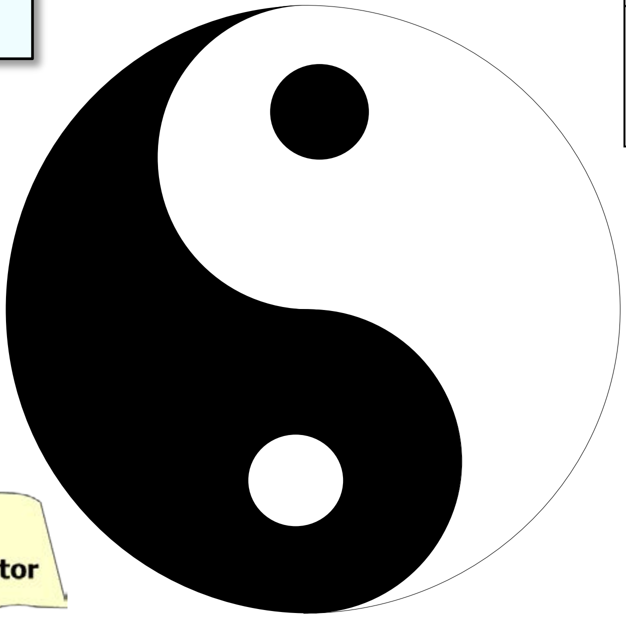
Patterns codify experience & guide design & architecture decisions

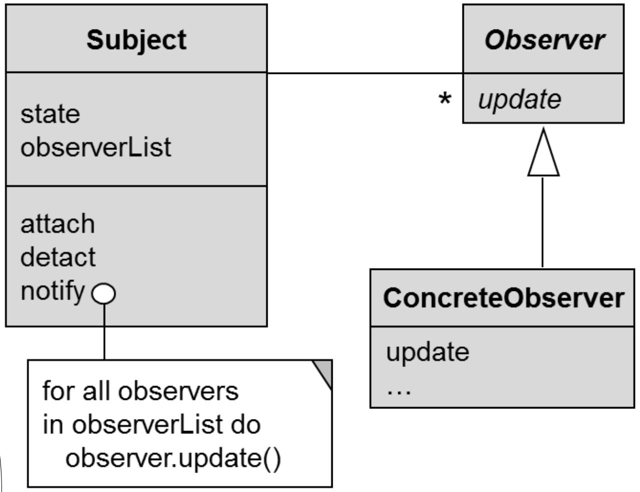
Software professionals also need implementation guidance

Motivation for Frameworks

Frameworks reify software experience & patterns in tangible code artifacts



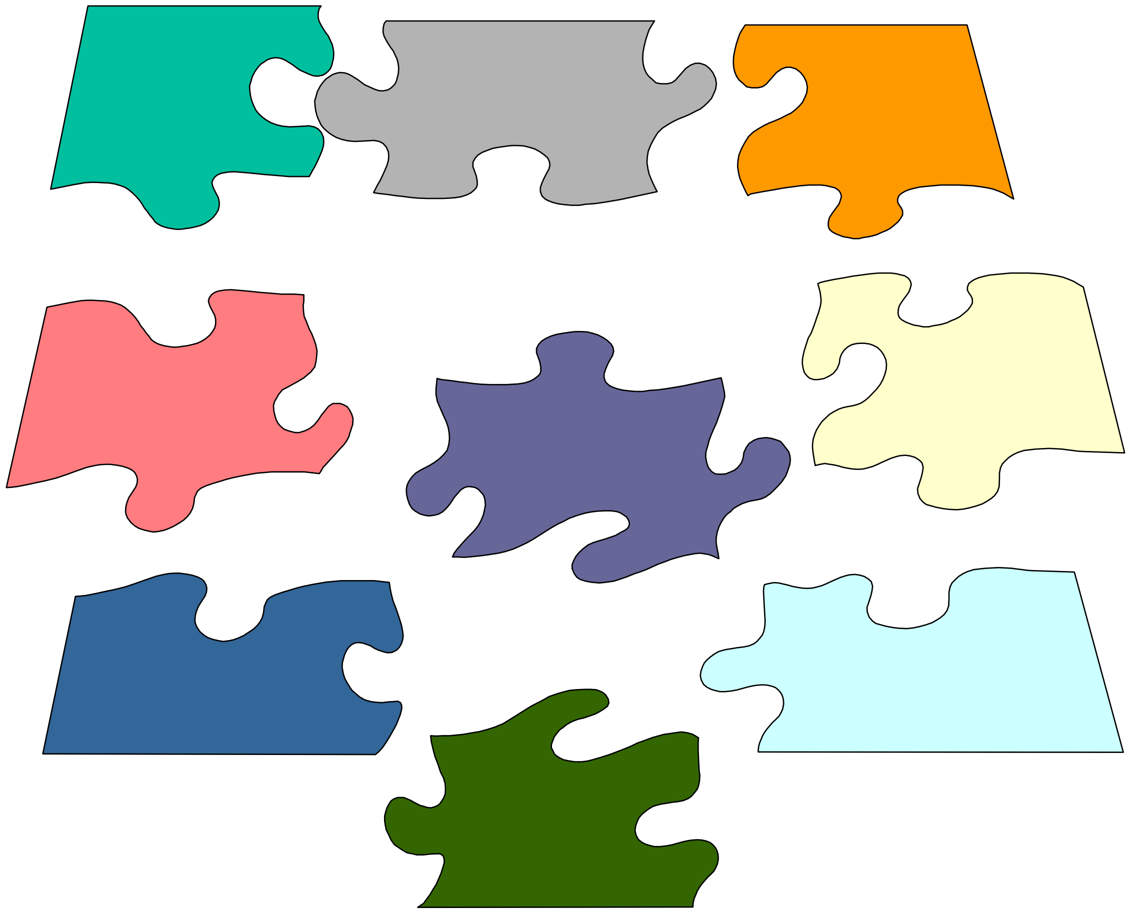




See en.wikipedia.org/wiki/Reification for more on what “reify” means

Overview of Frameworks

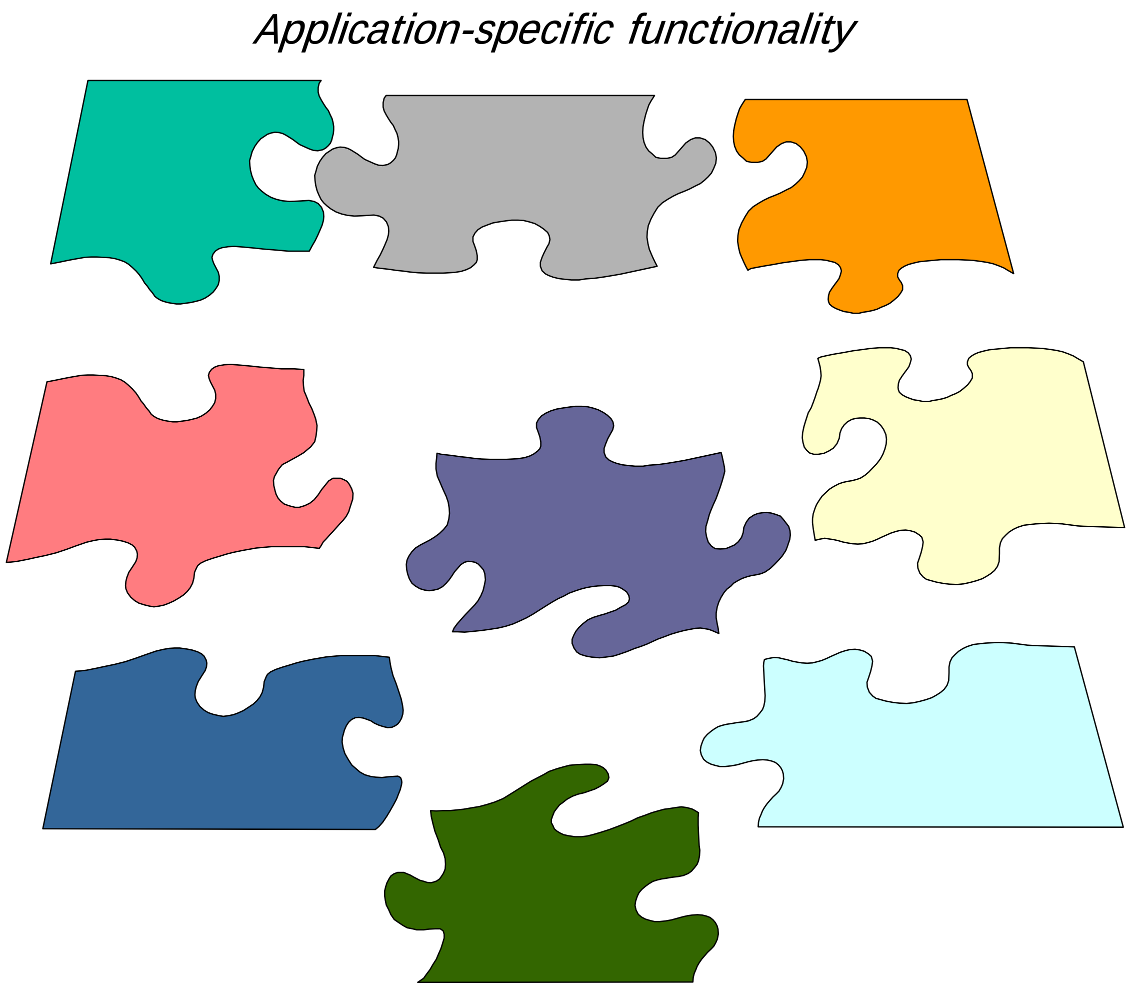
A framework is an integrated set of software components that collaborate to provide a reusable architecture for a family of related applications



See www.dre.vanderbilt.edu/~schmidt/CACM-frameworks.html for more info

Overview of Frameworks

- They exhibit “inversion of control” via callbacks



See www.dre.vanderbilt.edu/~schmidt/Coursera/articles/hollywood-principle.txt

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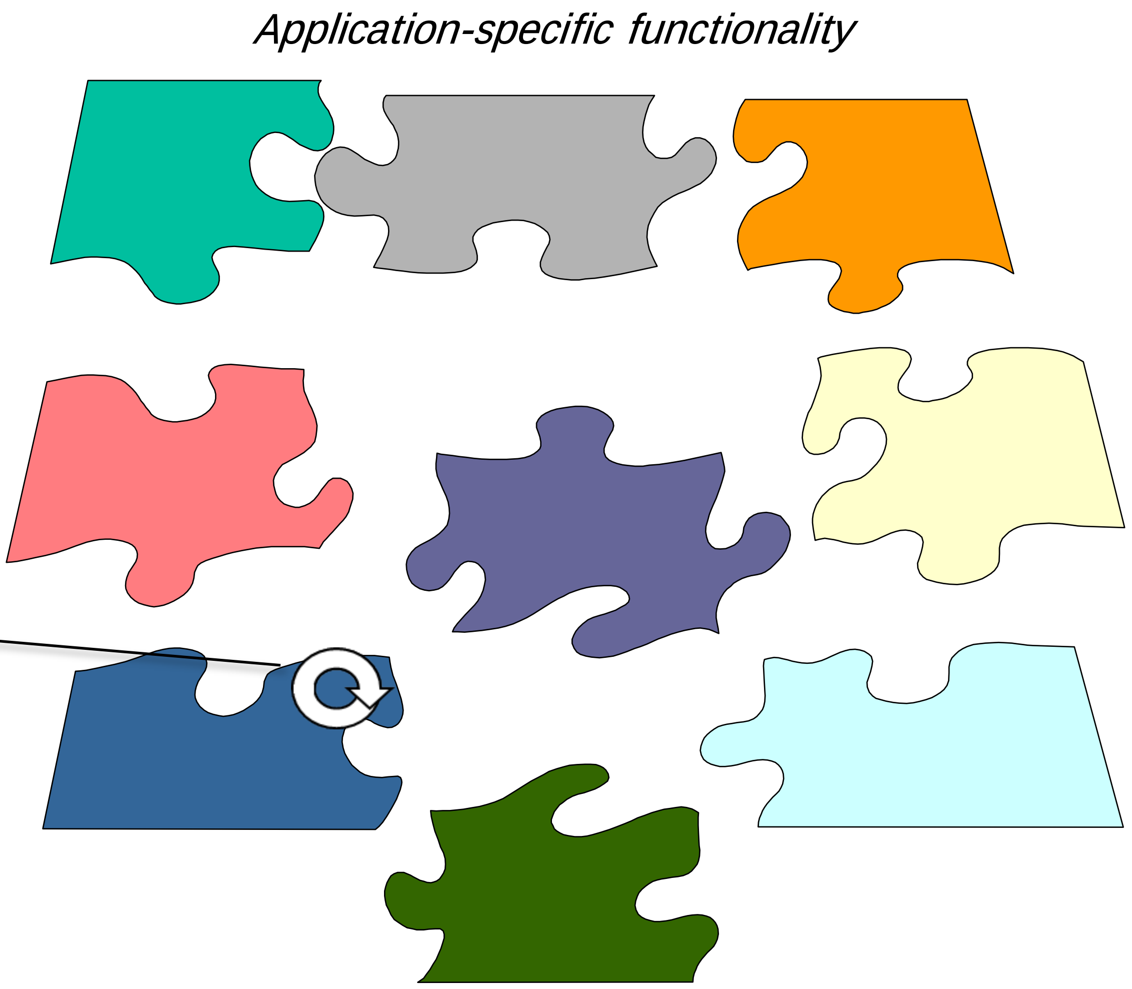

The framework owns the application event loop

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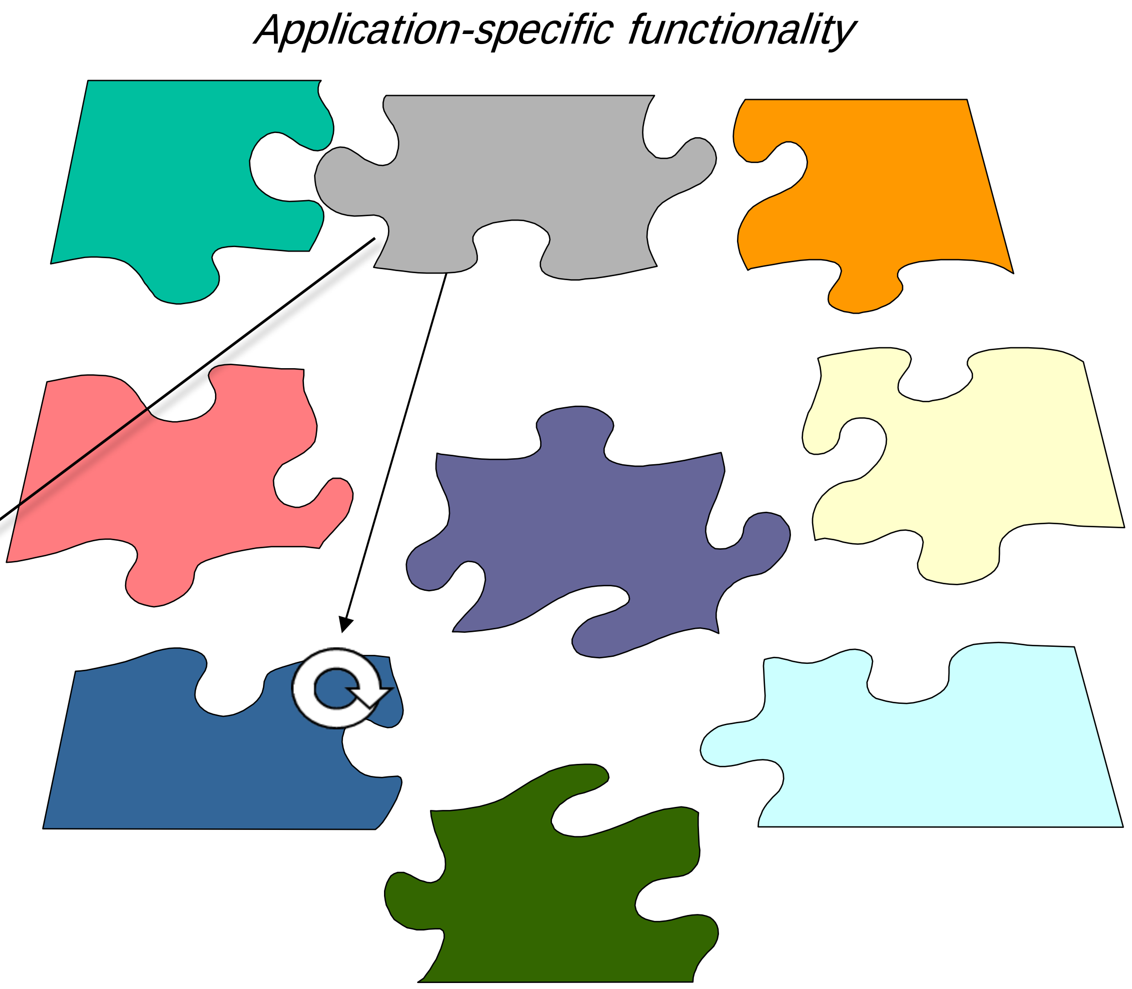

Applications register event handler objects with the framework

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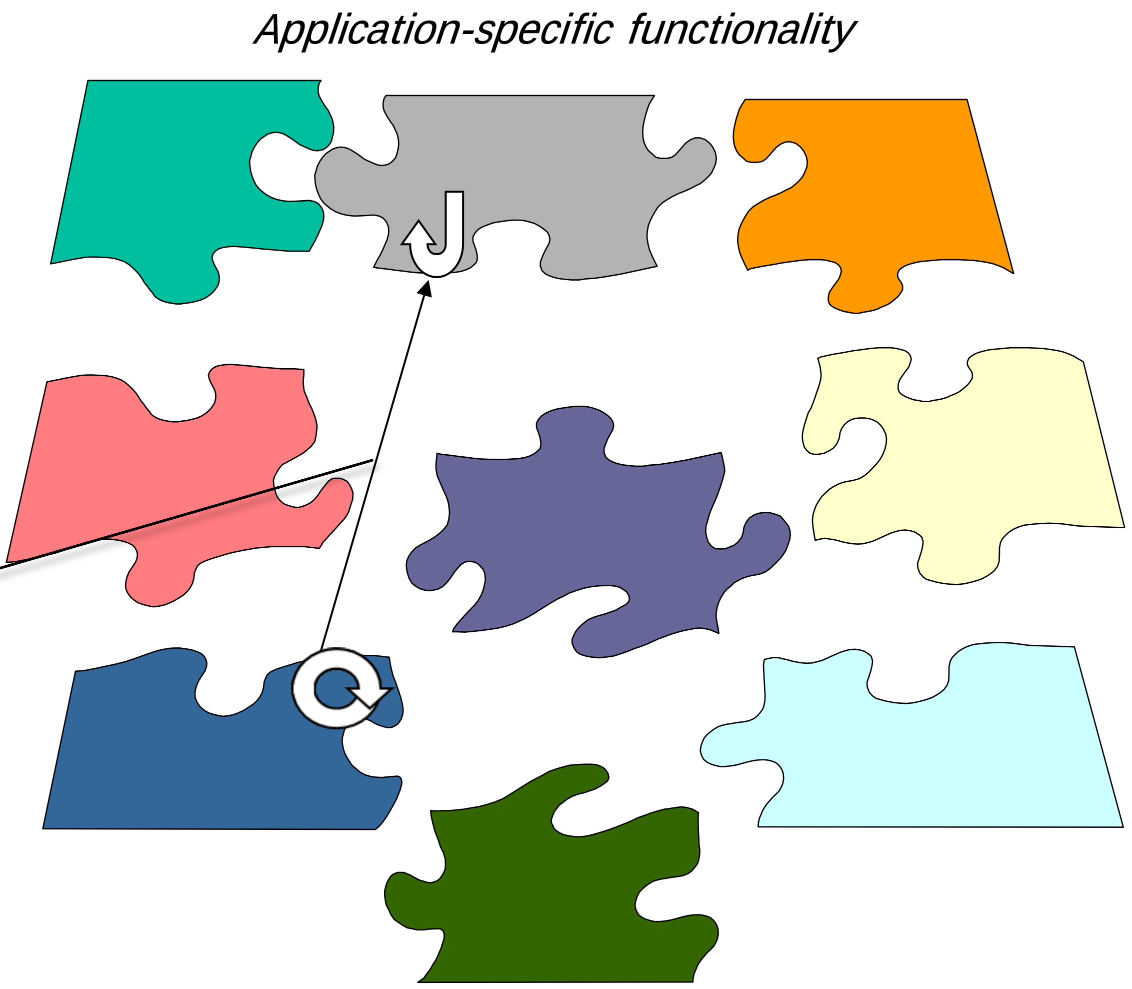

The framework dispatches events to hook methods defined in event handlers

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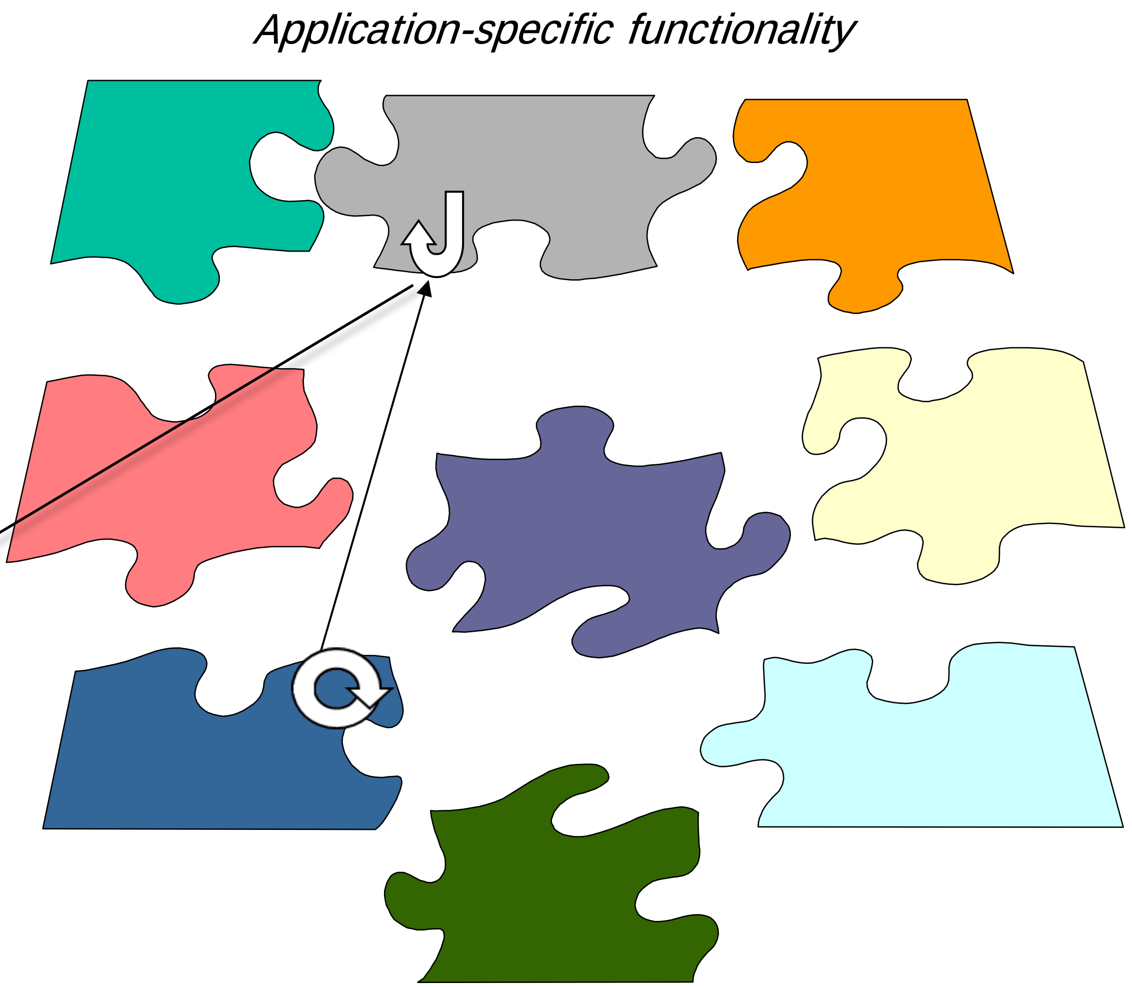

Hook methods customize generic framework components to run application-specific logic

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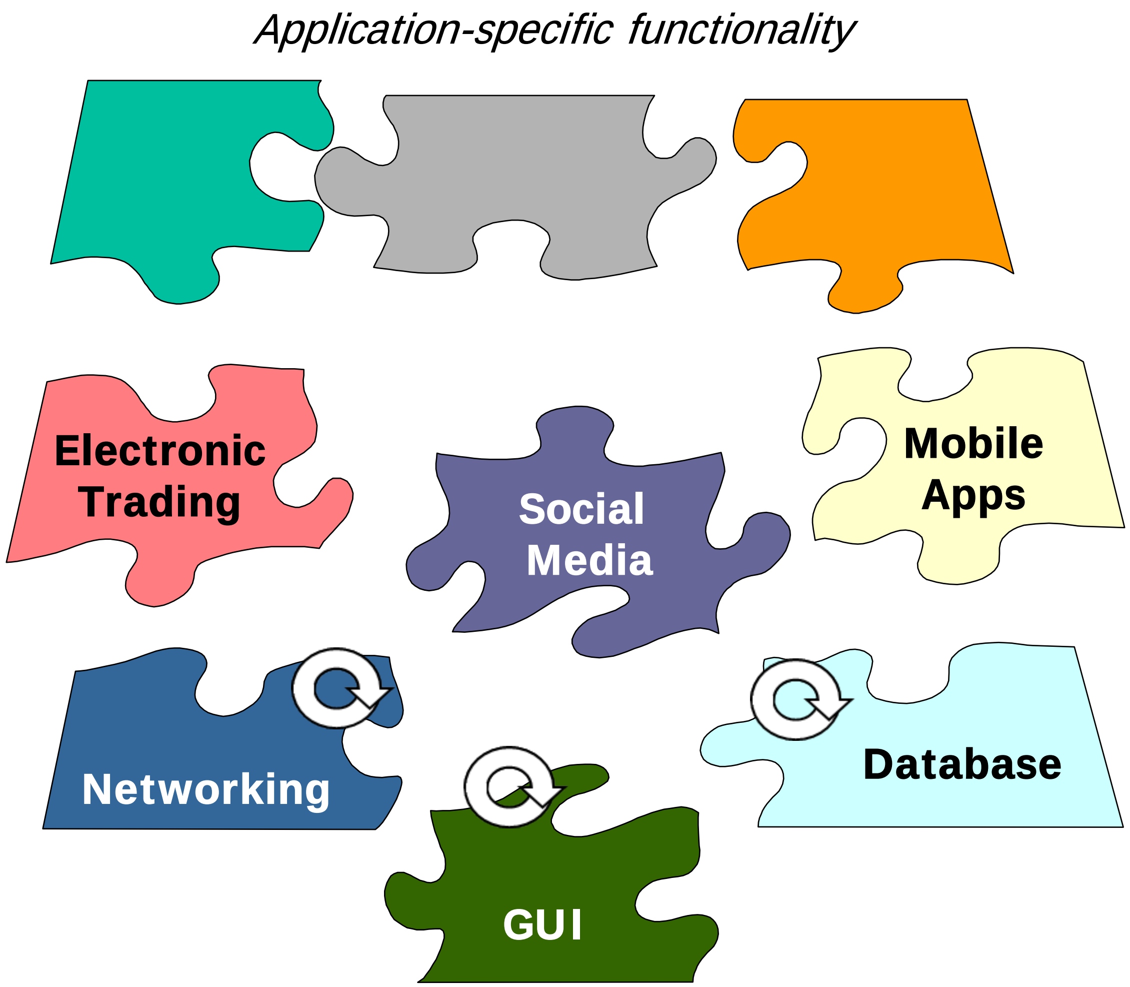
- They provide integrated domain-specific structures & functionality



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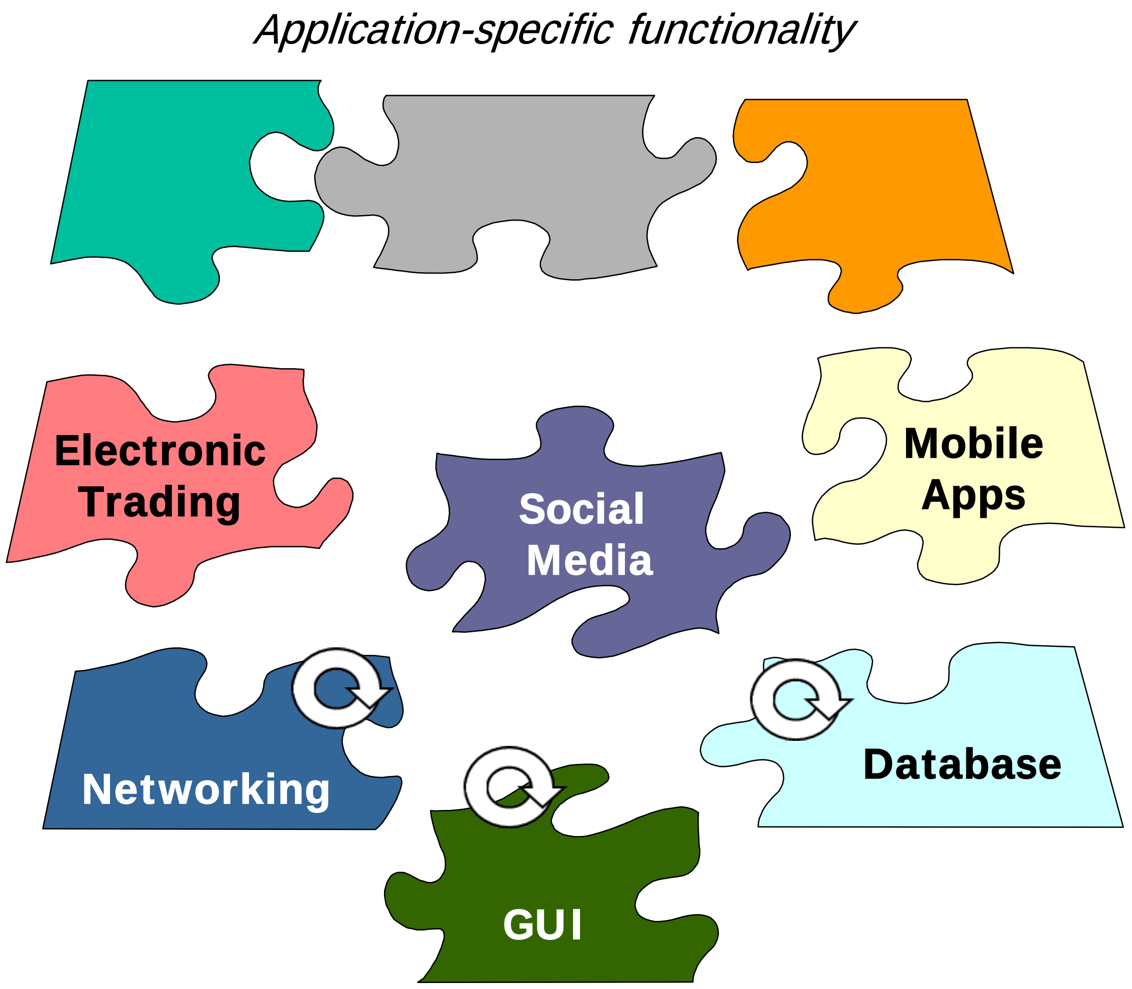
- They exhibit "inversion of control" via callbacks
- They provide integrated domain-specific structures & functionality, e.g.
  - Mediate common interactions between abstract & concrete classes



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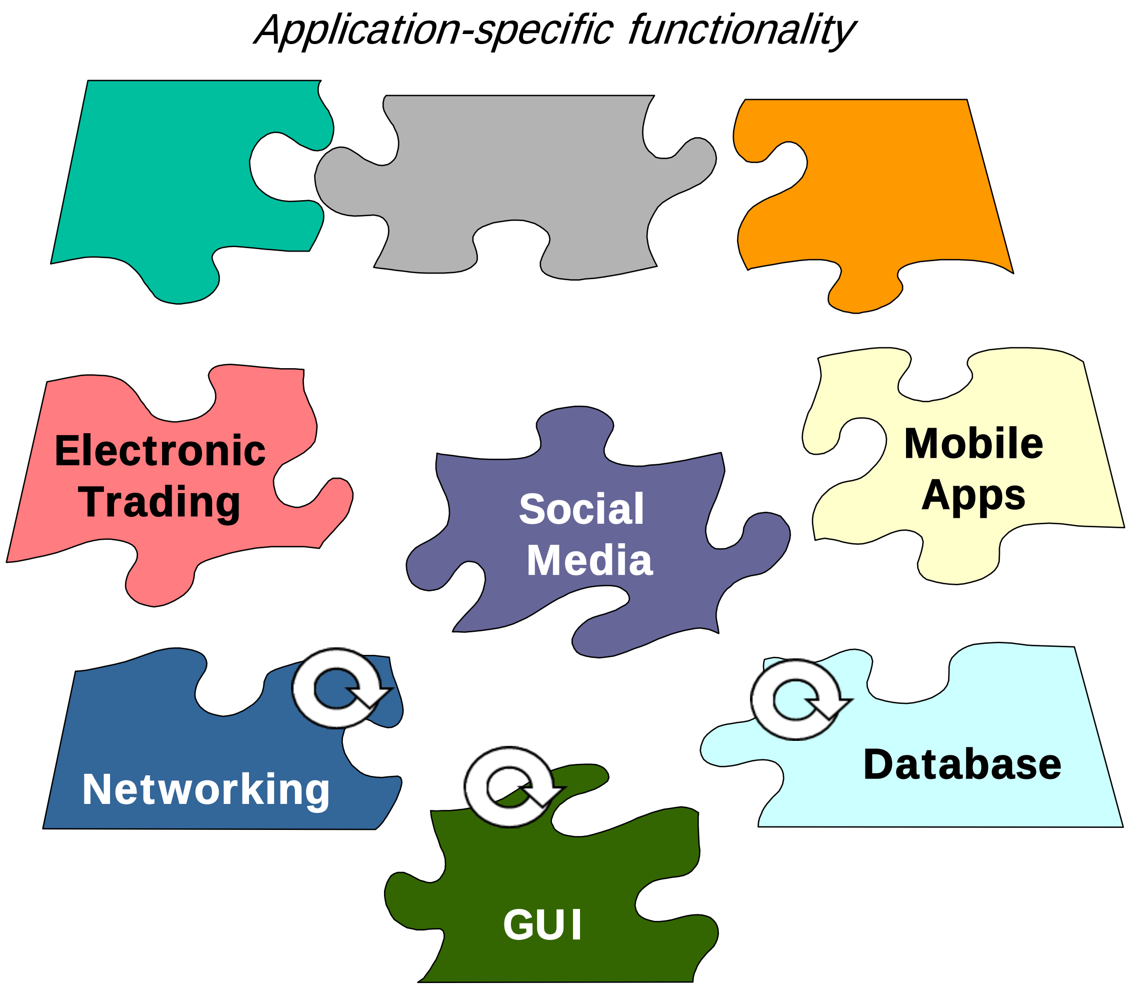
  - Mediate common interactions between abstract & concrete classes
  - Guide canonical flow of control



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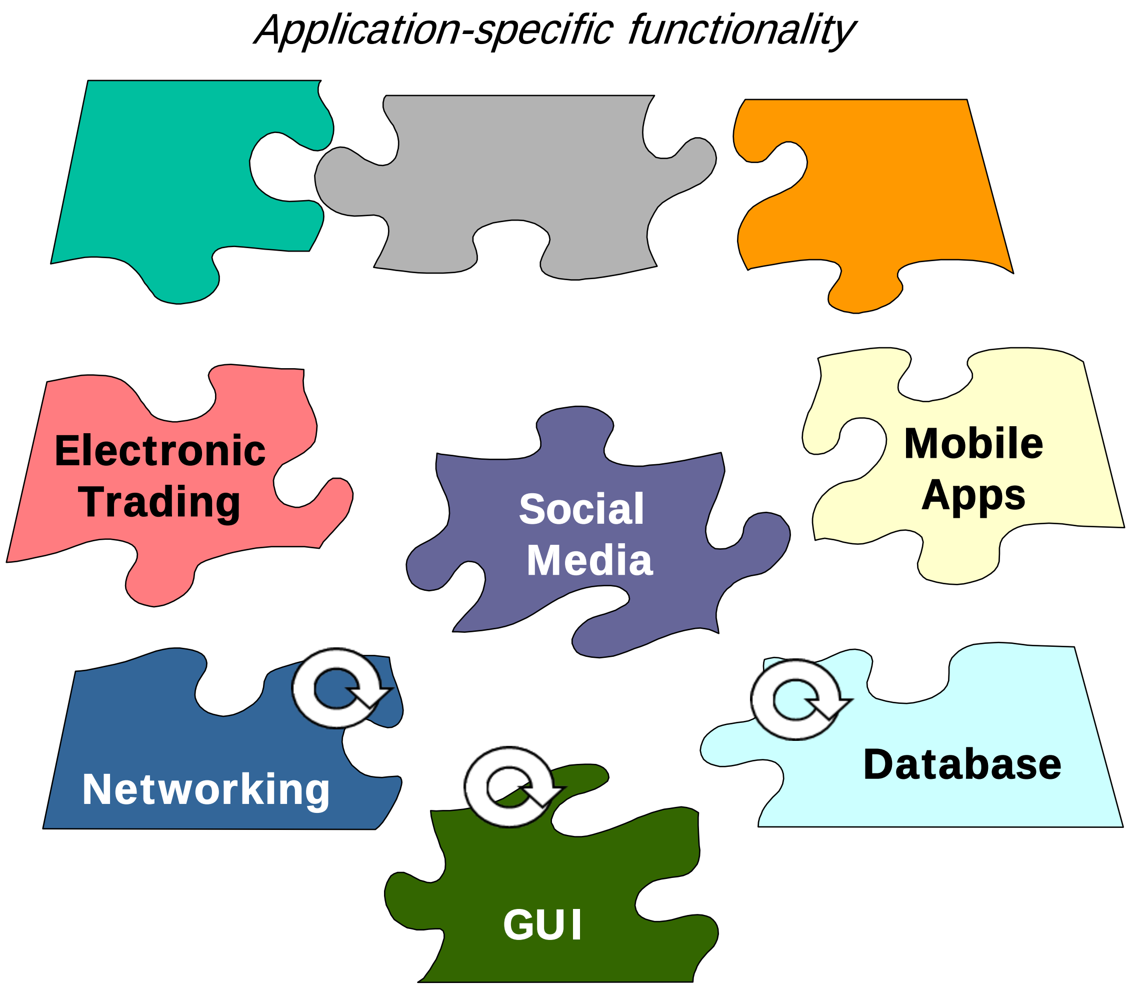
- They provide integrated domain-specific structures & functionality, e.g.
    - Mediate common interactions between abstract & concrete classes
    - Guide canonical flow of control
    - Enforce architectural constraints



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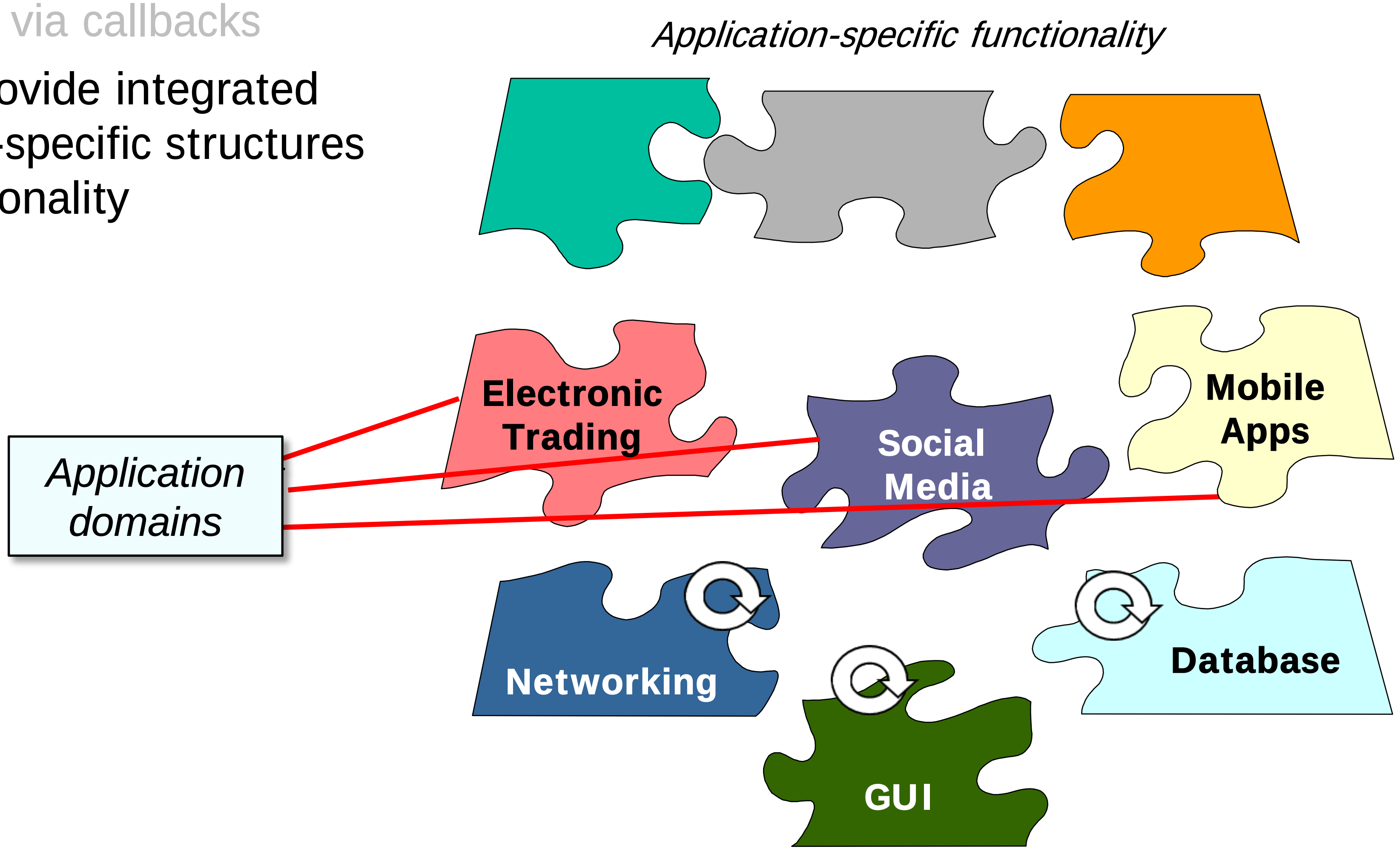

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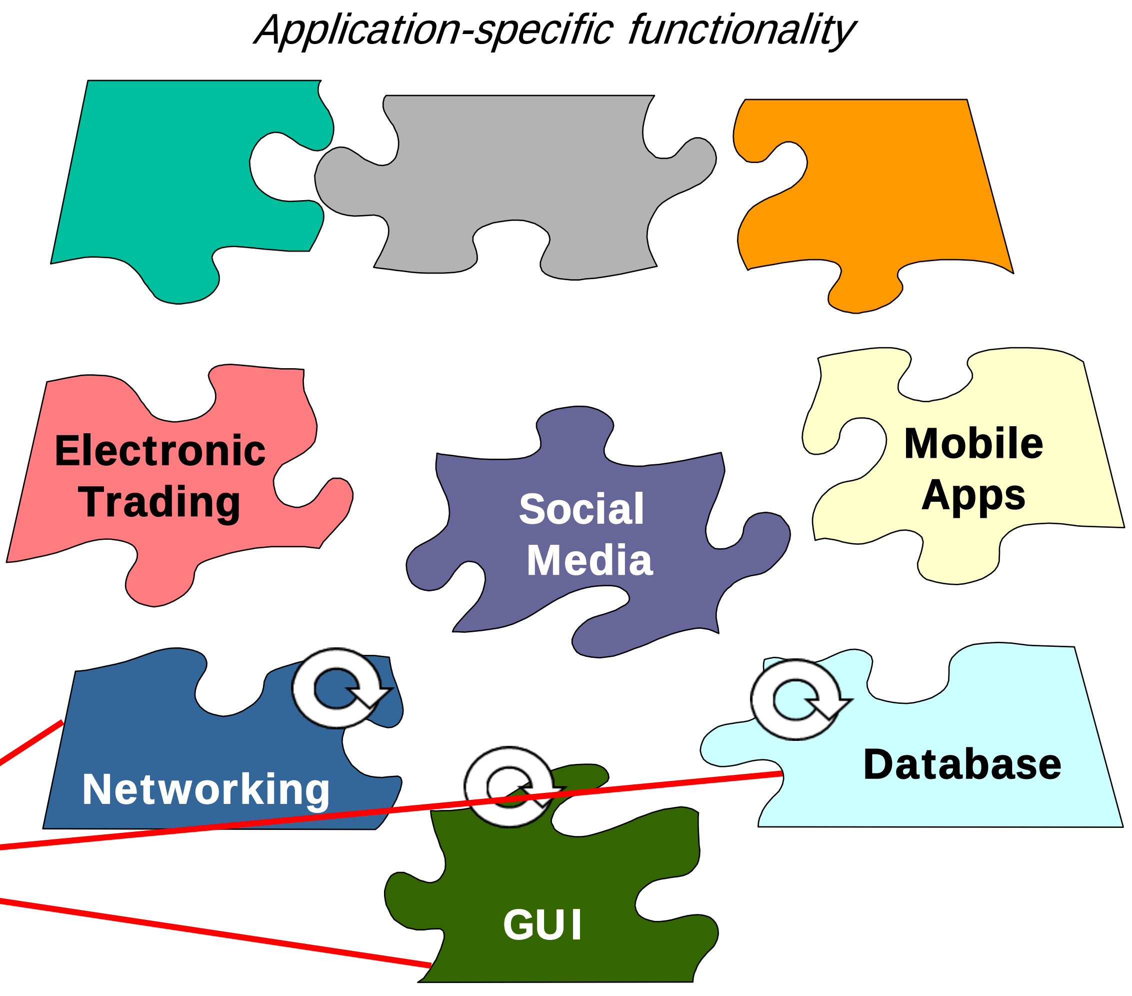

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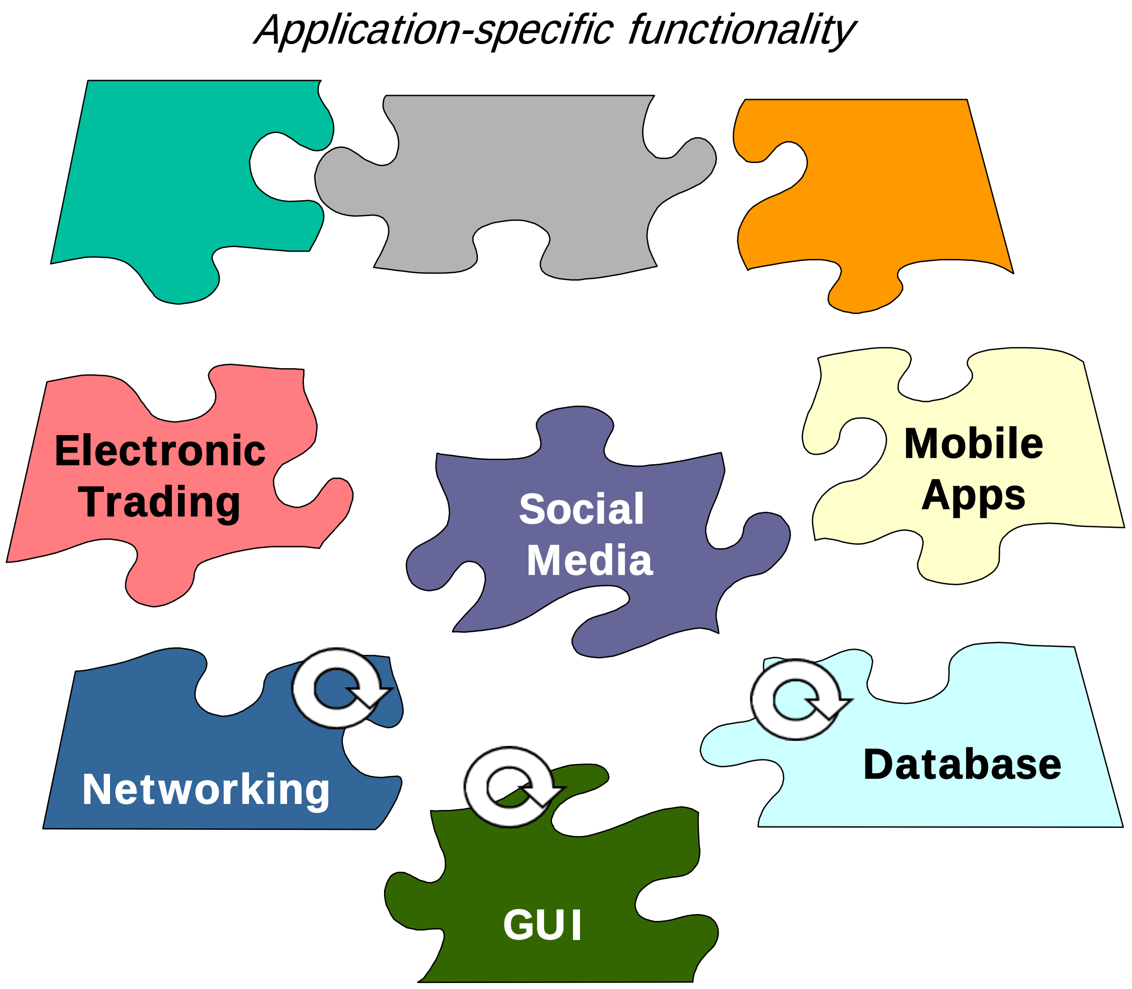
- They exhibit "inversion of control" via callbacks
- They provide integrated domain-specific structures & functionality
- They are "semi-complete" applications



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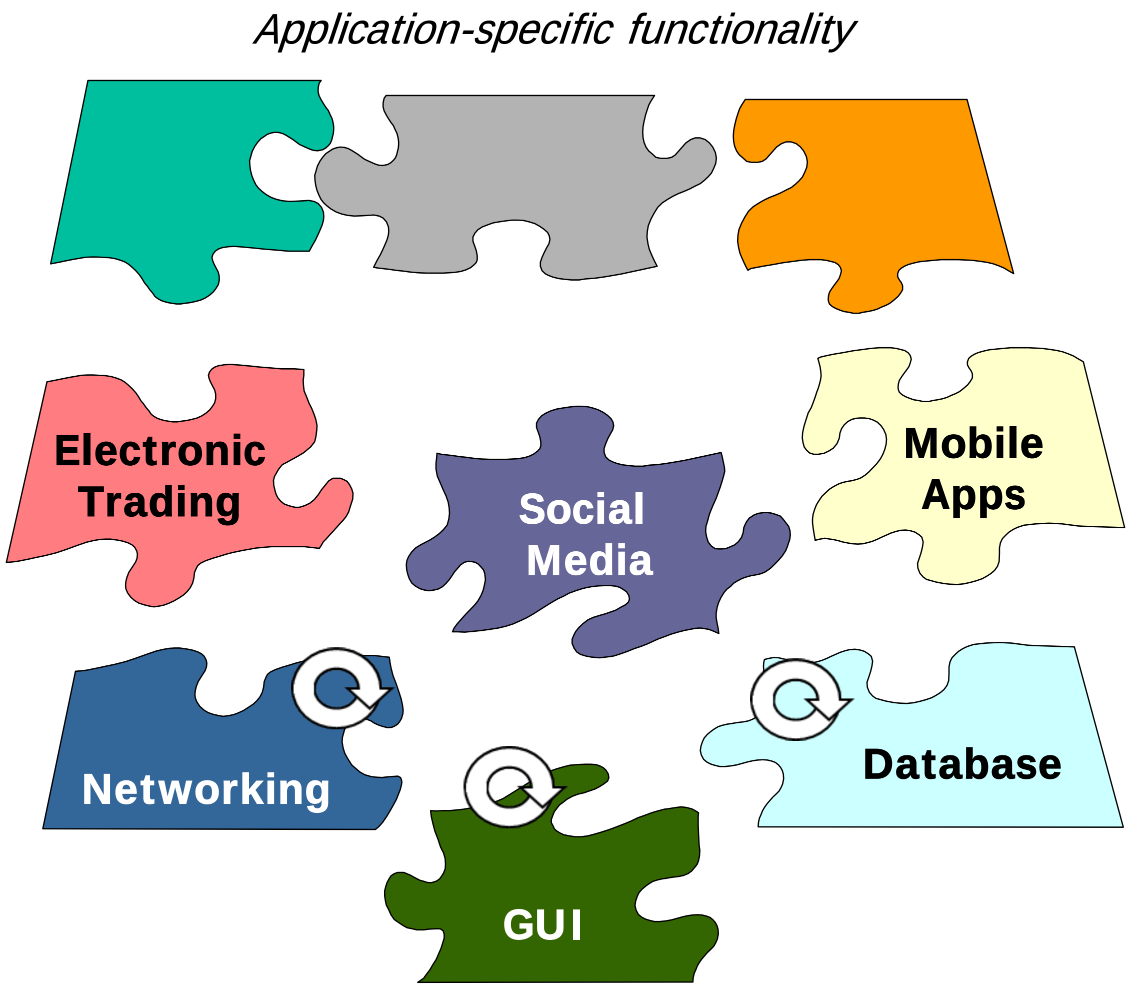
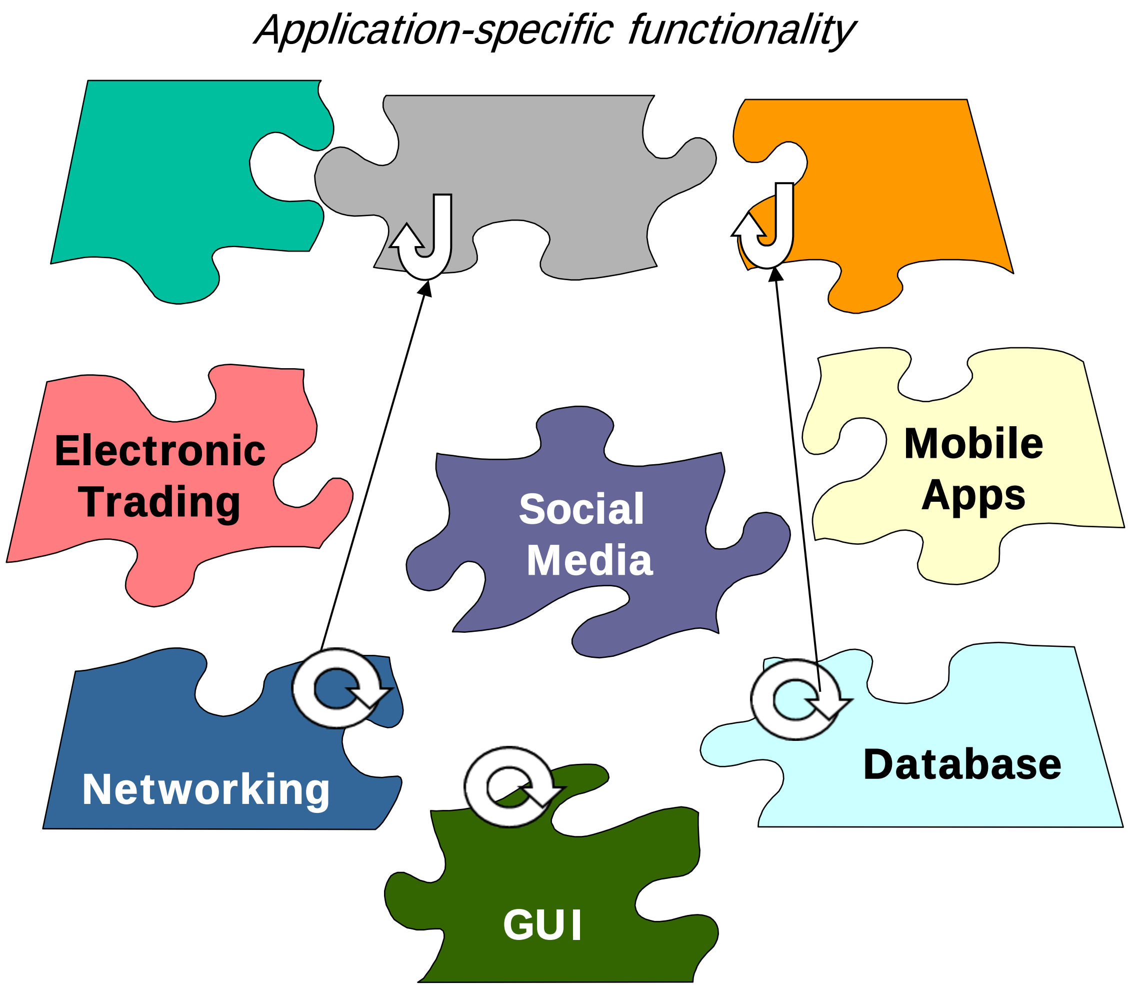
- They are "semi-complete" applications
  - Framework provides reusable interfaces & classes



Overview of Frameworks

- They exhibit "inversion of control" via callbacks
- They provide integrated domain-specific structures & functionality
- They are "semi-complete" applications
  - Framework provides reusable interfaces & classes
  - Applications customize frameworks via subclassing & overriding hook methods



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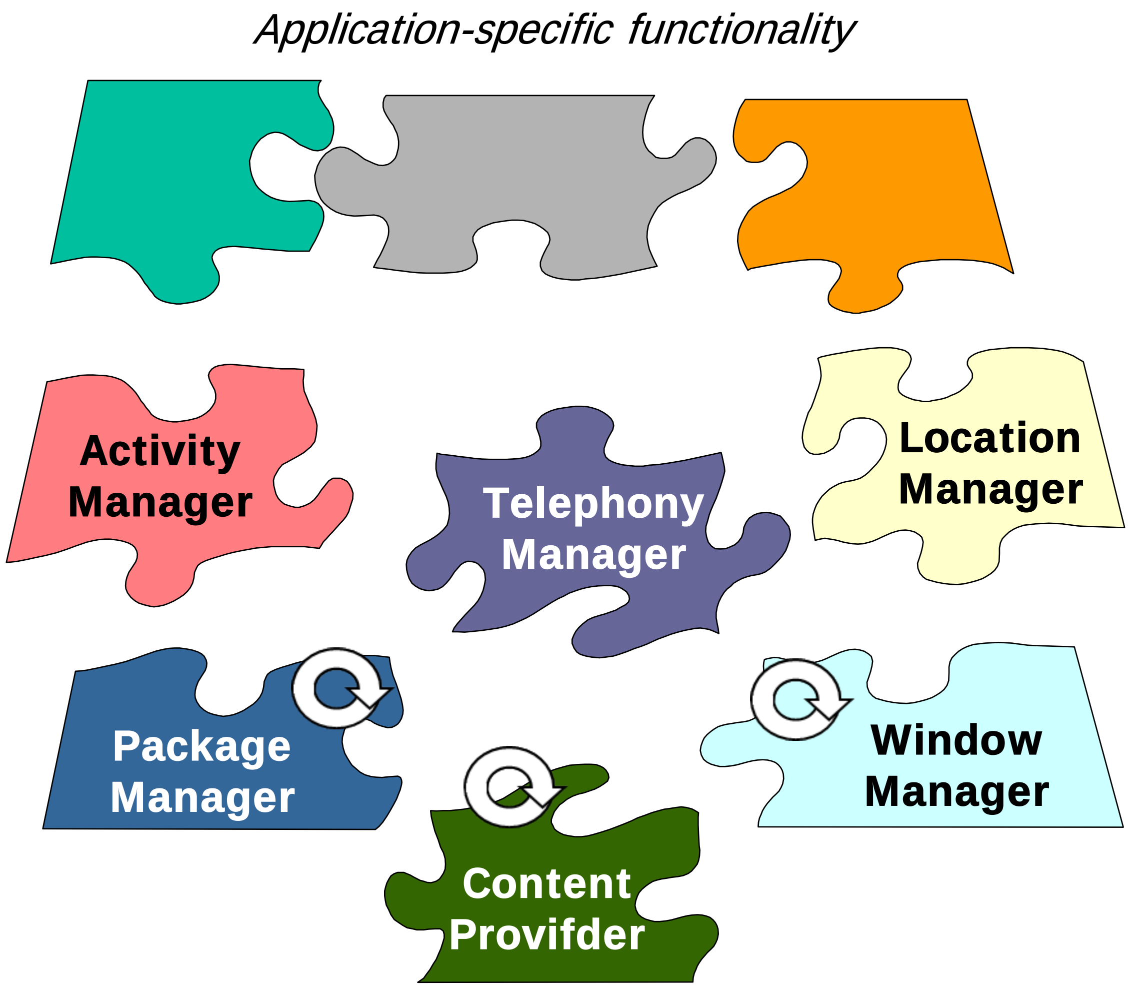
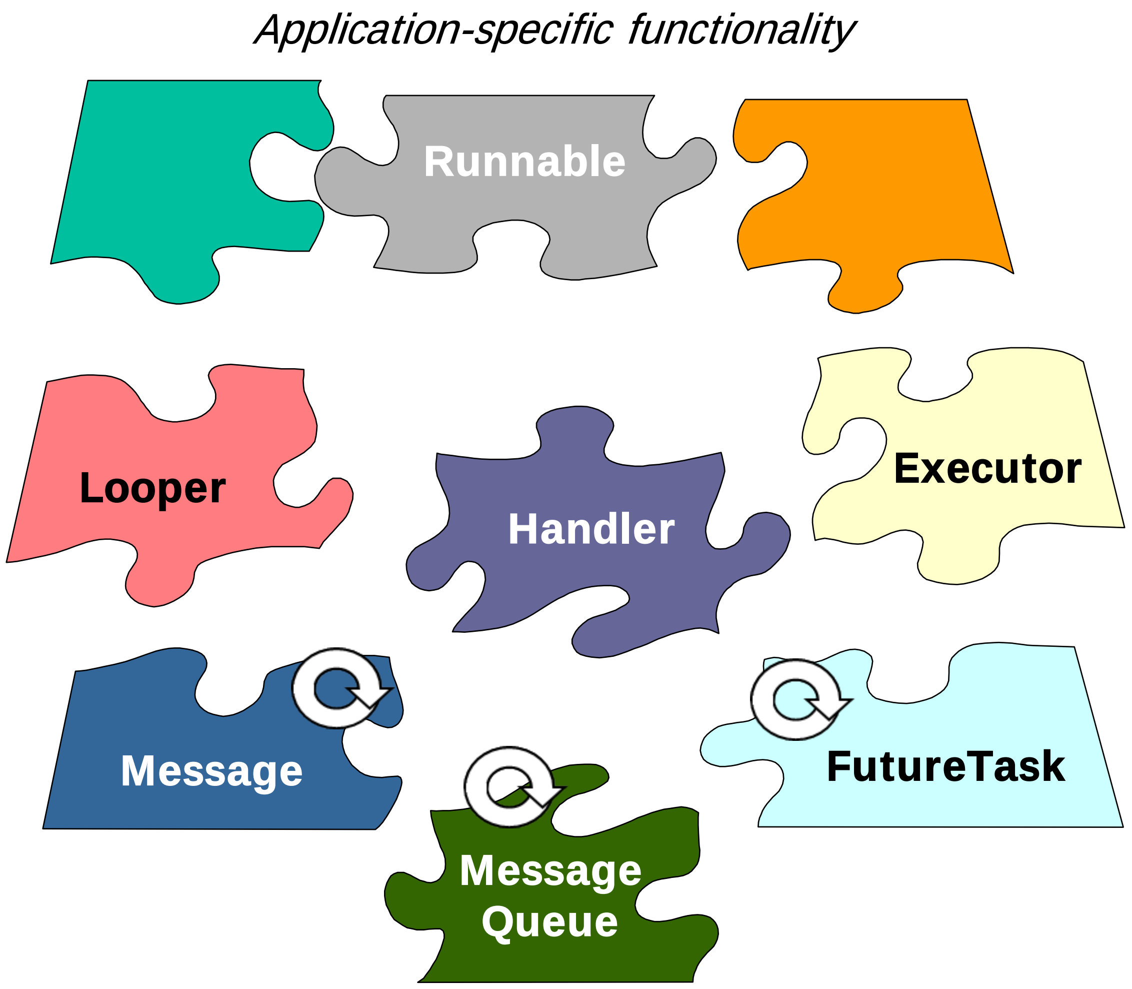


Overview of Frameworks

- They exhibit "inversion of control" via callbacks
- They provide integrated domain-specific structures & functionality
- They are "semi-complete" applications
- Android provides many frameworks
    - We focus on several Android concurrency & communication frameworks



See item #17 at class.coursera.org/posa-002/wiki/FrequentlyAskedQuestions

Applying the Observer Pattern in Android Frameworks

Applying Observer in Android Frameworks

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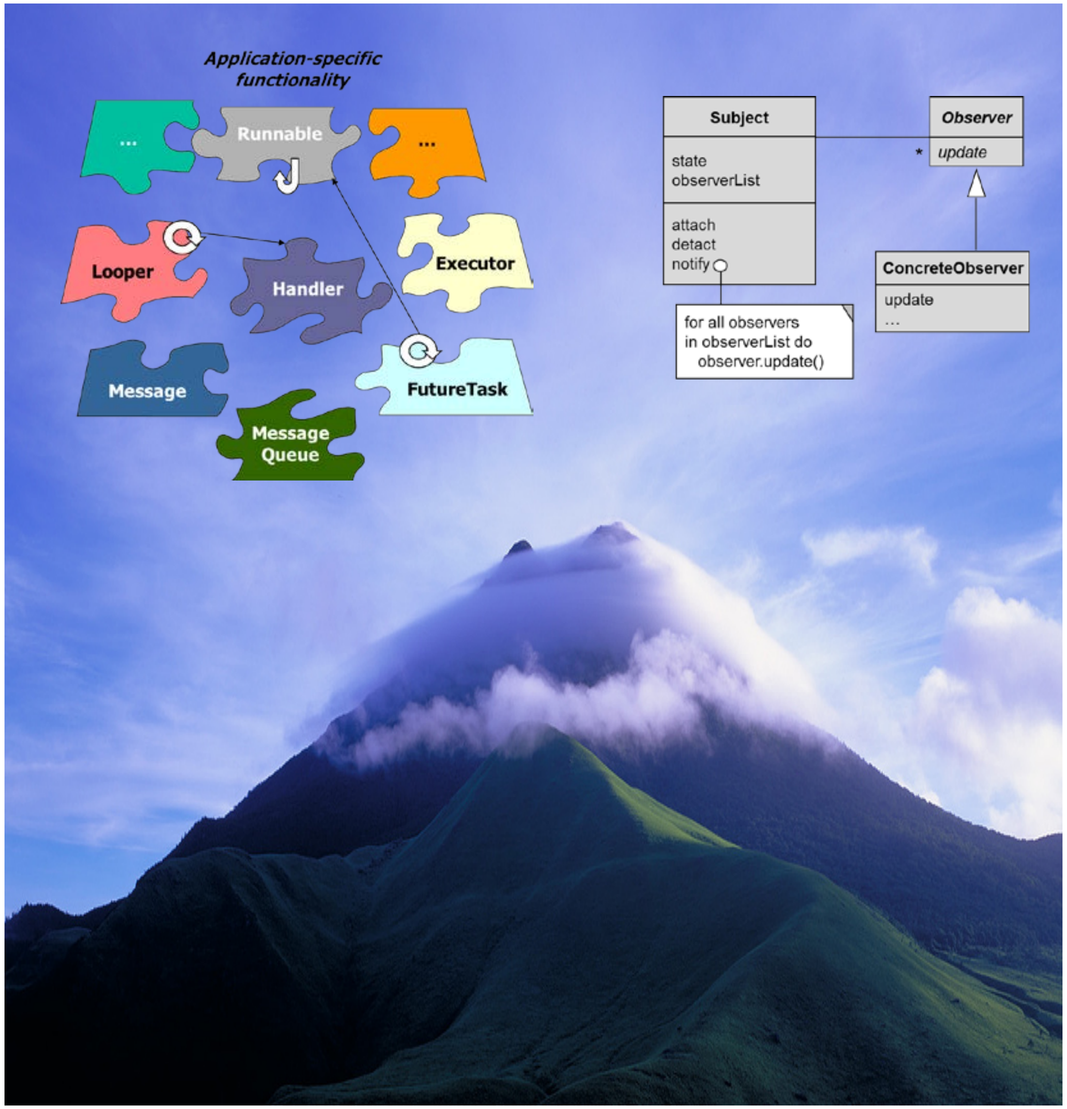

Applying Observer in Android Frameworks

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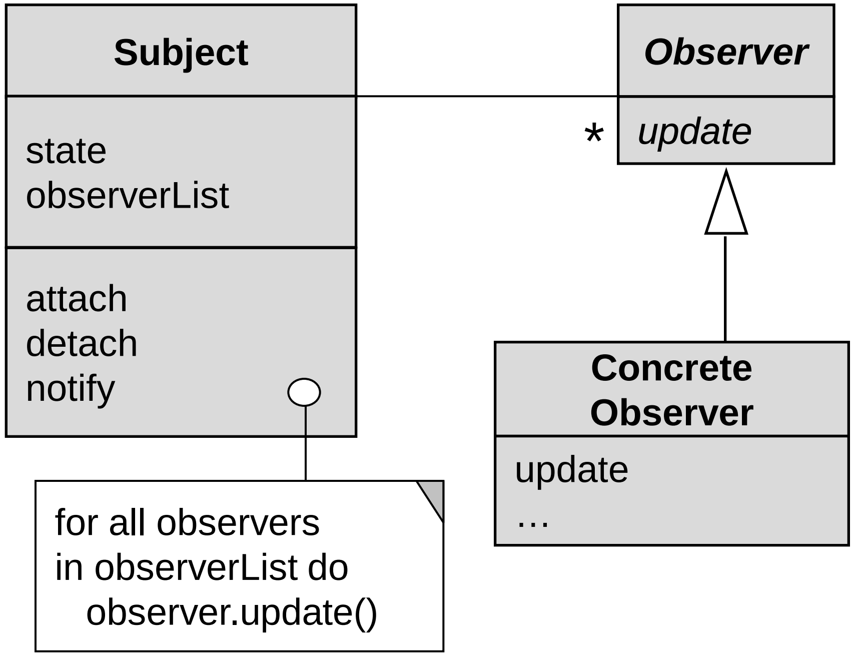
- We now show examples of applying the *Observer* pattern to several Android frameworks

The Observer pattern



Android applies the *Observer* pattern extensive throughout its frameworks

Applying Observer in Android Frameworks

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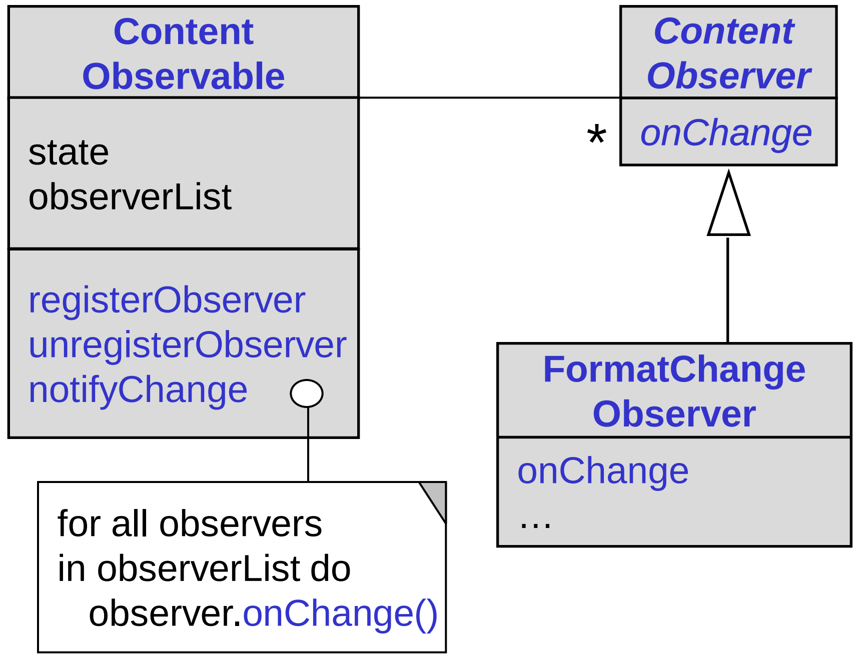
  - The Content Provider & Resolver framework uses it to notify when rows in an SQLite database change



One use of the *Observer* pattern in Android

See www.grokkingandroid.com/use-contentobserver-to-listen-to-changes

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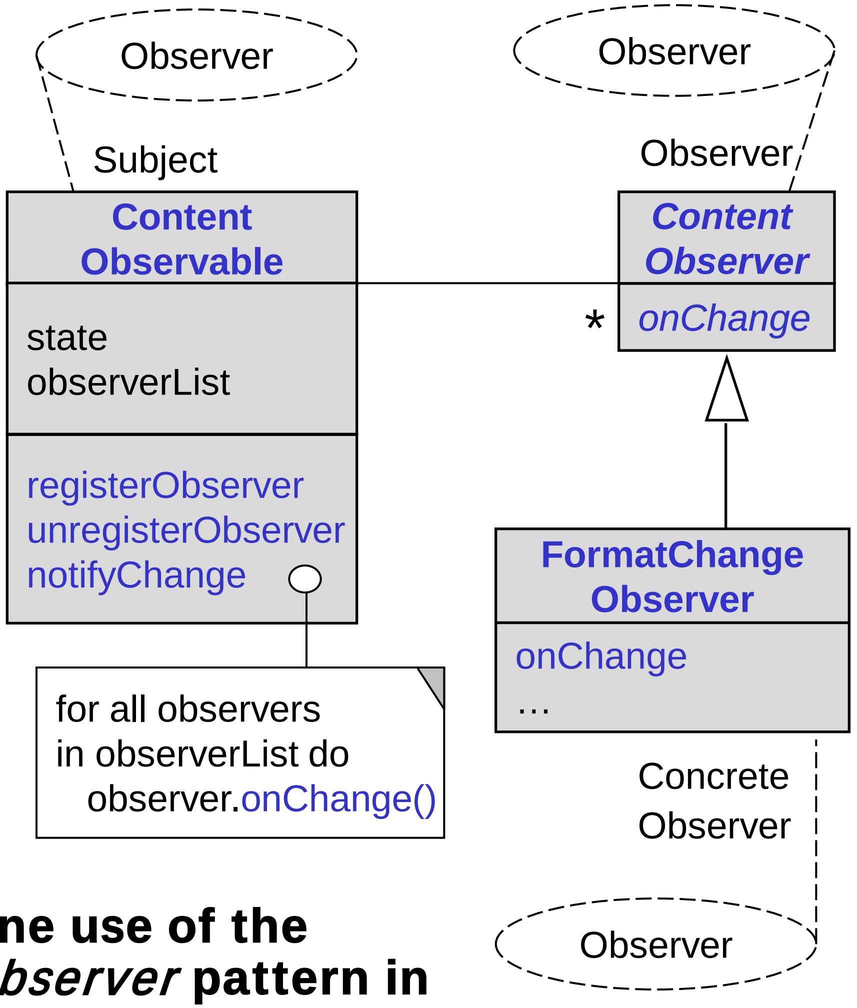

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See packages/apps/DeskClock/src/com/android/deskclock/DigitalClock.java

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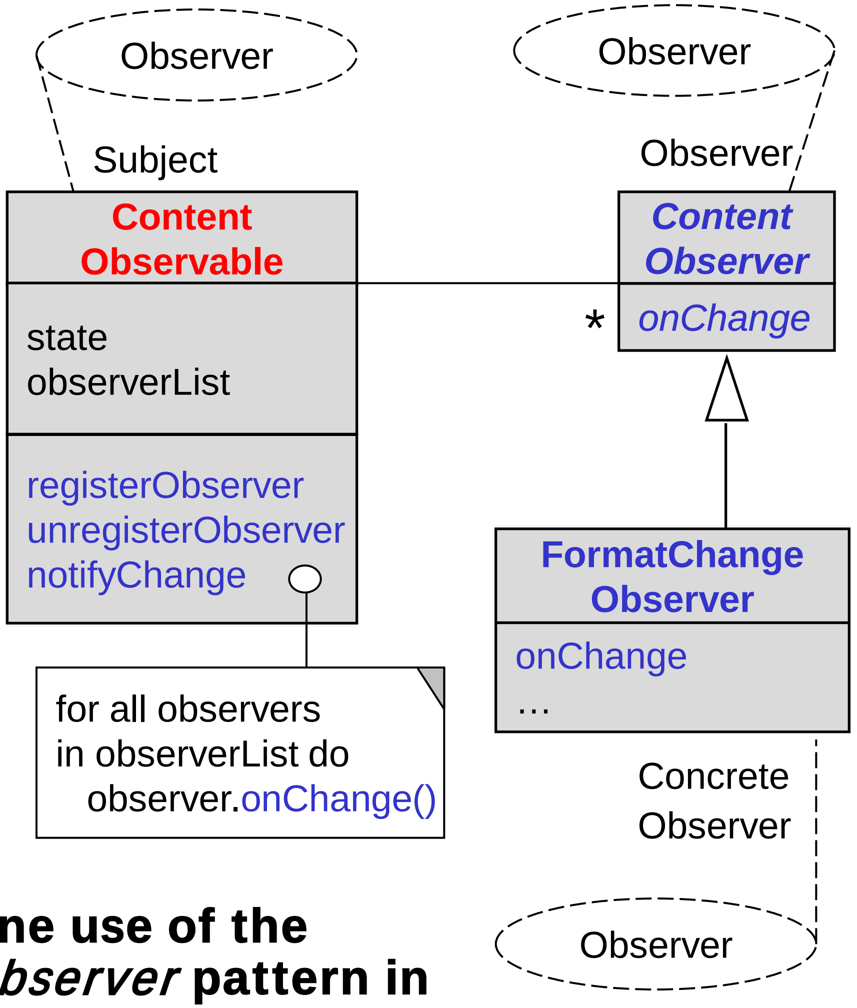

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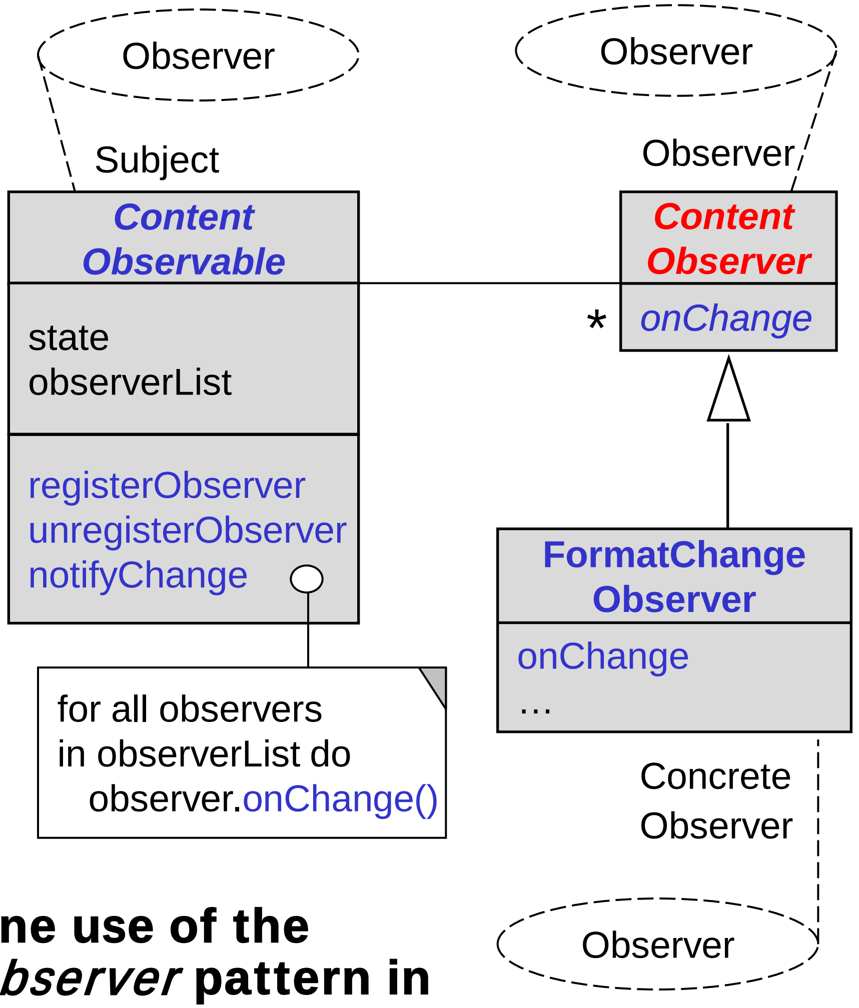

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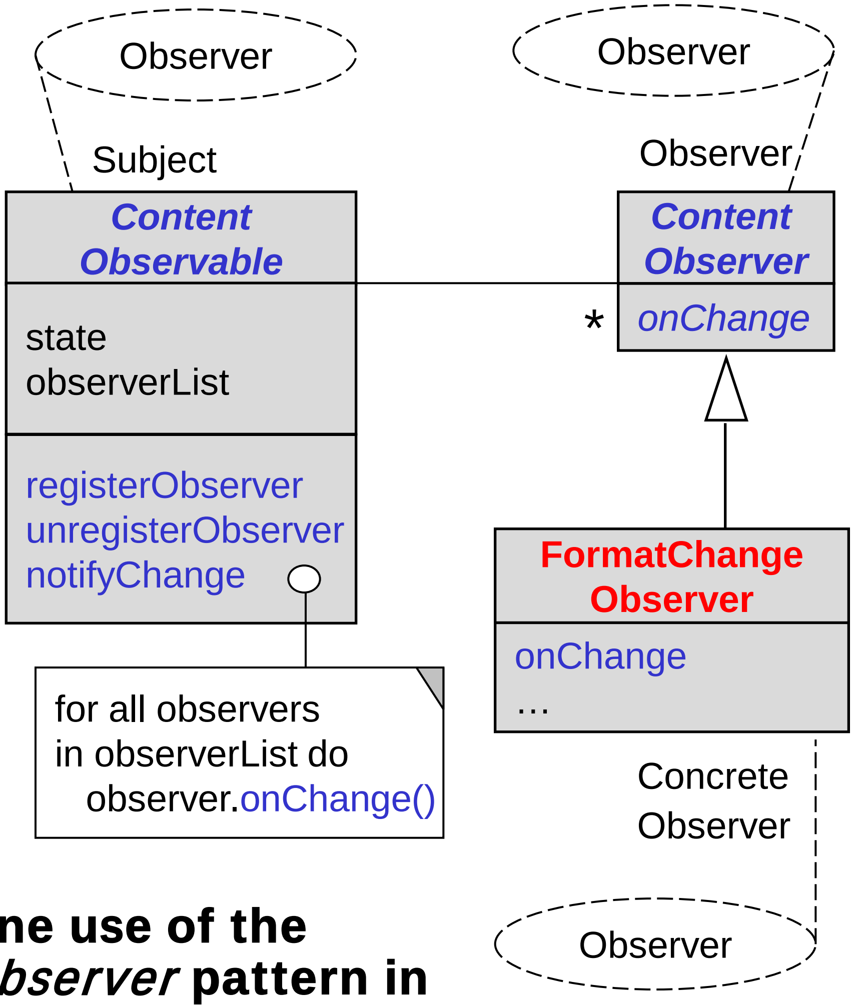

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Overview of Patterns

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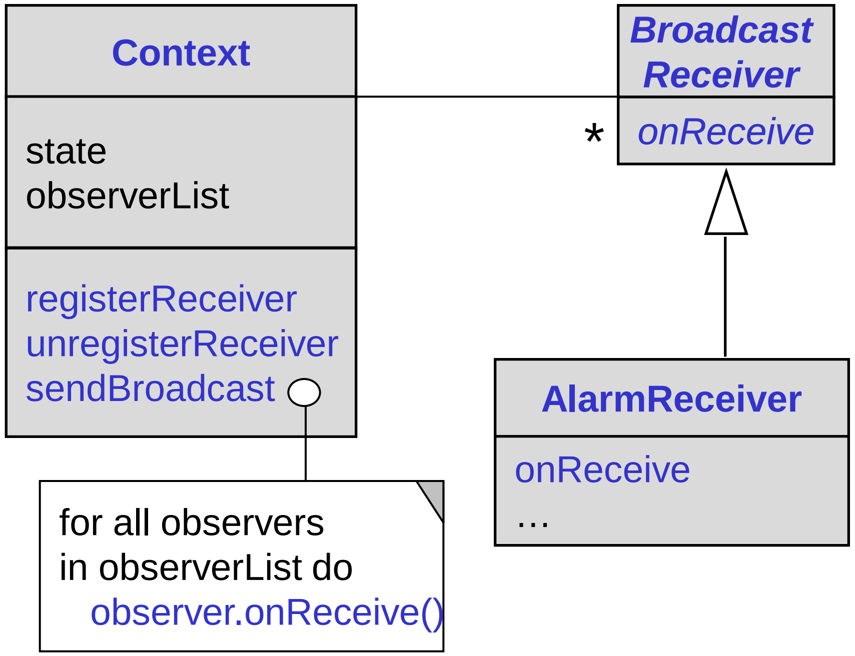
  - The Content Provider & Resolver framework uses it to notify when rows in an SQLite database change
  - Its Intents framework uses it to notify Broadcast Receivers that events of interest have occurred



A different use of the *Observer* pattern in Android

See developer.android.com/guide/components/intents-filters.html

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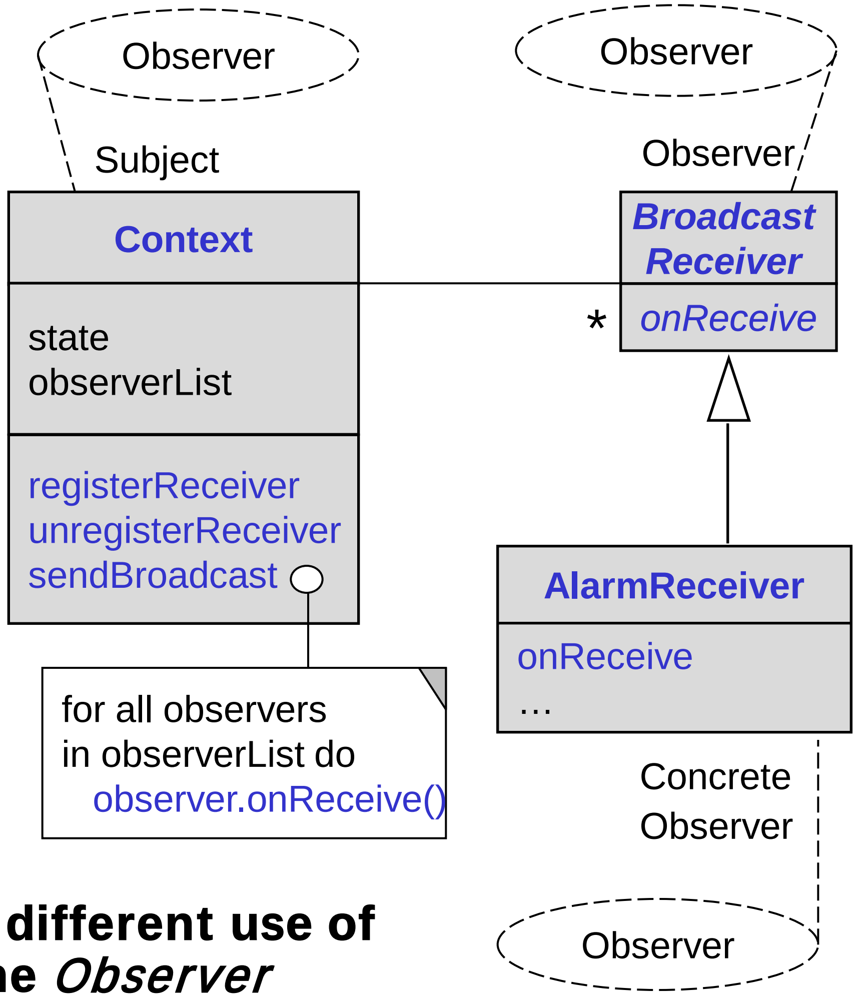

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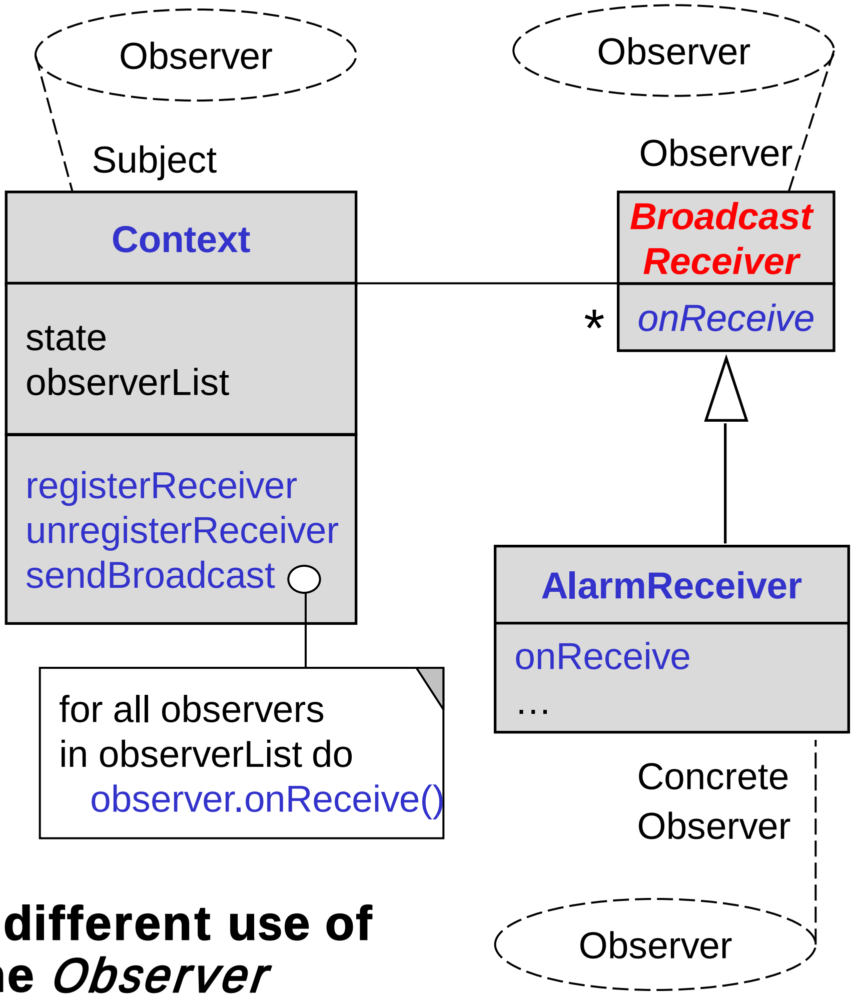

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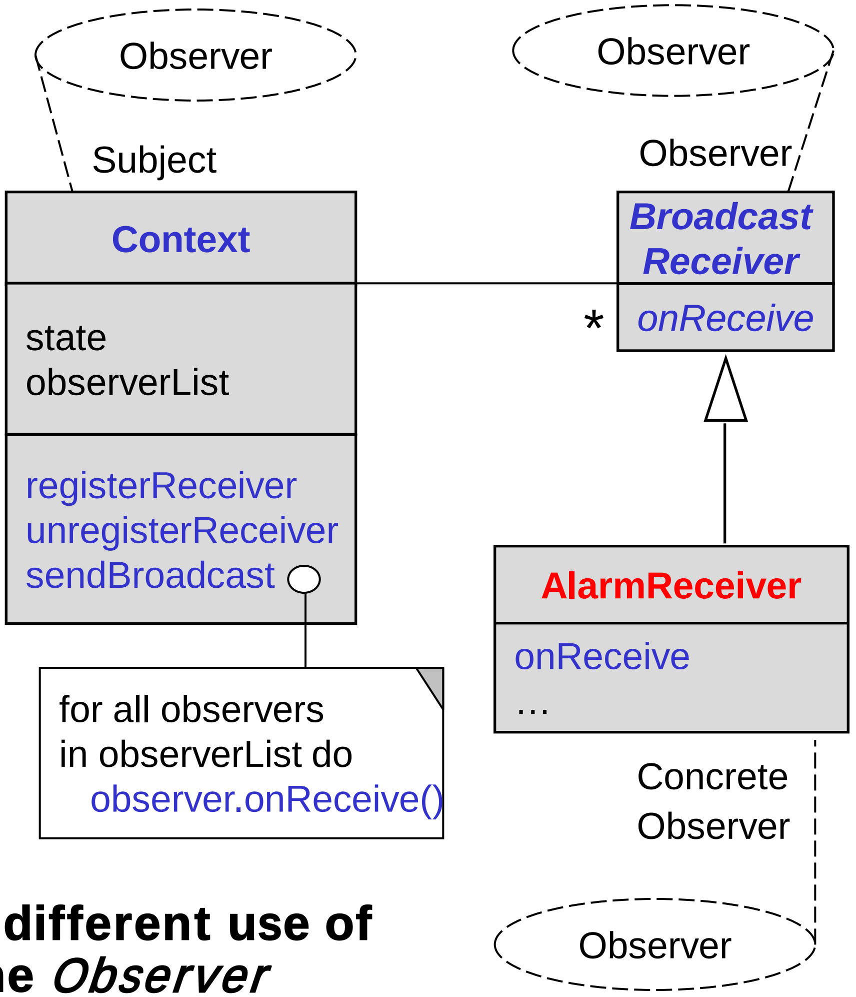

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See packages/apps/DeskClock/src/com/android/deskclock/AlarmReceiver.java

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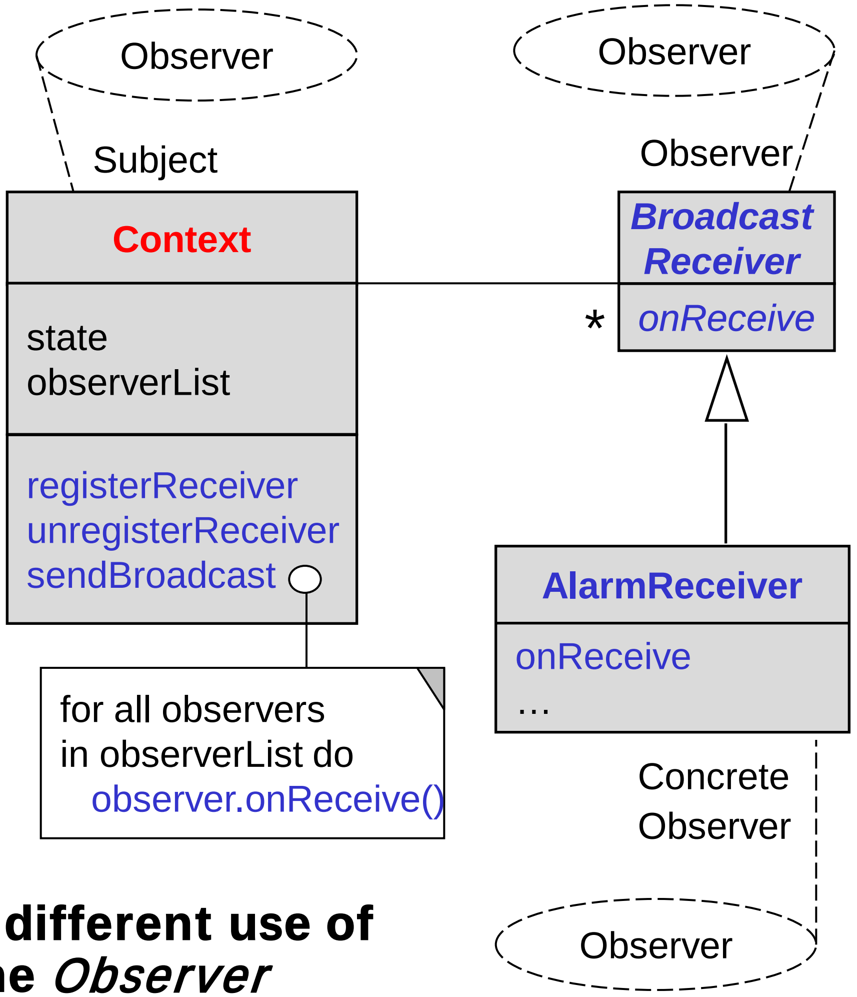

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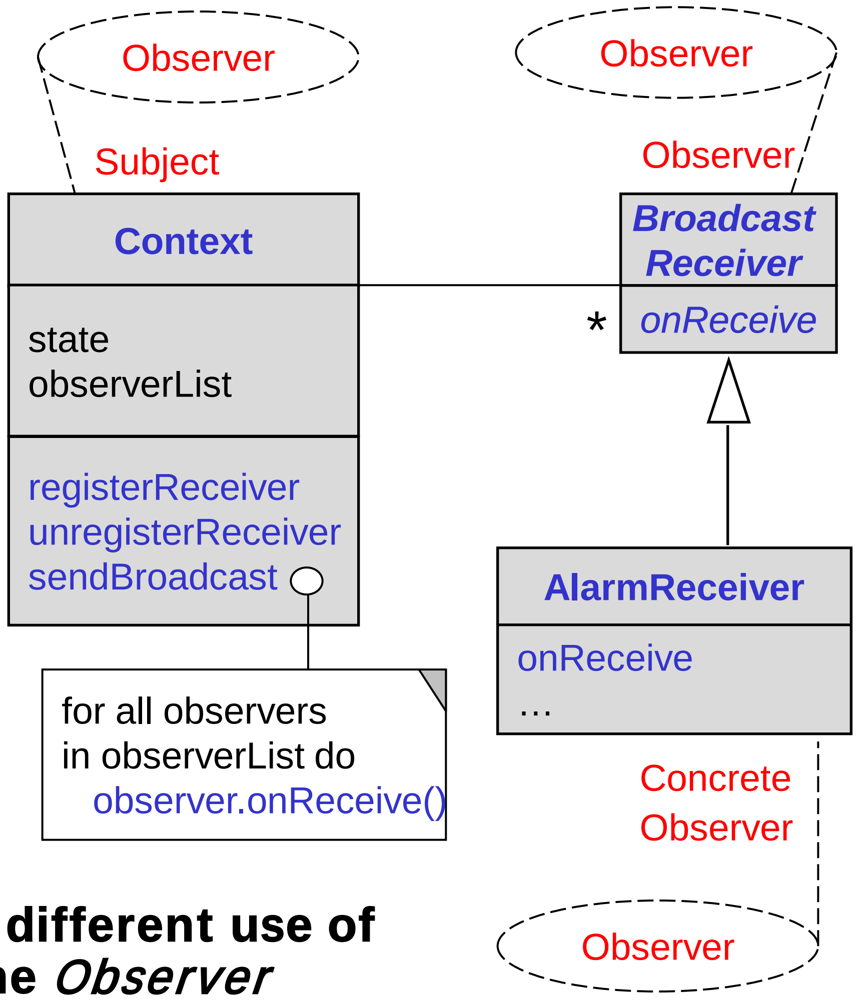

A different use of the *Observer* pattern in Android

Knowledge of *Observer* pattern reduces “surface area” of the design space

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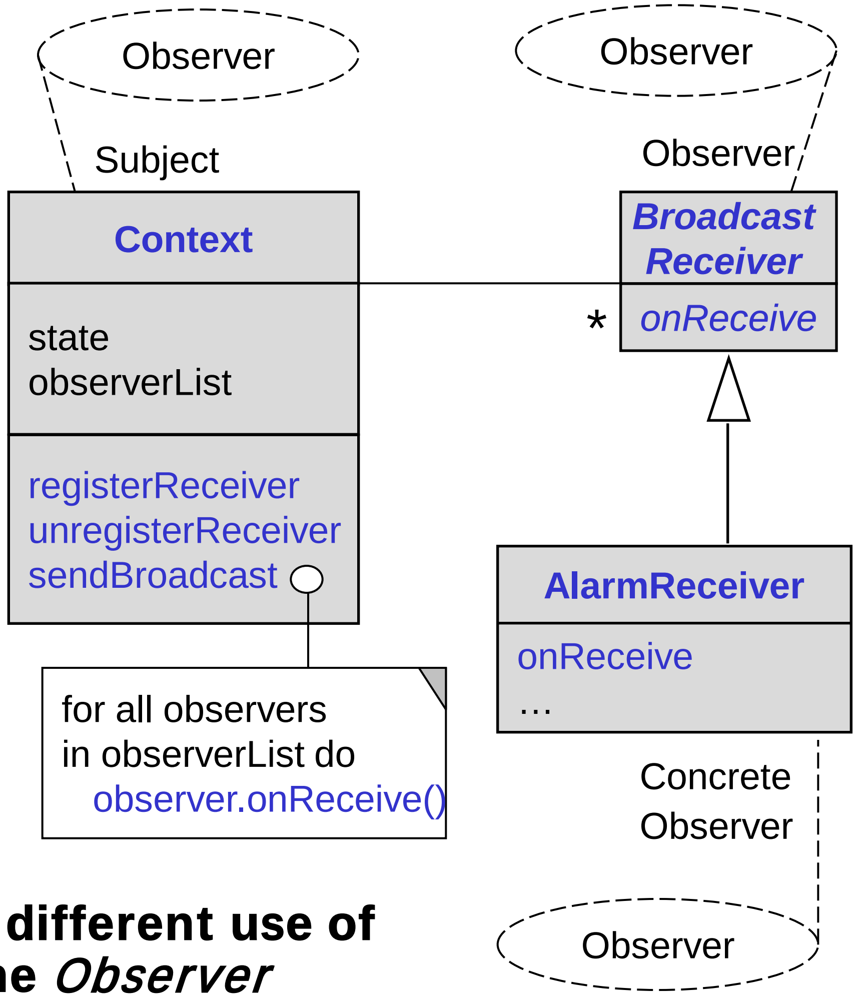


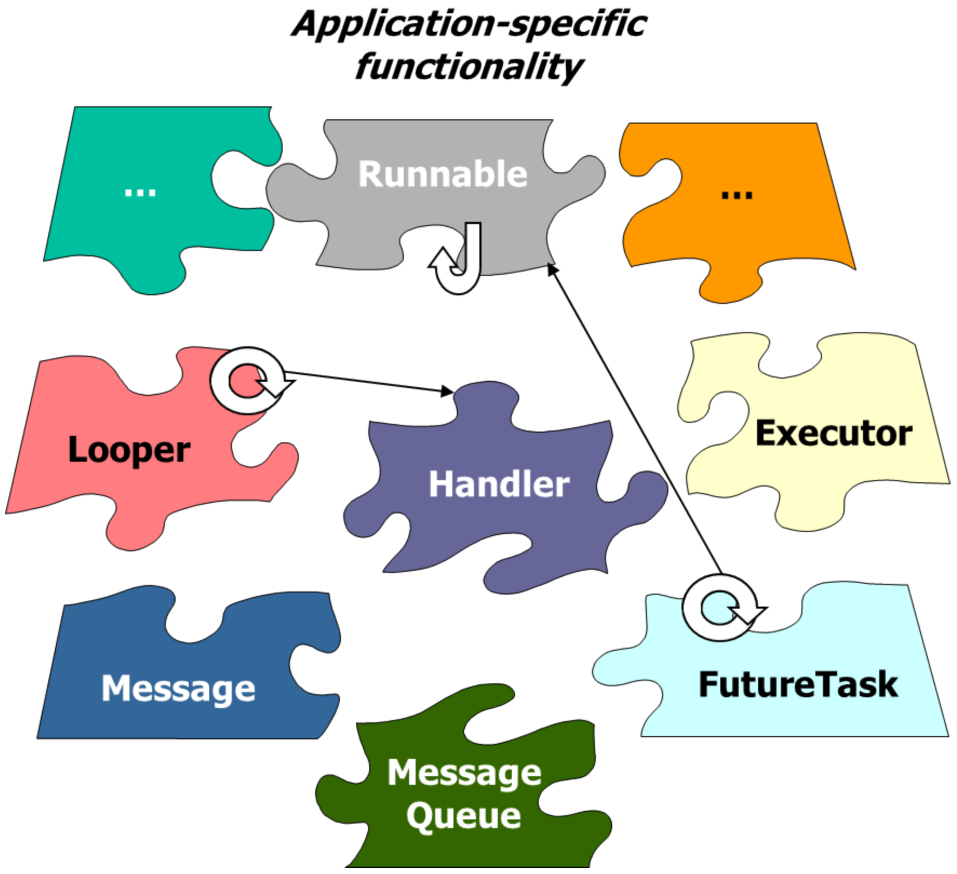
A different use of the *Observer* pattern in Android

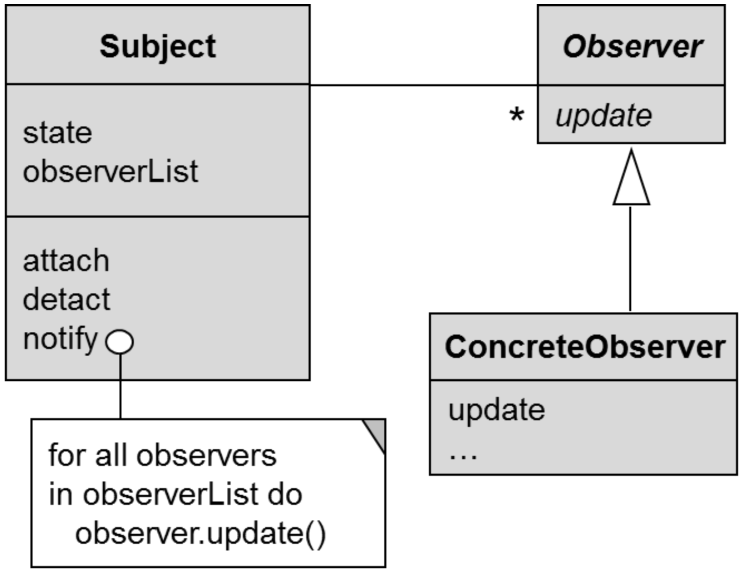
These *Observer* implementations also demonstrate framework characteristics

Summary

Summary

- Patterns & frameworks enhance *systematic reuse* of software





The *Observer* pattern

Summary

- Patterns & frameworks enhance *systematic reuse* of software
  - Create or acquire reusable assets & then consistently use & evolve them

martin.griss.com/pubs/fusion1.htm has more on systematic reuse

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- Patterns & frameworks enhance *systematic reuse* of software
- In contrast to opportunistic reuse, which involves "cutting & pasting"

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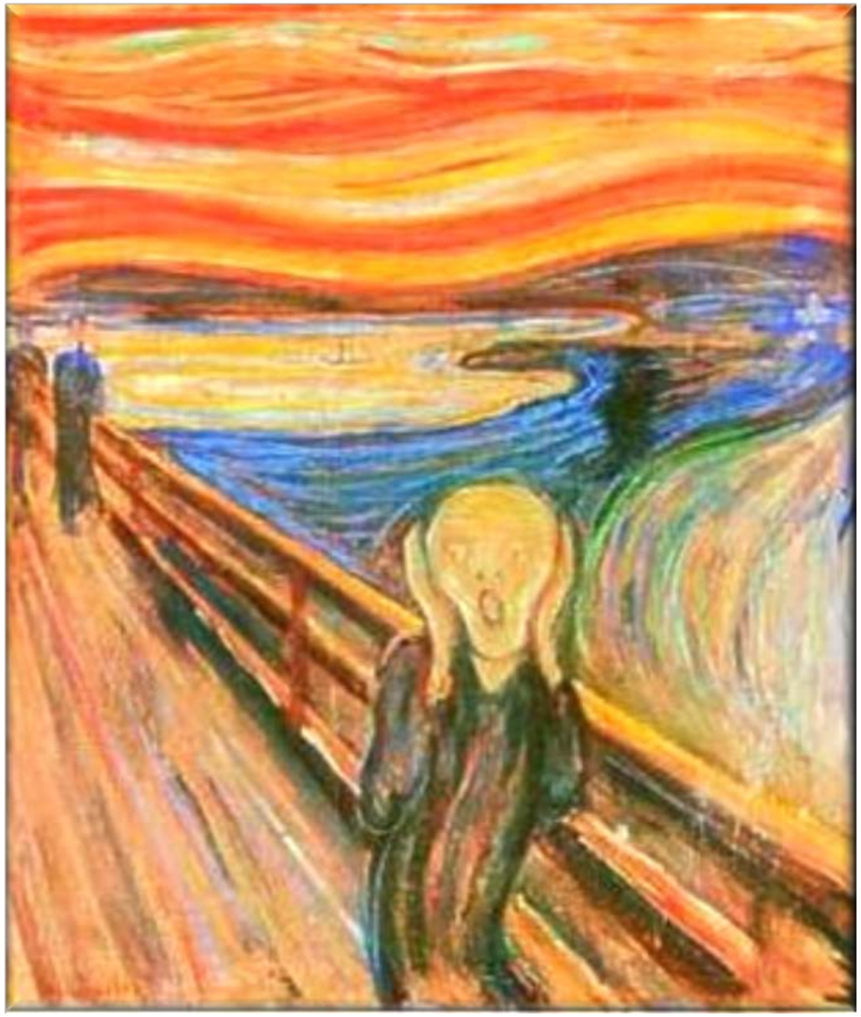
- In contrast to opportunistic reuse, which involves "cutting & pasting"
  - Yields many code forks that are hard to evolve & sustain over time



www.peachpit.com/articles/article.aspx?p=29753&seqNum=4 has more

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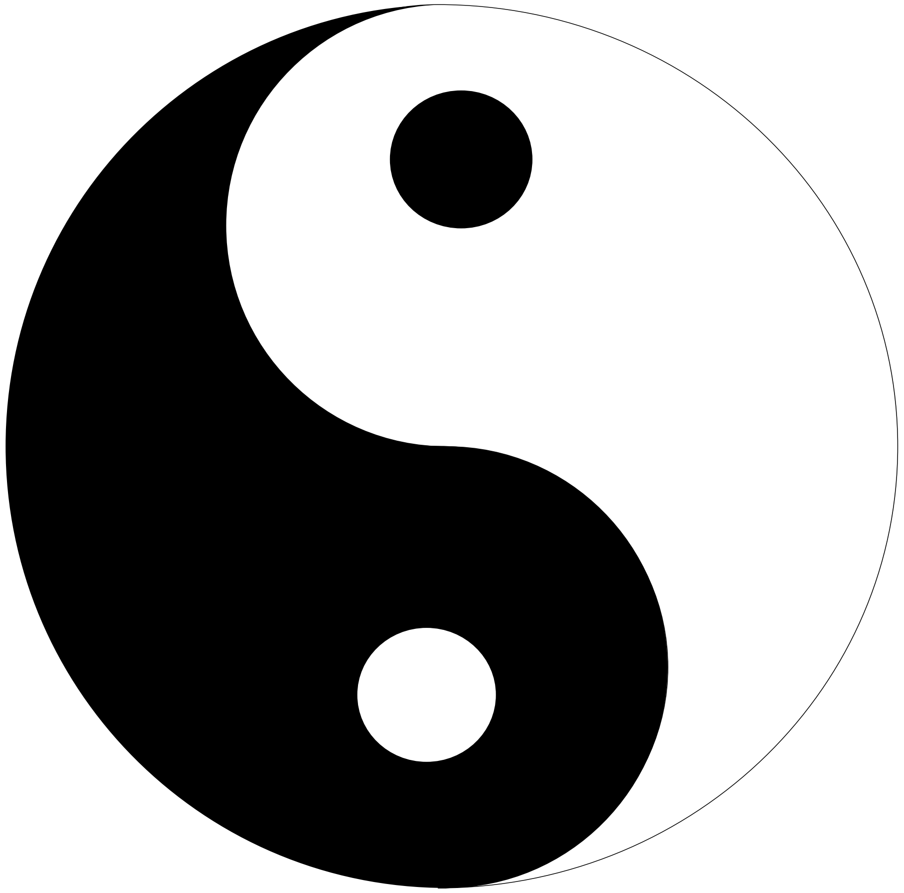

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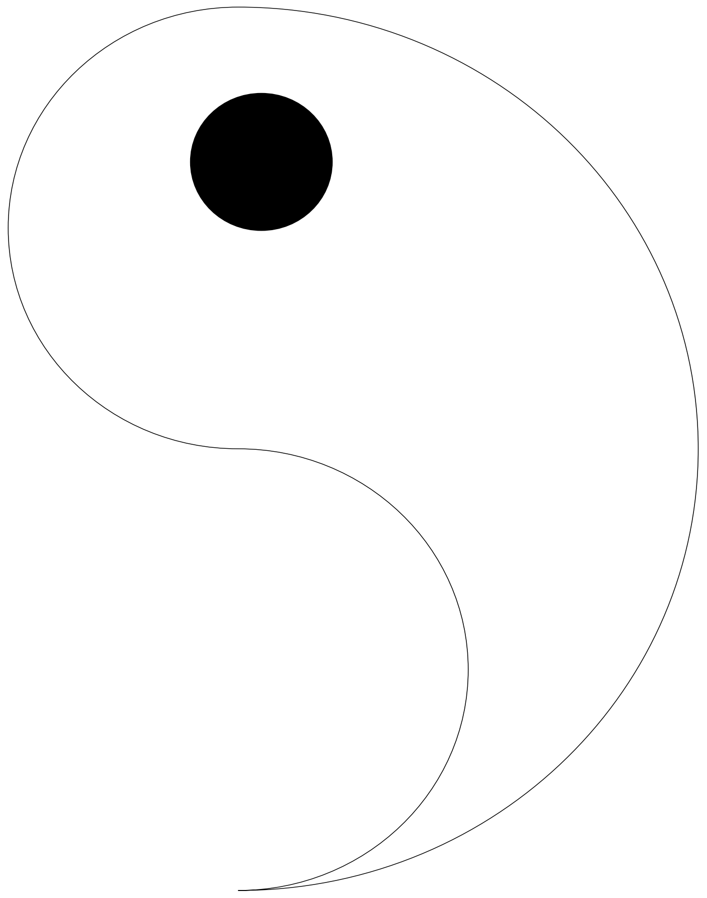

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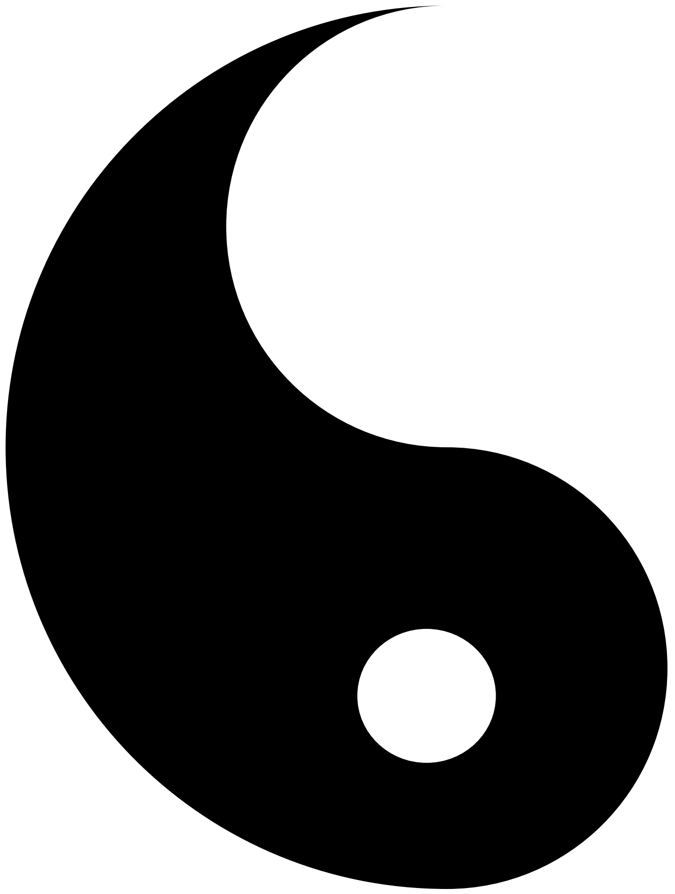
  - **Code reuse** – Reify proven designs within particular development environments & domains



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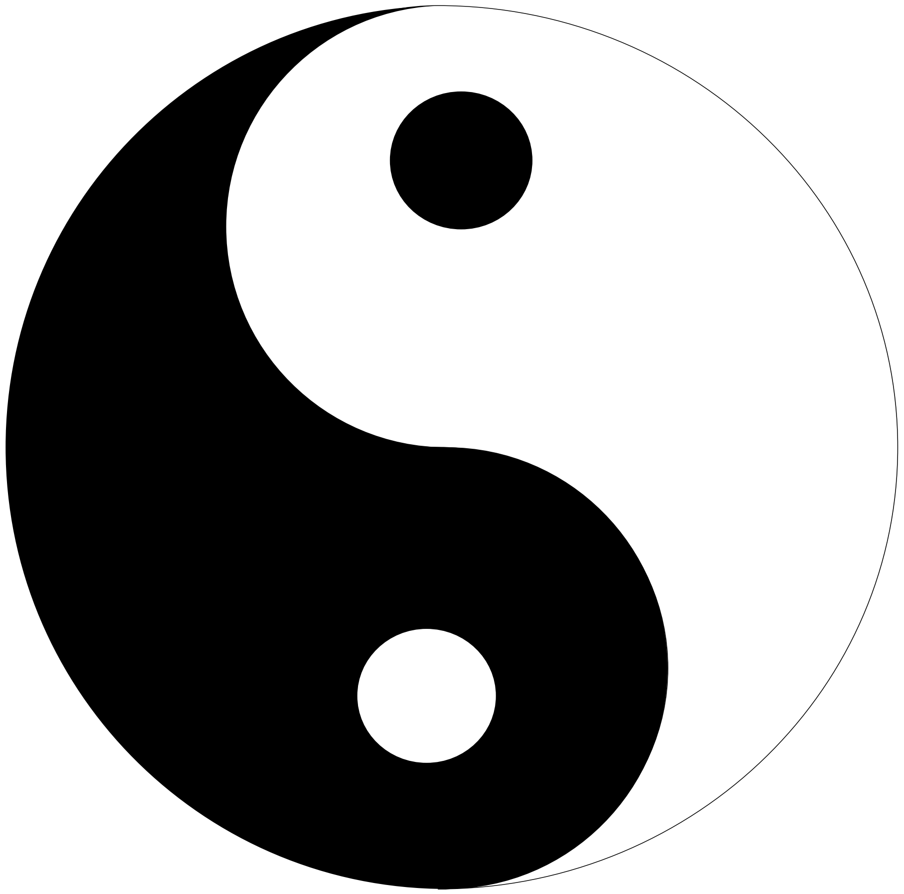

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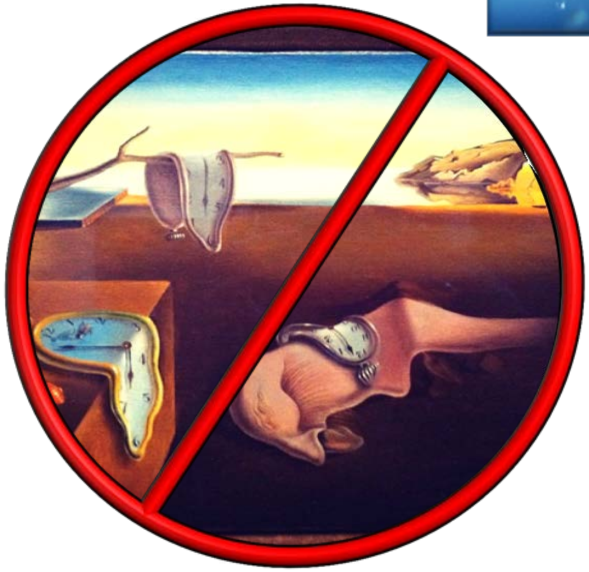

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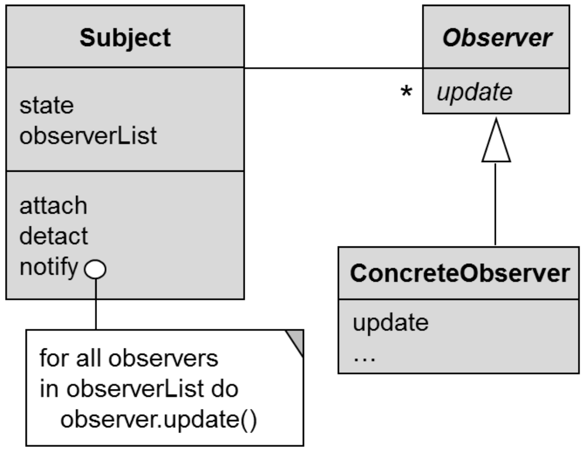
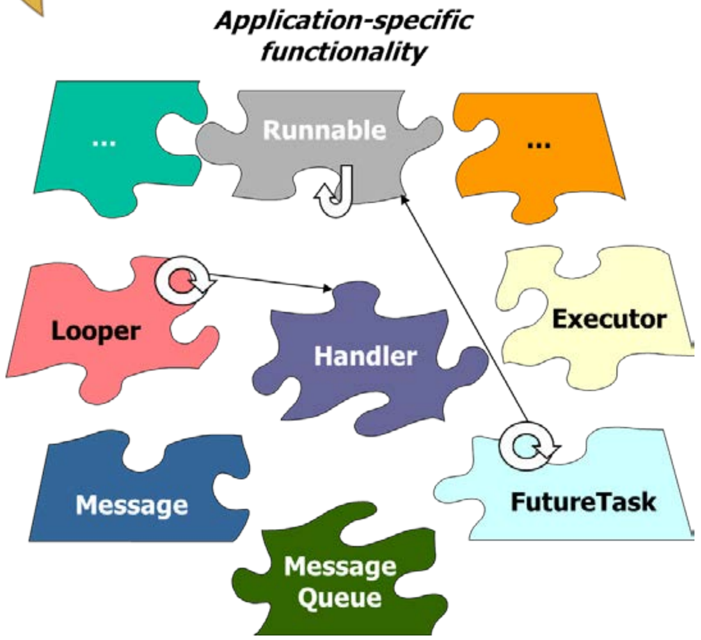
  - Improves quality over the lifecycle





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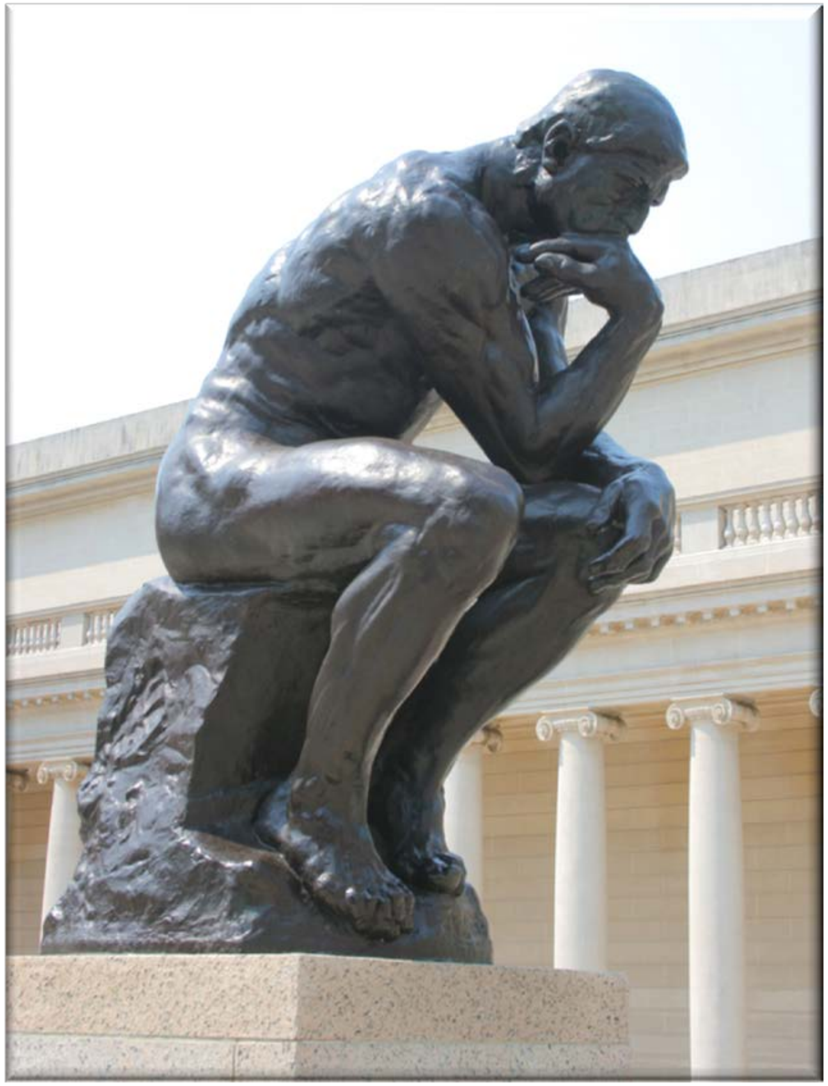

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Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides
Foreword by Grady Booch
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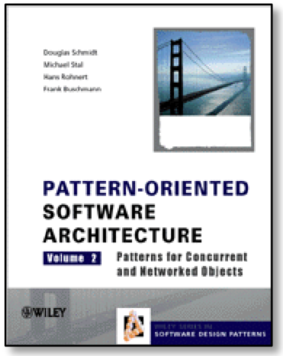
Douglas Schmidt
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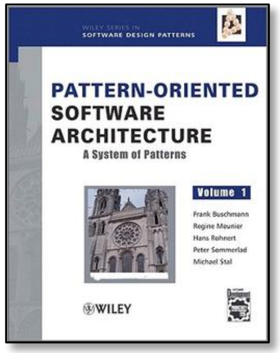

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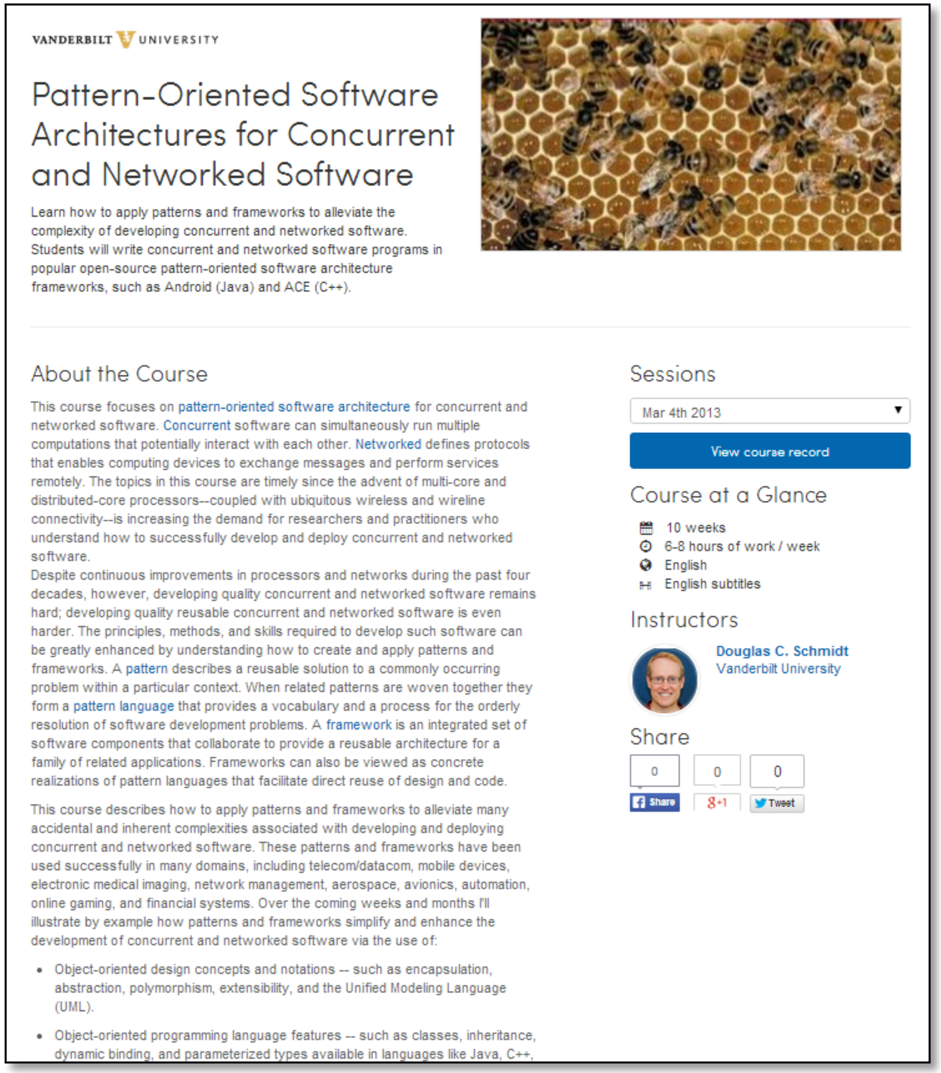

VANDERBILT UNIVERSITY

Pattern-Oriented Software Architectures for Concurrent and Networked Software

Learn how to apply patterns and frameworks to alleviate the complexity of developing concurrent and networked software. Students will write concurrent and networked software programs in popular open-source pattern-oriented software architecture frameworks, such as Android (Java) and ACE (C++).

About the Course

This course focuses on pattern-oriented software architecture for concurrent and networked software. Concurrent software can simultaneously run multiple computations that potentially interact with each other. Networked defines protocols that enables computing devices to exchange messages and perform services remotely. The topics in this course are timely since the advent of multi-core and distributed-core processors--coupled with ubiquitous wireless and wireline connectivity--is increasing the demand for researchers and practitioners who understand how to successfully develop and deploy concurrent and networked software.
Despite continuous improvements in processors and networks during the past four decades, however, developing quality concurrent and networked software remains hard; developing quality reusable concurrent and networked software is even harder. The principles, methods, and skills required to develop such software can be greatly enhanced by understanding how to create and apply patterns and frameworks. A pattern describes a reusable solution to a commonly occurring problem within a particular context. When related patterns are woven together they form a pattern language that provides a vocabulary and a process for the orderly resolution of software development problems. A framework is an integrated set of software components that collaborate to provide a reusable architecture for a family of related applications. Frameworks can also be viewed as concrete realizations of pattern languages that facilitate direct reuse of design and code.

This course describes how to apply patterns and frameworks to alleviate many accidental and inherent complexities associated with developing and deploying concurrent and networked software. These patterns and frameworks have been used successfully in many domains, including telecom/datacom, mobile devices, electronic medical imaging, network management, aerospace, avionics, automation, online gaming, and financial systems. Over the coming weeks and months I'll illustrate by example how patterns and frameworks simplify and enhance the development of concurrent and networked software via the use of:

- Object-oriented design concepts and notations -- such as encapsulation, abstraction, polymorphism, extensibility, and the Unified Modeling Language (UML).
- Object-oriented programming language features -- such as classes, inheritance, dynamic binding, and parameterized types available in languages like Java, C++,

Sessions

Mar 4th 2013 ▾

View course record

Course at a Glance

- 10 weeks
- 6-8 hours of work / week
- English
- English subtitles

Instructors

Douglas C. Schmidt
Vanderbilt University

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See item #22 at class.coursera.org/posa-002/wiki/FrequentlyAskedQuestions

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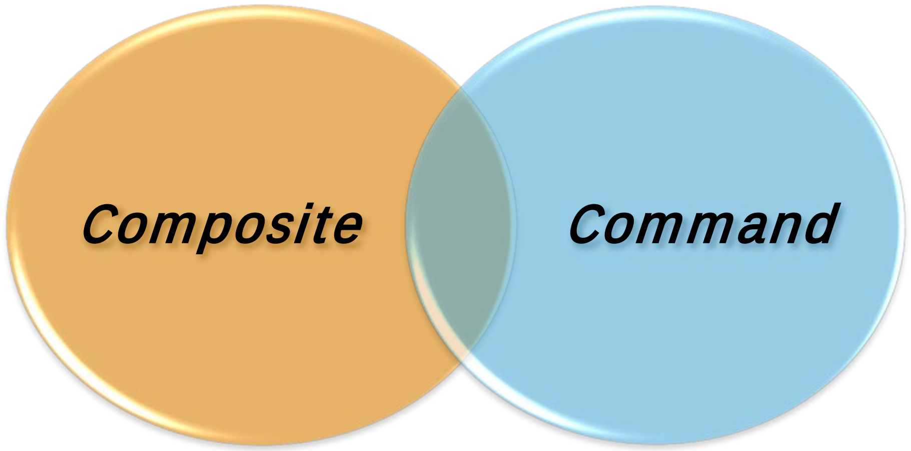

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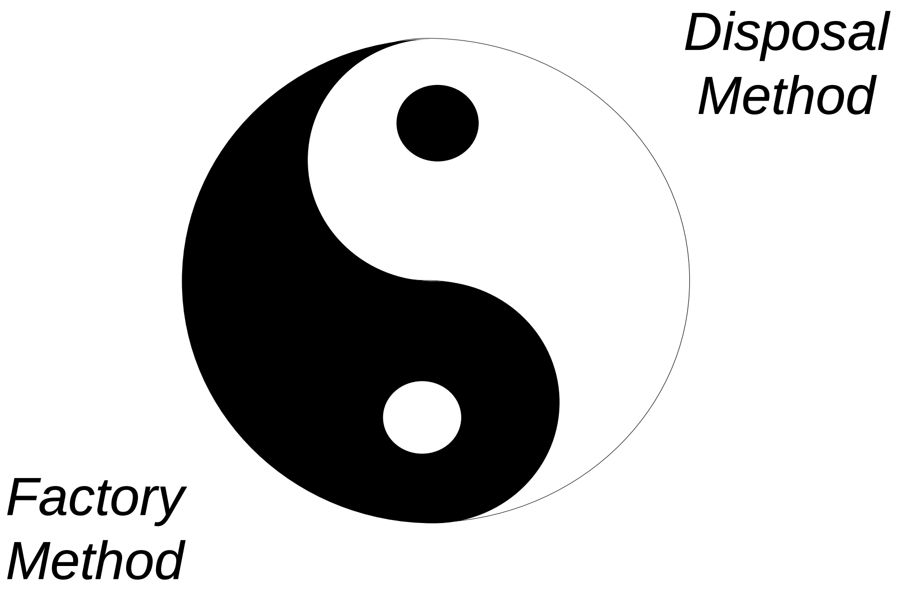

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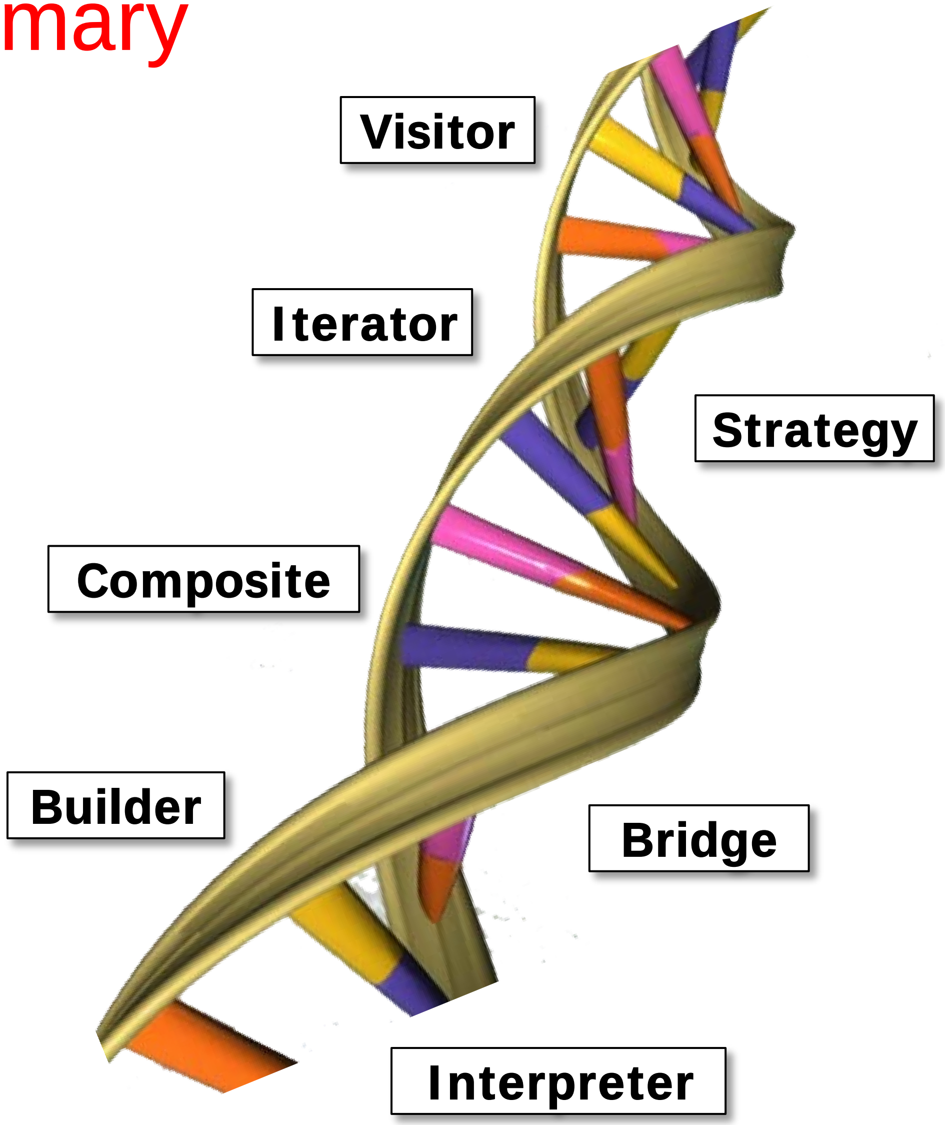

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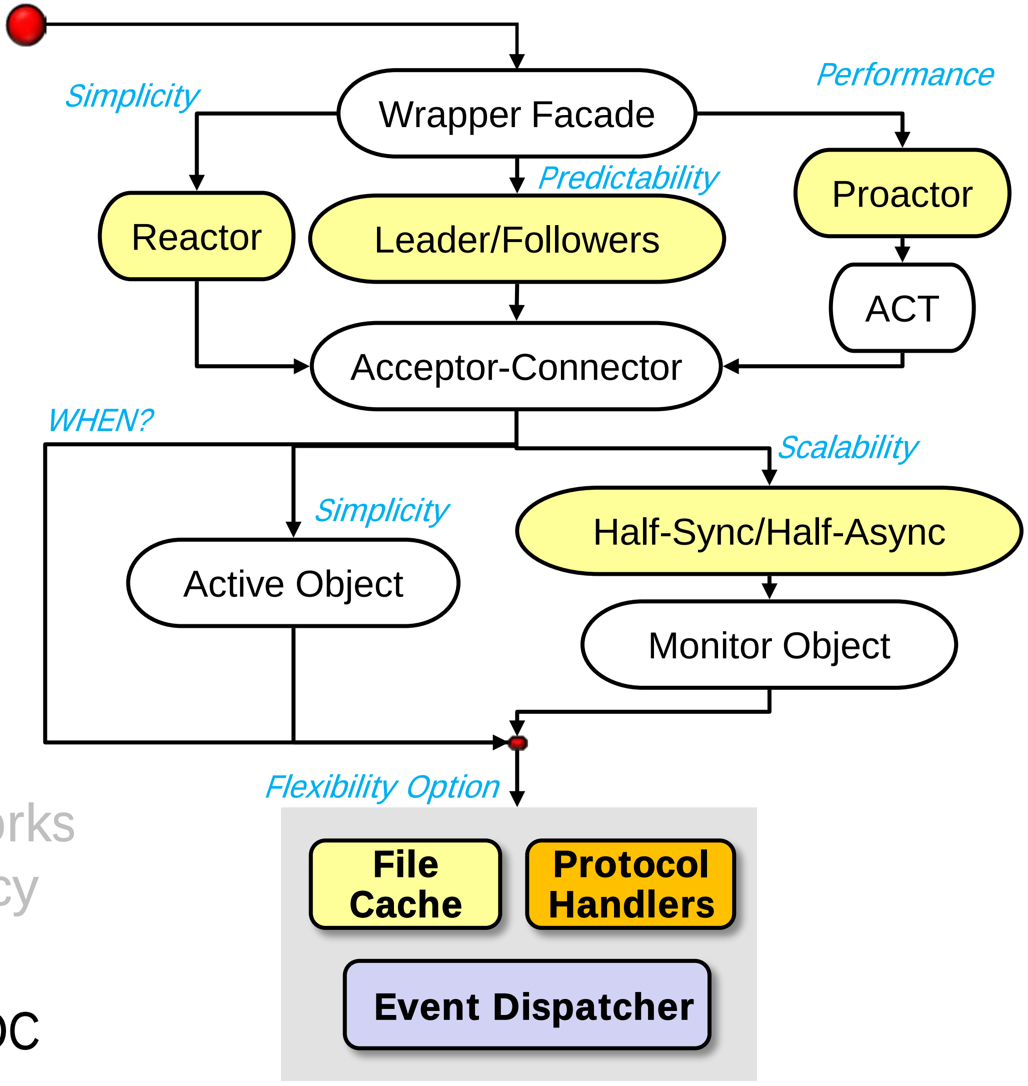

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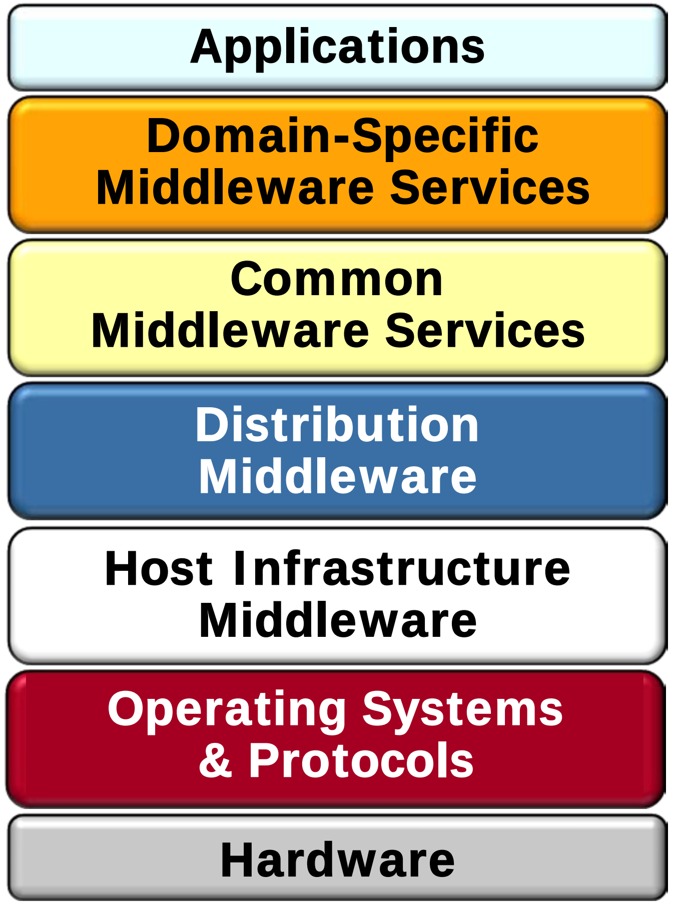
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Domain-Specific Middleware Services
Common Middleware Services
Distribution Middleware
Host Infrastructure Middleware
Operating Systems & Protocols
Hardware