Dept. of Computer Science, The University of Texas, Dallas

Patterns

- What are Patterns?
- Software Patterns
- Design Patterns
- Architectural Patterns
- J2EE
- Patterns: Still Evolving ...

What are Patterns?

"Each pattern describes
a problem which occurs over and over again
in our environment,

and then describes

the core of the solution to that problem,
in such a way that you can use this solution
a million times over,
without ever doing it the same way twice."

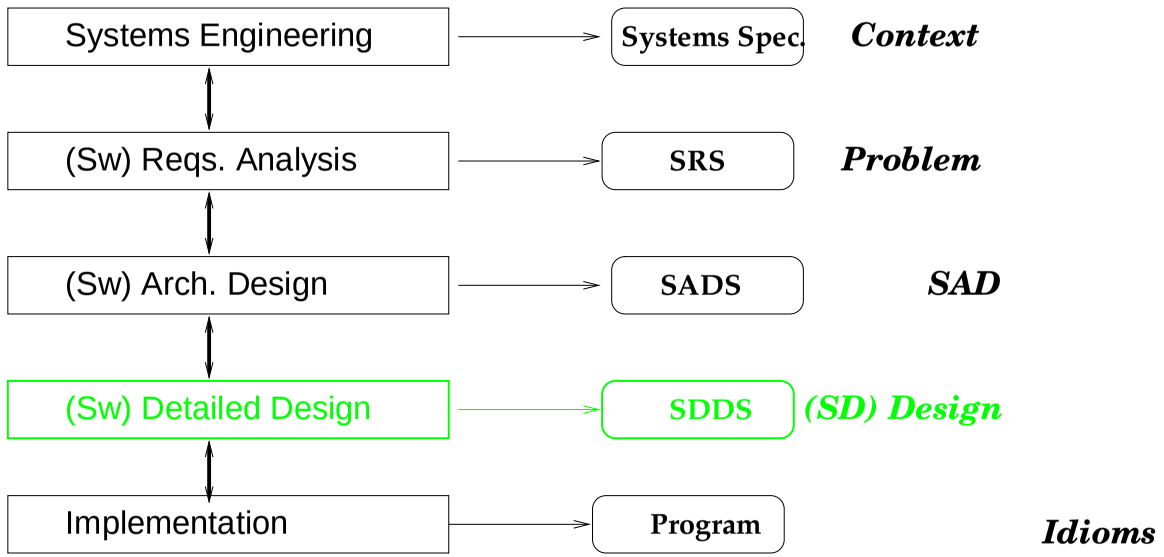
Christopher Alexander

Software Patterns

A Dictionary Definition

A discernible coherent system based on the intended interrelationships of component parts *[Webster Collegiate]*

Kinds of Software Patterns



Design Patterns

- **A key source**
  - Elements of Reusable Object-Oriented Software
    [Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides] (GoF)
  - A catalogue of 23 design patterns

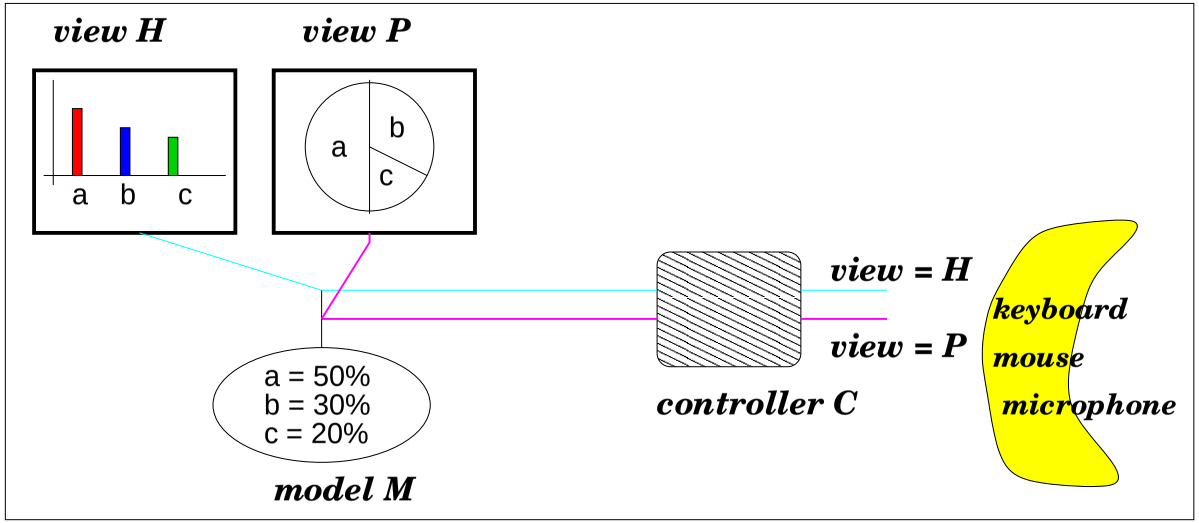
- **Four essential elements**

  Name, Problem, Solution, Consequences

- **Categories of design patterns**
  - ***By purpose (what does a pattern do?)***
    - Creational: concerns the process of object creatrion
    - Structural: concerns the composition of classes or objects
    - Behavioral: concerns the ways in which classes or objects interact and distribute responsibility (e.g., algorithms and flow of contrl)
  - ***By scope (Is the pattern for classes or instances?)***

Design Patterns: An Example

- **MVC (Model-View-Controller) classes for UI (in Smalltalk-80)**
  - Model: application object
  - View: screen presentation
  - Controller: the way the UI reacts to user input



- ***Advantages***
  - decoupling of views from models

    applicable to a more general problem: decoupling objects so that changes to one can affect any number of others without requiring the changed object to know details of the others ***= Observer***

OBSERVER — Object Behavioral

Intent

Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically.

Also Known As

Dependents, Publish-Subscribe

Motivation

... You don't want to achieve consistency by making the classes tightly coupled, because that reduces their reusability ...

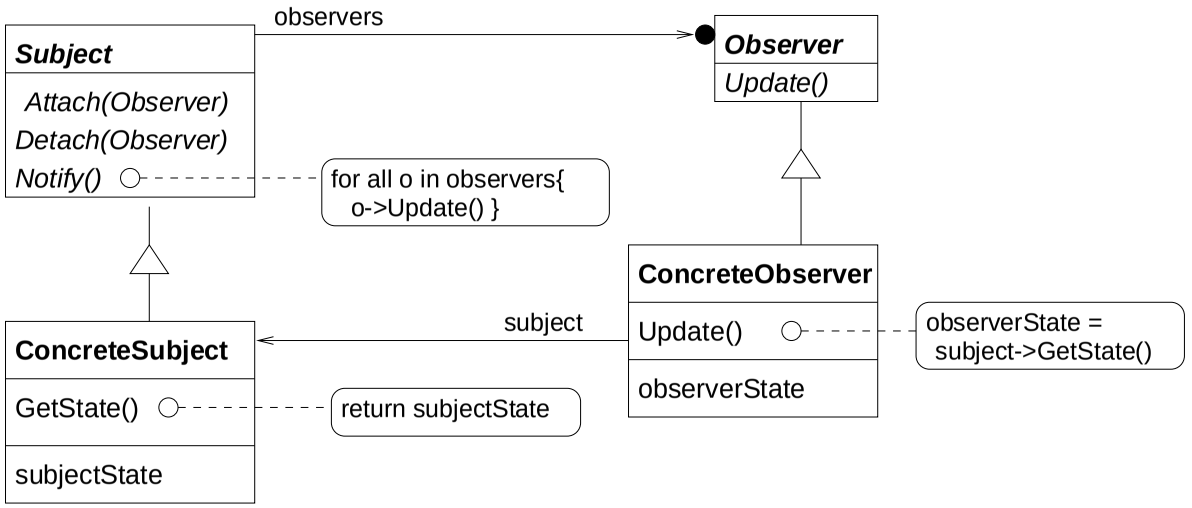
Applicability

Use the Observer pattern in any of the following situations:

- When an abstraction has two aspects, one dependent on the other .... lets you vary and reuse them independently
- When a change to one object requires changing others, and you don't know how many objects need to be changed
- When an object should be able to notify other objects without making assumptions about who these objects are

OBSERVER — Object Behavioral

Structure



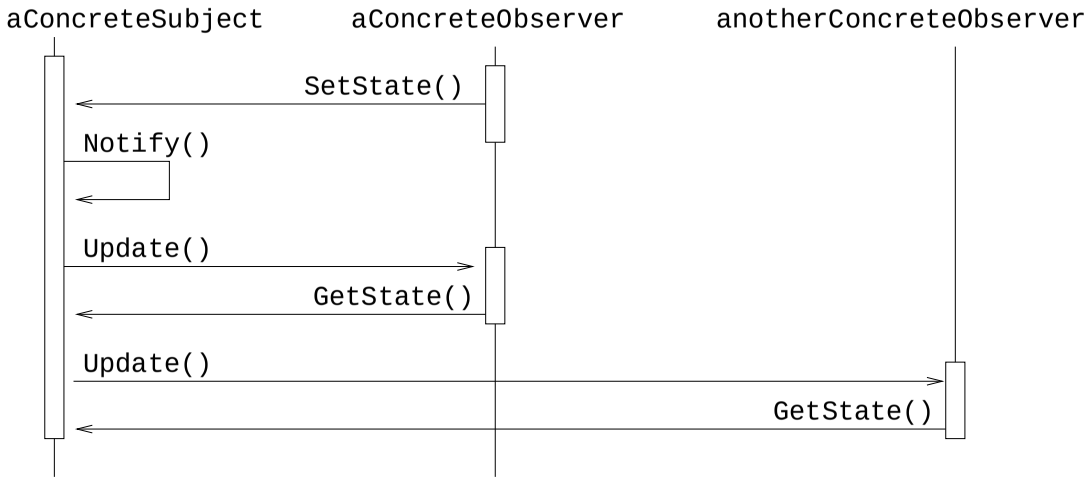
Participants

- Subject: knows its observers. Any number of Observer objects may observe a subject
  provides an interface for attaching and detaching Obsever objects
- Observer: defines an updating interface for objects to be notified of changes in a subject
- ConcreteSubject: stores state of interest to ConcreteObserver objects;
  sends a notification to its observers when its state changes
- ConcreteObserver: maintains a reference to a ConcreteSubject object;
  stores state that should stay consistent with the subject's
  implements Observer updating interface to keep its state consistent w subject's

OBSERVER — Object Behavioral

Collaborations

... The following interaction diagram illustrates the collaborations betw a subject & two observers:



Consequences

- Abstract coupling betw Subject & Observer: All a subject knows is that it has a list of observers.
- Support for broadcast communicaiton
- Upexpected updates: one subject operation may cause a cascade of updates to observers & their dependent objects

Implementation

Mapping subjects to their observers; Observing more than one subject;
Who triggers the update?; Dangling references to deleted subjects; ...

Design Patterns: An Example

MVC (Model-View-Controller) classes for UI (in Smalltalk-80)

- Model: application object
- View: screen presentation
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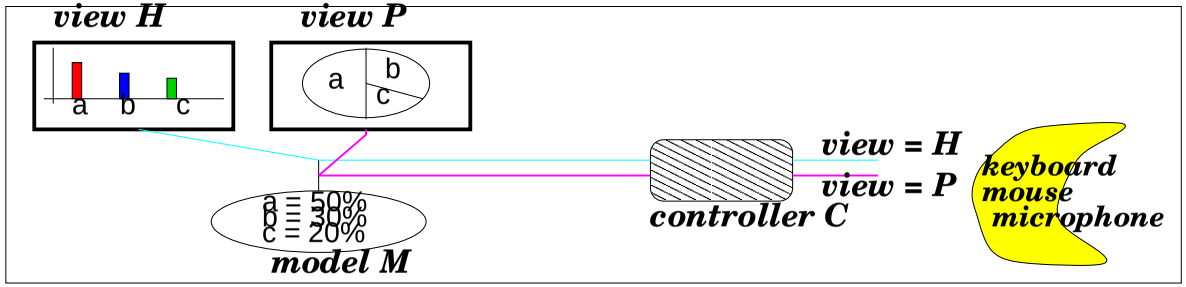


Advantages

- decoupling of views from models
  applicable to a more general problem: decoupling objects so that changes to one can affect any number of others without requiring the changed object to know details of the others *= Observer*

- nesting of views (control panel of buttons of buttons of ...)
  applicable to a more general problem: group objects & treat the group like an individual object *= Composite*

- Controller for changing the way a view responds to user input without changing the visual rep.
  applicable to a more general problem: replace an algorithm statically or dynamically *= Strategy*

- specify a default class (for controller) *= Factory Method*
  add scrolling to a view *= Decorator*

Composite — Object Structural

Intent

Compose objects into tree structures to represent part-whole hierarchies. Composite lets clients treat individual objects and compositions of objects uniformly.

Motivation

... Graphic applications like drawing editors and schematic capture systems let users build complex diagrams out of simple components. The user can group components to form larger components, which in turn can be grouped to form still larger components ...

Applicability

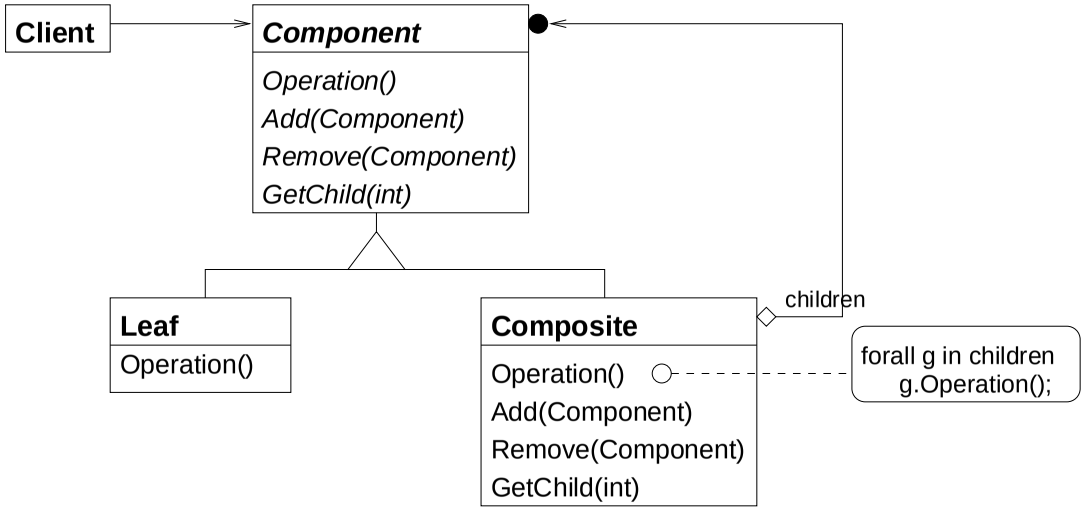
Use the Composite pattern when

- you want to represent part-whole hierarchies of objects
- you want to clients to be able to ignore the difference between compositions of objects and indificual objects. Clients will treat all objects in the composite structure uniformly.

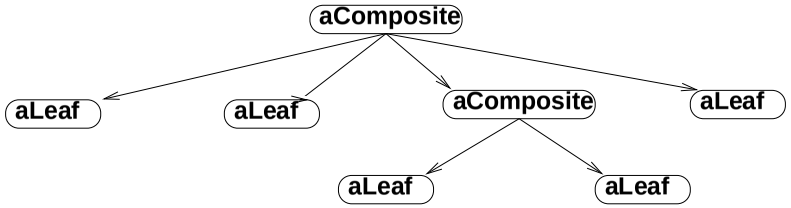
Composite — Object Structural

Structure

Compose objects into tree structures to represent part-whole hierarchies.
Composite lets clients treat individual objects and compositions of objects uniformly.



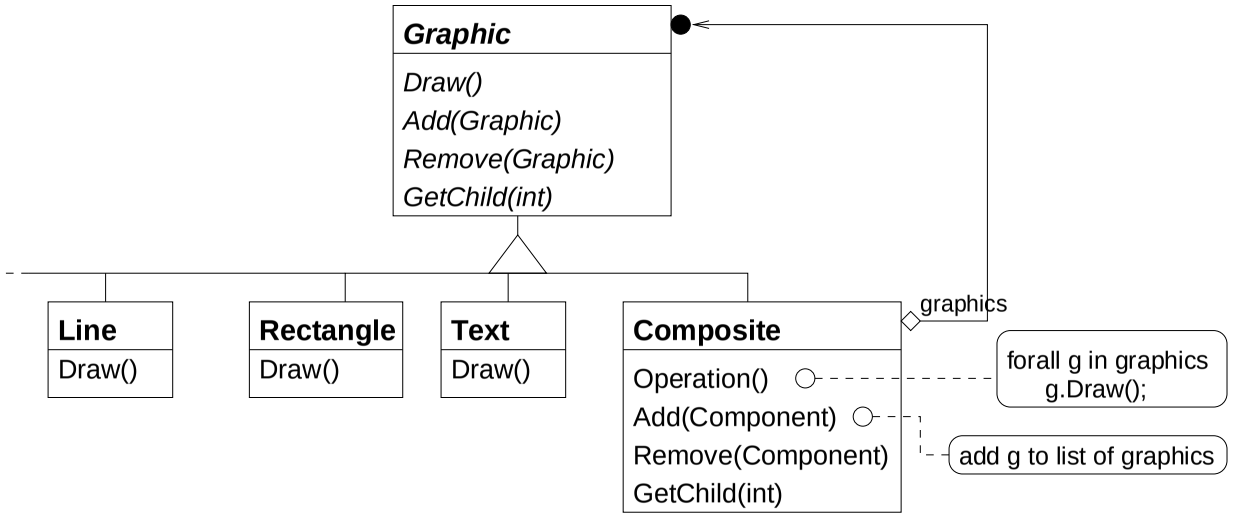
A typical Composite object structure might look like this:



Composite

Object Structural

Motivation (continued)



STRATEGY Object Behavioral

Intent

Define a family of algorithms, encapsulate each one, and make them interchangeable. Strategy lets the algorithm vary independently from clients that use it.

Also Known As

Policy

Motivation

Many algorithms exist for breaking a stream of text into lines. Hard-writing all such into the classes that require them isn't desirable for several reasons:

- Inclusion of the linebreaking code in the client makes it more complex bigger and harder to maintain, esp. if to support multiple linebreaking algorithms
- Differnt algorithms will be appropriate at different times
- difficult to add new algorithms and vary existing ones when linebreaking is an integral part of the client

Applicability

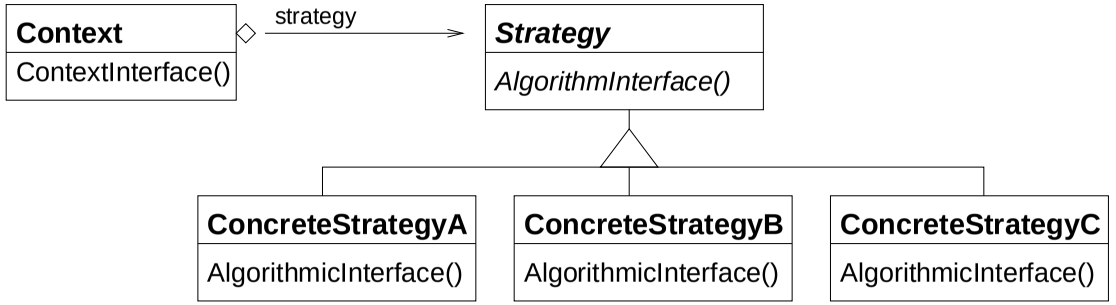
Use the Strategy pattern when

- many related classes differ only in their behavior
- need different variants of an algorithm, implemented as a class hierarchy
- an algorithm uses data that the client shouldn't know about

Strategy

Object Behavioral

Structure



Participants

Strategy (Compositor)

declares an interface common to all supported algorithms.
Context uses this interfce to call the algorithm defined by a ConcreteStrategy

ConcreteStrategy (SimpleCompositor, TeXCompositor, ArrayCompositor)

implements the algorithm using the Strategy interface

Context (Composition)

configured with a ConcreteStrategy

maintains a referece to a Strategy object

may define an interface that lets Strategy access its data

Design Pattern Space

		Purpose		
		Creational	**Structural**	**Behavioral**
Scope	**Class**	Factory Method	Adapter (class)	Interpreter Template Method
	Object	Abstract Factory Builder Prototype Singleton	Adapter (object) Bridge Composite Decorator Facade Flyweight Proxy	Chain of Responsibility Command Iterator Mediator Memento Observer State Strategy Visitor

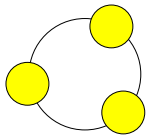
Architectural Patterns

- **Recall:**

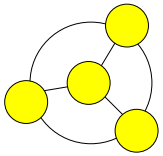
  A = <Com, I, Con, P, S, R>

- **Pattern Matching in IQ Test**

  - choose the closest match to



A.



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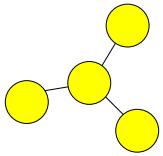

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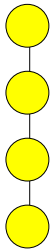

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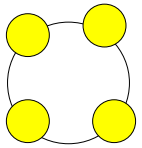


- **Topological View of Architectural Patterns**

  P (A) = <Com, I>

- **Modeling View of Architectural Patterns**

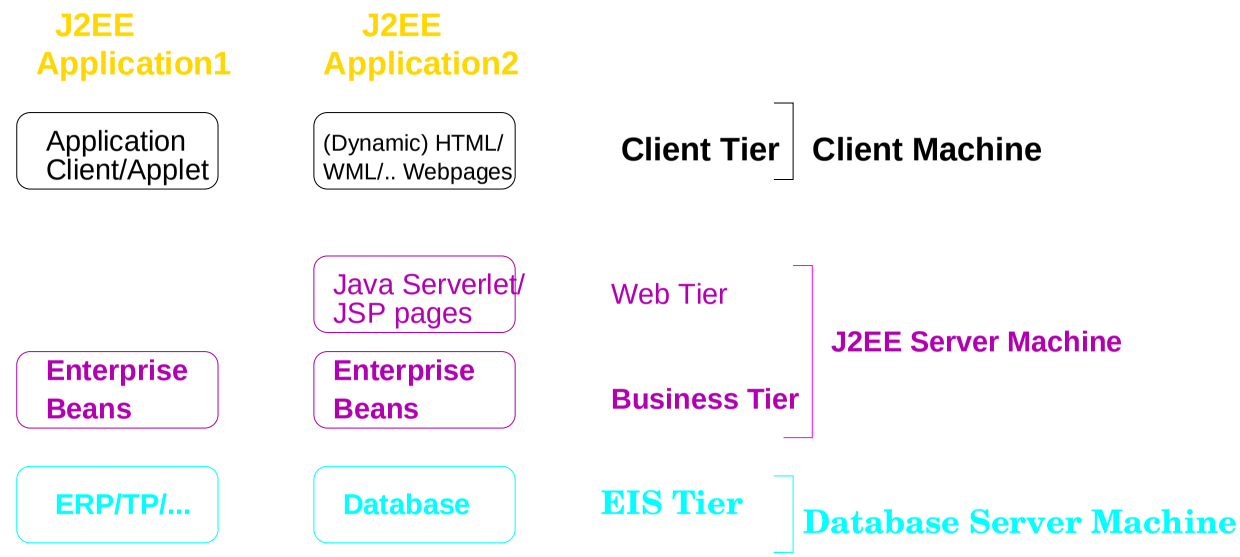
  P (A) = <Com, I, Con, S, R>

J2EE

Java 2 Platform Enterprise Edition

- **Vision**
  - an open standard
  - anything Java-related
  - for implementing and deploying component-based enterprise applications
- **Commerical platforms**
  - WebLogic (BEA Systems)
  - WebSphere (IBM)
  - iPlanet (Sun & NetScape)
  - JBoss (open source)
- **Reference application**
  - Pet Store
- **Services**
  - EJB components
  - JDBC API
  - CORBA technology
  - Java Servlets API
  - XML technology

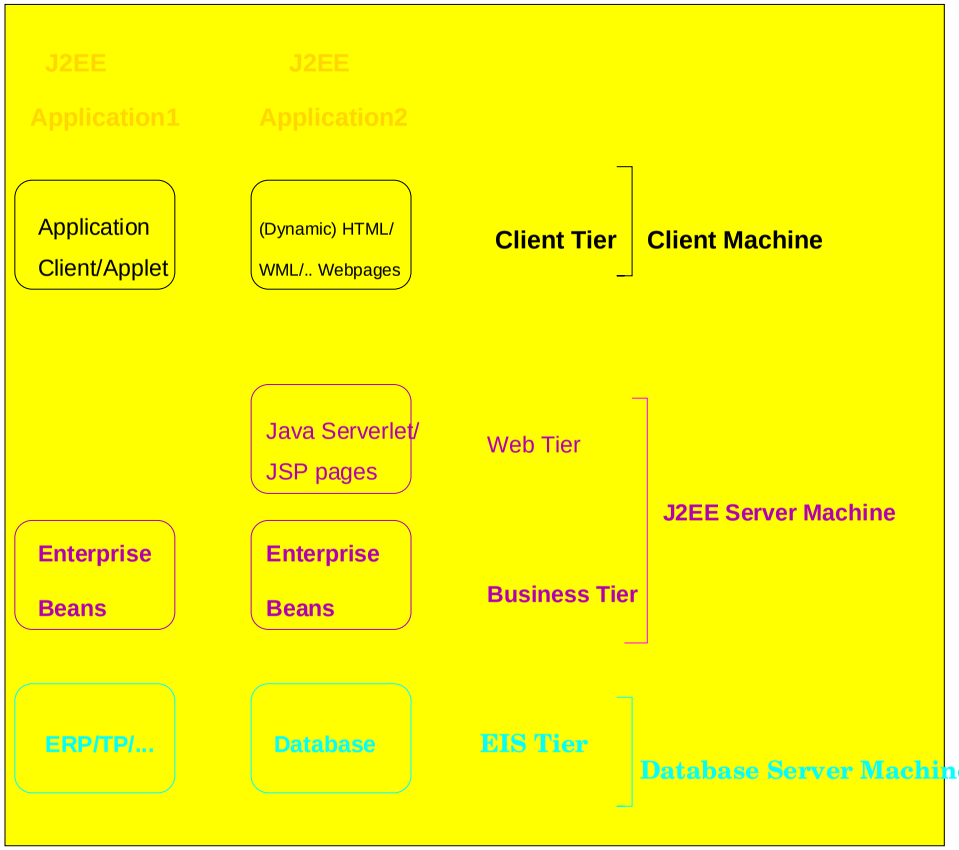
J2EE Distributed Multitiered Applications



EJB: server-side component containing the business logic of an application.
The application clients invoke their methods

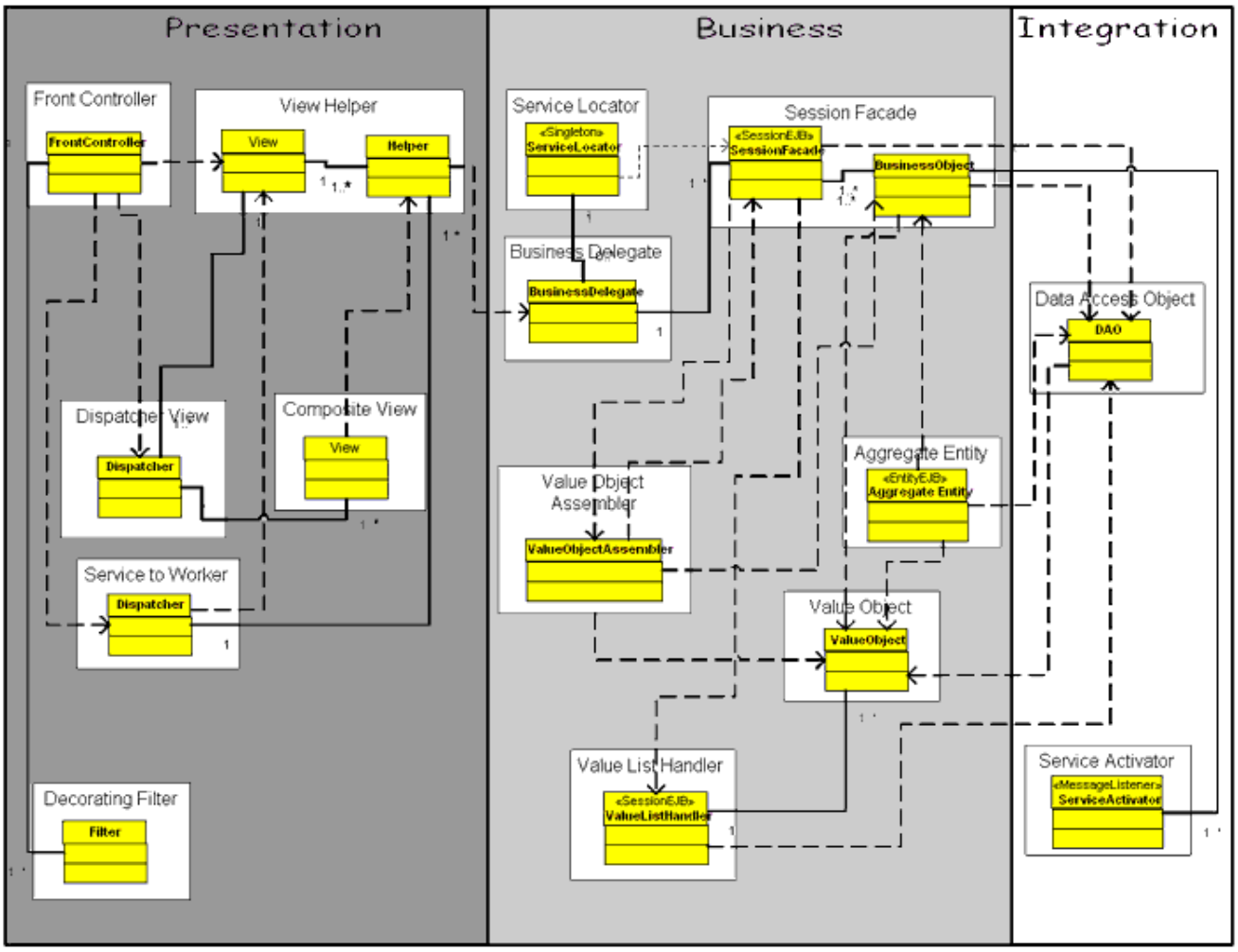
http://java.sun.com/j2ee/tutorial/1_3-fcs/doc/Overview2.html#68378

J2EE 5-Tier Model & Design Patterns

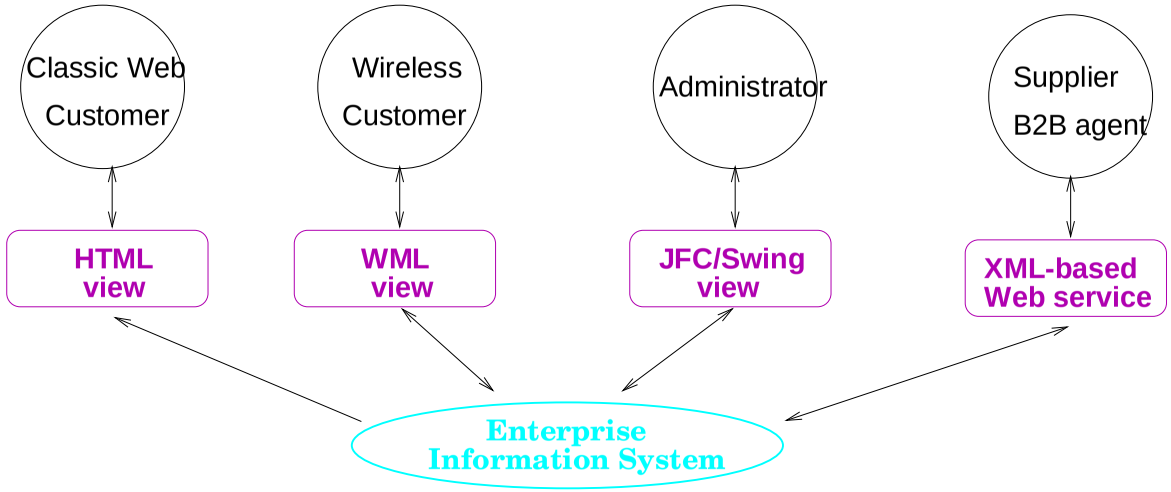


* JMS = Java Message Service API; * JDBC = Java Database Connectivity API;

http://java.sun.com/features/2001/03/patterns.html


Presentation
Business
Integration
Front Controller
FrontController
View Helper
View
Helper
Service Locator
«Singleton»
ServiceLocator
Session Facade
«SessionEJB»
SessionFacade
BusinessObject
Business Delegate
BusinessDelegate
Data Access Object
DAO
Dispatcher View
Dispatcher
Composite View
View
Aggregate Entity
«EntityEJB»
Aggregate Entity
Value Object Assembler
ValueObjectAssembler
Service to Worker
Dispatcher
Value Object
ValueObject
Value List Handler
«SessionEJB»
ValueListHandler
Service Activator
«MessageListener»
ServiceActivator
Decorating Filter
Filter

J2EE Design Patterns



The problem: Supporting Multiple Enterprise Clients → *A Solution: Model-View-Controller Architecture*

Design Patterns Catalog

Pattern	Intent
Data Access Object	
Fast-Lane Reader	Accelerate read-only data by not using enterprise beans
Front Controller	
Page-by-Page Iterator	
Session Facade	Provide a unified, workflow-oriented interface to a set of enterprise beans
Value Object	

http://java.sun.com/j2ee/blueprints/design_patterns/catalog.html

Patterns: Still Evolving ...

- **Architectural Patterns:**
  - **Not about detailed design:**
    cf. the Strategy design pattern for algorithms
- **Anti-Patterns:**
  - Those that describe a bad solution to a problem which resulted in a bad situation.
  - Those that describe how to get out of a bad situation and how to proceed from there to a good solution
- **Problem Patterns:**

  organizational/enterprise, business rules/logic, agent interaction, goal interaction
  task, resource usage
  structural (entity, activity, constraints), behavioral, nfr
- **OO Software Framework [GoF]:**

  a set of cooperating classes that make up a reusable design for a specific class of software
- **Pattern Mining:**
- **QWAN (Quality Without A Name) [Alexander]:**

  universally recognizable aesthetic beauty and order;
  recursively nested centers of symmetry and balance
  life and wholeness; resilience, adaptability, and durability
  human comfort and satisfaction; emotional and cognitive resonance