CSCI 253

Object Oriented Design:
Flyweight Pattern
George Blankenship

Overview

Creational Patterns
- Singleton
- Abstract factory
- Factory Method
- Prototype
- Builder

Structural Patterns
- Composite
- Façade
- Proxy
- Flyweight
- Adapter
- Bridge
- Decorator

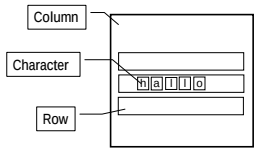
Behavioral Patterns
- Chain of Respons.
- Command
- Interpreter
- Iterator
- Mediator
- Memento
- Observer
- State
- Strategy
- Template Method
- Visitor

The Elements of a Design Pattern

- A pattern name
- The problem that the pattern solves
  - Including conditions for the pattern to be applicable
- The solution to the problem brought by the pattern
  - The elements (classes-objects) involved, their roles, responsibilities, relationships and collaborations
  - Not a particular concrete design or implementation
- The consequences of applying the pattern
  - Time and space trade off
  - Language and implementation issues
  - Effects on flexibility, extensibility, portability

The Flyweight Pattern: The Problem

Some applications benefit from using objects in their design but a naïve implementation is prohibitively expensive because of the large number of objects



- use an object for each character in a text document editor
- use a layout object for each widget in a GUI

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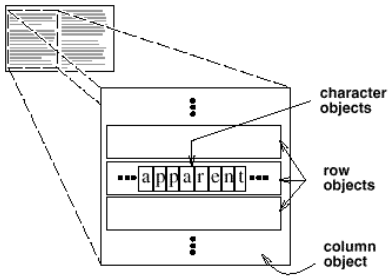
Page Objects



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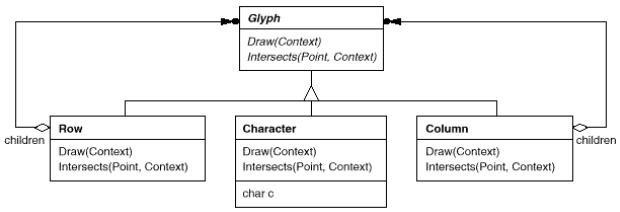
Page Classes



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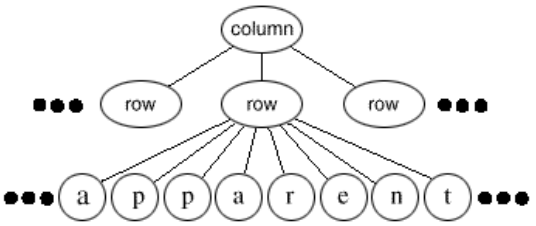
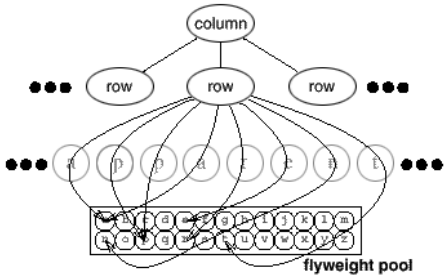
Object Hierarchy



Flyweight Objects



Java String

- Java Strings are flyweighted by the compiler wherever possible
- Can be flyweighted at runtime with the `intern` method

```
public class StringTest {
  public static void main(String[] args) {
    String fly  = "fly", weight  = "weight";
    String fly2 = "fly", weight2 = "weight";

    System.out.println(fly == fly2);                  // true
    System.out.println(weight == weight2);            // true

    String distinctString = fly + weight;
    System.out.println(distinctString == "flyweight"); // false

    String flyweight = (fly + weight).intern();
    System.out.println(flyweight == "flyweight");     // true
  }
}
```

StateVariable

```
public class StateVariable extends ListEntry {
public StateVariable(Trace t, StateMachine f, String s, StateVariable r, long ms) {
public StateMachine getFSM() {return fsm;}
public int getIndex() {return index;}
public String getDescription() {return description;}
public void setTime(long t) {time = t;}      // set start time of state
public long getTime() {return time;}         // fetch start time of state
public long getNormalTimeout() {return normalTimeout;}// fetch normal timeout of state
public void setTimeout(long t) {timeout=t;}  // change the timeout for the state
public long getTimeout() {return timeout;}   // fetch the timeout for the state
public void setMissed(boolean b) {missed = b;}
public boolean wasMissed() {return missed;}  // state missed (timeout occurred)
public boolean setNextState(StateVariable s) {
public StateVariable getNextState() {
public String getShortSummary() {
public String getSummary() {
```

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The Flyweight Pattern Applicability

- Apply flyweight when ALL of the following are true:
  - An application uses a large number of objects
  - Storage cost is high because of the quantity of objects
  - Most objects can be made extrinsic
  - Many groups of objects can be replaced by relatively few shared objects once extrinsic state is removed
  - The application does not depend on object identity

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The Flyweight Pattern Participants

- Flyweight
  - Declares an interface through which flyweights can receive and act upon extrinsic state
- Concrete Flyweight
  - Implements the flyweight interface and adds storage for intrinsic state
  - A concrete flyweight object must be sharable, i.e. all state must be intrinsic
- Unshared Concrete Flyweight
  - Not all flyweights subclasses need to be shared, unshared concrete flyweight objects have concrete flyweight objects at some level in the flyweight object structure

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The Flyweight Pattern Participants

- Flyweight Factory
  - Creates and manages flyweight objects
  - Ensures that flyweights are shared properly; when a client requests a flyweight the flyweight factory supplies an existing one from the pool or creates one and adds it to the pool
- Client
  - Maintains a reference to flyweight(s)
  - Computes or stores the extrinsic state of flyweight(s)

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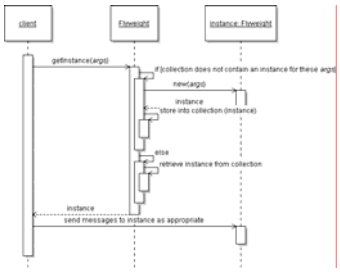
Sequence Diagram



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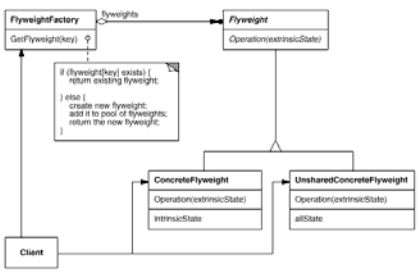
FlyweightFactory



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The Flyweight Pattern Collaborations

- State that a flyweight needs to function must be characterised as either intrinsic or extrinsic. Intrinsic state is stored in the concrete flyweight object.; extrinsic state is stored or computed by client objects. Clients pass this state to the flyweight when invoking operations.
- Clients should not instantiate concrete flyweights directly. Clients must obtain concrete flyweight objects exclusively from the flyweight factory object to enshure that they are shared properly

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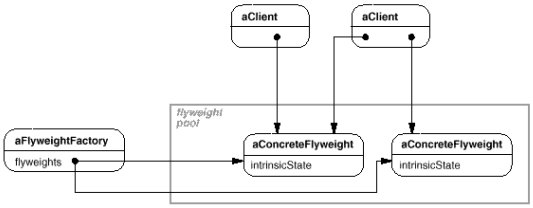
FlyweightFactory Participants



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The Flyweight Pattern Consequences

- - Flyweights may introduce run-time costs associated with transferring, finding, and/or computing extrinsic state
- + The increase in run-time cost are offset by storage savings which increase
  - as more flyweights are shared
  - as the amount of intrinsic state is considerable
  - as the amount of extrinsic state is considerable but can be computed
- - The flyweight pattern is often combined with the composite pattern to build a graph with shared leaf nodes. Because of the sharing, leaf nodes cannot store their parent which has a major impact on how the objects in the hierarchy communicate

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The Flyweight Pattern Implementation

- Removing extrinsic state:
  - Identify extrinsic state and remove it from the shared objects
  - Removing extrinsic state will not help if there are as many different kinds of extrinsic state as there are objects before sharing
  - Ideally extrinsic state can be computed from a separate object structure with far smaller storage requirements
- Managing shared objects:
  - Use an associative store with the flyweight factory to let clients locate a particular flyweight
  - Some form of reference counting or garbage collection is needed to reclaim a flyweight's storage when it is no longer needed
  - When the number of flyweights is small and fixed, consider to initialise the pool and keep the flyweights around permanently

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