Design

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Few Things About Projects

• Remember that we take academic integrity very seriously. We have software tools that allow us to:
  • Compare all students projects (even across sections)
  • Changing variable names, and spacing is something our tools recognize
• You should try to submit your project often
  • Even though through CVS you can get previous project versions, using the submit server is easier
About JUnit Tests

• Remember: you need to bring StudentTest to office hours
• Study public tests so you understand what they are testing
• Expected results are in the actual tests or in text files that are part of your project
• You can add output statements so you can see the your program results

```java
public void testSumBasic() {
    /* test code goes here */
    output += result[result.length-1];

    /* We don't need to print the result */
    /* Just to show we can see results from our code */
    System.out.println(output);

    assertEquals("1,3,6,10,15,21", output);
}
```

• Be careful and don’t modify public test (copy test to StudentTest file)
• You can step through tests using the debugger
• **Note:** We cannot disclose information about release tests or secret tests. After a project has been graded you can see a TA in order to see why you failed any release or secret tests
Applying Object-Oriented Design

• We can use the term “message” to describe the interaction between objects. Let’s see an example

• When designing a system based on a problem statement:
  • Look at objects participating in system
    • Find nouns in the problem statement (requirements & specifications)
    • Noun may represent class/variables needed in the design
    • Relationships (e.g., “has” or “belongs to”) may represent fields
  • Look at interactions between objects
    • Find verbs in problem statement
    • Verb may represent message between objects
  • Design classes accordingly
    • Determine relationship between classes
    • Find state & methods needed for each class
1) Finding Classes

- Problem Statement
  - Thermostat uses dial setting to control a heater to maintain constant temperature in room

- Nouns
  - Thermostat
  - Dial setting
  - Heater
  - Temperature
  - Room

- Analyze each noun
  - Does noun represent class needed in design?
  - Noun may be outside system
  - Noun may describe state in class
Analyzing Nouns

• Thermostat
  • Central class in model
• Dial setting
  • State in class (Thermostat)
• Heater
  • Class in model
• Room
  • Class in model
• Temperature
  • State in class (Room)
2) Finding Messages

- Thermostat uses dial setting to control a heater to maintain constant temperature in room

- Verbs
  - Uses
  - Control
  - Maintain

- Analyze each verb
  - Does verb represent interaction between objects?

- For each interaction
  - Assign methods to classes to perform interaction
Analyzing Verbs

• Uses
  • “Thermostat uses dial setting…”
  • ⇒ Thermostat.setDesiredTemp(int degrees)

• Control
  • “To control a heater…”
  • ⇒ Heater.turnOn()
  • ⇒ Heater.turnOff()

• Maintain
  • “To maintain constant temperature in room”
  • ⇒ Room.getTemperature()
Example Messages

- Room
  - getTemperature()

- Thermostat
  - setDesiredTemp()

- Heater
  - turnOn()
  - turnOff()
Resulting Classes

- **Thermostat**
  - State – dialSetting
  - Methods – setDesiredTemp()

- **Heater**
  - State – heaterOn
  - Methods – turnOn(), turnOff()

- **Room**
  - State – temp
  - Methods – getTemperature()

The above design could have been described using UML Class Diagrams
is-a vs. has-a

- Say we have two classes: Engine and Car
- Two possible designs
  - A Car object has a reference to an Engine object
    - has-a
  - The Car class is a subtype of Engine
    - is-a
Prefer Composition over Inheritance

- Generally, prefer composition/delegation (has-a) to subtyping (is-a)
  - Subtyping is very powerful, but easy to overuse and can create confusion and lead to mistakes
- Using is-a restricts you from having a car with more than one engine, or with no engine
- Tempting to use subtyping in places where it doesn’t really make conceptual sense to avoid having to delegate methods
  - Don’t
- Let’s see an example of where we have an Employee class and we need to kinds of Employee: salaried and hourly
Forms of Inheritance

• Extension
  • Adds new functionality to subclass
    • In Java → new method

• Limitation
  • Restricts behavior of subclass
    • In Java → override method, throw exception

• Combination
  • Inherits features from multiple superclasses
  • Also called multiple inheritance
  • Not possible in Java
    • In Java → implement interface instead
Multiple Inheritance Example

- Combination
  - AlarmClockRadio has two parent classes
  - State & behavior from both Radio & AlarmClock