CMSC 132:
OBJECT-ORIENTED PROGRAMMING II

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
Applying Object-Oriented Design

- Look at objects participating in system
  - Find **nouns** in problem statement (requirements & specifications)
  - Noun may represent class/variables needed in 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
Classes

• A class or interface defines and describes a set of objects
• It describes a set of methods or messages that the object responds to
  • Not only the name and signature of the method, but the contract the method respects
• Classes also provide/describe fields and method implementations
1) Finding Classes

- **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…”
  • \( \Rightarrow \) Thermostat.setDesiredTemp(int degrees)

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

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

- Thermostat
  - getTemperature()
  - setDesiredTemp()
  - turnOn()
  - turnOff()

- Room
- Heater
Resulting Classes

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

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

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