CS1007: Object Oriented Design and Programming in Java

Lecture #4

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Outline

- Feedback
- Review
- Homework
- Event Driven programming
- Showing off eclipse
- Graphic Programming I
- Graphic Programming II
- Object Oriented Design Process.
- Intro CRC & UML

- Background reading on graphics (basics and concepts)
- Next class Reading chapter 2-2.5

Announcements

- Please make sure to note : HW due: Feb 12 at 11pm (electronically).
- TA Announcement: Ohan will hold office hours from 4:30 to 6:30 today instead of 11-1 on Friday.

Feedback

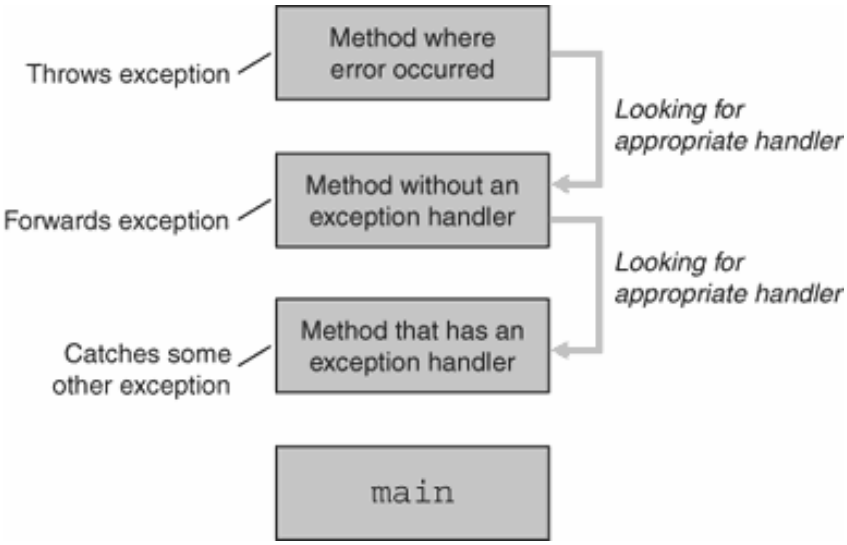
- Pace
- Graphic programming background

Exceptions

- Tool to handle error during program run
  - Exception == exceptional event
  - Idea: when an error occurs, a method can create an Object representing the error and hand it to the run time system
  - The runtime system now tries to find someone to handle the particular error, it uses the call stack to find a handler

Exception handlers

- Are defined by your catch expression
- If a specific method doesn't know how to handle the specific exception, it forwards it up the stack
- Remember: can have multiple catch blocks one after other
  - Exceptions have a hierarchy, they will be evaluated from highest to lowest, so the catch blocks must be in reverse order.



The birth of an exception

- You might use a method which might throw an exception
- You might create a method which creates and exception
- Your code might trigger an exception

InvalidAccountException

```
public class InvalidAccountException extends Exception {


   public InvalidAccountException (String message)
   {
       super(message);
   }

}
```

Your method

```
public boolean checkBalance(int account) throws
   InvalidAccountException{

if(account==null || account < 1){
 throw new InvalidAccountException(“Bad Account
   Number”);
}


... ...
}
```

Chaining Exceptions

```
try {
...
} catch (IOException e) {
   throw new SampleException("Other IOException", e);
}
```

Point

- Can deal with the problem
  - Ask user for help
  - Figure out what should be done
  - Log the error
  - Print a trace to debug
  - Die (ARGHHHHHH!)

Practical Tips

- In a general sense try, catch blocks impose some overhead to the resulting code
- Although can enclose all your code in some try, catch block its not a good idea
- Need to decide at what point, which errors can occur, and what the appropriate response will be

Homework

- Playing MasterMind

- G = guesses
- X = choices
- N = range of numbers

Programming Models

- Control Flow Programming
  - Program which follows control flow changing course at specific branch points.
- Event Driven Programming
  - Program which is driven by events (signal) and responses in an event loop framework.

- GUI
  - Window system which interacts with users
- AWT
  - Abstract Windows Toolkit
- SWING
  - Updated version of many AWT object with event driven paradigm design

Event and Listeners

- Event Objects
  - Objects which trigger a Listener Object
  - Example: click on a button
- Listener Object
  - Object which react to events
  - Example once clicked do something
- Exception Handling!!

Components and Containers

- Can program GUI using a surface and drawing circles, boxes, etc
- OOD:
- Components
  - Individual GUI objects
- Containers
  - Object which can hold components

Simple example

```
JFrame easyWindow = new JFrame();
easyWindow.setSize(300,300);
easyWindow.setTitle("This is your first
  window");
easyWindow.setDefaultCloseOperation(JFrame.E
  XIT_ON_CLOSE);
easyWindow.setVisible(true);
```

Adding a button

- One component is a button

```
JButton closeButton = new JButton(“Click to
  close”);

easyWindow.add(closeButton);
```

Events

- By default there are a few events associated with each general window (container)

- Maximize
- Minimize
- Close
- sizing

Can add events to components

```
closeButton.addActionListener(new ActionListener() {

public void actionPerformed(ActionEvent evt) {

  if (evt.getSource() instanceof JButton) {
  JButton closeButton = (JButton) evt.getSource();
  if (closeButton.getBackground() == Color.BLUE) {
      closeButton.setBackground(Color.YELLOW);
  } else {
      closeButton.setBackground(Color.BLUE);
      }
  }
}
} );
```

Alternativly can create a class

```
public class colorListener
  impliments ActionListener {

  public void
  actionperformed(action...
```

Adding a second button

- Can add more using the same code, but then bump into an issue of where do both buttons go??
- Ideas?!?

Layout Managers

- Layout managers are class which handle how things will be set out in the window

Ending a GUI program

- Think of it as being an infinite loop waiting for events
- So if you don't explicitly end the program……

Other GUI stuff

- Much more components
  - JLabels
  - JRadioButtons
  - Dozens more
- Other Containers
  - JWindow
  - JFrame
  - JPanel

Ahead

- Switch gears from programming java
- Object Oriented Design

Program Design

- Analysis
- Design
- Implementation

Analysis Phase

- Functional Specification
  - Completely defines tasks to be solved
  - Free from internal contradictions
  - Readable both by domain experts and software developers
  - Reviewable by diverse interested parties
  - Testable against reality

Design Phase

- Goals
  - Identify classes
  - Identify behavior of classes
  - Identify relationships among classes
- Artifacts
  - Textual description of classes and key methods
  - Diagrams of class relationships
  - Diagrams of important usage scenarios
  - State diagrams for objects with rich state

Implementation Phase

- Implement and test classes
- Combine classes into program
- Avoid "big bang" integration
- Prototypes can be very useful

Problem 1:

- Design a voicemail system for use in your typical cellphone.

- How would the requirements look like?
- What would be a typical session?
- What modules are involved?

Identifying Classes in design

- Rule of thumb: Look for nouns in problem description

- Mailbox
- Message
- User
- Passcode
- Extension
- Menu

When defining classes

- Focus on concepts, not implementation
- ????? stores messages
  - Lets say a messageQueue
- Don't worry yet how the queue is implemented

Categories

- Tangible Things
- Agents
- Events and Transactions
- Users and Roles
- Systems
- System interfaces and devices
- Foundational Classes

Identifying Responsibilities

- Rule of thumb: Look for verbs in problem description
- Behavior of MessageQueue:
- Add message to tail
- Remove message from head
- Test whether queue is empty

OO Design

- OO Principle: Every operation is the responsibility of a single class
- Example:
  - Add message to mailbox
- Who is responsible:
  - Message or Mailbox?

Relationship

- Dependency ("uses")
- Aggregation ("has")
- Inheritance ("is")

Dependancy

- C depends on D: Method of C manipulates objects of D

Example: Mailbox depends on Message

- If C doesn't use D, then C can be developed without knowing about D

Java defintions

- When class X extends Y
  - X is a subclass
  - Y is a superclass
- When interface A extends Interface B
  - A is a subinterface
  - B is a superinterface
- When G implements interface B
  - G is an implementation of B
  - B is an interface of class G

Independent operations

- Minimize dependency:
  - reduce having to relay on anything set in stone

- Example: Replace

void print() // prints to System.out

- with

String getText() // can print anywhere

- Removes dependence on System, PrintStream

Aggregation

- Object of a class contains objects of another class
- Example: MessageQueue aggregates Messages
- Example: Mailbox aggregates MessageQueue
- Implemented through instance fields

Relationships

- 1 : 1 or 1 : 0...1 relationship:

```
public class Mailbox
{
   . . .
   private Greeting myGreeting;
}
```

- 1 : n relationship:

```
public class MessageQueue
{
   . . .
   private ArrayList<Message> elements;
}
```

Inheritance

- More general class = superclass
- More specialized class = subclass
- Subclass supports all method interfaces of superclass (but implementations may differ)
- Subclass may have added methods, added state
- Subclass inherits from superclass
- Example:
  - ForwardedMessage inherits from Message
  - Greeting does not inherit from Message (Can't store greetings in mailbox)

Use Cases

- Analysis technique
- Each use case focuses on a specific scenario
- Use case = sequence of actions
- Action = interaction between actor and computer system
- Each action yields a result
- Each result has a value to one of the actors
- Use variations for exceptional situations

Use case: Leave a Message

1. Caller dials main number of voice mail system
2. System speaks prompt

- Enter mailbox number followed by #

3. User types extension number
4. System speaks

- You have reached mailbox xxxx. Please leave a message now

5. Caller speaks message
6. Caller hangs up
7. System places message in mailbox

Variations

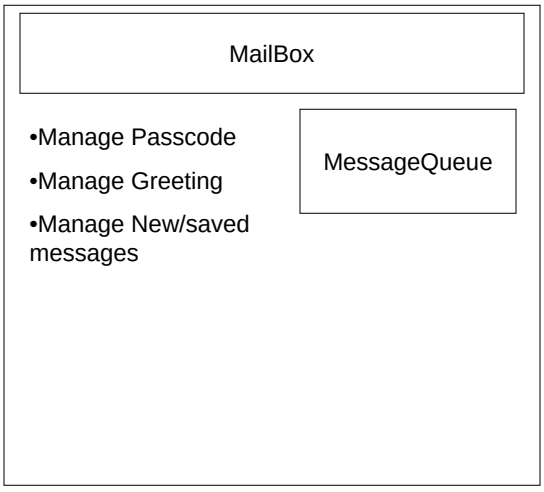
- user enters invalid extension number
  - What do you do?
  - Who does it?
- What if user hangs up instead of using message?
- How many attempts at password?

CRC Cards

- CRC = Classes, Responsibilities, Collaborators

- Use an index card for each class
- Class name on top of card
- Responsibilities on left
- Collaborators on right

CRC



- Responsibilities should be high level
- 1 - 3 responsibilities per card
- Collaborators are for the class, not for each responsibility

Example

- Use case: "Leave a message"
- Caller connects to voice mail system
- Caller dials extension number
- "Someone" must locate mailbox
- Neither Mailbox nor Message can do this
- New class: MailSystem
- Responsibility: manage mailboxes

UML

- UML = Unified Modeling Language
- Many diagram types
- We'll use three types:
  - Class Diagrams
  - Sequence Diagrams
  - State Diagrams

UML

- Why do we model?
  - Provide structure for problem solving
  - Experiment to explore multiple solutions
  - Furnish abstractions to manage complexity
  - Decrease development costs
  - Manage the risk of mistakes
- Graphical Approach
  - Picture is worth 1000 words

UML Building Blocks

- model elements (classes, interfaces, components, use cases, etc.)
- relationships (associations, generalization, dependencies, etc.)
- diagrams (class diagrams, use case diagrams, interaction diagrams, etc.)

- Simple building blocks are used to create large, complex structures
  - elements, bonds and molecules in chemistry
  - components, connectors and circuit boards in hardware

Next time

- Read
- Make sure sketch out the homework and have a rough outline of what you need to do
- Download Violet (UML designer) and try to play with it.