Selection Control Structures - if

Cmput 114 - Lecture 14
Department of Computing Science
University of Alberta

About This Lecture

- Each of our programs consists of a sequence of statements.
- Even though we decompose our programs into methods, each method consists of a sequence of statements.
- We will learn how to write code that can conditionally execute a statement or not.
- We will also learn how to write code that can execute one statement or another statement.

Outline

- The boolean type
- The if statement
- The compound statement
- The if-then-else statement
- Adventure Version 5

Sequence

- Every method we have seen so far consists of a sequence of statements.
- The statements include: import statements, variable declaration statements, message expression statements, assignment statements, and return statements:

```
String myString;
System.out.println("Java Rules!");
myString = keyboard.readString();
return name;
```


Selection

- Sometimes it is useful to execute a statement or not, based on a condition.
- A statement that allows such conditional execution is called a selection statement.
- For example, the Adventure program can ask a user an arithmetic question:
  - If a user responds correctly, the program executes statements that reward the user.
  - If a user responds incorrectly, the program executes statements that penalize the user.

The boolean Type

- To support selection, many programming languages introduce a type called boolean, that has two members: *TRUE* and *FALSE*.
- Depending on the programming language, *TRUE* and *FALSE* may be objects or values.
- In Java, boolean is a primitive type.
- There are two literal booleans values: true and false.

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Creating booleans

- Boolean values can be created by relational operators on int values:
  - greater or equal: `3 >= 4 --> false`
  - equal: `index == 4 --> ?`
- boolean values can also be created by boolean operators on boolean values:
  - and: `true && false --> false`
  - or: `raining || snowing --> ?`
- There are many other operators that create booleans as well.

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Syntax for the Java if Statement

- The syntax for an if statement in Java is:

```
<if statement> ::=
    if (<condition>) <statement>
```

- A condition is any expression that evaluates to a boolean value.
- For example:

```
if (taxRate > 0.40f) amount = 2400;
```

- The conventional format is:

```
if (this.chest != null)
  this.menu.add("Open the chest.");
```


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Semantics for "if"

- If the condition evaluates to true then the statement is executed.
- Otherwise the statement is skipped.
- For example, consider the statement:

```
if (this.chest != null)
  this.menu.add("Open the chest.");
```

- If the current room's chest is not equal to `null` an item is added to the menu.
- Otherwise, the item is not added to the menu.

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The Java Compound Statement

- Sometimes you want to execute more than one statement if the condition is satisfied.
- Java has a compound statement that can appear anywhere a statement can appear:

```
<compound statement> ::= \{ {<statement>} \}
```

- Recall that {<xx>} is EBNF syntax that means zero or more occurrences of <xx>.
- The character \ is a meta-character that indicates the next symbol is a real symbol, not a meta-character!

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Example Compound Statement

- For example,

```
if (action.equals("Open the chest.")) {
  this.chest.open(adventurer);
  this.chest = null;
}
```

- If the variable `action` is bound to a String that is equal to "Open the chest.", then an `open()` message is sent to the chest in the current room and then the chest variable is bound to `null`.

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Java if-then-else Statement

- Java has another form of if statement called an if-else statement:

```
<if statement> ::= if (<condition>)
    <statement1> else <statement2>
```

with semantics:

- If the condition is true then statement1 is executed and statement2 is skipped
- If the condition is false then statement1 is skipped and statement2 is executed

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If-then-else Example

- Here is an example from the class `Chest`:

```
if (question.ask())
  this.correctAnswer(adventurer);
else
  this.wrongAnswer(question, adventurer);
```

- The message `ask()` returns a boolean that represents whether the user correctly answered the `question`.
- The chest then executes one of two methods to reward the adventurer or to penalize the adventurer.

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Adventure Version 5

- We are going to add some functionality to the Arithmetic Adventure game .
- We will change the ask() method in class Question so it checks the user's answer against the correct answer and returns a boolean value true or false.
- We will change the open() method in the class Chest so that if the ask() messsage returns true then we will gain tokens and if returns false then we will remove tokens.

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Adventure - Code Change Summary

- In the Chest class we will:
  - Modify the method open(Adventurer)
- In the Question class we will:
  - Modify the method ask()
- Leave the Adventure class unchanged except for changing the comment to Version 5.
- Leave the Adventurer class unchanged.

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Running Adventure 5 (1)

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Running Adventure 5 (2)

NO CHANGES

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Class - Chest 5.1

```
import java.util.*;
public class Chest {
/*
  An instance of this class represents a treasure chest in
  the Adventure game. A Chest contains a number of tokens.
*/
/* Constructor */
  public Chest() {
  /*
     Initialize me so that I contain a random number of
     tokens.
  */
     this.tokens = Chest.generator.next(Chest.maxTokens);
  }
```

NO CHANGES 19

Class - Chest 5.2

```
/* Instance Methods */

  public void display() {
  /*
      Output a description of myself.
  */

      System.out.println("There is a small carved chest in
the center of the room.");
      System.out.println("It appears to be a treasure
chest!");
  }
```


OLD 20

Class - Chest 4.3

```
  public void open(Adventurer adventurer) {
  /*
      Ask the user an arithmetic question and if a correct
      answer is given, add tokens to the given Adventurer.
      If it is answered incorrectly, remove tokens.
  */
      Question question;

      question = new Question();
      question.ask();
      // We really want to do only one of the next two
      // lines, depending on the user's answer.
      this.correctAnswer(adventurer);
      this.wrongAnswer(question, adventurer);
  }
```


NEW 21

Class - Chest 5.3

```
  public void open(Adventurer adventurer) {
  /*
      Ask the user an arithmetic question and if a correct
      answer is given, add tokens to the given Adventurer.
      If it is answered incorrectly, remove tokens.
  */
      Question question;

      question = new Question();
      if (question.ask())
          this.correctAnswer(adventurer);
      else
          this.wrongAnswer(question, adventurer);
  }
```


NO CHANGES 22

Class - Chest 5.4

```
/* Private Static Variables */

  private static final int maxTokens = 10;
  private static final RandomInt
      generator = new RandomInt(1);

/* Private Instance Variables */

  private int tokens;

/* Private Instance Methods */
```


NO CHANGES 23

Class - Chest 5.5

```
  private void correctAnswer(Adventurer adventurer) {
  /* Congratulate the adventurer and add some tokens.*/
      System.out.println();
      System.out.println("A small loudspeaker appears in the air.");
      System.out.println("You hear the sound of a harp and
a pleasant voice says congratulations.");
      System.out.print("The lid of the chest opens to reveal ");
      System.out.print(this.tokens);
      System.out.println(" valuable tokens.");
      System.out.println("They literally fly into your
pocket and the chest disappears.");
      adventurer.gainTokens(this.tokens);
      adventurer.reportTokens();
  }
```


NO CHANGES 24

Class - Chest 5.6

```
  private void wrongAnswer(Question question, Adventurer adventurer) {
  /*
      Report the correct answer and remove some tokens
      from the given adventurer.
  */
      int   loss;

      System.out.println();
      System.out.println("A small loudspeaker appears in the air.");
      System.out.println("You hear the sound of a deep
gong and a pleasant voice says:");
      System.out.print("Sorry, the correct answer is ");
      System.out.print(question.answer());
      System.out.println(".");
```

NO CHANGES

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Class - Chest 5.7

```
    loss = Math.min(this.tokens, adventurer.tokens());
    System.out.print("You see ");
    System.out.print(loss);
    System.out.println(" valuable tokens fly out of your
pocket and fall to the floor.");
    System.out.println("A small vacuum cleaner appears,
sweeps up your scattered tokens and disappears.");
    adventurer.loseTokens(loss);
    adventurer.reportTokens();
  }
}
```


NO CHANGES

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Class - Question 5.1

```
import java.util.*;
public class Question {
/*
  An instance of this class represents an arithmetic
  problem in the Arithmetic Adventure game.
*/

/* Constructor */
  public Question() {
  /*
      Initialize me so that I have two operands.
  */
      this.leftOperand = Question.generator.next(Question.maxOperand);
      this.rightOperand = Question.generator.next(Question.maxOperand);
  }
```


OLD

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Class - Question 4.2

```
  /* Instance Methods */
  public void ask() {
  /*
      Pose myself. Eventually I would like to indicate
      whether the user's response was correct or not.
  */
      Integer     answer;

      System.out.print(this.leftOperand);
      System.out.print(" + ");
      System.out.print(this.rightOperand);
      System.out.print(" = ");
      answer = Keyboard.in.readInteger();
  }
```


NEW

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Class - Question 5.2

```
  /* Instance Methods */
  public boolean ask() {
  /*
      Pose myself. Return true if the user's response
      was correct and false otherwise.
  */
      Integer     answer;

      System.out.print(this.leftOperand);
      System.out.print(" + ");
      System.out.print(this.rightOperand);
      System.out.print(" = ");
      answer = Keyboard.in.readInteger();
      return answer.intValue() == this.answer();
}
```


NO CHANGES

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Class - Question 5.3

```
  public int answer() {
  /*
      Answer my correct answer.
  */
      return this.leftOperand + this.rightOperand;
  }

/* Private Static Variables */
  private static final int maxOperand = 9;
  private static final RandomInt
      generator = new RandomInt(2);
/* Private Instance Variables */
  private int leftOperand;
  private int rightOperand;
```


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No Changes to End of Lecture

- The rest of the Adventure program is included for completeness.
- There are no changes from the last version in the rest of these slides.

NO CHANGES 31

Program - Adventure 5.1

```
import java.util.*;
public class Adventure {
/* Version 5
   This program is an arithmetic adventure game …
*/

/* Constructors */

  public Adventure () {
  /*
      Initialize an adventure by creating the appropriate
      objects.
  */
  }
```


NO CHANGES 32

Program - Adventure 5.2

```
/* Main program */

  public static void main(String args[]) {
      Adventure   game;

      game = new Adventure();
      game.play();
  }
```


NO CHANGES 33

Program - Adventure 5.3

```
/* Private Instance Methods */

  private void play() {
  /*
      Plays the Adventure game.
  */

      Adventurer  adventurer;

      adventurer = this.greeting();
      this.enterRoom(adventurer);
      this.farewell(adventurer);
  }
```


NO CHANGES 34

Program - Adventure 5.4

```
  private Adventurer greeting() {
  /*
      Great the user and answer an Adventurer that
      represents the user.
  */
      String      playerName;

      System.out.println("Welcome to the Arithmetic Adventure game.");
      System.out.print("The date is ");
      System.out.println(new Date());
      System.out.println();
      System.out.print("What is your name?");
      playerName = Keyboard.in.readString();
```


NO CHANGES 35

Program - Adventure 5.5

```
      System.out.print("Well ");
      System.out.print(playerName);
      System.out.println(", after a day of hiking you spot a silver cube.");
      System.out.println("The cube appears to be about 5 meters on each side.");
      System.out.println("You find a green door, open it and enter.");
      System.out.println("The door closes behind you with a soft whir and disappears.");
      System.out.println("There is a feel of mathematical magic in the air.");
      Keyboard.in.pause();
      return new Adventurer(playerName);
  }
```


NO CHANGES 36

Program - Adventure 5.6

```
private void enterRoom(Adventurer adventurer) {
  /*
      The given adventurer has entered the
      first room.
  */
      Chest       chest;

      chest = new Chest();
      chest.display();
      chest.open(adventurer);
  }
```

NO CHANGES 37

Program - Adventure 5.7

```
  private void farewell(Adventurer adventurer) {
  /*
      Say farewell to the user and report the game result.
  */

      System.out.print("Congratulations ");
      System.out.print(adventurer.name());
      System.out.print(" you have left the game with ");
      System.out.print(adventurer.tokens());
      System.out.println(" tokens.");
  }
```


NO CHANGES 38

Class - RandomInt 5.1

```
import java.util.*;
public class RandomInt {
/*
  An instance of this class represents a generator that
  can generate a series of random positive ints.
*/

/* Contsructor */
  public RandomInt(int seed) {
  /*
      Initialize me so that I use the given seed.
  */
      this.generator = new Random(seed);
  }
```


NO CHANGES 39

Class - RandomInt 5.2

```
/* Instance Methods */

  public int next(int max) {
  /*
      Answer a Random int between 1 and the given max.
  */

      return Math.round(max * this.generator.nextFloat() -
  0.5f) + 1;
  }

/* Private Instance Variables */
  private Random generator;
```


NO CHANGES 40

Class - Adventurer 5.1

```
public class Adventurer {
/*
  An instance of this class represents a player of the
  Adventure game.
*/

/* Constructors */
  public Adventurer(String name) {
  /*
      Initialize me with the given name and zero tokens.
  */
      this.name = name;
      this.tokens = 0;
  }
```


NO CHANGES 41

Class - Adventurer 5.2

```
/* Instance Methods */

  public String name() {
  /*
      Answer a String representing my name.
  */
      return this.name;
  }

  public int tokens() {
  /*
      Answer my number of Tokens.
  */
      return this.tokens;
  }
```


NO CHANGES 42

Class - Adventurer 5.3

```
  public void gainTokens(int anInt) {
  /*
      Add the given number of tokens to my total.
  */
      this.tokens = this.tokens + anInt;
  }

  public void loseTokens(int anInt) {
  /*
      Remove the given number of tokens from my total.
  */
      this.tokens = this.tokens - anInt;
  }
```

NO CHANGES

Class - Adventurer 5.4

```
public void reportTokens() {
/*
    Output the number of tokens I have.
*/
    System.out.print("You have ");
    System.out.print(this.tokens);
    System.out.println(" tokens in your pocket.");
}

/* Private Instance Variables */

private String name;
private int tokens;
```


Selection Control Structures - switch

Cmput 114 - Lecture 15
Department of Computing Science
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About This Lecture

- In this lecture we will study another selection control structure called the switch statement.
- A switch statement conditionally executes one of many statements depending on a selection value.

Outline

- The switch statement
- Adventure Version 6

Java switch Statement Syntax

```
switch (<expression>) {
    case <value11>: case <value12>: …
            <statement1 block>
    case <value21>: case <value22>: …
            <statement2 block>
    …
    default:
            <defaultStatement block>
}
```

- A condition is any expression that evaluates to a boolean value.
- For example:

```
if (taxRate > 0.40f) amount = 2400;
```

- The conventional format is:

```
if (this.chest() != null)
    menu.add("Open the chest.");
```


Switch Statement Semantics 1

- If the expression evaluates to value11 or value12 then the statements in the first block are executed.
- If the expression evaluates to value21 or value22 then the statements in the second block are executed.
- If the value of the expression does not equal any value in any of the case clauses then the default statement block is executed.

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Switch Statement Semantics 2

- If a statement block is executed and it contains the statement:

  `break;`

  then the rest of the statement blocks are skipped.
- If a statement block is executed and it does NOT contain a break statement, then all of the following statement blocks are executed, regardless of the case values.

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Java switch Example

```
switch (index) {
  case 1:
      string = this.entry1;
      break;
  case 2:
      string = this.entry2;
      break;
  …
  case 5:
      string = this.entry5;
      break;
  default:
      string = this.entry1;
      break;
}
```


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Another Java switch Example

```
switch (index) {
  case 1: return this.entry1;
  case 2: return this.entry2;
  …
  case 5: return this.entry5;
  default: return this.entry1;
}
```


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Adventure 6

- We are going to add some functionality to the Arithmetic Adventure game .
- We are going to create a room for the Adventurer and allow the user to either open the chest in the room or quit.
- To do this we will create two new classes, Room and TextMenu.
- Later we will add more rooms, add doors to the room and allow the user to open a door and enter another room.

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Adventure - Code Change Summary

- In the Adventure class we will:
  - Modify the constructor Adventure() by adding code.
  - Add an an instance variable that is bound to the first Room object that the user enters.
  - Modify the play() method.
- Create the new class Room.
- Create the new class TextMenu.
- Leave the classes: Question, Chest, RandomInt and Adventurer unchanged.

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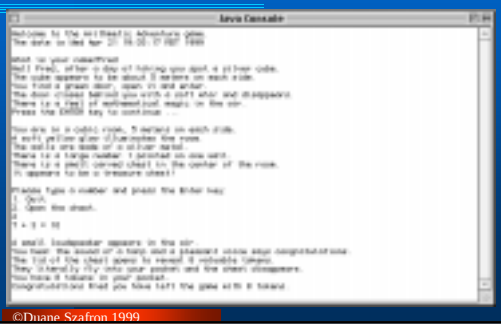
Adventure 6 (1)



55

Adventure 6 (2)

OLD

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Program - Adventure 5.1

```
import java.util.*;
public class Adventure {
/* Version 5
   This program is an arithmetic adventure game …
*/

/* Constructors */

   public Adventure () {
   /*
       Initialize an adventure by creating the appropriate
       objects.
   */
   }
```


NEW

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Program - Adventure 6.1

```
import java.util.*;
public class Adventure {
/* Version 6
   This program is an arithmetic adventure game …
*/

/* Constructors */

   public Adventure () {
   /*
       Initialize an adventure by creating the appropriate
       objects.
   */
       this.firstRoom = new Room(1);
   }
```


OLD

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Program - Adventure 5.2

```
/* Main program */

   public static void main(String args[]) {
       Adventure   game;

       game = new Adventure();
       game.play();
   }
```


NEW

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Program - Adventure 6.2

```
/* Main program */

   public static void main(String args[]) {
       Adventure   game;

       game = new Adventure();
       game.play();
   }

/* Private Instance Variables */

   private Room firstRoom;
```


OLD

60

Program - Adventure 5.3

```
/* Private Instance Methods */

   private void play() {
   /*
       Plays the Adventure game.
   */

       Adventurer  adventurer;

       adventurer = this.greeting();
       this.enterRoom(adventurer);
       this.farewell(adventurer);
   }
```

NEW 61

Program - Adventure 6.3

```
/* Private Instance Methods */

  private void play() {
  /*
      Plays the Adventure game.
  */

      Adventurer  adventurer;
      Room        room;

      adventurer = this.greeting();
      room = firstRoom.enter(adventurer);
      this.farewell(adventurer);
  }
```


NO CHANGES 62

Program - Adventure 6.4

```
  private Adventurer greeting() {
  /*
      Great the user and answer an Adventurer that
      represents the user.
  */
      String      playerName;

      System.out.println("Welcome to the Arithmetic Adventure game.");
      System.out.print("The date is ");
      System.out.println(new Date());
      System.out.println();
      System.out.print("What is your name?");
      playerName = Keyboard.in.readString();
```


NO CHANGES 63

Program - Adventure 6.5

```
      System.out.print("Well ");
      System.out.print(playerName);
      System.out.println(", after a day of hiking you spot a silver cube.");
      System.out.println("The cube appears to be about 5 meters on each side.");
      System.out.println("You find a green door, open it and enter.");
      System.out.println("The door closes behind you with a soft whir and disappears.");
      System.out.println("There is a feel of mathematical magic in the air.");
      Keyboard.in.pause();
      return new Adventurer(playerName);
  }
```


DELETED 64

Program - Adventure 5.6

```
private void enterRoom(Adventurer adventurer) {
  /*
      The given adventurer has entered the
      first room.
  */
      Chest       chest;

      chest = new Chest();
      chest.display();
      chest.open(adventurer);
  }
```


NO CHANGES 65

Program - Adventure 6.7

```
  private void farewell(Adventurer adventurer) {
  /*
      Say farewell to the user and report the game result.
  */

      System.out.print("Congratulations ");
      System.out.print(adventurer.name());
      System.out.print(" you have left the game with ");
      System.out.print(adventurer.tokens());
      System.out.println(" tokens.");
  }
```


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Class - Room 6.1

```
import java.util.*;
public class Room {
/*
  A room contains a treasure chest and some doors to
  adjoining rooms.
*/
/* Constructor */
  public Room(int anInt) {
  /*
      Initialize me so that I have the given room number,
      contain a treasure chest, and no doors.
  */
      this.number = anInt;
      this.chest = new Chest();
  }
```

Class - Room 6.2

```
/* Instance Methods */
  public Room enter(Adventurer adventurer) {
  /*
     Describe myself, display a list of options, and
     perform the selected option. If the user selected
     quit then return null. If the user selected to go
     to another Room then return that Room. Otherwise
     return this Room.
  */
     TextMenu    menu;
     String      action;
     this.display();
     menu = this.buildMenu();
     action = menu.launch();
     return this.performAction(action, adventurer);
  }
```


Class - Room 6.3

```
/* Private Instance Variables */
  private Chest   chest;
  private int     number;

/* Private Instance Methods */

  private void display() {
  /*
     Output a description of myself.
  */
     this.displayBasic();
     this.displayDoors();
     if (this.chest != null)
           this.chest.display();
  }
```


Class - Room 6.4

```
  private void displayBasic() {
  /*
     Output a basic description of myself that is
     independent of my doors and contents.
  */
     System.out.println();
     System.out.println("You are in a cubic room, 5 meters on each side.");
     System.out.println("A soft yellow glow illuminates the room.");
     System.out.println("The walls are made of a silver metal.");
     System.out.print("There is a large number ");
     System.out.print(this.number);
     System.out.println(" painted on one wall.");
  }
```


Class - Room 6.5

```
  private void displayDoors() {
  /*
     Output a description of all of my doors.
  */
  }
```


Class - Room 6.6

```
  private TextMenu buildMenu() {
  /*
     Create and answer a TextMenu containing the user's
     valid actions.
  */
     TextMenu    menu;

     menu = new TextMenu();
     menu.add("Quit");
     if (this.chest != null)
           menu.add("Open the chest.");
     // Add door choices here
     return menu;
  }
```


Class - Room 6.7

```
  private Room performAction(String action, Adventurer adventurer) {
  /*  Perform the action described by the given String for
     the given Adventurer. Return the room the user
     selected, null if the user selected quit and this
     room if the user selected to open the chest.
  */
     if (action.equals("Open the chest.")) {
           this.chest.open(adventurer);
           this.chest = null;
           return this;
     }
     if (action.equals("Quit"))
           return null;
     return null;
  }
}
```

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Class - TextMenu 6.1

```
import java.io.*;
import java.util.*;
public class TextMenu {
/*
   An instance of this class displays a list of strings for
   the user and allows the user to pick one. For now, up to
   five entries are supported.
*/
/* Contructor */

   public TextMenu() {
   /*
       Initialize me with no entries.
   */
   }
```


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Class - TextMenu 6.2

```
/* Instance Methods */
   public void add(String entry) {
   /*
       Add the given String to me as my next choice.
   */
       if (entry1 == null) {
              this.entry1 = entry;
              return;
       }
       if (entry2 == null) {
              this.entry2 = entry;
              return;
       }
   //more of the same for entries 3, 4 and 5.
   }
```


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Class - TextMenu 6.3

```
   public String launch() {
   /*
       Display myself and answer the String entry selected
       by the user.
   */
       Integer     choice;
       int         index;

       this.display();
       choice = Keyboard.in.readInteger();
       if (choice == null)
              return this.entry1;
       index = choice.intValue();
```


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Class - TextMenu 6.4

```
       switch (index) {
              case 1: return this.entry1;
              case 2: return this.entry2;
              case 3: return this.entry3;
              case 4: return this.entry4;
              case 5: return this.entry5;
              default: return this.entry1;
       }
   }
```


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Class - TextMenu 6.5

```
/* Private Instance Variables */

   private String entry1;
   private String entry2;
   private String entry3;
   private String entry4;
   private String entry5;

/* Private Instance Methods */
```


78

Class - TextMenu 6.6

```
   private void display() {
   /*
       Display myself on the screen.
   */
       String      entry;
       int         index;
       System.out.println();
       System.out.println("Please type a number and press the Enter key:");
       if (this.entry1 != null) {
              System.out.print("1. ");
              System.out.println(this.entry1);
       }
       // same code for entry2, entry3, entry4 and entry5
   }
}
```

79

No Changes to End of Lecture

- The rest of the Adventure program is included for completeness.
- There are no changes from the last version in the rest of these slides.

NO CHANGES

80

Class - Chest 6.1

```
import java.util.*;
public class Chest {
/*
  An instance of this class represents a treasure chest in
  the Adventure game. A Chest contains a number of tokens.
*/
/* Constructor */
  public Chest() {
  /*
      Initialize me so that I contain a random number of
      tokens.
  */
      this.tokens = Chest.generator.next(Chest.maxTokens);
  }
```


NO CHANGES

81

Class - Chest 6.2

```
/* Instance Methods */

  public void display() {
  /*
      Output a description of myself.
  */

      System.out.println("There is a small carved chest in
  the center of the room.");
      System.out.println("It appears to be a treasure
  chest!");
  }
```


NO CHANGES

82

Class - Chest 6.3

```
  public void open(Adventurer adventurer) {
  /*
      Ask the user an arithmetic question and if a correct
      answer is given, add tokens to the given Adventurer.
      If it is answered incorrectly, remove tokens.
  */
      Question question;

      question = new Question();
      if (question.ask())
          this.correctAnswer(adventurer);
      else
          this.wrongAnswer(question, adventurer);
  }
```


NO CHANGES

83

Class - Chest 6.4

```
/* Private Static Variables */

  private static final int maxTokens = 10;
  private static final RandomInt
      generator = new RandomInt(1);

/* Private Instance Variables */

  private int tokens;

/* Private Instance Methods */
```


NO CHANGES

84

Class - Chest 6.5

```
  private void correctAnswer(Adventurer adventurer) {
  /* Congratulate the adventurer and add some tokens.*/
      System.out.println();
      System.out.println("A small loudspeaker appears in the air.");
      System.out.println("You hear the sound of a harp and
  a pleasant voice says congratulations.");
      System.out.print("The lid of the chest opens to reveal ");
      System.out.print(this.tokens);
      System.out.println(" valuable tokens.");
      System.out.println("They literally fly into your
  pocket and the chest disappears.");
      adventurer.gainTokens(this.tokens);
      adventurer.reportTokens();
  }
```

NO CHANGES 85

Class - Chest 6.6

```
  private void wrongAnswer(Question question, Adventurer adventurer) {
  /*
      Report the correct answer and remove some tokens
      from the given adventurer.
  */
      int   loss;

      System.out.println();
      System.out.println("A small loudspeaker appears in the air.");
      System.out.println("You hear the sound of a deep
  gong and a pleasant voice says:");
      System.out.print("Sorry, the correct answer is ");
      System.out.print(question.answer());
      System.out.println(".");
```


NO CHANGES 86

Class - Chest 6.7

```
      loss = Math.min(this.tokens, adventurer.tokens());
      System.out.print("You see ");
      System.out.print(loss);
      System.out.println(" valuable tokens fly out of your
  pocket and fall to the floor.");
      System.out.println("A small vacuum cleaner appears,
  sweeps up your scattered tokens and disappears.");
      adventurer.loseTokens(loss);
      adventurer.reportTokens();
  }
}
```


NO CHANGES 87

Class - Question 6.1

```
import java.util.*;
public class Question {
/*
   An instance of this class represents an arithmetic
   problem in the Arithmetic Adventure game.
*/

/* Constructor */
   public Question() {
   /*
       Initialize me so that I have two operands.
   */
       this.leftOperand = Question.generator.next(Question.maxOperand);
       this.rightOperand = Question.generator.next(Question.maxOperand);
   }
```


NO CHANGES 88

Class - Question 6.2

```
   /* Instance Methods */
   public boolean ask() {
   /*
       Pose myself. Return true if the user's response
       was correct and false otherwise.
   */
       Integer     answer;

       System.out.print(this.leftOperand);
       System.out.print(" + ");
       System.out.print(this.rightOperand);
       System.out.print(" = ");
       answer = Keyboard.in.readInteger();
       return answer.intValue() == this.answer();
}
```


NO CHANGES 89

Class - Question 6.3

```
   public int answer() {
   /*
       Answer my correct answer.
   */
       return this.leftOperand + this.rightOperand;
   }

/* Private Static Variables */
   private static final int maxOperand = 9;
   private static final RandomInt
       generator = new RandomInt(2);
/* Private Instance Variables */
   private int leftOperand;
   private int rightOperand;
```


NO CHANGES 90

Class - RandomInt 6.1

```
import java.util.*;
public class RandomInt {
/*
   An instance of this class represents a generator that
   can generate a series of random positive ints.
*/

/* Contsructor */
   public RandomInt(int seed) {
   /*
       Initialize me so that I use the given seed.
   */
       this.generator = new Random(seed);
   }
```

NO CHANGES 91

Class - RandomInt 6.2

```
/* Instance Methods */

  public int next(int max) {
  /*
      Answer a Random int between 1 and the given max.
  */

      return Math.round(max * this.generator.nextFloat() -
  0.5f) + 1;
  }

/* Private Instance Variables */
  private Random generator;
```


NO CHANGES 92

Class - Adventurer 6.1

```
public class Adventurer {
/*
  An instance of this class represents a player of the
  Adventure game.
*/

/* Constructors */
  public Adventurer(String name) {
  /*
      Initialize me with the given name and zero tokens.
  */
      this.name = name;
      this.tokens = 0;
  }
```


NO CHANGES 93

Class - Adventurer 6.2

```
/* Instance Methods */

  public String name() {
  /*
      Answer a String representing my name.
  */
      return this.name;
  }

  public int tokens() {
  /*
      Answer my number of Tokens.
  */
      return this.tokens;
  }
```


NO CHANGES 94

Class - Adventurer 6.3

```
  public void gainTokens(int anInt) {
  /*
      Add the given number of tokens to my total.
  */
      this.tokens = this.tokens + anInt;
  }

  public void loseTokens(int anInt) {
  /*
      Remove the given number of tokens from my total.
  */
      this.tokens = this.tokens - anInt;
  }
```


NO CHANGES 95

Class - Adventurer 6.4

```
  public void reportTokens() {
  /*
      Output the number of tokens I have.
  */
      System.out.print("You have ");
      System.out.print(this.tokens);
      System.out.println(" tokens in your pocket.");
  }

/* Private Instance Variables */

  private String name;
  private int tokens;
```