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CS/ENGRD 2110
SPRING 2018

Lecture 3: Fields, getters and setters, constructors, testing
http://courses.cs.cornell.edu/cs2110

CS2110 Announcements

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Assignment A1 on course Piazza Thursday morning.

Piazza: Check pinned Assignment A1 note often!

Take course S/U?

OK with us. Check with your advisor/major. To get an S, you need to do at least C– work. Do D+ work or less, you get a U.

Please don't email us about prelim conflicts! We'll tell you at the appropriate time how we handle them.

If you are new to the course and want to submit a quiz or assignment that is past due, talk to or email you TA and ask for an extension.

Assignment A1

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Write a class to maintain information about PhDs ---e.g. their advisor(s) and date of PhD. Pay attention today, you will do exactly what I do in creating and testing a class!

Objectives in brief:

- Get used to Eclipse and writing a simple Java class
- Learn conventions for Javadoc specs, formatting code (e.g. indentation), class invariants, method preconditions
- Learn about and use JUnit testing

Important: READ CAREFULLY, including Step 8, which reviews what the assignment is graded on.

Groups. You can do A1 with 1 other person. FORM YOUR GROUP EARLY! Use Piazza Note @5 to search for partner!

Homework (not to be handed in)

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1. Course website will contain classes Time and TimeTester. The body of the one-parameter constructor is not written. Write it. The one-parameter constructor is not tested in TimeTester. Write a procedure to test it.

2. Visit course website, click on Resources and then on Code Style Guidelines. Study

   1. Naming conventions

   3.3 Class invariant

   4. Code organization

      4.1 Placement of field declarations

   5. Public/private access modifiers

3. Look at slides for next lecture; bring them to next lecture

Difference between class and object

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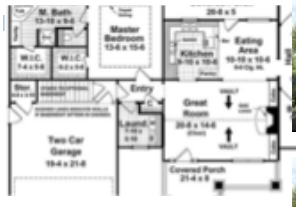

A blueprint, design, plan
A class

Can create many objects from the same plan (class). Usually, not all exactly the same.

A house built from the blueprint
An object

Overview

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- An object can contain variables as well as methods. Variable in an object is called a field.
- Declare fields in the class definition. Generally, make fields private so they can't be seen from outside the class.
- May add getter methods (functions) and setter methods (procedures) to allow access to some or all fields.
- Use a new kind of method, the constructor, to initialize fields of a new object during evaluation of a new-expression.
- Create a JUnit Testing Class to save a suite of test cases.

References in JavaHyperText entries

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Look at these JavaHyperText entries:

Declaration of fields: field

Getter/setter methods: getter setter

Constructors: constructor

Class String: toString

JUnit Testing Class: Junit

Overloading method names: overload

Overriding method names: override

class Time

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Object contains the time of day in hours and minutes.

Methods in object refer to fields in object.

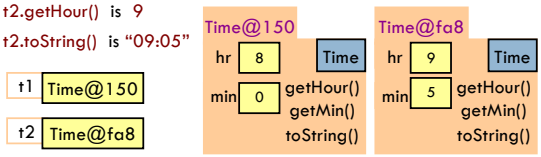
Could have an array of such objects to list the times at which classes start at Cornell.

With variables t1 and t2 below,

t1.getHour() is 8

t2.getHour() is 9

t2.toString() is "09:05"



Class Time

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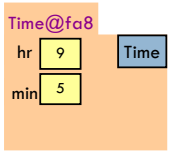
```
/** An instance maintains a time of day */
public class Time {
   private int hr;    //hour of the day, in 0..23
   private int min; // minute of the hour, in 0..59

}
```

Access modifier **private**:
can't see field from outside class
Software engineering principle:
make fields private, unless there is a real reason to make public



Class invariant

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Class invariant: collection of defs of variables and constraints on them (green stuff)

```
/** An instance maintains a time of day */
public class Time {
   private int hr;    // hour of the day, in 0..23
   private int min; // minute of the hour, in 0..59

}
```

Software engineering principle: Always write a clear, precise class invariant, which describes all fields.

Call of every method starts with class invariant true and should end with class invariant true.

Frequent reference to class invariant while programming can prevent mistakes.

Getter methods (functions)

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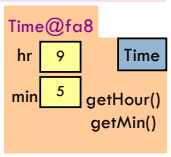
```
/** An instance maintains a time of day */
public class Time {
   private int hr;    // hour of the day, in 0..23
   private int min; // minute of the hour, in 0..59
   /** Return hour of the day */
   public int getHour() {
     return hr;
   }
   /** Return minute of the hour */
   public int getMin() {
     return min;
   }
}
```

Spec goes before method. It's a Javadoc comment —starts with /**



A little about type (class) String

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```
public class Time {
   private int hr;    //hour of the day, in 0..23
   private int min; // minute of the hour, in 0..59
   /** Return a represention of this time, e.g. 09:05*/
   public String toString() {
     return prepend(hr) + ":" + prepend(min);
   }
   /** Return i with preceding 0, if
       necessary, to make two chars. */
   private String prepend(int i) {
     if (i > 9 || i<0) return "" + i;
     return "0" + i;
   }
   …
```

Java: double quotes for String literals

Java: + is String catenation

Catenate with empty String to change any value to a String

"helper" function is private, so it can't be seen outside class

Concatenate or catenate?

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I never **concatenate** strings;
I just **catenate** those little things.
Of syllables few,
I'm a man through and through.
Shorter words? My heart joyfully sings!

Setter methods (procedures)

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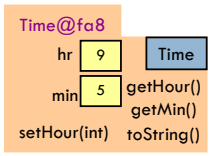
```
/** An instance maintains a time of day */
public class Time {
   private int hr;    //hour of the day, in 0..23
   private int min; // minute of the hour, in 0..59
   …
   /** Change this object's hour to h */
   public void setHour(int h) {
        hr= h;
   }
}
```

No way to store value in a field! We can add a "setter method"

setHour(int) is now in the object



Setter methods (procedures)

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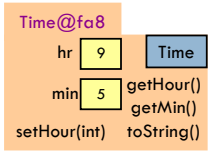
```
/** An instance maintains a time of day */
public class Time {
   private int hr;    //hour of day, in 0..23
   private int min; // minute of hour, in 0..59
   …
   /** Change this object's hour to h */
   public void setHour(int h) {
        hr= h;
   }
}
```

Do not say "set field hr to h"

User does not know there is a field. All user knows is that Time maintains hours and minutes. Later, we show an imple-mentation that doesn't have field h but "behavior" is the same



Test using a JUnit testing class

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In Eclipse, use menu item File → New → JUnit Test Case to create a class that looks like this:

```
import static org.junit.Assert.*;
import org.junit.Test;

public class TimeTester {
   @Test
   public void test() {
      fail("Not yet implemented");
   }
}
```

Select TimeTester in Package Explorer.

Use menu item Run → Run.

Procedure test is called, and the call fail(…) causes execution to fail:

Test using a JUnit testing class

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```
…
public class TimeTester {
   @Test
   public void testConstructor() {
      Time t1= new Time();
      assertEquals(0, t1.getHour());
      assertEquals(0, t1.getMin();
      assertEquals("00:00", t1.toString());
   }
}
```

Write and save a suite of "test cases" in TimeTester, to test that all methods in Time are correct

Store new Time object in t1.

Give green light if expected value equals computed value, red light if not:
assertEquals(expected value, computed value);

Test setter method in JUnit testing class

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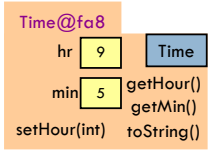
```
public class TimeTester {
   …

   @Test
   public void testSetters() {
      Time t1= new Time();
      t1.setHour(21);
      assertEquals(21, t1.getHour());
   }
}
```

TimeTester can have several test methods, each preceded by @Test.

All are called when menu item Run→ Run is selected



Constructors —new kind of method

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```
public class C {
   private int a;
   private int b;
   private int c;
   private int d;
   private int e;
}
```

```
C  var= new C();
var.setA(2);
var.setB(20);
var.setC(35);
var.setD(-15);
var.setE(150);
```

C has lots of fields. Initializing an object can be a pain —assuming there are suitable setter methods

Easier way to initialize the fields, in the new-expression itself. Use:

```
C var= new C(2, 20, 35, -15, 150);
```

But first, must write a new method called a constructor

Constructors —new kind of method

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```
/** An object maintains a time of day */
public class Time {
   private int hr;    //hour of day, 0..23
   private int min; // minute of hour, 0..59
   /** Constructor: an instance with
       h hours and m minutes.
       Precondition: h in 0..23, m in 0..59 */
   public Time(int h, int m) {
      hr= h;
      min= m;
   }
```

Purpose of constructor: Initialize fields of a new object so that its class invariant is true

Memorize!

Need precondition

No return type or void

Name of constructor is the class name

Time@fa8

hr 9 min 5 Time

getHour() getMin()
toString() setHour(int)
Time(int, int)

Revisit the new-expression

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Syntax of new-expression: **new** <constructor-call>

Example: **new** Time(9, 5)

Evaluation of new-expression:

1. Create a new object of class, with default values in fields
2. Execute the constructor-call
3. Give as value of the expression the name of the new object

Time@fa8

hr 9 min 5 Time

getHour() getMin()
toString() setHour(int)
Time(int, int)

If you do not declare a constructor, Java puts in this one:
public <class-name> () { }

How to test a constructor

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Create an object using the constructor. Then check that all fields are properly initialized —even those that are not given values in the constructor call

```
public class TimeTester {
   @Test
   public void testConstructor1() {
      Time t1= new Time(9, 5);
      assertEquals(9, t1.getHour());
      assertEquals(5, t1.getMin();
   }
   …
}
```

Note: This also checks the getter methods! No need to check them separately.

But, main purpose: check constructor

A second constructor

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```
/** An object maintains a time of day */
public class Time {
   private int hr;    //hour of day, 0..23
   private int min; // minute of hour, 0..59
   /** Constructor: an instance with
       m minutes.
       Precondition: m in 0..(23*60 +59) */
   public Time(int m) {
      hr= m/60; min= m%60;
      ??? What do we put here ???
   }
   …
```

Time is overloaded: 2 constructors! Have different parameter types. Constructor call determines which one is called

```
new Time(9, 5)
new Time(125)
```

Time@fa8

hr 9 min 5 Time

getHour() getMin()
toString() setHour(int)
Time(int, int) Time (int)

Generate javadoc

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- With project selected in Package explorer, use menu item Project -> Generate javadoc
- In Package Explorer, click on the project -> doc -> index.html
- You get a pane with an API like specification of class Time, in which javadoc comments (start with /**) have been extracted!
- That is how the API specs were created.

Method specs should not mention fields

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```
public class Time {
  private int hr;   //in 0..23
  private int min; //in 0..59
  /** return hour of day*/
  public int getHour() {
    return h;
  }
```

Time@fa8: hr 9, min 5; setHour(int) getMin() toString() getHour() — Time

Decide to change implemen -tation

```
public class Time {
  // min, in 0..23*60+59
  private int min;
  /** return hour of day*/
  public int getHour() {
    return min / 60;
  }
```

Time@fa8: min 545; getHour() getMin() toString() setHour(int) — Time

Specs of methods stay the same. Implementations, including fields, change!

Next week's section: Exception Handling

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Suppose we are supposed to read an integer from the keyboard and do something with it. If the user types something other than an integer, we want to ask the user again to type a integer.

```
String st= the integer from the keyboard;
int k= Integer.parseInt(st);  // return the int that is in st
```

```
public static int parseInt(String s) {
  …
  …
  …
}
```

user typed "x13", it was discovered here

parseInt doesn't know what to do with the error

Next week's section: Exception Handling

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Read an integer from keyboard. If user types something other than an integer, ask user again to type a integer.

```
String st= the integer from the keyboard;
int k= Integer.parseInt(st);  // return int that is in st
```

```
public static int parseInt(String s) {
  …
  …
  …
}
```

You will learn how the caller can catch the exception and ask user again to type an int

NFE@2 — Throwable — Exception — NumberFormatException

user typed "x13", it was discovered here

parseInt doesn't know what to do with the error

So it creates and *throws* a NumberFormatException to the caller. parseInt is then terminated. It's done.

Next week's section: Exception Handling

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You must read/watch the tutorial BEFORE the recitation:

Look at the pinned Piazza note Recitation/Homework.

Bring your laptop to class, ready to answer questions, solve problems. The questions will be on the course website the night before section (Monday evening).

During the section, you can talk to neighbors, discuss things, answer questions together. The TA will walk around and help. The TA will give a short presentation on some issue if needed.

You will have until Friday after the recitation to submit answers on the CMS.