CMSC 131: Chapter 14: Supplement
Classes III and System Design

Accessors and Mutators (Review)

Conventions:

Accessors: Methods that read (return) class data (without modifying).
Mutators: Methods that modify or update the values of a class data.

Examples:

Accessor: `int getMonth( ) { return month; }`
Mutator: `void incrementYear( ) { year++; }`

Accessors and Efficiency

It would seem that requiring each access to month, day, or year to use method call and return would be very inefficient.

Why not:

- The class designer is **free to change the internal representation**, without altering the class user's view of the class. **Example**:

```
public int getMonth( ) { return month + 1; }
public void setMonth( int m ) { month = m - 1; }
```

- A **good Java compiler** can identify these very short methods, and expand the code "**in-line**".

Example: Date2

To illustrate these concepts we define an enhanced class, **Date2**. It adds:

Public accessors:
getMonth( ), getDay( ), getYear( )

Public mutators:
setMonth(m), setDay(d), setYear(y)

Example: Date2.java

```
public class Date2 {
   private int month;
   private int day;
   private int year;

   /* Existing methods (details omitted, but all are the same as before) */
   public Date2( int m, int d, int y ) { … }
   public String toString( ) { … }
   public boolean equals( Date2 d ) { … }

   /* Accessors */
   public int getMonth( ) { return month; }
   public int getDay( ) { return day; }
   public int getYear( ) { return year; }

   /* Mutators */
   public void setMonth( int m ) { month = m; }
   public void setDay( int d ) { day = d; }
   public void setYear( int y ) { year = y; }
}
```

Example: Date2Demo.java

```
public class Date2Demo {

   public static void main( String[ ] args ) {
         Date2 bobsBDay = new Date2( 7, 18, 1985 );          // July 18, 1985
         Date2 carolsBDay = new Date2( 3, 23, 1985 );        // March 23, 1985
         final int DRINKING_AGE = 21;                // Legal drinking age

         System.out.println( "Carol was born in " + carolsBDay.getYear( ) );
         Date2 bobsFirstBeer = new Date2(
                                   bobsBDay.getMonth( ),
                                   bobsBDay.getDay( ),
                                   bobsBDay.getYear( ) + DRINKING_AGE );
         System.out.println( "Bob's first (legal) beer on " + bobsFirstBeer );
   }
}
```

Hierarchical Program Structure [see picture]

Hiding

When can things have the same name?

- **Methods** can have the same name (if parameter signatures differ)
- **Instance variables cannot** have the same name (in the same class)
- **Local variables cannot** have the same name (in the same method)

- How about an **instance variable** and **local variable**?

```
public class FooBar {
    private int data1;              // instance variable
    public void someMethod( ) {
        double data1;               // is this allowed?
        data1 = 5;                  // which data1 is altered?
    }
}
```

- **This is allowed**. The local variable takes precedence, and **hides** the instance variable.
- You can **explicitly** access the instance variable from within someMethod( ) using **this.data1**.

Wrappers

Java variables are either:

Primitive types (int, float, double, …):

Class Objects (String, Date, Rational, …):

Wouldn't it be nice if we could associate **methods** with **primitive types**?

Wrappers

Wrappers: Each class "wraps" a class around a primitive type.

Primitive type	Wrapper
byte	Byte
short	Short
int	Integer
long	Long
double	Double
char	Character
boolean	Boolean

Wrapper Methods

Each Wrapper provides a number of useful methods.

Integer Wrapper: (other numeric wrappers are similar)

Constructor:
```
Integer x = new Integer( 324 );
```
(no default constructor is provided)

Max and min:
```
Integer.MAX_VALUE      largest positive int
Integer.MIN_VALUE      smallest negative int
```

Conversions:
```
byte b = x.byteValue( );     cast x to byte
double d = x.doubleValue( ); cast x to double
int i = x.intValue( );       return integer value
…
```

Convert string to int:
```
int k = Integer.parseInt( "123" );
```

Convert int to string in various bases:
```
String s1 = Integer.toBinaryString( 21 );     base 2
String s2 = Integer.toHexString( 21 );        base 16
String s3 = Integer.toOctalString( 21 );      base 8
```

Computing and Programs

Review:
- **Software lifecycle**
- **Incremental** (stepwise) **design**
- **Pseudocode** and **flowcharting**
- **Prototyping** and **testing**

Today we take a **wider view** of program development.

Two principal aspects of program design:

A single computational entity:

Coordinating a community of entities:

A Single Computational Entity

Consider a **single computational entity** to solve a specific problem. The method used to solve the problem is called an **algorithm**.

Example: Make a peanut butter and jelly sandwich:

- Get a loaf of bread
- Remove two slices
- Get a jar of peanut butter
- Get a knife
- Open the jar
- Using the knife, get some peanut butter and spread it on one slice
- …blah, blah, blah

There is essentially **one sequential process** being described.

System Design: What is it?

System Design: Is concerned with coordinating a community of computational entities to achieve a complex process.

Single entity ←→ Make a sandwich
System design ←→ Run a restaurant

Running a restaurant involves the **coordinated interaction** of many entities:

- **Owner**
- **Chefs**
- **Waiters**
- **Diners**

System Design: What is it?

System Design: Identifying entities, assigning responsibilities, defining how these entities act and interact with each other.

Other Examples of Systems:

Classroom environment: Lecturers, TAs, students, …
Library: Circulation (checkout and return), indexing services (online catalogue), library users, book buyers, shelvers, …
Pharmacy: Patients (and medical records), pharmacists, doctors, drug retailers, the pharmacy (products in stock), …
Video game: Race cars, motorcycles, warriors, space ships, death squads, monsters, aliens, mutants, guns, swords, weapons of mass destruction, cute Japanese cartoon animals with huge eyes, …

Essential Questions

Challenges:

Essential Questions:

- What is the **desired behavior** of the program (as a whole)?
- What are the **entities** that produce this behavior?
- How does each one **work**?
- How do these entities **interact**?

Behavior

Specifying Desired Behavior: A **use case** is a description of the interaction of a user and the system. It includes:

- **Prerequisites (pre-conditions)**:
- **Possible actions and interactions**:
- **Effects (post-conditions)**:

Example: Customer in a restaurant.

- **Pre-conditions**:
  Customer: hungry and has money
  Restaurant: has food
- **Actions**: get menu, order food, be served, eat, pay, leave
- **Post-conditions**:
  Customer: less hungry and less money
  Restaurant: more money and less food.

Principal Design Elements

Components:

- What are the entities that make up our system?
- What are the roles they play?
- How do we separate the system into distinct units?

Contract: What are the responsibilities and services associated with each component? What guarantees does it make?

State: What is the current status/state of the units that define our system?

Communication: How components request interactions with each other?

Example: **Pharmacy Store System**

Components: Pharmacist, customers, doctors, prescription, store stock.

Fill-prescription Contract: A valid prescription is presented by the customer. Check patient records and inform of possible side-effects. Dispense the prescription. Update patient records. Deliver medication to patient.

State: For a patient: Current prescriptions, number of times refilled, date of last refill, health insurance information.

Relationship to Java

System: Java **program**

Components (or **community members**): Java **class objects**

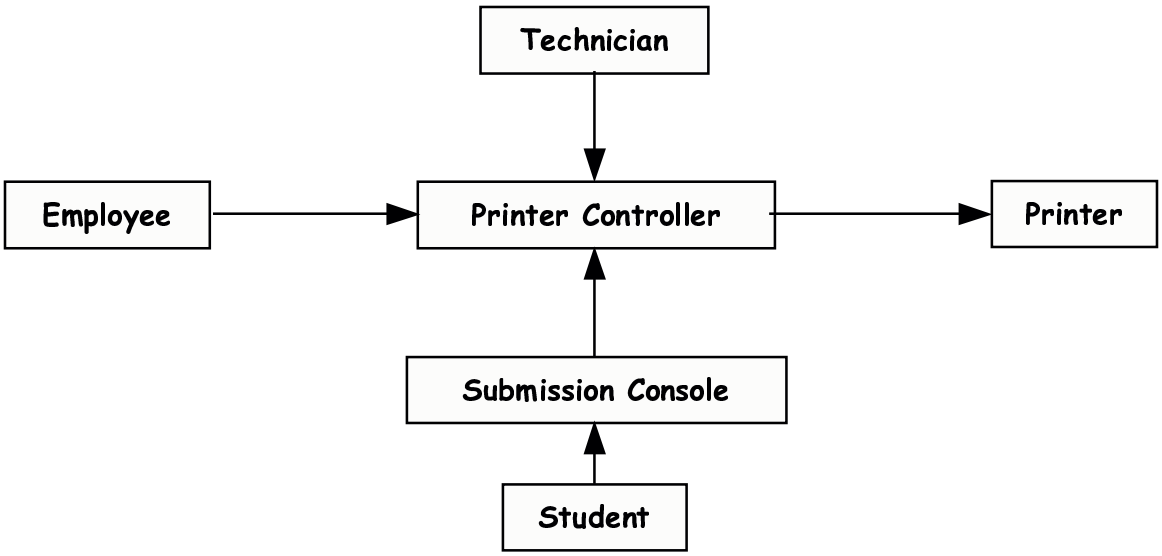
State: Stored in class **instance variables**.

Contract (or **specification**): This is called an **API** (Application Programmer Interface), or simply an **interface**. This is the **external** (class user) **view** of an object.

The contract is implemented by the object's class **methods**.

Printer Controller Example

Printer System: A printer system used by students to print projects, homeworks, etc. Students enter a room where the printer resides. Students submit requests from a special console. An employee operates a printer controller, and hands out a print job submitted by students. A technician maintains the printer controller if it breaks.



Printer Controller Example

Use Case Example 1: A student prints a document

Pre-conditions (prerequisites): A **document exist** and is ready to be printed.

Actions:

if (there is **space available** in the printer queue)
- specify **name of document** to print through the console
- printer controller accesses document and **sends it to the printer**

else
- printing of the document **does not** occur
- an appropriate **error message** is generated on the console

Post-conditions (effects):
a document has been printed
– or –
an error message has been generated.

Printer Controller Example

Use Case Example 2: A technician fixes a printer problem

Pre-conditions (prerequisites): A **problem** has been identified in the printer controller.

Actions:
- A technician enters his **password** in the printer controller (to gain access to the system).
- The technician asks for a **status report** from the controller.
- The nature of the **problem is identified**.
- The technician proceeds to **repair** the problem area in the printer.

Post-conditions (effects): The printer is **now operational**. The controller reflects the new status.

Printer Controller Example

Use Case Example 3: An employee picks up a student print-out

Pre-conditions (prerequisites): A document has been sent to the printer by a student through the console.

Actions:

- a student inquires about his/her particular document
- the employee checks the stack of printed documents in the printer tray.
- if document is found
  - the document is handed to the student
- else
  - student is informed that the document is not printed

Post-conditions (effects): A student has a printed document or has been informed that the document is not been printed.

Printer Controller Example: Components

Examples of some Components:

Name: **Printer**
Description: Provide paper printouts of documents.
State: Paper quantity and other printer status information.

Name: **Printer Controller**
Description: Used by the Employee and Technician to interact with printer.
State: Must keep track of documents to be processed documents already finished, and status of the printer.

Name: **Printer Request Console**
Description: Used by students to submit a document to print.
State: The set of user's allowed in the system, and the set of students that are currently in the system.

Printer Controller Example: Interactions

Examples of some Interactions:

Interaction 1: Controller and Printer

The controller sends documents to process to the printer. It also gathers status information from the printer which is made available to the employee or technician.

Interaction 2: Console and Controller

The console sends a query to the controller which determines whether the document can be printed or not. It schedules the job to be printed. Status information about the job is sent back to the console.