Software Engineering

(Chap. 1)

Object-Centered Design

When we prepare a program, the experience can be just like composing poetry or music … My claim is that it is possible to write grand programs, noble programs, truly magnificent ones! … Computer programming is an art.

- Donald Knuth, "Programming as an Art", 1974

Problem Solving

Let's solve this *temperature-conversion problem*:

Write a program that, given a temperature in Celsius, displays that temperature in Fahrenheit.

5 Phases of Software Life Cycle:

- Problem Analysis and Specification
- Design ← **OCD (Object-Centered Design)**
- Implementation (Coding)
- Testing, Execution and Debugging
- Maintenance

OCD in a Nutshell

- Behavior
- Objects
- Operations
- Algorithm

Using OCD

Behavior

A. Describe the desired behavior of the program:

Our program should display a prompt for the Celsius temperature on the screen, read that temperature from the keyboard, compute the corresponding Fahrenheit temperature, and display that temperature along with a descriptive label on the screen.

Using OCD

Objects

B. Identify the *nouns* in the behavioral description:

> Our program should display a prompt for the Celsius temperature on the screen, read that temperature from the keyboard, compute the corresponding Fahrenheit temperature, and display that temperature along with a descriptive label on the screen.

These make up the *objects* in our program.

5

Using OCD

Operations

C. Identify the *verbs* in the behavioral description:

> Our program should display a prompt for the Celsius temperature on the screen, read that temperature from the keyboard, compute the corresponding Fahrenheit temperature, and display that temperature along with a descriptive label on the screen.

These make up the *operations* in our program.

6

Using OCD

Algorithm

D. Organize the objects and operations into a sequence of steps that solves the problem, called an *algorithm*.

1. Ask *the screen* to display *a prompt* for *the Celsius temperature* on *the screen*.
2. Ask *the keyboard* to read *the temperature*.
3. Compute *the Fahrenheit temperature* from *the Celsius temperature*.
4. Ask *the screen* to display *the Fahrenheit temperature*, plus an *informative label* on *the screen*.

7

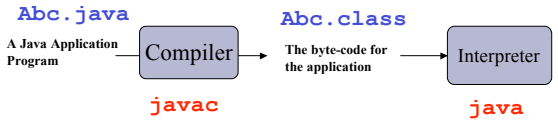
Don't even think about coding until you're sure of your algorithm.

Coding

- We now translate the algorithm into an HLL.
- Use the features of the Java language to:
  - represent our objects
  - perform our operations
- Java provides two implementation methods:
  - Java **applications**
  - Java **applets** (Sec. 1.3)

Java Applications

- Programming languages traditionally allow programmers to write stand-alone applications.
- In Java, these are called *applications*.



Representing Objects

Determine a **type and name** for each object:

ObjectJava TypeNamethe programa promptthe Celsius ten

Performing Operations

Identify the Java operator to perform a given operation, if there is one…

OperationLibrary?Name Display a stringRead a doubleComp

To compute the Fahrenheit temperature, we need to find the Celsius to Fahrenheit formula in a reference book...

fahrenheit = (9/5)*celsius* + 32

Operations (Revised)

We can now add more detail to the computation:

Operation	Library?	Name
Display a string	`ann.easyio`	`print()`
Read a double	`ann.easyio`	`readDouble()`
Compute fahrenheit	--	--
Divide two ~~ints~~ doubles	built-in	/
Multiply two doubles	built-in	*
Add two doubles	built-in	+
Display a double	`ann.easyio`	`print()`

COMPILATION HINT

- Use the tools available to you.
- Specifically, use `M-x compile` in xemacs.
  - Use `C-x` ` (or middle mouse button) to run through the error messages.
    - Xemacs will automatically go to the next message.
    - It will even load in the proper file and go to the offending line.
    - Why do you want to do this work?
  - Run only one session of xemacs; open multiple files into the same session.
  - If you aren't comfortable or used to it, practice.

The Code

Objects? Operations?

```
/* Temperature.java converts Celsius
 *      temperatures to Fahrenheit.
 * Author: Keith Vander Linden
 * Date:   2 June 2001
 * Modified: L. Nyhoff, Sept. 2002
 */

import ann.easyio.*;  // Screen & Keyboard classes

class Temperature extends Object
{
    public static void main(String [] args)
    {
        Screen theScreen = new Screen();
        theScreen.print("Welcome to the temperature converter!\n" +
                        "Please enter the temperature in Celsius: ");

        Keyboard theKeyboard = new Keyboard();
        double celsius = theKeyboard.readDouble();

        double fahrenheit = ((9.0/5.0)*celsius) + 32;

        theScreen.print(celsius + " degrees Celsius is " +
                        fahrenheit + " degrees Fahrenheit.\n" +
                        "It's been a pleasure!\n");
    }
}
```

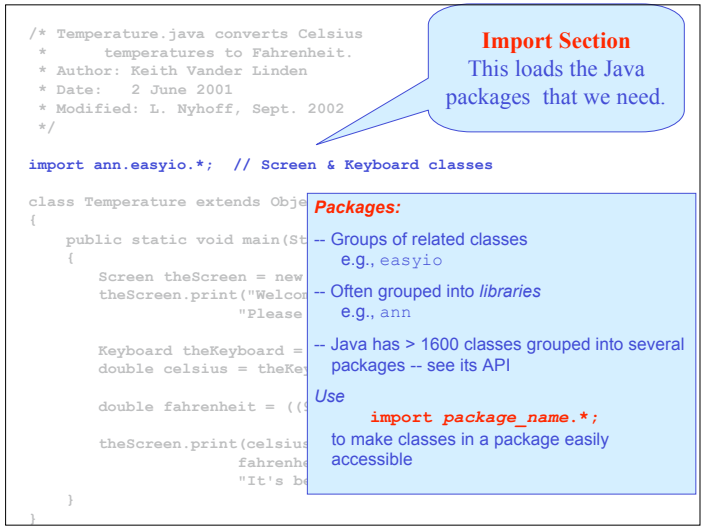
Documentation
Always begin a file with an *opening comment* similar to this..

3 Kinds of Comments:

`/*...*/` multi-line comment
`//` single-line comment
-- indicate what classes of a package are used.
-- explain obscure code

`/**...*/` Javadoc multi-line comment
`javadoc` program extracts these into special documentation.format
-- see Java'sAPI (Section 2.4)

Compiler ignores all comments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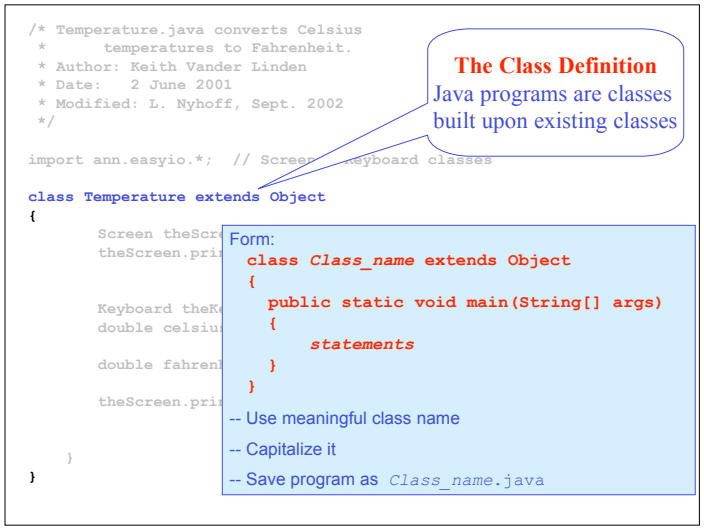
double fahrenheit = ((
theScreen.print(celsius
fahrenhe
"It's be
}
}
Import Section
This loads the Java packages that we need.
Packages:
-- Groups of related classes
e.g., easyio
-- Often grouped into libraries
e.g., ann
-- Java has > 1600 classes grouped into several packages -- see its API
Use
import package_name.*;
to make classes in a package easily accessible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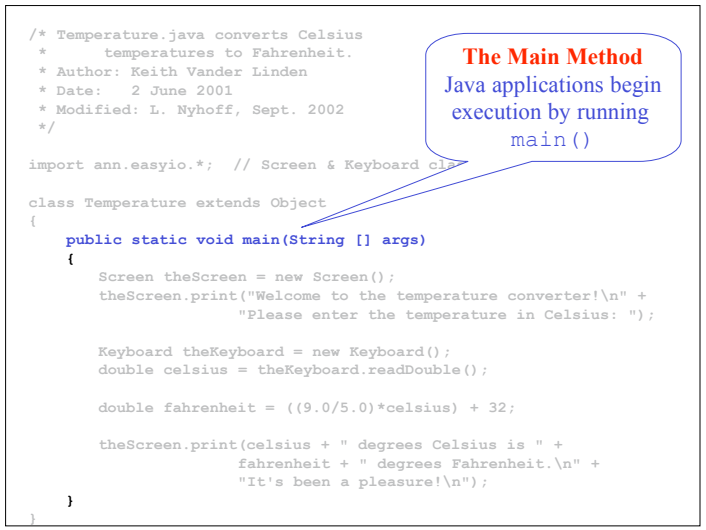
theScreen.pri
Keyboard theK
double celsiu
double fahren
theScreen.pri
}
}
The Class Definition
Java programs are classes built upon existing classes
Form:
class Class_name extends Object
{
public static void main(String[] args)
{
statements
}
}
-- Use meaningful class name
-- Capitalize it
-- Save program as Class_name.java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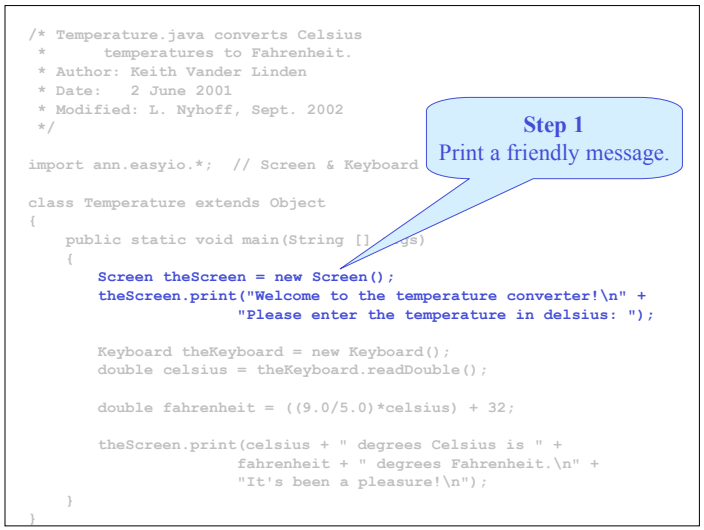
double celsius = theKeyboard.readDouble();
double fahrenheit = ((9.0/5.0)*celsius) + 32;
theScreen.print(celsius + " degrees Celsius is " +
fahrenheit + " degrees Fahrenheit.\n" +
"It's been a pleasure!\n");
}
}
The Main Method
Java applications begin execution by running main()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double celsius = theKeyboard.readDouble();
double fahrenheit = ((9.0/5.0)*celsius) + 32;
theScreen.print(celsius + " degrees Celsius is " +
fahrenheit + " degrees Fahrenheit.\n" +
"It's been a pleasure!\n");
}
}
Step 1
Print a friendly message.

```
/* Temperature.java converts Celsius
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        double fahrenheit = ((9.0/5.0)*celsius) + 32;

        theScreen.print(celsius + " degrees Celsius is " +
                        fahrenheit + " degrees Fahrenheit.\n" +
                        "It's been a pleasure!\n");
    }
}
```

Step 2
Read the Celsius temperature.

```
/* Temperature.java converts Celsius
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class Temperature extends Object
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        double celsius = theKeyboard.    Double();

        double fahrenheit = ((9.0/5.0)*celsius) + 32;

        theScreen.print(celsius + " degrees Celsius is " +
                        fahrenheit + " degrees Fahrenheit.\n" +
                        "It's been a pleasure!\n");
    }
}
```

Step 3
Calculate the
Fahrenheit temperature.

```
/* Temperature.java converts Celsius
 *      temperatures to Fahrenheit.
 * Author: Keith Vander Linden
 * Date:   2 June 2001
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 */

import ann.easyio.*;  // Screen & Keyboard classes

class Temperature extends Object
{
    public static void main(String [] args)
    {
        Screen theScreen = new Screen
        theScreen.print("Welcome to t
                        "Please enter

        Keyboard theKeyboard = new Keyboa
        double celsius = theKeyboard.rea    e();

        double fahrenheit = ((9.0/5.0  celsius) + 32;

        theScreen.print(celsius + " degrees Celsius is " +
                        fahrenheit + " degrees Fahrenheit.\n" +
                        "It's been a pleasure!\n");
    }
}
```

Step 4
Display the results.

Running the Program

You can now run your application:

```
Welcome to the temperature converter!
Please enter the temperature in Celsius: 20
20.0 degrees Celsius is 68.0 degrees Fahrenheit.
It's been a pleasure!
```

Testing

- Getting your code to compile and run is not the main goal.
- Rather, your goal is to produce a useful program that is:
  - correct
  - efficient
  - readable
  - usable

Running Test Cases

Do many tests on "interesting" data points.

```
Welcome to the temperature converter!
Please enter the temperature in Celsius: 0
0.0 degrees Celsius is 32.0 degrees Fahrenheit.
It's been a pleasure!

Welcome to the temperature converter!
Please enter the temperature in Celsius: -17.78
-17.78 degrees Celsius is -0.0040000000000048885
degrees Fahrenheit.
It's been a pleasure!
```

Writing Code

- Comments (`/* ... */` or `//`) are completely ignored by the compiler.
- Whitespace matters only two places:
  - Inside quotes, and
  - In comment delimiters (`/*`, `*/`, `//`).
- A semi-colon indicates the end of a program statement.

COMPILATION HINT

- Forgotten or extra semi-colons confuse the compiler.
- The compiler never recognizes that there's a semi-colon problem; it usually won't say what's wrong.
- Usually a "parse error" is an indication that the *previous* line of code is missing a semi-colon or has one it shouldn't.