Building Java Programs

Chapter 1
Lecture 1-2: Static Methods, Avoiding Redundancy

reading: 1.4 - 1.5
self-check: 16-25
exercises: #5-10
videos: Ch. 1 #1

Today

- A couple odds and ends:
  - Print blank lines with `System.out.println();`
  - Comments: why and details
- Methods
  - Why
    - To provide logical structure
    - To avoid redundancy
  - How
    - Defining methods
    - Calling methods
  - Idea of *control flow*
- Program-design practice: drawing figures

Comments

- **comment**: A note written in source code by the programmer to describe or clarify the code.
  - Not executed when your program runs.
- Syntax:

```
// comment text, on one line
```

or,

```
/* comment text; may span multiple lines */
```

- Examples:

```
// This is a one-line comment.

/* This is a
   two-line comment. */
```

Using comments

- Where to place comments:
  - at the top of each file (a "comment header")
  - at the start of every method (seen later)
  - to explain complex pieces of code

- Comments are useful for:
  - Understanding larger, more complex programs.
  - Multiple programmers working together, who must understand each other's code.

Comments example

```
/* Suzy Student, CSE142, Spring 2009
   This program prints lyrics about ... something. */

public class BaWitDaBa {
    public static void main(String[] args) {
        // first verse
        System.out.println("Bawitdaba");
        System.out.println("da bang a dang diggy diggy");
        System.out.println();

        // second verse
        System.out.println("diggy said the boogy");
        System.out.println("said up jump the boogy");
    }
}
```

Algorithms

- **algorithm**: Exact description for how to produce an answer.
- Example algorithm: "How to make sugar cookies"
  - Mix the dry ingredients.
  - Cream the butter and sugar.
  - Beat in the eggs.
  - Stir in the dry ingredients.
  - Set the oven temperature.
  - Set the timer.
  - Put the cookies in the oven.
  - Allow the cookies to bake.
  - Spread frosting and sprinkles onto the cookies.
  - ...

Java version

```
// This program prints a sugar-cookie recipe
public class BakeCookies {
    public static void main(String[] args) {
        System.out.println("Mix the dry ingredients.");
        System.out.println("Cream the butter and sugar.");
        System.out.println("Beat in the eggs.");
        System.out.println("Stir in the dry ingredients.");
        System.out.println("Set the oven temperature.");
        System.out.println("Set the timer.");
        System.out.println("Place a batch of cookies into the oven.");
        System.out.println("Allow the cookies to bake.");
        System.out.println("Mix ingredients for frosting.");
        System.out.println("Spread frosting and sprinkles.");
    }
}
```

First problem

- Our cookie algorithm (in text or Java) is *unstructured*
  - Lots of small steps not grouped into understandable parts
- **structured algorithm**: Split into coherent tasks.

  1 Make the cookie batter.
  - Mix the dry ingredients.
  - Cream the butter and sugar.
  - Beat in the eggs.
  - Stir in the dry ingredients.

  2 Bake the cookies.
  - Set the oven temperature.
  - Set the timer.
  - Place the cookies into the oven.
  - Allow the cookies to bake.

  3 Add frosting and sprinkles.
  - Mix the ingredients for the frosting.
  - Spread frosting and sprinkles onto the cookies.

  ...

Structured algorithms

- **structured algorithm**: Split into coherent tasks.

  1 Making cookie batter
  - Mix the dry ingredients.
  - Cream the butter and sugar.
  - Beat in the eggs.
  - Stir in the dry ingredients.

  2 Baking cookies
  - Set the oven temperature.
  - Set the timer.
  - Place the cookies into the oven.
  - Allow the cookies to bake.

  3 Decorating cookies
  - Mix the ingredients for the frosting.
  - Spread frosting and sprinkles onto the cookies.

  ...

Second Java version

```
// This program prints a sugar-cookie recipe
public class BakeCookies {
    public static void main(String[] args) {
        // Print the part about batter making
        System.out.println("Mix the dry ingredients.");
        System.out.println("Cream the butter and sugar.");
        System.out.println("Beat in the eggs.");
        System.out.println("Stir in the dry ingredients.");

        // Print the part about baking
        System.out.println("Set the oven temperature.");
        System.out.println("Set the timer.");
        System.out.println("Place a batch of cookies into the oven.");
        System.out.println("Allow the cookies to bake.");

        // Print the part about frosting
        System.out.println("Mix ingredients for frosting.");
        System.out.println("Spread frosting and sprinkles.");
    }
}
```

Second problem

- Our cookie algorithm doesn't have reusable parts
- Consider making a double batch...
  - Mix the dry ingredients.
  - Cream the butter and sugar.
  - Beat in the eggs.
  - Stir in the dry ingredients.
  - Set the oven temperature.
  - Set the timer.
  - Place the first batch of cookies into the oven.
  - Allow the cookies to bake.
  - Set the timer.
  - Place the second batch of cookies into the oven.
  - Allow the cookies to bake.
  - Mix ingredients for frosting.
  - ...

Java version

```
// This program prints a sugar-cookie recipe
public class BakeCookies {
    public static void main(String[] args) {
        System.out.println("Mix the dry ingredients.");
        System.out.println("Cream the butter and sugar.");
        System.out.println("Beat in the eggs.");
        System.out.println("Stir in the dry ingredients.");

        System.out.println("Set the oven temperature.");
        System.out.println("Set the timer.");
        System.out.println("Place a batch of cookies into the oven.");
        System.out.println("Allow the cookies to bake.");

        System.out.println("Set the oven temperature.");
        System.out.println("Set the timer.");
        System.out.println("Place a batch of cookies into the oven.");
        System.out.println("Allow the cookies to bake.");

        System.out.println("Mix ingredients for frosting.");
        System.out.println("Spread frosting and sprinkles.");
    }
}
```

Removing redundancy

- A well-structured algorithm can describe repeated tasks with less redundancy.

1 Making cookie batter.
- Mix the dry ingredients.
- ...

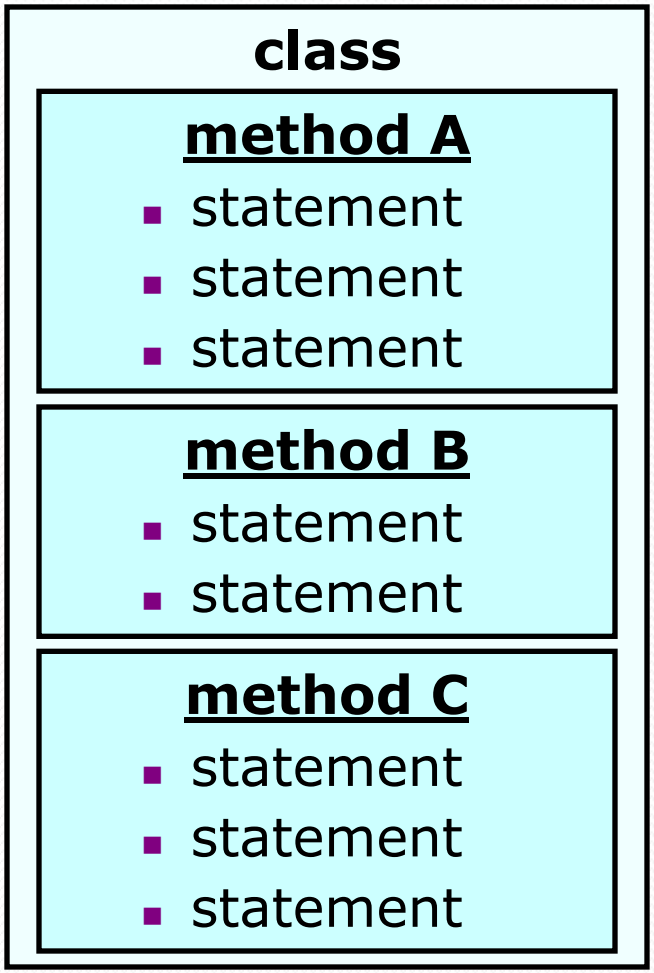
2 Baking cookies.
- Set the oven temperature.
- Set the timer.
- ...

3 Decorating cookies.

Making a single batch: (1), then (2), then (3)
Making a double batch: (1), then (2), then (2), then (3)

Static methods

- **static method**: A named group of statements.
  - denotes the *structure* of a program
  - eliminates *redundancy* by code reuse
  - **procedural decomposition**: dividing a problem into methods
- Writing a static method is like adding a new command to Java.



Using static methods

1. Design the algorithm.
   - Look at the structure, and which commands are repeated.
   - Decide what are the important overall tasks.

2. **Define** (write down) the methods.
   - Arrange statements into groups and give each group a name.

3. **Call** (run) the methods.
   - The program's `main` method executes the other methods to perform the overall task.

Final cookie program

```
// This program displays a delicious recipe for baking cookies.
public class BakeCookies3 {
    public static void main(String[] args) {
        makeBatter();
        bake();         // 1st batch
        bake();         // 2nd batch (remove for single batch)
        decorate();
    }

    // Step 1: Make the cake batter.
    public static void makeBatter() {
        System.out.println("Mix the dry ingredients.");
        System.out.println("Cream the butter and sugar.");
        System.out.println("Beat in the eggs.");
        System.out.println("Stir in the dry ingredients.");
    }

    // Step 2: Bake a batch of cookies.
    public static void bake() {
        System.out.println("Set the oven temperature.");
        System.out.println("Set the timer.");
        System.out.println("Place a batch of cookies into the oven.");
        System.out.println("Allow the cookies to bake.");
    }

    // Step 3: Decorate the cookies.
    public static void decorate() {
        System.out.println("Mix ingredients for frosting.");
        System.out.println("Spread frosting and sprinkles.");
    }
}
```

Declaring a method

Gives your method a name so it can be executed

- Syntax:

```
public static void name() {
    statement;
    statement;
    ...
    statement;
}
```

- Example:

```
public static void printWarning() {
    System.out.println("This product causes cancer");
    System.out.println("in lab rats and humans.");
}
```

Calling a method

Executes the method's code

- Syntax:

```
name();
```

  - You can call the same method many times.

- Example:

```
printWarning();
```

  - Output:

```
This product causes cancer
in lab rats and humans.
```

Program with static method

```
public class RepeatIt {
    public static void main(String[] args) {
        rap();                      // Calling (running) the rap method
        System.out.println();
        rap();                      // Calling the rap method again
    }

    // This method prints the lyrics to my favorite song.
    public static void rap() {
        System.out.println("Now this is the story all about how");
        System.out.println("My life got flipped turned upside-down");
    }
}
```

Output:

```
Now this is the story all about how
My life got flipped turned upside-down

Now this is the story all about how
My life got flipped turned upside-down
```

Methods calling methods

```
public class MethodsExample {
    public static void main(String[] args) {
        message1();
        message2();
        System.out.println("Done with main.");
    }

    public static void message1() {
        System.out.println("This is message1.");
    }

    public static void message2() {
        System.out.println("This is message2.");
        message1();
        System.out.println("Done with message2.");
    }
}
```

- Output:

```
This is message1.
This is message2.
This is message1.
Done with message2.
Done with main.
```

Control flow

- When a method is called, the program's execution...
  - "jumps" into that method, executing its statements, then
  - "jumps" back to the point where the method was called.

```
public class MethodsExample {
    public static void main(String[] args) {
        message1();

        message2();

        System.out.println("
    }

    ...
}
```

```
public static void message1() {
    System.out.println("This is message1.");
}
```

```
public static void message2() {
    System.out.println("This is message2.");
    message1();

    System.out.println("Done with message2.");
}
```

```
public static void message1() {
    System.out.println("This is message1.");
}
```

When to use methods

- Place statements into a static method if:
  - The statements are related structurally, and/or
  - The statements are repeated.

- You should not create static methods for:
  - An individual `println` statement.
  - Unrelated or weakly related statements.
    (Consider splitting them into two smaller methods.)

- The order of methods in a class does *not* matter to Java
  - Pick a sensible order for humans
  - Example: main either at top or bottom (let's say top)

Drawing complex figures with static methods

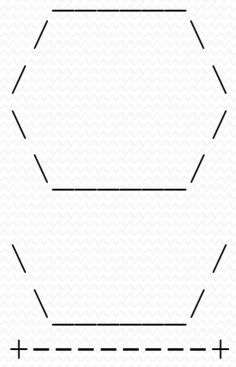
reading: 1.5
(Ch. 1 Case Study: `DrawFigures`)

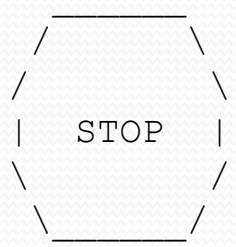
exercises: #7-9

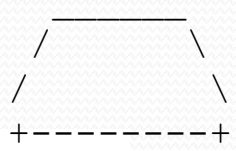
videos: Ch. 1 #2

Static methods question

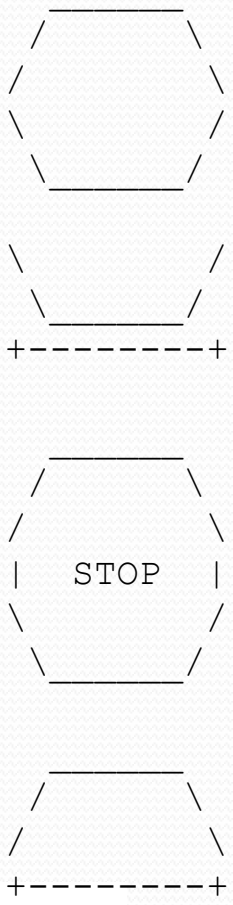
- Write a program to print these figures using methods.







Development strategy



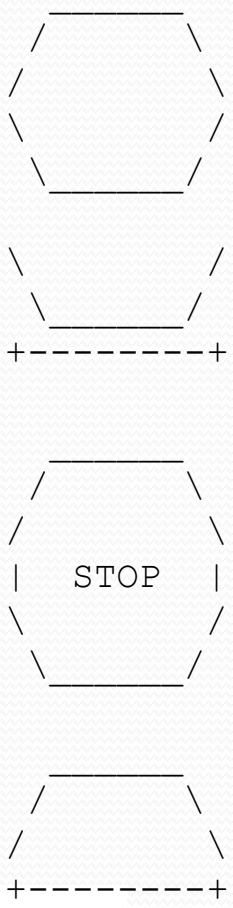
First version (unstructured):

- Create an empty program and `main` method.
- Copy the expected output into it, surrounding each line with `System.out.println` syntax.
- Run it to verify the output.

Program version 1

```
public class Figures1 {
    public static void main(String[] args) {
        System.out.println("  ______");
        System.out.println(" /      \\");
        System.out.println("/        \\");
        System.out.println("\\        /");
        System.out.println(" \\______/");
        System.out.println();
        System.out.println("\\        /");
        System.out.println(" \\______/");
        System.out.println("+--------+");
        System.out.println();
        System.out.println("  ______");
        System.out.println(" /      \\");
        System.out.println("/        \\");
        System.out.println("|  STOP  |");
        System.out.println("\\        /");
        System.out.println(" \\______/");
        System.out.println();
        System.out.println("  ______");
        System.out.println(" /      \\");
        System.out.println("/        \\");
        System.out.println("+--------+");
    }
}
```

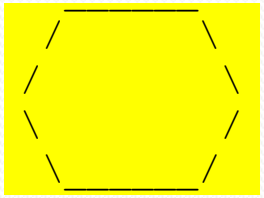
Development strategy 2

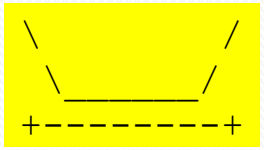


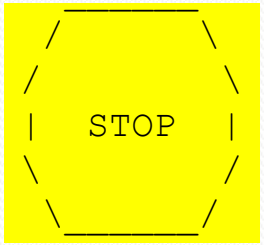
Second version (structured, with redundancy):

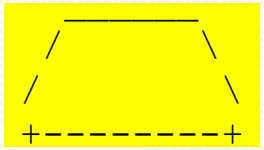
- Identify the structure of the output.
- Divide the `main` method into static methods based on this structure.

Output structure









The structure of the output:

- initial "egg" figure
- second "teacup" figure
- third "stop sign" figure
- fourth "hat" figure

This structure can be represented by methods:

- `egg`
- `teaCup`
- `stopSign`
- `hat`

Program version 2

```
public class Figures2 {
    public static void main(String[] args) {
        egg();
        teaCup();
        stopSign();
        hat();
    }

    public static void egg() {
        System.out.println("  _______");
        System.out.println(" /       \\");
        System.out.println("/         \\");
        System.out.println("\\         /");
        System.out.println(" \\_______/");
        System.out.println();
    }

    public static void teaCup() {
        System.out.println("\\         /");
        System.out.println(" \\_______/");
        System.out.println("+--------+");
        System.out.println();
    }
    ...
```

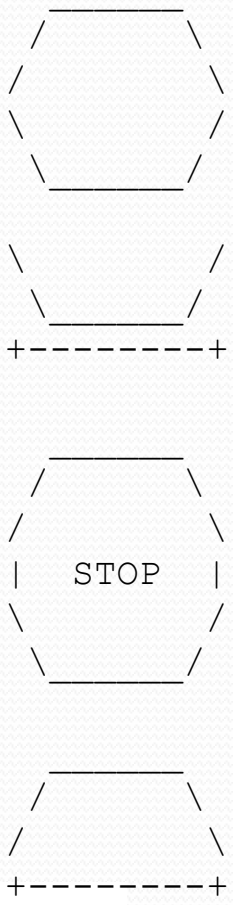
Program version 2, cont'd.

```
    ...

    public static void stopSign() {
        System.out.println("  _______");
        System.out.println(" /       \\");
        System.out.println("/         \\");
        System.out.println("|  STOP   |");
        System.out.println("\\         /");
        System.out.println(" \\_______/");
        System.out.println();
    }

    public static void hat() {
        System.out.println("  _______");
        System.out.println(" /       \\");
        System.out.println("/         \\");
        System.out.println("+---------+");
    }
}
```

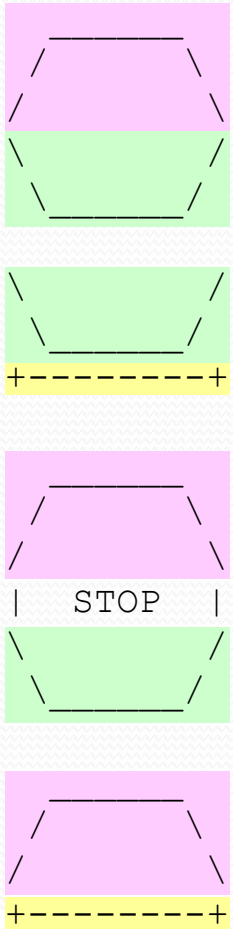
Development strategy 3



Third version (structured, without redundancy):

- Identify redundancy in the output, and create methods to eliminate as much as possible.
- Add comments to the program.

Output redundancy



The redundancy in the output:

- egg top: reused on stop sign, hat
- egg bottom: reused on teacup, stop sign
- divider line: used on teacup, hat

This redundancy can be fixed by methods:

- `eggTop`
- `eggBottom`
- `line`

Program version 3

```
// Suzy Student, CSE 138, Spring 2094
// Prints several figures, with methods for structure and redundancy.
public class Figures3 {
    public static void main(String[] args) {
        egg();
        teaCup();
        stopSign();
        hat();
    }

    // Draws the top half of an an egg figure.
    public static void eggTop() {
        System.out.println("  ______");
        System.out.println(" /______\\");
        System.out.println("/        \\");
    }

    // Draws the bottom half of an egg figure.
    public static void eggBottom() {
        System.out.println("\\        /");
        System.out.println(" \\______/");
    }

    // Draws a complete egg figure.
    public static void egg() {
        eggTop();
        eggBottom();
        System.out.println();
    }

    ...
```

Program version 3, cont'd.

```
    ...
    // Draws a teacup figure.
    public static void teaCup() {
        eggBottom();
        line();
        System.out.println();
    }

    // Draws a stop sign figure.
    public static void stopSign() {
        eggTop();
        System.out.println("|  STOP  |");
        eggBottom();
        System.out.println();
    }

    // Draws a figure that looks sort of like a hat.
    public static void hat() {
        eggTop();
        line();
    }

    // Draws a line of dashes.
    public static void line() {
        System.out.println("+--------+");
    }
}
```