Building Java Programs

Chapter 4
Lecture 4-3: Strings and objects; `printf`

reading: 3.3, 4.3 - 4.4
self-check: Ch. 4 #12, 15
exercises: Ch. 4 #15, 16
videos: Ch. 3 #3

Formatting text with `printf`

```
System.out.printf("format string", parameters);
```

- A format string can contain *placeholders* to insert parameters:
  - `%d` integer
  - `%f` real number
  - `%s` string
    - these placeholders are used instead of + concatenation
  - Example:

```
int x = 3;
int y = -17;
System.out.printf("x is %d and y is %d!\n", x, y);
                  // x is 3 and y is -17!
```

    - `printf` does not drop to the next line unless you write `\n`

printf width

- %**W**d integer, **W** characters wide, right-aligned
- %-**W**d integer, **W** characters wide, *left*-aligned
- %**W**f real number, **W** characters wide, right-aligned
- ...

```
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 10; j++) {
        System.out.printf("%4d", (i * j));
    }
    System.out.println();   // to end the line
}
```

Output:

```
   1   2   3   4   5   6   7   8   9  10
   2   4   6   8  10  12  14  16  18  20
   3   6   9  12  15  18  21  24  27  30
```

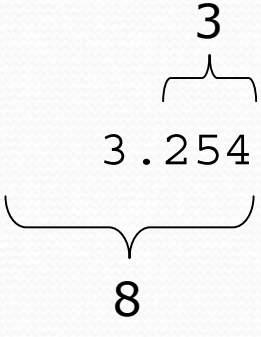
printf precision

- `%.Df` real number, rounded to **D** digits after decimal
- `%W.Df` real number, **W** chars wide, **D** digits after decimal
- `%-W.Df` real number, **W** wide (left-align), **D** after decimal

```
double gpa = 3.253764;
System.out.printf("your GPA is %.1f\n", gpa);
System.out.printf("more precisely: %8.3f\n", gpa);
```

Output:

```
your GPA is 3.3
more precisely:    3.254
```



`printf` question

- Modify our `Receipt` program to better format its output.
  - Display results in the format below, with `$` and 2 digits after `.`

- Example log of execution:

```
How many people ate? 4
Person #1: How much did your dinner cost? 20.00
Person #2: How much did your dinner cost? 15
Person #3: How much did your dinner cost? 25.0
Person #4: How much did your dinner cost? 10.00

Subtotal:   $70.00
Tax:        $5.60
Tip:        $10.50
Total:      $86.10
```

printf answer (partial)

```
...
// Calculates total owed, assuming 8% tax and 15% tip
public static void results(double subtotal) {
    double tax = subtotal * .08;
    double tip = subtotal * .15;
    double total = subtotal + tax + tip;

    // System.out.println("Subtotal: $" + subtotal);
    // System.out.println("Tax: $" + tax);
    // System.out.println("Tip: $" + tip);
    // System.out.println("Total: $" + total);

    System.out.printf("Subtotal: $%.2f\n", subtotal);
    System.out.printf("Tax:      $%.2f\n", tax);
    System.out.printf("Tip:      $%.2f\n", tip);
    System.out.printf("Total:    $%.2f\n", total);
}
}
```

Objects and Classes

reading: 3.3 - 3.4

Classes and objects

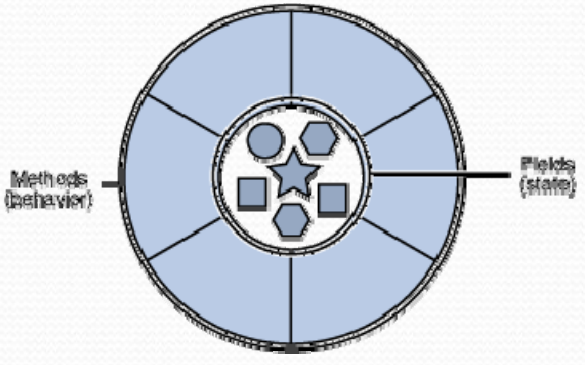
- **class**: A program entity that represents either:
  1. A program / module, or
  2. A type of objects.

  - A class is a blueprint or template for constructing objects.
  - Example: The `DrawingPanel` class (type) is a template for creating many `DrawingPanel` objects (windows).
    - Java has 1000s of classes. Later (Ch.8) we will write our own.

- **object**: An entity that combines data and behavior.
  - **object-oriented programming (OOP)**: Programs that perform their behavior as interactions between objects.

Objects

- **object:** An entity that contains data and behavior.
  - *data*: variables inside the object
  - *behavior*: methods inside the object
    - You interact with the methods; the data is hidden in the object.



- Constructing (creating) an object:

```
Type objectName = new Type(parameters);
```

- Calling an object's method:

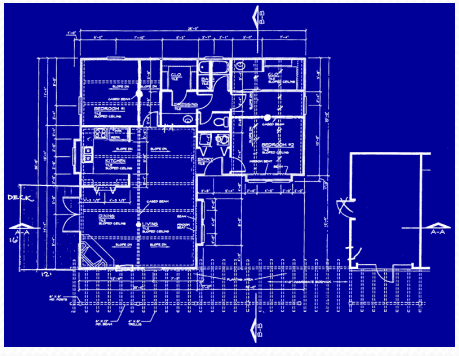
```
objectName.methodName(parameters);
```

Blueprint analogy

iPod blueprint/factory

state:
- current song
- volume
- battery life

behavior:
- power on/off
- change station/song
- change volume
- choose random song



creates

iPod #1

state:
- song = "1,000,000 Miles"
- volume = 17
- battery life = 2.5 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPod #2

state:
- song = "Letting You"
- volume = 9
- battery life = 3.41 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPod #3

state:
- song = "Discipline"
- volume = 24
- battery life = 1.8 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

`Point` objects

```
import java.awt.*;
...
Point p1 = new Point(5, -2);
Point p2 = new Point();          // the origin (0, 0)
```

- Data:

Name	Description
`x`	the point's x-coordinate
`y`	the point's y-coordinate

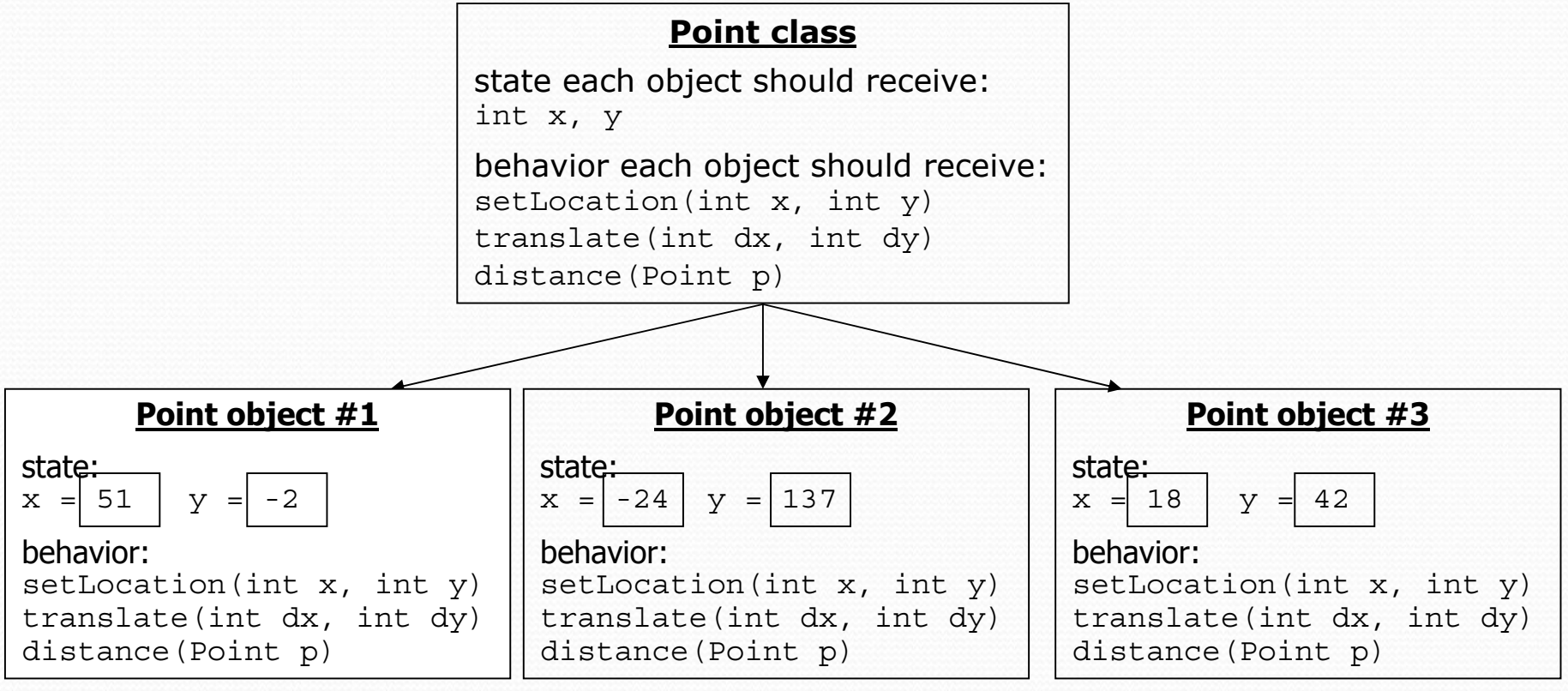
- Methods:

Name	Description
`setLocation(`**x**`, `**y**`)`	sets the point's x and y to the given values
`translate(`**dx**`, `**dy**`)`	adjusts the point's x and y by the given amounts
`distance(`**p**`)`	how far away the point is from point *p*

Using `Point` objects

```
public class PointMain {
    public static void main(String[] args) {
        // create two Point objects
        Point p1 = new Point();
        p1.y = 8;
        Point p2 = new Point(5, 7);
        p2.x = 4;

        System.out.println(p1.x + ", " + p1.y);    // 0, 8

        // move p2 and then print it
        p2.x += 2;
        p2.y++;
        System.out.println(p2.x + ", " + p2.y);    // 6, 8

        // move p1 and then print it
        p1.translate(4, -5);
        System.out.println(p1.x + ", " + p1.y);    // 4, -3

        // compute distance between two points
        double dist = p1.distance(p2);
        System.out.println("Distance = " + dist);
    }
}
```

`Point` class as blueprint



- The class (blueprint) describes how to create objects.
- Each object contains its own data and methods.
  - The methods operate on that object's data.

Strings

reading: 3.3, 4.3 - 4.4

self-check: Ch. 3 #12-13; Ch. 4 #12, 15-16
exercises: Ch. 3 #7-9, 11; Ch. 4 #3, 15-17

Strings

- **string**: An object storing a sequence of text characters.
  - Unlike most other objects, a `String` is not created with `new`.

```
String name = "text";
String name = expression;
```

  - Examples:

```
String name = "Marla Singer";

int x = 3;
int y = 5;
String point = "(" + x + ", " + y + ")";
```

Indexes

- Characters of a string are numbered with 0-based *indexes*:

```
String name = "R. Kelly";
```

index	0	1	2	3	4	5	6	7
character	R	.		K	e	l	l	y

  - First character's index : 0
  - Last character's index : 1 less than the string's length

  - The individual characters are values of type `char` (seen later)

`String` methods

Method name	Description
`indexOf(`**`str`**`)`	index where the start of the given string appears in this string (-1 if not found)
`length()`	number of characters in this string
`substring(`**`index1`**`, `**`index2`**`)` or `substring(`**`index1`**`)`	the characters in this string from *index1* (inclusive) to *index2* (exclusive); if *index2* is omitted, grabs till end of string
`toLowerCase()`	a new string with all lowercase letters
`toUpperCase()`	a new string with all uppercase letters

- These methods are called using the dot notation:

```
String gangsta = "Dr. Dre";
System.out.println(gangsta.length());    // 7
```

`String` method examples

```
// index      012345678901
String s1 = "Stuart Reges";
String s2 = "Marty Stepp";

System.out.println(s1.length());          // 12
System.out.println(s1.indexOf("e"));      // 8
System.out.println(s1.substring(7, 10)); // "Reg"

String s3 = s2.substring(1, 7);
System.out.println(s3.toLowerCase());     // "arty s"
```

- Given the following string:

```
// index        012345678901234567890
String book = "Building Java Programs";
```

  - How would you extract the word `"Java"` ?

Modifying strings

- Methods like `substring` and `toLowerCase` build and return a new string, rather than modifying the current string.

```
String s = "lil bow wow";
s.toUpperCase();
System.out.println(s);   // lil bow wow
```

- To modify a variable's value, you must reassign it:

```
String s = "lil bow wow";
s = s.toUpperCase();
System.out.println(s);   // LIL BOW WOW
```

Strings as user input

- `Scanner`'s `next` method reads a word of input as a `String`.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
name = name.toUpperCase();
System.out.println(name + " has " + name.length() +
    " letters and starts with " + name.substring(0, 1));
```

Output:

```
What is your name? Chamillionaire
Chamillionaire has 14 letters and starts with C
```

- The `nextLine` method reads a line of input as a `String`.

```
System.out.print("What is your address? ");
String address = console.nextLine();
```

Strings question

- Write a program that outputs a person's "gangsta name."
  - first initial
  - *Diddy*
  - last name (all caps)
  - first name
  - *-izzle*

Example Output:

```
Type your name, playa: Marge Simpson
Your gangsta name is "M. Diddy SIMPSON Marge-izzle"
```

Strings answer

```
// This program prints your "gangsta" name.
import java.util.*;

public class GangstaName {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        System.out.print("Type your name, playa: ");
        String name = console.nextLine();

        // split name into first/last name and initials
        String first = name.substring(0, name.indexOf(" "));
        String last = name.substring(name.indexOf(" ") + 1);
        last = last.toUpperCase();
        String fInitial = first.substring(0, 1);

        System.out.println("Your gangsta name is \"" + fInitial +
                ". Diddy " + last + " " + first + "-izzle\"");
    }
}
```

Comparing strings

- Relational operators such as `<` and `==` fail on objects.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
if (name == "Barney") {
    System.out.println("I love you, you love me,");
    System.out.println("We're a happy family!");
}
```

  - This code will compile, but it will not print the song.

  - `==` compares objects by *references* (seen later), so it often gives `false` even when two `String`s have the same letters.

The `equals` method

- Objects are compared using a method named `equals`.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
if (name.equals("Barney") {
    System.out.println("I love you, you love me,");
    System.out.println("We're a happy family!");
}
```

  - Technically this is a method that returns a value of type `boolean`, the type used in logical tests.

`String` test methods

Method	Description
`equals(`**`str`**`)`	whether two strings contain the same characters
`equalsIgnoreCase(`**`str`**`)`	whether two strings contain the same characters, ignoring upper vs. lower case
`startsWith(`**`str`**`)`	whether one contains other's characters at start
`endsWith(`**`str`**`)`	whether one contains other's characters at end
`contains(`**`str`**`)`	whether the given string is found within this one

```
String name = console.next();
if (name.startsWith("Prof")) {
    System.out.println("When are your office hours?");
} else if (name.equalsIgnoreCase("STUART")) {
    System.out.println("Let's talk about meta!");
}
```