Week 3

Methods and Strings

This week...

- Methods: functions vs procedures
- String functions
- Process: break it down, build it up.

Methods

Methods

We consider two kinds of methods:

1. A **procedure** does something. It's name is a verb.
2. A **function** returns something. It's name is a noun.

Procedures

- A procedure is a method that does an action / has some “effect”.
  e.g. prints a value, changes a value
- A procedure may take parameters, but should return nothing.
- The name of a procedure is a verb describing the goal.

```
public static void showCircleArea(double radius) {
    double area = Math.PI * radius * radius;
    System.out.println(“The area of the circle is “ + area);
}
```

- A procedure may use local variables. A local variable is temporary. It is deleted when the method exits.

Functions

- A function is a method that returns a value.
- A function should **not** have any side effects.
  e.g. It should **not** print a value. It should **not** change a value.
- A function may take parameters.
- The name of a function is a noun describing what is returned.

```
public static double circleArea(double radius) {
    double area = Math.PI * radius * radius;
    return area;
}
```

- A function may also use local variables.

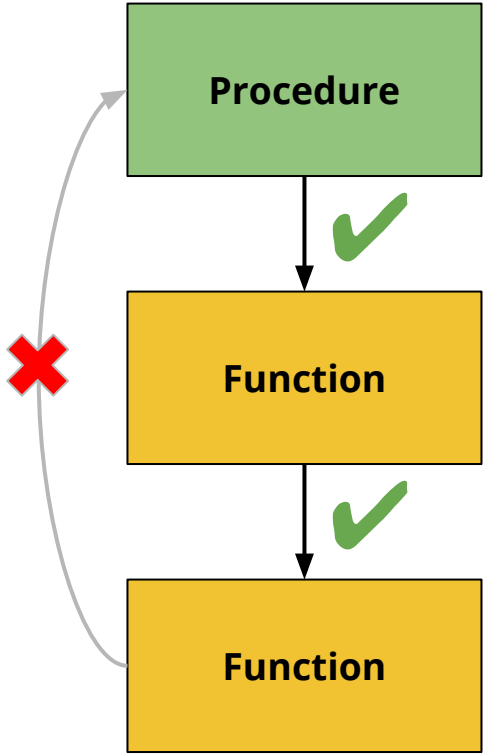
Side effects

- Function design rule
  A function returns a value and changes nothing
- If a function changes something, this is called a “side effect”
- Side effects are bad:
  - the reader assumes the function changes nothing
  - the reader does not look inside the function
  - because a function changes nothing
- Avoid programming by side effect.
  Unless it is a known pattern.

Interaction between procedures and functions

- A procedure can call a function.
- A function can call a function.
- **But** a function should not call a procedure

  Functions should not have side effects
  Calling a procedure may introduce side effects



String functions

Strings

- In java, String is a class, providing a set of useful functions.

int length()	returns the length of the string
char charAt(int i)	returns the character at position i
String[] split(String separator)	returns an array of substrings split by the separator

e.g.

```
String s = "hello world";
System.out.println(s.length());
System.out.println(s.charAt(1));
String[] words = s.split(" ");
```

prints 11

prints "e"

returns { "hello", "world" }

The “string loop” pattern

Goal: Loop over the characters in a string.

```
for (int i = 0; i < <str>.length(); i++) {
    <use character str.charAt(i)>
}
```

Example:
Count the number of l’s in the word “hello”.

```
String s = “hello”;
int count = 0;
for (int i = 0; i < s.length(); i++) {
    if (s.charAt(i) == ‘l’)
        count++;
}
System.out.println(“Number of l’s = “ + count);
```

The “for-each” loop

Create an array of values

```
String[] array = { “car”, “truck”, “bus”, “van” };
```

These two code fragments **do the same thing**:

```
for (int i = 0; i < array.length; i++)
    System.out.println(array[i]);
```

Array loop

```
for (String word : array)
    System.out.println(word);
```

For-each loop

Read: **For** each word **in** array, print that word.

Looping over words in a string using “split”

Program:

```
String sentence = “Eat your vegetables”;
for (String word : sentence.split(“ “))
    System.out.println(“Next word = “ + word);
```

Output:

```
Next word = Eat
Next word = your
Next word = vegetables
```

Split by one or more spaces

- If you have a string with extra spaces between words:

```
String sentence = "Eat      your  vegetables";
```

- Use the regular expression " +" as the separator

```
for (String word : sentence.split(" +"))
    System.out.println("Next word = " + word);
```

Output:

```
Next word = Eat
Next word = your
Next word = vegetables
```

More String functions...

boolean contains(String s)	does this string contain s?
int indexOf(String s)	returns the position where s is found
boolean startsWith(String s)	does this string start with s?
boolean endsWith(String s)	does this string end with s?
boolean equals(String s)	does this string equal s?
String substring(start, end)	returns a substring from start to end
String toUpperCase() / String toLowerCase()	returns the string in upper/lower case
String trim()	returns the string without leading/trailing spaces.

For more, see the documentation: https://docs.oracle.com/javase/7/docs/api/java/lang/String.html

Functional patterns

When to use a function

If it produces a value, make it a function.

Read functions

- The read pattern returns a value, so it is a function.
  The name has the form read<X>

```
int readAge() {
    System.out.print("Age: ");
    return In.nextInt();
}

String readName() {
    System.out.print("Name: ");
    return In.nextLine();
}
```

The “old” read loop pattern

Specification: Read and ages until the user enters -1.

```
System.out.print(“Age: “);
int age = In.nextInt();
while (age != -1) {
    <use age>
    System.out.print(“Age: “);
    age = In.nextInt();
}
```

Problem: There is repeated code.

Don’t repeat code. Put it in a method.

Read loop with read functions

```
int age = readAge();
while (age != -1) {
     <use age>
     age = readAge();
}


int readAge() {
     System.out.print("Age: ");
     return In.nextInt();
}
```

Problem: There is still repeated code: age = readAge();

Merged read loop

```
double age;
while ((age = readAge()) != -1) {
     <use age>
}

int readAge() {
     System.out.print("Age: ");
     return In.nextInt();
}
```

Key: call readAge() inside the while condition.

Exercise: can you make this into a pattern?

Merged read loop

- Whenever you need a read loop, always use the **merged** read loop.

- Example: reading characters:

```
char c;
while ((c = readChar()) != '.') {
    <use c>
}
```

- Example: reading strings:

```
String s;
while (!(s = readString()).equals("end")) {
    <use s>
}
```

The “any” pattern

Goal: Determine if any item in a collection passes <test>

```
<for each item>
     if (<item passes test>)
          return true;
return false;
```

Example: Test if any number in an array is negative:

```
boolean anyNegative(int[] array) {
     for (int item : array)
          if (item < 0)
               return true;
     return false;
}
```

Key idea:

If any item is negative return true.

Homework:
Two variations of the “any” pattern for you to work out...

1. The “every” pattern

Goal: Determine if all items in a collection pass <test>

```
<for each item>
    if (! <item passes test>)
        return false;
return true;
```

2. The “none” pattern

Goal: Determine if no items in a collection pass <test>

```
<for each item>
    if (<item passes test>)
        return false;
return true;
```

Boolean functions

Bad boolean tests

- Bad: if (matches == true)
- Good: if (matches)
  - There is no need to compare a boolean to true or false
  - A boolean **is** true or false

- Bad: if (c == ‘x’ || ‘y’ || ‘z’) ← won’t compile
- Good: if (c == ‘x’ || c == ‘y’ || c == ‘z’)
  - Each OR component must be a full boolean expression

Boolean functions

- A boolean function returns a boolean value:

```
boolean isDry(int rain) {
    return rain == 0;
}
```

- The name of a boolean function is an adjectival phrase:

```
boolean dry(int rain)
boolean isDry(int rain)
boolean hasDry()
```

Bad boolean functions

- Bad:

```
boolean isDry(int rain) {
    if (rain == 0)
        return true;
    else
        return false;
}
```

- Good:

```
boolean isDry(int rain) {
    return rain == 0;
}
```

- No need to test if (rain == 0). It is a boolean. Just return it.

Process:
Break it down, build it up.

Break down a program into functions

Specification: Read in a sentence. Show the number of words that contain a lowercase vowel.

Remember: Each goal goes in a separate method.

Levels of processing

Read a sentence. Show the number of words that contain a lowercase vowel.

Level	Goal	Pattern
Sentence level	**Goal: How many matching words in this sentence?**	**count**
Word level	**Goal: Are there any lowercase vowels in this word?**	**any**
Character level	**Goal: Is this character any of these: a/e/i/o/u?**	**any**

What is the form of each method?

Read a sentence. Show the number of words that contain a lowercase vowel.

Level	Goal	Form
Sentence level	**Goal: How many matching words in this sentence?**	param: String sentence result: int
Word level	**Goal: Are there any lowercase vowels in this word?**	param: String word result boolean
Character level	**Goal: Is this character any of these: a/e/i/o/u?**	param: char c result boolean

DEMO

DEMO

DEMO

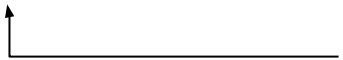
A complete program still needs procedures!

- Functions don't have any "effect".
- To cause something to "happen" we need procedures.
- e.g. "show" the number of matching words in the terminal:

```
public static void showMatchingWords(String sentence) {
    System.out.println("Matching words = " + matchingWords(sentence));
}
```

- Every program must have a main also have a main method:

```
public static void main(String[] args) {
    showVowelWords(readSentence());
}
```



read pattern

Interaction between procedures and functions

- The functions do all the grunt work
  - split a sentence into words
  - count the vowel words
  - test if a word contains a vowel
  - test if a character is a vowel
- The procedures just present the result of that hard work.