RISD Graphic Design Students

A product team from Adobe wants to meet with RISD graphic design students to understand their existing workflows and future needs.

To participate, you should be a RISD design student :

- working in print and digital, ideally across multiple channels
- focused on typography and layout (not web and app design)
- working as part of a collaborative project team
- creating, managing or working with design systems

Details:

Contact Bob Zeleznik (bcz@cs.brown.edu) by Friday 9/16 for a pre-screening interview. Adobe will visit Friday 9/30.

WiCS

Women In Computer Science

Join our listserv to get updates and hear opportunities!
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Suggest topics for events this semester!
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Join our listserv: http://tinyurl.com/jc7yktj

MOSAIC+

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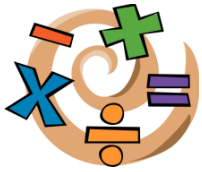
Reminder: Lecture slides

- Lecture slides are posted online and are available before class
- Use these during class and outside of class!
- If you can, download the lecture before class so you can take notes on the slides
- Useful to be able to go back a few slides to answer clicker questions



Lecture 3

Introduction to Parameters / Math

This Lecture:

1. Mathematical functions in Java
2. Defining more complicated methods with inputs and outputs
3. The constructor
4. Creating instances of a class
5. Understanding Java flow of control

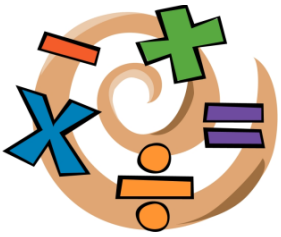
Defining Methods

- We know how to define simple methods
- Today, we will define more complicated methods that have both **inputs** and **outputs**
- Along the way, you will learn the basics of manipulating numbers in Java

BookstoreAccountant

- We will define a BookstoreAccountant class that models an employee in a bookstore, calculating certain costs
  - finding the price of a purchase, calculating change needed, etc.
- Each of the accountant's methods will have inputs (numbers) and an output (numeric answer)

Basic Math in Java



- First, we'll talk about numbers and mathematical expressions in Java

Integers

- An integer is a whole number, positive or negative, including 0

- Depending on size of the integer, can use one of four numerical **base types** (primitive Java data types): `byte`, `short`, `int`, and `long`, in order of number of bits of precision
- Bit: binary digit, 0 or 1

Integers

Base Type	Size	Minimum Value	Maximum Value
`byte`	8 bits	-128 (-2^7)	127 ($2^7 - 1$)
`short`	16 bits	-32,768 (-2^{15})	32,767 ($2^{15} - 1$)
`int`	32 bits	-2,147,483,648 (-2^{31})	2,147,483,647 ($2^{31} - 1$)
`long`	64 bits	-9,223,372,...,808 (-2^{63})	9,223,372,...,807 ($2^{63} - 1$)

In CS15, you will almost always use `int` – good range and we're not as memory-starved as we used to be

Floating Point Numbers

- Sometimes, need more precision than integers can provide
- How to represent pi = 3.14159...?
- **Floating point numbers** - more precise representation
  - called "floating point" because decimal point can "float"-- no fixed number of digits before and after it-- historical nomenclature
  - used for representing numbers in "scientific notation", with decimal point and exponent, e.g., 4.3×10^{-5}
- Two numerical base types in Java represent floating point numbers: `float` and `double`

Floating Point Numbers

Base Type	Size
`float`	32 bits
`double`	64 bits

Feel free to use both in CS15. Use of `double` is more common in modern Java code, as we are not as memory-starved as we used to be

Operators and Math Expressions (1/2)

Operator	Meaning
+	addition
-	subtraction
*	multiplication
/	division
%	remainder

- Example expressions:

```
4 + 5
3.33 * 3
11 % 4
3.0 / 2.0
3 / 2
```


Operators and Math Expressions (2/2)

- What does each of these expressions evaluate to?
- Example expressions:

```
4 + 5 → 9
3.33 * 3 → 9.99
11 % 4 → 3
3.0 / 2.0 → 1.50
3 / 2 → 1
```

why???

Be careful with integer division!

- When dividing two integer types, result is rounded down to an `int`
- 3 / 2 evaluates to 1
- If either number involved is floating point, result is floating point: allows greater precision
  - called mixed-mode arithmetic

```
3 / 2 → 1
3.0 / 2 → 1.50
3 / 2.0 → 1.50
3.0 / 2.0 → 1.50
```


Evaluating Math Expressions

- Java follows same evaluation rules that you learned in math class years ago - PEMDAS
- Evaluation takes place left to right, except:
  - expressions in parentheses evaluated first, starting at the innermost level
  - operators evaluated in order of precedence/priority (* has priority over +)

```
2 + 4 * 3 - 7 → 7
(2 + 3) + (11 / 12) → 5
3 + (2 - (6 / 3)) → 3
```


Clicker Question

What does the x evaluate to?

int x = (((5/2)*3)+5);

A. 12.5
B. 11
C. 13
D. 10

BookstoreAccountant

- BookstoreAccountants should be able to find the price of a set of books
- When we tell a BookstoreAccountant to calculate a price, we want it to do it and then **tell us the answer**
- To do this, we need to learn how to write a method that **returns** a value - in this case, a number

Return Type

- The **return type** of a method is the kind of data it gives back to whoever called it
- So far, we have only seen return type `void`
- A method with a return type of `void` doesn't give back anything when it's done executing
- `void` just means "this method does not return anything"

```
public class Robot {
    public void turnRight() {
            // code that turns robot right
          }

    public void moveForward(int numberOfSteps) {
        // code that moves robot forward
    }

    public void turnLeft() {
        this.turnRight();
        this.turnRight();
        this.turnRight();
    }
}
```


Return Type

- If we want a method to return something, replace `void` with the type of thing we want to return
- If method should return an integer, specify `int` return type
- When return type is not `void`, we've promised to end the method with a **return statement**
  - any code following the return statement will not be executed

A silly example:

```
public int giveMeTwo() {
    return 2;
}
```

This is a **return statement**.

Return statements always take the form:

```
return <something of specified return type>;
```


Accountant (1/6)

- Let's write a silly method for BookstoreAccountant called priceTenDollarBook() that finds the cost of a $10 book
- It will return the value "10" to whoever called it
- We will generalize this silly example soon…

```
public class BookstoreAccountant {

    /* Some code elided */

}
```


Accountant (1/6)

- Let's write a silly method for BookstoreAccountant called priceTenDollarBook() that finds the cost of a $10 book
- It will return the value "10" to whoever called it
- We will generalize this silly example soon…

```
public class BookstoreAccountant {

    /* Some code elided */

    public int priceTenDollarBook() {
        return 10;
    }

}
```

"10" is an integer - it matches the return type, int!

Accountant (2/6)

- What does it mean for a method to "return a value to whoever calls it"?
- Another object can call priceTenDollarBook on a BookstoreAccountant from somewhere else in our program and use the result
- For example, consider a Bookstore class that has an accountant named **myAccountant**
- We will demonstrate how the Bookstore can call the method and use the result

Accountant (3/6)

```
/* Somewhere in the Bookstore class lives an instance
 of the BookstoreAccountant class named myAccountant
 */

myAccountant.priceTenDollarBook();
```

- We start by just calling the method
- This is fine, but we are not doing anything with the result!
- Let's use the returned value by **printing it to the console**

```
public class BookstoreAccountant {

  /* Some code elided */

    public int priceTenDollarBook() {
        return 10;
    }




}
```


Accountant (4/6)

- In a new method, `manageBooks()`, print result
- "Printing" in this case means displaying a value to the user of the program
- To print to console, we use `System.out.println` ("print line")
- `println` method prints out value of expression you provide within the parentheses

```
public class BookstoreAccountant {

  /* Some code elided */

    public int priceTenDollarBook() {
        return 10;
    }

    public void manageBooks() {
        System.out.println(
            this.priceTenDollarBook());
    }

}
```


Accountant (5/6)

- We have provided the expression `this.priceTenDollarBook()` to be printed to the console
- This information given to the `println` method is called an **argument**: more on this in a few slides
- Putting one method call inside another is called **nesting** of method calls; more examples later

```
public class BookstoreAccountant {

  /* Some code elided */

    public int priceTenDollarBook() {
        return 10;
    }

    public void manageBooks() {
        System.out.println(
            this.priceTenDollarBook());
    }

}
```


Accountant (6/6)

- When this line of code is evaluated:
  - `println` is called on `System.out`, and it needs to use result of `priceTenDollarBook`
  - `priceTenDollarBook` is called on `this`, returning 10
  - `println` gets 10 as an argument, 10 is printed to console

```
public class BookstoreAccountant {

  /* Some code elided */

    public int priceTenDollarBook() {
        return 10;
    }

    public void manageBooks() {
        System.out.println(
            this.priceTenDollarBook());
    }

}
```

argument

Aside: `System.out.println`

- `System.out.println` is an awesome tool for testing and debugging your code – learn to use it!
- Lets you see what is happening in your code by printing out values as it executes -- otherwise, methods execute, but you don't see return value
- If `Bookstore` program is not behaving properly, can test whether `priceTenDollarBook` is the problem by printing its return value to verify that it is "10" (yes, obvious in this trivial case, but not in general!)

Accountant: a more generic price calculator

- Now your accountant can get the price of a ten dollar book -- but that's completely obvious
- For a functional bookstore, we'd need a separate method for each possible book price!
- Instead, how about a generic method that finds the price of any number of copies of a book, given its price?
  - useful when the bookstore needs to order new books

```
public class BookstoreAccountant {

    public int priceTenDollarBook() {
        return 10;
    }

    public int priceBooks(int numCps, int price) {
        // let's fill this in!
    }
}
```

cost of the purchase

number of copies you're buying

price per copy

Accountant: a more generic price calculator

- Method answers the question: given a number of copies and a price per copy, how much do all of the copies cost?
- To put this in algebraic terms, we want a method that will correspond to the function:
  f(x, y) = x * y
- "x" represents the number of copies; "y" is the price per copy

```
public class BookstoreAccountant {

    public int priceTenDollarBook() {
        return 10;
    }

    public int priceBooks(int numCps, int price) {
        // let's fill this in!
    }
}
```


Accountant: a more generic price calculator

Mathematical function:

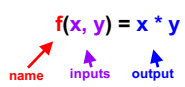
f(x, y) = x * y

Equivalent Java method:

```
public int priceBooks(int numCps, int price) {
    return numCps * price;
}
```


Accountant: a more generic price calculator

Mathematical function:



Equivalent Java method:

Accountant: a more generic price calculator

- Method takes in two integers from caller, and gives appropriate answers depending on those integers
- When defining a method, extra pieces of information that the method needs to take in (specified inside the parentheses) are called **parameters**
- `priceBooks` takes in two parameters, "numCps" and "price" -- these, like variable names, are arbitrary, i.e., your choice

```
public class BookstoreAccountant {

  /* Some code elided */

  public int priceBooks(int numCps, int price) {
      return numCps * price;
  }

}
```

parameters

Parameters (1/3)

- General form of a method you are defining that takes in parameters:

```
<visibility> <returnType> <methodName>(<type1> <name1>, <type2> <name2>...) {
        <body of method>
}
```

- Parameters are specified as comma-separated list
  - for each parameter, specify **type** (for example, `int` or `double`), and then **name** ("x", "y", "banana"... whatever you want!)
- In algebra, do not specify type because context makes clear what kind of number we want. In programming use many different types, and must tell Java explicitly what we intend
  - Java is a "strictly typed" language, i.e., makes sure the user of a method passes the right number of parameters of the specified type, in the right order – if not, compiler error! In short, the compiler checks for a one-to-one correspondance

Parameters (2/3)

- Name of each parameter is **almost** completely up to you
  - Java naming restriction: needs to start with a letter
  - refer to CS15 style guide for naming conventions
- It is the name by which you will refer to the parameter throughout method

The following methods are completely equivalent:

type name type name

```
public int priceBooks(int numCps, int price) {
        return numCps * price;
}

public int priceBooks(int bookNum, int pr) {
        return bookNum * pr;
}

public int priceBooks(int a, int b) {
        return a * b;
}
```

Parameters (3/3)

- Remember `Robot` class from last lecture?
- Its `moveForward` method took in a parameter-- an `int` named **numberOfSteps**
- Follows same parameter format: **type**, then **name**

```
/* Within Robot class definition */
                          type          name
public void moveForward(int numberOfSteps)
    // code that moves the robot
    // forward goes here!
}
```


With great power comes great responsibility...

- Try to come up with descriptive names for parameters that make their purpose clear to anyone reading your code
- `Robot`'s `moveForward` method calls its parameter "numberOfSteps", not "x" or "thingy"
- We used "numCps" and "price"
- Try to avoid single-letter names for anything that is not strictly mathematical; be more descriptive

Accountant

- Let's give `BookstoreAccountant` class more functionality by defining more methods!
- Methods to calculate change needed or how many books a customer can afford
- Each method will take in parameters, perform operations on them, and return an answer
- We choose arbitrary but helpful parameter names

```
public class BookstoreAccountant {

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    // calculates a customer's change
    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    // calculates max # of books you can buy
    public int calcMaxBks(int bookPr, int myMoney) {
        return myMoney / bookPr;
        }
}
```


Accountant

- `calcMaxBks` takes in a price per book (`bookPr`) and an amount of money you have to spend (`myMoney`), tells you how many books you can buy
- `calcMaxBks` works because when we divide 2 `int`s, Java rounds the result down to an `int`!
  - Java **always rounds down**
- $25 / $10 per book = 2 books

```
public class BookstoreAccountant {

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    // calculates a customer's change
    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    // calculates max # of books customer can buy
    public int calcMaxBks(int bookPr, int myMoney) {
        return myMoney / bookPr;
        }
}
```


Calling Methods with Parameters

- Now that we've *defined* `priceBooks, calcChange,` and `calcMaxBks` methods, can *call* them on any `BookstoreAccountant`
- Want to call `calcChange` method and tell it how much was paid and how much the puchase cost
- How do we *call* a method that takes in parameters?

Calling Methods with Parameters

- You already know how to call a method that takes in one parameter!
- Remember `moveForward`?

```
public void moveForward(int numberOfSteps) {
  // code that moves the robot
  // forward goes here!
}
```

Calling Methods with Parameters

- When we *call* a method, we pass it any extra piece of information it needs as an **argument** within parentheses
- When we call `moveForward` we must supply one `int` as argument

```
public class RobotMover {

    /* additional code elided */

    public void moveRobot(Robot samBot) {
        samBot.moveForward(4);
        samBot.turnRight();
        samBot.moveForward(1);
        samBot.turnRight();
        samBot.moveForward(3);
    }

}
```

arguments

Arguments vs. Parameters

```
// within the Robot class
                                  parameter
public void moveForward(int numberOfSteps) {
  // code that moves the robot
  // forward goes here!
}
```

- In ***defining*** a method, the **parameter** is the name by which a method refers to a piece of information passed to it-- e.g. "x" and "y" in the function f(x, y) = x + y - it is a "dummy name" determined by definer
- In ***calling*** a method, an **argument** is the actual value passed in -- e.g. 2 and 3 in `add(2, 3)`

```
// within the RobotMover class

public void moveRobot(Robot samBot) {
    samBot.moveForward(4);
    samBot.turnRight();
    samBot.moveForward(1);
    samBot.turnRight();
    samBot.moveForward(3);
}
```

argument, argument, argument

Calling Methods That Have Parameters

- When we call `samBot.moveForward(3)`, we are passing 3 as an **argument**
- When `moveForward` executes, its **parameter is assigned the value of argument that was passed in**
- That means `moveForward` here executes with `numberOfSteps` = 3

```
// in some other class...
samBot.moveForward(3);

_____________________________________

// in the Robot class...
public void moveForward(int numberOfSteps) {
  // code that moves the robot
  // forward goes here!
}
```


Calling Methods That Have Parameters

- When calling a method that takes in parameters, must provide a valid argument for each parameter
  - loose analogy: parameter is like parking space, argument is like car
- Means that number and type of arguments must match number and type of parameters: one-to-one correspondence
- Order matters! The first argument you provide will correspond to the first parameter, second to second, etc.

Calling Methods That Have Parameters

- Each of our accountant's methods takes in two `int`s, which it refers to by different names (no need or ability for user to know those names, also called identifiers)
- Whenever we call these methods, must provide two `int`s-- first our desired value for first parameter, then desired value for second

```
public class BookstoreAccountant {

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    // calculates a customer's change
    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    // calculates max # of books you can buy
    public int calcMaxBks(int bookPr, int myMoney)
        return myMoney / bookPr;
        }

}
```


Calling Methods That Have Parameters

- Let's say we have an instance of `BookstoreAccountant` named **myAccountant**
- When we call a method on **myAccountant**, we provide a comma-separated list of arguments (in this case, `int`s) in parentheses
- These **arguments** are values we want the method to use for first and second parameter when it runs. Note `calcChange`(8, 4) isn't `calcChange`(4, 8) - order matters!

```
/* somewhere else in our code… */

myAccountant.priceBooks(2, 16);
myAccountant.calcChange(18, 12);
myAccountant.calcMaxBks(6, 33);
```

arguments

Calling Methods That Have Parameters

```
/* somewhere else in our code… */

myAccountant.priceBooks(2, 16);
```

```
/* in the BookstoreAccountant class…
*/

public int priceBooks(int numCps, int price) {
        return numCps * price;
}
```

- Java does "parameter passing" by:
  - first checking that one-to-one correspondence is honored,
  - then substituting arguments for parameters,
  - and finally executing the method body using the arguments

Calling Methods That Have Parameters

```
/* somewhere else in our code… */

myAccountant.priceBooks(2, 16);
```

```
/* in the BookstoreAccountant class…
*/

public int priceBooks(int numCps, int price) {
        return numCps * price;
}
```

- Java does "parameter passing" by:
  - first checking that one-to-one correspondence is honored,
  - then substituting arguments for parameters,
  - and finally executing the method body using the arguments

Calling Methods That Have Parameters

```
/* somewhere else in our code… */

myAccountant.priceBooks(2, 16);
```

```
/* in the BookstoreAccountant class…
*/

public int priceBooks(  2,  16) {
        return 2 * 16;
}
```

32 is returned

- Java does "parameter passing" by:
  - first checking that one-to-one correspondence is honored,
  - then substituting arguments for parameters,
  - and finally executing the method body using the arguments

Calling Methods That Have Parameters

```
/* somewhere else in our code… */

System.out.println(myAccountant.priceBooks(2, 16));
```

```
/* in the BookstoreAccountant class…
*/

public int priceBooks(int numCps, int price) {
        return numCps * price;
}
```

- If we want to check the result returned from our method call, use `System.out.println` to print it to the console
- We'll see the number 32 printed out!

Clicker Question

Which of the following contains arguments that satisfy the parameters of the method calcChange in the BookstoreAccountant class?

A. BookstoreAccountant.calcChange(20, 14.50)
B. BookstoreAccountant.calcChange(10.00, 5.00)
C. BookstoreAccountant.calcChange(20, 10)
D. None of the above

Where did `myAccountant` come from?

- We know how to send messages to an instance of a class by calling methods
- So far, we have called methods on **samBot**, an instance of `Robot`, and **myAccountant**, an instance of `BookstoreAccountant`…
- Where did we get these objects from?
- Next: how to use a class as a blueprint to actually build instances!

Constructors (1/3)

- Accountants can `priceBooks`, `calcChange`, and `calcMaxBks`
- Can call any of these methods on any instance of `BookstoreAccountant`
- But how did these instances get created in the first place?
- Define a special kind of method in the `BookstoreAccountant` class: a **constructor**
- **Note: every object must have a constructor**

```
public class BookstoreAccountant {

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    public int calcMaxBks(int bookPr, int myMoney) {
        return myMoney / bookPr;
        }

}
```


Constructors (2/3)

- A **constructor** is a special kind of method that is called whenever an object is to be "born", i.e., created – see shortly how it is called
- Constructor's name is always same as name of class
- If class is called "BookstoreAccountant", its constructor **must be called "BookstoreAccountant"**. If class is called "Dog", its constructor had better be called "Dog"

```
public class BookstoreAccountant {

    public BookstoreAccountant() {
        // this is the constructor!
    }

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    public int calcMaxBks(int bookPr, int myMoney) {
        return myMoney / bookPr;
        }

}
```


Constructors (3/3)

- Constructors are special methods: used only once, to create and return the instance
- And we never specify a return value in its declaration
- Constructor for `BookstoreAccountant` does not take in any parameters (notice empty parentheses)
- Constructors can, and often do, take in parameters-- stay tuned for next lecture

```
public class BookstoreAccountant {

    public BookstoreAccountant() {
        // this is the constructor!
    }

    public int priceBooks(int numCps, int price) {
        return numCps * price;
    }

    public int calcChange(int amtPaid, int price) {
        return amtPaid - price;
    }

    public int calcMaxBks(int bookPr, int myMoney) {
        return myMoney / bookPr;
        }

}
```


Clicker Question

Which of the following is not true of constructors?

A. Constructors are methods
B. Constructors always have the same name as their class
C. Constructors should specify a return value
D. Constructors can take in parameters

Instantiating Objects (1/3)

- Now that the `BookstoreAccountant` class has a constructor, we can create instances of it!
- Here is how we create a `BookstoreAccountant` in Java:

```
new BookstoreAccountant();
```

- This means "use the `BookstoreAccountant` class as a blueprint to create a new `BookstoreAccountant` instance"
- `BookstoreAccountant()` is a call to `BookstoreAccoutant`'s constructor, so any code in constructor will be executed as soon as you create a `BookstoreAccountant`

Instantiating Objects (2/3)

- We refer to "creating" an object as **instantiating** it
- When we say:

```
new BookstoreAccountant();
```

- … We're **creating an instance** of the `BookstoreAccountant` class, a.k.a. **instantiating** a new `BookstoreAccountant`
- Where exactly does this code get executed?
- Stay tuned for the next lecture to see how this constructor is used by another instance to create a new `BookstoreAccountant`!

Aside: Nesting

- Our `calcChange` method takes in two `int`s - the amount the customer paid, and price of the purchase
- Our `priceBooks` method finds the price of the purchase
- What if we want to use result of `priceBooks` as an argument to `calcChange`?
- Say we have got 3 copies of an $11 book. We also have $40 in cash to pay with. `priceBooks` will tell us that purchase costs $33 - we want to use this as "price" parameter for `calcChange`
- How do we do this? **Nesting!**

Aside: Nesting

- `myAccountant.priceBooks(3, 11)` returns "33"
  - we want to pass this number into `calcChange`
- We can **nest** `myAccountant`'s `priceBooks` method within `myAccountant`'s `calcChange` method:

```
myAccountant.calcChange(40, myAccountant.priceBooks(3,11));
```

returns 33

```
myAccountant.calcChange(40, 33);
```

- And `calcChange` will return 7!

Clicker Question

You have an instance of BookstoreAccountant, accountant. With the methods given from before, what is the proper way to calculate the change you will have if you pay with a $50 bill for 5 books at a cost of $8 each?

A. accountant.priceBooks(5, 8);
B. accountant.priceBooks(8, 5);
C. accountant.calcChange(accountant.priceBooks(5, 8));
D. accountant.calcChange(50, accountant.priceBooks(5, 8));

Important Techniques

- Defining methods that take in **parameters** as input
- Defining methods that **return** something as an output
- Defining a **constructor** for a class
- Creating an **instance** of a class with the `new` keyword
- Up next: Flow of Control

What is Flow of Control?

- We've already seen lots of examples of Java code in lecture
- But how does all of this code actually get executed, and in what order?
- **Flow of control** or **control flow** is order in which individual statements in a program (lines of code) are executed
- Understanding flow of control is essential for hand simulation and debugging

Overview: How Programs are Executed

- Code in Java is executed sequentially, line by line
- Think of an arrow "pointing" to the current line of code
- Where does execution start?
  - in Java, first line of code executed is in a special method called the `main` method

The Main Method

- Every Java program begins at first line of code in `main` method
  - and ends after last line of code in `main` is executed-you will see this shortly!
- You will see this method in every project or lab stencil, typically in App.java (the `App` class)
  - by CS15 convention, start our programs in `App`
- Program starts when you run file that contains `main` method
- Every other part of application is invoked from `main`

Ignore this parameter for now, we'll discuss it later this semester

```
public static void main(String[] args)
{
    System.out.println("first line");
    System.out.println("last line");
}
```


Method Calls and Constructors

- When a method is called, execution steps into the method
  - next line to execute will be first line of method definition
- Entire method is executed sequentially
  - when end is reached (when method returns), execution *returns* to the line following the method call
- Constructor is special type of method - flow of control works in same way
  - when `new <object>()` is called, code inside constructor is executed

Example: Baking Cookies

- Some of your TAs are trying to bake cookies for a grading meeting
  - they've decided to make snickerdoodles, the HTAs' favorite kind
- Let's write a program that will have a baker make a batch of cookies

The `bakeCookies` Method

- First, let's define a method to make cookies, in the `Baker` class
  - `public void bakeCookies()`
- What are the steps of making cookies?
  - combine wet ingredients (and sugars) in one bowl
    - mix this
  - combine dry ingredients in another bowl, and mix
  - combine wet and dry ingredient bowls
  - form balls of dough
  - bake for 10 minutes
  - sometime before baking, preheat oven to 400º
- Order is *not fixed*, but some steps must be done before others
- Let's write methods for these steps and call them in order in `bakeCookies()`

Defining the Baker Class

- First, here are more methods of the `Baker` class - method definitions are elided

```
public class Baker {

    public Baker() {
        // constructor code elided for now
    }

    public void combineWetIngredients() {
        // code to mix eggs, sugar, butter, vanilla
    }

    public void combineDryIngredients() {
        // code to mix flour, salt, baking soda
    }

    public void combineAllIngredients() {
        // code to combine wet and dry ingredients
    }

    public void formDoughBalls(int numBalls) {
        // code to form balls of dough
    }

    public void bake(int cookTime) {
        //code to bake cookies and remove from
        //oven
    }

    public void preheatOven(int temp) {
        // code to preheat oven to a temp
    }

} // end of Baker class
```


The bakeCookies method

```
public void bakeCookies() {
    this.preheatOven(400);
    this.combineWetIngredients();
    this.combineDryIngredients();
    this.combineAllIngredients();
    this.formDoughBalls(24);
    this.bake(10);
}
```

Clicker Question

Using the Baker class from before, is the following method correct for creating cookie dough? Why or why not?

```
public class Baker {
    //constructor elided
    public void createDough() {
        this.combineWetIngredients();
        this.combineAllIngredients();
        this.combineDryIngredients();
    }
    //other methods elided
}
```

A. Yes, it has all the necessary methods in proper order
B. No, it uses this instead of Baker
C. No, it has the methods in the wrong order
D. No, it is inefficient

Flow of Control Illustrated

- Each of the methods we call in `bakeCookies()` has various substeps involved
  - `combineWetIngredients()` involves adding sugar, butter, vanilla, eggs and mixing them together
  - `bake(int cookTime)` involves putting cookies in oven, waiting, taking them out
- In current code, every substep of `combineWetIngredients()` is completed before `combineDryIngredients()` is called
  - execution steps into a called method, executes everything within method
  - both sets of baking steps must be complete before combining bowls, so these methods are called before `combineAllIngredients()`
  - could easily switch order in which those two methods are called

Putting it Together

- Now that `Baker`s have a method to bake cookies, let's put an app together to make them do so
- Our app starts in the `main` method, in `App`
  - generally, use `App` class to start our program and nothing else

```
public class App {

    public static void main(String[] args) {

    }
}
```


Putting it Together

- First, we need a `Baker`
- Calling `new Baker()` will execute `Baker`'s constructor
  - currently empty
- How do we get our `Baker` to bake cookies?
  - call the `bakeCookies` method from constructor!
  - this is not the only way - stay tuned for next lecture

```
public class App {

    public static void main(String[] args) {
        new Baker();
    }
}
```

instantiates a Baker

```
// in Baker class
public Baker() {
    this.bakeCookies();
}
```


Following Flow of Control

```
public class App {
    public static void main(String[] args) {
        new Baker();
    }
}

public class Baker {
    public Baker() {
        this.bakeCookies();
    }
    public void bakeCookies() {
        this.preheatOven(400);
        this.combineWetIngredients();
        this.combineDryIngredients();
        this.combineAllIngredients();
        this.formDoughBalls(24);
        this.bake(10);
    }

    public void preheatOven(int temp) {
        // code to preheat oven to a temp
    }

    public void combineWetIngredients() {
        // code to mix eggs, sugar, butter, vanilla
    }

    public void combineDryIngredients() {
        // code to mix flour, salt, baking soda
    }

    public void combineAllIngredients() {
        // code to combine wet and dry ingredients
    }

    public void formDoughBalls(int numBalls) {
        // code to form balls of dough
    }

    public void bake(int cookTime) {
        //code to bake cookies and remove from oven
    }
} // end of Baker class
```


Modifying Flow of Control

- In Java, various *control flow statements* modify sequence of execution
  - these cause some lines of code to be executed multiple times, or skipped over entirely
- We'll learn more about these statements in *Making Decisions* and *Loops* lectures later on

Announcements

- AndyBot and HW1 are out now!
  - HW1 is due on **9/18 at 2PM**
  - AndyBot is due on **9/20 at 11:59pm**
  - *These must be turned in through the cs015_handin script*
- Lab 0 is due by your next lab
  - If you went to Tues at 5pm last week, you must get lab0 checked off by Tues at 6:30pm (end of lab)
- Review sessions start **today**
  - Twice/week, Thurs 7:30-9, Sun 12-1:30 at MacMillan 115
- Questions on homeworks or course material?
  - Sign up for Piazza at https://piazza.com/class/iohq4igg3922li
  - Make sure your questions are private
- Remember to sign your collab policy!

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