Topic 13
procedural design

"Ugly programs are like ugly suspension bridges: they're much more liable to collapse than pretty ones, because the way humans (especially engineer-humans) perceive beauty is intimately related to our ability to process and understand complexity."

- Eric S. Raymond,

Author of *The Cathedral and the Bazaar*

Based on slides bu Marty Stepp and Stuart Reges from http://www.buildingjavaprograms.com/

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https://www.cs.utexas.edu/~scottm/cs312/handouts/slides/topic13_procedural_design.pdf
https://www.cs.utexas.edu/~chand/cs312/topic13_procedural_design.pdf

Coding Problem 1

Formula for earnings:

dollarsEarned = dollarsPerHour * hoursWorked

- Write a program that produces output like the following:

```
This program reads data for two people
and reacts to their earnings.

Enter next person's info:
pay rate (in dollars per hour)? 1
hours worked? 1
Work more!

Enter next person's info:
pay rate (in dollars per hour)? 10
hours worked? 10
Good job!

Earnings difference = $99.00
```

Easy but bad design (1 of 2)

```
import java.util.Scanner;

public class Cs312 {
    public static void main(String[] args) {
        Scanner key = new Scanner(System.in);
        System.out.println("This program reads data for two people");
        System.out.println("and reacts to their earnings.");
        System.out.println();

        System.out.println("Enter next person's info: ");
        System.out.print("pay rate (in dollars per hour)? ");
        double dollarsEarnedPerHour1 = key.nextDouble();
        System.out.print("hours worked? ");
        double hoursWorked1 = key.nextDouble();
        double dollarsEarned1 = dollarsEarnedPerHour1 * hoursWorked1;

        if (dollarsEarned1 < 10.0) {
            System.out.println("Work more!");
        } else if (dollarsEarned1 < 100.0) {
            System.out.println("Good, but work even more.");
        } else if (dollarsEarned1 < 1000.0) {
            System.out.println("Good job!");
        } else if (dollarsEarned1 < 10000.0) {
            System.out.println("Great job!");
        } else {
            System.out.println("$$$$$$$$$!");
        }
        System.out.println();
```

Easy but bad design (2 of 2)

```
        System.out.println("Enter next person's info: ");
        System.out.print("pay rate (in dollars per hour)? ");
        double dollarsEarnedPerHour2 = key.nextDouble();
        System.out.print("hours worked? ");
        double hoursWorked2 = key.nextDouble();
        double dollarsEarned2 = dollarsEarnedPerHour2 * hoursWorked2;

        if (dollarsEarned2 < 10.0) {
            System.out.println("Work more!");
        } else if (dollarsEarned2 < 100.0) {
            System.out.println("Good, but work even more.");
        } else if (dollarsEarned2 < 1000.0) {
            System.out.println("Good job!");
        } else if (dollarsEarned2 < 10000.0) {
            System.out.println("Great job!");
        } else {
            System.out.println("$$$$$$$$$!");
        }
        System.out.println();

        double difference = Math.abs(dollarsEarned2 - dollarsEarned1);
        System.out.printf("Earnings difference = $%.2f\n", difference);

        key.close();
    }
}
```

Procedural heuristics

1. Each method should have a clear set of responsibilities.

2. No method should do too large a share of the overall task.

3. Minimize coupling and dependencies between methods.

4. The main method should read as a concise summary of the overall set of tasks performed by the program.

5. Variables should be declared/used at the lowest level possible.

Better solution

```
import java.util.Scanner;

public class Cs312 {
    public static void main(String[] args) {
        Scanner key = new Scanner(System.in);
        introduction();

        double dollarsEarned1 = getDollarsEarned(key);
        printResults(dollarsEarned1);

        double dollarsEarned2 = getDollarsEarned(key);
        printResults(dollarsEarned2);

        printDifference(dollarsEarned1, dollarsEarned2);

        key.close();
    }

    public static void introduction() {
        System.out.println("This program reads data for two people");
        System.out.println("and reacts to their earnings.");
        System.out.println();
    }

    public static double getDollarsEarned(Scanner key) {
        System.out.println("Enter next person's info: ");
        double dollarsEarnedPerHour1 = getNextValue(key, "pay rate (in dollars per hour)?");
        double hoursWorked1 = getNextValue(key, "hours worked?");
        return dollarsEarnedPerHour1 * hoursWorked1;
    }
```

Better solution, cont'd.

```
public static double getNextValue(Scanner key, String promptNoSpace) {
        System.out.print(promptNoSpace + " ");
        return key.nextDouble();
    }

    public static void printResults(double dollarsEarned) {
        System.out.println(reaction(dollarsEarned));
        System.out.println();
    }

    public static String reaction(double dollarsEarned) {
        if (dollarsEarned < 10.0) {
            return "Work more!";
        } else if (dollarsEarned < 100.0) {
            return "Good, but work even more.";
        } else if (dollarsEarned < 1000.0) {
            return "Good job!";
        } else if (dollarsEarned < 10000.0) {
            return "Great job!";
        } else {
            return "$$$$$$$$$!";
        }
    }

    public static void printDifference(double dollarsEarned1, double dollarsEarned2) {
        double difference = Math.abs(dollarsEarned2 - dollarsEarned1);
        System.out.printf("Earnings difference = $%.2f\n", difference);
    }
}
```

Coding Problem 2

Formula for body mass index (BMI):

$$BMI = \frac{weight}{height^2} \times 703$$

- Write a program that produces output like the following:

```
This program reads data for two people and computes
their body mass index (BMI) and weight status.

Enter next person's information:
height (in inches)? 73.5
weight (in pounds)? 230
BMI = 29.93
overweight

Enter next person's information:
height (in inches)? 71
weight (in pounds)? 220.5
BMI = 30.75
obese

Difference = 0.82
```

BMI	Weight class
below 18.5	underweight
18.5 - 24.9	normal
25.0 - 29.9	overweight
30.0 and up	obese

One-person, no methods

```
import java.util.*;

public class BMI {
    public static void main(String[] args) {
        System.out.println("This program reads ... (etc.)");
        Scanner console = new Scanner(System.in);

        System.out.println("Enter next person's information:");
        System.out.print("height (in inches)? ");
        double height = console.nextDouble();

        System.out.print("weight (in pounds)? ");
        double weight = console.nextDouble();

        double bmi = weight * 703 / height / height;

        System.out.printf("BMI = %.2f\n", bmi);
        if (bmi < 18.5) {
            System.out.println("underweight");
        } else if (bmi < 25) {
            System.out.println("normal");
        } else if (bmi < 30) {
            System.out.println("overweight");
        } else {
            System.out.println("obese");
        }
    }
}
```

Better solution

```
// This program computes two people's body mass index (BMI) and
// compares them.
// The code uses Scanner for input, and parameters/returns.

import java.util.Scanner;

public class BMI {
    public static void main(String[] args) {
        introduction();
        Scanner console = new Scanner(System.in);
        double bmi1 = person(console);
        double bmi2 = person(console);

        // report overall results
        report(1, bmi1);
        report(2, bmi2);
        System.out.println("Difference   = "
                                    + Math.abs(bmi1 - bmi2));

    }

    // prints a welcome message explaining the program
    public static void introduction() {
        System.out.println("This program reads ...");
        // ...
    }
...
```

Better solution, cont'd.

```
    // reads information for one person, computes their BMI,and returns it
    public static double person(Scanner console) {
        System.out.println("Enter next person's information:");
        System.out.print("height (in inches)? ");
        double height = console.nextDouble();

        System.out.print("weight (in pounds)? ");
        double weight = console.nextDouble();
        System.out.println();

        return bmi(height, weight);
    }

    // Computes/returns a person's BMI based on their height and weight.
    public static double bmi(double height, double weight) {
        return weight * 703 / (height * height);
    }

    // Outputs information about a person's BMI and weight status.
    public static void report(int number, double bmi) {
        System.out.printf("Subject%5dBMI = %.2f\n", number, bmi);
        if (bmi < 18.5) {
            System.out.println("underweight");
        } else if (bmi < 25) {
            System.out.println("normal");
        } else if (bmi < 30) {
            System.out.println("overweight");
        } else {
            System.out.println("obese");
        }
    }
}
```