Compsci 201
Arrays, ArrayList, APIs

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Today is the last day of drop/add
It is almost too late…

• You cannot switch your section without a permission number.
• DO NOT drop your section until you can get a perm number for the other section
• Go to https://www.cs.duke.edu/undergrad/registration
• Scroll down below office hours til you see
  Permission number for Spring 2020 courses
• Then fill out that form
• You must use permission number today!
• We will not be handing them out after 5pm
D is for …

- **Debugging**
  - A key skill in making your programs *correct*, your program will *run* without this skill

- **Digital**
  - All about the 1s and 0s
Plan for Today

• What work is here, what work is coming
  • P0, P1, APTs

• Understanding arrays and ArrayList: Tradeoffs
  • APTS always use arrays, convert to ArrayList?

• Reasoning empirically and analytically
  • Working well enough and working at scale
Announcements

• Assignment P0 due last week
  • No late penalty since first assignment til Jan 24
• APT-1 now due Thurs, January 23
  • Can still turn in Friday til 11:59pm
• Discussion 3 on January 27
  • Prediscussion, do before, out by Friday
• APT-2 out today, due January 28 (short 1 due)
• Assignment P1 out Friday, due Thursday, Jan 30
• Reading on calendar
  • Slowing down …..
  • try to read by date posted, ok if you need a few more days
Visualizations Help Understanding?

• Javatutor to visualize code: [http://pythontutor.com/java.html](http://pythontutor.com/java.html)
  • Using the java.awt.Color class
  • Both String and Color are **immutable**
    • Once created, cannot ever change

```java
import java.awt.*;

public class ObjectColorDemo {
    public static void main(String[] args) {
        Color c = Color.RED;
        Color d = c;
        Color e = c.darker();
        Color f = new Color(255,0,0);

        System.out.printf("%s\n%2s\n%2s\n%2s\n", c, d, e, f);
    }
}
```
Arrays and APIs

- Accessing a list of sandwich ingredients
  
  [Link](https://www2.cs.duke.edu/csed/newapt/sandwichbar.html)
  
  - Ingredients specified as string "lettuce tomato"
  - String split method

  ```java
  String[] d = "lettuce tomato".split(" ");
  ```
Arrays and APIs

- Accessing a list of sandwich ingredients
  https://www2.cs.duke.edu/csed/newapt/sandwichbar.html
  - Ingredients specified as string "lettuce tomato"
  - String split method
    
    ```java
    String[] d = "lettuce tomato".split(" ");
    ```

    d is
    ```javascript
    [ "lettuce", "tomato" ]
    ```
APTs: parsing/processing data

• String <-> String[]: parameter and return types
  String s = "apple pear lemon orange";
  String [] ar = s.split(" ");

• Bridge from array to string?
  String[] a = {"one", "two", "three"}
  String b = String.join(":", a);
APTs: parsing/processing data

• String <-> String[]: parameter and return types

```java
String s = "apple pear lemon orange";
String[] ar = s.split(" ");
// ar is ["apple", "pear", "lemon", "orange"]
```

• Bridge from array to string?

```java
String[] a = {"one", "two", "three"}
String b = String.join(":",a);
// b is "one:two:three"
```
Helper methods
Creating your own API

• **SandwichBar APT** writeup
  https://www2.cs.duke.edu/csed/newapt/sandwichbar.html
• Clue/hint that indexing loop appropriate
• *Helper function*: array of strings contains all strings. Be creative in wanting an API for that
WOTO SandwichBar

• How to test locally?
  • Write main method. Create new object …
  • Faster to debug locally, even use debugger?

```java
public static void main(String[] args) {
    SandwichBar sb = new SandwichBar();
    String[] av = {"cheese", "cheese", "cheese", "tomato"};
    String[] orders = {
        "ham ham ham", "water", "pork", "bread",
        "cheese tomato cheese", "tomato lettuce"};
    int dex = sb.whichOrder(av, orders);
    System.out.printf("index = \%d\n", dex);
}
```
Helper methods
Creating your own API

• **SandwichBar APT** writeup

• *Helper function*: array of strings contains all strings. Be creative in wanting an API for that
Helper methods
Creating your own API

• **SandwichBar APT** writeup

  • **Helper function**: array of strings contains all strings. Be creative in wanting an API for that

```java
public class SandwichBar {
    public int whichOrder(String[] available, String sandwich) {
        for (int k=0; k<orders.length; k++) {
            String sandwich = orders[k];
            if (canMake(available, sandwich)) {
                return k;
            }
        }
    }
}
```
Helper methods
Creating your own API

- **SandwichBar APT** writeup
  - **Helper function**: array of strings contains all strings. Be creative in wanting an API for that

```java
public class SandwichBar {
    public int whichOrder(String[] available, String[] orders) {
        for (int k=0; k<orders.length; k+=1) {
            String sandwich = orders[k];
            if (canMake(available, sandwich)) {
                return k;
            }
        }
    }
}
```
Scoring WOTOs going forward

• Each regular WOTO form is worth 2 pts
• If 2 WOTOs in a lecture, each worth 2 pts
• Some WOTO forms correctness will count and each problem is worth pts (likely 1 pt each)
• We are dropping all WOTOs done before today

• SUBMIT ALL WOTO FORMS – they count!
• Work Together with others
WOTO (4 minutes)

Nancy Leveson: Software Safety

• (@MIT) Mathematical and engineering aspects, invented the discipline
  • Air traffic control
  • Microsoft word
  “There will always be another software bug; never trust human life solely on software” [huffington post?](http://en.wikipedia.org/wiki/Therac-25)

• Therac 25: Radiation machine
  • Software and steam engines
Source Code, Byte Code

• High level languages compiled to low level languages
  • In C/C++ low-level *specific to platform*
  • In Java byte code is low-level
• Execute by machine: real or virtual
• JVMs must be ported to platform
• Android doesn't use JVM
  • Dalvik and now ARM
• Be grateful!!!!!!
  • High level source code
From Hello.java to Hello.class

```java
public class Hello {
    public static void main(String[] args) {
        System.out.println("hello world");
    }
}
```

Code:
```
0: aload_0
1: invokespecial #1
4: return
```

Code:
```
0: getstatic #2
3: ldc #3
5: invokevirtual #4
8: return
```
Project P1 out soon

• See course website for details, discussion D3
  • Not quite this, but …
    https://www.youtube.com/watch?v=DoLe1c-eokI
• Read assignment before starting to code
  • Think before fingers on keys
• Use Piazza and Helper Hours
Projects in 201: Review

• Start with GitLab project, fork repository
  • Starter code and cloud-based storage for projects
  • Clone repo to your machine: you need Git for this

• You use Duke Compsci GitLab website
  • You manage your code/projects with GitLab

• Make changes, complete project
  • Push changes frequently using Git … hourly/daily
What is Git?

- Git is a free and open source distributed version control system designed to handle everything from small to very large projects with speed and efficiency. [https://git-scm.com/](https://git-scm.com/)

- In teams, huge win. Individually, huge win
  - Git is complicated when it doesn’t work, lots of commands
  - Git relies on SSH to be secure
Assignments P0 and P1

• Simple Java class with driver programs
  • How is a program run? What is main?
  • Testing methods and testing classes

• Example of 201 work-flow
  • GitLab for starter code and your code
  • Using SSH and GitLab together
  • Submitting via Gradescope, Analysis
What is a static method?

- Objects are instances of a class
  - Thus objects have instance variables
  - Typically private, accessed in methods

- Static method belongs to class, not object
  - No instance variables
  - Accesses static variables and methods
  - More on this later, for now? …
Static Methods

• The class Math has many (java.lang)
  • `sqrt`, `cos`, `abs`, ...
• The class Arrays has many (java.util)
  • `sort`, `fill`, `toString`, `asList`, ...

• Invoke as `Math.sqrt(25.0)` or `String.join(…)`
  • Math is a class. Convention for name?
  • There aren't different Math objects, none!
    • No state needed, all code in methods
WOTO: Correctness Counts