Compsci 201
Classes, Arrays, APIs

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Be in the know …

• Add yourself to compsci@duke.edu
  • Duke University mailing lists – add yourself
    https://lists.duke.edu/sympa
  • Compsci related events, jobs, research opportunities

• Apply for Data+, CS+, Code+
  • summer research at Duke, paid, hire lots of 1st year students, 2nd year, etc.
  • Apply in January!
    https://www.cs.duke.edu/undergrad/summer_research
My Digital Hand

- A fifth of you are not in the know……

- Sign up for my digital hand

- Check your email……
C is for …

• Class
  • Framework for creating objects

• Collections and Collection
  • See java.util.* for details

• Collaboration
  • Review the policy
Plan for the Day

- Review Object concept: classes, P0
  - What is a class, object, instance variable

- Review arrays in Java: methods and concepts
  - Required for APTs due next week
  - Move toward ArrayList and other collections

- Coding and helper functions
  - Efficient programming and not efficient programs
Strings: Example from last time

• You can’t modify a string, always create new String

```java
String s = new String(“joy”);

String t = s;

s = t + t;
```
Strings: Example from last time

• You can’t modify a string, always create new String

```java
String s = new String("joy");
// s is "joy"

String t = s;

s = t + t;
```
Strings: Example from last time

- You can’t modify a string, always create new String

```java
String s = new String("joy");

String t = s;
// s is "joy"
// t is "joy"

s = t + t;
```
Strings: Example from last time

• You can’t modify a string, always create new String

```java
String s = new String("joy");

String t = s;

s = t + t;  // create new String
// s is "joyjoy"
// t is "joy"
```
Class

• Adjective, noun, close to a verb
  • Show some ___ you're in a great ___, that's a ____ act, let's ____-ify that

• Fundamental part of object-oriented programming
  • All Java code is in a class, alas the primitives
  • In Python int is a class, has no upper bound
  • In Java int is a primitive, $2^{31}-1$ maximal value
Class encapsulates state and behavior

• Class is a template, object has characteristics
  • Dogs have fur, speed, temperament, size, …
• Typically we don’t use examples like this, but they can help build intuition and understanding
  • Class dog, retriever extends dog, method bark()
Class and Object

• If we had a Retriever class we could *instantiate an instance of the class, i.e., create an object*

  Retriever ks = new Retriever("kelsey");

• Class is an *object factory*, calling new creates a new object that is an instance of the class

  • We could call a method: **ks.bark()**
Classes in Java

- Define class `Foo` in `Foo.java`
- Create object by calling `new Foo(..)`
- Access object by calling methods: `obj.doSomething()`
- Some methods return a value, use it!
Classes in Java

- **State**: instance variables: private
- **Constructors**: initialize instance variables
- **Methods**: functions aka behavior
- **Documentation**: Javadoc and other comments
Classes in Java

• **State**: instance variables: private

• **Constructors**: initialize instance variables

• **Methods**: functions aka behavior

• **Documentation**: Javadoc and other comments
Work-Flow for Assignments

• What is the work-flow for P0 and Assignments?
  • Login to gitlab
  • Code URL to P0 in gitlab
    https://coursework.cs.duke.edu/201spring20/p0-person-sp20
  • Fork it (makes a copy in the cloud)
  • Clone with ssh
Using a shell

- Place to type shell commands
- On Mac use Terminal, Windows use Bash Git
- What is this?

```
$ is a prompt, ready for a shell command
```

```
Susan@LAPTOP-NTK3PPUUK MINGW64 ~/IdeaProjects/spring20
$ 
```
Using a shell

- **Place to type shell commands**
- **On Mac use Terminal, Windows use Bash Git**
- **What is this?**

It’s a path:
- **Folder named IdeaProjects**
  - **Folder named spring20**
    - May have other folders inside it
- **$ is a prompt, ready for a shell command**
A few shell commands

- `pwd` — display current path
- `cd` — change into main folder/directory
- `cd name` — change into folder named name
- `cd ..` — change back into parent folder
- `ls` — show files in current folder

- Let’s see some of those…. 
Back to Work-Flow for Assignments

• Clone with ssh

• Go to your shell
  • cd (to folder you want to put your P0 in)
  • git clone (SSH URL you copied)
  • ls (will show your files)

• Using IntelliJ complete the assignment
  • Save code often to gitlab!
Work-Flow for Assignments (cont)

• Send code back to gitlab (DO OFTEN)
  • cd ( into project folder)
  • git add .

  • git commit –m “comment on what you did”

  • git push

• Now to Gradescope and submit project
  • Don’t like results - fix code, push code, run on Gradescope again
Work-Flow for Assignments (cont)

• Send code back to gitlab (DO OFTEN)
  • cd (into project folder)
  • git add .
    • Puts code in staging area, tells git you want to update
  • git commit –m “comment on what you did”
    • Changes are recorded in local repo
  • git push
    • Uploads the changes to your gitlab repo

• Now to Gradescope and submit project
  • Don’t like results - fix code, push code, run on Gradescope again
Classes and P0

• How many Person objects created?
  • Each has a name and an age, different for each instance. Thus: instance variables

```java
public class PersonDriver {
    public static void main(String[] args) {
        Person p = new Person();
        Person q = new Person(name: "Sam", age: 21);

        System.out.println(p.getName());
        System.out.println(q.getName());
        System.out.println(p.getAge());
        System.out.println(q.getAge());
        System.out.println(p);
        System.out.println(q);
    }
}
```
Classes and P0

• How many Person objects created?
  • Each has a name and an age, different for each instance. Thus: instance variables

• To create? Call new which invokes a constructor
  • No return type, initialize instance variables

• Access levels: private only within class, public from other classes
  • Technically there is a package access, we ignore
public class Person {
    private String myName;
    private int myAge;

    public Person(String name, int age) {
        myName = name;
        myAge = age;
    }

    public Person() {
        this(name: "NoName", age: 13);
    }

    public String getName() { return myName; }
    public int getAge() { return myAge; }

    @Override
    public String toString() {
        return String.format("%s %d", getName(), getAge());
    }
}
Constructor

• Same name as class
  • No return type

• Overload with different parameters
  • Each should initialize all instance variables

• Factor out common code into helper method if lengthy
  • Can call another constructor using `this(...)`
What is **this**?

- An object instance refers to itself
  - Method or constructor: object references itself
  - Every reference to an instance variable `myVar` could be written as `this.myVar`

- Code for an object to pass itself:
  - `callMethod(this,"hello");`
- Constructor can call other constructor
  - `this("hello");`
Running a Java Program

- On laptop/desktop launch/run point is the main method in any class
  - Driver programs in P0, runs/drives the code
  - Method signature **required** to run program

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        System.out.println(p.getAge());
        System.out.println(q.getAge());
        System.out.println(p);
        System.out.println(q);
    }
}
```
WOTO (3 minutes)

Luis von Ahn

- Duke 2000, Math
- Duke Honorary Degree 2017
- CEO Duolingo
- Macarthur Award, 2006
- MIT-Lemelson Prize, 2018

“It’s amazing how motivating it is to sit with somebody and say, ‘What you’re doing is really important.’ I use that a lot.”
Arrays, APTs, and APIs

• Why is alliteration important in writing?
• Why are these important in programming?
• APIs create possibilities
Array Details

• Once array created, it's size is fixed, can't grow!
  • Indexable elements can be changed

• Using `a[k]` we can read/write values
  • Instance variable `a.length` is size of array
    • No parentheses, hence not a method
  • Notice dot notation: object dot name
Indexing for loops and arrays

• Constructing and initializing …
  
  ```java
  int[] a = new int[100];
  for(int k=0; k < a.length; k += 1){
    a[k] = 99;
  }
  ```

• Let an API-call fill in array: `java.util.Arrays`
  • `Arrays.fill(a,99);`
  • [https://docs.oracle.com/en/java/javase/11/docs/api/java.base/java/util/Arrays.html](https://docs.oracle.com/en/java/javase/11/docs/api/java.base/java/util/Arrays.html)
For each loops and arrays

- For each loop: no index, no changing what’s stored

```java
int[] a = {1,2,3,4,5,6,7,8,9,10};
int sum1 = 0; int sum2 = 0;
for(int k=0; k < a.length; k += 1){
    sum1 += a[k];
}
for(int value : a){
    sum2 += value;
}
System.out.println(sum1 == sum2);
```
For Loop Summary

- for(init; boolean guard; update) {...}
- for(int k=0; k < a.length; k+=1) {...}
  - Initialization happens once, before guard checked for the first time, never again
  - Initialization can introduce variables: loop scope

- Guard checked, if true loop body executes
- After loop body, update executes, guard checked
Control Construct Summary

• if (boolean) {...}
  • Block executed when guard is true
  • { } not needed for single statement, use anyway
• if (boolean) {...} else {...}
  • Code in else block when negation true
• while (boolean) {...}
  • Check boolean guard, execute body, repeat
  • Guard checked again after body executed
From Control to APIs

• List and ArrayList similar to array, but ....
  • Grow as needed, can't use [k] to access
  • Powerful APIs, e.g., as follows

```java
jshell> for(int k=0; k < f.length; k+=1){
    ...> if (f[k].equals(a)) System.out.printf("found %d\n",k);
    ...> }
found 2

jshell> f
f ==> String[4] { "apple", "cherry", "banana", "melon" }

jshell> a
a ==> "banana"

jshell> Arrays.asList(f).indexOf(a)
$6 ==> 2
```
From Control to APIs

• List and ArrayList similar to array, but ….
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```

Arrays.asList() powerful!
Solving an APT Together

• Totality (see APT page on course site)
  http://www.cs.duke.edu/csed/newapt/totality.html

• Solve by hand: \(a = \{20,30,40,50,60\}\) stype=“odd”

• Use what you know, but implement in Java
  • Check ideas using jshell (Java 9 and later)
  • Command line is your friend!
Think Before You Code

- Solve by hand ... Check your understanding of examples ... think about solution you’ll write ... 
- Then think before fingers on keys
Coding Interlude

• Working on Totality APT in IntelliJ
  • Odd? Even?
  • Control: if, if-else, …
WOTO (3 minutes)

APIs should be easy to use and hard to misuse. It should be easy to do simple things; possible to do complex things; and impossible, or at least difficult, to do wrong things.
Summary of Java-isms

• Loop using indexes over an array
  • The for-loop: initialize; guard/check; update
• Totality: loop over odd indexes only?
  • In some cases, …
• How do we check for String equality?
  • .equals compared to ==

• How do we submit an APT?
  • Test, Grade, REFLECT
  • APTS – one grace day, NO LATE AFTER THAT