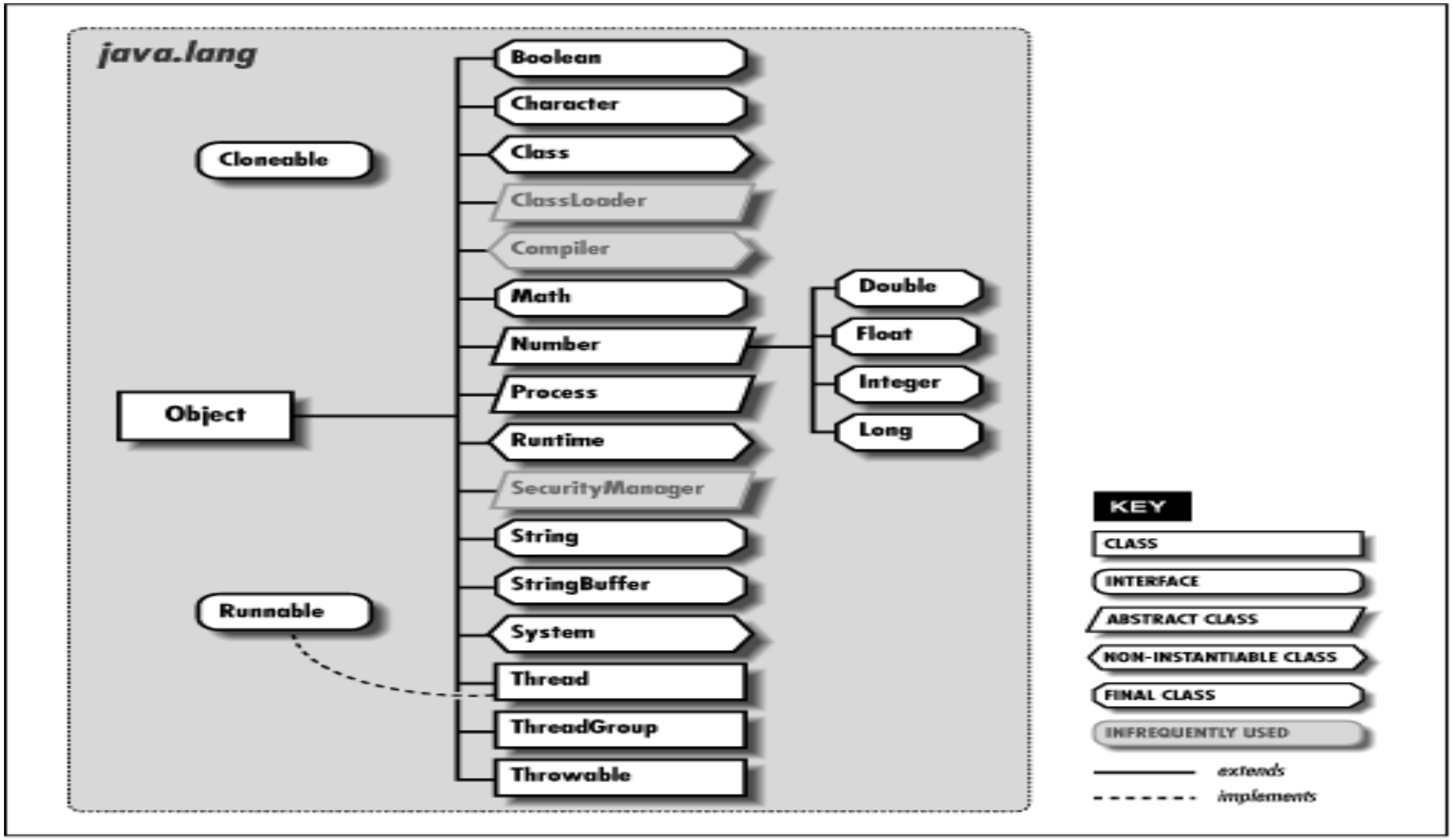
CS151

I/O Methods

Files/Exceptions

Inheritance

Start of the Java class hierarchy



http://web.deu.edu.tr/doc/oreily/java/langref/ch10_js.htm

Java Object Methods

- **public boolean equals(Object ob)**
- **public String toString()**

- public Class getClass()

- protected Object clone()
- protected void finalize()
- public int hashCode()
- public void notify()
- public void notifyAll()
- public void wait()
- public void wait(long l)
- public void wait(long l, int ii)

Inheritance in Java

```java
public class Inherit extends Object {
    public static void main(String[] args) {
        Inherit inh1 = new Inherit();
        Inherit inh2 = new Inherit();
        Inherit inh3 = inh1;

        System.out.println(inh1); // implicit use of toString()
        System.out.println(inh2.toString());  // explicit toString
        System.out.println("Equals " + inh1.equals(inh2));
        System.out.println("Equals " + inh1.equals(inh3));
        System.out.println("== " + (inh1 == inh2));
        System.out.println("== " + (inh1 == inh3));
    }
}
```

Equals and Objects

Overriding Inheritance

```
public class Inherit2 {
    @Override
    public String toString() {
        return “Inherit2 toString " + super.toString();
    }
    @Override
    public boolean equals(Object o) {
        return this == o;
    }
    public static void main(String[] args) {
        Inherit inh1 = new Inherit();
        Inherit2 inh2 = new Inherit2();
        System.out.println(inh1);
        System.out.println(inh2);
        System.out.println("Equals " + inh1.equals(inh1));
        System.out.println("Equals " + inh2.equals(inh1));
    }
}
```

Same as the default

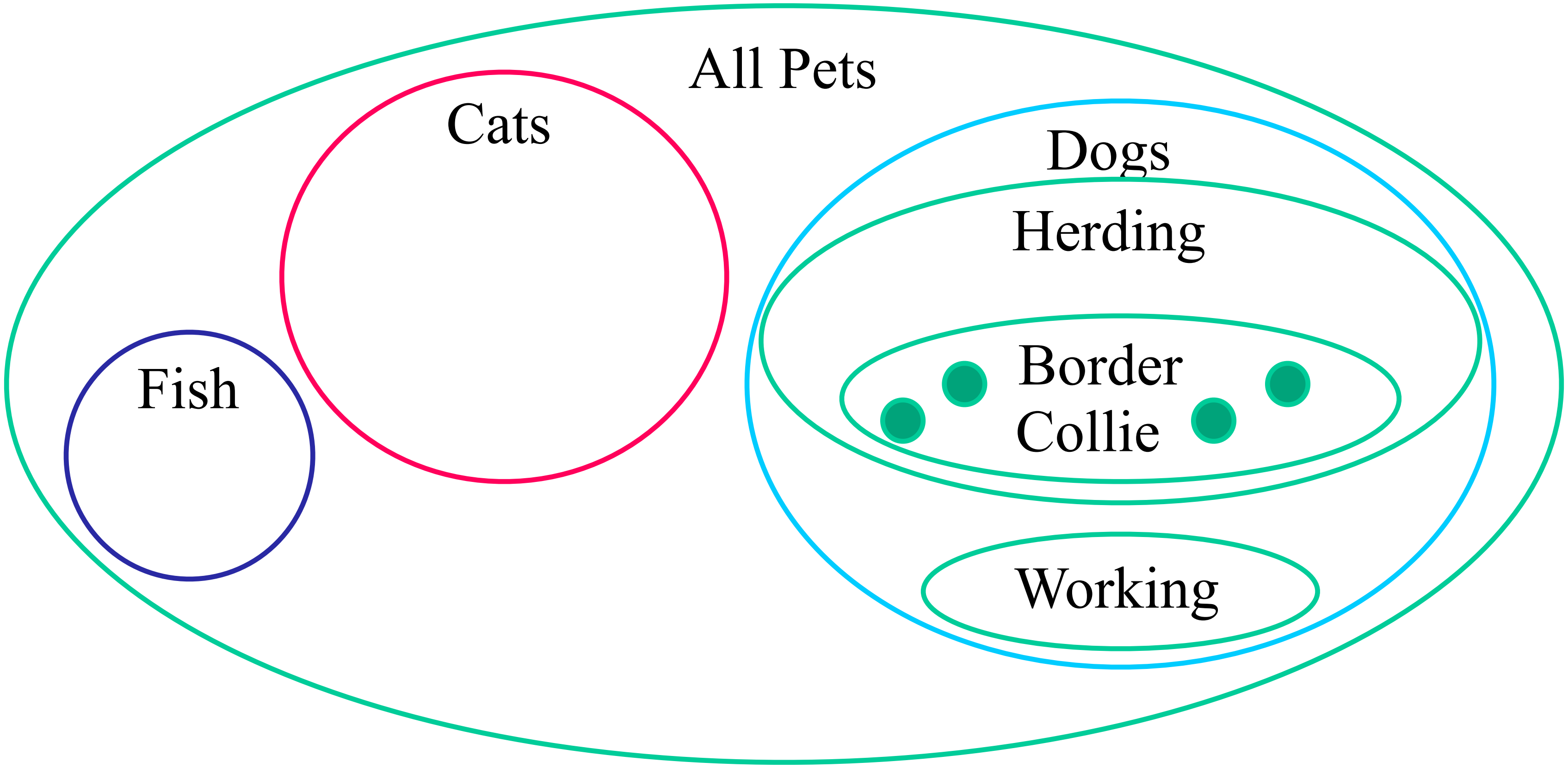
Overloading

```
public class Inherit3 extends Object {
    private int value; //just hold a value from the constructor.
    public Inherit3() { this(0); }
    public Inherit3(int vvv) { this.value = vvv; }
    public boolean equals(Inherit3 o3) {
        System.out.print("I am here   ");
        return o3.value == this.value;
    }
    public static void main(String[] args) {
        Inherit inhA = new Inherit();
        Inherit3 inhB = new Inherit3(6);
        Inherit3 inhC = new Inherit3(6);
        System.out.println("Equals " + inhB.equals(inhA));
        System.out.println("Equals " + inhB.equals(inhC));
        System.out.println("Equals " + inhB.equals((Object) inhC));
    }
}
```

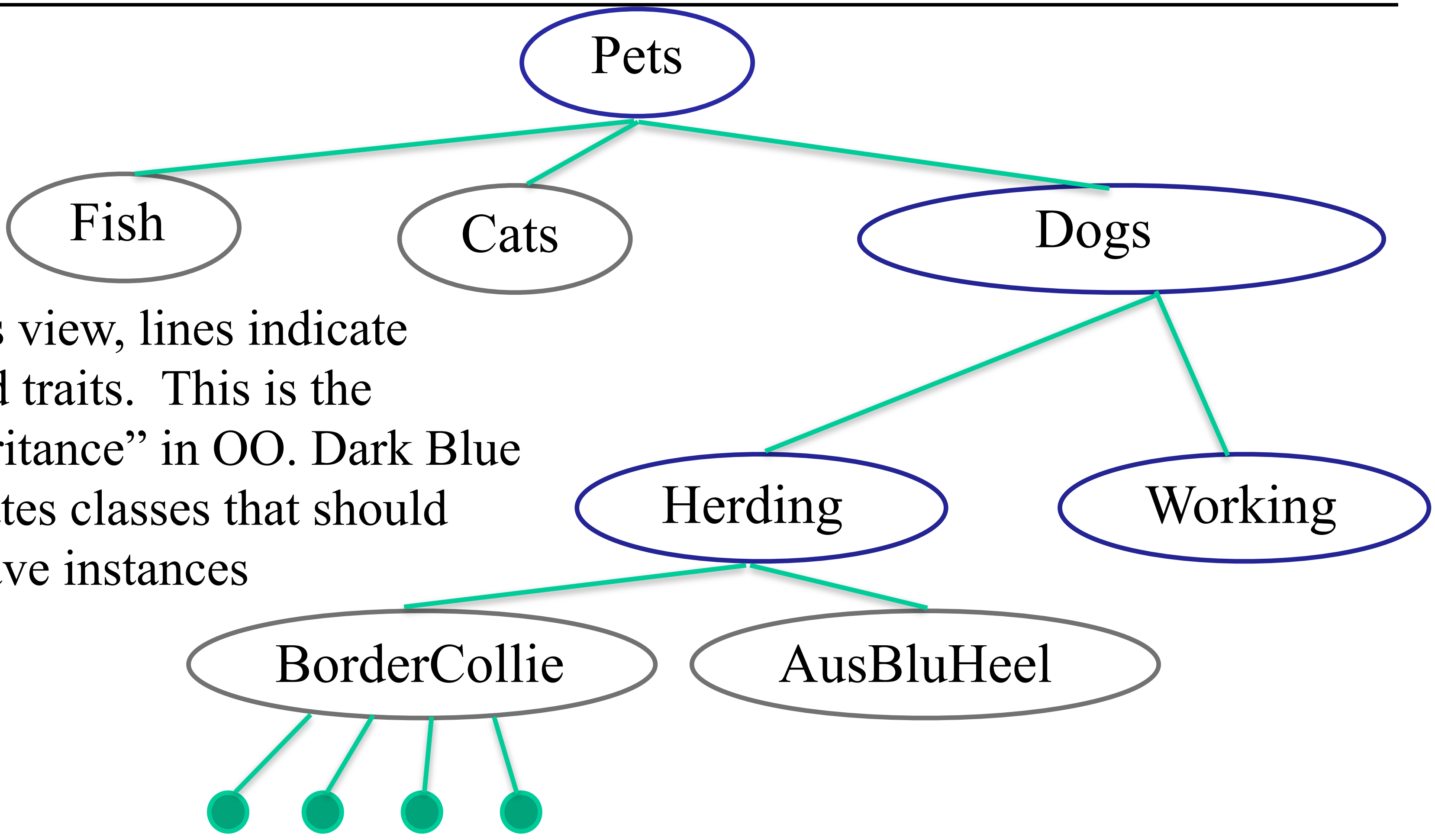
Overloaded

Classes and Inheritance

Consider Pets in a classic Venn Diagram view

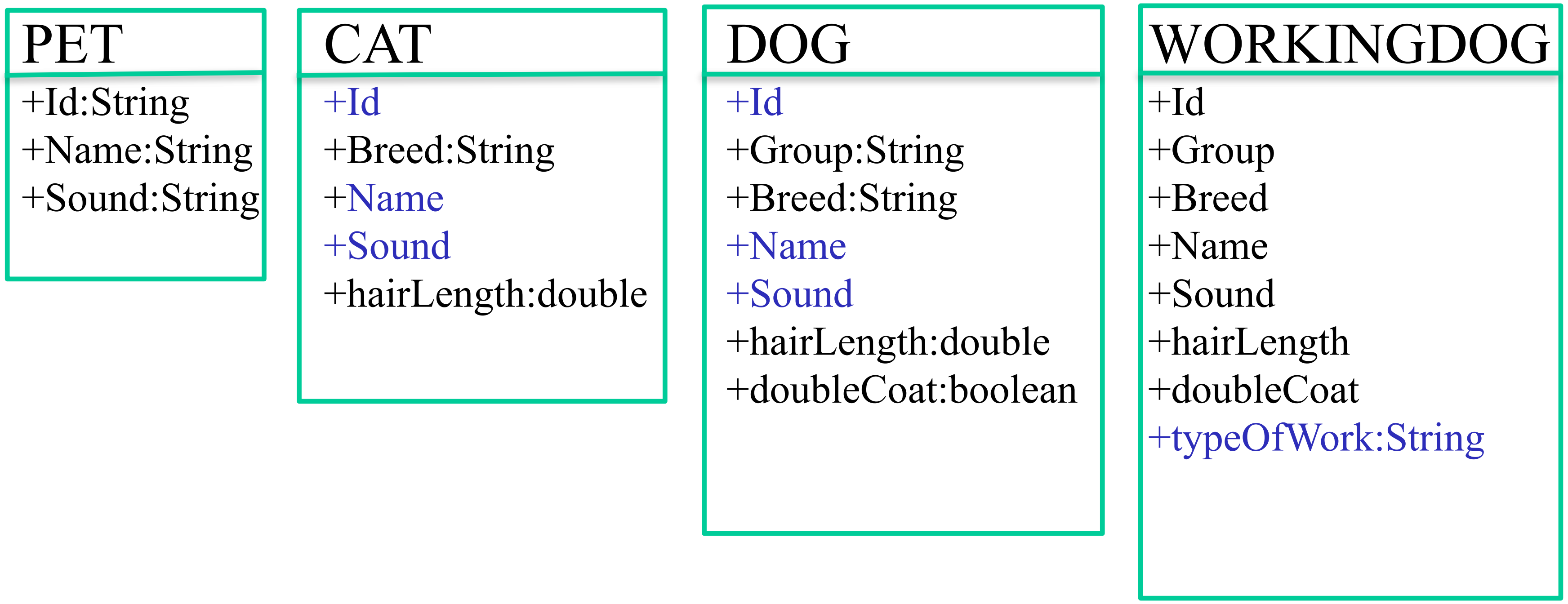


Classes and Inheritance



In this view, lines indicate shared traits. This is the "inheritance" in OO. Dark Blue indicates classes that should not have instances

Classes, Interfaces, UML



Pet Class

```
public class Petv1 extends Object {
    private String iD;
    private String name;
    public String sound() {
        return "silence";
    }
    public String getId() {
        return iD;
    }
    public String getName() {
        return name;
    }
}
```

private to protected

add equals

```
public class Pet {
    protected String iD;
    protected String name;
    public String sound() {
        return "silence";
    }
    public String getId() {
        return iD;
    }
    public String getName() {
        return name;
    }
    public boolean equals(Pet p) {
        return iD.equals(p.getId());
    }
}
```

Cat class

```
public class Cat extends Pet {
   private String breed;
   private double hairLength;
   public Cat(String name, String id, String breed) {
        this.name = name;
        this.iD = id;
        this.breed = breed;
    }
    @Override
    public String sound() {
        return "meow";
    }
    @Override
    public String toString() {
        return "My name is " + name + " breed " + breed + " and I say
" + sound();
    }
    public static void main(String[] args) {
        System.out.println(new Cat("calypso", "112234", "siberian"));
    }}
```

Dog Classes

```
public class Dog extends Pet{
    protected String group;
    protected double hairLength;
    protected boolean doubleCoat;
    @Override
    public String sound() {
        return "arf";
    }
    @Override
    public String toString() {
        return sound();
    }
    public static void
main(String[] args) {
        System.out.println(new
Dog());
    }
}
```

```
public class WorkingDog extends Dog
{
    protected String breed;
    protected String task;
    @Override
    public String toString() {
        return super.toString() + "
work " + task;
        }
    @Override
    public String sound() {
        return "woof";
    }
}
```

Casting, Classes and Inheritance

- Suppose:
  SPCA pet shelter
- Desire: A program that tracks all animals at shelter
- Approach
  - Use single array to hold all Pets
- Complaint: Mixed the problem of storing animals with the shelter's needs

```
public class Shelter {
    Pet[] animals = new Pet[100];
    int animalCount=0;
    public void addAnimal(Pet animal) {
        animals[animalCount++]=animal;
    }
    public Pet getAnimal(int location) {
        return animals[location];
    }
   public static void main(String[] args) {
        Shelter shelter = new Shelter();
        shelter.addAnimal(new Dog());
        shelter.addAnimal(new Cat());
      }}
```

  - better to separate the storage problem from the other needs of the shelter
    - The storage problem is exactly what data structures are for

Data Structure for Shelter

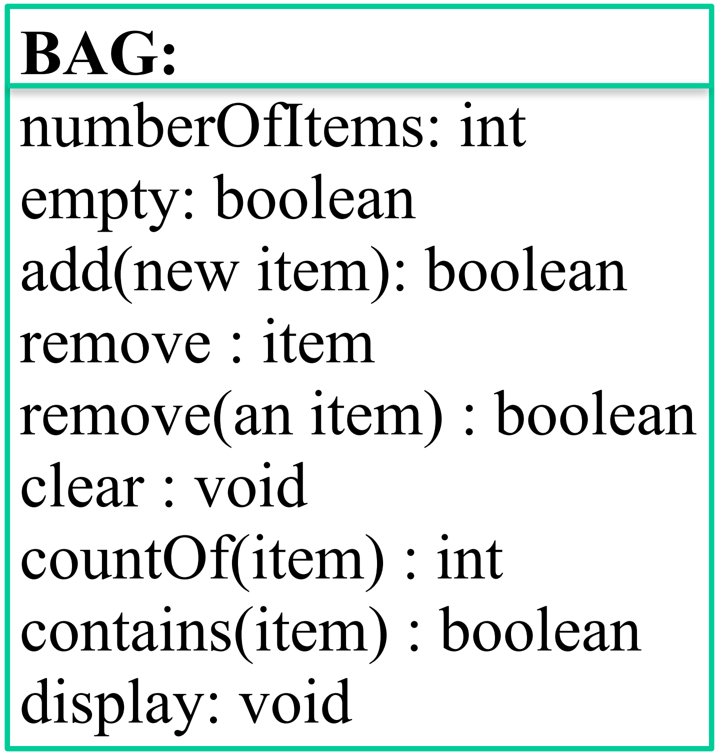
- Desired Behaviors
  - Add an Item
  - Remove a particular item
  - Number of times a particular item is in bag
    - probably should be 1, but maybe CatDog should be in twice
  - Does structure contain particular item?
  - Others?

None of these reqs have anything to do with shelter. So we can make a structure to do this for shelter AND others

Print entire contents, number of items in, remove an item, remove all

UML

- UML is
  - "Unified Modeling Language"
  - A programming language independent way of expressing classes
  - (I will not use +/-)



BAG:

numberOfItems: int
empty: boolean
add(new item): boolean
remove : item
remove(an item) : boolean
clear : void
countOf(item) : int
contains(item) : boolean
display: void

Java Interfaces

- No data fields
- No constructors
- No private methods
- No protected methods
- No bodies for methods

- Lots of instructions about how the IO behavior of methods
- I will tend to use Java interfaces rather than UML

- `javadoc BagOfPets.java`

```
/**
 * Interface definition for Bag
 * Adapted slightly from Carrano & Henry
 * @author GTowell
 * Created: July 2021
 */
public interface BagOfPets {
    /**
     * The number of pets in the bag
     * @return the number of pets in the bag
     */
    public int numberOfItems();

    /**
     * true if there is at least one pet in the ba
     * @return true if there is at least one pet i
     */
    public boolean isEmpty();

//etc
```

Java Interfaces

In a file Vehicle.java

Interfaces are usually EXTENSIVELY documented so programmers know what is intended for implementation

```
public interface Vehicle {
    void changeGear(int a);
    void speedUp(int a);
    void applyBrakes(int a);
}
```

Methods defined in interfaces are always public, so public can be omitted. Clashes with class definition in which "" indicates package (Horrific inconsistency!)

Java Interfaces

- Java allows only single inheritance.
  - A class can only extend one class
    - public class Myclass extends Pet
  - As a result, Java does not need any collision resolution.
- BUT a class can “implement” any number of Interfaces
  - Interfaces only define methods
    - they do not provide method bodies so no collision resolution required.
    - Programmer of class that “implements” interface MUST write method bodies.

Think before coding

- Point of UML (and one of the points of Java interfaces) is to get you to think about a problem before writing code
- Please do so
- While writing code,
  - get up and walk about
  - talk to a classmate about your thoughts
- Start early … please

Implementing BagOfPets

- java
  - `public X implements Y`
  - This says making a class that will provide bodies for EVERY method in interface Y
  - Possibly more methods
    - private or protected helpers for public
    - private instance variables

```java
/**
 * An implementation of the BagOfPets interface
 *
 * Note that everything marked with @Override does not
 * need documentation as it
 * should be documented elsewhere.
 * @author gtowell
 * Created: July 2021
 *
 */
public class PetBag implements BagOfPets {


    @Override
    public int numberOfItems() {
```

In class

- Continue implementation