Homework 8: Critters

reading: HW8 spec

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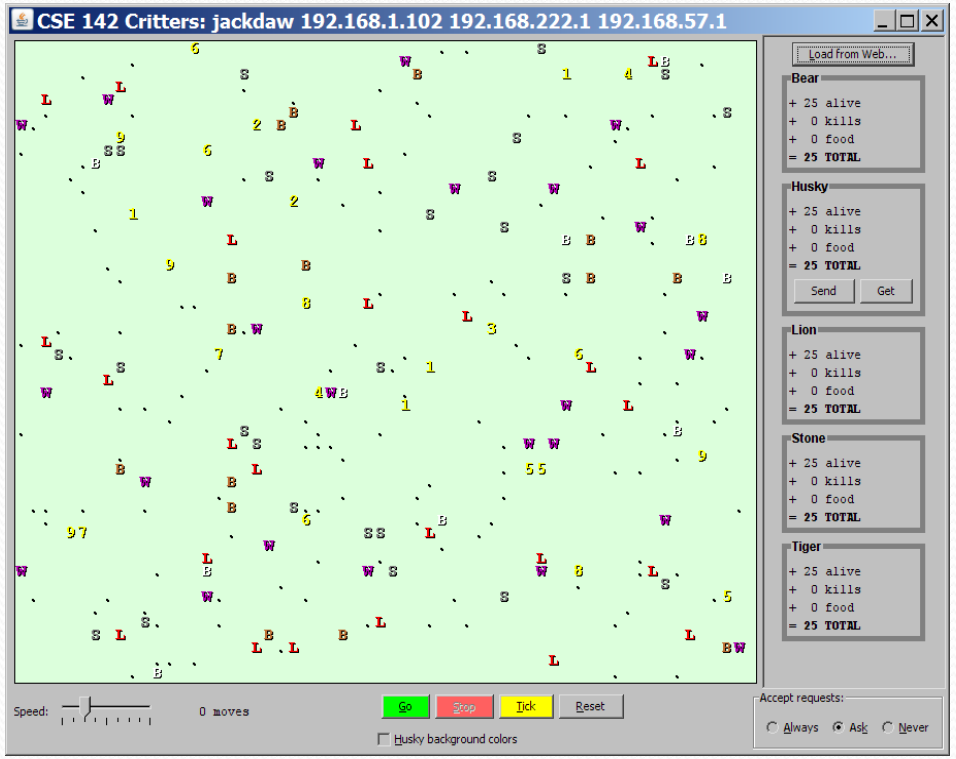
CSE 142 Critters

- `Ant`
- `Bird`
- `Hippo`
- `Vulture`
- `Husky` (creative)



- behavior:
  - `eat` eating food
  - `fight` animal fighting
  - `getColor` color to display
  - `getMove` movement
  - `toString` letter to display

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A Critter subclass

```
public class name extends Critter { ... }

public abstract class Critter {
    public boolean eat()
    public Attack fight(String opponent)
            // ROAR, POUNCE, SCRATCH
    public Color getColor()
    public Direction getMove()
            // NORTH, SOUTH, EAST, WEST, CENTER
    public String toString()
}
```

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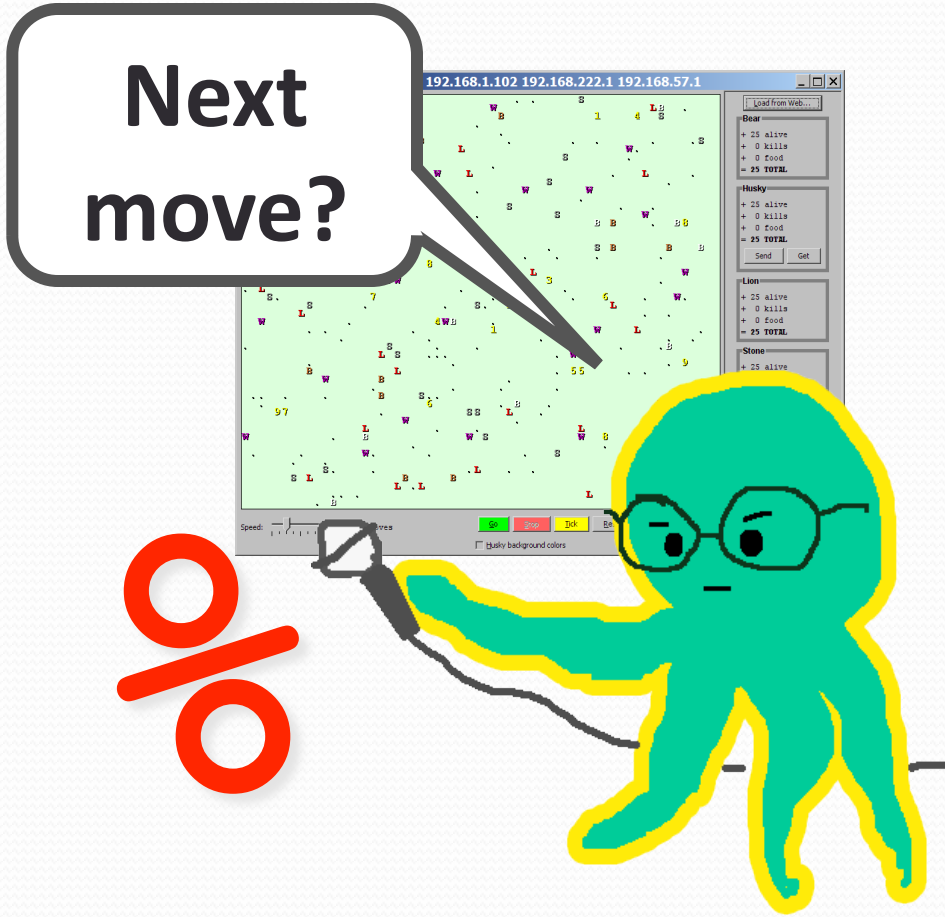
How the simulator works

- "Go" → loop:
  - move each animal (`getMove`)
  - if they collide, `fight`
  - if they find food, `eat`

- Simulator is in control!
  - `getMove` is <u>one move</u> at a time
    - (*no loops*)
  - Keep <u>state</u> (fields)
    - to remember future moves



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Development Strategy

- Do one species at a time
  - in ABC order from easier to harder (Ant → Bird → ...)
  - debug `println`s

- Simulator helps you debug
  - smaller width/height
  - fewer animals
  - **"Tick"** instead of "Go"
  - **"Debug"** checkbox
  - drag/drop to move animals

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Critter exercise: `Cougar`

- Write a critter class `Cougar`:

Method	Behavior
constructor	`public Cougar()`
`eat`	Always eats.
`fight`	Always pounces.
`getColor`	Blue if the `Cougar` has never fought; red if he has.
`getMove`	Walks west until he finds food; then walks east until he finds food; then goes west and repeats.
`toString`	`"C"`

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Ideas for state

- You must not only have the right state, but update that state properly when relevant actions occur.
- Counting is helpful:
  - How many total moves has this animal made?
  - How many times has it eaten? Fought?
- Remembering recent actions in fields is helpful:
  - Which direction did the animal move last?
    - How many times has it moved that way?
  - Did the animal eat the last time it was asked?
  - How many steps has the animal taken since last eating?
  - How many fights has the animal been in since last eating?

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Cougar solution

```
import java.awt.*;  // for Color

public class Cougar extends Critter {
    private boolean west;
    private boolean fought;

    public Cougar() {
        west = true;
        fought = false;
    }

    public boolean eat() {
        west = !west;
        return true;
    }

    public Attack fight(String opponent) {
        fought = true;
        return Attack.POUNCE;
    }

    ...
```

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Cougar solution

```
    ...

    public Color getColor() {
        if (fought) {
            return Color.RED;
        } else {
            return Color.BLUE;
        }
    }

    public Direction getMove() {
        if (west) {
            return Direction.WEST;
        } else {
            return Direction.EAST;
        }
    }

    public String toString() {
        return "C";
    }
}
```

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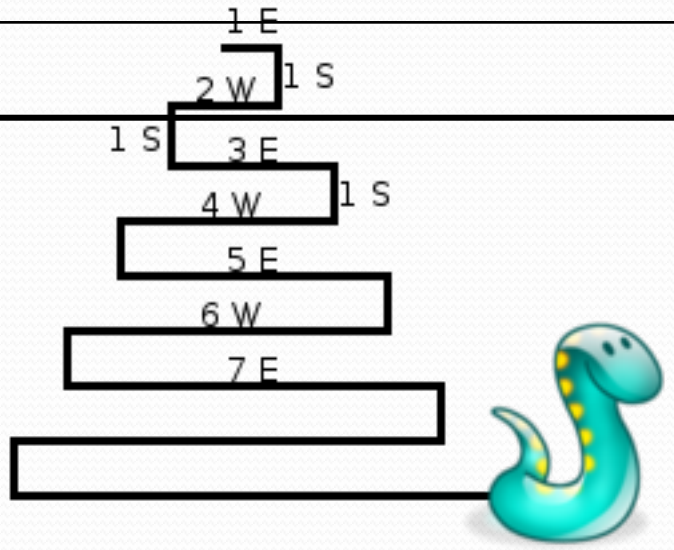
Critter exercise: `Snake`

Method	Behavior
constructor	`public Snake()`
`eat`	Never eats
`fight`	always forfeits
`getColor`	black
`getMove`	1 E, 1 S; **2** W, 1 S; **3** E, 1 S; **4** W, 1 S; **5** E, ...
`toString`	`"S"`



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Determining necessary fields

- Information required to decide what move to make?
  - Direction to go in
  - Length of current cycle
  - Number of moves made in current cycle

- Remembering things you've done in the past:
  - an `int` counter?
  - a `boolean` flag?

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Snake solution

```
import java.awt.*;    // for Color

public class Snake extends Critter {
    private int length;   // # steps in current horizontal cycle
    private int step;     // # of cycle's steps already taken

    public Snake() {
        length = 1;
        step = 0;
    }

    public Direction getMove() {
        step++;
        if (step > length) {   // cycle was just completed
            length++;
            step = 0;
            return Direction.SOUTH;
        } else if (length % 2 == 1) {
            return Direction.EAST;
        } else {
            return Direction.WEST;
        }
    }

    public String toString() {
        return "S";
    }
}
```

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Critter exercise: `Hipster`

- All hipsters want to get to the bar with the cheapest PBR
- That bar is at a randomly-generated board location
  (On the 60-by-50 world)
- They go north then east until they reach the bar

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A flawed solution

```
import java.util.*;   // for Random

public class Hipster extends Critter {
    private int cheapBarX;
    private int cheapBarY;

    public Hipster() {
        Random r = new Random();
        cheapBarX = r.nextInt(60);
        cheapBarY = r.nextInt(50);
    }

    public Direction getMove() {
        if (getY() != cheapBarY) {
            return Direction.NORTH;
        } else if (getX() != cheapBarX) {
            return Direction.EAST;
        } else {
            return Direction.CENTER;
        }
    }
}
```

- Problem: Each hipster goes to a different bar.
  We want all hipsters to share the same bar location.

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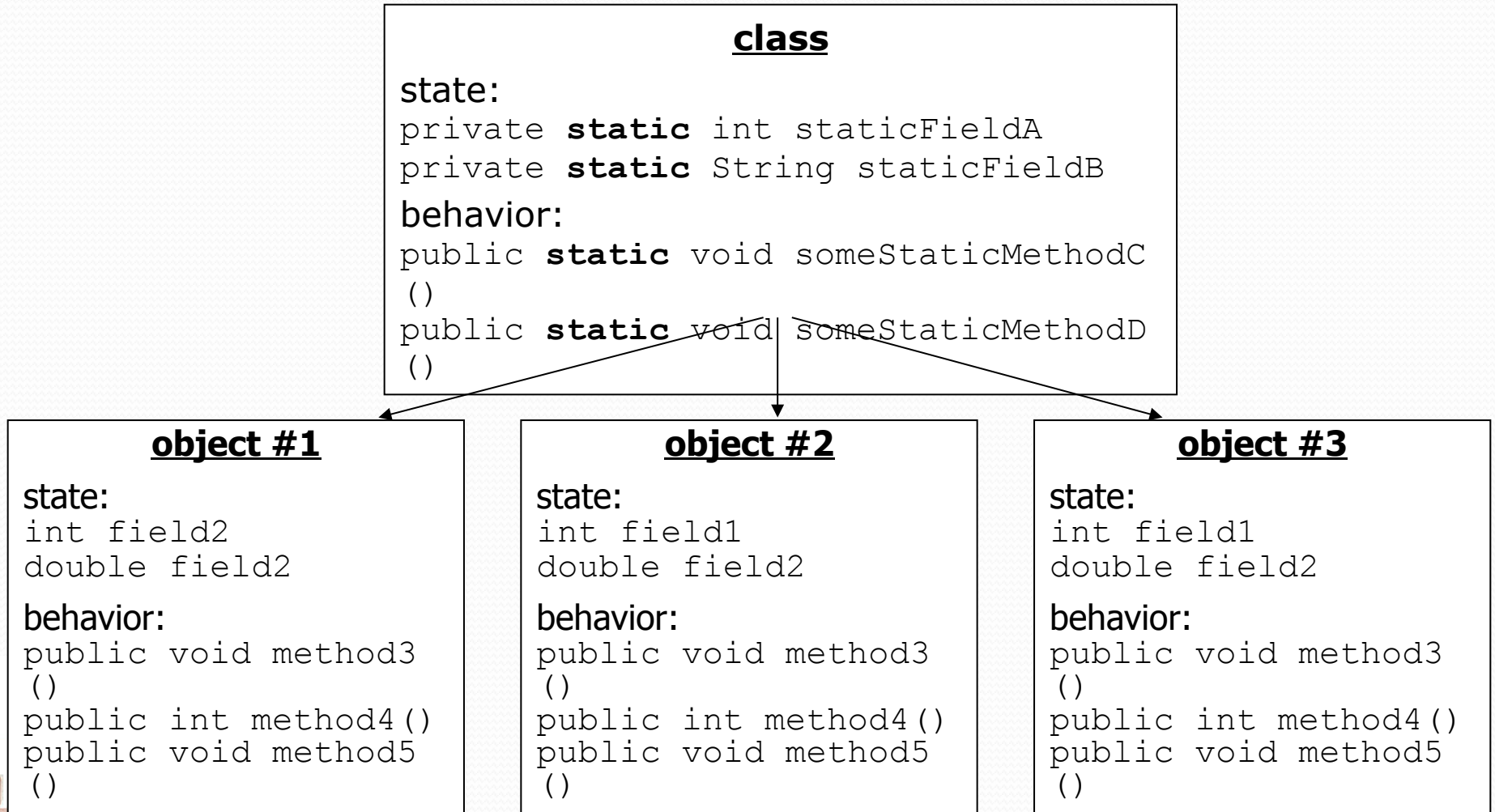
Static members

- **static**: Part of a class, rather than part of an object.
  - Object classes can have static methods *and fields*.
  - Not copied into each object; shared by all objects of that class.



Static fields

```
private static type name;
```

or,

```
private static type name = value;
```

- Example:

```
private static int theAnswer = 42;
```

- **static field**: Stored in the class instead of each object.
  - A "shared" global field that all objects can access and modify.
  - Like a class constant, except that its value can be changed.

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Accessing static fields

- From inside the class where the field was declared:

```
fieldName                       // get the value
fieldName = value;              // set the value
```

- From another class (if the field is `public`):

```
ClassName.fieldName             // get the value
ClassName.fieldName = value;    // set the value
```

  - generally static fields are not `public` unless they are `final`

- Exercise: Modify the `BankAccount` class shown previously so that each account is automatically given a unique ID.
- Exercise: Write the working version of `Hipster`.

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Hipster solution

```
import java.util.*;   // for Random

public class Hipster extends Critter {
    // static fields (shared by all hipsters)
    private static int cheapBarX = -1;
    private static int cheapBarY = -1;

    // object constructor/methods (replicated into each hipter)
    public Hipster() {
        if (cheapBarX < 0 || cheapBarY < 0) {
            Random r = new Random();   // the 1st hipster created
            cheapBarX = r.nextInt(60);    // chooses the bar location
            cheapBarY = r.nextInt(50);    // for all hipsters to go to
        }
    }

    public Direction getMove() {
        if (getY() != cheapBarY) {
            return Direction.NORTH;
        } else if (getX() != cheapBarX) {
            return Direction.EAST;
        } else {
            return Direction.CENTER;
        }
    }
}
```


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Static methods

```
// the same syntax you've already used for methods
public static type name(parameters) {
    statements;
}
```

- **static method**: Stored in a class, not in an object.
  - Shared by all objects of the class, not replicated.
  - Does not have any *implicit parameter*, `this`;
    therefore, cannot access any particular object's fields.

- Exercise: Make it so that clients can find out how many total `BankAccount` objects have ever been created.

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BankAccount solution

```
public class BankAccount {
    // static count of how many accounts are created
    // (only one count shared for the whole class)
    private static int objectCount = 0;

    // clients can call this to find out # accounts created
    public static int getNumAccounts() {
        return objectCount;
    }

    // fields (replicated for each object)
    private String name;
    private int id;

    public BankAccount() {
        objectCount++;      // advance the id, and
        id = objectCount;   // give number to account
    }

    ...
    public int getID() {    // return this account's id
        return id;
    }
}
```

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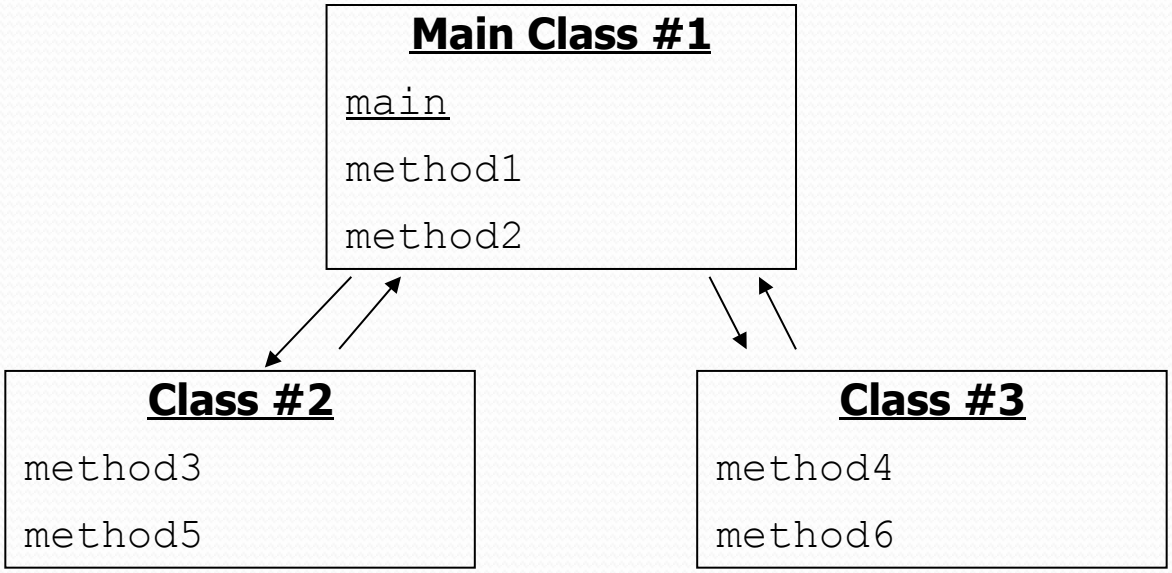
Multi-class systems

- Most large software systems consist of many classes.
  - One main class runs and calls methods of the others.
- Advantages:
  - code reuse
  - splits up the program logic into manageable chunks



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Summary of Java classes

- A class is used for any of the following in a large program:
  - a *program* : Has a main and perhaps other static methods.
    - example: `Bagels`, `Birthday`, `BabyNames`, `CritterMain`
    - does not usually declare any static fields (except `final`)
  - an *object class* : Defines a new type of objects.
    - example: `Point`, `BankAccount`, `Date`, `Critter`, `Hipster`
    - declares object fields, constructor(s), and methods
    - might declare static fields or methods, but these are less of a focus
    - should be encapsulated (all fields and static fields `private`)
  - a *module* : Utility code implemented as static methods.
    - example: `Math`

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