Manipulating Turtles

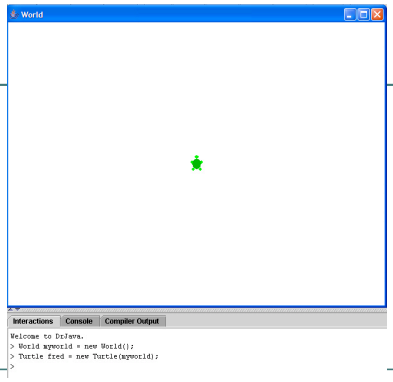
CS1316: Representing Structure and Behavior

Story

- Introduction to the Turtle
  - Historical: A Child's First Object
  - Modern day: Traffic, Ants, and Termites
- A Java Turtle
  - On Worlds and Pictures
  - Moving and rotating and composing pictures
- Using the Java Turtle to create animations

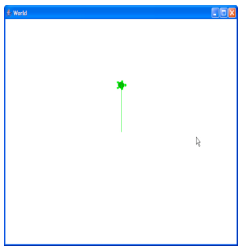
The Logo Turtle

- A robot with pen
  - For children to program graphics, in a day before graphics terminals.
  - Literally, a pen would drop down (with the command *penDown*) and would draw on the paper below it, as the turtle moved with commands like *forward* and *right*.
- Nowadays, replaced with a graphical representation.



Turtles can go forward and turn; they know heading and position

```
> fred.forward(100);
> fred.turn(90);
> fred.getHeading()
90
> fred.getXPos()
320
> fred.getYPos()
140
```

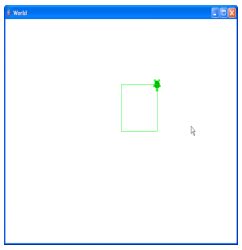


Obviously: Turtles are objects

- Turtles can *do*:
  - forward(pixels)
  - turn(degrees)
- Turtles *know*:
  - Heading
  - Position

Drawing with Turtles

```
> for (int sides=0; sides
    <= 4 ; sides++)
  {fred.forward(100);
   fred.turn(90);}
// Actually did five sides
   here...
```



Can we cascade?

- Will this work?

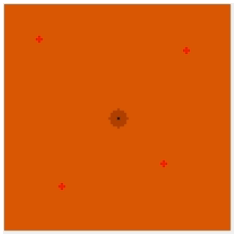
  turtle.forward(100).turn(90)

- Hint: Think about the returns!

Modern turtles: Turtle Geometry and StarLogo

- diSessa and Abelson's *Turtle Geometry* showed that simple turtle geometry could explore complex math, including Einstein's Theory of Relativity
- Mitchel Resnick's StarLogo used thousands of turtles to explore behavior of traffic, ants, and termites.

Exploring ants with turtles



Each turtle:

-Move randomly

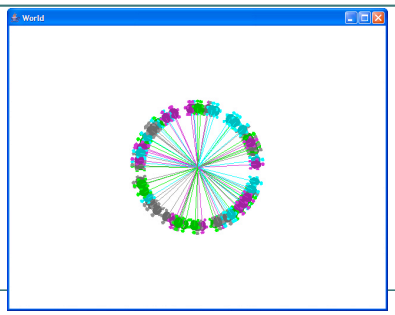
- If you find food: Grab it, go home, dropping scent.

- If you find scent, turn towards the direction of the scent.

100 Turtles

```
public class LotsOfTurtles {

  public static void main(String[] args){
    // Create a world
    World myWorld = new World();
    // A flotilla of turtles
    Turtle [] myTurtles = new Turtle[100];

    // Make a hundred turtles
    for (int i=0; i < 100; i++) {
      myTurtles[i] = new Turtle(myWorld);
    }

    //Tell them all what to do
    for (int i=0; i < 100; i++) {
      // Turn a random amount between 0 and 360
      myTurtles[i].turn((int) (360 * Math.random()));
      // Go 100 pixels
      myTurtles[i].forward(100);
    }
  }
}
```

Making a circle



Thought Experiment

- What's the difference between this:

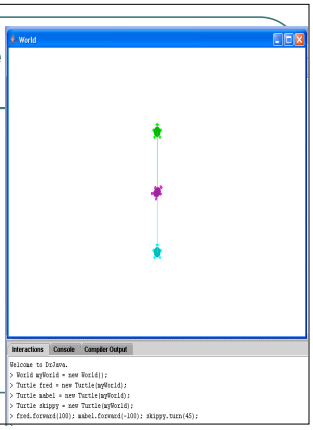
```
Turtle [] myTurtles = new Turtle[100];
```

- And this?

```
for (int i=0; i < 100; i++) {
      myTurtles[i] = new Turtle(myWorld);
   }
```

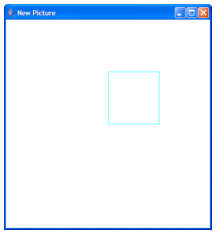
- What are each doing?

More than one Turtle at once



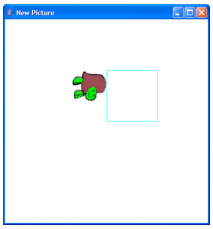
Putting Turtles on Pictures

> Picture canvas = new Picture(400,400);
> Turtle mabel = new Turtle(canvas);
> for (int sides=1; sides <= 4 ; sides++) {mabel.forward(100); mabel.turn(90);}
> canvas.show();



Using Turtles to compose Pictures

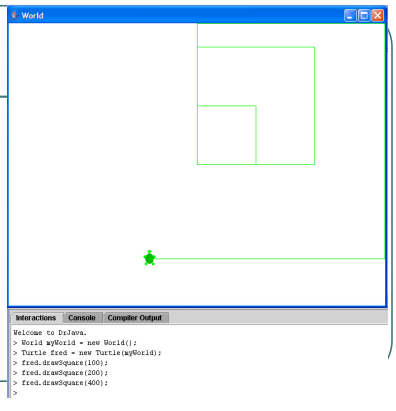
> Picture t = new Picture("D:/cs1316/MediaSources/Turtle.jpg");
> mabel.drop(t)
> canvas.repaint();



Adding new methods to Turtle

```
 * Method to draw a square with a width and height
 * of 30
 */
public void drawSquare()
{
  this.turnRight();
  this.forward(30);
  this.turnRight();
  this.forward(30);
  this.turnRight();
  this.forward(30);
  this.turnRight();
  this.forward(30);
}

public void drawSquare(int size)
{
  for (int i=1; i <= 4; i++)
  {
    this.forward(size);
    this.turn(90);
  }
}
} // end of class (do not remove this and put new methods before it)
```

Testing our new method



Thought Experiment

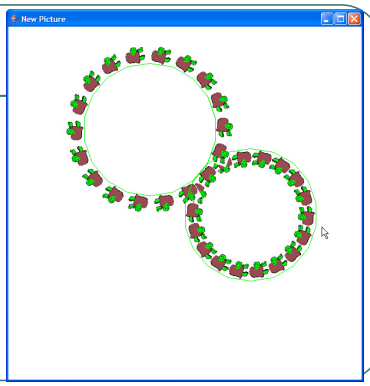
- We can have two methods with the same name?
- How did Java know which one to use?

Making more complex pictures: Using main()

Also: Note use of getMediaPath

```
public class MyTurtlePicture {

  public static void main(String [] args) {
     Picture canvas = new Picture(600,600);
     Turtle jenny = new Turtle(canvas);
      Picture lilTurtle = new
     Picture(FileChooser.getMediaPath("Turtle.jpg"));

    for (int i=0; i <=40; i++)
    {
      if (i < 20)
       {jenny.turn(20);}
      else
       {jenny.turn(-20);}
      jenny.forward(40);
      jenny.drop(lilTurtle.scale(0.5));
    }

    canvas.show();
  }

}
```

Result:



Thought Experiments

- Is this myTurtlePicture a class? An object?
- Can we access variables from the Interactions Pane?
- Can we return values to the Interactions Pane?
- When is it useful to use a *main()*?

Explaining public, and static, and void, and main, and String [] args

public static void main(String [] args);

- *Public*: This method can be accessed by any other class.
- *Static*: This is a method that can be accessed through the *class*, even if no *instances* of the class exist.
- *Void:* This method doesn't return anything.
- *String [] args:* If called from the Command Line (outside DrJava), inputs could be provided.
  - They'd show up as strings in this array.

Creating an animation with FrameSequence

- *FrameSequence* stores out *Pictures* to a directory, and can show/replay the sequence.
  - *new FrameSequence(dir): dir* where the Pictures should be stored as JPEG frames
  - *.addFrame(aPicture):* Adds this *Picture* as a frame
  - *.show():* Show the frames as they get added
  - *.replay(wait):* Replay the sequence, with *wait* milliseconds between frames.

Using FrameSequence

```
Welcome to DrJava.
> FrameSequence f = new FrameSequence("D:/Temp");
> f.show()
There are no frames to show yet.  When you add a frame it will be shown
> Picture t = new Picture("D:/cs1316/MediaSources/Turtle.jpg");
> f.addFrame(t);
> Picture barb = new Picture("D:/cs1316/MediaSources/Barbara.jpg");
> f.addFrame(barb);
> Picture katie = new Picture("D:/cs1316/MediaSources/Katie.jpg");
> f.addFrame(katie);
> f.replay(1000);
```

Making a turtle drawing animate

```
Welcome to DrJava.
> MyTurtleAnimation anim = new
  MyTurtleAnimation();
> anim.next(20);
> anim.replay(500);
```

Animated turtle

```
public class MyTurtleAnimation {

  Picture canvas;
  Turtle jenny;
  FrameSequence f;

  public MyTurtleAnimation() {

    canvas = new Picture(600,600);
    jenny = new Turtle(canvas);
    f = new FrameSequence("D:/Temp");
  }

  public void next(){
    Picture lilTurtle = new Picture(FileChooser.getMediaPath("Turtle.jpg"));

    jenny.turn(-20);
    jenny.forward(30);
    jenny.turn(30);
    jenny.forward(-5);
    jenny.drop(lilTurtle.scale(0.5));
    f.addFrame(canvas.copy());
  }

  public void next(int numTimes){
    for (int i=0; i < numTimes; i++)
    {this.next();}
  }

  public void show(){
    f.show();
  }

  public void replay(int delay){
    f.show();
    f.replay(delay);
  }
}
```

Declarations

```
public class MyTurtleAnimation {

  Picture canvas;
  Turtle jenny;
  FrameSequence f;
```

- We're going to need a canvas, a Turtle, and a FrameSequence for each instance of MyTurtleAnimation.
  - That's what the instances *know*
  - These are called *instance variables*

A constructor

```
public MyTurtleAnimation() {

    canvas = new Picture(600,600);
    jenny = new Turtle(canvas);
    f = new FrameSequence("D:/Temp/");
  }
```

- A method with the same name of the class is called to *initialize* (or *construct*) the new instance.
- We don't need to declare *canvas*, *jenny*, or *f*—the instance knows those already

Each step of the animation

```
public void next(){
    Picture lilTurtle = new
     Picture(FileChooser.getMediaPath("Turtle.jpg"));

    jenny.turn(-20);
    jenny.forward(30);
    jenny.turn(30);
    jenny.forward(-5);
    jenny.drop(lilTurtle.scale(0.5));
    f.addFrame(canvas.copy());
  }
```

- Do one stage of the drawing.

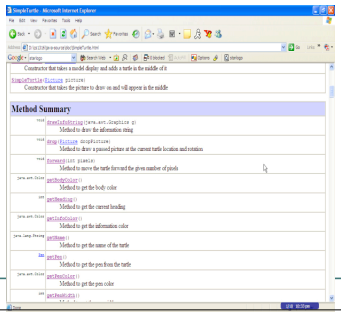
Try it!

- Why do we call *.copy* on the canvas?
- Try it without it!
- What does the result suggest to you about how *FrameSequence* instances store their frames internally?

Being able to replay and see it

```
public void next(int numTimes){
   for (int i=0; i < numTimes; i++)
   {this.next();}
 }

 public void show(){
   f.show();
 }

 public void replay(int delay){
   f.show();
   f.replay(delay);
 }
```

JavaDoc on SimpleTurtle



Thought Experiment

- Why SimpleTurtle (and SimplePicture)?
- Hint:
  - Think about *information hiding*

Other useful methods known to Turtles

- getPicture() – returns the picture that the turtle was opened on.
- turnToFace(aTurtle) – turns to face a particular turtle.
- getDistance(x,y) – returns the number of turtle steps (roughly, pixels) from *this* turtle to the (x,y) location.

We'll use these later, in simulations