Spirals, trees, and stars
TurtleWorld

CS111 Computer Programming
Department of Computer Science
Wellesley College

Honey, I shrunk the Buggle

- Turtles* are like Buggles, only smaller and more carefree (no grid).
- To create a new Turtle
  ```
  new Turtle();
  ```
- At birth, Turtles are centered, pointing EAST, pen down, and red.

*If you have programmed in LOGO, Turtles should be old friends.
**Turtle is an artist**

- A selection of Turtle's drawings may be viewed by going to the cs111 download site.

**What's going on here?**

```
fd(0); lt(90);
fd(0+3); lt(90);
fd(3+3); lt(90);
fd(6+3); lt(90);
fd(9+12); lt(90);
```
Recurse 100 levels

The Java behind the curtain

- We write a recursive method named `spiral(...)` to create these graphics.
- What parameters does `spiral` require to do its job?
  
  Hint:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps</td>
<td>100</td>
</tr>
<tr>
<td>Angle</td>
<td>90</td>
</tr>
<tr>
<td>Length</td>
<td>0</td>
</tr>
<tr>
<td>Increment</td>
<td>3</td>
</tr>
</tbody>
</table>
One small step

```java
public void spiral(int steps, int angle, int length, int increment) {
    if (steps <= 0) { // do nothing
    } else {
        fd(length);
        lt(angle);
        spiral(steps-1, angle, length+increment, increment);
    }
}
```

*Before we leave SpiralWorld, let's check out a few more of Turtle's drawings.*
How to make a level 4 tree

and two level 3 trees set at 45° angles

Make a trunk

TurtleWorld 11-10

```plaintext
fd(100);
rt(45);
make level 3 tree
  w/ trunk 0.6*100
  lt(2*45);
make level 3 tree
  w/ trunk 0.6*100
  rt(45);
bd(100);
```
How to make a level 3 tree

and two level 2 trees set at 45° angles

Make a trunk 0.6 as long as before

How to make a level 2 tree

and two level 1 trees set at 45° angles

Make a trunk 0.6 as long as before

```
fd(60);
rt(45);
make level 2 tree
w/ trunk 0.6*60
lt(2*45);
make level 2 tree
w/ trunk 0.6*60
rt(45);
bd(60);
```

```
fd(60);
rt(45);
make level 2 tree
w/ trunk 0.6*36
lt(2*45);
make level 1 tree
w/ trunk 0.6*36
rt(45);
bd(36);
```
**How to make a level 1 tree**

- Make a trunk 0.6 as long as before
- and two level 0 trees set at 45° angles

```python
fd(21.6); rt(45);
make level 0 tree w/ trunk 0.6*21.6
lt(2*45);
make level 0 tree w/ trunk 0.6*21.6
rt(45);
bd(21.6);
```

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**How to make a level 0 tree**

- Do nothing!
A tree method

- We write a recursive method named `tree(...)` to create tree graphics.
- What parameters does `tree` require to do its job?
  
  **Hint:**

- What is its base case? Its recursive case?

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Java

```java
public void tree(int levels, double length, double angle, double shrink)
{
    if (levels <= 0) {
        // do nothing
    } else {
        fd(length);
        rt(angle);
        tree(levels-1, length*shrink, angle, shrink);
        lt(2*angle);
        tree(levels-1, length*shrink, angle, shrink);
        rt(angle);
        bd(length);
    }
}
```