Strings
Part One
The Chaos Game Revisited
The Chaos Game

• Pick any three points.

• Starting at any of the points:
  • Choose one of the three points randomly.
  • Move halfway from your current location to the chosen point.
  • Draw a dot at your current location.
  • Repeat.
A Minor Change
What Just Happened?
double x = 0;
double y = 0;

while (true) {
    moveRandomly(x, y);
    plotPixel(x, y);
}

0 0
GPoint d = getRandomPoint();

x = (x + d.getX()) / 2.0;
y = (y + d.getY()) / 2.0;
GPoint d = getRandomPoint();

x = (x + d.getX()) / 2.0;
y = (y + d.getY()) / 2.0;
double x = 0;
double y = 0;

while (true) {
    moveRandomly(x, y);
    plotPixel(x, y);
}

x
0

y
0
GPoint pt = new GPoint(0, 0);

while (true) {
    moveRandomly(pt);
    plotPixel(pt);
}
GPoint pt = new GPoint(0, 0);

while (true) {
    moveRandomly(pt);
    plotPixel(pt);
    pause(PAUSE_TIME);
}

GPoint d = chooseRandomPoint();

pt.setLocation((pt.getX() + d.getX()) / 2.0,
                (pt.getY() + d.getY()) / 2.0);
GPoint pt = new GPoint(0, 0);
while (true) {
    moveRandomly(pt);
    plotPixel(pt);
    pause(PAUSE_TIME);
}

GPoint d = chooseRandomPoint();
pt.setLocation((pt.getX() + d.getX()) / 2.0, (pt.getY() + d.getY()) / 2.0);
GPoint pt = new GPoint(0, 0);

while (true) {
    moveRandomly(pt);
    plotPixel(pt);
}
Parameter Passing

- All parameters in Java are passed by value.
- In Java, variables of primitive type (int, double, etc.) store actual values.
- In Java, variables of object type (GOval, GRect, etc.) don't actually store those objects. They store references to those objects.
  - They “point” to where the object really is.
Another Variation
GPoint pt = new GPoint(0, 0);

while (true) {
    moveRandomly(pt);
    plotPixel(pt);
}
GPoint d = chooseRandomPoint();
GPoint result =
    new GPoint((pt.getX() + d.getX()) / 2.0, (pt.getY() + d.getY()) / 2.0);
pt = result;

GPoint d = chooseRandomPoint();
GPoint result =
    new GPoint((pt.getX() + d.getX()) / 2.0,
               (pt.getY() + d.getY()) / 2.0);

pt = result;

result
pt
(137, 42)
(0, 0)
GPoint d = chooseRandomPoint();
GPoint result =
    new GPoint((pt.getX() + d.getX()) / 2.0,
                (pt.getY() + d.getY()) / 2.0);

pt = result;
GPoint pt = new GPoint(0, 0);

while (true) {
    moveRandomly(pt);
    plotPixel(pt);
}

pt (0, 0)
A Nuance

- If you pass an object into a method, that method can change properties of the object passed in.
  - The caller can then see these changes.
- If you pass an object into a method, that method cannot change which object is being referred to.
  - The caller will always end up referring to the same object, though the properties of that object might have changed.
One Final Approach...
GPoint pt = new GPoint(0, 0);

while (true) {
    pt = moveRandomly(pt);
    plotPixel(pt);
}
GPoint pt = new GPoint(0, 0);
while (true) {
    moveRandomly(pt);
    plotPixel(pt);
    pause(PAUSE_TIME);
}

GPoint d = chooseRandomPoint();
GPoint result =
    new GPoint((pt.getX() + d.getX()) / 2.0,
               (pt.getY() + d.getY()) / 2.0);
return result;
GPoint d = chooseRandomPoint();
GPoint result =
    new GPoint((pt.getX() + d.getX()) / 2.0, (pt.getY() + d.getY()) / 2.0);

return result;
GPoint pt = new GPoint(0, 0);

while (true) {
    pt = moveRandomly(pt);
    plotPixel(pt);
}
Summary

- Primitive types are passed by value.
  - The callee gets a copy of the value.
  - The callee can change that copy, but cannot change the original.

- Object references are passed by value.
  - The callee gets a copy of the reference, not a copy of the object.
  - The callee can change the object, but cannot change which object is referred to.
Time-Out for Announcements!
Assignment 3

• Assignment 3 is out now, due next Monday at 3:15PM.

• **Recommendation:** Try to get the bricks created and the paddle set up and moving by this Wednesday.
Midterm Logistics

- First midterm is **Wednesday, February 12** from 7PM – 10PM.
  - Room assignments TBA.
- Covers material up through and including strings.
- Practice exam released; solutions will follow later this week.
  - *Take this practice exam under realistic conditions!*
Back to CS106A!
An Interesting Article

“How Revolutionary Tools Cracked a 1700s Code”

A string is a sequence of characters.
Hello!
Hello!

`string.charAt(index)`
The Data Type `char`

• The primitive type `char` represents a single character or glyph.

• Some examples:

```java
char letterA = 'A';
char plus = '+'
char zero = '0';
```