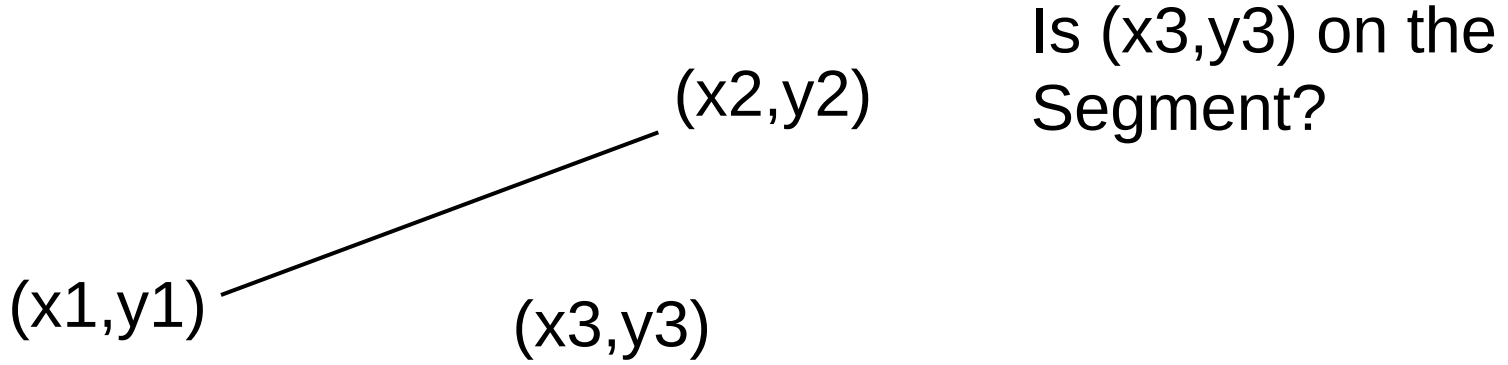
Classes and Enumerations

- Assignment 3 - example of working with a class interface
- Class variables and methods
- Converting object references
- Extending classes
- Enumerations
  - Dealing with collections of objects

Assignment 3 - Example

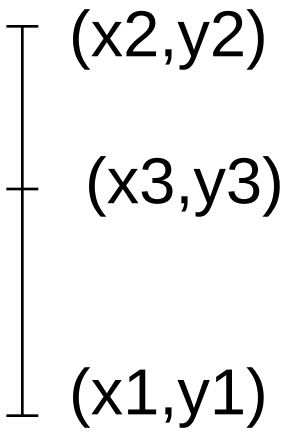
- **Define `boolean pointOnSegment(Point)` in the Segment class**
- **How to design this method?**



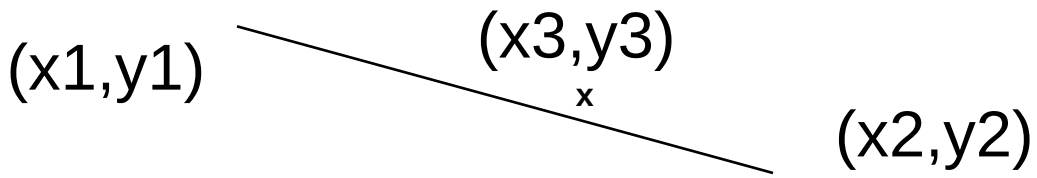
Example

- **Some assumptions:**
  - **(x1,y1) != (x2,y2)**
  - **if the segment is part of a vertical line, we'll have to use a special case, because of the properties of the y = slope*x + y_intercept eqn**
  - **also, the following can occur in combination:**
    - **y1 <= y2 OR y1 > y2 combined with**
    - **x1 <= x2 OR x1 > x2.**
  - **after we check that the point is on the line, we must check that point is actually on the Segment**

Example



- **If segment is vertical, then**
  - **abs(x1-x2) < tolerance**
    - **to be on same line, then abs(x3-x1) < tolerance && y1<= y3 <= y2 OR y2<= y3 <= y1.**



- **If segment is not vertical, then need to calculate equation of line containing segment and make sure (x3,y3) is on that line between the other two points.**

Equation of a Line

y = m*x + b

y1 = m* x1 + b and y2 = m*x2 + b

therefore, m = (y1-y2)/(x1-x2).

substituting that into the equation for (x1,y1)
we derive: b = y1-(y1-y2)/(x1-x2)*x1

so we have,

y = (y1-y2)/(x1-x2)*x + y1-(y1-y2)/(x1-x2)*x1

y = m *x + b

pointOnSegment(Point p)

```
public boolean pointOnSegment(Point p){
//first get endpoints of Segment
double x1 = (this.getFirstPoint()).getX(),
        y1 = (this.getFirstPoint()).getY(),
        x2 = (this.getSecondPoint()).getX(),
        y2 = (this.getSecondPoint()).getY(),
        x3 = p.getX(),
        y3 = p.getY();
//calculate slope and intercept
double ptTol = Point.getTolerance();
//check for vertical Segment
if (Math.abs(x1-x2) < ptTol) {
                if (!(Math.abs(x1-x3)<ptTol))
                  return false;
                else {if(((y1<=y3)&&(y3<=y2))||
                         ((y2<=y3)&&(y3<=y1)))
                            return true;
                     else return false;}
  }
```

pointOnSegment()

```
//if reach here, Segment is not vertical
//have to check that (x3,y3) is on same line and
//between the endpoints
double  m = (y1-y2)/(x1-x2),
        b = y1 - ((y1-y2)/(x1-x2))*x1;
// is (x3,y3) on line?
if (!(Math.abs(y3 - (m*x3+b)) < ptTol)) return
   false;

// is (x3,y3) between (x1,y1) and (x2,y2)?
if (((x1<=x3)&&(x3<=x2))||((x2<=x3)&&(x3<=x1)))
   return true;
else return false;//on line but outside Segment
}
```

Class Variables

- **Used to keep information shared by all objects created of this class**
- **Only one copy of a class variable; every object created in the class has access to the SAME class variable**
- ***Static* keyword denotes that a variable is a class variable rather than an instance variable**

```
public static int count;
```

Class Variables

- **For example,**
  - **count the number of times of day which were converted by users of our UStime class**

```
public static int usecount;
```

  - **tolerance class variables in Point class**

```
//separation required for points to
//be different
private static double tolerance =
    1.e-10;// tolerance for class
```

Class Methods

- **Usually used to manipulate class variables or to provide functionality not linked to a particular object**
  - **`getTolerance(),setTolerance()` in Point**
- **Defined with keyword *static***

```
public static void setTolerance(double t)
public static boolean allConcentric(Set s)
```

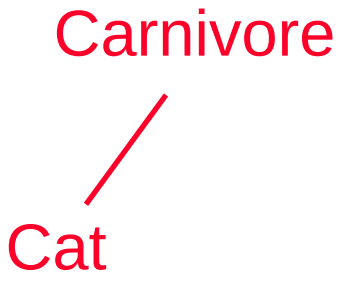
- **Accessed as <classname>.<method-name>**

Instance versus Class Methods

- **How to tell if a method should be a class method or instance method?**
  - **Ask if it is an action with respect to a particular object?**
    - **If yes, then define an instance method**
    - **If no, then define a class method**
  - **Ask if you really need this method? always a good question -:)**
  - **Might this method naturally be defined in another class?**

Conversion between Classes

- Can always go up the tree
  - a Cat is a Carnivore
- Same idea as widening
- Always works




```
Cat c;
Carnivore k;
Cat c = new Cat;
k = c;//now k refers to a Cat object
  which is also a Carnivore.
```

Conversion between Classes - 2

- **Moving down the hierarchy doesn't always work; when it does, it needs a cast.**
  - **Some Carnivores are Cats**
  - **If cast fails, it generates a ClassCastException at run-time**

```
Cat c;
Carnivore k;
...
c = (Cat)k;//only works when k
    //actually refers to a Cat object
    //which is a Carnivore.
```

An Enumeration

- **Provides way to iterate over a collection of objects**
- **Returns each element in the collection, one by one, in no particular order**
- **Has two required methods**
  - **`hasMoreElements()`: returns `true` if enumeration has more elements to return, else returns `false`**
  - **`nextElement()`: returns next element of the enumeration defined to be of type Object**

An Enumeration

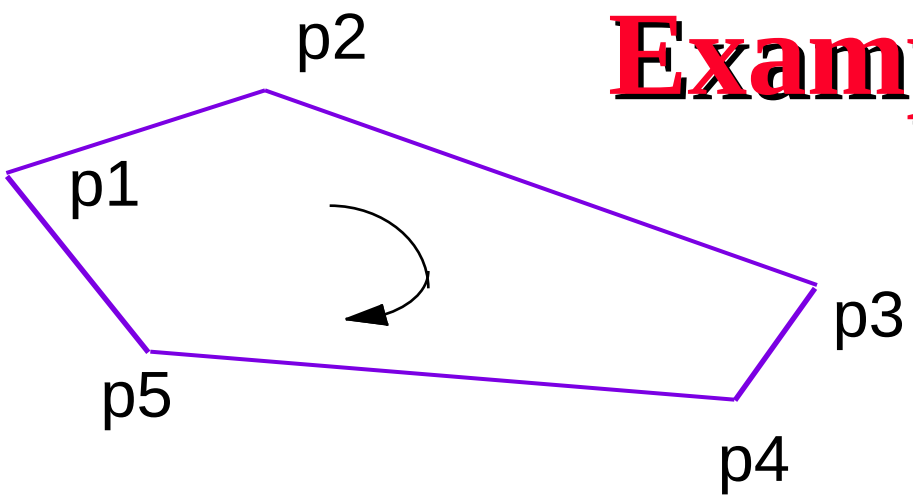
- **Usage often requires casting of the returned object to the proper type**
- **Enumeration is a Java *interface,* something which requires a class be created to implement the methods specified**
- **Can think of interface as a class which contains only specifications of methods, no implementations**
- **A class which implements an interface promises to define the specific set of functions in that interface**

Example

- a Polygon is a set of Segment objects
- `getEdges()` in class Polygon returns an enumeration object for the constituent edges of its Polygon receiver
- Use of the enumerator, assuming Polygon `polyp` exists:

```
Enumeration edgeEnum = polyp.getEdges();
while (edgeEnum.hasMoreElements()){//note cast
   Segment seg = (Segment)edgeEnum.nextElement();
   System.out.println(" " + seg.toString());
}
```

Example



An enumeration would return segments: p1-p2, p2-p3, p3-p4, p4-p5, p5-p1, although not necessarily in that order.

After 5 `nextElement()` calls, the enumeration would be finished having returned each edge ONCE!

To loop through the edges again would require a NEW Enumeration object.

What's important?

- How to use Enumeration objects?
- Remember that if you change the underlying collection while you are enumerating over it, unforeseen results will happen
- Once you iterate over all the objects the enumeration will be used up

Perimeter of a Polygon

- **First, need to calculate the length of a Segment**
- **Second, need to enumerate all the Segments which form the Polygon and sum their lengths**

getLength() in Segment

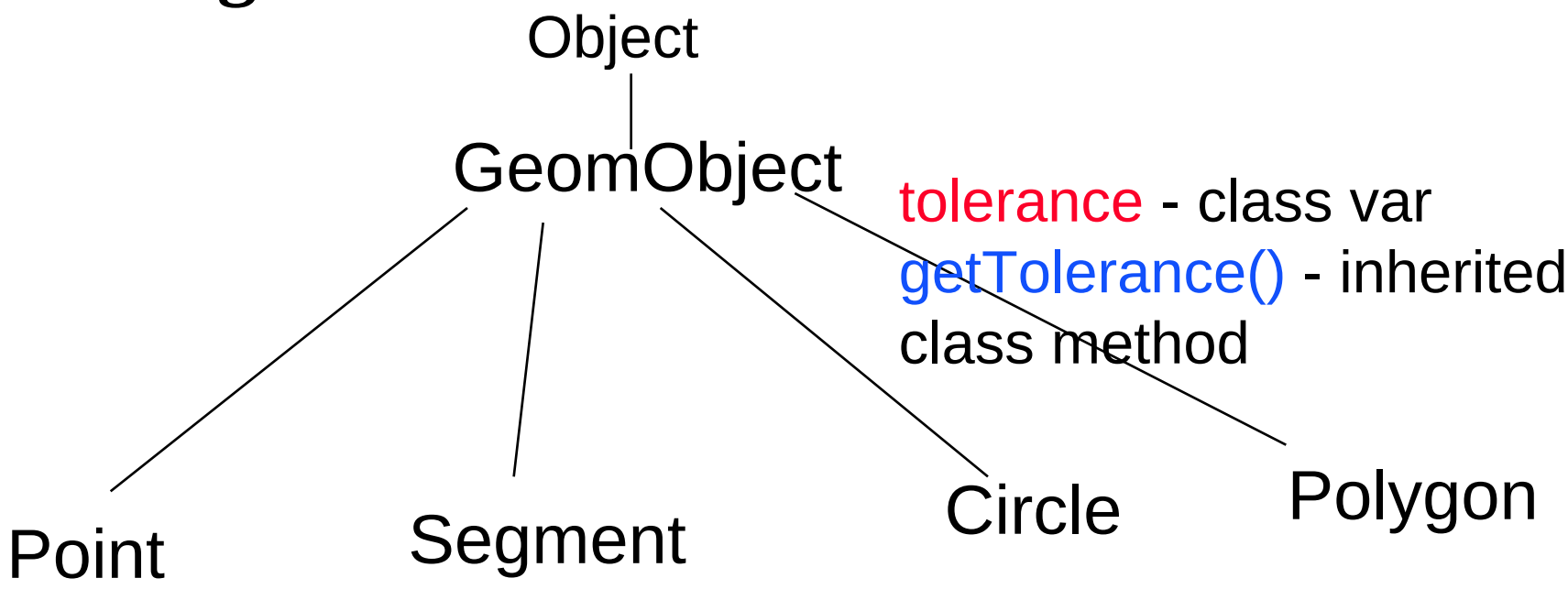
```
public double getLength(){
//uses distanceTo() in Point to calculate
//length of a Segment
        return
  (this.getFirstPoint()).distanceTo(
            this.getSecondPoint());
}
```

Perimeter of a Polygon

```
//method to use an enumerator to calculate
//the perimeter of a Polygon object
//needs to use getLength() from Segment class
        public double getPerimeter(){
        double perimeter = 0.0;
        Enumeration edgeEnum = this.getEdges();
        while (edgeEnum.hasMoreElements()){
        Segment seg = (Segment)edgeEnum.nextElement();
                perimeter += seg.getLength();
        }
        return perimeter;
        }
```

Extending Classes - Alternative

- **Could use one tolerance over all geometric classes in their equals() methods. Then could create GeomObject class and make all other geometric classes subclasses of it.**



Extending Classes - Alternative

- **Invoke by GeomObject.getTolerance()**
- **Could also put some instance variables and instance methods shared by all GeomObjects in the superclass**
  - **color - all GeomObjects have a color**
  - **getColor() - an observer method**
  - **`Point p; Color c = p.getColor()`**
- **This class hierarchy is NOT in Assignment 3, but it represents an alternative to what we have done.**