Advanced Object-Oriented Design

Objects vs. Data

an API perspective studying Point

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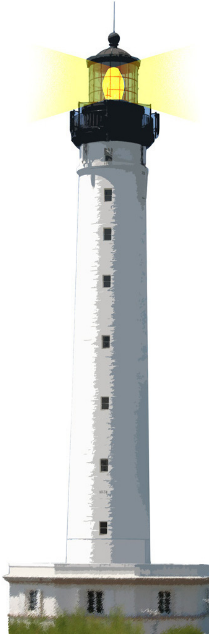

http://www.pharo.org

Goals

- Difference between an object and a data structure
- APIs and encapsulation play an important role
- Looking at two concrete implementations of Point: in Java and Pharo
- Understanding the impact of strong API

Java Points - Getters and Setters

- Point getLocation(): returns the location of this point (to be polymorphic with Component. A location is just a point.)
- void setLocation(double x, double y): sets the location of this point to the specified double coordinates.
- void setLocation(int x, int y): changes the point to have the specified location.
- void setLocation(Point p): sets the location of the point to the specified location.
- double getX(): returns the X coordinate of this Point2D in double precision.
- double getY(): returns the Y coordinate of this Point2D in double precision.

Java Points - the ’rest’

- boolean equals(Object obj): whether or not two points are equal.
- void move(int x, int y): moves this point to the specified location in the (x,y) coordinate plane.
- void translate(int dx, int dy): translates this point, at location (x,y), by dx along the x axis and dy along the y axis so that it now represents the point (x+dx,y+dy).
- String toString(): returns a string representation of this point and its location in the (x,y) coordinate space.

Inherited from Point2D

- distance() and clone()

Analysis

- A poor data structure, not an object
- Super limited interface
- Points do not define behavior beside move and translate!

An Example in Java

How to make a robot walks from distance in its current direction (in degree).

```
public class Bot {
  int tilt = 0;
  Point position = new Point(0,0);
```

```
public void go(int distance){
  position = new Point(
      (Math.round(Math.cos(Math.toRadians(tilt))) * distance + position.x()),
      (Math.round(Math.sin(Math.toRadians(tilt))) * distance + position.y()))) ;
    }
}
```

Analysis (2)

- Arithmetic of Points is defined **outside** of them!
  - Points cannot sum themselves
  - Points cannot shape themselves (rounded, normal, reciprocal,...)
- When an object exposes a shallow API, it favors logic duplication in clients!

Bot » go: in Pharo

```
public void go(int distance){
   position = new Point(
     (Math.round(Math.cos(Math.toRadians(tilt))) * distance + position.x()),
     (Math.round(Math.sin(Math.toRadians(tilt))) * distance + position.y())) ;
   }
}
```

In Pharo

```
Bot >> go: aDistance
  position := position + ((tilt degreeCos @ tilt degreeSin) * aDistance) rounded
```

- Read better
- Use **point**’s addition, multiplication, and rounding
- Use "Number"’s sin and cos
- Highlight behavior logic

Points in Pharo

Rich API:

- normalized, normal, transposed, reflectedAbout:
- distanceTo:, squaredDistanceTo:
- crossProduct:, dotProduct:
- \ - *, reciprocal,/, +, min // abs max
- >= > <= min:max: min: < closeTo: closeTo:precision: max: =
- negated, translateBy:, scaleBy:, scaleTo:, scaleFrom:to:, adhereTo:,
- triangleArea:with:, to:intersects:to:, to:sideOf:, isInsideCircle:with:with:, sideOf:
- rectangle:, extent:, corner:

Points in Pharo (Continued)

- degrees, theta,
- onLineFrom:to:, angleWith:, angle, rotateBy:about:, rotateBy:centerAt:, bearingToPoint:,
- roundUpTo:, ceiling, truncated, truncateTo:, roundTo:, floor, roundDownTo:, rounded,
- quadrantOf:, leftRotated, nearestPointAlongLineFrom:to:, flipBy:centerAt:, nearestPointOnLineFrom:to:, dotProduct:, squaredDistanceTo:, insideTriangle:with:with:, directionToLineFrom:to:, sign, octantOf:, rightRotated,
- fourNeighbors, grid:, eightNeighbors, fourDirections

Simple example

```
Point >> crossProduct: aPoint
  "Answer a number that is the cross product of the receiver and the
  argument, aPoint."

  ^ (x * aPoint y) – (y * aPoint x)
```

- Obvious but still useful
- No need to duplicate it in clients

Simple example: comparing points

```
< aPoint
  "Answer whether the receiver is above and to the left of aPoint."

  ^ x < aPoint x and: [ y < aPoint y ]
```

Example: More challenging

```
Point >> degrees
  "Answer the angle the receiver makes with origin in degrees. right is 0; down is 90."
  | tan theta |
  ^ x = 0
    ifTrue: [ y >= 0
          ifTrue: [ 90.0 ]
          ifFalse: [ 270.0 ] ]
    ifFalse: [ tan := y asFloat / x asFloat.
        theta := tan arcTan.
        x >= 0
          ifTrue: [ y >= 0
            ifTrue: [ theta radiansToDegrees ]
            ifFalse: [ 360.0 + theta radiansToDegrees ] ]
        ifFalse: [ 180.0 + theta radiansToDegrees ] ]
```

Nobody wants to be forced to reimplement it.

Polymorphic with related concepts

```
Point >> asPoint
  "Answer the receiver itself."

  ^ self
```

```
Number >> asPoint
  "Answer a Point with the receiver as both coordinates; often used to
  supply the same value in two dimensions, as with symmetrical gridding
  or scaling."

  ^ self @ self
```

This way we can manage list of objects and easily convert them to point

```
{ 1 . 2 . 3 . 33@33 . 4} collect: [ :a | a asPoint ]
>> {1@1 . 2@2 . 3@3 . 33@33 . 4@4}
```

Point Arimethic

- Points know how to *, +, /, ... **themselves**
- We can compose points, rectangles, and numbers

```
drawString: aString at: aPoint font: aFontOrNil color: aColor
  self
    drawString: aString
    in: (origin + aPoint extent: self clipRect extent)
    font: aFontOrNil
    color: aColor
```

Analysis

- In Pharo Points are more than a data structure
- They define **advanced** behavior
- Functionality is not in clients
- Clients benefit and reuse behavior!

What you should know

- Objects are not data structures
- Objects are more that structure
- Objects are about behavior and services they offer
- An object should encapsulate logic and lets its client **reuse** such a logic!

A course by

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