```
fun append (xs,ys) =
    if xs=[]
    then ys
    else (hd xs)::append(tl xs,ys)

fun map (f,xs) =
    case xs of
        [] => []
      | x::xs' => (f x)::(map(f,xs'))

val a = map (increment, [4,8,12,16])
val b = map (hd, [[8,6],[7,5],[3,0,9]])
```

Programming Languages

Dan Grossman

Subclassing

Next major topic

- Subclasses, inheritance, and overriding
  - The essence of OOP
  - Not unlike you may have seen in Java/C#/C++/Python, but worth studying from PL perspective and in a more dynamic language

Subclassing

- A class definition has a *superclass* (**`Object`** if not specified)

```
class ColorPoint < Point  …
```

- The superclass affects the class definition:
  - Class *inherits* all method definitions from superclass
  - But class can *override* method definitions as desired

- Unlike Java/C#/C++:
  - No such thing as “inheriting fields” since all objects create instance variables by assigning to them
  - Subclassing has nothing to do with a (non-existent) type system: can still (try to) call any method on any object

Example (to be continued)

```
class Point
  attr_accessor  :x, :y
  def initialize(x,y)
    @x = x
    @y = y
  end
  def distFromOrigin
    # direct field access
    Math.sqrt(@x*@x
              + @y*@y)
  end
  def distFromOrigin2
    # use getters
    Math.sqrt(x*x
              + y*y)
  end
end
```

```
class ColorPoint < Point
  attr_accessor  :color
  def initialize(x,y,c)
    super(x,y)
    @color = c
  end
end
```

An object has a class

```
p  = Point.new(0,0)
cp = ColorPoint.new(0,0,"red")
p.class                          # Point
p.class.superclass               # Object
cp.class                         # ColorPoint
cp.class.superclass              # Point
cp.class.superclass.superclass   # Object
cp.is_a? Point                   # true
cp.instance_of? Point            # false
cp.is_a? ColorPoint              # true
cp.instance_of? ColorPoint       # true
```

- Using these methods is usually non-OOP style
  - Disallows other things that "act like a duck"
  - Nonetheless semantics is that an instance of **`ColorPoint`** "is a" **`Point`** but is not an "instance of" **`Point`**
  - [Java note: **`instanceof`** is like Ruby's **`is_a?`**]