A Bit of History

Some notable examples of early object-oriented languages and systems:

- Sketchpad (Ivan Sutherland’s 1963 PhD dissertation) was the first system to use classes and instances (although Sketchpad is an application, not a programming language)

- First object-oriented programming language: Simula I, then Simula 67, created by Ole-Johan Dahl and Kristen Nygaard at the Norwegian Computing Center in Oslo.

- Smalltalk: developed at Xerox Palo Alto Research Center by the Learning Research Group in the 1970’s (Smalltalk-72, Smalltalk-76, Smalltalk-80)

- Today: mature language paradigm. Some significant examples: C++, Java, C#, Python, Ruby.
Ruby

Why Ruby?

Some basics of Ruby programs

• Syntax
• Classes, Methods
• Variables, fields, scope
• Dynamic typing
• The rep-loop, the main class, etc.

Note: Read Thomas book chapters 1–9 (or free first edition 1–8)

• Skip/skim regexps and ranges
• Not every detail: focus on OO, dynamic typing, blocks, mixins
Principal Properties of Ruby

- *Pure* object-oriented: *all* values are objects
- Class-based
- Dynamically typed
- Convenient *reflection*

A good starting point for discussing what each of these means and what other languages look like.

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<thead>
<tr>
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<th>dynamically typed</th>
<th>statically typed</th>
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<td>functional</td>
<td>Scheme</td>
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<td>object-oriented</td>
<td>Ruby</td>
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Ruby vs. Smalltalk

Smalltalk: language definition unchanged since 1980 (although lots of work on the environment and packages), is also pure OO, class-based, dynamically-typed.

- Smalltalk: tiny language (smaller than Scheme), elegant, regular, can learn whole thing
- Smalltalk: integrated into cool, malleable GUI environment
- Ruby: large language with a “why not?” attitude
- Ruby: scripting language (light syntax, some “odd” scope rules)
- Ruby: very popular, massive library support especially for strings, regular expressions, “Ruby on Rails.” Won’t be our focus at all.
- Ruby: mixins (a cool, advanced OO modularity feature)
- Ruby: blocks, libraries encourage lots of FP idioms
Really key ideas

• Really, everything is an object (with constructor, fields, methods)
• Every object has a class, which determines how the object responds to messages.
• Dynamic typing (everything is an object)
• Dynamic dispatch
• Sends to self (a special identifier; Java’s this)
• Everything is “dynamic” – evaluation can add/remove classes, add/remove methods, add/remove fields, etc.
• Blocks are *almost* first-class anonymous functions (later)
  – Can convert to/from real lambdas (class Proc)
(Also has some more Java/C like features – loops, return, etc.)
Lack of variable declarations

If you assign to a variable in scope, it’s mutation.

If the variable is not in scope, it gets created (!)

• Scope is the method you are in

Same with fields: an object has a field if you assign to it

• So different objects of the same class can have different fields (!)

This “cuts down on typing” but catches fewer bugs (misspellings)

• A hallmark of “scripting languages” (an informal term)
Protection?

• Fields are inaccessible outside of instance
  – Define accessor/mutator methods as desired
    * Use attr_read and attr_writer
  – Good OO design: subclasses can override accessors/mutators

• Methods are public, protected, or private
  – protected: only callable from class or subclass object
  – private: only callable from self

• Later: namespace management, but no hiding
Unusual syntax

Just a few random things (keep your own mental list):

- Variables and fields are written differently
  - @ for fields
  - @@ for class fields (Java’s static fields)
- Newlines often matter — need extra semicolons, colons, etc. to put things on one line
- Message sends do not need parentheses (especially with 0 arguments)
- Operators like + are just message sends
- Class names must be capitalized
Duck Typing

“If it walks like a duck and quacks like a duck, it’s a duck.”

A method might think, “I need an Octopus” but really it only needs an object that has similar enough methods that it acts enough like a Octopus that the method works.

Embracing duck typing: Methods that make method calls rather than assume the class of their argument.

Plus: More code reuse, very OO approach

• What messages can some object receive is all that matters

Minus: Almost nothing is equivalent

• \( x+x \) versus \( x*2 \) versus \( 2*x \)

• Callees may not want callers assuming so much
Blocks and Iterators

Many methods in Ruby “take a block,” which is a “special” thing separate from the argument list.

They are used very much like closures in functional programming; can take 0 or more arguments (see examples)

The preferred way for iterating over arrays, doing something \( n \) times, etc.

They really are closures (can access local variables where they were defined).

Useful on homework: each, possibly inject

Useful in Ruby: many, many more
Blocks vs. Procs

These block arguments can be used only by the “immediate” callee via the `yield` keyword.

If you really want a “first-class object” you can pass around, store in fields, etc., convert the block to an instance of `Proc`.

- `lambda { |x,y,z| e}`
- Instances of `Proc` have a method `call`
- This `really` is exactly a closure.

Actually, there is a way for the caller to pass a block and the callee convert it to a `Proc`.

- Look it up if you’re curious.
- This is what `lambda` does
  (just a method in `Object` that returns the `Proc` it creates)
Subclasses

Ruby is dynamically typed, so subclassing is not about what type-checks.

Subclassing is about inheriting methods from the superclass.

- In Java, it’s about inheriting fields too, but we can just write to any field we want.

Example: ThreeDPoint inherits methods x and y.

Example: ColorPoint inherits distFromOrigin and distFromOrigin2.
Overriding

If it were just inheritance, then with dynamic typing subclassing would just be avoiding copy/paste.

It's more.

But first, “simple” overriding lets us redefine methods in the subclass.

- Often convenient to use `super` to use superclass definition in our definition.

This is still “just” avoiding copy-paste.

Example: `distFromOrigin` and `initialize` in `ThreeDPoint`. 
Ruby-ish Digression

Why make a subclass when we could just add/change methods to the class itself?

• Add a color field to Point itself

• Affects all Point instances, even those already created (!!)

Plus: Now a ThreeDPoint has a color field too.

Minus: Maybe that messes up another part of your program.

Fun example: Redefining Fixnum’s + to return 5.
Late-Binding

So far, this OO stuff is very much like functional programming

- Fields are just like things in a closure’s environment (remember simulating objects in Scheme)

But this is totally different:

- When a method defined in a superclass makes a self call it resolves to the method defined in the subclass (typically via overriding)

Example: distFromOrigin2 in PolarPoint still works correctly!!!

Next batch of slides: Studying this very carefully.