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>
<th></th>
<th>dynamically typed</th>
<th>statically typed</th>
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<td>functional</td>
<td>Scheme</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 an 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
- Callers 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.
**Overridding**

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`.

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**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.

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**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.