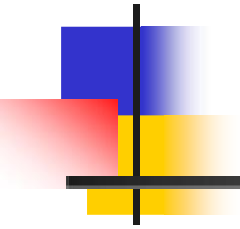

On to Java!

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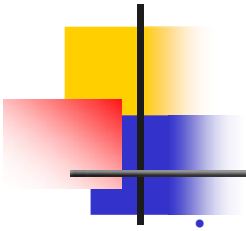
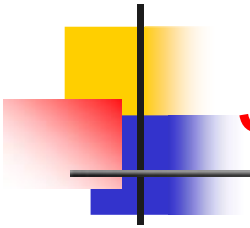


From Racket to Java

- Racket and Java look completely different
- Don't be fooled. Java is very Racket-like underneath (perhaps excessively so).
  - Self-identifying data (not present in C, C++)
  - Implicit sharing of objects (discouraging mutation); assignment does not copy!
- C++ and C# vs. Java?
  - In the Rice curriculum, C++ and C# are little-used.
  - In industry, Java is still dominant. The flexibility of open source is more important than the first-class generics offered in C#. C++ still used where performance is paramount, but it is costly.
  - For IOS (iPhones) and MacOS, Swift which has much in common with Java except: (i) no VM and (ii) a reference-counted heap.
  - For high-performance, Rust? A type safe language with C like syntax and support for traits rather than unrestricted inheritance (as in C++).
- DrRacket → DrJava



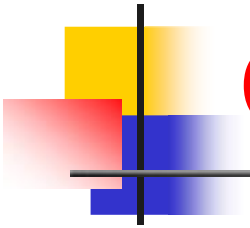
Java Notation

Breezy Overview of Java

- Syntax is wordy and rather ugly. Lots of warts thanks to C/C++ heritage. I presume everyone in this class already knows how to program in Java (perhaps with bad taste).

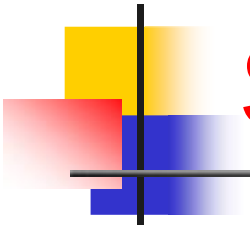
A functional programmers view of Java:

- What is a Java program? A collection of classes.
- What is a class? Rough answer: a Racket struct declaration on steroids. Instead of writing functions that manipulate structs, you add "methods" to a class which are members of the class.
- All Java code belongs to some class.



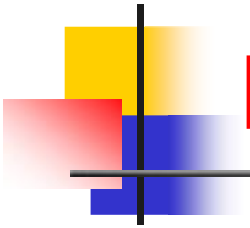
Guiding Vision

- Good program design in Java is *data-directed*. Design the data abstractions first; they will determine the structure of the code. In OOP circles, this data design process is often called *object-modeling.*
- Software development is incremental and test-driven. The same design recipe, as taught in this course, can be used in both OO and FP languages.
- Key to OO approach: common data and programming abstractions are codified as *design patterns*. Primary control structure is dynamic dispatch.



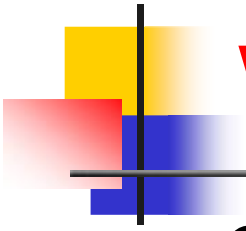
Secondary Theme: DrJava

- DrJava, our lightweight, reactive environment for Java, was created specifically to foster learning to program in Java.
- DrJava facilitates *active learning*; with DrJava learning Java is a form of *exploration.*
- DrJava is not a toy; DrJava is developed using DrJava. It includes everything that we believe is important and nothing more.



Remainder of Lecture is Review

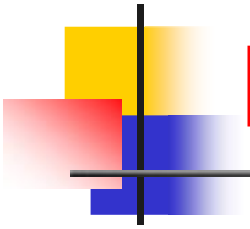
- Chapter 1 of my OO Design Notes presents an expository summary of core Java from a functional point of view. Skim it except for sections that cover aspects of Java program design that you have not seen in detail before, *e.g.*, the visitor pattern.
- Since I suspect nearly all of you have seen essentially all of the Java material before, I am going to breeze through it in lecture.
- Important take-away. Note how I use familiar Java constructs in perhaps unfamiliar ways to support a functional programming perspective.



What Is an Object?

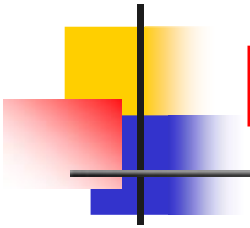
- Collection of *fields* bound to primitive values or objects *representing* the properties of a conceptual or physical object.
- Collection of operations called *methods* for observing and *changing* the fields of the object. Mutation is available, but should be used sparingly. In a functional Java program, fields are not mutated. We will only write functional programs in Java (with a few noted exceptions).

These fields and methods often called the *members* of the object (Java parlance).



How Are Objects Defined?

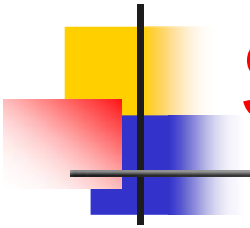
- All objects are created using templates (cookie cutters) just like Racket structs.
- Instead of writing **`define-struct`** statements, we write **`class`** definitions.
- Since all code is contained within a class, class definitions tend to be much richer (and more complex in real world examples) than **`define-struct`** statements. After all, the code that would be written in function definitions in Racket must be written as methods of some class.



Example: a Phone Directory

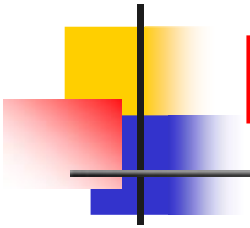
- Task: maintain a directory containing the office address and phone number for each person in the Rice Computer Science Dept.
- Each entry in such a directory has a natural representation as an object with three fields containing a person's
  - name
  - address
  - phone number

  represented as character strings (no symbols in Java).



Summary of **`Entry`** Format

- Fields:
  - **`String name`**
  - **`String address`**
  - **`String phone`**
- Implicitly generated methods (in Functional Language Level of DrJava):
  - **`String name()`**
  - **`String address()`**
  - **`String phone()`**



Entry Demo in DrJava

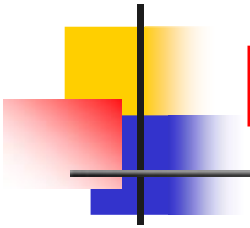
- Create an object
- How do perform any computation with it?

Java Method Invocation

- A Java method m is executed by sending a *method invocation (method call)*

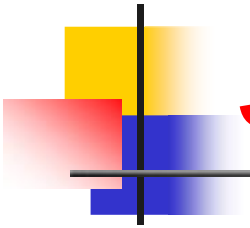
  ```
  o.m()
  ```

  to an object o, called the *receiver*. The method m must be a *member* (perhaps inherited) of **o**. From a conventional procedural or functional perspective, the receiver is the primary argument passed in a method call. In the machine implementation, the receiver is passed as the first argument on the stack. Any remaining arguments (the method parameters) immediately follow. So methods are actually implemented in machine code as procedures.
- The code defining the method **m** can refer to the receiver argument using the keyword **this**.



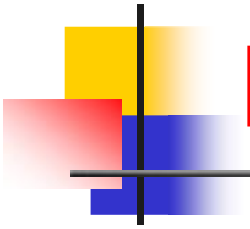
Method Invocation Demo

- Apply some auto-generated methods to an `Entry`
- How do we build up expressions from method invocations?
  - Apply operators (built-in to Java)
  - Invoke methods



Java Expressions

- Java supports essentially the same expressions over primitive types (**`int`**, **`float`**, **`double`**, **`boolean`**) as C/C++.
- Notable differences:
  - **`boolean`** is a distinct type from **`int`**
  - no unsigned version of integer types
  - explicit **`long`** type



Defining (Instance) Methods

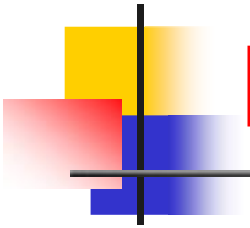
- Recall our definition of the **Entry** class. How can we add methods to this class?
- Suppose we want **Entry** to support a method:

  ```
  boolean match(String keyname)
  ```

  invoked by syntax like

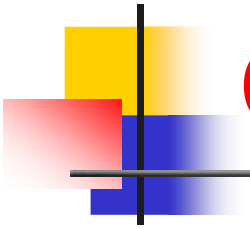
  ```
  e.match("Corky")
  ```

  where `e` is an **Entry**.



Method Definition Demo

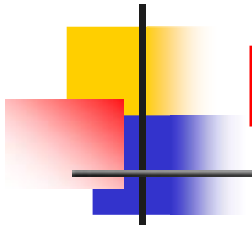
- Comment notation:
  - `//` opens a line comment
  - Block comments are enclosed in `/* … */`



Code for Entry with match

```
class Entry {
  /* fields */
  String name, address, phone;

  /** return true iff name matches keyName.*/
   boolean match(String keyName) {
     return keyName.equals(name));
   }
}
```



Presumed Knowledge

Reading: OO Design Notes, Ch 1.