ESS 201: Programming in Java

Week 2
Term 1: 2018-19
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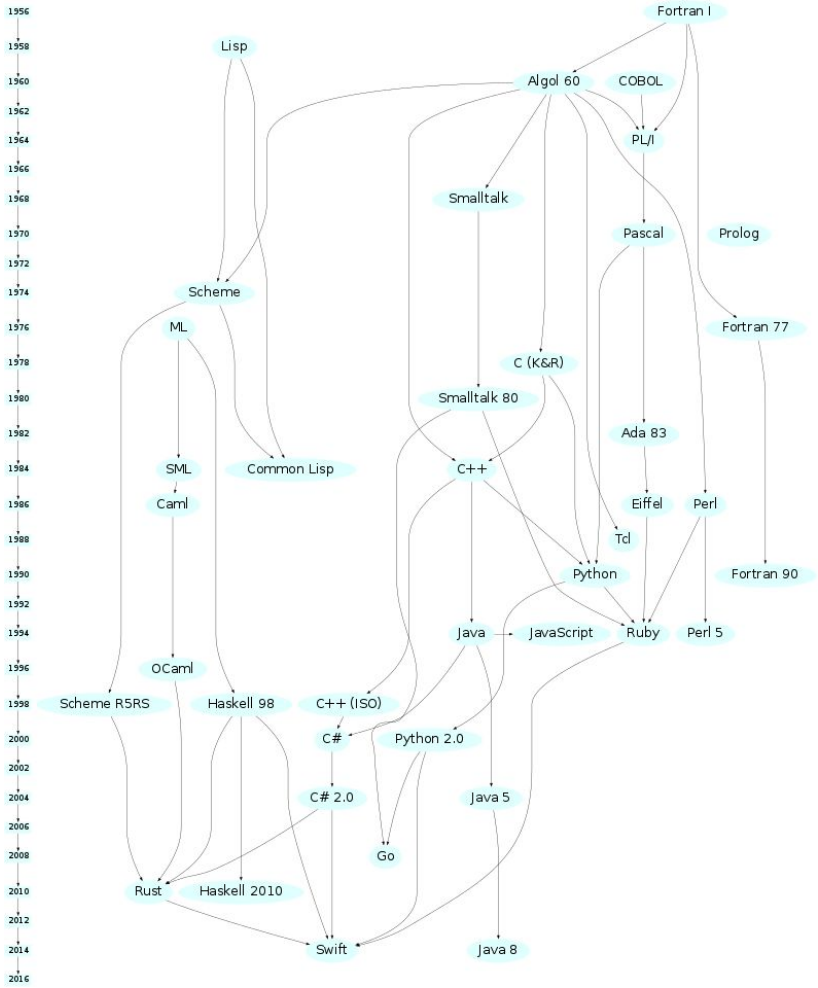
History of languages

Indicative - not necessarily complete



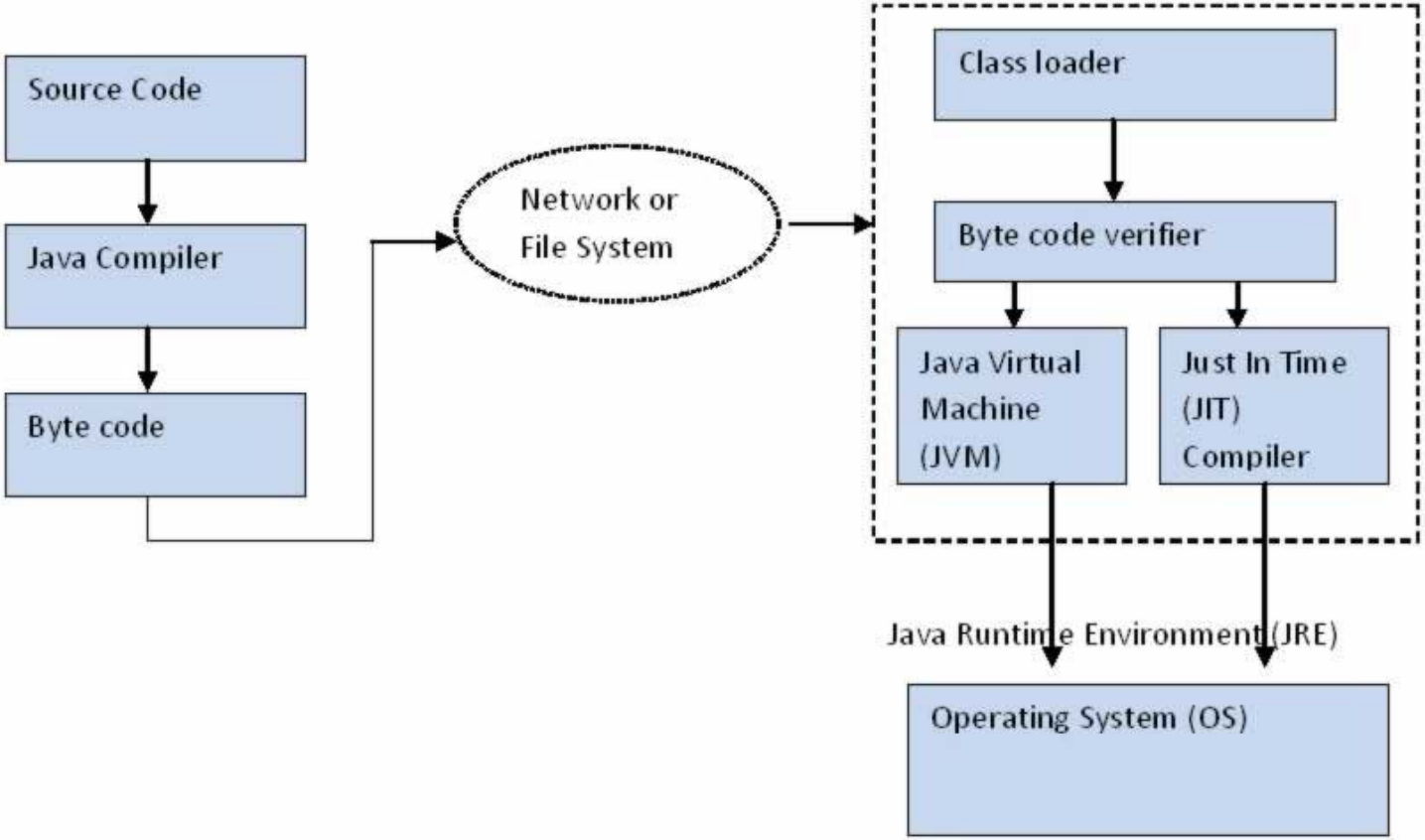
rigaux.org/language-study/diagram.html

Java: Design Goals

“Java technology must enable the development of *secure, high performance,* and highly *robust* applications on *multiple platforms* in *heterogeneous*, *distributed networks*.” And be developer friendly

1. Simple and familiar. Leverage existing languages
2. Object-oriented. Standard set of APIs for basic and advanced capabilities
3. Robust and secure. Avoid ability to directly manipulate hardware/memory, strong type checking, make it difficult for other programs to impact a Java program (and vice versa)
4. Architecture neutral and portable: work on multiple hardware platforms, architectures and OS. “Write once, run anywhere”
5. High performance. Should not have performance challenges
6. Interpreted and dynamic. Ability to not have to go through compiling, global linking etc. Can ease the prototyping phase - quick edit/compile/link/run
7. Multi-threaded. Be able to multi-task and do multiple things at the same time.
8. Distributed computing. Run across machines, including across networks

Byte code and compilation process



Version	Release date	End of Public Updates[4]
JDK Beta	1995	?
JDK 1.0	1996	?
JDK 1.1	1997	?
J2SE 1.2	1998	?
Java SE 8 (LTS)	2014	January 2019 (commercial) December 2020 (non-commercial)
Java SE 9	2017	March 2018
Java SE 10 (18.3)	2018	September 2018
Java SE 11 (18.9 LTS)	2018	N/A

Source: Wikipedia

Hello World!

```
public class HelloWorld{
	public static void main(String[] args) {
		System.out.println(“Greetings!”);
	}
}
```

File: HelloWorld.java

Only one public class per file

Can we have main in multiple classes/files? Why would we do that?

Compilation and running

> javac HelloWorld.java

produces .class file(s)

> java HelloWorld

Runs the :main” in this class

Automatic compilation of referenced classes

Logical collection of classes/libraries can be packed into “jar” files

Java Class Library

- Provide the programmer with a well-known set of functions to perform common tasks, such as maintaining lists of items or performing complex string parsing.
- Provide an abstract interface to tasks that would normally depend heavily on the hardware and operating system.
- Some underlying platforms may not support all of the features a Java application expects. In these cases, the class libraries can either emulate those features using whatever is available, or provide a consistent way to check for the presence of a specific feature.

Types in Java

- reference
- primitives
- Array
- (a special type) void

Primitive types

Fixed size of basic types

boolean true, false (not equivalent to 0 or 1)
char 16 bits (unicode)
byte 8 bits
short 16 bits
int 32 bits
long 64 bits
float 32 bits
double 64 bits

all numeric types are “signed”. No “unsigned”
Note: primitives **are NOT** objects

Objects and references

- Everything is an “object” - an instance of a “class”
- You manipulate objects through their references
- Objects (state) may change, but references do not
- Methods are passed references to objects (or primitives), so always “call by value”
- Objects are allocated on the heap, references are on the program stack or heap (depending on whether they are local variables or members of objects)
- Memory of objects are “garbage collected” when no longer referenced (How?)

String and Array

Both are **classes**

Specific methods, constructors, operations

String: immutable in size and content - can only be queried

Operators such as concatenation (+) defined.

Array:

Size defined at construct time

Can be queried for length (arr.length)

Class definition

```
class IceCreamBar {

    String getName() {  }

    String getFlavour() {  }

    float getTemp() {  }

    float getPrice() {  }

    ….

}
```

Methods

Class definition

```
class IceCreamBar {

    String getName() {  }

    String getFlavour() {  }

    float getTemp() {  }

    float getPrice() {  }

    String name, flavour;

    float temp, price;

}
```

Methods

Data members

Class definition

```
class IceCreamBar {

  String getName() {  }

  String getFlavour() {  }

  float getTemp() {  }

  float getPrice() {  }

  private String name, flavour;

  private float temp, price;

}
```

Methods

Data members

Class definition

```
class IceCreamBar {

    IceCreamBar(String iname, String iflavour, float itemp, float iprice) { }

    String getName() {  }

    String getFlavour() {  }

    float getTemp() {  }

    float getPrice() {  }

    private String name, flavour;

    private float temp, price;

}
```

Constructor

Methods

Data members

Constructors

Every class should have at least one constructor

Constructor that takes no arguments is called the *default constructor*

Compiler defines a default constructor if no constructors have been defined for the class. This default version sets all data members to their default initial value.

All instance variables are initialized to default values, if not explicitly initialized in a constructor

If any constructor is defined for the class, then the constructor does not define the default constructor

Note: no notion of "*destructors*". Facility for cleanup

Class definition

```
class IceCreamBar {

  IceCreamBar(String iname, String iflavour, float itemp, float iprice) { }

  String getName() { return name; }

  String getFlavour() { return flavour; }

  float getTemp() { return temp; }

  float getPrice() { return price; }

  …

}
```

Class definition

```
class IceCreamBar {
  IceCreamBar(String iname, String iflavour, float itemp, float iprice) {
       name = iname; flavour = iflavour;
       temp = itemp;
       price = iprice;
  }
  String getName() { return name; }
  String getFlavour() { return flavour; }
  float getTemp() { return temp; }
  float getPrice() { return price; }
…
}
```

Class definition

```
class IceCreamBar {
  IceCreamBar(String iname, String iflavour, float itemp, float iprice) {
        name = iname; flavour = iflavour;
        temp = itemp;
        price = iprice;
  }
  String getName() { return name; }
  String getFlavour() { return flavour; }
  float getTemp() { return temp; }
  float getPrice() { return price; }
  void setTemp(float t) { temp = t;}
  void setPrice(float p) { price = p;}
  ...
}
```

Invoking class methods

```
IceCreamBar ic1 = new IceCreamBar(“CH”, “Chocolate”, 8.0, 90.0);

….

System.out.println(“Flavour “ + ic1.getFlavour() +
                        “ from “ + ic1.getName() +
                        “costs “ + ic1.getPrice() +
                        “ and is stored at “ + ic1.getTemp() + “ degrees.”);
```

Should print:
Flavour Chocolate from CH costs 90.0 and is stored at 8.0 degrees.

Some rules (best practices)

1. All data members are private
2. No casts*
3. No compiler warnings

* except is very specific situations - to be discussed later

Java operators and control statements

Operators:

- Generally follow the syntax of C/C++
- No operator overloading

Control statements:

- If-else, while, do-while, for: similar to C/C++

Incidentally, Java does not have a *sizeof* method/operator. Why?

Also, the perils of “data conversion”:

A Bug and a Crash, James Gleick, 1996

https://around.com/ariane.html

for loop - additional syntax

```
for( T elem: <<array of T>>) {
 // elem is successively bound to each element of the array
}
```

E.g.

```
int[] scores = new int[400];
… initialize scores
int total = 0;
for (int score: scores) {
   total += score;
}
```

Useful when iterating through an array, but not modifying array or its elements

switch statement

variable being tested in switch can evaluate to constants of byte, short, char, and int primitive data types

Can also be used with enum

As well as String

Primitive wrapper classes

primitive variables are not objects - i.e. not instances of some class

Java provides “wrapper” classes corresponding to each primitive type: Byte, Short, Integer,, Float, Double, …

Compiler supports automatic conversion between primitives and their corresponding wrapper classes: auto boxing and unboxing (like an implicit cast).

- Passed as a parameter to a method that expects an object of the corresponding wrapper class.
- Assigned to a variable of the corresponding wrapper class.

Auto boxing and unboxing

```
int i=3;
Integer j = i;
int k = j;
```

```
void m1(Integer i, Character c) {}
```

Can be invoked as:

```
int i=3;
char c ‘ ‘a’;
m1(i, c);
```

Method signatures

The name and parameter list (arguments and their types) defines the *signature* of a method

Method overloading

- we can multiple methods in a class with the same name, but with different arguments. E.g. constructors with different sets of arguments

When an overloaded method is invoked, the compiler maps this to that method whose signature most closely matches the invocation

- Number and order of arguments must match, and the types of arguments should be “compatible” (to be discussed later)

Scope and lifetime (of primitives, references, objects)

The scope of primitives and references defined by the block where they are declared. And so is their lifetime (memory no longer available once out of scope)

```
{
    int x = 7;
    Box b1 = new Box();
    ...
}
```

Objects live on independent of the block where they were constructed. Accessible as long as some reference to them is still alive.

static methods and data members

A method specified as **static** is considered as a method defined on the class, and not tied to any instance.

Can be invoked even without creating instances of that class

static methods cannot access data (or methods) that are non-static - even of the same class

Similarly, static data members are shared by all instances of that class - there is only piece of storage associated with that data member.

Static methods/members are accessed with

classname.member

static methods

```
class Account {
  …
  static Account max(Account[] acs) {}

   private String name;
   private float balance;
}
```

Usage:

```
Account[] accounts = new
Account[10];

// …. Iniitalize array

Account largest =

  Account.max(accounts);
```

static data fields

```
class Account {
  …
   Account() {
       accountNumber = nextId++;
  }
  static Account max(Account[] acs) {}
  ...
   private static int nextId = 1;
   private String name;
   private float balance;
   private int accountNumber;
}
```

final variables

A variable labelled as **final** implies value cannot be changed once it is initialized

final variables must be initialized

- when declared
- or, in every constructor (also called “blank final”)
- Compiler error if attempt to re-assign a value

Note: if a reference to an object is final, the reference itself cannot change, however, the object it refers to can change.

For example, in the IceCreamBar example, the name and flavour should be defined final, if the intent is that these cannot change once the object is initialized.

Access specifiers

classes, methods and data fields can have specifiers added to them that control who all (which other classes) can access them

public, private (and later, **protected**, as well as a *default* (i.e. no specifier)) access

public: visible to all other classes

private: only visible from within (methods or class definition) of the same class

Does a *private class* make sense?

Public/private members

Visibility of members (methods or data) of a class A from within class B:

Specifier (in class A)	For class A	For class B
public	Y	Y
private	Y	N