An Introduction to Software Engineering

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Software Today

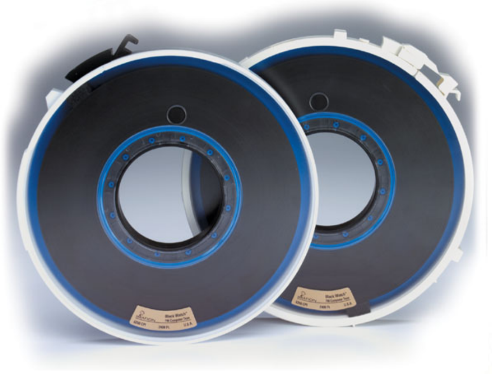
"This Internet parental controls software is kind of difficult to install. You might want your kids to do it for you."

Software Development

- **Pre-1970’s - Emphasis on efficiency**
    - Compact, fast algorithms on machines with limited memory
    - Required long learning curve, cryptic code
- **Today**
    - Emphasis on programmer productivity, team development, reusable code, maintainable code, portable code
    - Relatively user-friendly code

Evolution of Computer Architecture

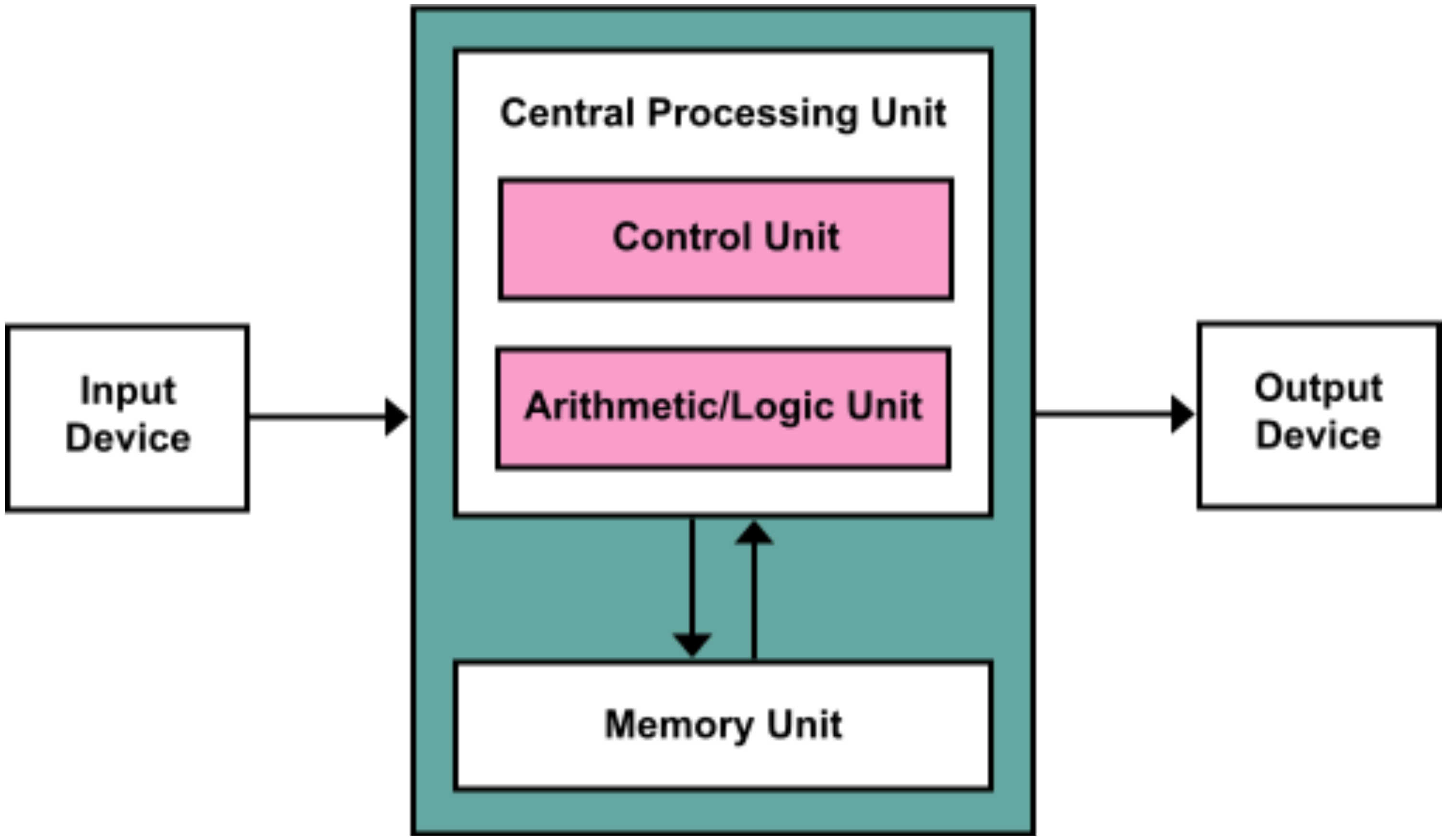
- **Pre-Programmable machines**
  - **Fixed machines** - the instructions were in the design
  - **Wired machines** - the instructions were in the wiring



- **Early stored program machines**
  - Program by loading cards, tape, etc.
- **Von Neumann architecture**
  - Modern computer architecture
  - Stores both the instructions and the data

- **Modified Harvard machine**
  - Special-purpose processors, like a GPU
  - Two sets of registers: one dedicated for instructions and the other for data

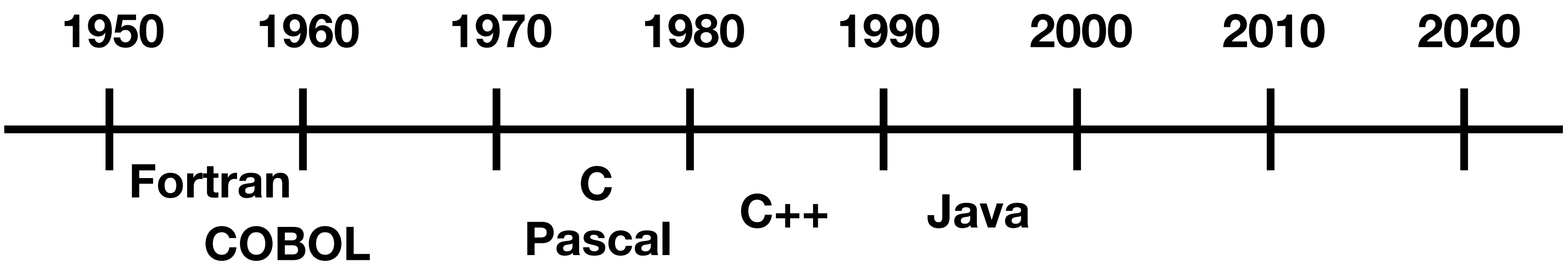
Modern Von Neumann Architecture



Needs a high-level language

High-level Language Timeline (Abridged)

- FORTRAN (1956) - FORmula TRANslator, for scientific applications
- COBOL (1960) - for business applications
- Pascal and C (1970's) - block structured
- C++ (1980's) - the OOP version of C
- Java (1990's) - a platform-independent language for the Internet, also OOP

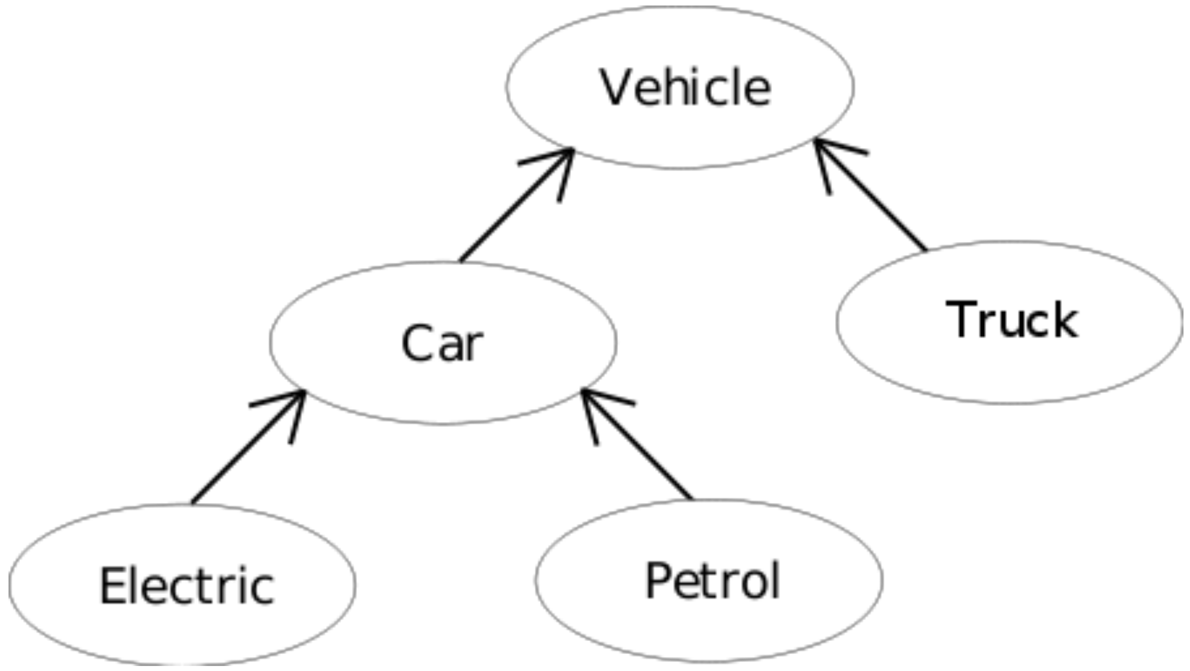


OOP - Object-Oriented Programming

- OOP models a world of **active objects**.
- An object has “**memory**” or “**state**”, and can contain other objects.
- An object has “**behaviors**” or “**methods**” that process messages from other objects.
- An object’s method can change it’s state, send messages to other objects, and create new objects.
- An object belongs to a particular **class.** A class determines the functionality of all objects that belong to that class.
- Programmers define classes to create an OOP application.

Main OOP Concepts

- **Inheritance**: a <u>subclass</u> can take on all of the attributes (states) and behaviors (methods) of another class, can redefine those behaviors, add new behaviors, and add new attributes.

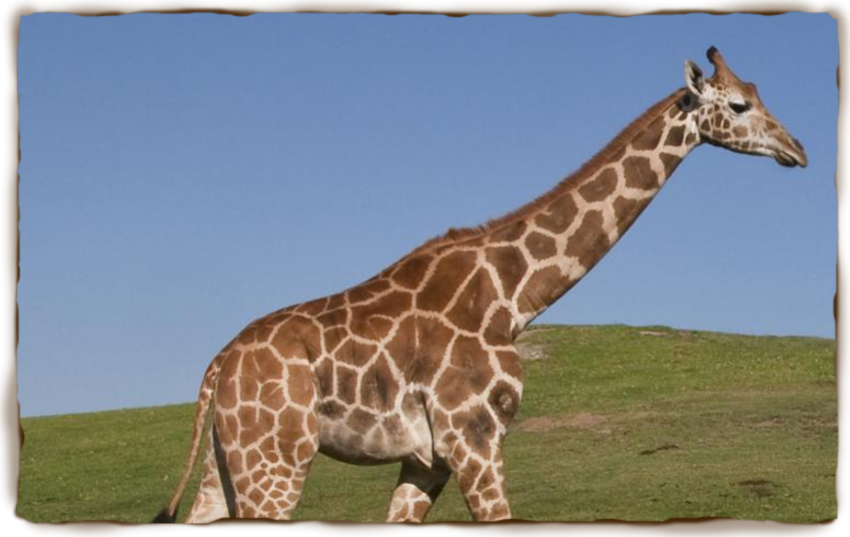


Main OOP Concepts

- **Polymorphism:** to process objects differently based upon their data types

Mammals

Function: eats()

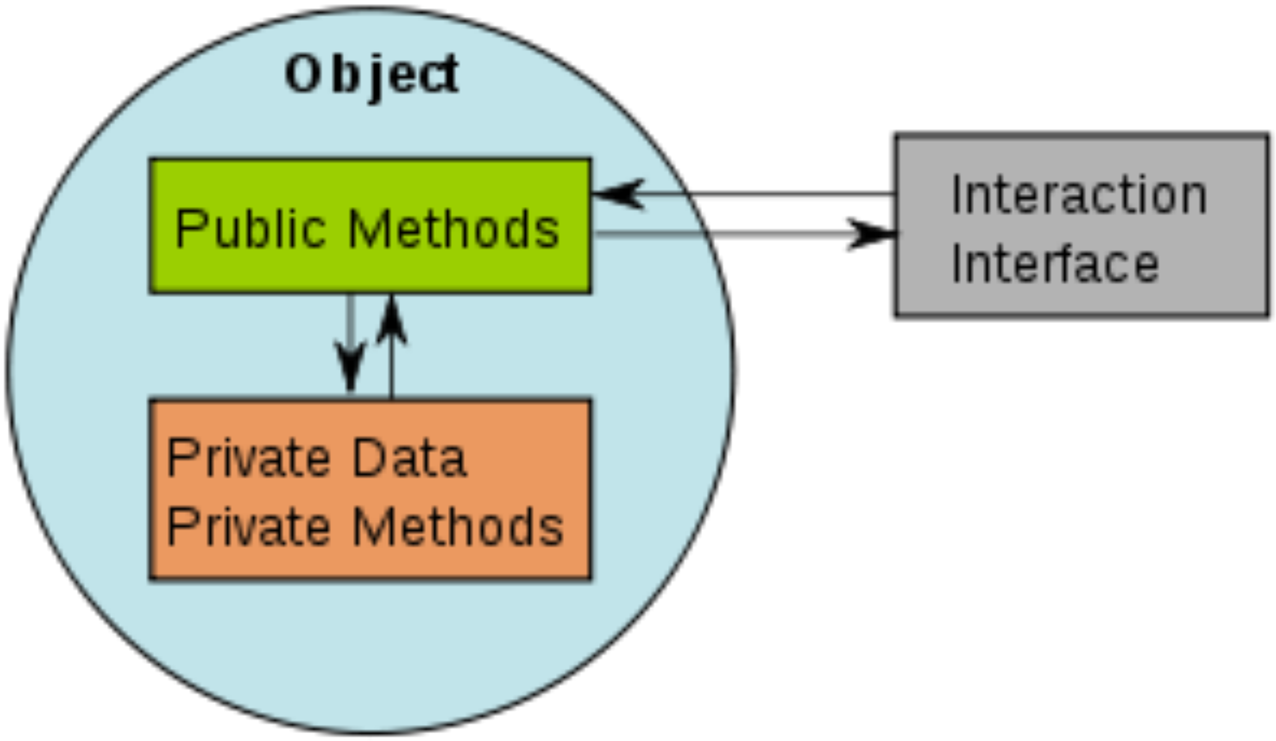


Function: eats()

eats() is defined differently for each.

Main OOP Concepts

- **Encapsulation:** keeps the data and code safe from outside influence



OOP Benefits

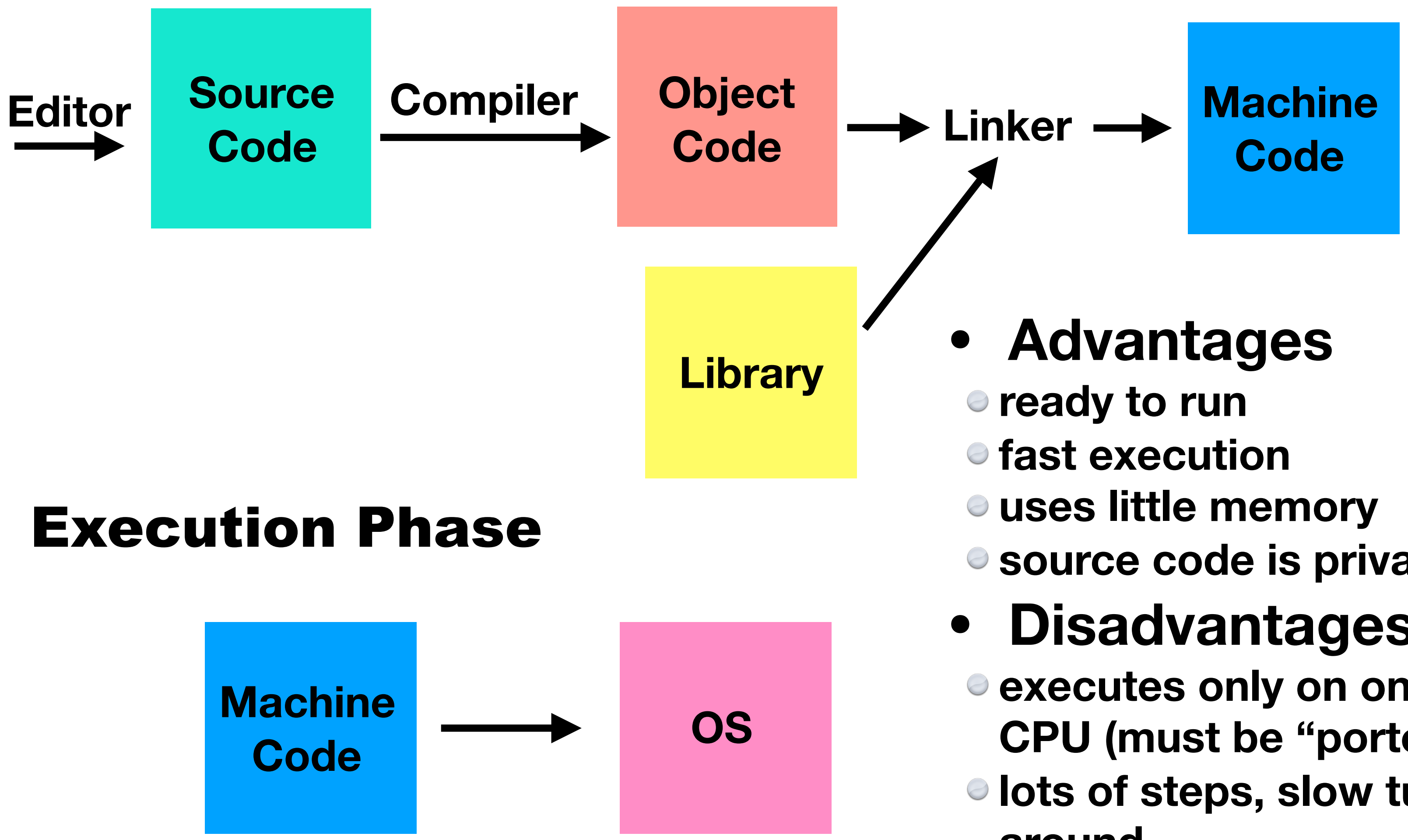
- Easier to reuse components
- Easier to maintain
- Allows for team development

High-level Language Development Environments

File Types

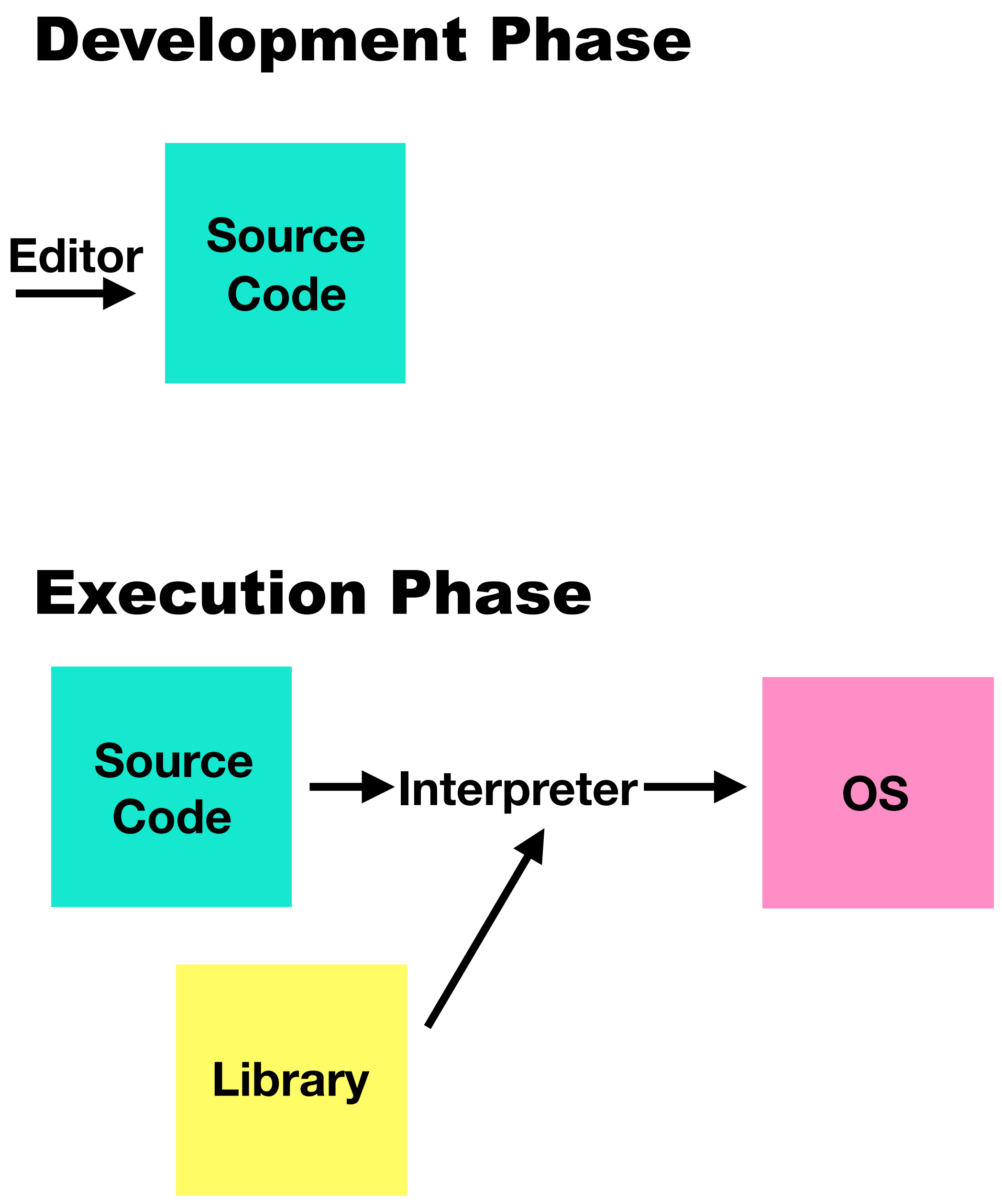
- **source code** - a file that contains the program in a programming language
- **object code** - a file that is generated by the compiler which contains the program in a form specific to the CPU
- **machine code** - an executable file that runs on a specific CPU
- **bytecode** - a file generated by the Java compiler that can be run by the Java interpreter. It is neither object nor machine code!

C Program (Compiler Paradigm)



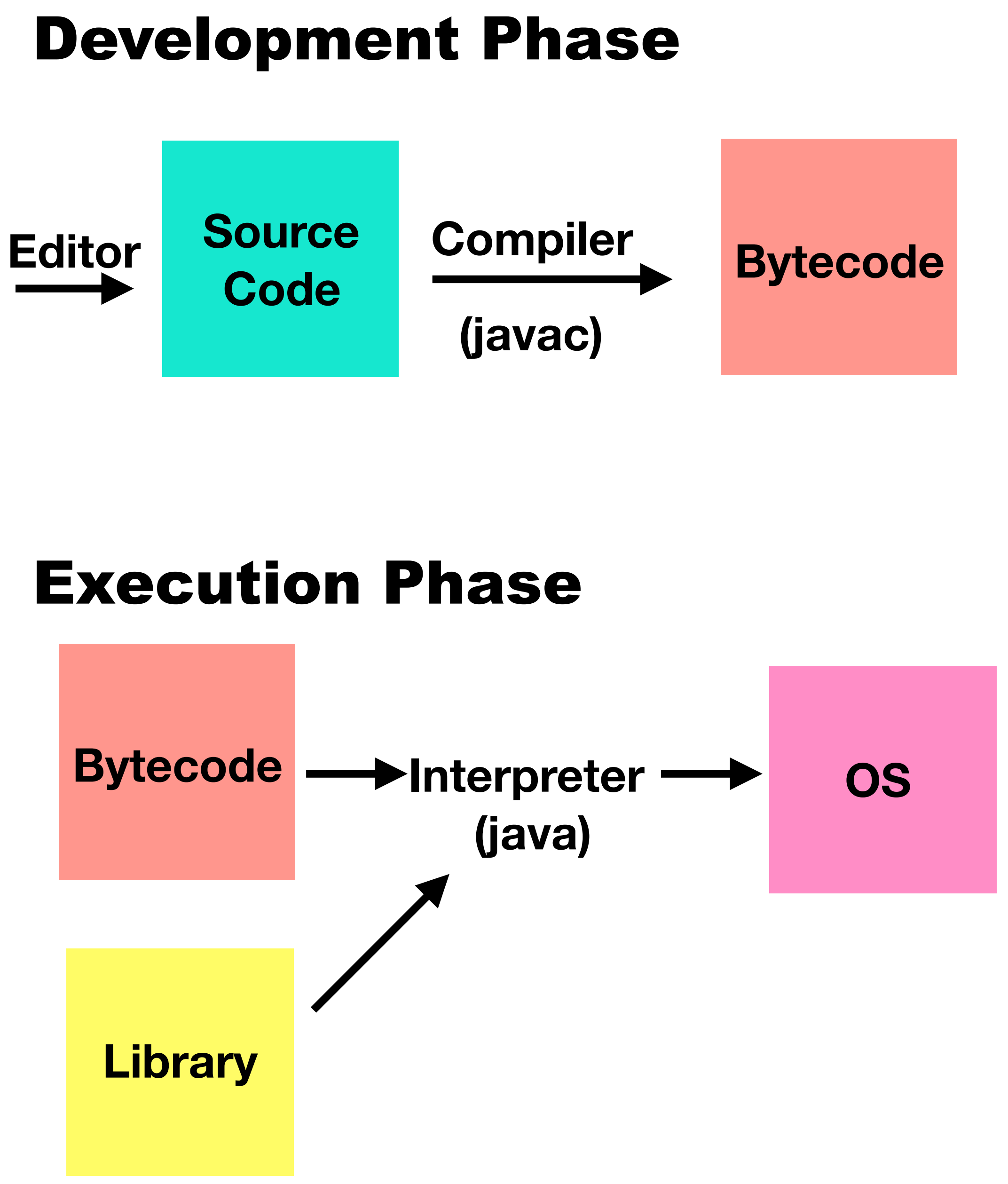
- **Advantages**
  - ready to run
  - fast execution
  - uses little memory
  - source code is private
- **Disadvantages**
  - executes only on one CPU (must be "ported")
  - lots of steps, slow turn-around
  - inflexible

BASIC Program (Interpreter Paradigm)



- **Advantages**
  - portable between CPUs
  - dynamic typing and scoping
  - simple to test
  - easy to debug
- **Disadvantages**
  - slower than other paradigms
  - uses more memory
  - requires interpreter specific to each CPU and OS
  - source code not private

Java Program (Compiler + Interpreter Paradigm)



- **Advantages**
  - Bytecode portable between CPUs and OSs
  - runs faster than Interpreter Paradigm
  - source code is private
  - interpreter can perform extra checking (like virus checking)
- **Disadvantages**
  - every code change requires recompiling
  - requires compiler and interpreter ported to each CPU and OS
  - generally slower than Compiler Paradigm

Programs for Development

- **editor** - a program that provides the user a GUI to input text and output a source file
- **compiler** - a program that converts high-level code into object code (for CPU) or bytecode (for Virtual Machine)
- **linker** - a program that “links” the object code with prebuilt library functions
- **interpreter** - a program that reads and executes source code or bytecode, and contains an embedded linker

Java Compiler

- **Checks program syntax** - reports syntax errors based on strict syntactic rules

- **Creates bytecode file** - only when there are no syntax errors

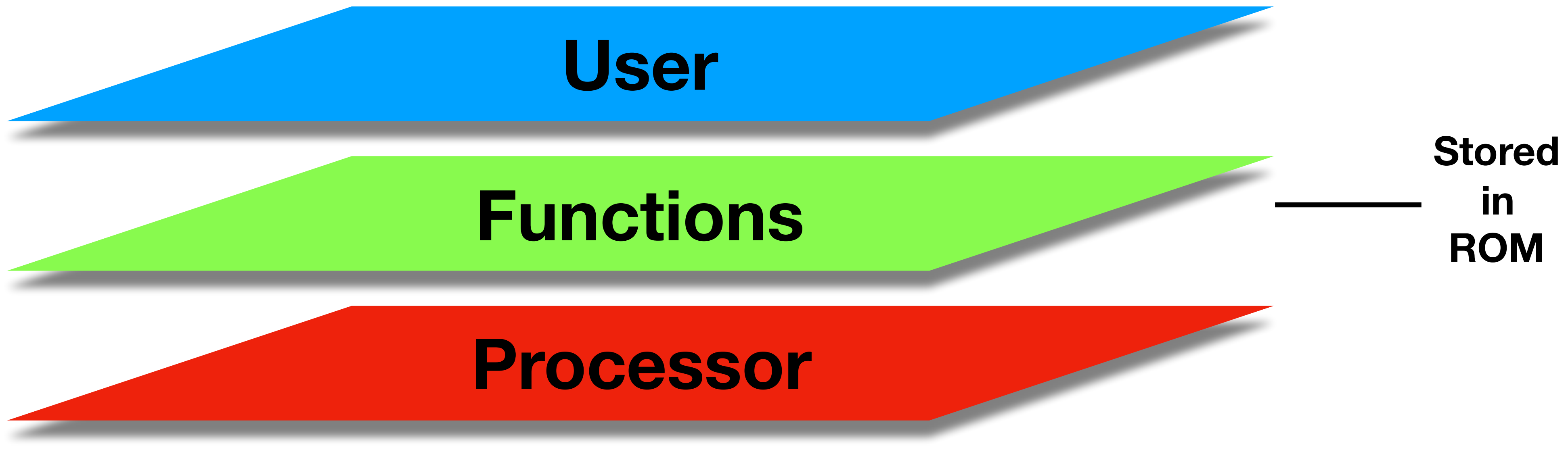
```
% javac MyPerfectProgram.java
MyPerfectProgram.java:7: cannot find symbol
symbol  : variable i
location: class MyPerfectProgram
       i = 1;
       ^
MyPerfectProgram.java:8: incompatible types
found   : int
required: boolean
       for (int a; 5; a++)
                   ^
2 errors
%
```

Java Interpreter

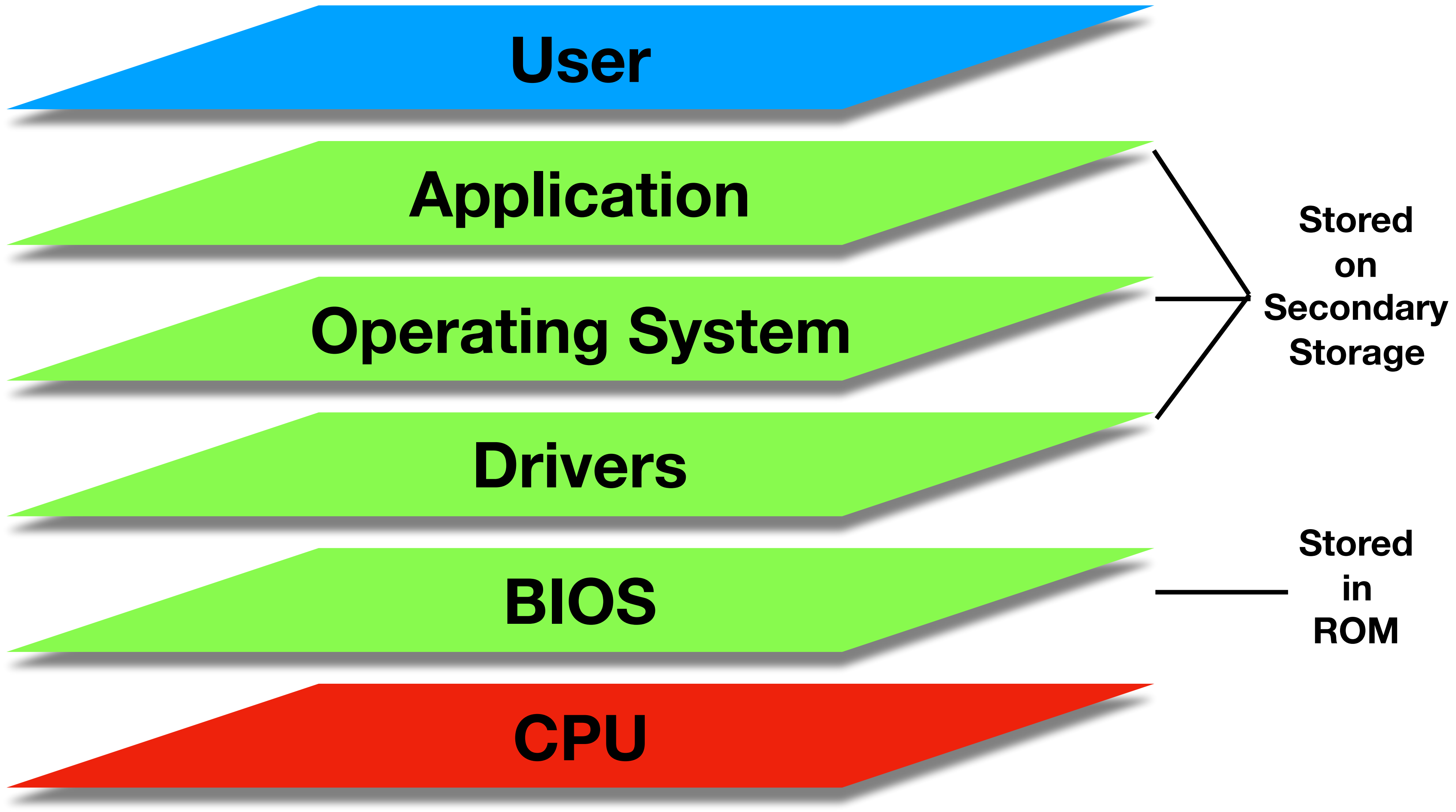
- **Links and executes the bytecode program**
- **Allocates memory during runtime**
- **Catches and reports runtime errors** - allows for a graceful exit to the OS if there is a problem

```
% java HereWeGo
Exception in thread "main"
java.lang.ArrayIndexOutOfBoundsException: 5
   at HereWeGo.main(HereWeGo.java:10)
%
```

Layers of a Simple Calculator



Layers in a Computer



The Java Development Environment

JDK - Java Development Kit

- **javac**
  - Java compiler
- **java**
  - Java interpreter
- **javadoc**
  - Generates HTML documentation from the source code
- **jar**
  - Creates a Java package file (JAR file)

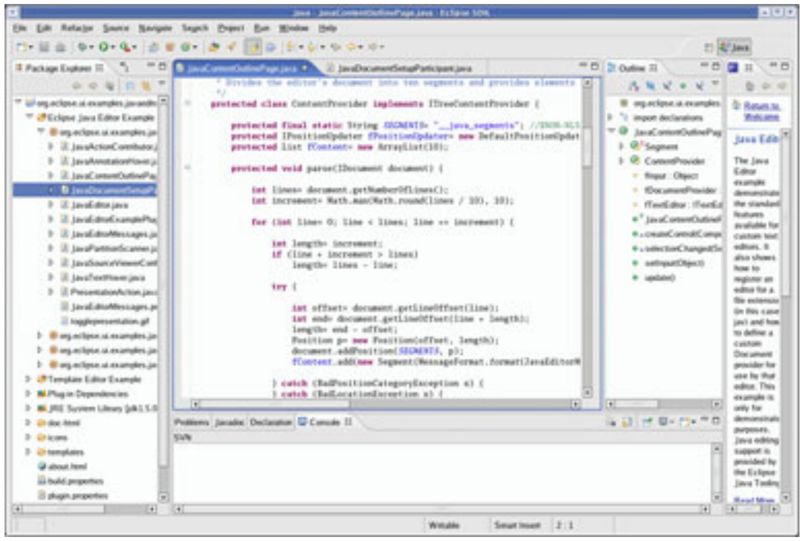
Command line tools, no GUI

JDK - <u>J</u>ava <u>D</u>evelopment <u>K</u>it (cont.)

- **Originally developed by Sun Computer (now Oracle)**
  - Jim Gosling - “Father of Java”
- **Download is available for all OS platforms (we use runtime version 7 in the lab)**
  - For PC or Linux: Google “jdk 7”
  - For Mac: Google “legacy jdk 6 mac” (unfortunately, must have maintenance agreement to get version 7)

IDE
(Integrated Development Environment)

- **GUI frontend for programming languages**
- **Integrates editor, compiler, interpreter, and debugger into one tool**
- **Popular IDEs for Java**
  - Eclipse
  - BlueJ
  - NetBeans



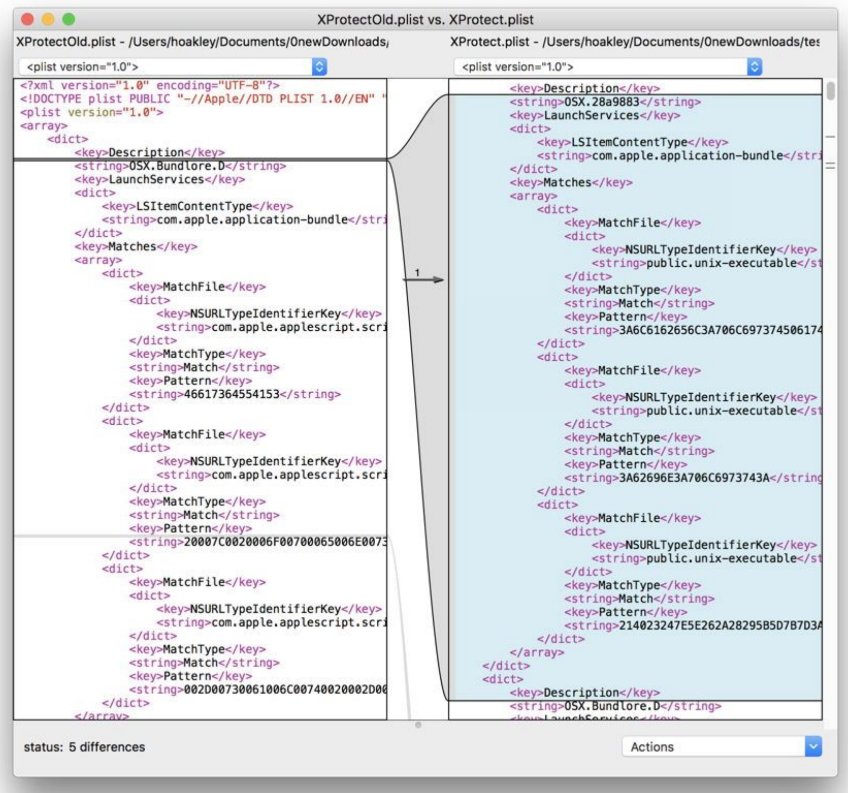
```
 * Divides the editor's document into ten segments and provides elements
 */
protected class ContentProvider implements ITreeContentProvider {

    protected final static String SEGMENTS= "__java_segments"; //$NON-NLS
    protected IPositionUpdater fPositionUpdater= new DefaultPositionUpdat
    protected List fContent= new ArrayList(10);

    protected void parse(IDocument document) {

        int lines= document.getNumberOfLines();
        int increment= Math.max(Math.round(lines / 10), 10);

        for (int line= 0; line < lines; line += increment) {

            int length= increment;
            if (line + increment > lines)
                length= lines - line;

            try {

                int offset= document.getLineOffset(line);
                int end= document.getLineOffset(line + length);
                length= end - offset;
                Position p= new Position(offset, length);
                document.addPosition(SEGMENTS, p);
                fContent.add(new Segment(MessageFormat.format(JavaEditorM

            } catch (BadPositionCategoryException x) {
            } catch (BadLocationException x) {
```

- **The IDE good, bad, and ugly**
  - Good: Speeds the development process.
  - Bad: Hinders the process of learning languages. Mr Greenstein does not provide help if you have an IDE problem.
  - Ugly: <u>Constant use could negatively affect your grade!</u>

My advice: DO NOT USE IDE!

Text Editor

- **Creates the Java source code file**
- **Recommend using bare-bones editors**
  - For Linux we recommend *Geany*
  - For PC we recommend *NotePad* or *Sublime*
  - For Mac we recommend *BBEdit (free version)*


XProtectOld.plist vs. XProtect.plist
XProtectOld.plist - /Users/hoakley/Documents/OnewDownloads/
XProtect.plist - /Users/hoakley/Documents/OnewDownloads/tes
<plist version="1.0">
<plist version="1.0">
1
status: 5 differences
Actions

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "
<plist version="1.0">
<array>
    <dict>
        <key>Description</key>
        <string>OSX.Bundlore.D</string>
        <key>LaunchServices</key>
        <dict>
            <key>LSItemContentType</key>
            <string>com.apple.application-bundle</stri
        </dict>
        <key>Matches</key>
        <array>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
                    <string>com.apple.applescript.scri
                </dict>
                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
                <string>46617364554153</string>
            </dict>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
                    <string>com.apple.applescript.scri
                </dict>
                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
                <string>20007C0020006F00700065006E0073
            </dict>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
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                </dict>
                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
                <string>002D00730061006C00740020002D00
            </dict>
        </array>
```

```
        <key>Description</key>
        <string>OSX.28a9883</string>
        <key>LaunchServices</key>
        <dict>
            <key>LSItemContentType</key>
            <string>com.apple.application-bundle</stri
        </dict>
        <key>Matches</key>
        <array>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
                    <string>public.unix-executable</st
                </dict>
                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
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            </dict>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
                    <string>public.unix-executable</st
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                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
                <string>3A62696E3A706C6973743A</string
            </dict>
            <dict>
                <key>MatchFile</key>
                <dict>
                    <key>NSURLTypeIdentifierKey</key>
                    <string>public.unix-executable</st
                </dict>
                <key>MatchType</key>
                <string>Match</string>
                <key>Pattern</key>
                <string>214023247E5E262A28295B5D7B7D3A
            </dict>
        </array>
    </dict>
    <dict>
        <key>Description</key>
        <string>OSX.Bundlore.D</string>
```

Questions???