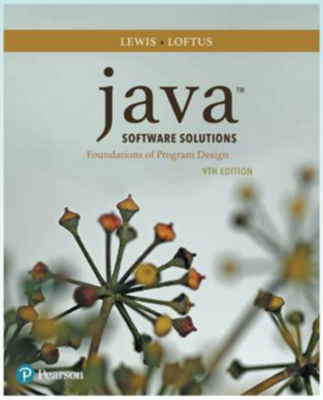
Chapter 1
Introduction

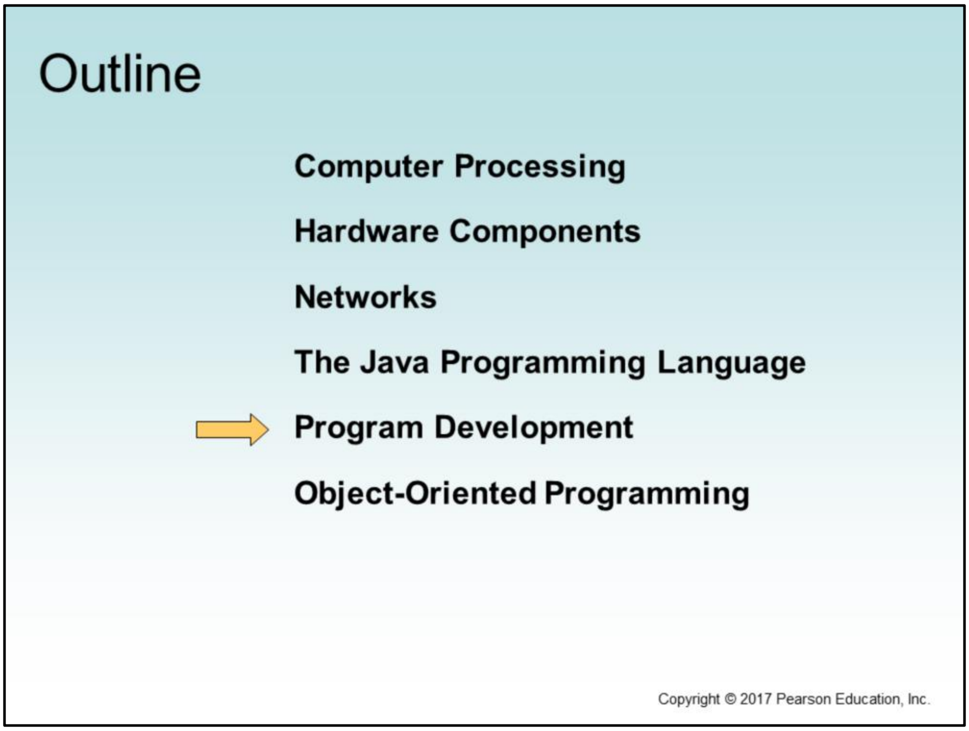


Java Software Solutions

Foundations of Program Design

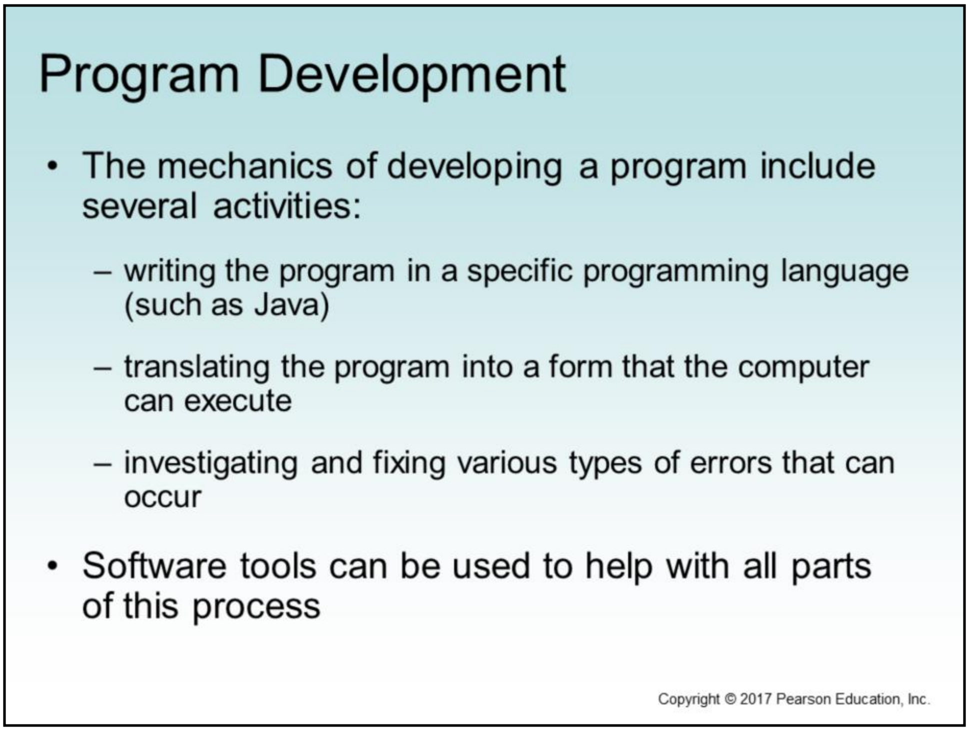
9th Edition

John Lewis
William Loftus



Outline

- Computer Processing
- Hardware Components
- Networks
- The Java Programming Language
- ➡ Program Development
- Object-Oriented Programming



Program Development

- The mechanics of developing a program include several activities:
  - writing the program in a specific programming language (such as Java)
  - translating the program into a form that the computer can execute
  - investigating and fixing various types of errors that can occur
- Software tools can be used to help with all parts of this process

-Problems can be solved using a computer in different languages

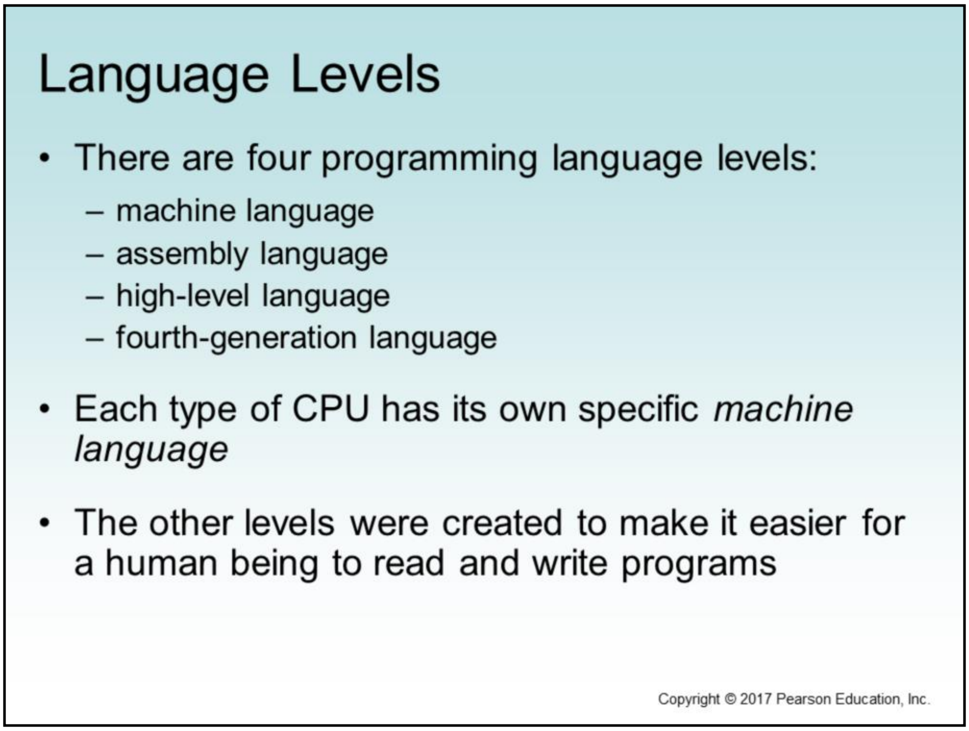
-Regardless of the language; the goal is to **solve problems**

-One of our goals is to learn how to instruct a machine to solve problems

-Involved in this goal is how to organize (design) the instructions in our program

-This **design** process involves thinking about problems in an **object-oriented** manner

-Remember, learning Java is secondary – goal is designing software to solve problems!



Language Levels

- There are four programming language levels:
  - machine language
  - assembly language
  - high-level language
  - fourth-generation language
- Each type of CPU has its own specific *machine language*
- The other levels were created to make it easier for a human being to read and write programs

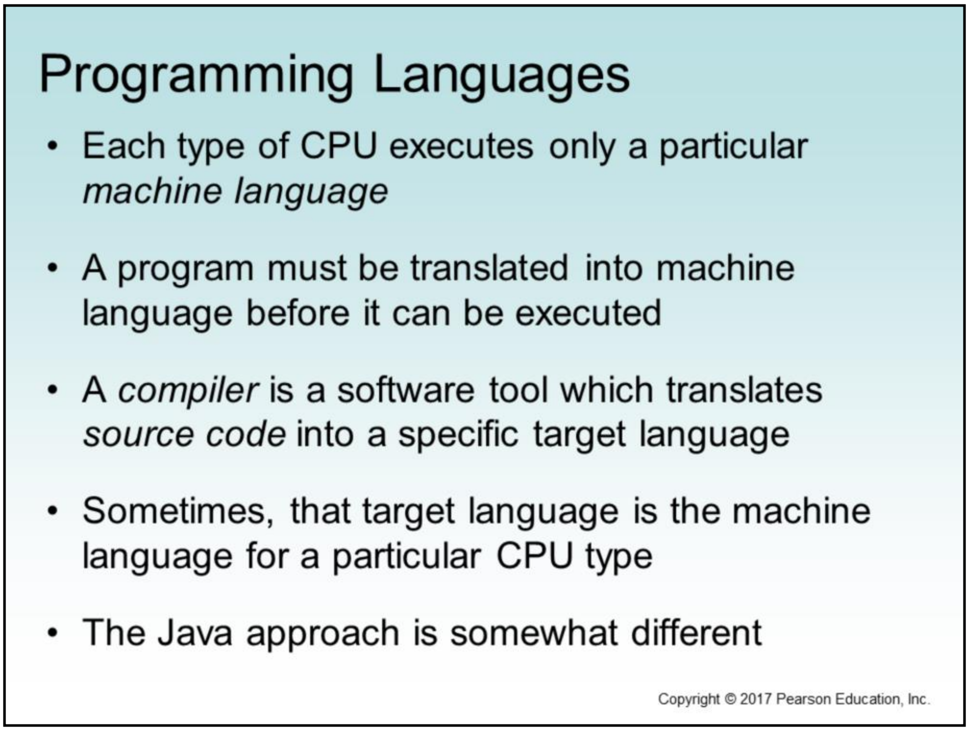
-Programs in a machine language for one type of CPU won't execute on a different CPU

-We'll see that Java technology solves this problem using a **Virtual Machine**

-Assembly language uses short words to represent instructions

-High-level languages can represent more instructions (note. Fig. 1.19)

-4th generation examples: SQL, Mathematica



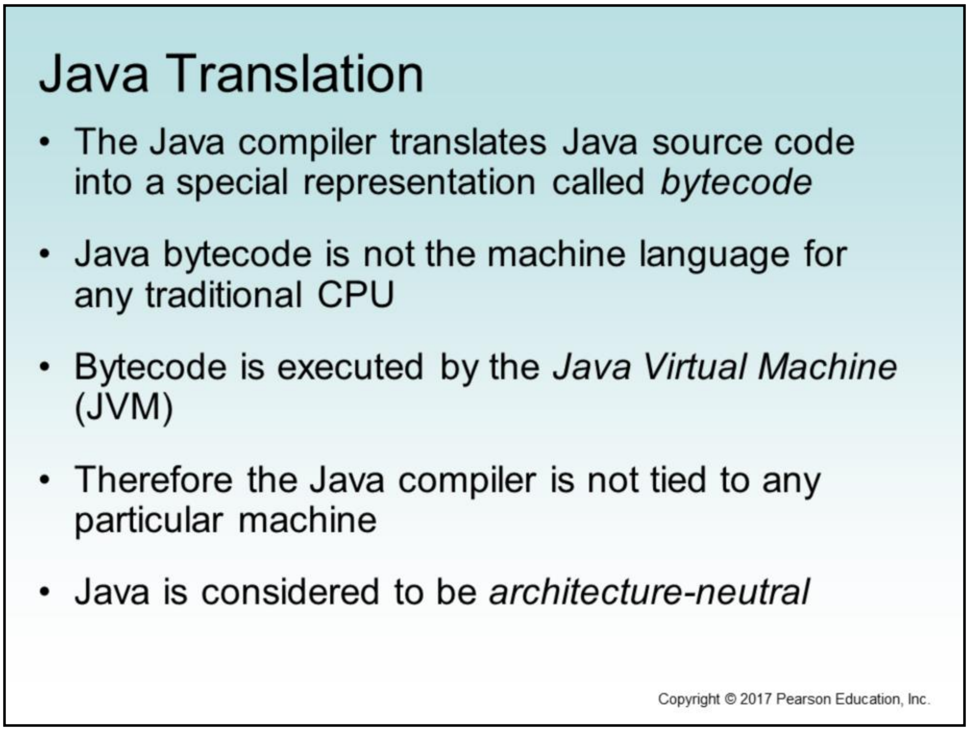
Programming Languages

- Each type of CPU executes only a particular *machine language*
- A program must be translated into machine language before it can be executed
- A *compiler* is a software tool which translates *source code* into a specific target language
- Sometimes, that target language is the machine language for a particular CPU type
- The Java approach is somewhat different

-**Source code**: Language instructions originating (i.e. “source”) from programmer

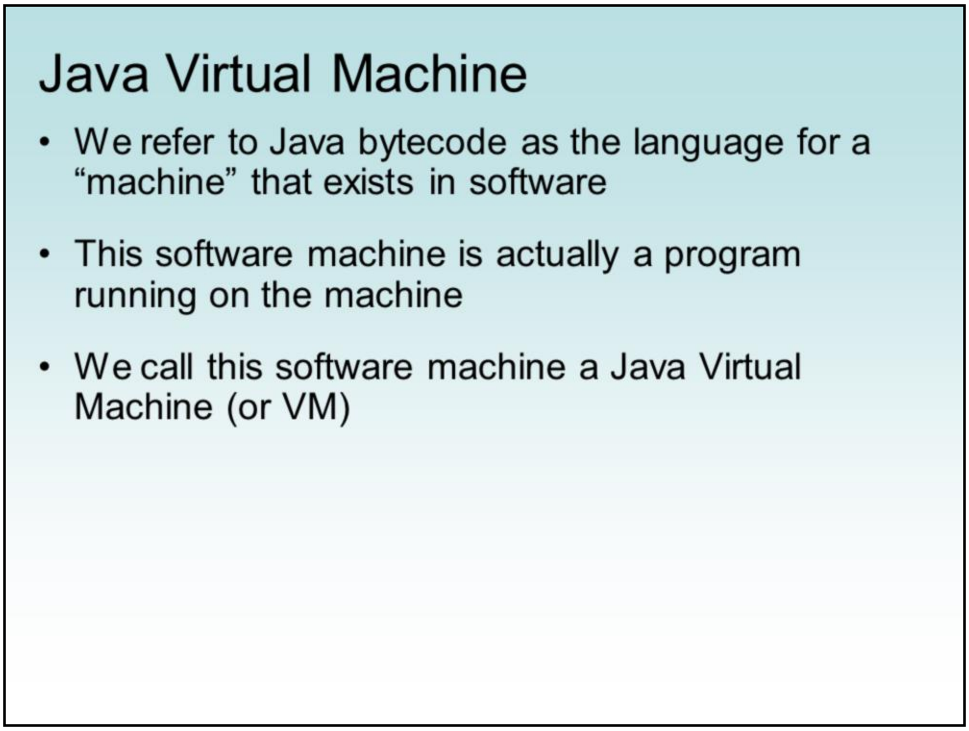
-**Compilers** translate the **entire** program into machine language

-**Interpreters** (typically) translate **one statement** into machine language, execute it, then repeat



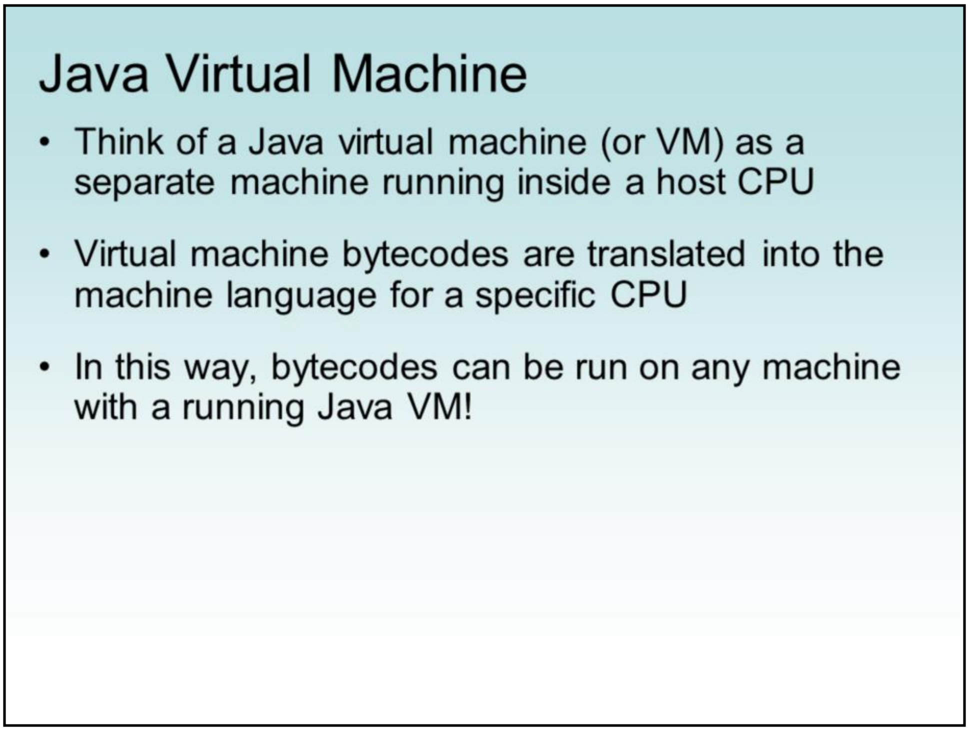
Java Translation

- The Java compiler translates Java source code into a special representation called *bytecode*
- Java bytecode is not the machine language for any traditional CPU
- Bytecode is executed by the *Java Virtual Machine* (JVM)
- Therefore the Java compiler is not tied to any particular machine
- Java is considered to be *architecture-neutral*



Java Virtual Machine

- We refer to Java bytecode as the language for a "machine" that exists in software
- This software machine is actually a program running on the machine
- We call this software machine a Java Virtual Machine (or VM)

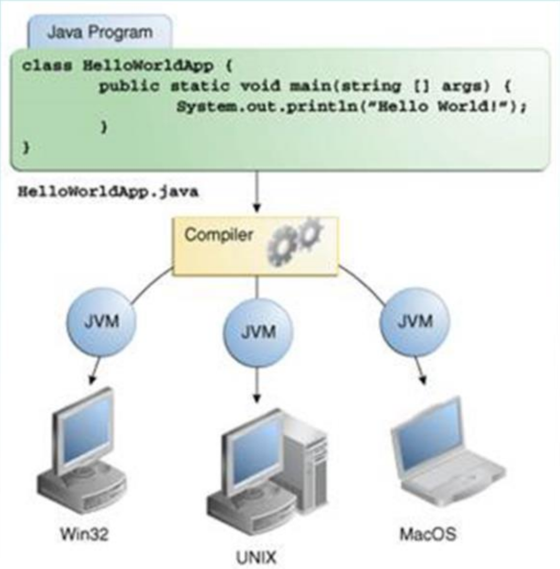


Java Virtual Machine

- Think of a Java virtual machine (or VM) as a separate machine running inside a host CPU
- Virtual machine bytecodes are translated into the machine language for a specific CPU
- In this way, bytecodes can be run on any machine with a running Java VM!

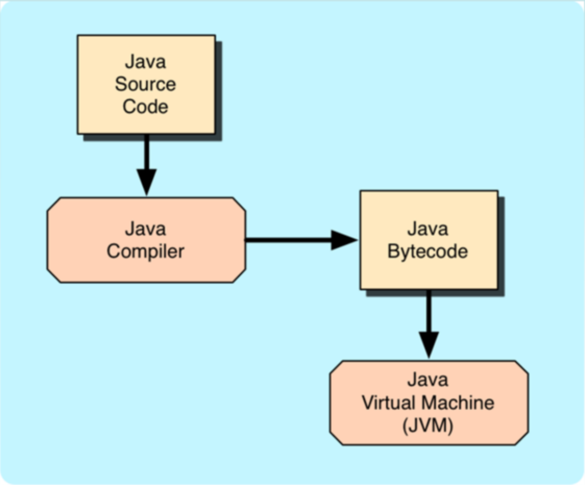
Java Virtual Machine

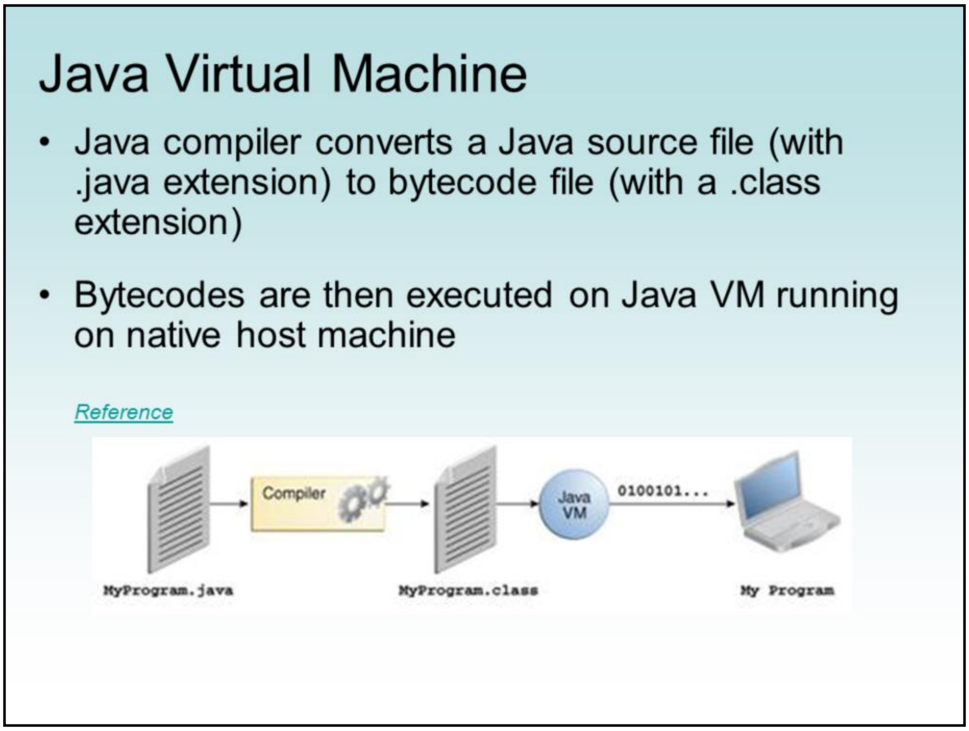
Reference



```
class HelloWorldApp {
        public static void main(string [] args) {
                System.out.println(“Hello World!”);
        }
}
```

Java Translation





Java Virtual Machine

- Java compiler converts a Java source file (with .java extension) to bytecode file (with a .class extension)
- Bytecodes are then executed on Java VM running on native host machine

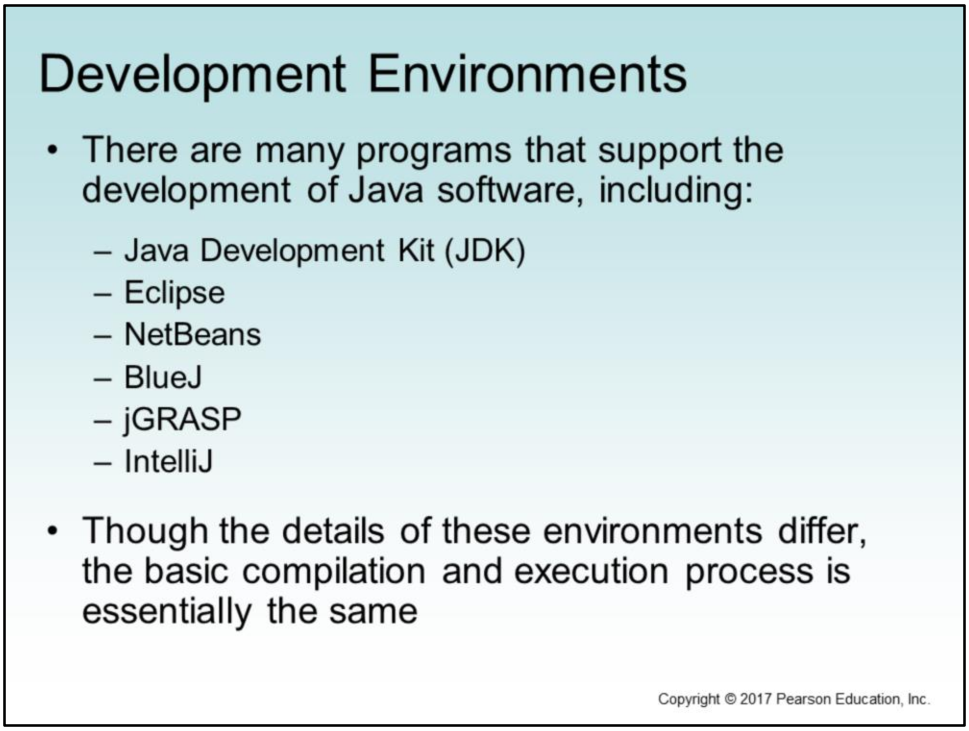
Reference

-Look in your Eclipse workspace directory for your first sample project or lab

-Note that Java source code is in a .java file in your **src** directory

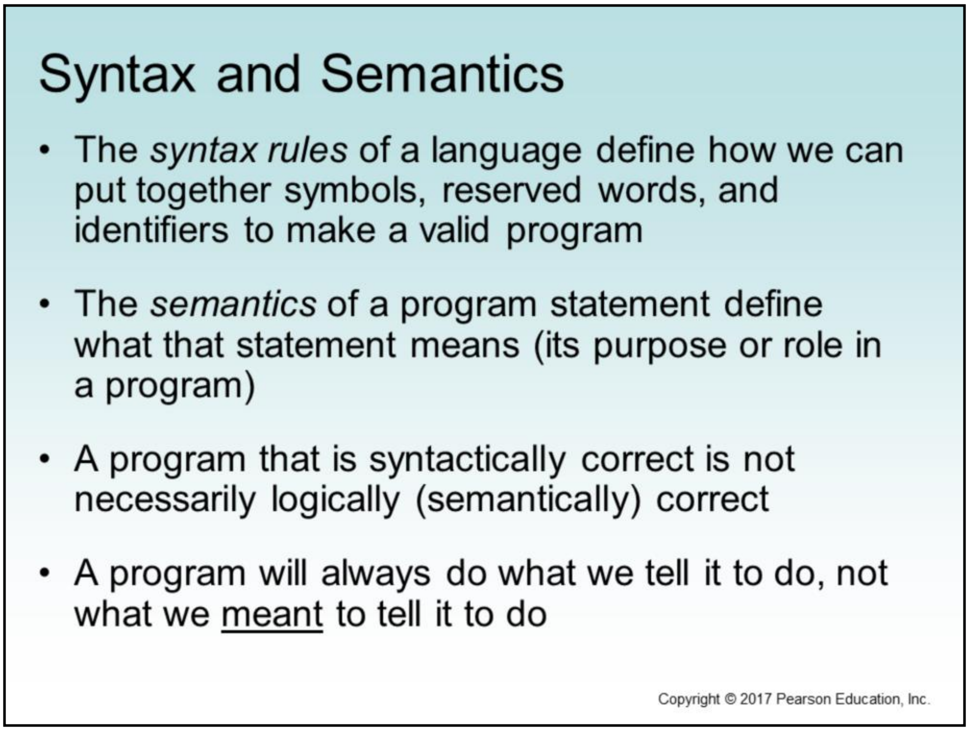
-Note that the compiled Java bytecode is in a .class file in your **bin** directory

-Java bytecodes can be ported to any machine running a Java virtual machine



Development Environments

- There are many programs that support the development of Java software, including:
  - Java Development Kit (JDK)
  - Eclipse
  - NetBeans
  - BlueJ
  - jGRASP
  - IntelliJ
- Though the details of these environments differ, the basic compilation and execution process is essentially the same



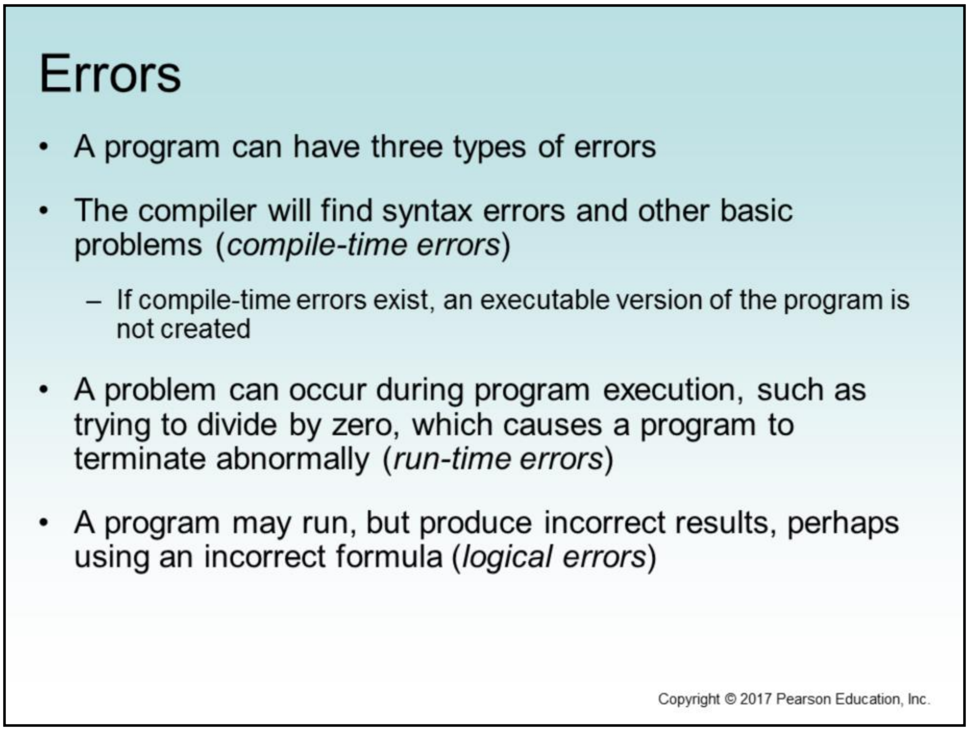
Syntax and Semantics

- The *syntax rules* of a language define how we can put together symbols, reserved words, and identifiers to make a valid program
- The *semantics* of a program statement define what that statement means (its purpose or role in a program)
- A program that is syntactically correct is not necessarily logically (semantically) correct
- A program will always do what we tell it to do, not what we <u>meant</u> to tell it to do

-Appendix I in textbook contains formal description of rules of language (syntax)

-When we write statements, we need to “think like the compiler”

-Try to interpret what the compiler will do when it sees a statement



Errors

- A program can have three types of errors
- The compiler will find syntax errors and other basic problems (*compile-time errors*)
  - If compile-time errors exist, an executable version of the program is not created
- A problem can occur during program execution, such as trying to divide by zero, which causes a program to terminate abnormally (*run-time errors*)
- A program may run, but produce incorrect results, perhaps using an incorrect formula (*logical errors*)

-Debugging: finding and correcting defects in a program

-As programmers, we must all learn to work hard at debugging our programs

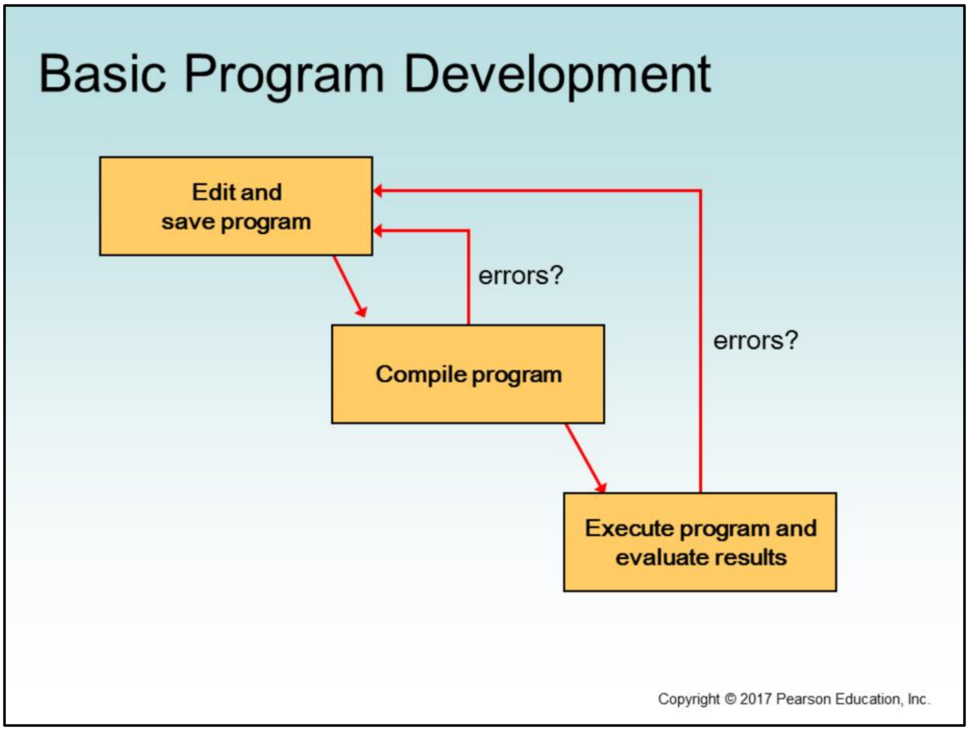
-When your program doesn’t work, don’t immediately give up

-Analyze your code line by line and examine what is happening

-This is part of what becoming a good software developer is all about!

-Instructor/CA will not debug your code for you, this is something you do!

-Instead, we may help direct you to the problem area



Basic Program Development

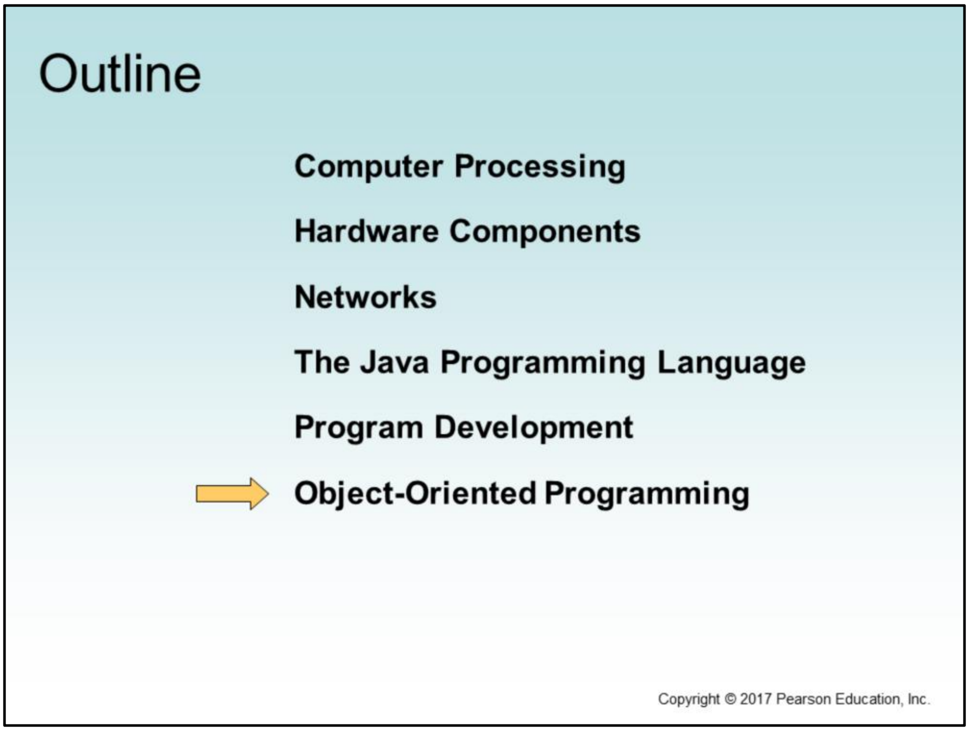
Edit and
save program

Compile program

Execute program and
evaluate results

errors?

errors?



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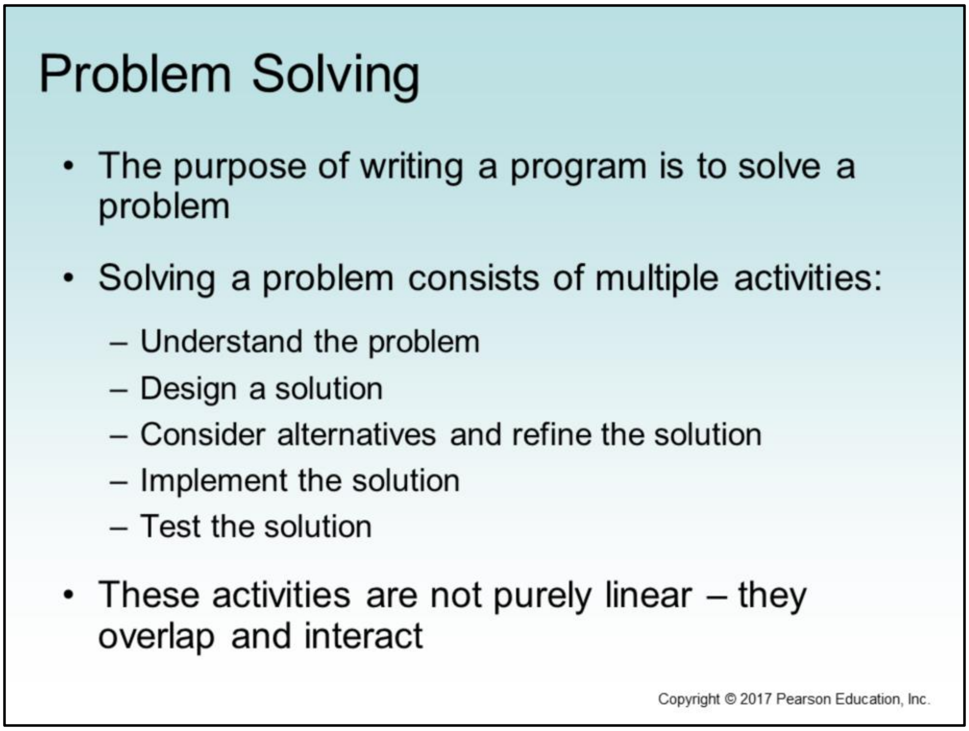
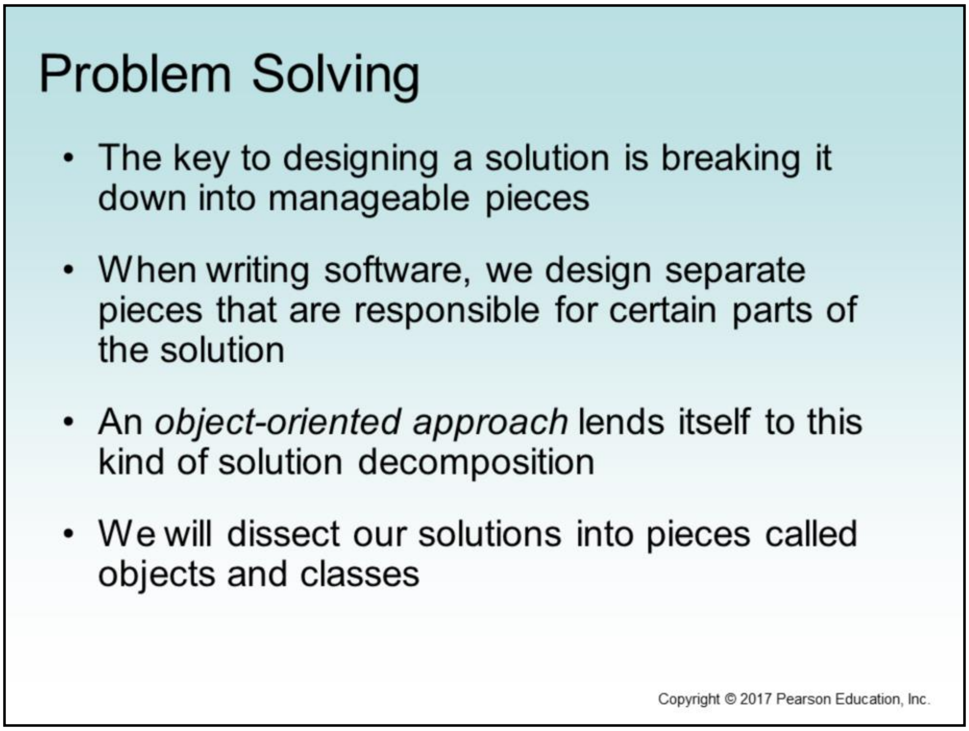
➡ Object-Oriented Programming



Problem Solving

- The purpose of writing a program is to solve a problem
- Solving a problem consists of multiple activities:
  - Understand the problem
  - Design a solution
  - Consider alternatives and refine the solution
  - Implement the solution
  - Test the solution
- These activities are not purely linear – they overlap and interact



Problem Solving

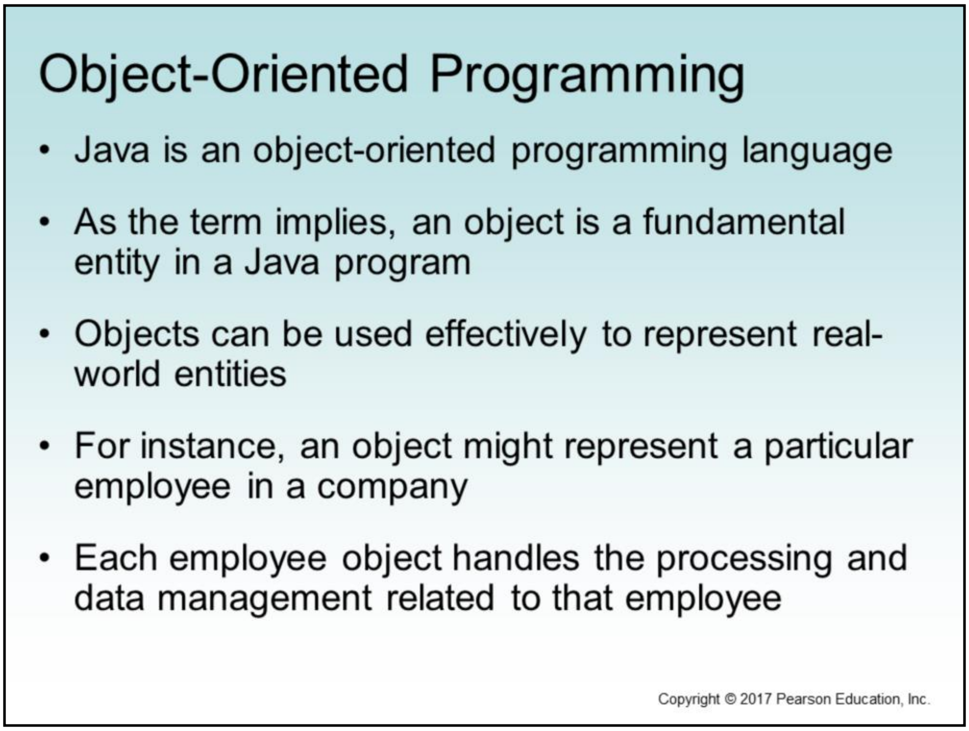
- The key to designing a solution is breaking it down into manageable pieces
- When writing software, we design separate pieces that are responsible for certain parts of the solution
- An *object-oriented approach* lends itself to this kind of solution decomposition
- We will dissect our solutions into pieces called objects and classes

-Our goal is to learn how to be software **designers** as well as programmers

-Software development is more about design than implementation

-We will learn how to design a solution to a problem using a certain method

-This method is based on **object-oriented** principles



Object-Oriented Programming

- Java is an object-oriented programming language
- As the term implies, an object is a fundamental entity in a Java program
- Objects can be used effectively to represent real-world entities
- For instance, an object might represent a particular employee in a company
- Each employee object handles the processing and data management related to that employee

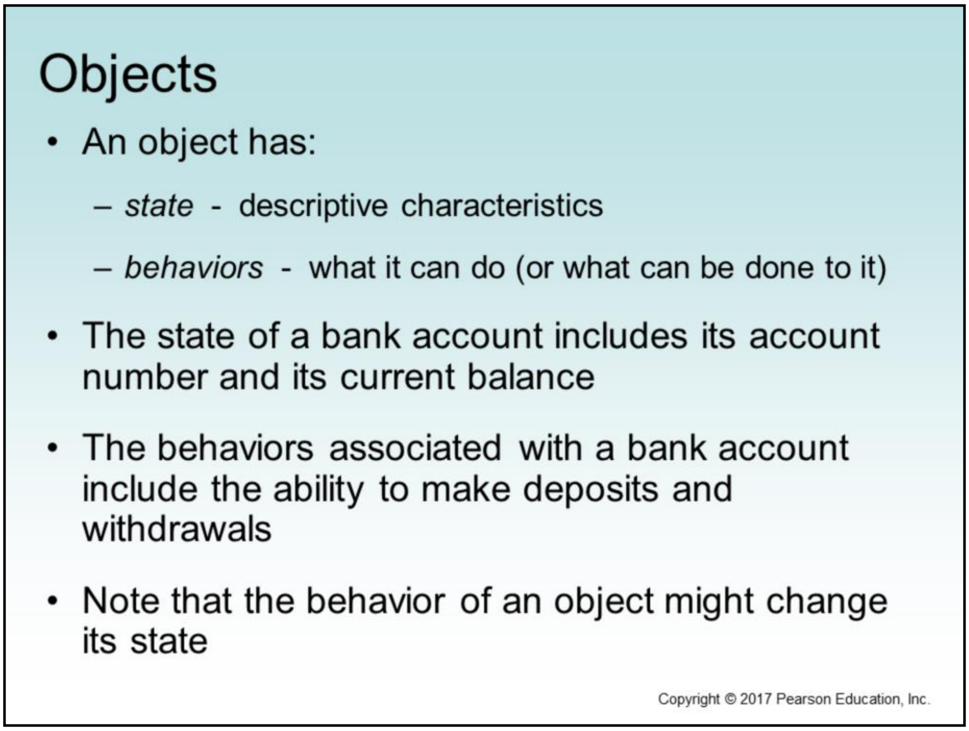
-We’ll learn how to look at a problem description and identify the **objects**

-Another term used for an object is a **data model**

-We’ll see that the objects in a problem description are typically the **nouns**

-Once identified, we’ll build software to describe these objects

-These are essentially the Java **classes** that we’ll use and write



Objects

- An object has:
  - *state* - descriptive characteristics
  - *behaviors* - what it can do (or what can be done to it)
- The state of a bank account includes its account number and its current balance
- The behaviors associated with a bank account include the ability to make deposits and withdrawals
- Note that the behavior of an object might change its state

-We'll design objects by what they "know" and what they "do"

-The object **state** is what it knows; The object **behaviors** are what they **do**

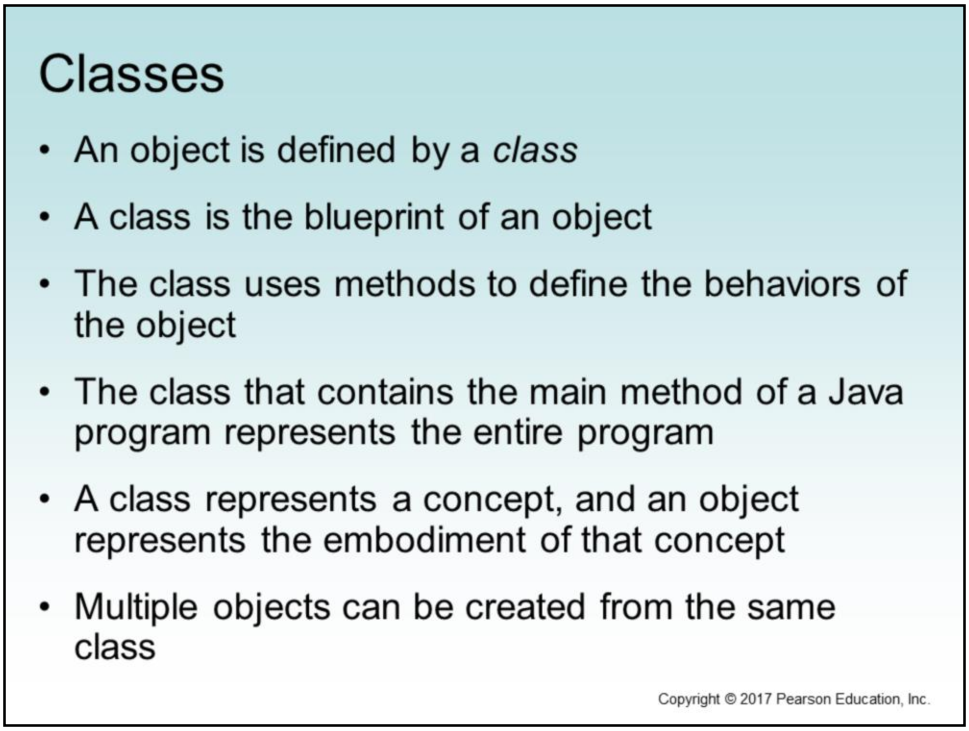
-The program is simply objects that interact with each other to solve the problem

-Consider, for example, a bowling scoring system

  -objects are the nouns (ball, pin, scorecard)

  -program consists of a ball, pins, and scorecard all interacting to compute the score

-Notice how we are thinking about the nouns (objects) to solve the problem



Classes

- An object is defined by a *class*
- A class is the blueprint of an object
- The class uses methods to define the behaviors of the object
- The class that contains the main method of a Java program represents the entire program
- A class represents a concept, and an object represents the embodiment of that concept
- Multiple objects can be created from the same class

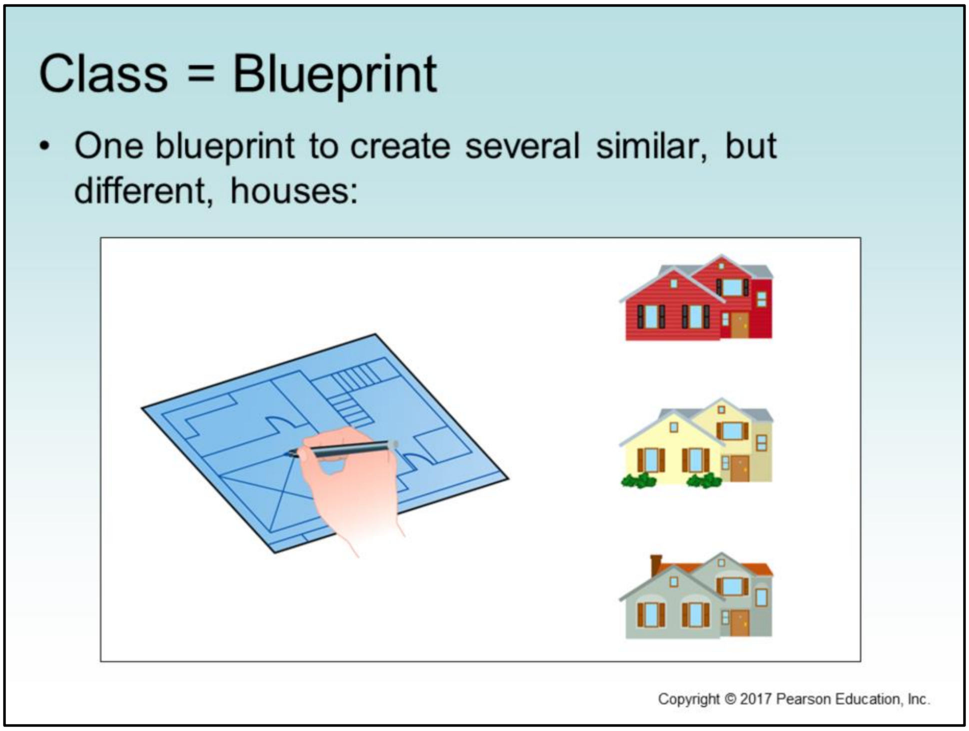
-We describe our object with a definition, similar to a blueprint, called a **class**

-The class defines how to create an actual object(s) we use in a program

-This is similar to how a blueprint is used to create an actual house

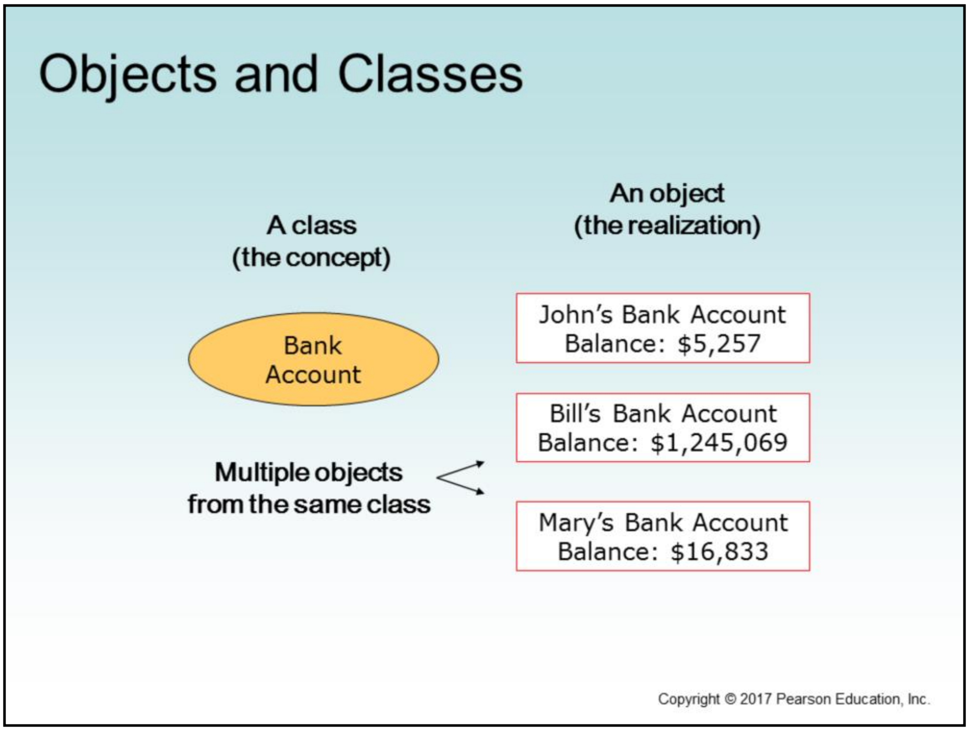
-The object actually “lives” in memory during a program

-The class is used by the CPU to describe how to build the object in memory



Class = Blueprint

- One blueprint to create several similar, but different, houses:



Objects and Classes

A class
(the concept)

An object
(the realization)

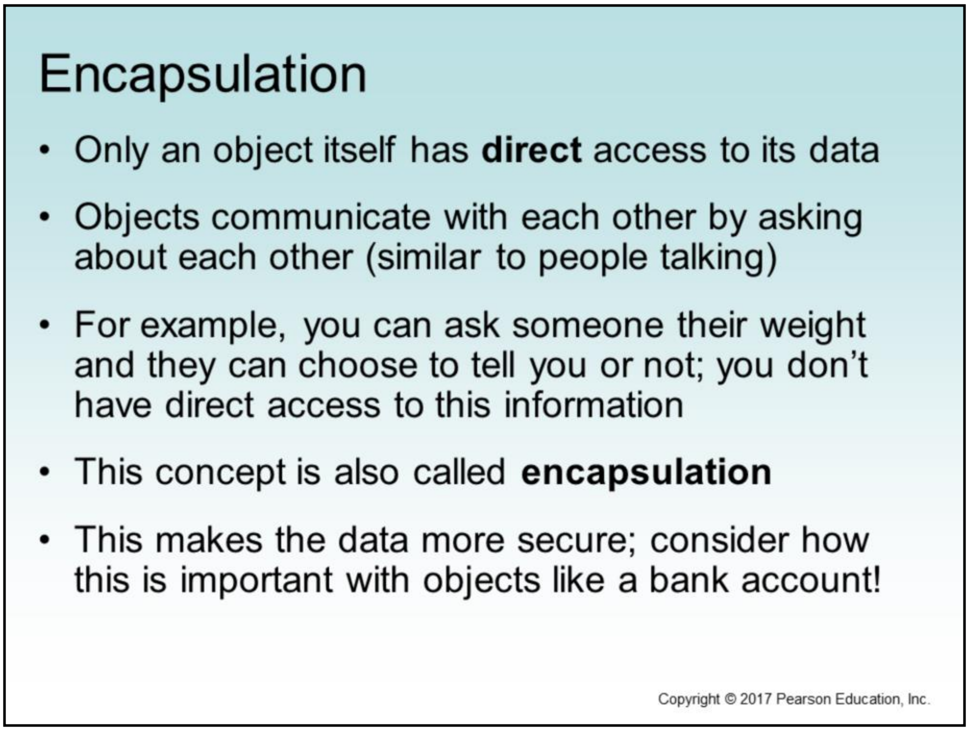
Bank
Account

John's Bank Account
Balance: $5,257

Bill's Bank Account
Balance: $1,245,069

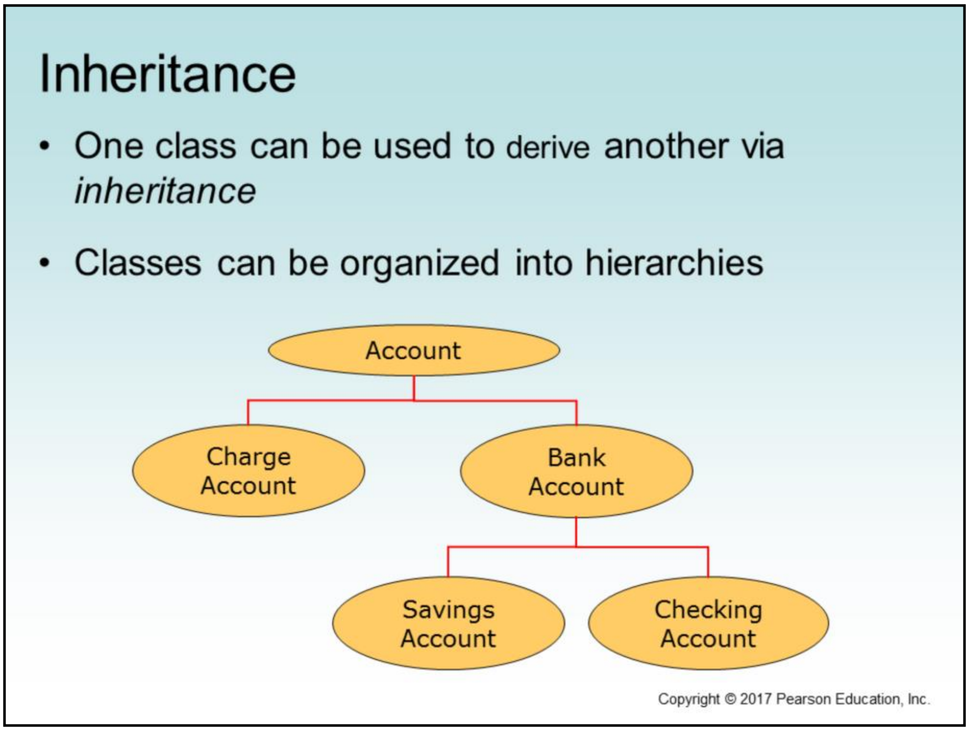
Mary's Bank Account
Balance: $16,833

Multiple objects
from the same class



Encapsulation

- Only an object itself has **direct** access to its data
- Objects communicate with each other by asking about each other (similar to people talking)
- For example, you can ask someone their weight and they can choose to tell you or not; you don’t have direct access to this information
- This concept is also called **encapsulation**
- This makes the data more secure; consider how this is important with objects like a bank account!



Inheritance

- One class can be used to derive another via *inheritance*
- Classes can be organized into hierarchies

-Inheritance mimics the real-world; consider designing classes representing animals

-different **types of** animals; dogs, cats, horses

-different **types of** dogs, cats, horses

-Inheritance allows us to categorize and organize classes into hierarchies

-By deriving one class from another, we can reuse definitions

-**Reusability** is an important aspect in designing effective software

-**Polymorphism**: different objects respond differently using the same method name

-We'll be studying these concepts in detail as we begin designing our own classes