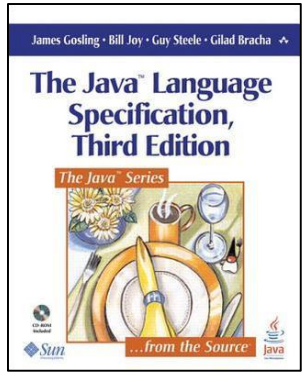
Day 1

What is Java?

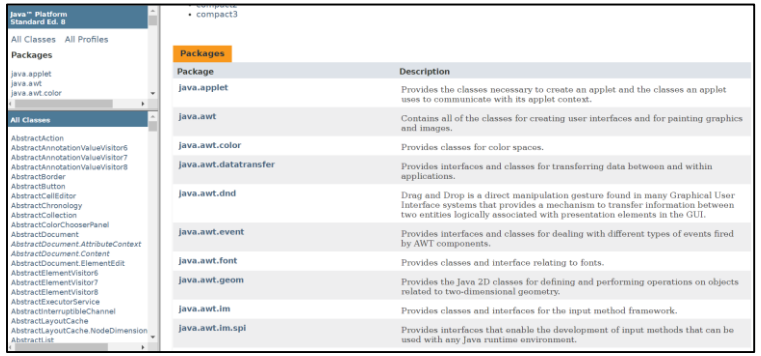
- Java is a platform developed by Sun Microsystems in the early 90's
- Was released in May 23 1995
- Claim to fame
  - Application are operating system independent - "Write Once, Run Everywhere"
  - Able to write program for different platforms, from microchip, mobile phone, PC, servers
- Originally Java came in 3 'flavours'
  - Java ME - Java Micro Edition
  - Java SE - Java Standard Edition
  - Java EE - Java Enterprise Edition

Java Components



Java Programming Panguage

Java Class Libraries



Java Virtual Machine

Java Development Kit

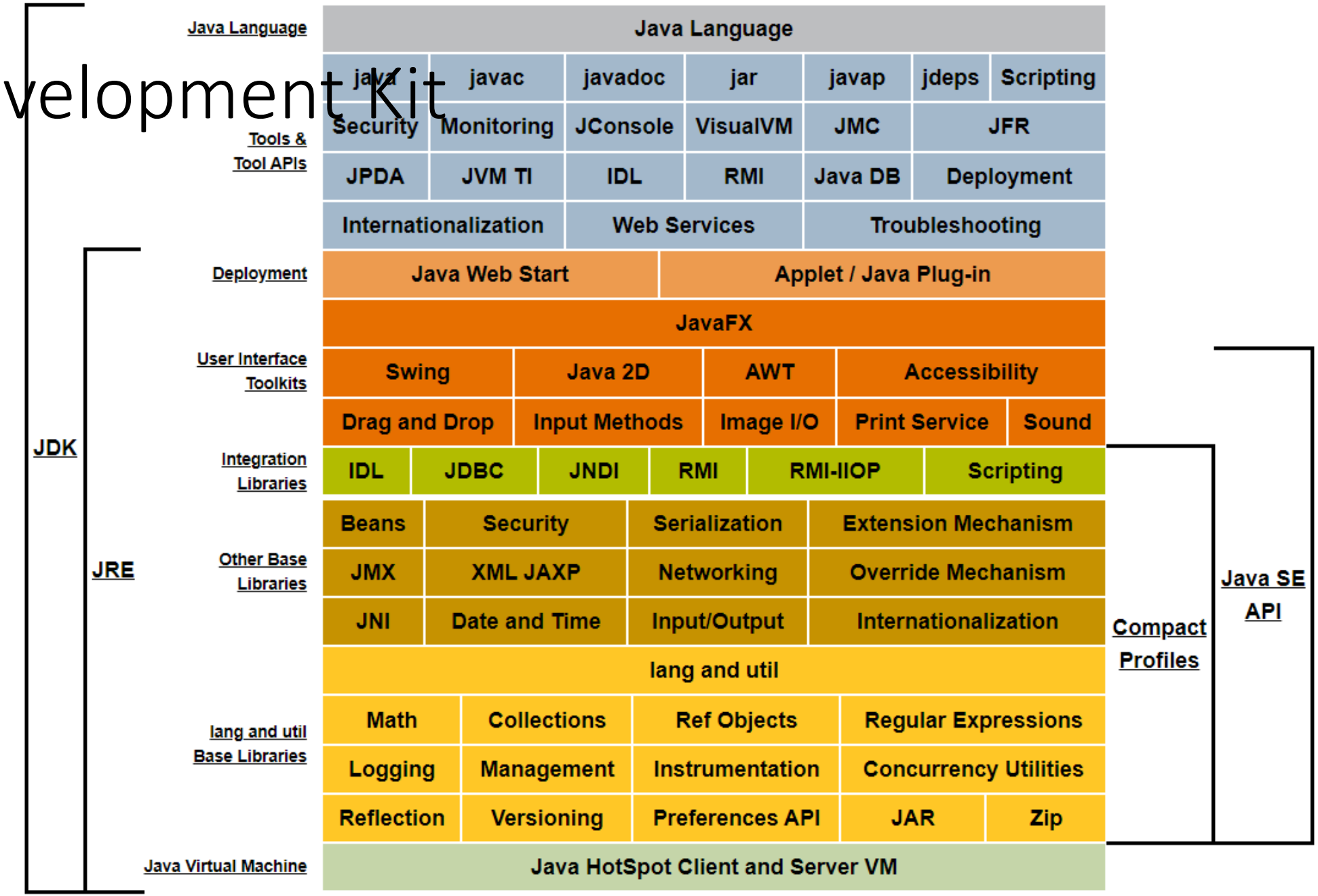
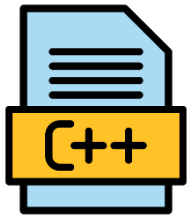


Image from https://docs.oracle.com/javase/8/docs/index.html

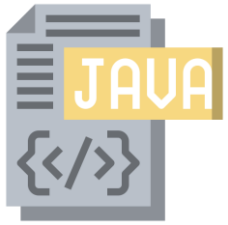
Portable

Source code



Compiler

Executable



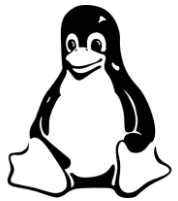
Source code

Compiler

Class File

Java Virtual Machine

Operating System



Evolution of the JDK

Jun 1991
Gosling, Sheridan and Naughton started development of new programming language with the name 'Oak'

Jun 1991
Initially named as **Oak** when they discussed under Oak tree near Gosling's office

Jul 1991
Later it was named as **Green** and then as **Java** to remind their favourite Java Coffee from Indonesia.

1995
JavaSoft was taken over by Sun Microsystems and announced the release of Java soon.

Jan 23, 1996
Sun Microsystems released first official Java 1.0

Feb, 1997
First stable release of Java as Dev Kit (1.1) released. Arthur van Hoff rewritten Java 1.0 compiler using Java itself.

1998
Java 1.2 released as J2SE along with Swing graphical API library with codename **PlayArea**

2000
Java 1.3 released with JVM, JNDI with code name KESTRAL

2002
Java 1.4 with Regexp release with codename **Merlin**

2004
Java 1.5 (J2SE 1.5) released with most of standard features in core libraries (lang, util) like Generics

2006
Multiple variants of Java released as J2SE, J2ME, J2EE with codename **Mustang**

Nov, 2006
JVM officially released as free/OpenSource under GNU GPL License.

Java
Sun Microsystems

Java became multi-faceted releases with from Jrocket, IBM, OpenJDK

Java
ORACLE

2011
J2SE 7 released with codename **Dolphin** with dynamic language, string optimization and GC optimization

2014
J2SE 8 released with Major changes like Lambda and datetime API

March, 2018
J2SE 10 released with memory features like Heap allocation and Thread local

March, 2019
J2SE 12 released with Shenandoah GC, Switch Expressions, JVM Constants API

March 2020
J2SE 14 released with Incubator, JFR Event Streaming, Java Records

2017
J2SE 9 released with codename **Jigsaw** with features like Streaming API, JShell, improved features in Collections API

Sept, 2018
J2SE 11 released with Epsilon GC, Heap profiling and improved features of Lambda.

Sept, 2019
J2SE 13 released with Text Blocks, Improved File IO API, Socket API

Sept 2020
J2SE 15 released with Z GC, preview of sealed class, hidden classes.

Image from https://dzone.com/articles/why-java-is-so-young-after-25-years-an-architects

Hello World

Directory name must be the same as package name

File name must be the same as class name
One class per file

```
myapp/HelloWorld.java

package myapp;

import java.lang.*;

public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("hello, world");
    }
}
```

The package name that this class belongs to

List of classes from other packages

Class name

Program entry point. This is the method that the JVM will invoke to start the program

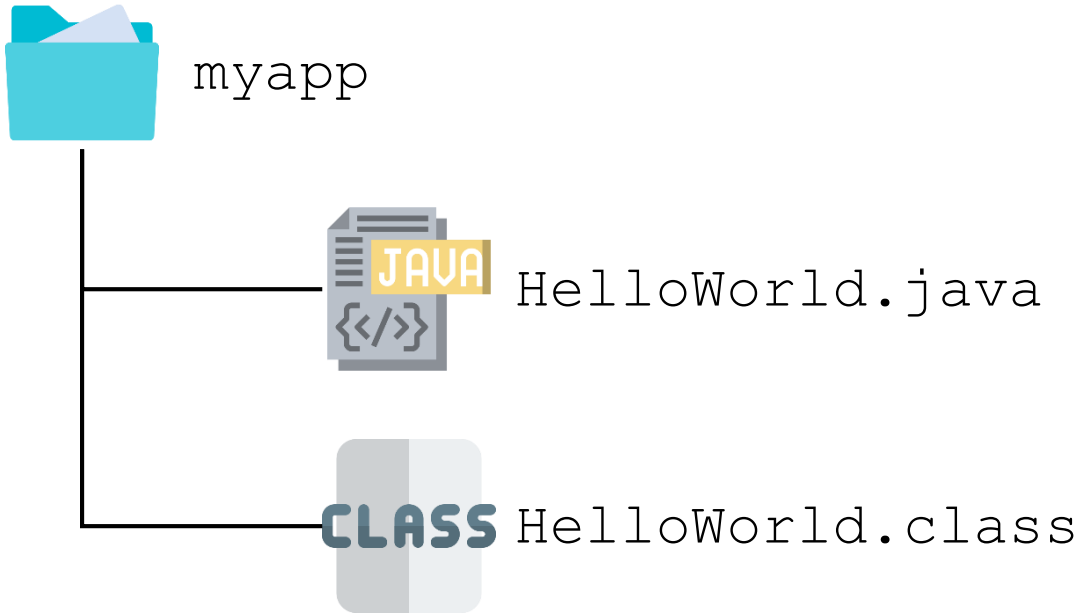
`System` class from `java.lang` package

Java statements are terminated with a semi-colon

Compile

```
javac myapp/HelloWorld.java
```

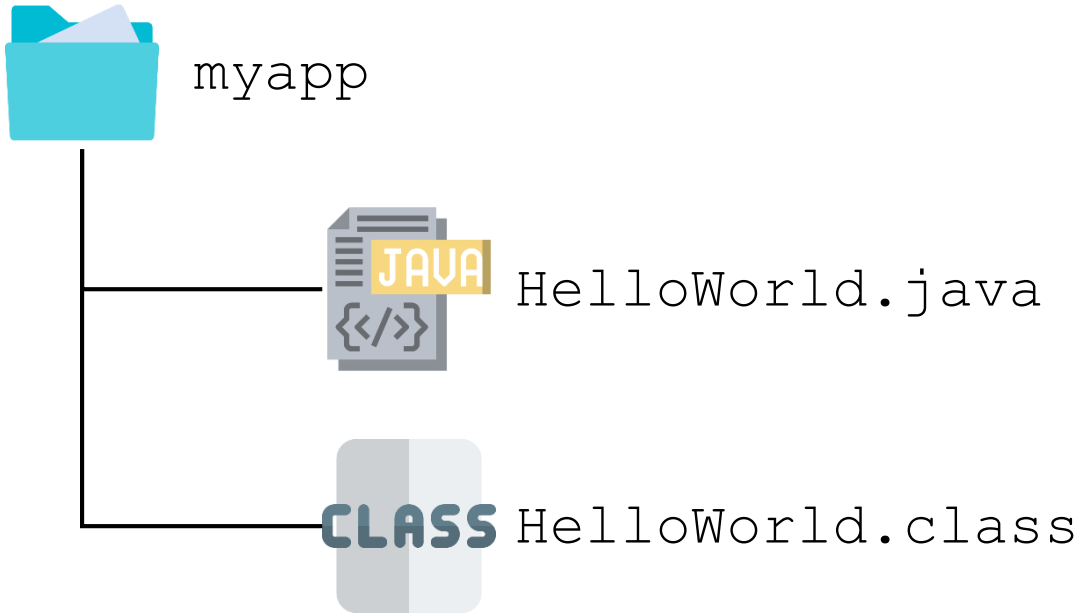
- `javac` is the Java compiler
- Will produce a `.class` file `HelloWorld.class` in `myapp`



Run

```
java myapp.HelloWorld
```

- `java` starts the Java Virtual Machine (JVM)
- `myapp.HelloWorld` is the fully qualified class name
- JVM will look for a class file called `HelloWorld.class` under `myapp` directory
  - Will scan the list of directories set by the `CLASSPATH` environment variable



CLASSPATH

```
java myapp.HelloWorld
```

- Environment variable that indicate to the JVM where to look for Java classes
- One or more directories separated by
  - : (colon) - Linux / OSX
  - ; (semicolon) - Windows

```
export CLASSPATH="/opt/java/classes:."
```

CLASSPATH

```
export CLASSPATH="/opt/java/classes:./classes:."

java myapp.HelloWorld
```

The JVM

Search the following locations

```
/opt/java/classes/myapp/HelloWorld.class
./classes/myapp/HelloWorld.class
./myapp/HelloWorld.class
```

- Environment variable that indicate to the JVM where to look for Java classes
- One or more directories separated by
  - : (colon) - Linux / OSX
  - ; (semicolon) - Windows

Packaging Java Applications

- Java applications are packaged and delivered as a JAR (Java Archive) file
- Package all the class files into a JAR with the jar

JAR all files and directories in the current directory

Create JAR

JAR tool

```
jar -c -v -f myapp.jar -e myapp.HelloWorld .
```

JAR file name

The main class

- Execute the JAR

Run the main class in `myapp.jar`

```
java -jar myapp.jar
```

- Maven, build tool can automate this process

Java Data Types

- Primitive type
  - `boolean`
  - `char` - character
  - `byte` (8), `short` (16), `int` (32), `long` (64) - integers of different sizes
  - `float` (32), `double` (64) - floating point
  - `String` - a string of character, Java treats String as a primitive type
- Class equivalent of primitive types, can be used interchangeably
  - `Boolean`
  - `Character`
  - `Byte`, `Short`, `Integer`, `Long`
  - `Float`, `Double`
  - `String`
  - Java automatically autobox (converts) between primitive and their equivalent classes

Example

```
import java.io.Console;

public class Main {
    public static void main(String[] args) {

        Console cons = System.console();

        String name = cons.readLine("What is your name? ");

        System.out.printf("Hello %s. Please to meet you.\n", name);
    }
}
```

Get the console. This program can only run from terminal

Display the prompt; read a line of text until the new line is pressed

Formatted print

Substitute the value in name variable as `String` in the position indicated by `%s`

Boolean Expression

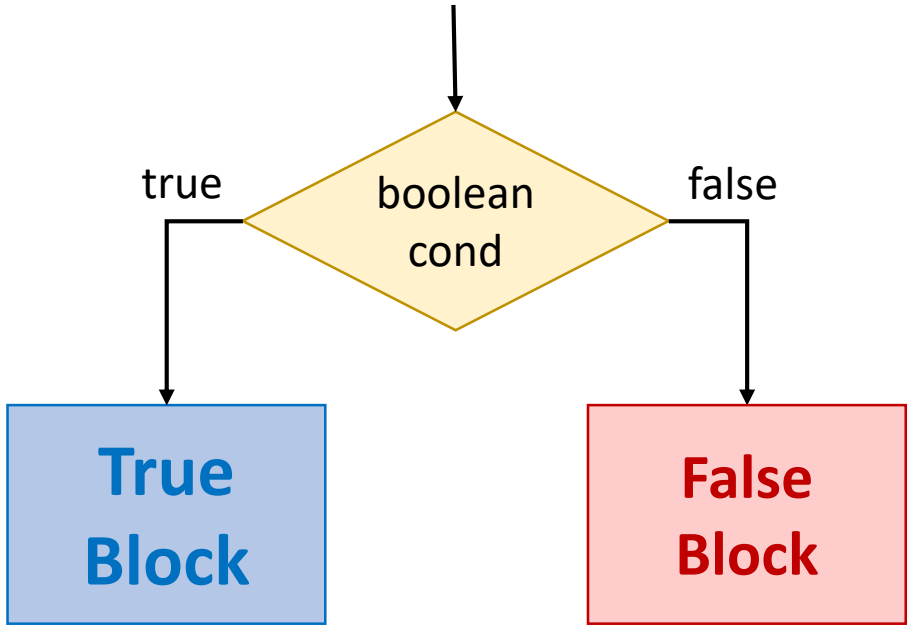
Relational Operators

- == Equality
- != Not equals
- > Greater than
- >= Greater than or equals to
- < Less than
- <= Less than or equals to

Boolean Operators

- || Or
- && And
- ! Not

If Statement




```
String name = cons.readLine("What is your name? ");
if (name.length() > 0) {
    System.out.printf("Hello %s\n", name);
} else {
    System.err.println(
        "You have not told me your name");
}
```

Else is optional

All statements between the **{ }** belongs to that branch of the condition

Example - If Statement

```
String input = cons.readLine("What is your hobby? ");
input = input.trim();

if (input.equals("swim"))
    System.out.println("The nearest public swimming pool is in Clementi");

else if (input.equals("jog"))
    System.out.println("How fast can you jog a kilometer?");

else if (input.equals("code"))
    System.out.println("Cool!");

else
    System.out.println("What is this %s hobby of yours?", input);
```

`trim()` removes the white spaces surrounding a string

`String` equality. Do not use `==`

Do not need `{ }` if it is just a single line

Example - Switch Statement

```
String input = cons.readLine("What is your hobby? ");

switch (input.trim().toLowerCase()) {
    case "swim": // input.equals("swim")
        System.out.println("The nearest public swimming pool is in Clementi");
        break;

    case "jog": // input.equals("jog")
        System.out.println("How fast can you jog a kilometer?");
        break;

    case "code": // input.equals("code")
        System.out.println("Cool!");
        break;

    default:
        System.out.println("What is this %s hobby of yours?", input);
}
```

Where possible, good to covert string to either lower or upper case before comparison

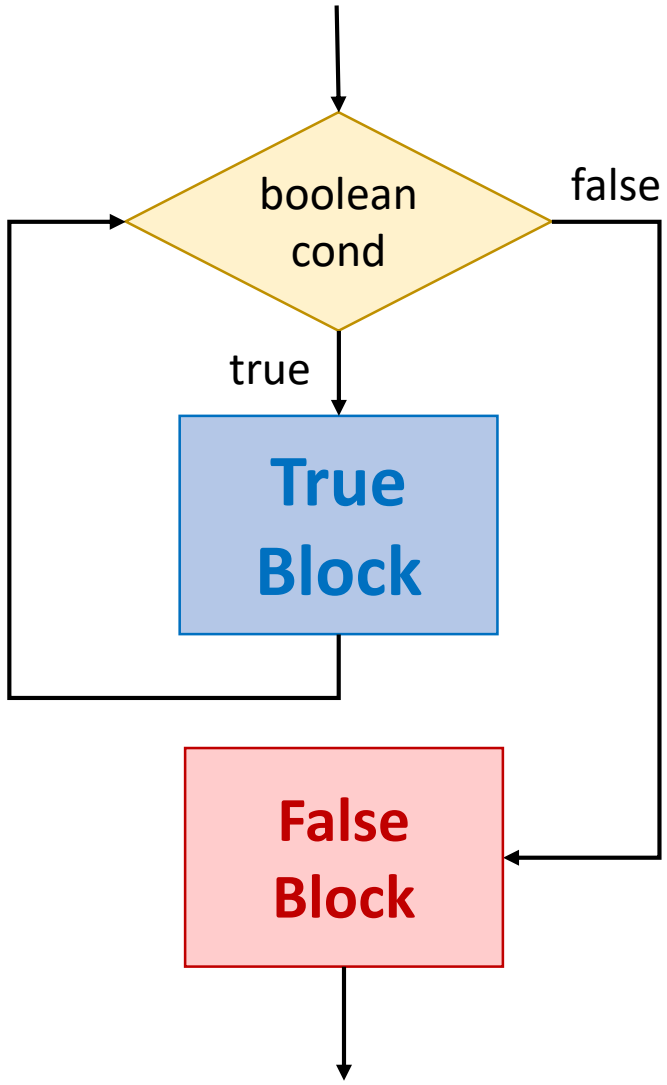
Use `switch` when the if statement is multi branch comparison

`break` exits the switch statement.
Otherwise will fallthru to the next case

Example - If Statement

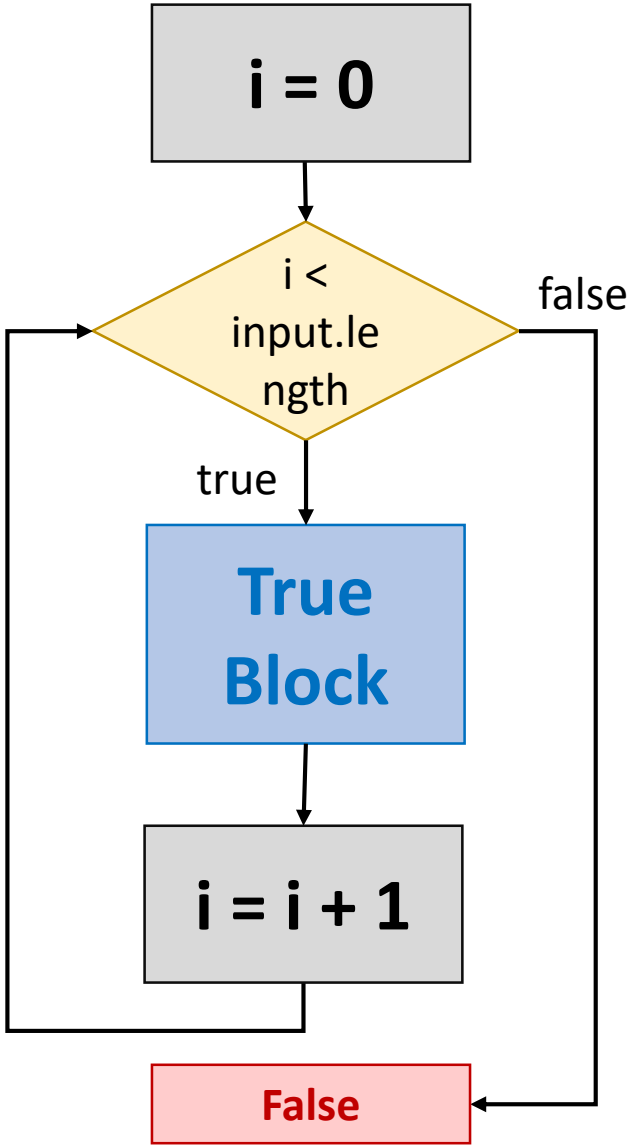
```
String input = cons.readLine("What is your age? ");
Integer age = Ingeger.parseInt(input);
if (age <= 0)
    System.err.println("Are you sure?");

else if ((age > 0) && (age < 7))
    System.out.println("You are a toddler");

else if ((age >= 7) && (age < 12))
    System.out.println("You are a child");

else if ((age >= 12) && (age < 18))
    System.out.println("You are a teen");

else
    System.out.println("You are an adult");
```

While Loop




```
String name = "";

while (name.length() <= 0) {
    name = cons.readLine("What is your name? ");
    name = name.trim();
}

System.out.printf("Hello %s\n", name);
```

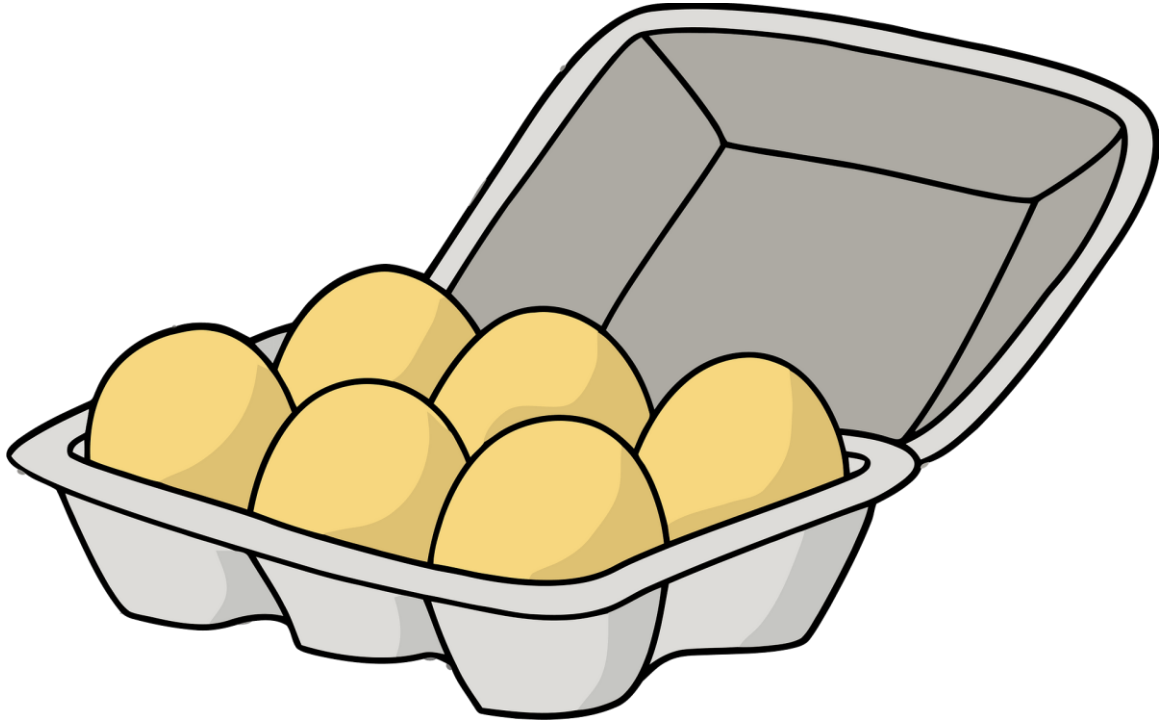
While Loop




```
String input = cons.readLine("Type a phrase: ");
for (int i = 0; i < input.length(); i++)
    System.out.println(input.substring(0, i));
```

Array

- A variable that can store more than 1 value
- The values are indexed from 0
- Arrays have fixed size
  - Need to provide the size when the array is created
- Arrays have a length property
  - The size of the array



Example - Array

[ ] indicates that this is an array

Instantiate an array of type `String` with the `new` keyword
5 values in `todo`: `todo[0]`, `todo[1]`, .. `todo[4]`

```
Console cons = System.console();

String[] todo = new String[5];

for (int i = 0; i < todo.length; i++) {
    String task = cons.readLine("Enter task %d: ", (i + 1));
    todo[i] = task;
}

for (int i = 0; i < todo.length; i++)
    System.out.println(todo[i]);
```

length property give the size/capacity of the array

Assign a value into one of element in the array

Retrieve a value from the array indexed by i

Command Line Arguments

Java program entry point

Arguments are passed in via the array. Array will be empty if no command line arguments

```
public class HelloWorld {

    public static void main(String[] args) {
        String name = "fred";
        if (args.length > 0)
            name = args[0];
        System.out.printf("Hello %s\n", name);
    }
}
```

```
java -jar hello.jar fred flintstone
```

```
args[ "fred", "flintstone" ]
```

```
java -jar hello.jar "fred flintstone"
```

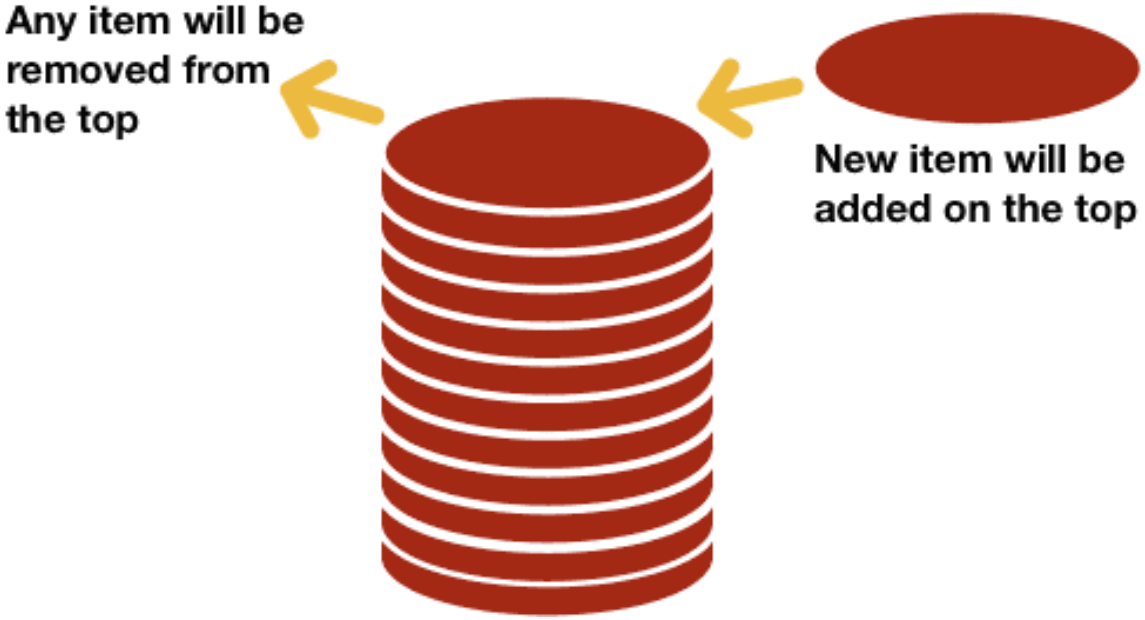
```
args[ "fred flintstone" ]
```

List

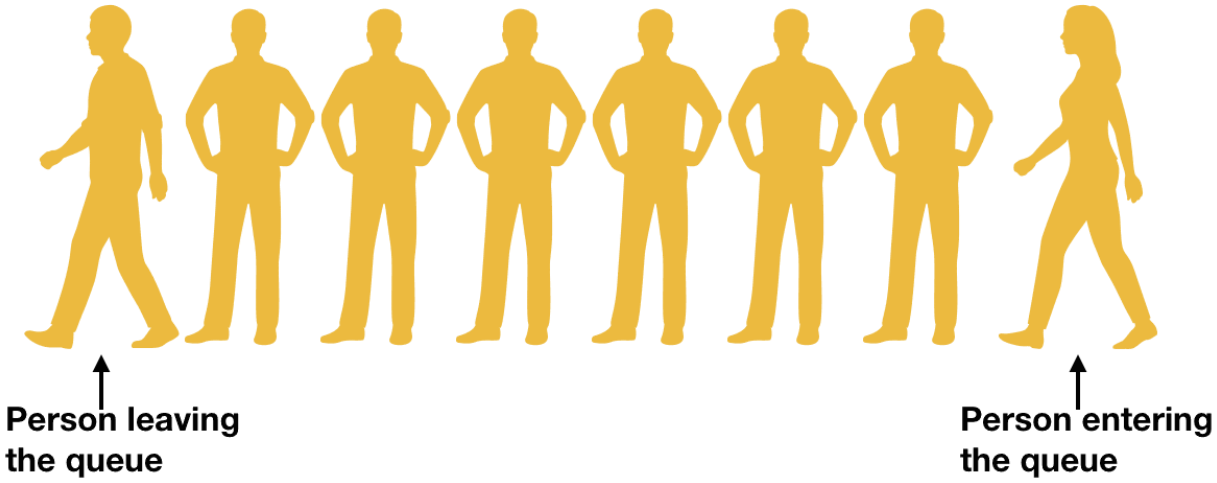
- Items can be added and removed from any where in a list
- Item will remain in the positon where it is inserted
- Can add duplicate items to a list
- Items are numbered
- Some list have fixed size
- Array is a form of list

Stack

- Items can only be added to the top and removed from the top
  - Last In First Out
- Cannot access to other items from a stack except the top item
- Push - adding an item to a stack
- Pop - remove an item from a stack
- Allow duplicate



Queues



- Item are added to the back of a queue and removed from the front
  - First In First Out
- Queues preserve the arrival order of the items
- Enqueue - add an item to a queue
- Dequeue - remove an item from a queue
- Allow duplicates

Maps

- Like a list except elements are accessed with a key instead of a numerical index
- Keys have to be unique, but can have duplicate values
- Also know as dictionary

plumber /ˈplʌmə(r)/ *n* [C] person whose job is to fit and repair water pipes

plumbing /ˈplʌmɪŋ/ *n* [U] **1** system of water pipes, tanks, etc in a building **2** work of a plumber

plume /pluːm/ *n* [C] **1** cloud of sth that rises into the air **2** large feather

plummet /ˈplʌmɪt/ *v* [I] fall suddenly and quickly from a high level: *House prices have ~ed.*

plump /plʌmp/ *adj* having a soft, round body; slightly fat ● **plump** *v* [T] **~ (up)** make sth larger, softer and rounder: *~ up the pillows* [PV] **plump for sb/sth** (*infml*) choose sb/sth ▶ **plumpness** *n* [U]

plunder /ˈplʌndə(r)/ *v* [I,T] steal things from a place, esp during a war ● **plunder** *n* [U] **1** act of plundering **2** things that have been stolen, esp during a war

plunge /plʌndʒ/ *v* [I,T] (cause sb/sth to) move suddenly forwards and/or downwards: *The car ~d into the river.* ◇ *He ~d his hands into his pockets.* ● **plunge** *n* [C, usu sing] sudden movement downwards or away from sth; decrease [IDM] **take the plunge** (*infml*) finally decide to do sth important or difficult ▶ **plunger** *n* [C] part of a piece of equipment that can be pushed down

pluperfect /ˌpluːˈpɜːfɪkt/ *n* (*gram*) = THE PAST PERFECT (PAST[1])

plural /ˈplʊərəl/ *n* [usu sing] *adj*

p.m. /ˌpiː ˈem/ *abbr* after 12 o'clock noon

pneumatic /njuːˈmætɪk/ *adj* **1** filled with air: *a ~ tyre* **2** worked by air under pressure: *a ~ drill* ▶ **pneumatically** /-kli/ *adv*

pneumonia /njuːˈməʊniə/ *n* [U] serious illness affecting the lungs

PO /ˌpiː ˈəʊ/ *abbr* **1** = POST OFFICE (POST[1]) **2** = POSTAL ORDER (POSTAL) ■ **P'O box** (*also* **post office box**) *n* [C] used as a kind of address, so that mail can be sent to a post office where it is kept until it is collected

poach /pəʊtʃ/ *v* **1** [T] cook fish or an egg without its shell in water that is boiling gently **2** [I,T] illegally hunt animals, birds or fish on sb else's property **3** [T] take from sb/sth dishonestly; steal sth ▶ **poacher** *n* [C] person who illegally hunts animals, birds or fish on sb else's property

pocket /ˈpɒkɪt/ *n* [C] **1** small bag sewn into a piece of clothing so that you can carry things in it **2** small bag or container fastened to sth so that you can put things in it, eg in a car door or handbag **3** [usu sing] amount of money that you have to spend: *He had no intention of paying out of his own ~.* **4** small separate group or area [IDM] **in/out of pocket** (*esp GB*) having gained/lost money as a result of sth ● **pocket** *v* [T] **1** put sth into your pocket **2** keep or take

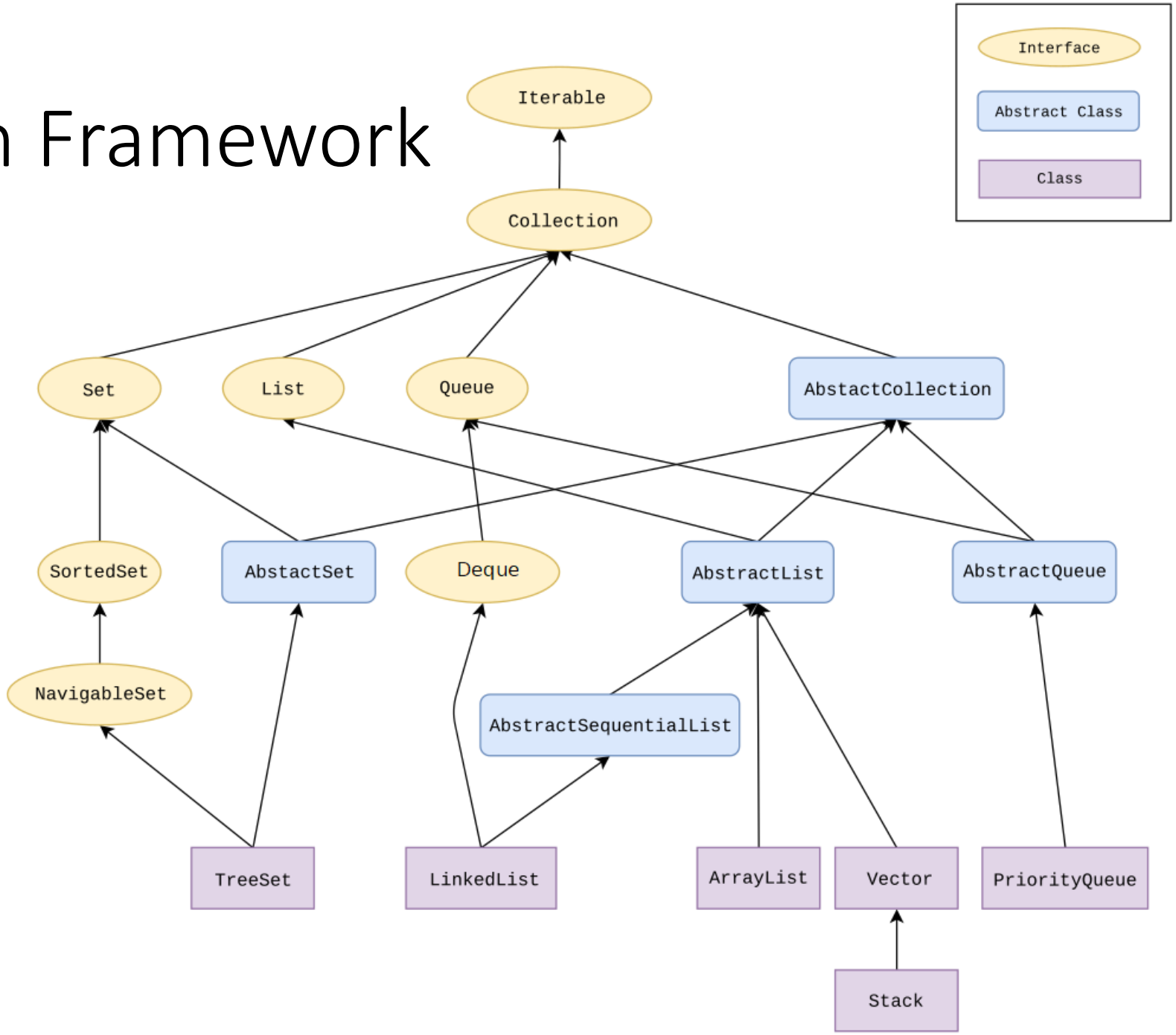
Set

- Only store unique values, no duplicates
  - Duplicates will be removed
- Items in a set are not ordered

Collection Framework

- Array is a data structure for storing multiple values
  - Most programming languages support array
- Arrays are quite restrictive
  - Cannot dynamically grow or shrink
  - Have to manually implement features in set, map, stack, etc.
- Collection framework is a standard library that implements many common data structures
  - Stack, Queue, Set, List, Map
- There are many different implementation of a data structure
  - Eg `List` - `ArrayList`, `LinkedList`, `CopyOnWriteArrayList`
  - Select different implementation based on runtime characteristics of the list
  - Property of the data structure remains unchanged

Collection Framework



Not exhaustive

Example - List

<String> is a List of String

Instantiate a list of string. Use the linked list implementation of list

```
Console cons = System.console();

List<String> myTodo = new LinkedList<>();
String input = "";

while (!"stop".equals(input)) {
   input = cons.readLine("? ");

   if (!"stop".equals(input))
      myTodo.add(input);
}
```

Insert into the list from the end

Example - Loop a Collection

Number of elements in the list

```
for (int i = 0; i < myList.size(); i++)
   System.out.printf("%d: %s\n", i, myList.get(i));
```

Get the ith element. The value will be of type String because type parameter (`<String>`) of the list is String

Each iteration, item will get one element from `myList`

```
for (String item: myList)
   System.out.printf("%s\n", item);
```

Special for loop for collections or any class that implements `Iterable`
Useful if you don't require the index

Example - Scanner

Monday **go for a jog**

`scan.next()` `scan.nextLine()`

Read/scan from input

```
Scanner scan = new Scanner(System.in);
String day = scan.next();
String description = scan.nextLine();
```

Example - Todo

Create a map where the key and the value are `String`

```
Map<String, String> todos = new HashMap<>();
String day = "";
String todo = "";

Scanner scan = new Scanner(System.in);

while (!"stop".equals(day)) {
    day = scan.next().toLowerCase();
    todo = scan.nextLine().trim();

    if ("stop".equals(day))
        break;

    todos.put(day, todo);
}
```

Exits the loop

Use the day as the key

Example - Todo

Return the keys as a Set

```
for (String day: todos.keySet())
   System.out.printf("%s: %s\n", day, todos.get(day))
```

Use the key (day) to access the value