

Java & Linux

Building blocks of Hadoop

Apache Hadoop

- Open source platform built on two technologies
 - Written in Java programming language.
 - Runs on Linux operating system

Java

Storing, analysing and processing large data sets.

Installing and Configuring Java and Eclipse

- Java
 - Available for Windows / Linux / MacOS etc
 - Download from <http://www.oracle.com/>
- Eclipse
 - Integrated Development Environment (IDE) which is used for building applications in languages like Java, C, C++, C#, etc
 - Available for Windows / Linux / MacOS etc
 - Download from <http://www.eclipse.org/downloads/eclipse-packages/>

How much Java to learn?

Since Hadoop is written in Java, this knowledge of Java basics is essential to learn Hadoop

- Class & Object
- Variables & Data Types
- Arrays
- Inheritance & Interfaces
- Control Flows
- Exception Handling
- Serialization & Deserialization

Class & Object

Class

Class is a blueprint that defines the behavior and property of an object i.e. it is the template for an object. Every class has a **state** and **behavior**.

Example: Bicycles have **State**

- current gear
- current speed
- current pedal, etc

Bicycles have **Behaviour**

- change pedal
- change gear
- apply brakes, etc

Bicycle Class

```
public class Bicycle {  
  
    final String manufacturerName; // Single line comment  
    final float bicycleHeight, bicycleWeight;  
    final int[] gears;  
  
    /*  
    Multi line comment  
    Constructor  
    */  
    public Bicycle(String manufacturerName, float bicycleHeight, float bicycleWeight, int[] gears) {  
        this.manufacturerName = manufacturerName;  
        this.bicycleHeight = bicycleHeight;  
        this.bicycleWeight = bicycleWeight;  
        this.gears = gears;  
    }  
  
    int currentGear;  
    float currentSpeed, currentDistance; // Single line declaration  
  
    public void accelerate(){ currentSpeed ++; }  
  
    public void brake(){ currentSpeed --; }  
  
    public void changeGear(){ currentGear = gears[(int)(Math.random() * gears.length + 1)]; }  
}
```


Object

It is an instance or copy of the blueprint known as Class. For programmers to use the **state** and the **behavior** of a particular class, it is necessary to create an object. An object of a class has all the attributes bundled in it. Identifying the **state** and **behavior** for an object is crucial when designing a class for a real world application.

Bicycle Object

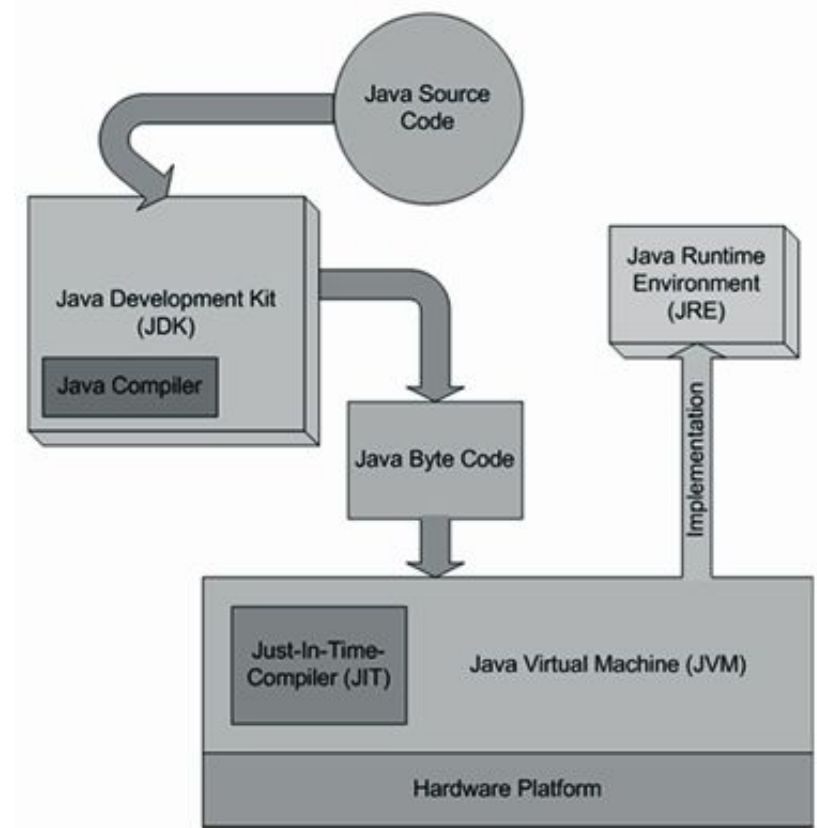
```
public class BicycleObject {  
    public static void main(String[] args) {  
        int[] gears = {1,2,3,4,5,6};  
        Bicycle bicycle = new Bicycle("BSA", 27*2.54f, 20.0f, gears);  
  
        bicycle.accelerate();  
  
    }  
}
```

Execution

main() method in Java is static because it can then be invoked by the runtime engine without having to instantiate an instance of the parent class.

JVM, JRE, JDK and JIT

- Java bytecode runs in a JRE
- JRE is composed of the Java API and the JVM.
- **A virtual machine (VM) is a software implementation of a machine**
- JVM runs on all kinds of hardware to execute the **Java Bytecode** without changing the Java execution code (WORA)
- To implement WORA, the JVM uses Java bytecode, a middle-language between Java (user language) and the machine language.
- JIT compiler **compiles** the entire **bytecode** to change it to native code.



JDK

javac, jar, debugging tools,
javap

JRE

java, javaw, libraries,
rt.jar

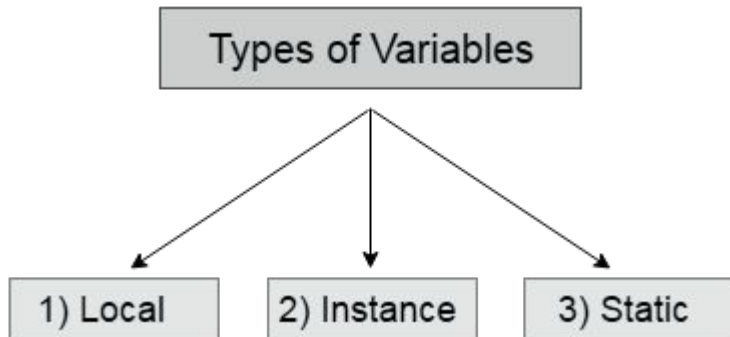
JVM

Just In Time
Compiler (JIT)

Variables & Data types

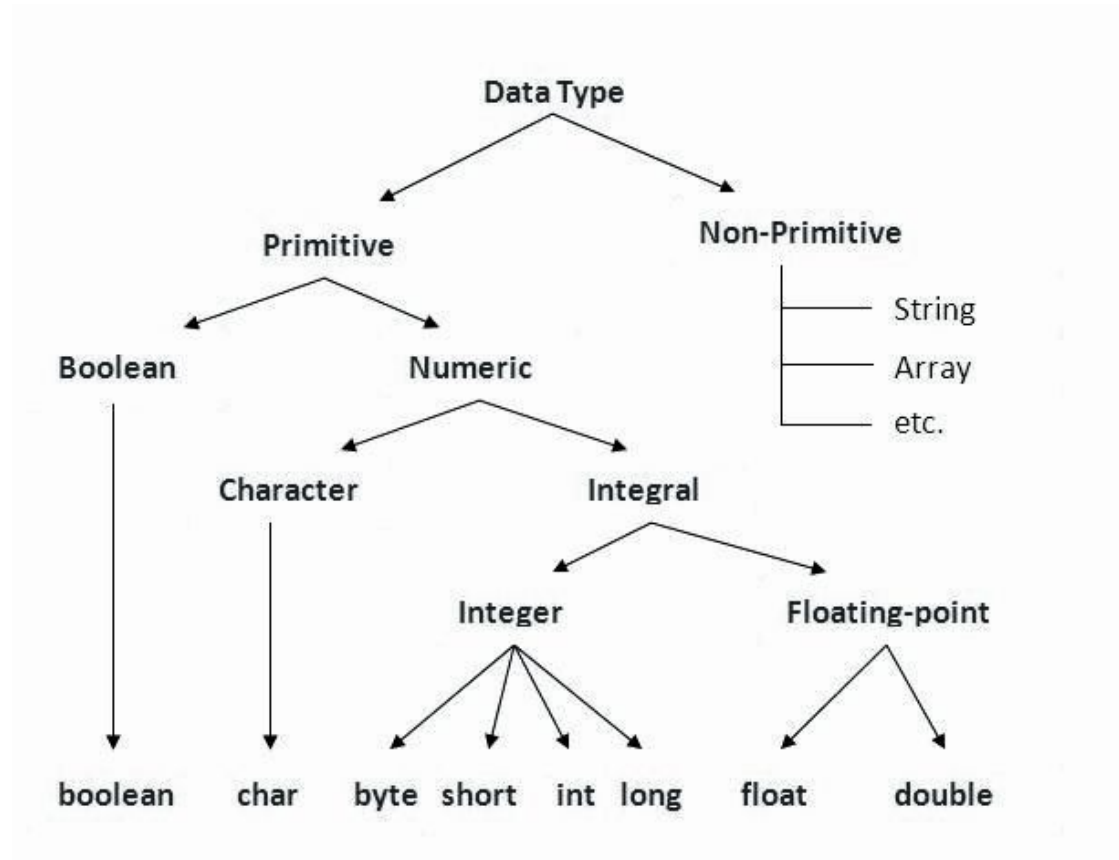
Variables

Variable is a name of memory location.



```
public class BSABicycle {  
  
    String manufacturerName = "BSA"; // instance variable  
    static String cycleModel = "mountainbike"; // static variable  
  
    public void accelerate(){  
        int step = 1; // local variable  
        currentSpeed = currentSpeed + step;  
    }  
}
```


DataTypes



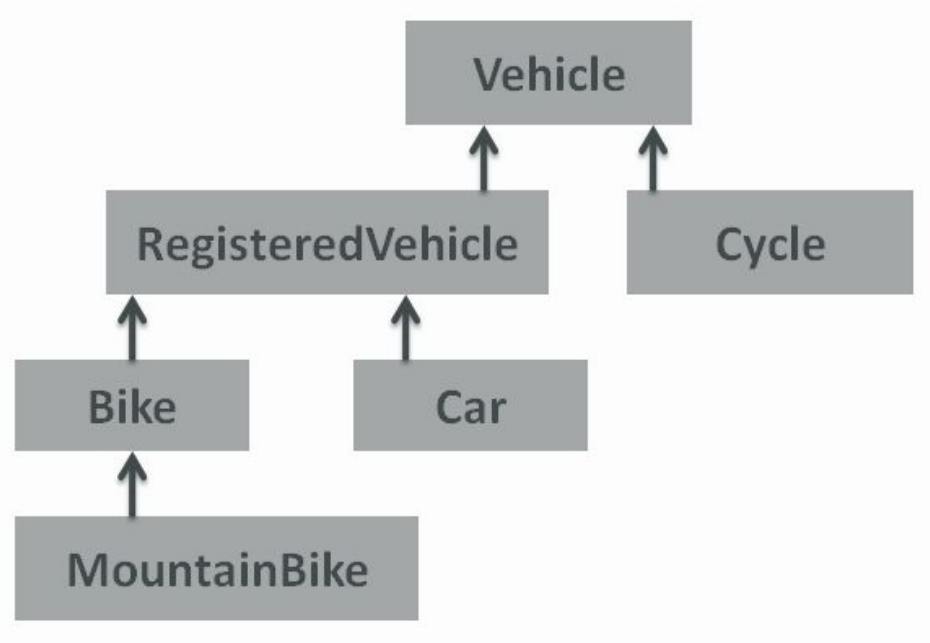
Examples

- Sum
- Widening
- Narrowing

Inheritance & Interface

Inheritance

The process of **sharing the properties and behavior of one class to another** is known as Inheritance. A class that inherits (derives) the properties and behavior of another class is referred to as the Child Class or Subclass or derived class. The class that extends its properties and behavior to the child class is known as the Parent class or Superclass.



IS - A relationship

```
public class Animal{  
}  
  
public class Mammal extends Animal{  
}  
  
public class Reptile extends Animal{  
}  
  
public class Dog extends Mammal{  
}
```

Now, based on the above example, In Object Oriented terms, the following are true:

- Animal is the superclass of Mammal class.
- Animal is the superclass of Reptile class.
- Mammal and Reptile are subclasses of Animal class.
- Dog is the subclass of both Mammal and Animal classes.

Now, if we consider the IS-A relationship, we can say:

- Mammal IS-A Animal
- Reptile IS-A Animal
- Dog IS-A Mammal
- Hence : Dog IS-A Animal as well

Abstract Class

A class that is **declared with abstract keyword**, is known as abstract class in java.

It can have abstract and non-abstract methods (method with body).

```
public abstract class BicycleFramework {  
    public abstract void accelerate();  
}
```

```
public class Bicycle extends BicycleFramework{  
    // -----  
    @Override  
    public void accelerate(){  
        currentSpeed ++;  
    }  
}
```

What is Abstraction?

Abstraction is a process of **hiding the implementation details and showing only functionality to the user**. It shows only important things to the user and hides the internal details for example sending sms, you just type the text and send the message.

Abstraction lets you focus on what the object does instead of how it does it.

Ways to achieve Abstraction

- Abstract class (0 to 100%)
- Interface (100%)

Method Overloading

```
public class Main{  
    public void sum(int a, int b){  
        System.out.println(a+b);  
    }  
    public void sum(double a, double b){  
        System.out.println(a+b);  
    }  
  
    public static void main(String args[]){  
        Main test = new Main();  
        test.sum(10,20);  
        test.sum(10.5,20.5);  
    }  
}
```

Method Overloading (Compile time polymorphism)

- If a class have multiple methods by same name but different parameter is known as Method Overloading.
- appear in the same class or a subclass have the same name but, have different parameter lists, and, can have different return types

Advantage of Method Overloading

- Method overloading increases the readability of program.

There are two way to overload the method.

- By changing number of arguments.
- By changing the data type of arguments.

Method Overriding

```
class Vehicle{  
    void run(){System.out.println("Vehicle is running");}  
}  
  
class Bike extends Vehicle{  
    void run(){System.out.println("Bike is running safely");}  
  
    public static void main(String args[]){  
        Bike obj = new Bike();  
        obj.run();  
    }  
}
```

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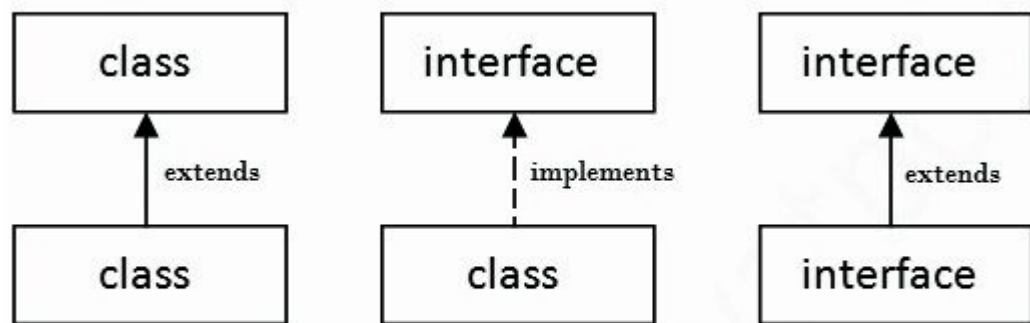
Interface

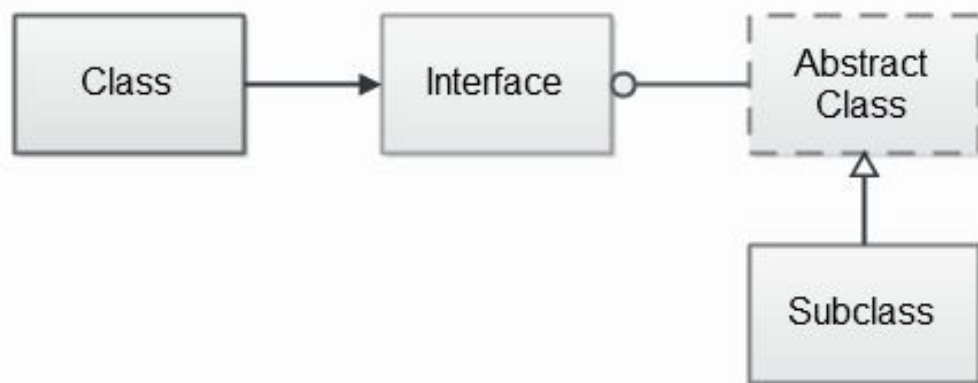
An **Interface in java** is a blueprint of a class. It has static constants and abstract methods.

The interface in java is a **mechanism to achieve abstraction**. There can be only abstract methods in the java interface not method body. It is used to achieve abstraction and multiple inheritance in Java.

Java Interface also represents **IS-A relationship**.

It cannot be instantiated just like abstract class.





ClassA

```
public class ClassA {  
    public String getMessage() {  
        return "Hello";  
    }  
}
```

InterfaceA

```
public interface InterfaceA {  
    default String getMessage() {  
        return "Hola";  
    }  
}
```

DemoClass

TopjavaTutorial.com

```
public class DemoClass extends ClassA implements InterfaceA {  
  
    public static void main(String[] args) {  
        System.out.println(new DemoClass().getMessage());  
    }  
}
```

Significance of Interfaces in Java

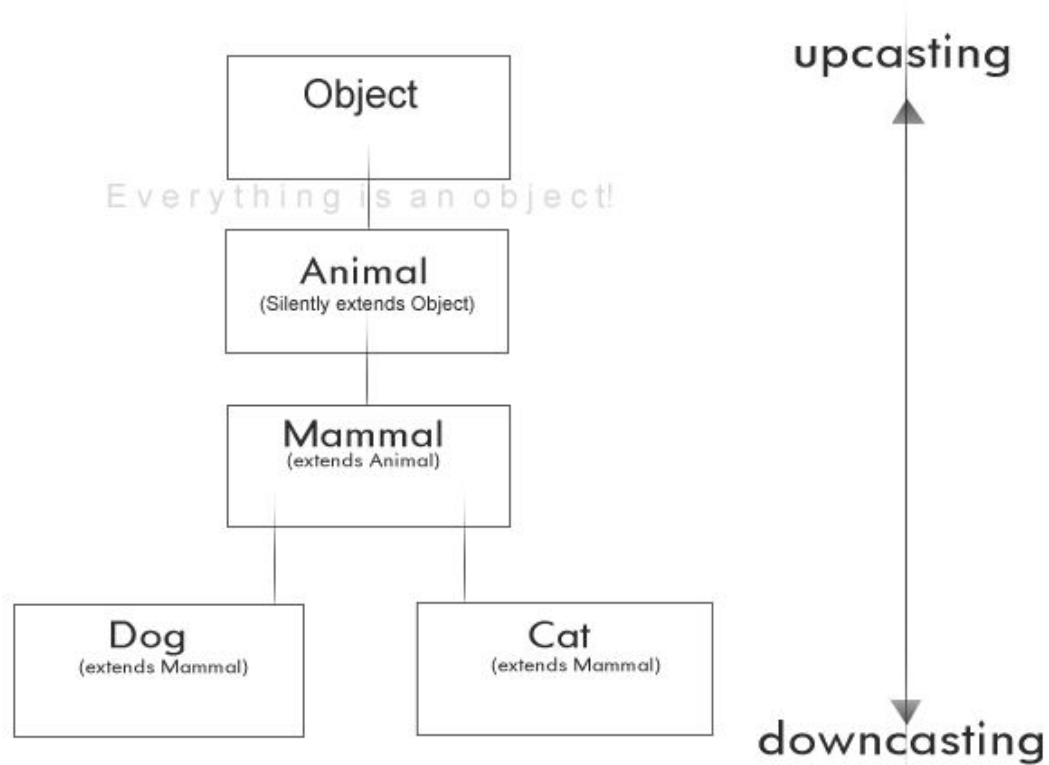
- **Interface acts as an agreement** for all child classes that want to inherit it.
- **Interfaces are a great starting point to define Type and create top level hierarchy.** At later point of time, if something else is needed it can be added to child classes.
- **Multiple inheritance:** Extending multiple super entities is called Multiple Inheritance. In Java a class is not allowed to extend multiple classes. To achieve multiple inheritance in Java, interfaces can be used means that a class can access various variables declared in more than one interface. Also it can provide implementation for the methods which can be inherited from multiple interfaces.
“Implements” is the keyword used to inherit from an interface
- **Polymorphism:** Having different flavors of the same method is referred to as Polymorphism. This simply means that the method with same name can behave differently at different places. With interfaces, different classes can provide separate implementation of the same method declared in the interface.

Characteristics of an Interface

- An interface can **only hold a method's declaration but not its complete implementation**. This means that you can define the signature and template for a method but can't fill it with any logic. Such methods are known as Abstract methods.
- You **cannot create objects of an interface unlike classes** which can be instantiated and used through its instance/object.
- Interfaces **do not have constructors** as they cannot be instantiated.
- Any **variable in an interface is public, static and final**. Hence, we need not specify these properties explicitly. Final variables are the one that can't be modified once they are initialized.
- Any **method in an interface is by default abstract and public**
- An **interface can extend only another interface** but not classes.
- A class **implementing an interface must provide implementation for all of its method** unless it's an abstract class.

Polymorphism

- A Dog IS-A Animal
- A Dog IS-A Mammal
- A Dog IS-A Carnivorous
- A Dog IS-A Dog
- A Dog IS-A Object



by Sinipull for codecall.net

Control Flows

if-then-else

```
void applyBrakes() {  
    if (isMoving) {  
        currentSpeed--;  
    } else {  
        System.err.println("The bicycle has already stopped!");  
    }  
}
```

```
if (testscore >= 90) {  
    grade = 'A';  
} else if (testscore >= 80) {  
    grade = 'B';  
} else if (testscore >= 70) {  
    grade = 'C';  
} else if (testscore >= 60) {  
    grade = 'D';  
} else {  
    grade = 'F';  
}
```

switch-case

```
switch (month) {  
    case 1: monthString = "January";  
        break;  
    case 2: monthString = "February";  
        break;  
    case 3: monthString = "March";  
        break;  
    case 4: monthString = "April";  
        break;  
    case 12: monthString = "December";  
        break;  
    default: monthString = "Invalid month";  
        break;  
}
```

do-while

```
class DoWhileDemo {  
    public static void main(String[] args){  
        int count = 1;  
        do {  
            System.out.println("Count is: " + count);  
            count++;  
        } while (count < 11);  
    }  
}
```

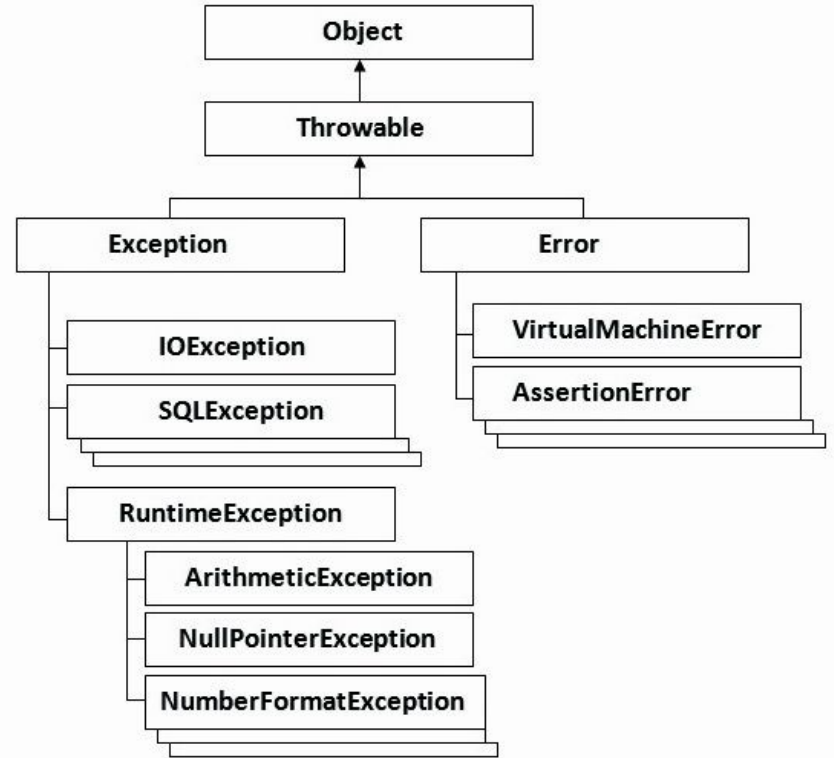
Exception Handling

Exception Handling in Java

The exception handling in java is one of the powerful **mechanism to handle the runtime errors and maintain the normal flow of application.**

Types of Exception

- Checked Exception
- Unchecked Exception
- Error



Exception Types

- **Checked Exception** : The classes that extend Throwable class except RuntimeException and Error are known as checked exceptions e.g. IOException, SQLException etc. **Checked exceptions are checked at compile-time.**
- **Unchecked Exception** : The **classes that extend RuntimeException** are known as unchecked exceptions e.g. ArithmeticException, NullPointerException, ArrayIndexOutOfBoundsException etc. Unchecked exceptions are not checked at compile-time rather they are checked at runtime.
- **Error** : Error is **irrecoverable** e.g. OutOfMemoryError, VirtualMachineError, AssertionError etc.

Catching Exceptions

- If exception occurs in try block's body then control immediately transferred(**skipping rest of the statements in try block**) to the catch block. Once catch block finished execution then finally block and after that rest of the program.
- If there is no exception occurred in the code which is present in try block then first, the try block gets executed completely and then control gets transferred to finally block (**skipping catch blocks**).
- If a return statement is encountered either in try or catch block. In such case also **finally runs**. Control first goes to finally and then it returned back to **return statement**.

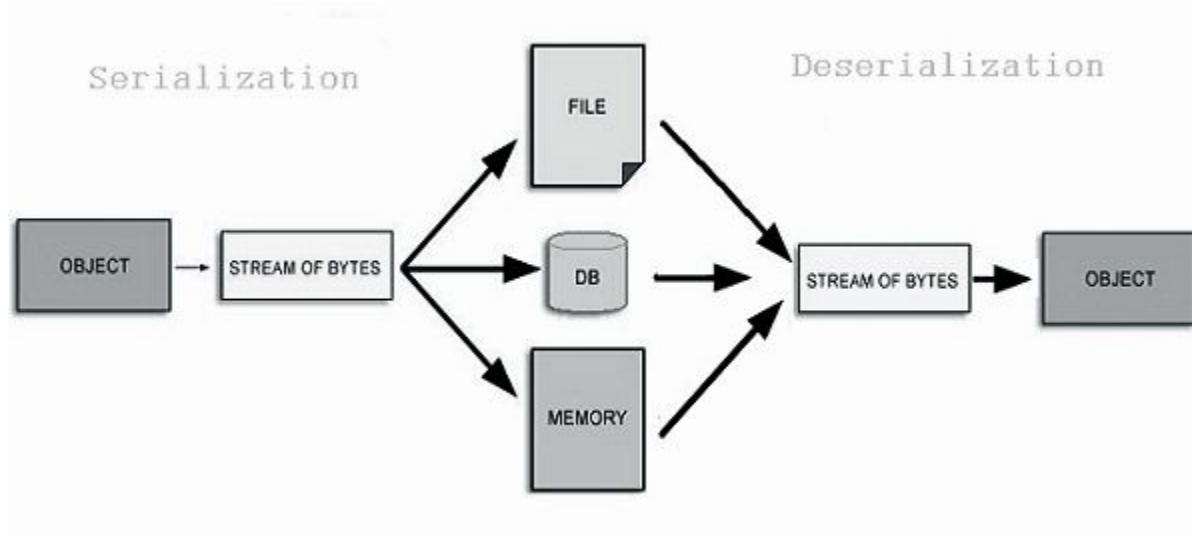
```
public class TestException{  
    public static void main(String args[]){  
        try{  
            int data=25/0;  
            System.out.println(data);  
        }  
        catch(ArithmeticException e){System.out.println(e);}  
        finally{  
            System.out.println("finally block is always executed");  
            System.out.println("rest of the code...");  
        }  
    }  
}
```

Serialization and Deserialization

Serialization and Deserialization

Serialization is a process of **converting an object into a sequence of bytes** which can be persisted. The reverse process of **creating object from sequence of bytes** is called deserialization.

A **class must implement Serializable interface** present in java.io package in order to serialize its object successfully. Serializable is a marker interface that adds serializable behaviour to the class implementing it.



```
public final void writeObject(object x) throws IOException
```

```
public final Object readObject() throws IOException, ClassNotFoundException
```

```

import java.io.*;
class Studentinfo implements Serializable {
    String name;
    int rid;
    static String contact;
    studentinfo(string n, int r, string c) {
        this.name = n;
        this.rid = r;
        this.contact = c;
    }
}

class Test {
    public static void main(String[] args) {
        try {
            Studentinfo si = new studentinfo("Abhi", 104, "110044");
            FileOutputStream fos = new
FileOutputStream("student.ser");
            Objectoutputstream oos = new ObjectOutputStream(fos);
            oos.writeObject(si);
            oos.close();
            fos.close();
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}

```

```

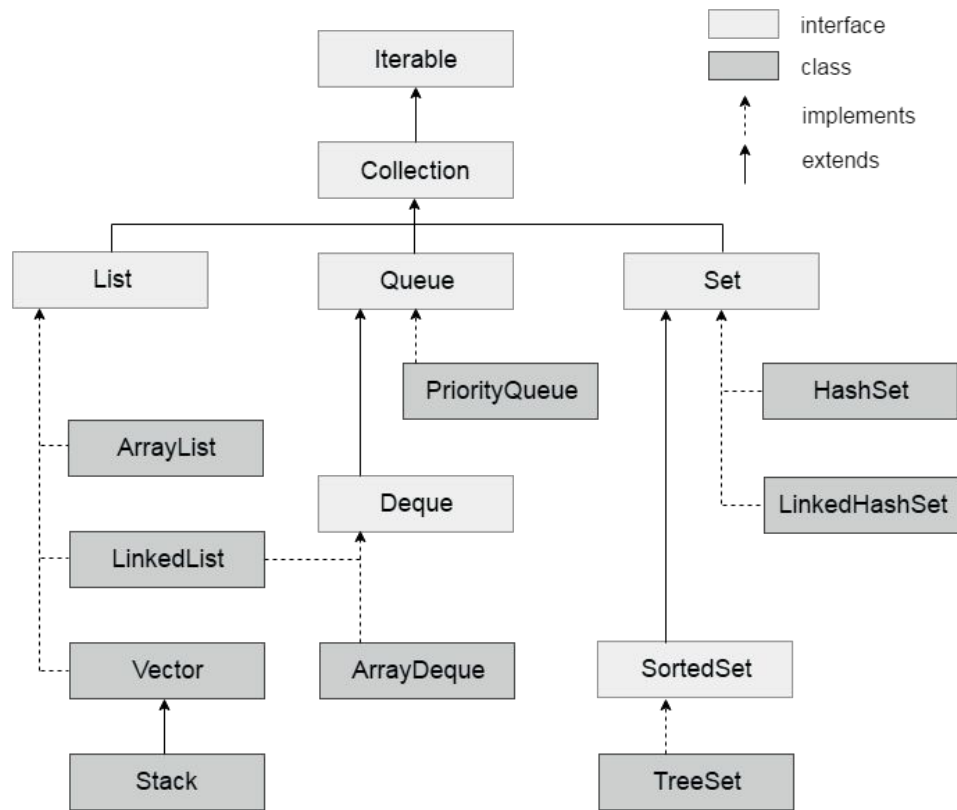
import java.io *;
class DeserializationTest {
    public static void main(String[] args) {
        Studentinfo si = null;
        try {
            FileInputStream fis = new
FileInputStream("student.ser");
            ObjectOutputStream ois = new
ObjectOutputStream(fis);
            si = (Studentinfo) ois.readObject();
        } catch (Exception e) {
            e.printStackTrace();
        }
        System.out.println(si.name);
        System.out.println(si.rid);
        System.out.println(si.contact);
    }
}

```

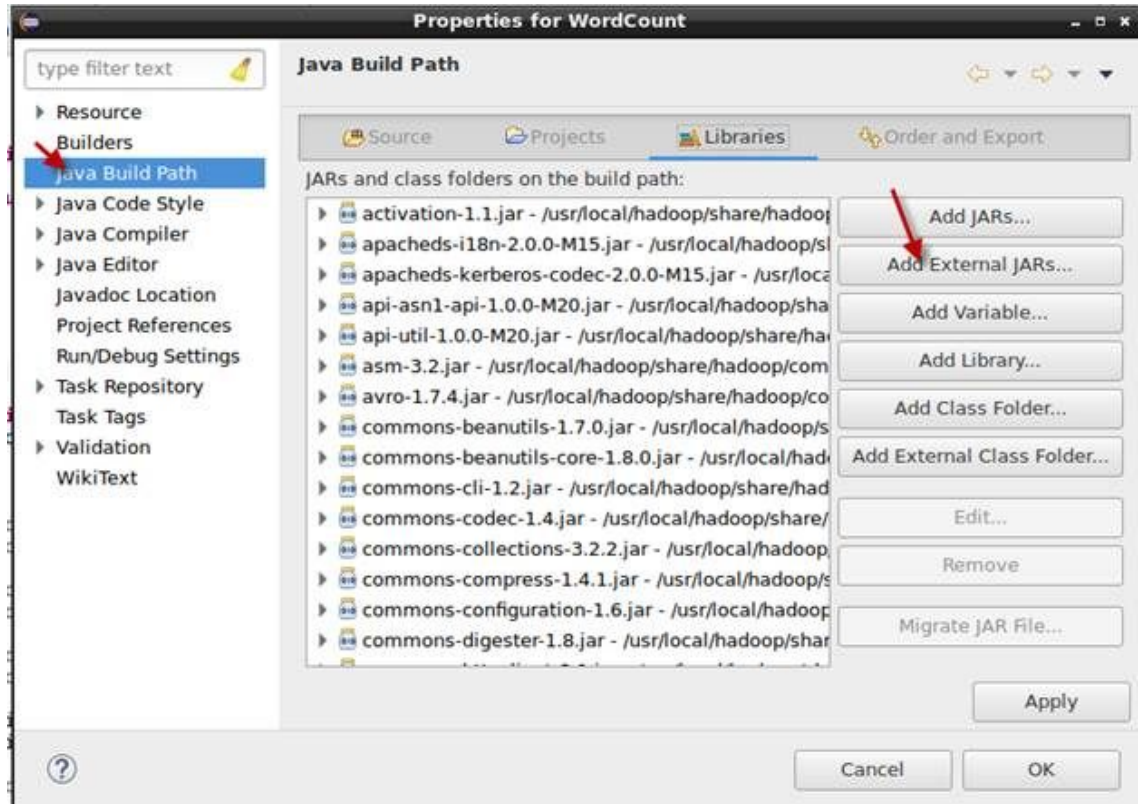
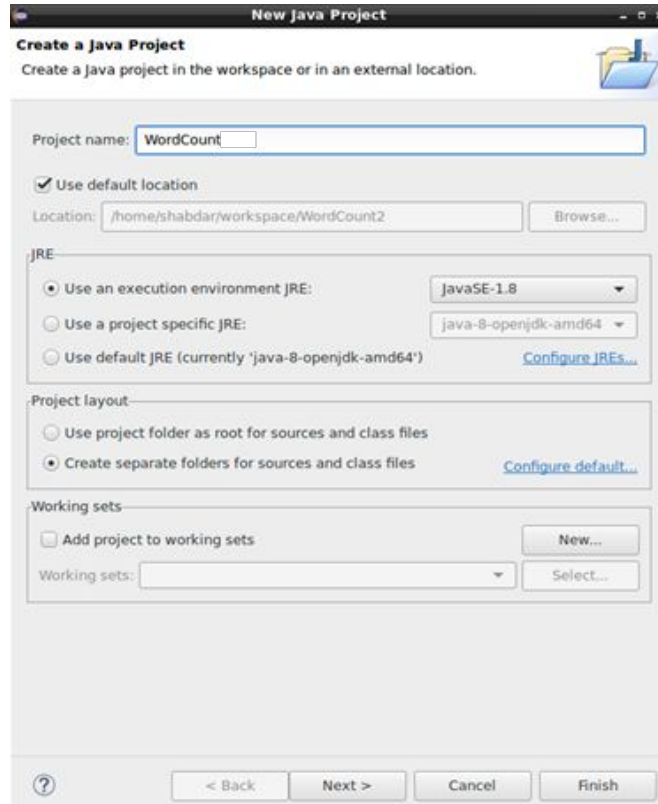
Collections

What are collections

Collections in java is a framework that provides an architecture to store and manipulate the group of objects.



MapReduce using Java



JAR Selection

usr local hadoop share hadoop mapreduce

Name

hadoop-mapreduce-client-app-2.7.2.jar
hadoop-mapreduce-client-common-2.7.2.jar
hadoop-mapreduce-client-core-2.7.2.jar
hadoop-mapreduce-client-hs-2.7.2.jar
hadoop-mapreduce-client-hs-plugins-2.7.2.jar
hadoop-mapreduce-client-jobclient-2.7.2.jar
hadoop-mapreduce-client-jobclient-2.7.2-tests.jar
hadoop-mapreduce-client-shuffle-2.7.2.jar
hadoop-mapreduce-examples-2.7.2.jar
lib
lib-examples
sources

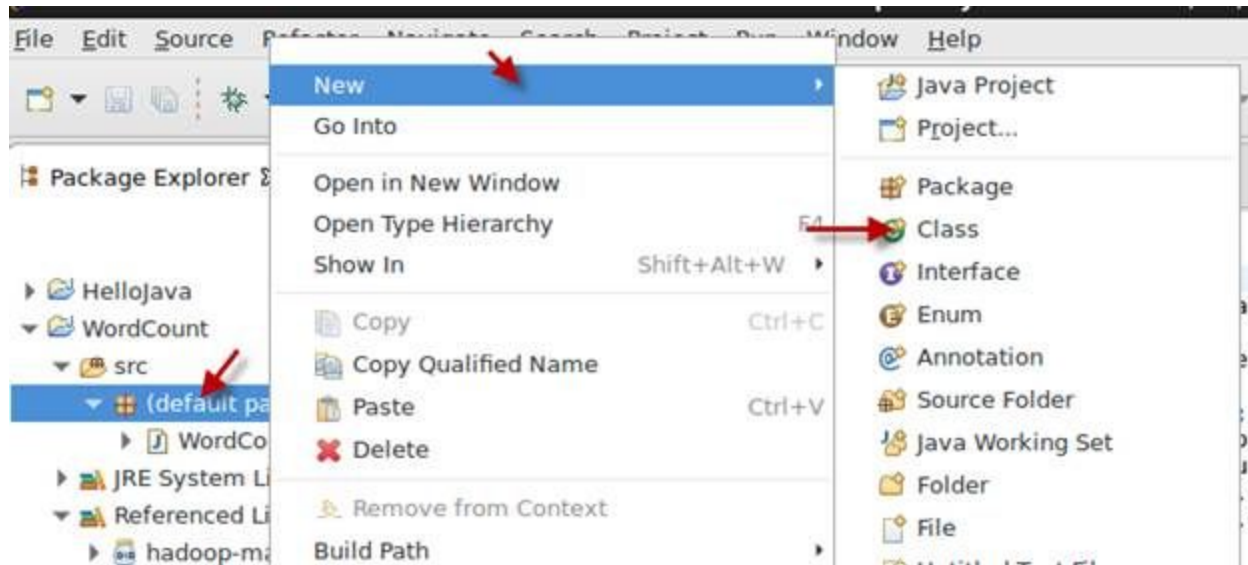


JAR Selection

usr local hadoop share hadoop common lib

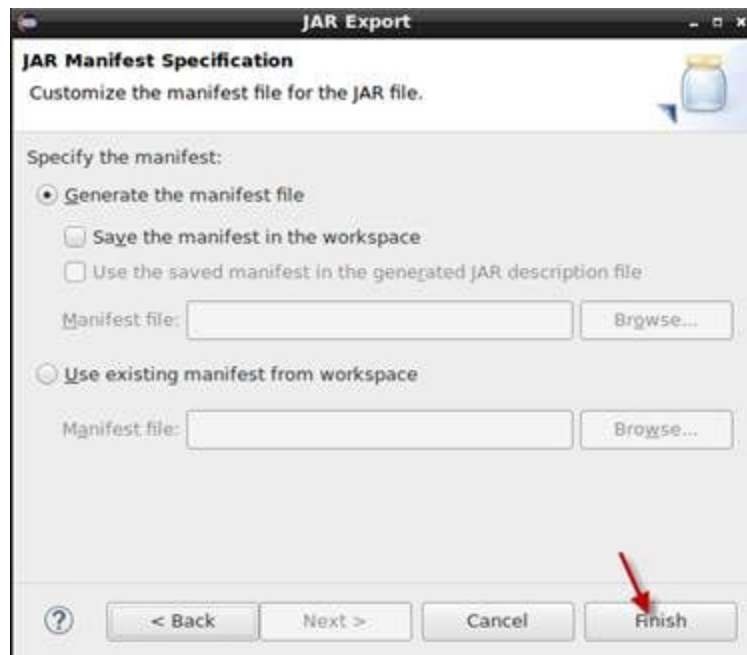
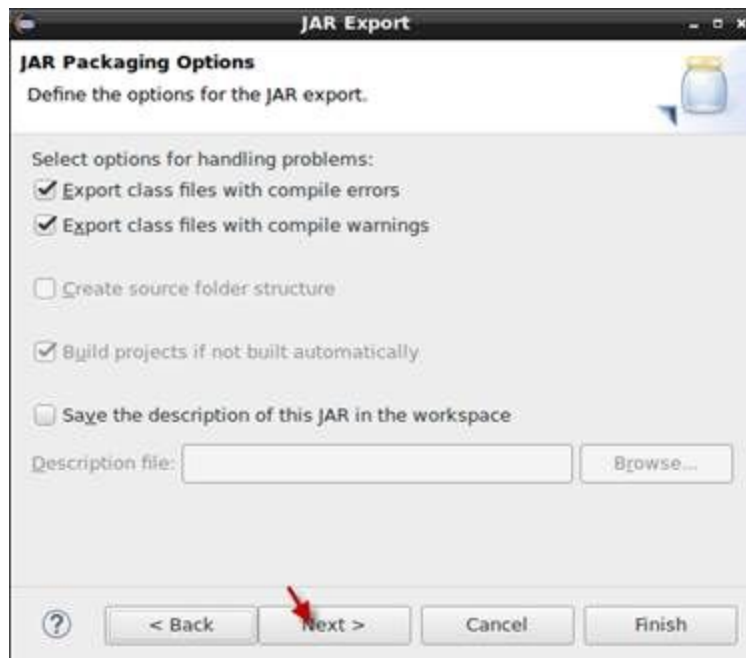
Name

activation-1.1.jar
apacheds-i18n-2.0.0-M15.jar
apacheds-kerberos-codec-2.0.0-M15.jar
api-asn1-api-1.0.0-M20.jar
api-util-1.0.0-M20.jar
asm-3.2.jar
avro-1.7.4.jar
commons-beanutils-1.7.0.jar
commons-beanutils-core-1.8.0.jar
commons-cli-1.2.jar
commons-codec-1.4.jar
commons-collections-3.2.2.jar
commons-compress-1.4.1.jar
commons-configuration-1.6.jar
commons-digester-1.8.jar
commons-httpclient-3.1.jar
commons-io-2.4.jar
commons-lang-2.6.jar
commons-logging-1.1.3.jar



Implementation of a MapReduce program

```
public class WordCount {  
  
    public static class TokenizerMapper extends Mapper<Object, Text, Text, IntWritable>{  
        // ----  
        public void map(Object key, Text value, Context context) throws IOException,  
            InterruptedException {  
            // ----  
        }  
  
        public static class IntSumReducer extends Reducer<Text,IntWritable,Text,IntWritable> {  
            // ----  
            public void reduce(Text key, Iterable<IntWritable> values,Context context) throws  
                IOException, InterruptedException {  
                // ----  
            }  
        }  
  
        public static void main(String[] args) throws Exception {  
            // ----  
        }  
    }  
}
```

Once exported, it is time to run JAR file. But before that, create input folder on HDFS that will hold one or more text files for counting words.

```
$> hadoop fs -mkdir input
```

Create a text file with some text and copy it in Input folder. You can create multiple text files if you wish.

```
$> vi wordcounttest.txt
```

Add some sample test in this file and save it. Under Ubuntu you can also use nano editor which is easier than vi editor.

```
$> hadoop fs -put wordcounttest.txt input/wordcounttest.txt
```

Make sure output directory do not exist yet. If it already exists then remove it with below command, otherwise JAR will throw an error that directory already exist.

```
$> hadoop fs -rm -r output
```

Now run JAR file with command as below. Please note you may need to adjust path of jar file depending on where you exported it.

```
$> hadoop jar /home/rohit/workspace/WordCount/WordCount.jar WordCount input/ output/
```

Please note that this program will read all text files from input folder on HDFS and count total number of words in each file. Output is stored under output folder on HDFS.

Once run is successful, you should see below 2 files in output folder.

```
$> hadoop fs -ls output
```

```
-rw-r--r--  1 rohit rohit      0 2017-04-12 13:54 output/_SUCCESS  
-rw-r--r--  1 rohit rohit    73 2017-04-12 13:54 output/part-r-00000
```

_SUCCESS file is an empty file indicating RUN was successful. To see output of run, view part-r-00000 file.

```
$> hdfs fs -cat output/part-r-00000
```


Linux

What is Linux?

Linux is **an operating system**.

An **operating system** is a software that enables communication between **computer hardware and software**. It conveys input to get processed by the **processor and brings output to the hardware to display it**. This is the basic function of an operating system.

Structure of Linux

- Kernel
- System Libraries
- System Tools

Kernel

Core of the operating system. It establishes communication between devices and software. Moreover, it manages the system resources.

- Device Management
- Memory Management
- Process Management
- Handling System Calls

Linux Commands

A command is an instruction given to our computer by us to do whatever we want. In Mac OS, and Linux it is called terminal, whereas, in windows it is called command prompt. Commands are always case sensitive.

Commands are executed by typing in at the command line followed by pressing enter key.

This command further passes to the shell which reads the command and execute it. Shell is a method for the user to interact with the system. Default shell in Linux is called bash (Bourne-Again Shell).

FILE COMMANDS

ls -al	=>Display all information about files/ directories
pwd	=>Show the path of current directory
mkdir directory-name	=>Create a directory
rm file-name	=>Delete file
rm -r directory-name	=>Delete directory recursively
rm -f file-name	=>Forcefully remove file
rm -rf directory-name	=>Forcefully remove directory recursively
cp file1 file2	=>Copy file1 to file2
cp -r dir1 dir2	=>Copy dir1 to dir2, create dir2 if it doesn't exist
mv file1 file2	=>Rename source to dest / move source to directory
ln -s /path/to/file-name link-name	#Create symbolic link to file-name
touch file	=>Create or update file
cat > file	=>Place standard input into file
more file	=>Output contents of file
head file	=>Output first 10 lines of file
tail file	=>Output last 10 lines of file
tail -f file	=>Output contents of file as it grows starting with the last 10 lines
gpg -c file	=>Encrypt file
gpg file.gpg	=>Decrypt file
wc	=>print the number of bytes, words, and lines in files
xargs	=>Execute command lines from standard input

PROCESS RELATED

ps	=>Display your currently active processes
ps aux grep 'telnet'	=>Find all process id related to telnet process
pmap	=>Memory map of process
top	=>Display all running processes
kill pid	=>Kill process with mentioned pid id
killall proc	=>Kill all processes named proc
pkill process-name	=>Send signal to a process with its name
bg	=>Resumes suspended jobs without bringing them to foreground
fg	=>Brings the most recent job to foreground
fg n	=>Brings job n to the foreground

DIRECTORY TRAVERSE

<code>cd ..</code>	=>To go up one level of the directory tree
<code>cd</code>	=>Go to \$HOME directory
<code>cd /test</code>	=>Change to /test directory

FILE TRANSFER

<code>scp</code>	
<code>scp file.txt server2:/tmp</code>	=>Secure copy file.txt to remote host /tmp folder
<code>rsync -a /home/apps /backup/</code>	=>Synchronize source to destination

DISK USAGE

<code>df -h</code>	=>Show free space on mounted filesystems
<code>df -i</code>	=>Show free inodes on mounted filesystems
<code>fdisk -l</code>	=>Show disks partitions sizes and types
<code>du -ah</code>	=>Display disk usage in human readable form
<code>du -sh</code>	=>Display total disk usage on the current directory
<code>findmnt</code>	=>Displays target mount point for all filesystem
<code>mount device-path mount-point</code>	=>Mount a device

COMPRESSION / ARCHIVES

<code>tar cf home.tar home</code>	=>Create tar named home.tar containing home/
<code>tar xf file.tar</code>	=>Extract the files from file.tar
<code>tar czf file.tar.gz files</code>	=>Create a tar with gzip compression
<code>gzip file</code>	=>Compress file and renames it to file.gz

SEARCH

<code>grep pattern files</code>	=>Search for pattern in files
<code>grep -r pattern dir</code>	=>Search recursively for pattern in dir
<code>locate file</code>	=>Find all instances of file
<code>find /home/tom -name 'index*'</code>	=>Find files names that start with "index"
<code>find /home -size +10000k</code>	=>Find files larger than 10000k in /home

SYSTEM

uname -a	=>Displaylinux system information
uname -r	=>Display kernel release information
uptime	=>Show how long the system has been running + load
hostname	=>Show system host name
hostname -i	=>Display the IP address of the host
last reboot	=>Show system reboot history
date	=>Show the current date and time
cal	=>Show this month calendar
w	=>Display who is online
whoami	=>Who you are logged in as
finger user	=>Display information about user

FILE PERMISSION RELATED

chmod octal file-name	=>Change the permissions of file to octal
Example	
chmod 777 /data/test.c	=>Set rwx permission for owner,group,world
chmod 755 /data/test.c	=>Set rwx permission for owner,rx for group and world
chown owner-user file	=>Change owner of the file
chown owner-user:owner-group file-name	=>Change owner and group owner of the file
chown owner-user:owner-group directory	=>Change owner and group owner of the directory

Questions
