

Java Tutorial



Write Once, Run Anywhere



Java - General

- Java is:
 - platform independent programming language
 - similar to C++ in syntax
 - Supports object oriented & functional programming paradigm (since Java SE 8)

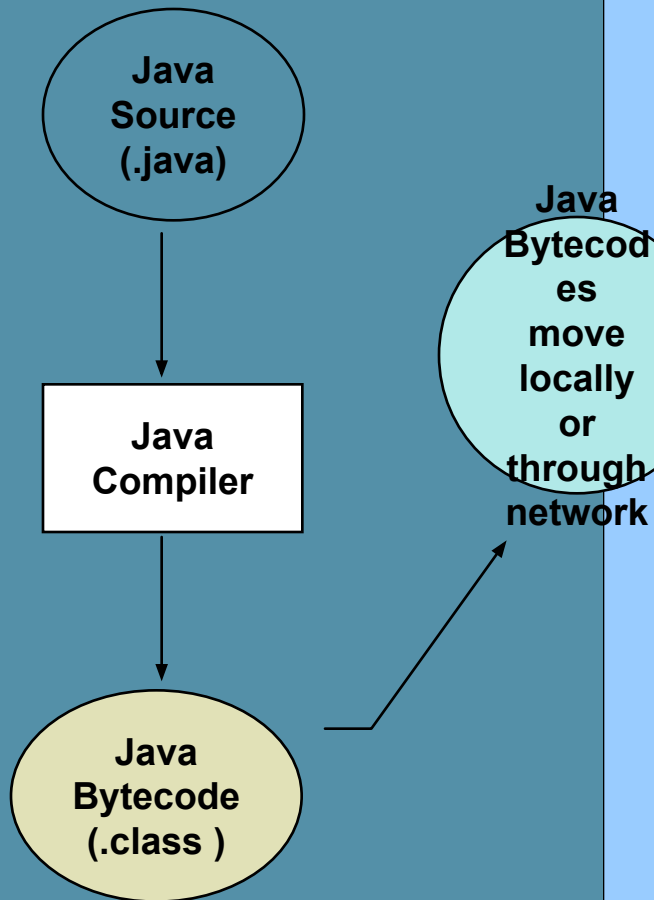


Java - General

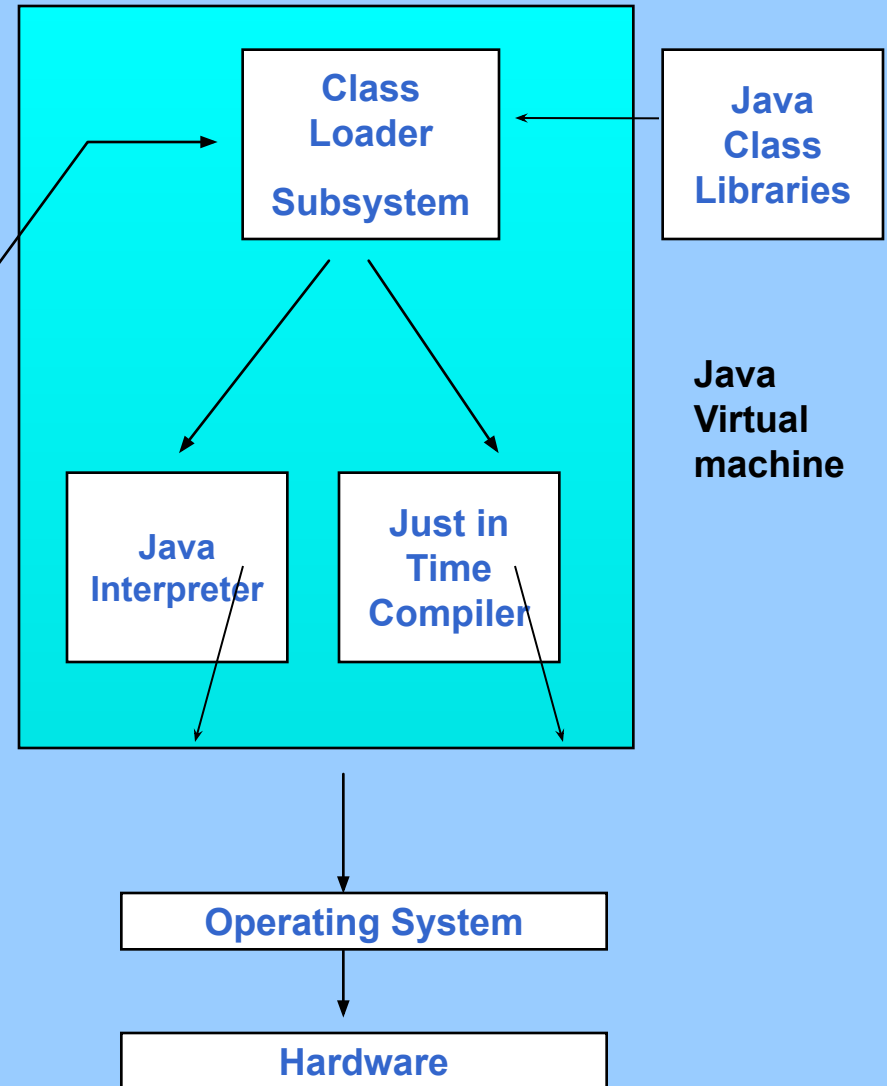
- Java has some interesting features:
 - Statically typed language,
 - automatic garbage collection,
 - simplifies pointers; no directly accessible pointer to memory,
 - simplified network access,
 - multi-threading!

How it works...!

Compile-time Environment



Run-time Environment





How it works...!

- Java is independent only for one reason:
 - Only depends on the Java Virtual Machine (JVM),
 - code is compiled to *bytecode*, which is interpreted by the resident JVM,
 - JIT (just in time) compilers attempt to increase speed.



Java - Security

- Pointer denial - reduces chances of virulent(harmful – virus prone) programs corrupting host,
- Applets even more restricted -
 - May not
 - run local executables,
 - Read or write to local file system,
 - Communicate with any server other than the originating server.



Object-Oriented

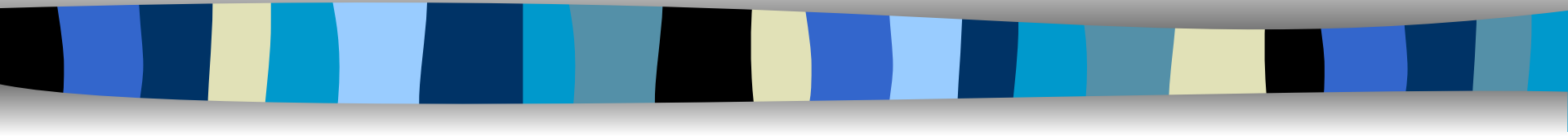
- Java supports OOD
 - Polymorphism
 - Inheritance
 - Encapsulation
- Java programs contain nothing but definitions and instantiations of classes
 - Everything is encapsulated in a class!



Java Advantages

- Portable - Write Once, Run Anywhere
- Security has been well thought through
- Robust memory management
- Designed for network programming
- Multi-threaded (multiple simultaneous tasks)
- Dynamic & extensible (loads of libraries)
 - Classes stored in separate files
 - Loaded only when needed

Basic Java Syntax





Primitive Types and Variables

boolean, char, byte, short, int, long, float, double etc.

These basic (or primitive) types are the only types that are not objects (due to performance issues).

This means that you don't use the new operator to create a primitive variable.

Declaring primitive variables:

```
float initVal;
```

```
int retVal, index = 2;
```

```
double gamma = 1.2, brightness;
```

```
boolean valueOk = false;
```



Initialisation

- If no value is assigned prior to use, then the compiler will give an error
- Java sets primitive variables to zero or false in the case of a boolean variable
- All object references are initially set to null
- An array of anything is an object
 - Set to null on declaration
 - Elements to zero false or null on creation



Declarations

```
int index = 1.2;      // compiler error
boolean retOk = 1;    // compiler error
double fiveFourths = 5 / 4; // no error!
float ratio = 5.8f;    // correct
double fiveFourths = 5.0 / 4.0; // correct
```

- 1.2f is a float value accurate to 7 decimal places.
- 1.2 is a double value accurate to 15 decimal places.



Assignment

- All Java assignments are right associative

```
int a = 1, b = 2, c = 5;
```

```
a = b = c;
```

```
System.out.print(
```

```
    "a= " + a + "b= " + b + "c= " + c);
```

- What is the value of a, b & c
- Done right to left: `a = (b = c);`

Basic Mathematical Operators

- `*` `/` `%` `+` `-` are the mathematical operators
- `*` `/` `%` have a higher precedence than `+` **or** `-`

```
double myVal = a + b % d - c * d / b;
```

- Is the same as:

```
double myVal = (a + (b % d)) -  
                ((c * d) / b);
```



Statements & Blocks

- A simple statement is a command terminated by a semi-colon:
`name = "Fred";`
- A block is a compound statement enclosed in curly brackets:
`{
 name1 = "Fred"; name2 = "Bill";
}`
- Blocks may contain other blocks



Flow of Control

- Java executes one statement after the other in the order they are written
- Many Java statements are flow control statements:

Alternation: if, if else, switch

Looping: for, while, do while

Escapes: break, continue, return



If – The Conditional Statement

- The if statement evaluates an expression and if that evaluation is true then the specified action is taken

```
if ( x < 10 ) x = 10;
```

- If the value of x is less than 10, make x equal to 10
- It could have been written:

```
if ( x < 10 )
```

```
  x = 10;
```

- Or, alternatively:

```
if ( x < 10 ) { x = 10; }
```



Relational Operators

== Equal (careful)

!= Not equal

>= Greater than or equal

<= Less than or equal

> Greater than

< Less than



If... else

- The if ... else statement evaluates an expression and performs one action if that evaluation is true or a different action if it is false.

```
if (x != oldx) {  
    System.out.print("x was changed");  
}  
else {  
    System.out.print("x is unchanged");  
}
```



Nested if ... else

```
if ( myVal > 100 ) {  
    if ( remainderOn == true) {  
        myVal = mVal % 100;  
    }  
    else {  
        myVal = myVal / 100.0;  
    }  
}  
else  
{  
    System.out.print("myVal is in range");  
}
```



else if

Useful for choosing between alternatives:

```
if ( n == 1 ) {  
    // execute code block #1  
}  
else if ( n == 2 ) {  
    // execute code block #2  
}  
else {  
    // if all previous tests have failed,  
    execute code block #3  
}
```



A Warning...

WRONG!

```
if( i == j )
    if ( j == k )
        System.out.print(
            "i equals
            k");
    else
        System.out.print(
            "i is not
            equal to j");
```

CORRECT!

```
if( i == j ) {
    if ( j == k )
        System.out.print(
            "i equals
            k");
}
else
    System.out.print(
        "i is not equal to
        j");// Correct!
```



The switch Statement

```
switch ( n ) {  
    case 1:  
        // execute code block #1  
        break;  
    case 2:  
        // execute code block #2  
        break;  
    default:  
        // if all previous tests fail then  
        // execute code block #4  
        break;  
}
```



The **for** loop

- Loop n times

```
for ( i = 0; i < n; i++ ) {  
    // this code body will execute n times  
    // i from 0 to n-1  
}
```

- Nested for:

```
for ( j = 0; j < 10; j++ ) {  
    for ( i = 0; i < 20; i++ ){  
        // this code body will execute 200 times  
    }  
}
```




while loops

```
while(response == 1) {  
    System.out.print( "ID =" +  
        userID[n]);  
    n++;  
    response = readInt( "Enter ");  
}
```

What is the minimum number of times the loop is executed?

What is the maximum number of times?



do { ... } while loops

```
do {  
    System.out.print( "ID =" + userID[n] );  
    n++;  
    response = readInt( "Enter " );  
}while (response == 1);
```

What is the minimum number of times the loop is executed?

What is the maximum number of times?



Break

- A break statement causes an exit from the innermost containing **while**, **do**, **for** or **switch** statement.

```
for ( int i = 0; i < maxID, i++ ) {  
    if ( userID[i] == targetID ) {  
        index = i;  
        break;  
    }  
} // program jumps here after break
```



Continue

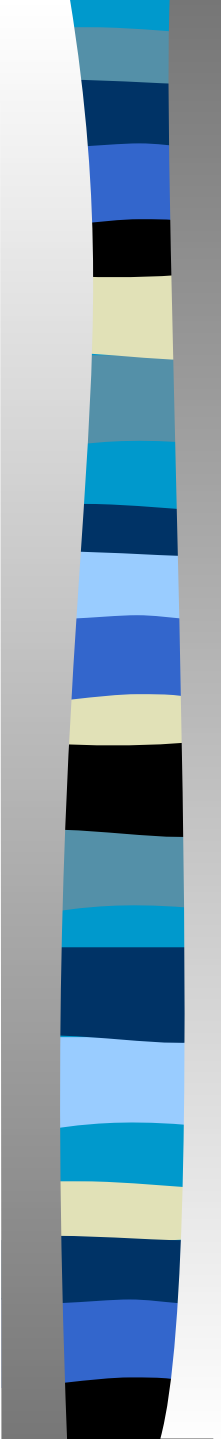
- Can only be used with while, do or for.
- The continue statement causes the innermost loop to start the next iteration immediately

```
for ( int i = 0; i < maxID; i++ ) {  
    if ( userID[i] != -1 ) continue;  
    System.out.print( "UserID " + i + " : " +  
        userID );  
}
```



Arrays

- An array is a list of similar things
- An array has a fixed:
 - name
 - type
 - length
- These must be declared when the array is created.
- Arrays sizes cannot be changed during the execution of the code



myArray =

3	6	3	1	6	3	4	1
0	1	2	3	4	5	6	7

myArray has room for 8 elements

- the elements are accessed by their index
- in Java, array indices start at 0



Declaring Arrays

`Int[] myArray` OR `int myArray[];`

declares *myArray* to be an array of integers

`myArray = new int[8];`

sets up 8 integer-sized spaces in memory,
labelled *myArray[0]* to *myArray[7]*

`int myArray[] = new int[8];`

combines the two statements in one line



Assigning Values

- refer to the array elements by index to store values in them.

```
myArray[0] = 3;
```

```
myArray[1] = 6;
```

```
myArray[2] = 3; ...
```

- can create and initialise in one step:

```
int myArray[] = {3, 6, 3, 1, 6, 3, 4, 1};
```




Iterating Through Arrays

- *for* loops are useful when dealing with arrays:

```
for (int i = 0; i <
    myArray.length; i++) {
    myArray[i] = getsomevalue();
}
```



Arrays of Objects

- So far we have looked at an array of primitive types.
 - integers
 - could also use doubles, floats, characters...
- Often want to have an array of objects
 - Students, Books, Loans
- Need to follow 3 steps.



Declaring the Array

1. Declare the array

```
private Student studentList[];
```

– this declares studentList

2 .Create the array

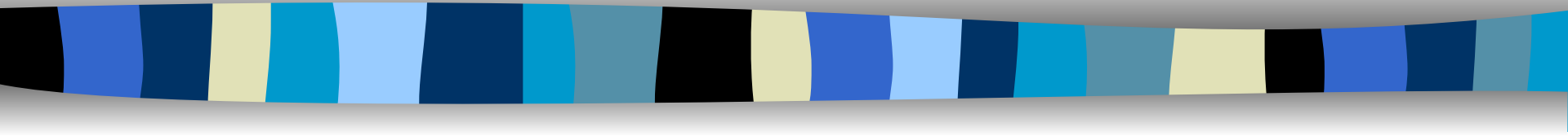
```
studentList = new Student[10];
```

– this sets up 10 spaces in memory that can hold references to Student objects

3. Create Student objects and add them to the

array: `studentList[0] = new Student("Cathy", "Computing");`

Java Methods & Classes





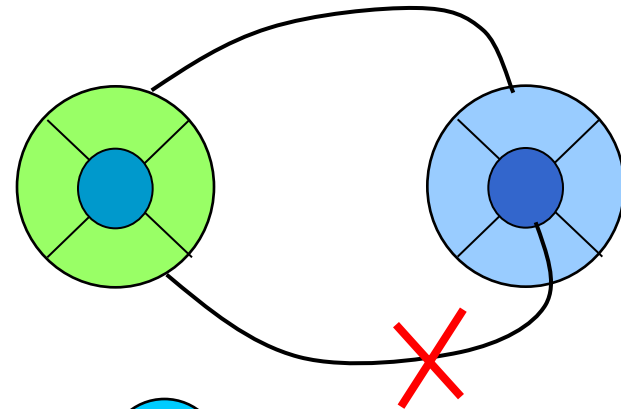
Classes ARE Object Definitions

- OOP - object oriented programming
- code built from objects
- Java these are called ***classes***
- Each class definition is coded in a separate .java file
- Name of the object must match the class/object name

The three principles of OOP

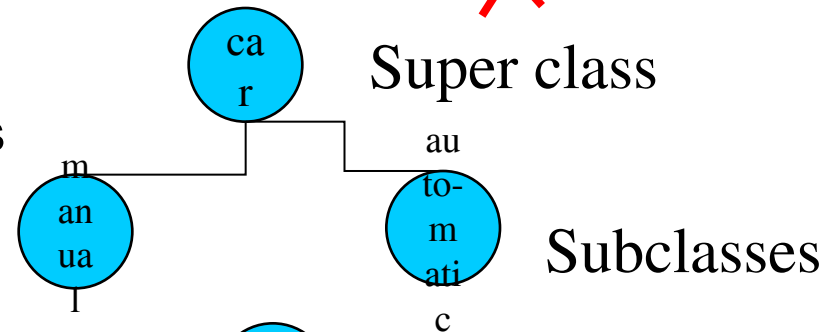
■ Encapsulation

- Objects hide their functions (**methods**) and data (**instance variables**)



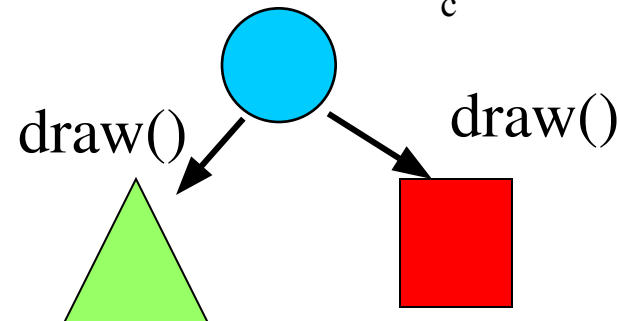
■ Inheritance

- Each **subclass** inherits all variables of its **superclass**



■ Polymorphism

- Interface same despite different data types





Simple Class and Method

```
Class Fruit{  
    int grams;  
    int calsPerGram;  
  
    int totalCalories() {  
        return(grams* calsPerGram);  
    }  
}
```



Methods

- A method is a named sequence of code that can be invoked by other Java code.
- A method takes some parameters, performs some computations and then optionally returns a value (or object).
- Methods can be used as part of an expression statement.

```
public float convertCelsius(float tempC) {  
    return( ((tempC * 9.0f) / 5.0f) + 32.0 );  
}
```




Method Signatures

- A method signature specifies:
 - The name of the method.
 - The type and name of each parameter.
 - The type of the value (or object) returned by the method.
 - The checked exceptions thrown by the method.
 - Various method modifiers.
 - *modifiers type name (parameter list) [throws exceptions]*
- ```
public float convertCelsius (float tCelsius) {}
public boolean setUserInfo (int i, int j, String name) throws
 IndexOutOfBoundsException {}
```



# Public/private

- Methods/data may be declared ***public*** or ***private*** meaning they may or may not be accessed by code in other classes ...
- Good practice:
  - keep data private
  - keep most methods private
- well-defined interface between classes - helps to eliminate errors



# Using objects

- Here, code in one class creates an instance of another class and does something with it

...

```
Fruit plum=new Fruit();
int cals;
cals = plum.total_calories();
```

- ***Dot operator*** allows you to access (public) data/methods inside Fruit class



# Constructors

- The line

```
plum = new Fruit();
```

- invokes a constructor method with which you can set the initial data of an object
- You may choose several different type of constructor with different argument lists

```
eg Fruit(), Fruit(a) ...
```



# Overloading

- Can have several versions of a method in class with different types/numbers of arguments

```
Fruit() {grams=50;}
```

```
Fruit(a,b) { grams=a; cals_per_gram=b;}
```

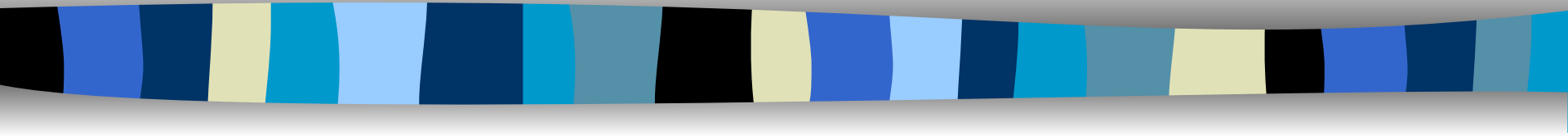
- By looking at arguments Java decides which version to use



# Java Development Kit

- javac - The Java Compiler
  - java - The Java Interpreter
  - jdb - The Java Debugger
  - appletviewer - Tool to run the applets
- 
- javap - to print the Java bytecodes
  - javaprof - Java profiler
  - javadoc - documentation generator
  - javah - creates C header files

# Stream Manipulation





# Streams and I/O

- basic classes for file IO
  - FileInputStream, for reading from a file
  - FileOutputStream, for writing to a file

- Example:

Open a file "myfile.txt" for **reading**

```
FileInputStream fis = new FileInputStream("myfile.txt");
```

Open a file "outfile.txt" for **writing**

```
FileOutputStream fos = new FileOutputStream ("myfile.txt");
```





# Display File Contents

```
import java.io.*;
public class FileToOut1 {
 public static void main(String args[]) {
 try {
 FileInputStream infile = new FileInputStream("testfile.txt");
 byte buffer[] = new byte[50];
 int nBytesRead;
 do {
 nBytesRead = infile.read(buffer);
 System.out.write(buffer, 0, nBytesRead);
 } while (nBytesRead == buffer.length);
 }
 catch (FileNotFoundException e) {
 System.err.println("File not found");
 }
 catch (IOException e) { System.err.println("Read failed"); }
 }
}
```



# Filters

- Once a stream (e.g., file) has been opened, we can attach filters
- Filters make reading/writing more efficient
- Most popular filters:
  - For basic types:
    - `DataInputStream`, `DataOutputStream`
  - For objects:
    - `ObjectInputStream`, `ObjectOutputStream`

# Writing data to a file using Filters

```
import java.io.*;
public class GenerateData {
 public static void main(String args[]) {
 try {
 FileOutputStream fos = new FileOutputStream("stuff.dat");
 DataOutputStream dos = new DataOutputStream(fos);
 dos.writeInt(2);
 dos.writeDouble(2.7182818284590451);
 dos.writeDouble(3.1415926535);
 dos.close(); fos.close();
 }
 catch (FileNotFoundException e) {
 System.err.println("File not found");
 }
 catch (IOException e) {
 System.err.println("Read or write failed");
 }
 }
}
```

# Reading data from a file using filters

```
import java.io.*;
public class ReadData {
 public static void main(String args[]) {
 try {
 FileInputStream fis = new FileInputStream("stuff.dat");
 DataInputStream dis = new DataInputStream(fis);
 int n = dis.readInt();
 System.out.println(n);
 for(int i = 0; i < n; i++) { System.out.println(dis.readDouble());
 }
 dis.close(); fis.close();
 }
 catch (FileNotFoundException e) {
 System.err.println("File not found");
 }
 catch (IOException e) { System.err.println("Read or write failed");
 }
 }
}
```



# Object serialization

Write objects to a file, instead of writing primitive types.

Use the `ObjectInputStream`, `ObjectOutputStream` classes, the same way that filters are used.

# Write an object to a file

```
import java.io.*;
import java.util.*;
public class WriteDate {
 public WriteDate () {
 Date d = new Date();
 try {
 FileOutputStream f = new FileOutputStream("date.ser");
 ObjectOutputStream s = new ObjectOutputStream (f);
 s.writeObject (d);
 s.close ();
 }
 catch (IOException e) { e.printStackTrace(); }

 public static void main (String args[]) {
 new WriteDate ();
 }
}
```

# Read an object from a file

```
import java.util.*;
public class ReadDate {
 public ReadDate () {
 Date d = null;
 ObjectInputStream s = null;
 try { FileInputStream f = new FileInputStream ("date.ser");
 s = new ObjectInputStream (f);
 } catch (IOException e) { e.printStackTrace(); }
 try { d = (Date)s.readObject (); }
 catch (ClassNotFoundException e) { e.printStackTrace(); }
 catch (InvalidClassException e) { e.printStackTrace(); }
 catch (StreamCorruptedException e) { e.printStackTrace(); }
 catch (OptionalDataException e) { e.printStackTrace(); }
 catch (IOException e) { e.printStackTrace(); }
 System.out.println ("Date serialized at: "+ d);
 }
 public static void main (String args[]) { new ReadDate (); }
}
```