Topic #6:
Intro to Java

CSE 413, Autumn 2004

Programming Languages

http://www.cs.washington.edu/education/courses/413/04au/

Readings and References

- Reading
  - » Chapter 15, *Concepts of Programming Languages*, by Sebesta
- Other References
  - » "Object-Oriented Programming Concepts", Java tutorial
    http://java.sun.com/docs/books/tutorial/java/concepts/index.html
  - » "Language Basics", Java tutorial
    http://java.sun.com/docs/books/tutorial/java/nutsandbolts/index.html

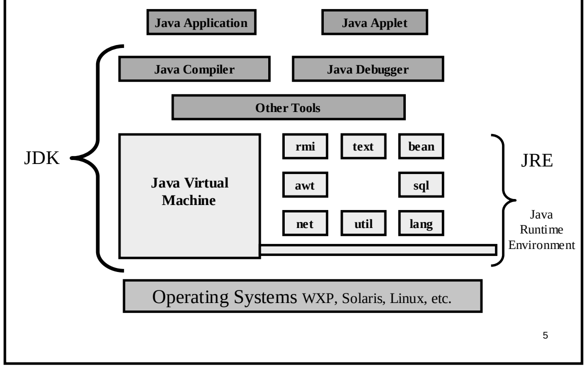
What is Java?

- An object-oriented programming language
  - » source code
- Application Programming Interfaces (APIs)
  - » extensive class libraries
- A virtual machine
  - » runs programs that were written in the source language and compiled to binary bytecodes

Java vs. Other Languages

- Java syntax is very much like C syntax
- Java does not explicitly support pointers or any other direct access to memory
- Java is automatically garbage-collected
- Java is interpreted.
- Java is dynamically linked, with run-time polymorphism

Java Developers Kit (JDK)



Java Application

Java Applet

Java Compiler

Java Debugger

Other Tools

JDK

Java Virtual Machine

rmi

text

bean

awt

sql

net

util

lang

JRE

Java Runtime Environment

Operating Systems WXP, Solaris, Linux, etc.

Tools in the JDK

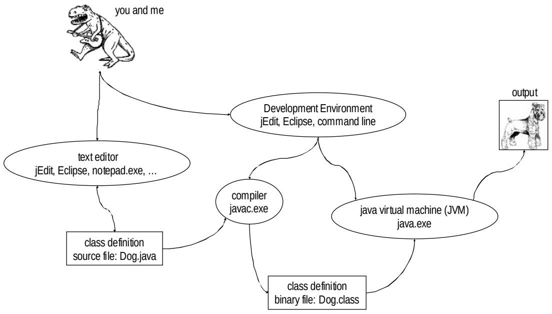
- **javac** - Java compiler
- **java** - Java interpreter
- **jdb** - Java debugger
- **appletviewer** - viewer for Java applets
- **javap** - Java bytecode disassembler
- **javadoc** - Java documentation generator
- Documentation for the JDK can be explored with your Web browser

Installing the JDK

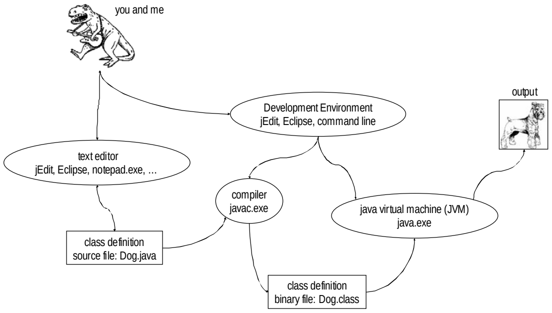
- Instructions on the class software page
- JDK
  - » tools
  - » library sources
- Java API documentation
- Learning and reference materials
  - » Java tutorial

    http://java.sun.com/docs/books/tutorial/
  - » take the time to set up one-click shortcuts now

Our Environment



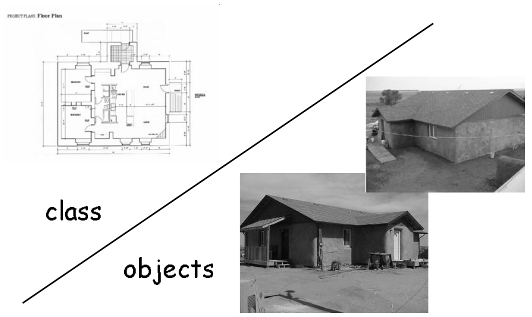
Compile It



Objects and Classes

- A class is a definition of a *type of thing*
  - » The class definition is where we find a description of how things of this type behave.
- An object is a *particular thing*
  - » There can be many objects of a given class. An object is an *instance* of a class.
  - » All objects of a given class exhibit the same behavior.

Houses are instances of blueprints



http://online.caup.washington.edu/programs/uwbasic/go/projects/aih/projects/index.htm

Instantiate - create an object

- Once we create a class definition using an editor and the compiler, we can *instantiate* it with the "**`new`**" operator
  - » `Oval moon = new Oval(100,100,20,20,Color.gray,true);`
- We can then manipulate these objects to do the work that needs to be done
- Note that many classes have already been defined for us

Class Concepts

- Class definitions have two important components:
  - » state
  - » behavior or interface

Class Concepts: State

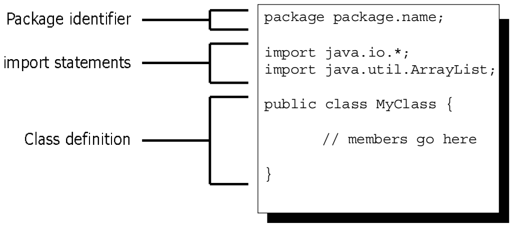
- State is a complete description of all the things that make a class a class.
- For example, part of the state of class Employee is the Employee’s UWNetID
  - » All objects of class Employee will have a UWNetID specified.
- State is stored in data members
  - » also known as fields, member variables, instance variables, properties

Class Concepts: Behavior

- Behavior of a class defines how other classes may interact with it. It indicates the capabilities of the class to “do” things.
- Behavior is defined in methods
  - » Methods look like functions in C, methods in C++, subroutines in Fortran, procedures in Scheme, etc

Structure of Source File

Three components to a Java source file, in order



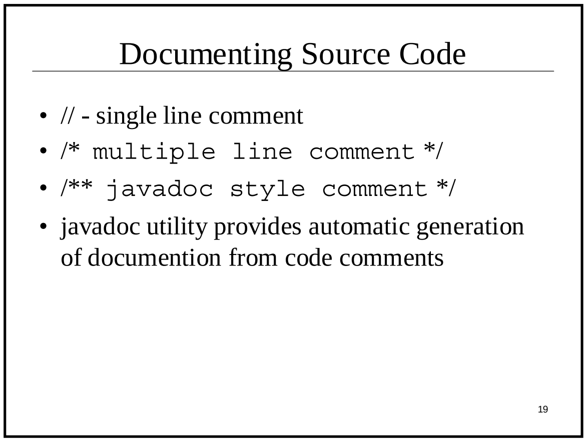
```
package package.name;

import java.io.*;
import java.util.ArrayList;

public class MyClass {

        // members go here

}
```

Example class

```
public class Dog  {
  public Dog(double rate) {
     consumptionRate = rate;
     weight = 20;
  }
  public void bark() { ... }
  public double getRate() { ... }
  public void eat(double pounds) { ... }

  private double consumptionRate;
  private double weight;
}
```

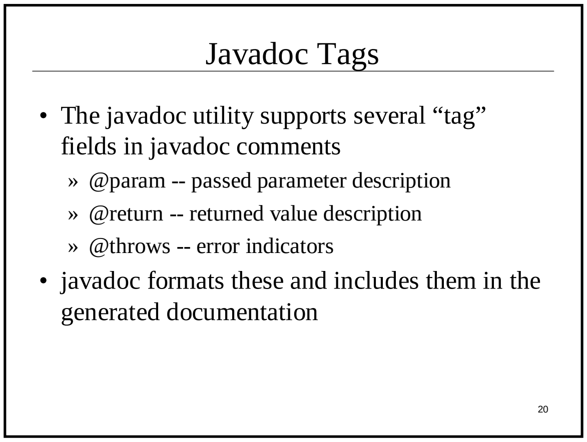
Basic Libraries Sample Members

- java.lang - Object class, numbers, strings, System, Exceptions, Threads and more
- java.io - streams, readers, writer, files
- java.util - Dates, Locales, data structures, zip
- java.net - Sockets, URLs, datagrams, InetAddresses, connections
- java.awt, javax.swing - Graphics, Layout, Event, User Interaction



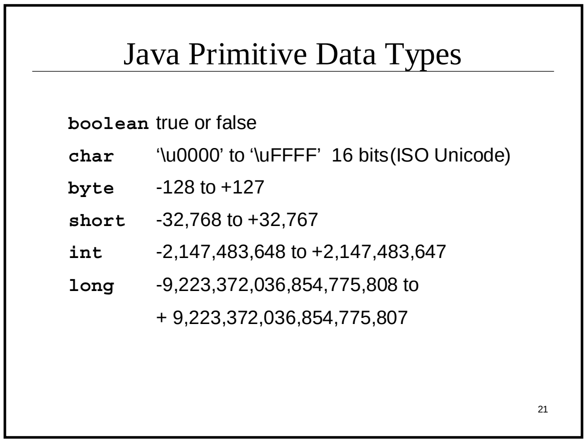
Documenting Source Code

- // - single line comment
- /* `multiple line comment` */
- /** `javadoc style comment` */
- javadoc utility provides automatic generation of documention from code comments



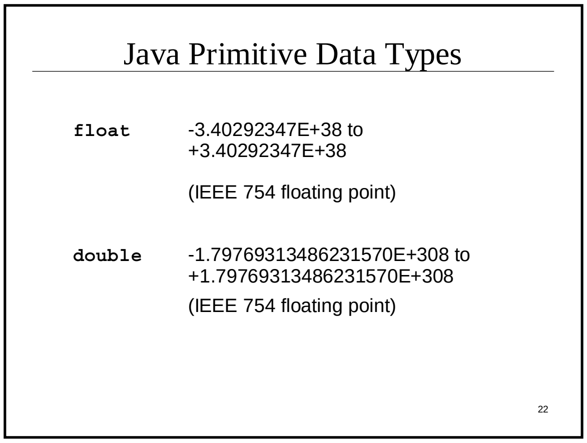
Javadoc Tags

- The javadoc utility supports several “tag” fields in javadoc comments
  - » @param -- passed parameter description
  - » @return -- returned value description
  - » @throws -- error indicators
- javadoc formats these and includes them in the generated documentation



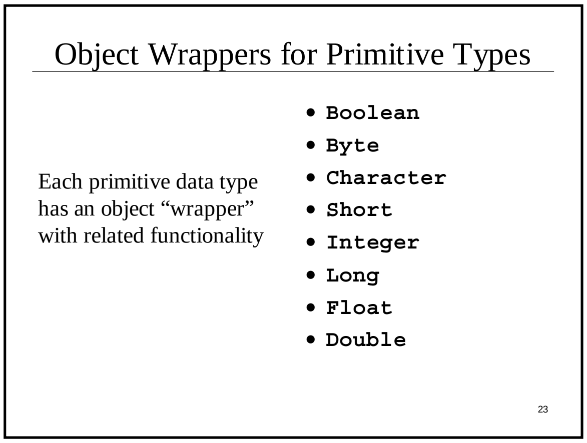
Java Primitive Data Types

`boolean`	true or false
`char`	‘\u0000’ to ‘\uFFFF’ 16 bits(ISO Unicode)
`byte`	-128 to +127
`short`	-32,768 to +32,767
`int`	-2,147,483,648 to +2,147,483,647
`long`	-9,223,372,036,854,775,808 to + 9,223,372,036,854,775,807



Java Primitive Data Types

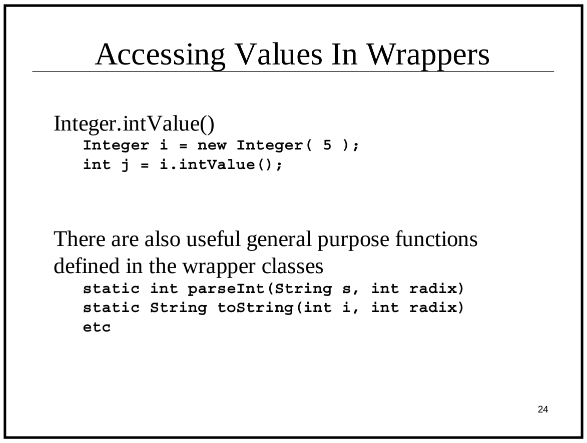
`float`	-3.40292347E+38 to +3.40292347E+38 (IEEE 754 floating point)
`double`	-1.79769313486231570E+308 to +1.79769313486231570E+308 (IEEE 754 floating point)



Object Wrappers for Primitive Types

Each primitive data type has an object “wrapper” with related functionality

- **`Boolean`**
- **`Byte`**
- **`Character`**
- **`Short`**
- **`Integer`**
- **`Long`**
- **`Float`**
- **`Double`**



Accessing Values In Wrappers

Integer.intValue()

```
Integer i = new Integer( 5 );
int j = i.intValue();
```

There are also useful general purpose functions defined in the wrapper classes

```
static int parseInt(String s, int radix)
static String toString(int i, int radix)
etc
```

Sequence and Grouping

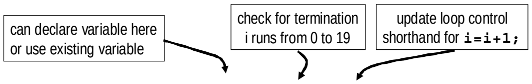
```
//Simple sequence

statement1;
statement2;

//Grouped -- can replace a single
//statement anywhere

{
   statement1;
   statement2;
}
```

Identifiers

- Variable, method, class, or label
- Keywords and reserved words not allowed
- Must begin with a letter, dollar($), or underscore(_)
- Subsequent letters, $, _, or digits
  - » foobar // valid
  - » 3_node // invalid

`for` example

- a counting loop implemented with `for`



can declare variable here or use existing variable

check for termination i runs from 0 to 19

update loop control shorthand for `i=i+1;`

```
for (int i=0; i<20; i++) {
    testB.grow();
}
```

Looper.java

limited life of a loop control variable

- The scope of a local variable declared in the ForInit part of a for statement includes all of the following:
  - » Its own initializer
  - » Any further declarators to the right in the ForInit part of the for statement
  - » The Expression and ForUpdate parts of the for statement
  - » The contained Statement

from Java Language Specification, section 6.3

Short-Circuit Operators

- With && and ||, only as much of the logical expression as needed is evaluated
- Example:

```
int i=1;
if (false && (++i == 2))
   System.out.println(i);
if (true || (++i == 2))
   System.out.println(i);
```

- Don't use increment operator in places where it might not get executed (as in this example)

boolean expressions and variables

- If you find yourself doing something like this

```
if (pageNumber == lastPage) {
  allDone = true;
} else {
  allDone = false;
}
```

- there is an easier way

```
allDone = (pageNumber == lastPage);
```

conditional operator (3 operands)

- If you find yourself doing something like this

```
if (score < 0) {
  color = Color.red;
} else {
  color = Color.black;
}
```

- there is an easier way

```
color = (score < 0) ? Color.red : Color.black;
```

APPENDIX

Packages

- A way to group related classes
- A key part of Java’s encapsulation mechanism
- Class is permanently associated with its package
- Period (.) separated name generally mirrors directory structure where classes are stored
- “Default” package is the current directory
- Classes without a package identifier are in the default package

import - help the compiler find classes

- A class’ full name includes its package.
  - » java.util.ArrayList or java.io.FileReader
- Usually it is more convenient simply to use the class name without the package
- The `import` statement allows this shortcutting
- Classes can be imported individually, or all classes in a package can be imported
- java.lang.* is imported automatically by the compiler
- is not like #include in C/C++

Java Operators are Much Like C/C++

- Arithmetic +, -, *, /, %
- Preincrement and postincrement (++, --)
- Assignment (=, +=, -=, etc.)
- Relational comparison operators (==,<,>,<=,>=)
- Boolean logical operators (!, &&, ||)
- Bitwise operators (~,&,|,^)
- Shift operators (>>, <<,>>>)
- No programmer-defined operator overloading (java does overload + for string concatenation)

Integer division and remainder

- Recall this
  - » value = quotient * divisor + remainder
- The division operator is /

```
int x = 7;
int y = x / 2;
```

  - » **`y`** will have the value 3 at this point
- The remainder operator is %

```
int rem = x % 2;
```

  - » **`rem`** will have the value 1 at this point since 7-(3*2) is equal to 1

increment and decrement

- ++ and -- operators allow you to concisely indicate that you want to *use* and *increment or decrement* a variable's value
- pre-increment : ++i
  - » the value of i is incremented before being used in the expression
- post-increment: i++
  - » the value of i is incremented after being used in the expression
- in a statement by itself, makes no difference
  - » there is no expression of interest, just increment the value

Assignment Operators

- Sets a value or expression to a new value
- Simple uses

```
int a = 10;
```

- Compound +=, *=   in form of *x op= y*, is short hand for *x = x op y*

```
a += 10;
a = a + 10; // equivalent
```

Relational operators

- Relational operators: boolean result

  < less than

  > greater than

  <= less than or equal

  >= greater than or equal

  == equivalence

Boolean Logical Operators

- Used to group, join and change boolean results of relationals

  && logical AND

  || logical OR

  ! logical NOT

Bitwise Operators

- Integers types only, produce int or long

  ~ bitwise not (reverses bits)

  & bitwise and

  | bitwise or

  ^ bitwise exclusive or

```
char aChar = 'c'; // 99 = 0x63 = 110 0011
int mask = 0xF;
int z = (aChar & mask);
```

Shift Operators

- Integers types only, produce int or long

  << (left shift): shifts bits to left

  >> (signed right shift): shifts bits to right, keeps the sign (+ value fills with zeros; - value fills with ones)

  >>> (unsigned right shift): shifts bits to right, fills with zeros regardless of sign

Java Keywords

abstract	boolean	break	byte	case
catch	char	class	continue	default
do	double	else	extends	false
final	finally	float	for	if
implements	import	instanceof	int	interface
long	native	new	null	package
private	protected	public	return	short
static	super	switch	synchronized	this
throw	throws	transient	true	try
void	volatile	while		

Keywords that are reserved but not used in Java

const goto

Literals - boolean, char, String

- true or false
  - » **`boolean isBig = true;`**
  - » **`boolean isLittle = false;`**
- character in an enclosing single quotes
  - » **`char c = 'w';`**
- Unicode
  - » **`char c1 = '\u4567';`**
- String
  - » **`String s = "hi there";`**

Literals - Integer types

- Expressed in decimal, octal, or hexadecimal
  - » 28 = decimal
  - » 034 = octal
  - » 0x1c = hexadecimal
- Default is 32 bits (ie, int)
  - » to get a long literal specify a suffix of L: 4555L

Literals - floating-point

- floating-point numeric value
- decimal point 16.55
- scientific notation, E or e: 4.33E+44
- 32-bit float, suffix F or f : 1.82F
- 64-bit double, suffix D or d: 12345d
- Default without F or D is 64-bit double

The **`if`** statement

```
if (condition) {
    this block is executed if the condition is true
} else {
    this block is executed if the condition is false
}
```

- The condition is a logical expression that is evaluated to be **`true`** or **`false`**, depending on the values in the expression and the operators

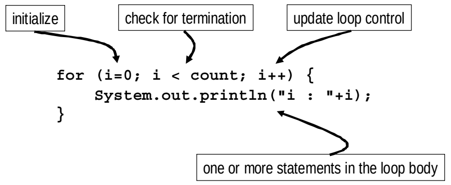
`switch` statement

```
switch (integral type) {

   case value1 : {
      statement1;
      break; //Break out of switch
   }
   case value2 : {
      statement2;
      break;
   }
   default : {
      statement3;
   }

}
```

there are lots of limitations and potential bugs in using this, so be careful!

The **`for`** loop

- A counting loop is usually implemented with **`for`**
  - » The **`for`** statement is defined in section 14.13 of the Java Language Specification



initialize

check for termination

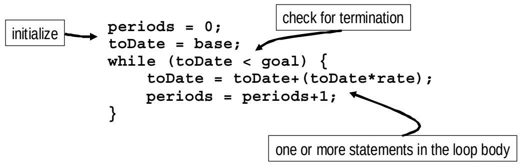
update loop control

```
for (i=0; i < count; i++) {
     System.out.println("i : "+i);
}
```

one or more statements in the loop body

The **`while`** loop

- condition loop is usually implemented with **`while`**
  - » The **`while`** statement is defined in section 14.11 of the Java Language Specification



initialize

check for termination

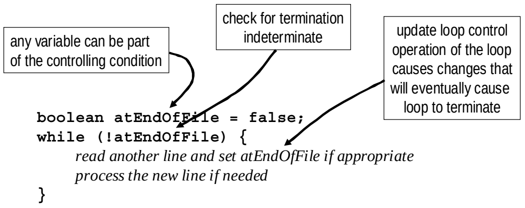
```
periods = 0;
toDate = base;
while (toDate < goal) {
     toDate = toDate+(toDate*rate);
     periods = periods+1;
}
```

one or more statements in the loop body

Note: reaching a limit by counting is satisfying a condition.
`for` loops can be rewritten as **`while`** loops, and vice versa

`while` example

- a condition loop implemented with **`while`**



any variable can be part of the controlling condition

check for termination indeterminate

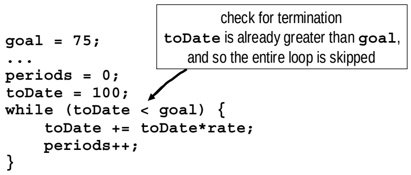
update loop control operation of the loop causes changes that will eventually cause loop to terminate

```
boolean atEndOfFile = false;
while (!atEndOfFile) {
     read another line and set atEndOfFile if appropriate
     process the new line if needed
}
```

Looper.java

body of loop may not execute at all

- Notice that depending on the values of the control variables, it is quite possible that the body of the loop will not execute at all in both **`for`** and **`while`**



check for termination
`toDate` is already greater than **`goal`**, and so the entire loop is skipped

```
goal = 75;
...
periods = 0;
toDate = 100;
while (toDate < goal) {
     toDate += toDate*rate;
     periods++;
}
```

Early terminaton of the loop statement

- A loop is often used to look at all the elements of a list one after another
  - » all the Animals in a PetSet
  - » all the Shapes in a Car
- Sometimes we want to
  - » exit the loop statement early if we find some particular element or condition while we are looping
  - » ie, get out of the loop statement (for, while) entirely

break - jump to loop exit

```
public void snack() {
  for (int i=0; i<theBunch.size(); i++) {
    if (remainingFood <= 0) {
      System.out.println("No food left, so no more snacks.");
      break;
    }
    Animal pet = (Animal)theBunch.get(i);
    double s = Math.min(remainingFood,pet.getMealSize());
    pet.eat(s);
    remainingFood -= s;
  }
  // the break statement takes us here, out of the loop entirely
}
```

Early cycling of the loop

- Sometimes we want to
  - » Stop processing the item we are looking at right now and go on to the next one
- The loop statement (for, while) is still the controlling structure, but we just want to go to the next iteration of the loop

continue - jump to loop end

```
public void dine() {
  for (int i=0; i<theBunch.size(); i++) {
    Animal pet = (Animal)theBunch.get(i);
    double s = 2*pet.getMealSize();
    if (remainingFood < s) {
      System.out.println("Not enough food for "+pet+
        "'s dinner, so we'll skip to next animal.");
      continue;
    }
    pet.eat(s);
    remainingFood -= s;
    // continue takes us here, the end of this loop
  }
}
```

Positional Notation

- Each column in a number represents an additional power of the base number
- in base ten
  - » $1=1*10^0$, $30=3*10^1$, $200=2*10^2$
- in base sixteen
  - » $1=1*16^0$, $30=3*16^1$,$200=2*16^2$
  - » we use A,B,C,D,E,F to represent the numbers between 9_{16} and 10_{16}

Binary, Hex, and Decimal

$2^8=256_{10}$	$2^7=128_{10}$	$2^6=64_{10}$	$2^5=32_{10}$	$2^4=16_{10}$	$2^3=8_{10}$	$2^2=4_{10}$	$2^1=2_{10}$	$2^0=1_{10}$	Hex_{16}	Decimal_{10}
							1	1	3	3
					1	0	0	1	9	9
					1	0	1	0	A	10
					1	1	1	1	F	15
				1	0	0	0	0	10	16
				1	1	1	1	1	1F	31
		1	1	1	1	1	1	1	7F	127
	1	1	1	1	1	1	1	1	FF	255

Binary, Hex, and Decimal

Binary_2	$16^4=65536_{10}$	$16^3=4096_{10}$	$16^2=256_{10}$	$16^1=16_{10}$	$16^0=1_{10}$	Decimal_{10}
11					3	3
1001					9	9
1010					A	10
1111					F	15
1 0000				1	0	16
1 1111				1	F	31
111 1111				7	F	127
1111 1111				F	F	255

Binary, Hex, and Decimal

Binary_2	Hex_{16}	$10^3=1000_{10}$	$10^2=100_{10}$	$10^1=10_{10}$	$10^0=1_{10}$
11	3				3
1001	9				9
1010	A			1	0
1111	F			1	5
1 0000	10			1	6
1 1111	1F			3	1
111 1111	7F		1	2	7
1111 1111	FF		2	5	5