



Basic Input and Output

Methods for reading input and writing output.

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Display output

```
System.out.println("I'm a string" + " again");
```

```
System.out.print("apple");
```

```
System.out.print("banana\n");
```

```
System.out.print("grape");
```

```
I'm a string again
```

```
applebanana
```

```
grape
```

Input

System.in can only read bytes. Not very useful.

```
int c = System.in.read( ); // read 1 byte
byte[] b;
System.in.read( b ); // array of bytes
```

Use a Scanner to read input as int, double, String, etc.

```
Scanner console = new Scanner(System.in);
String word = console.next();
String line = console.nextLine();
int number = console.nextInt();
double x = console.nextDouble();
```

Console Output: `print`

`System.out` is a `PrintStream` object.

It has a "`print`" method to output (display) :

- any primitive data type
- a String
- any Object

```
int a = 100;
System.out.print("a = "); // print a string
System.out.print(a);      // print an int
System.out.print('\t');   // print a TAB char
System.out.print("Square Root of 2 = ");
System.out.print(Math.sqrt(2)); // print double
```

```
a = 100    Square Root of 2 = 1.4142135623730951
```

Console Output: `println`

`println` is like `print`, but after printing a value it also outputs a newline character to move to start of next line.

`println` can output:

- any primitive type
- a String
- any Object: it automatically calls `object.toString()`

```
System.out.print("a = "); // print a string
System.out.println(a);    // print an int
System.out.println();     // empty line
System.out.println(1.0/3.0); // print double
```

```
a = 100
```

```
0.3333333333333333
```

More on `print` and `println`

To print several values at once, if the *first value is a String*, you can "join" the other values using +

```
System.out.println("a = " + a);
```

Is the same as:

```
System.out.print("a = ");           // print a string  
System.out.println(a);             // print an int
```

```
a = 100
```

Printing an Object

If the argument is an object, Java will call the object's `toString()` method and print the result.

```
Date now = new Date( );  
System.out.println( now );  
    // invokes now.toString()
```

Common Error

ERROR:

```
double angle = Math.toRadians(45);  
double x = Math.sin(angle);  
System.out.println("sin(" , angle ,") = " , x);
```

mus use + not comma

Formatted Output: printf

Creating nice output using println can be difficult.

```
public class SalesTax {
    public static final double VAT = 0.07; // 7% tax
    public static void showTotal( double amount ) {
        double total = amount * ( 1.0 + VAT );
        System.out.println("The total including VAT is "
            +total+" Baht");
    }
    public static void main( String [] args ) {
        showTotal(10000);
        showTotal(95);
    }
}
```

```
The total including VAT is 10700.0 Baht
```

```
The total including VAT is 104.86 Baht
```

printf

Java 1.5 added a "printf" statement similar to C:

```
public static void showTotal( double amount) {
    double total = amount * ( 1.0 + VAT );
    System.out.printf(
        "The total including VAT is %8.2f Baht", total);
}
public static void main( String [] args ) {
    showTotal(10000);
    showTotal(95);
}
```

Format: output a float (%f) using 8 characters with 2 decimal digits

The total including VAT is 10700.00 Baht

The total including VAT is 104.86 Baht

printf Syntax

The syntax of printf is:

```
System.out.printf (Format_String, arg1, arg2, ... ) ;  
or (no arguments):  
System.out.printf (Format_String) ;
```

The *Format_String* can contain text and format codes. Values of arg1, arg2, are substituted for the format codes.

```
int x = 100, y = 225;  
System.out.printf("The sum of %d and %d is %6d\n",  
                x, y, x+y );
```

%d is the format code to output an "int" or "long" value.

%6d means output an integer using exactly 6 digit/spaces

printf Syntax

Example: print the average

```
int x = 100, y = 90;  
System.out.printf("The average of %d and %d is %6.2f\n",  
    x, y, (x+y)/2.0 );
```

%6.2f means output a floating point using a width of 6 and 2 decimal digits.

The average of 100 and 90 is 95.00

%d

%6.2f

Common printf Formats

Format	Meaning	Examples
%d	decimal integers	%d %6d
%f	fixed pt. floating-point	%f %10.4f
%e	scientific notation	%10e (1.2345e-02)
%g	general floating point (use %e or %f, whichever is more compact)	%10g
%s	String	%s %10s %-10s
%c	Character	%c

```
String owner = "Taksin Shinawat";  
int acctNumber = 12345;  
double balance = 4000000000;  
System.out.printf("Account %6d Owner %-18s has %10.2f\n",  
    acctNumber, owner, balance );
```

```
Account 12345 Owner Taksin Shinawat has 4000000000.00
```

More details on printf

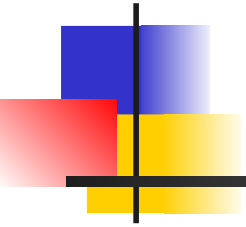
- `printf` is an *instance of the* **Formatter** class.
- It is predefined for `System.out`.
- `System.out.printf(...)` is same as `System.out.format(...)`.
- For complete details see Java API for "Format".
- For tutorial, examples, etc. see:
 - *Sun's Java Tutorial*
 - *Core Java*, page 61.

String.format

A useful method that creates a String using a format.

```
/** describe a bank account */  
String name = "John Doe";  
long accountId = 12345;  
double balance = 123.456;  
String result = String.format(  
    "Acct: %09d Owner: %s Balance: %.2f",  
        accountId, name, balance );  
return result;
```

```
Acct: 000012345 Owner: John Doe Balance: 123.46
```



Input

Input byte-by-byte

`System.in` is an `InputStream` object.

It reads data **one byte at a time**, or an array of bytes.

Use `System.in.read()` to get "raw" data, such as an image:

```
int a = System.in.read( );
if (a < 0) /* end of input */;
else {
    byte b = (byte)a;
    handleInput( b );
}
```

Boring, isn't it?

Input Line-by-Line

To get a line of input as a String, you can create a `BufferedReader` object that "wraps" `System.in`.

```
BufferedReader reader = new BufferedReader(  
    new InputStreamReader( System.in ) );  
String s = reader.readLine( ); // read one line
```

The `readLine()` method removes the NEWLINE (`\n`) from the input, so you won't see it as part of the string.

Check for end of data

If there is no more data in the input stream, `readLine()` returns a null String.

For console input, `readLine()` will *wait (block)* until user inputs something.

Here is how to test for end of data:

```
BufferedReader reader = new BufferedReader(  
    new InputStreamReader( System.in ) );  
String s = reader.readLine( ); // read one line  
if ( s == null ) return; // end of data
```

Handling I/O Errors

When you use `System.in.read` or a `BufferedReader` an input error can occur -- called an *IOException*.

Java requires that your program either "catch" this exception to declare that it might "throw" this exception.

To be lazy and "throw" the exception use:

```
public static void main(String [] args)
    throws IOException {

    BufferedReader reader = new BufferedReader(
        new InputStreamReader( System.in ) );
    // read a line of input
    String inline = reader.readLine( );
```

Catching I/O Errors

To "catch" the exception and do something, use:

```
BufferedReader reader = new BufferedReader(  
    new InputStreamReader( System.in ) );  
  
// read a line of input.  
// display message and return if error  
String line = null;  
try {  
    line = bin.readLine( );  
    buf.append( line );  
}  
catch( IOException ioe ) {  
    System.err.println( ioe.getMessage() );  
    return;  
}
```

Flexible Input: Scanner class

The `Scanner` class allow much more flexible input.

A Scanner can:

- ▣ read entire line or one word at a time
- ▣ test for more data
- ▣ test if the *next* input (word) is an int, long, double, etc.
- ▣ read input and convert to int, long, float, double
- ▣ *skip unwanted data*
- ▣ report errors (*Exceptions*) that occur

Import Scanner

Scanner is a "utility" so it is package `java.util`.
You should import this class to use it:

```
package myapp;  
import java.util.Scanner;  
...  
  
public class InputDemo {
```

Create a Scanner Object

Scanner "wraps" an InputStream.

You give the InputStream object as parameter when you create a Scanner object...

```
// create a Scanner to read from System.in  
Scanner console = new Scanner( System.in );
```


Where to Create Scanner object?

1) You can create a Scanner as a local variable

```
public void myMethod( ) { // no IOException !  
    // create a Scanner as a local variable  
    Scanner in = new Scanner( System.in );  
    // read some different types of data  
    int count = in.nextInt( );  
}
```

2) or create as an attribute.

Typically a *static* attribute since System.in is static.

```
public class InputDemo {  
    // create a Scanner as static attribute  
    static Scanner console =  
        new Scanner( System.in );  
  
    // can use console in any method.  
}
```

Using Scanner

Look at some simple examples

```
public void myMethod( ) { // no IOException !
    // create a Scanner to process System.in
    Scanner in = new Scanner( System.in );

    // read some different types of data
    int count = in.nextInt( );
    long big   = in.nextLong( );
    float x    = in.nextFloat( );
    double y   = in.nextDouble( );

    // read Strings
    String word = scan.next( ); // next word
    String line = scan.nextLine( ); // next line
```

Input Errors

If you try to read an "int" but the next input is *not* an integer then Scanner throws an InputMismatchException

```
Scanner scan = new Scanner( System.in );  
  
// read a number  
System.out.print("How many Baht? ");  
int amount = scan.nextInt( );
```

convert next input
word to an "int"

```
How many Baht?    I don't know  
Exception in thread "main"  
java.util.InputMismatchException
```

How to Test the Input

Scanner has methods to **test** the next input value:

```
Scanner scanner = new Scanner( System.in );
int amount;
// read a number
System.out.print("How many Baht? ");
if ( scanner.hasNextInt( ) )
    amount = scanner.nextInt( );
else {
    System.out.println("Please input an int");
    scanner.nextLine(); // discard old input
}
```

true if the next input value is an "int"

```
How many Baht?    I don't know
Please input an int
```

Testing the input

So now you can check for invalid input.

But, what do you do with the bad input?

If `scan.hasNextInt()` is false, then the program doesn't read it.

So, the bad input is still waiting to be read. Like this:



How many Baht? I don't know

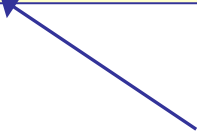
Next input value to read.

We want to **remove** this **bad input**, so we can ask the user to try again. ...what should we do?

Discarding the input

If the input is wrong, then *throw it away* by reading the line and discarding it.

```
Scanner scanner = new Scanner( System.in );
int amount;
// read a number
System.out.print("How many Baht? ");
if ( scanner.hasNextInt( ) )
    amount = scanner.nextInt( );
else {
    System.out.println("Please input an int");
    scanner.nextLine(); // discard input
}
```



get the input line but don't assign it to anything! (discard it)

Useful Scanner Methods

Return type	Method	Meaning
String	<code>next()</code>	get next "word"
String	<code>nextLine()</code>	get next line
int	<code>nextInt()</code>	get next word as int
long	<code>nextLong()</code>	get next word as long
float	<code>nextFloat()</code>	get next word as float
double	<code>nextDouble()</code>	get next word as double
boolean	<code>hasNext()</code>	true if there is more input
boolean	<code>hasNextInt()</code>	true if next word can be "int"
boolean	<code>hasNextLong()</code>	true if next word can be "long"
boolean	<code>hasNextFloat()</code>	true if next word can be "float"
boolean	<code>hasNextDouble()</code>	true if next word can be "double"

See Java API for `java.io.Scanner` for a complete list of methods.

Input/Output Example

Read some numbers and output their sum...

```
Scanner scanner = new Scanner( System.in );
double sum = 0.0;
// prompt user for input
System.out.print("Input some numbers: ");
// read as long as there are more numbers
while ( scanner.hasNextDouble( ) ) {
    double x = scanner.nextDouble( );
    sum = sum + x;
}
System.out.println();
System.out.println("The sum is "+sum);
```

