The Java Language

Reference: The Java Language Specification, 2nd ed.

http://java.sun.com/docs/books/jls/second_edition/html/jTOC.doc.html

Language Elements

Types

Literals

Variables

Operators

Control Structures

Exceptions

Arrays

Data Types

Everything that has a *value* also has a *type*.

- anything that can be stored in a variable, passed to a method, returned from a method or operated on by an operator.

In Java there are two kinds of types:

- Primitive Types
  - *Builtin data types.*
- Reference Types
  - *Everything else, including objects*

Primitive Types

char: unicode (2 bytes each!)

Integral types

- **byte**: 8 bit signed 2's complement integer
- **short**: 16 bit signed 2's complement integer
- **int**: 32 bit signed 2's complement integer
- **long**: 64 bit signed 2's complement integer

More Primitive Types

Floating Point

- **float** 32 bit IEEE 754
- **double** 64 bit IEEE 754 (double precision)

boolean: **true** or **false** only

- not like C/C++: 0 doesn't mean false !

Reference Types

Everything that is not a primitive type is a *reference type.*

Three kinds of reference types:

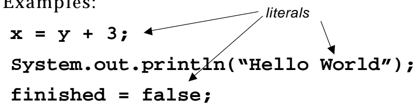
- Classes
- Arrays
- Interfaces

Literals

Literals are fixed values found in a program.

- we don't use the term "constant" for this, we use "constant" for something else...

Examples:




```
x = y + 3;
System.out.println("Hello World");
finished = false;
```


Boolean Literals

There are only two:

true

false

Integer Literals

Default is decimal (base 10). Examples

`23    100    0    1234567`

Java also supports hexadecimal (base 16).

`0x23    0x1    0xaf3c21    0xAF3C21`

and octal (base 8)

`023    01    0123724`

any integer literal that starts with a leading 0 is treated by Java as an octal number!

Long Literals

Literal has the suffix 'l' or 'L'

```
23L   100l   0xABCDEF01234L
```

Without the trailing 'l' any integral literal is an **integer** type.

Floating Point Literals

Decimal only (base 10).

Optional suffix:

- 'f' or 'F' means **float**
- 'd' or 'D' means **double**

```
12.5   6.02E23D   1.5e-4
```


Character Literals

characters are represented using unicode, not ASCII.

- we (programmers) don't have to deal with this issue as much as you might think.
- character literals look just like they do in C/C++

```
'a'   'b'   'C'   '\n'   '\t'
```

- anything that starts with \u is treated as hex encoding of the unicode number

```
'\u03df'        '\u003f'
```

Other Literals

There are also string literals

```
"Hello World"
```

and array literals (used only for initialisation):

```
int a[] = {1,3,5,7,9};
```


Variables

Storage location (chunk of memory) and an associated type.

- type is either a primitive type or a reference type.

For primitive type variables, a variable holds the actual value (the memory is used to store the value).

For reference type variables, a variable holds a reference to an object.

Variable Names

Variable names are *identifiers* (so are class names, interface names, method names, ...)

Identifiers are made of any length sequence of letters, digits and the underscore character '_'.

- The character '$' is also supported, but is generally only used by code generators, not by humans.

The first character of an identifier must not be a digit.

Kinds of variables

There are lots of kinds of variables, we will bump in to the various kinds as we go...

class variables (static)

instance variables

parameters (method, constructor, exception handler)

local variables

array components

Operators

arithmetic/logical

assignment

boolean/relational (comparison)

string

Arithmetic/Logic Operators

additive: `+` `-` *(unary and binary operators)*

multiplicitive: `*` `/` `%`

increment/decrement: `++` `--`

bitwise: `&` `|` `^` `~`

shift: `<<` `>>` `>>>`

Assignment Operators

```
=
+=   -=    *=    /=    %=   <<= …
```

- You can use any of the arith/logic operators with assignment.

An assignment expression has a value (just like in C/C++):

```
a = (b = 3);
x +=  (y -=2) +2;
```


Boolean/Relational Operators

Equality: `==` `!=`

Inequality: `<` `>` `<=` `>=`

Conditional AND: `&&`

Conditional OR: `||`

Comparison of reference types is an important issue (the above operators might not do what you think they do)!

The + String Operator

Strings in Java are objects (just like any other object), except that the language includes special support:

- String literals are part of the language.
- The string concatenation operator **+** is part of the language.

```
System.out.println("Hello " + "World");
```

Control Structures

if
if/else
do
while
for
switch

Syntax is very similar (in most cases identical) to C/C++

if

```
if ( condition )
  statement;

if ( condition ) {
  statement1;
  statement2;
  …
}
```

example code

```
if ( a < 12 )
  b = 45;

if ( x.length()<10) {
  x = x + "BLAH";
  y=x.length()-3;
}
```


if else

```
if ( condition )
  statement;
else
  statement;
```

```
if ( a < 12 )
  b = 45;
else {
  if ( x<10 || y>2 )
    z=3;
}
```

while loop

```
while ( condition )
  statement;
```

```
i = 0;
x = 0;
while (i < 10) {
   x = x + i;
   i++;
}
```


do

```
do
  statement;
while ( condition )
```

```
i=0; x=0;
do {
  x += i;
  i++;
} while ( i<10 );
```


for

```
for ( initialization; condition; incrementor )
   statement;
```

initialization code is executed only once (before anything else)

condition is evaluated before ***statement*** is executed (every time).

incrementor code is executed after ***statement*** (every time).

`for` examples

```
for (i=0; i<10; i++)
  System.out.println("i is " + i);

for (int j=10; j>=0; j=j-2 ) {
  System.out.println("j is " + j);
   if (j>x)
      break;
}
```


`switch`

```
switch ( int expression ) {
   case int expression :
     statement;
     break;
   case int expression :
     statement;
     break;
   default :
     statement;
}
```


`switch` example

```
switch(food) {
  case 1:
    System.out.println("Chicken");
    break;
  case 2:
    System.out.println("Pizza");
    break;
  default:
    System.out.println("Sorry, we are out");
}
```

break and **continue**

The **break** statement is similar to C++:

- get out of a loop or case

break can also specify a loop *target* (a label in the code). This allows **break** to jump out of nested loops.

continue is used in loops to jump back to the beginning of the loop (skipping any statements between the **continue** and the end of the loop).

break examples

```
for (int i=0;i<10;i++) {
   System.out.println("i is " + i);
   if (i==3) break;
}

outer: for (int j=0;j<5;j++) {
   for (int k=0;k<5;k++) {
     if (k==3) break outer;
     System.out.println("j,k: " + j + "," + k);
   }
}
```


continue examples

```
for (int i=0;i<10;i++) {
   System.out.println("i is " + i);
   if (i==3) continue;
}

outer: for (int j=0;j<5;j++) {
   for (int k=0;k<5;k++) {
     if (k==3) continue outer;
     System.out.println("j,k: " + j + "," + k);
   }
}
```

Exceptions

The Java language provides support for handling errors (or any kind of unusual condition).

This is also available in C++, although it is not required (and often not used).

If you want to use any Java libraries you need to understand exceptions (and you can't do much of anything in Java unless you use libraries!).

Exception Handling

When an *exception* occurs, control is *thrown* to a special chunk of code that deals with the problem.

This frees your chunks of code from needing lots of error handling code.

- you still have to write code to deal with errors, but it goes in a special place and once chunk of error handing code can take the place of lots of error handling/checking code.

Advantages of Exceptions

You don't need to return error codes from methods.

- instead you indicate errors by using a special construct : you *throw* an error.

You do need to think about what kind of errors can occur.

- In some other languages you are free to ignore the possibility of errors. Is this a feature or weakness?

`try/catch`

```
try {
   statements . . .
} catch (ExceptionType ename) {
   error handling statements . . .
}
```

This is the code that might generate exceptions (error conditions)

This is the code that deals with exceptions.

`try/catch` examples

```
try {
   readFromFile("datafile");
} catch (FileNotFoundException e) {
   System.err.println("Error: File not found");
}
```

```
try {
   readFromFile("datafile");
} catch (Exception e) {
   System.err.println("Error: " + e );
}
```


Multiple `catches`

```
try {
   statements . . .
} catch (ExceptionType1 ename1) {
   error handling statements . . .
} catch (ExceptionType2 ename2) {
   error handling statements . . .
} catch (ExceptionType3 ename3) {
   error handling statements . . .
}
```

Generating Exceptions

Many libraries (objects) generate exceptions when things go wrong. You will need to catch those exceptions!

You can generate an exception with the **`throw`** keyword:

```
if (x > 100)
  throw new Exception("x is too big");
```


Exceptions are objects

There are many exception types that are already defined (and documented in the Java API docs).

Exceptions types are defined as an object type (a class).

- we will look at this more closely once we deal with creating classes and inheritance.

Arrays

Arrays are objects.

- Sort-of.
- With special support in the language.

Array syntax is very similar to C/C++

Every array access is checked (at run time) to make sure it is within the bounds of the array.

- arrays have fixed sizes (like in C/C++).

Array of what?

You can have an array of anything, but all the elements of an array are the same type.

- any primitive type.
- any reference type.

You need to declare the type of an array (the type of each element).

You also need to explicitly create an array

- just declaring the type is not enough.

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Array variable declaration

```
element_type [] variablename;
```

Examples:

```
int [] foo;
String [] studentNames;
```

These variable now exist, but there are not yet any arrays!

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Creating an Array

You use the Java **`new`** operator:

```
foo = new int [100];
studentNames = new String[20];
```

You often see both declaration an creation like this:

```
int [] foo = new int [100];
String [] studentNames = new String[20];
```

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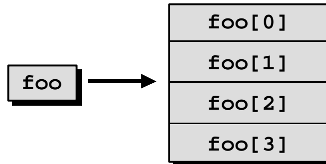
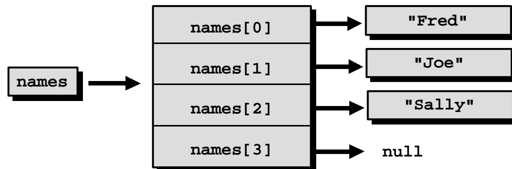
An important picture

```
int [] foo = new int [4];
```



An even more important picture

```
String [] names = new String [4];
```



Array Length

The length of an array is available as a *field* of the array.

```
byte [] buff = new byte[100];
for (int i=0;i<buff.length;i++)
  buff[i]=i;
```

Array initializers

You can use an *array literal* to create an array

- you assign the literal to the array variable.

```
int [] foo = { 8, 2, 1, 4, 5 };
for (int i=0;i<foo.length;i++)
   System.out.println("foo["+i+"]="+foo[i]);
```