

Lexical Structure (Chapter 3, JLS)

- A Java source code file is viewed as a string of unicode characters, including line separators.
- A Java source code file is segregated into recognizable substrings known as input elements.
- Some input elements—white space and comments—are ignored.
- Some input elements—identifiers, literals, separators and operators—are relevant.

- White Space

$(\text{HT} \mid \text{LF} \mid \text{VT} \mid \text{FF} \mid \text{CR} \mid \text{ })^+$

- ignored by the compiler
- serves to delimit other input elements
- subject to conventions on indentation, spacing, empty lines

- Comment

`/* ... */`

`// ... (CR | LF | CRLF)`

`/** ... */`

- ignored by the compiler
- traditional, end-of-line and documentation comments

- Identifier

$(\text{Letter} \mid _ \mid \$)(\text{Letter} \mid \text{Digit} \mid _ \mid \$)^*$

- names a variable or method (beginning conventionally with a lower-case letter)
- names a class (beginning conventionally with an upper-case letter)
- some identifiers are reserved, known as keywords

- Integer Literal

$0 \mid 1-9\textit{Digit}^*[1 \mid \textit{L}]$
 $0(\textit{x} \mid \textit{X})(\textit{Digit} \mid \textit{a-f} \mid \textit{A-F})^*[1 \mid \textit{L}]$
 $0(0-7)^+[1 \mid \textit{L}]$

- represents an integer number
- decimal, hexadecimal and octal integer literals

- Floating-Point Literal

$\textit{Digit}^+.\textit{Digit}^*[\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D}]$
 $\textit{Digit}^+.\textit{Digit}^*(\textit{e} \mid \textit{E})[+ \mid -]\textit{Digit}^*[\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D}]$
 $.\textit{Digit}^*[\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D}]$
 $.\textit{Digit}^*(\textit{e} \mid \textit{E})[+ \mid -]\textit{Digit}^*[\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D}]$
 $\textit{Digit}^*(\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D})$
 $\textit{Digit}^*(\textit{e} \mid \textit{E})[+ \mid -]\textit{Digit}^*[\textit{f} \mid \textit{F} \mid \textit{d} \mid \textit{D}]$

- represents an (approximate) real number
- decimal or scientific notation floating-point literals

- Boolean Literal

`true` | `false`

- Character Literal

'Character'

- represents a single Unicode character
- characters ' and \ are represented in a string by \' and \\

- String Literal

"Character"*

- represents a finite sequence of Unicode characters
- characters " and \ are represented in a string by \" and \\
- characters HT, LF, FF and CR are represented in a string by \t, \n, \f and \r

- Separator

(|) | [|] | { | } | ; | , | .

- Operator

= | > | < | ! | ~ | ? | : |
== | <= | >= | != | && | || | ++ | -- |
+ | - | * | / | & | | | ~ | % | << | >> | >>> |
+= | -= | *= | /= | &= | |= | ^= | %= | <<= | >>= | >>>=

Types, Values and Variables (Chapter 4, JLS)

Primitive Types	Values	Representation
boolean	{false, true}	1-bit (possibly padded to 1 byte)
Numeric Types		
Integral Types	$\subseteq \mathbf{Z}$	
byte	$-2^7 \dots (2^7 - 1)$	8-bit signed two's complement
short	$-2^{15} \dots (2^{15} - 1)$	16-bit signed two's complement
int	$-2^{31} \dots (2^{31} - 1)$	32-bit signed two's complement
long	$-2^{63} \dots (2^{63} - 1)$	64-bit signed two's complement
char	$0..(2^{16} - 1)$	16-bit Unicode (www.unicode.org)
Floating-Point Types	$\subseteq \mathbf{R}$	
float		32-bit ANSI/IEEE Standard 754
double		64-bit ANSI/IEEE Standard 754
Reference Types		
Class Type	user-defined objects	
e.g. Object		
e.g. String		
Array Type	sequence of <i>Type</i>	
e.g. int []		
e.g. String []		

Variables

Primitive Types

- Value stored in variable
 - e.g. `boolean x = true;`
 - e.g. `int y = 5;`
 - e.g. `char z = 'A';`
- Default value stored is false or 0
 - e.g. `boolean x;`
 - e.g. `int y;`
- final variables can be assigned at most once
 - e.g. `final int SIZE = 10;`
 - e.g. `final char EXCELLENT = 'A';`
 - e.g. `final float PI = 3.14159;`

Reference Types

- Reference (i.e., pointer) to value (i.e., object) stored in variable
 - e.g. `String x = "hello";`
 - e.g. `Widget y = new Widget();`
 - e.g. `int[] z = {3, 2, 4, 5};`
- Default reference stored is null, which refers to nothing
 - e.g. `String x;`
 - e.g. `int[] y;`
- final variables can be assigned at most once; however, objects to which they refer can be modified
 - e.g. `final String GREETING = "hello";`
 - e.g. `final int[] CUTOFFS = {90, 80, 70, 60};`

Expressions (Chapter 15, JLS)

Literals

Variables

Operations:

Prec./Assoc.	Category	Operator	Operand(s)	Result	
high	n/a	Postfix	++ --	numeric variable	numeric value, before side effect
↓	n/a	Prefix	++ --	numeric variable	numeric value, after side effect
↓	←	Unary	+ - ~ !	$\left\{ \begin{array}{l} \text{numeric (+ -)} \\ \text{integral (~)} \\ \text{boolean (!)} \end{array} \right.$	$\left\{ \begin{array}{l} \geq 32\text{-bit numeric value} \\ \geq 32\text{-bit integral value} \\ \text{boolean value} \end{array} \right.$
↓	→	Multiplicative	* / %	numeric, numeric	$\geq 32\text{-bit numeric value}$
↓	→	Additive	+ -	numeric, numeric	$\geq 32\text{-bit numeric value}$
↓	→	Shift	<< >> >>>	integral, integral	$\geq 32\text{-bit integral value}$
↓	n/a	Relational	< > <= >=	numeric, numeric	boolean value
↓	→	Equality	== !=	$\left\{ \begin{array}{l} \text{boolean, boolean} \\ \text{numeric, numeric} \\ \text{reference, reference} \end{array} \right.$	boolean value
↓	→	Bitwise	$\left\{ \begin{array}{l} \& \\ \wedge \\ \end{array} \right.$	$\left\{ \begin{array}{l} \text{boolean, boolean} \\ \text{integral, integral} \end{array} \right.$	$\left\{ \begin{array}{l} \text{boolean value} \\ \geq 32\text{-bit integral value} \end{array} \right.$
↓	→	Boolean	$\left\{ \begin{array}{l} \&\& \\ \end{array} \right.$	boolean, boolean	boolean value, short-circuit
↓	←	Conditional	?:	boolean, any, any	value, short-circuit
low	←	Assignment	= *= /= %= += -= <<= >>= >>>= &= ^= =	$\left\{ \begin{array}{l} \text{variable, any (=)} \\ \text{numeric variable, numeric (*= /= %= += -=)} \\ \text{integral variable, integral (<<= >>= >>>= \&= ^= =)} \\ \text{boolean variable, boolean (\&= ^= =)} \end{array} \right.$	value, after side effect

- Order of operations determined by
 - 1) parentheses
 - 2) precedence
 - 3) associativity
- Evaluation: result (and possible side effect) obtained by
 - 1) evaluating left operand
 - 2) evaluating right operand (unless short-circuit)
 - 3) applying operation

Statements (Chapter 14, JLS)

- Block

{ Statement }*

- used to execute a sequence of statements

- Empty statement

;

- has no effect

- Labeled statement

Identifier : Statement

- used with labeled break and continue statements

- Local variable declaration

[final] Type Identifier [= Expression](, Identifier [= Expression]) ;*

- used to create local variable(s) and optionally assign initial value(s)
- scope of variable is from point of declaration to end of block in which declared

- Expression

Expression ;

- *Expression* must have a side effect

- if statement

if (Expression) Statement [else Statement]

- condition *Expression* must be of type boolean

- switch statement

switch (Expression) { ((case Expression :)+ Statement⁺)[default : Statement⁺] }*

- condition *Expression* must be integral
- case *Expression*(s) must be integral constant (literal or final variable)

- while statement
 - while (*Expression*) *Statement*
 - condition *Expression* must be of type boolean
- do statement
 - do *Statement* while (*Expression*) ;
 - condition *Expression* must be of type boolean
- for statement
 - for ([*Expression*(, *Expression*)*]; [*Expression*]; [*Expression*(, *Expression*)*]) *Statement*
 - for (*LocalVariableDeclaration*; [*Expression*]; [*Expression*(, *Expression*)*]) *Statement*
 - initial *Expression*(s) must have a side effect
 - condition *Expression* must be of type boolean
 - update *Expression*(s) must have a side effect
- break statement
 - break [*Identifier*] ;
 - must occur inside a switch, while, do or for statement
- continue statement
 - continue [*Identifier*] ;
 - must occur inside a while, do or for statement

Arrays (Chapter 10, Sections 15.10 and 15.13, JLS)

- Arrays are objects that contain zero or more component variables.
- Arrays are homogeneous—components have the same type.
- Arrays are created dynamically (as the program executes).
- The length of an array is the number of components therein; it does not change after creation.

- Array type

Type (*[]*)⁺

- component type may be any *Type* (including array types)
- dimension is number of pairs of *[]*

- Array initializer

{ [*Expression* (, *Expression*)^{*}] [,] }

{ [*ArrayInitializer* (, *ArrayInitializer*)^{*}] [,] }

- creates an array
- components are assigned from expression values
- length is number of expressions or array initializers

- Array creation expression

new ArrayType ArrayInitializer

- creates an array having a specific component type
- dimension, length and compatible component values can be given

new Type ([*Expression*])⁺ (*[]*)^{*}

- dimension and lengths (in some dimensions) can be given by expression values

- Array type local variable declaration

[*final*] *ArrayType Identifier* [= *Expression*] (, *Identifier* [= *Expression*])^{*} ;

[*final*] *ArrayType Identifier* [= *ArrayInitializer*] (, *Identifier* [= *ArrayInitializer*])^{*} ;

- used to create local array variable(s) and optionally assign initial component value(s)
- expressions must be array creation expressions
- scope of variable is from point of declaration to end of block in which declared

- Array access expression

Expression [*Expression*]

- array reference expression must be array type and have non-null value
- index expression must be integral type and have value between 0 and length-1
- first, second, third, . . . components are accessed by index expression values 0, 1, 2, . . .

- Array length expression

Identifier . *length*