

JAVA VARIABLES

(Primitive Data Types In Depth)

* What is a variable?

- It is a container which holds a value
- How to declare?

- Datatype Variable Name = value;

Eg: int x = 1;

boolean xyz = True;

↓ ↑ ↑
Datatype Variable name Value

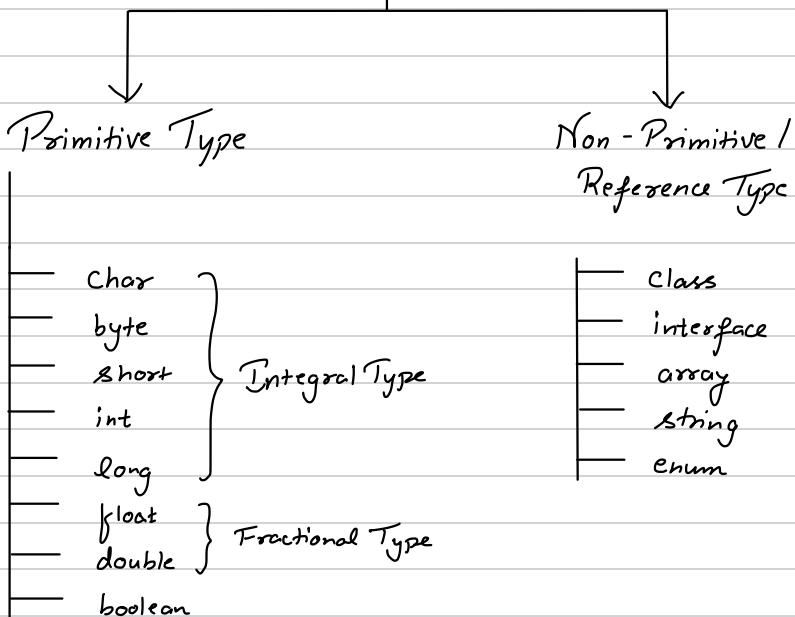
* Java is Static typed language i.e we mandatorily have to define the datatype of a variable.

* Java is a Strongly Typed Language i.e there is a restriction on what value can be assigned to a variable.

⇒ Variable Naming Convention:-

- Variable name is case sensitive.
- Variable name can be any legal identifier means can contain Unicode letters & Digits
- Variable name can start with \$, _ (underscore) and letter.
- Variable name cannot be Java reserved Keyword like "new", "class", "while", "for", "interface", "int", "float" etc.
- Variable should be small if it contains only 1 word else camel case should be followed.
- For constant, variable name should be defined in Capital Letters.

Types Of Variables



So, there are 8 types of primitive variables :-

1) char

- 2 bytes i.e 16 bits
- Character representation of ASCII values
- Range : 0 to 65535 i.e. '\u0000' to '\uffff'
- Default value is '\u0000' i.e NUL

2) byte

- 1 byte i.e 8 bits
- Signed 2^8 complement
- Range : -128 to 127

- default value is 0

$\begin{array}{r} 0 \\ \swarrow \\ \text{positive} \end{array} \quad - - - - -$

$\begin{array}{r} 1 \\ \swarrow \\ \text{negative} \end{array} \quad - - - - -$

$$2^{\text{nd}} \text{ complement} = \text{Complement} + 1$$

Let's take an example of 3

So +3 is 0011

Now -3 is second complement of +3

$$\text{i.e. } +3 \quad \begin{array}{r} 0 \ 0 \ 1 \ 1 \\ \underline{1 \ 1 \ 0 \ 0} \quad (\text{Complement}) \end{array}$$

$$\begin{array}{r} +1 \\ 1 \ 1 \ 0 \ 1 \quad (2^{\text{nd}} \text{ Complement}) \end{array}$$

So if we add +3 + -3

$$\begin{array}{r} +3 \quad 0 \ 0 \ 1 \ 1 \\ -3 \quad 1 \ 1 \ 0 \ 1 \\ \hline 0 \ 0 \ 0 \ 0 \quad \text{i.e. } 0 \end{array}$$

So in total 7 bits represent number 0

Last bit represent sign.

3) Short

→ 2 bytes i.e. 16 bits

→ Signed 2^{nd} complement

- Range : -32768 to 32767

- Default value is 0

4) int

- 4 bytes ie 32 bits

- Range : -2^{31} to $2^{31} - 1$

- Default value is 0

- Signed 2nd Complement

5) Long

- 8 bytes ie 64 bits

- Signed 2nd complement

- Range : -2^{63} to $2^{63} - 1$

- Default value is 0

- Eg:- long var = 100l;

→ This l signifies that it is long type.

* We'll discuss fractional type in detail later.

6) boolean

- 1 bit

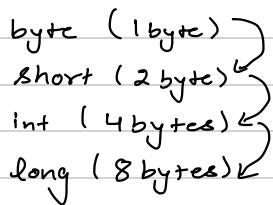
- Value : True or False

- Default Value is True

* Types of conversion :-

1) Widening / Automatic Conversion

- Automatic conversion when we go from lower datatype to higher datatype



Eg:- int var = 10;

long varlong = var; // Automatically converted int to long

2) Narrowing / Downcasting / Explicit Conversion

- It is opposite of widening ie going from higher datatype to lower datatype.
- In this case downcasting doesn't happen automatically. So, we have to manually do it.

Eg:- int integerVariable = 10;

byte byteVariable = (byte)integerVariable;

- If we're downcasting beyond range then it'll again reset to -128 & it goes on.

So if integerVariable's value is 128 then byteVariable's value will be -128 (Next after 127 is -128 for byte)

If it's 148 then byteVariable's value will be -108

3) Promotion during expression

- This happens internally during expression
- As soon as value of expression crosses the range of the datatype then promotion happens internally to higher datatype.

- byte & short promotes to int.

- Eg:- byte a = 1

byte b = 127

byte sum = a + b; // won't work since range is crossing

So we'll have to declare it as int as the result will be int.

Although we can explicitly downcast it but value will change as per explicit downcasting terms.

↳ This is also explicit casting during expression.

- In an expression, if one datatype is of higher datatype, then all other will also be automatically converted to higher datatype.

Eg:- int a = 34;

double doubleVar = 2.0d;

int sum = a + doubleVar; // give error

double sum = a + doubleVar;

⇒ Kind Of Variables :-

* Member / Instance Variable

- It is a variable of the class i.e. is created when an object of the class containing it is created. So, each object of the class has its individual copy of member variable.

* Local Variable

- These variables are the variables that are defined inside a method.
- If the method finishes, it gets destroyed.

* Static / Class Variable

- Only one copy of static / class variable exists. All objects can access it using class name.

* Method Parameters

- These are the variables that are passed to a method.

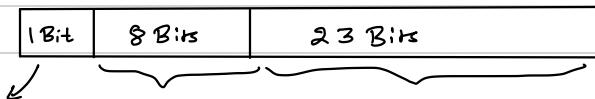
* Constructor Parameters

- These are the variables that are passed to a constructor.

⇒ Fractional Types

* How float & double are stored in memory?

- Float



Stores Sign Stores Stores Mantissa /
ie 0 → positive exponent Significant
1 → negative

Eg:- 4.125f

Step - 1 : Convert to binary

$$\begin{aligned} 4 \rightarrow 100 \quad .125 &= 0.125 \times 2 = 0.25 & 0 \\ & \cdot 25 \times 2 = 0.5 & 0 \\ & \cdot 5 \times 2 = 1.00 & 1 \end{aligned}$$

↓

$$0.125 = 0.001$$

So binary equivalent of $4.125 = 100.001$

Step - 2 : Make it in the form of $(1.\text{xxx}) \times 2^{\text{exponent}}$

$$100.001 \Rightarrow 1.00001 \times 2^2$$

(Since base is binary, moving 2 decimal left adds 2 as power of 2)

Step - 3 : Add bias to the exponent

$$100.001 \Rightarrow \underbrace{1.00001}_{\text{Mantissa}} \times 2^{\text{exponent}}$$

Since bias for float is 127 we'll add it to exponent
ie $127 + 2 = 129$

Step - 4 Fill the numbers

0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 --- 0

Sign bit Binary of 129 Since Mantissa is 00001 rest bits are empty.
ie exponent

Now let's convert this binary form back to float

$$(-1)^{\text{sign}} \times (1 + \text{mantissa}) \times 2^{\text{exponent} - 127}$$

This is reverse of the above process

$$\begin{aligned} & (-1)^0 \times (1 + 00001) \times 2^{129 - 127} \\ & 1 \times (1 + 2^{-5}) \times 2^2 \\ & 1 \times (1 + 0.03125) \times 4 \text{ ie } \underline{4.125} \end{aligned}$$

Now for 0.7f

Step-1 $0.7 \times 2 = 1.4$ 1

$.4 \times 2 = 0.8$ 0

$.8 \times 2 = 0.6$ 1

$.6 \times 2 = 0.2$ 1

$.2 \times 2 = 0.4$ 0

$.4 \times 2 = 0.8$ 0

$.8 \times 2 = 0.6$ 1

!

Keeps repeating

So binary is 0.10110011001100110

Step-2 : It becomes $(1.011001100110) \times 2^{-1}$

-1 since decimal shifted 1 pos to right

Step-3 : $-1 + 127 = 126$ (Add 127 bias)

Step-4: Now assemble 1st one

0 0111110 0 110 0110 0110 0110 0110 011
↓ { exponent } { mantissa }

Sign

Q if we revert back to float

$$(-1)^0 \times (1 + \text{mantissa}) \times 2^{126-127}$$

$$\text{Mantissa} = \frac{1}{2^2} + \frac{1}{2^3} + \frac{1}{2^6} + \frac{1}{2^7} + \frac{1}{2^{10}} + \frac{1}{2^{11}} + \frac{1}{2^{14}} + \frac{1}{2^{15}} + \frac{1}{2^{18}} + \frac{1}{2^{19}} \dots$$

So mantissa will be 0.399414062

$$\text{So } 1 \times (1 + 0.399414062) \times 1^{-1}$$

$$= \underbrace{0.699707031}_{\sim}$$

So here value comes out to be less than 0.7 when we stored, so we generally use BigDecimal instead of float

* This is same for double as well, just that double is 64 Bits