Session 02:
Variables and Calculations

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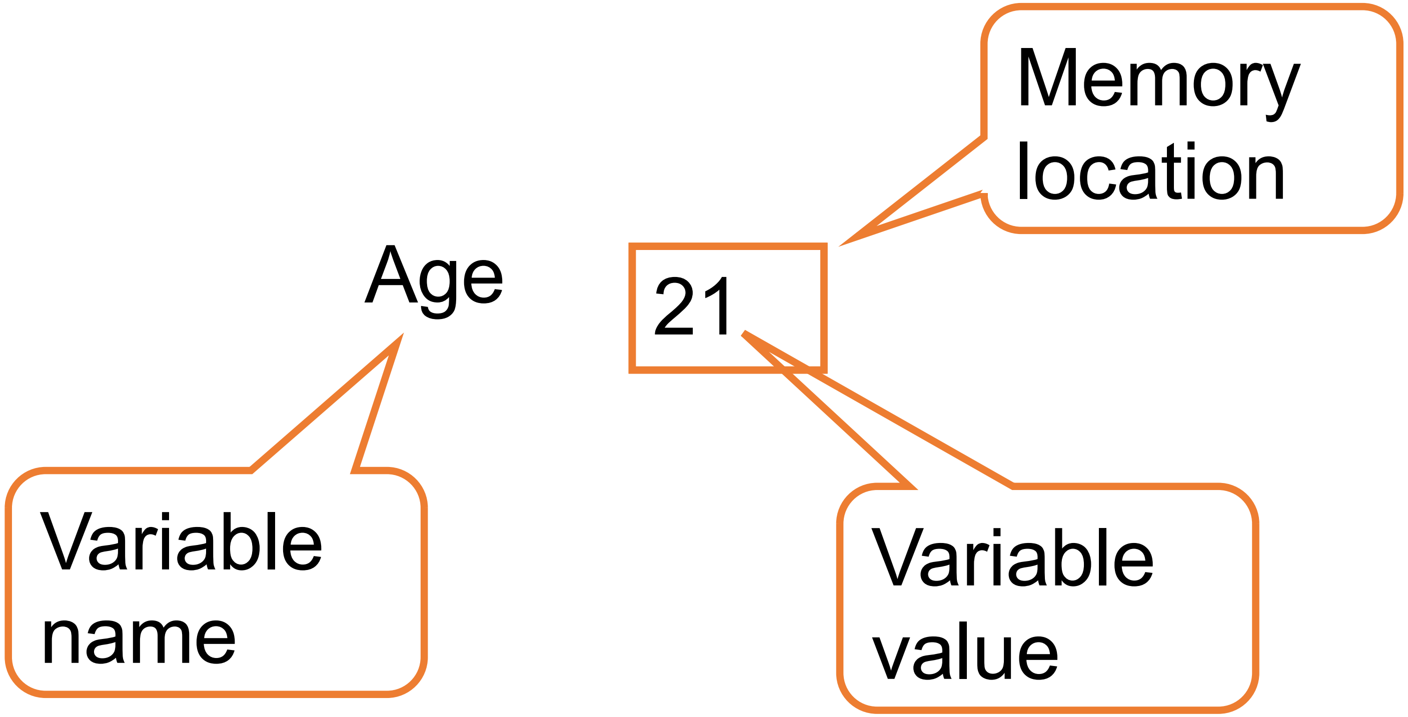
Lecture outline

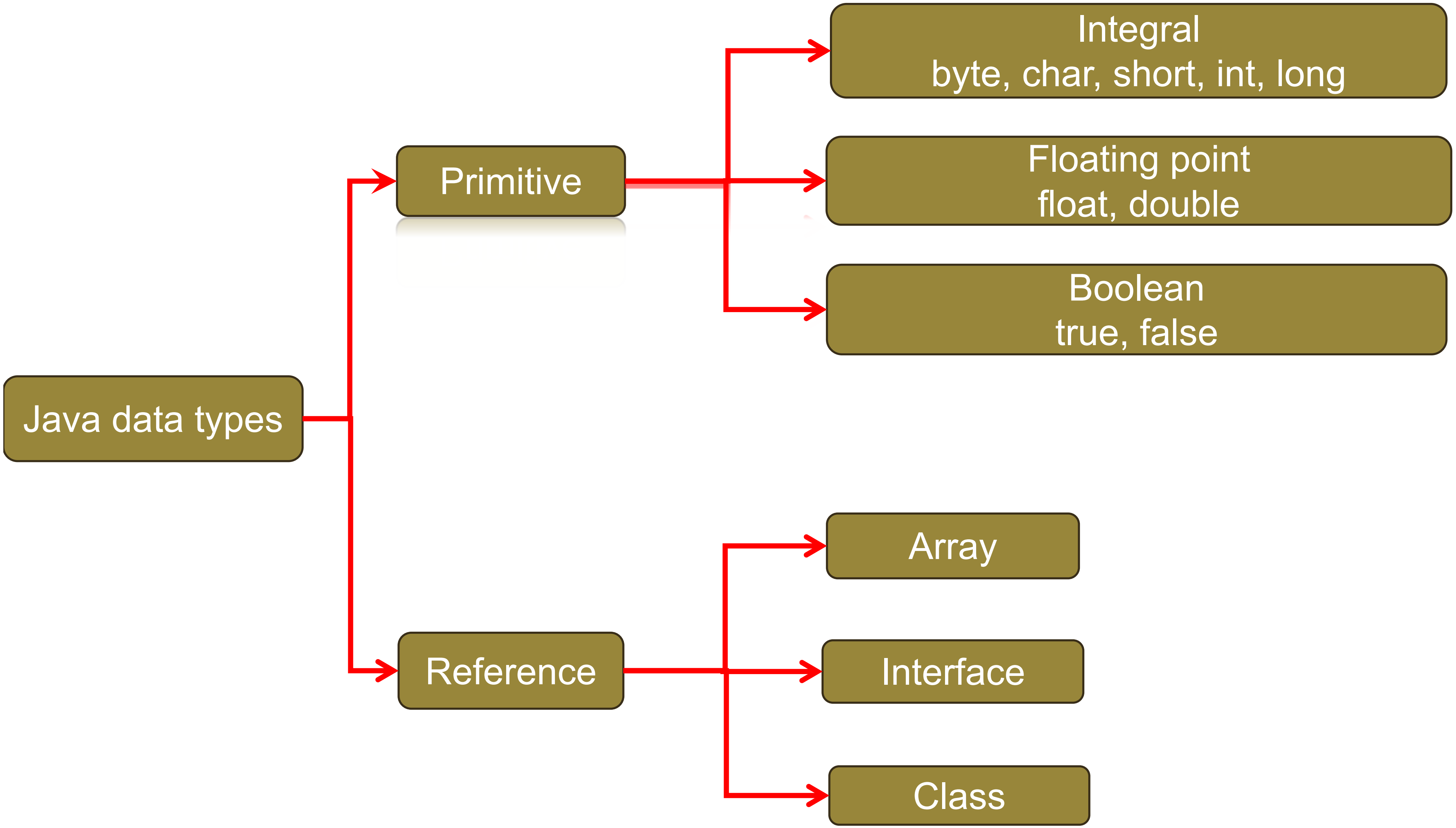
- Numeric data types
  - Byte, short, int, long, float
  - Declaring numeric data
  - Arithmetic operations
- Character data types

Variables

- A place in the computer’s memory to store a number.



Java data types



Java data types

Primitive

Integral
byte, char, short, int, long

Floating point
float, double

Boolean
true, false

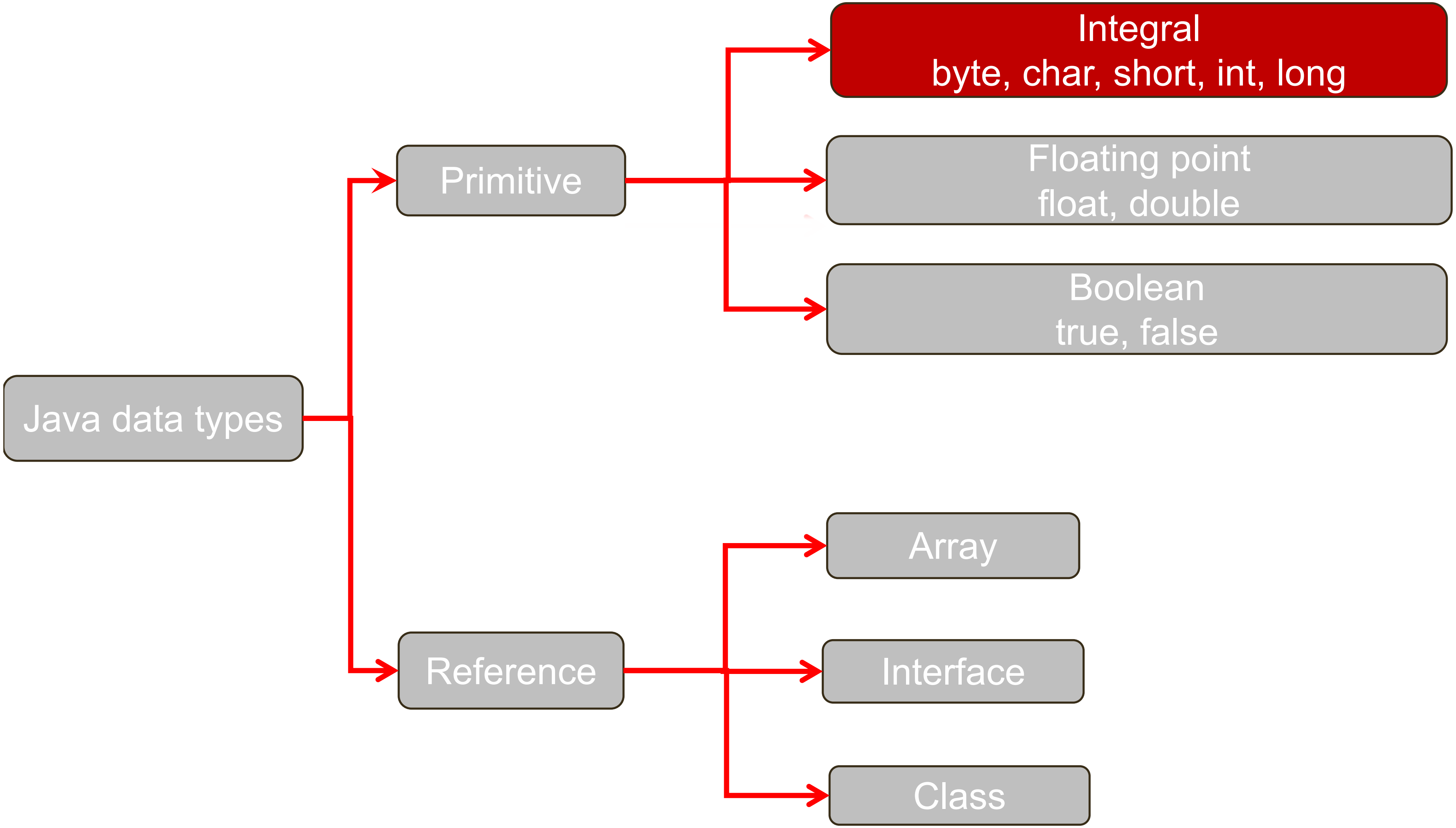
Reference

Array

Interface

Class

Java data types



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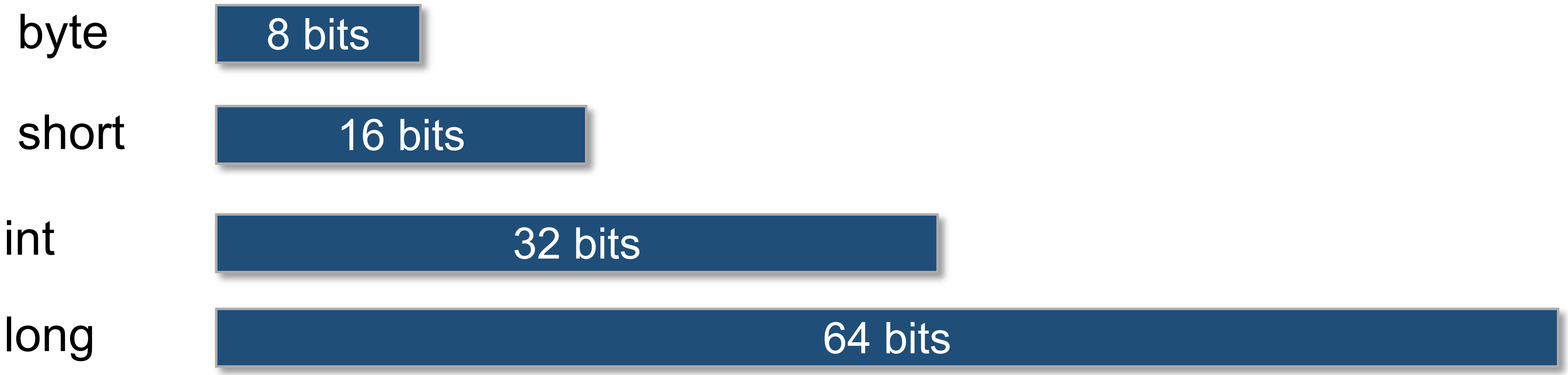
Integral Types

- byte, short, int and long → refer to integer values
  - 22 16 546
- Negative integers:
  - -45 -925

Integral Types



- int is the most commonly used. It ranges from -2147483648 to + 2147483647

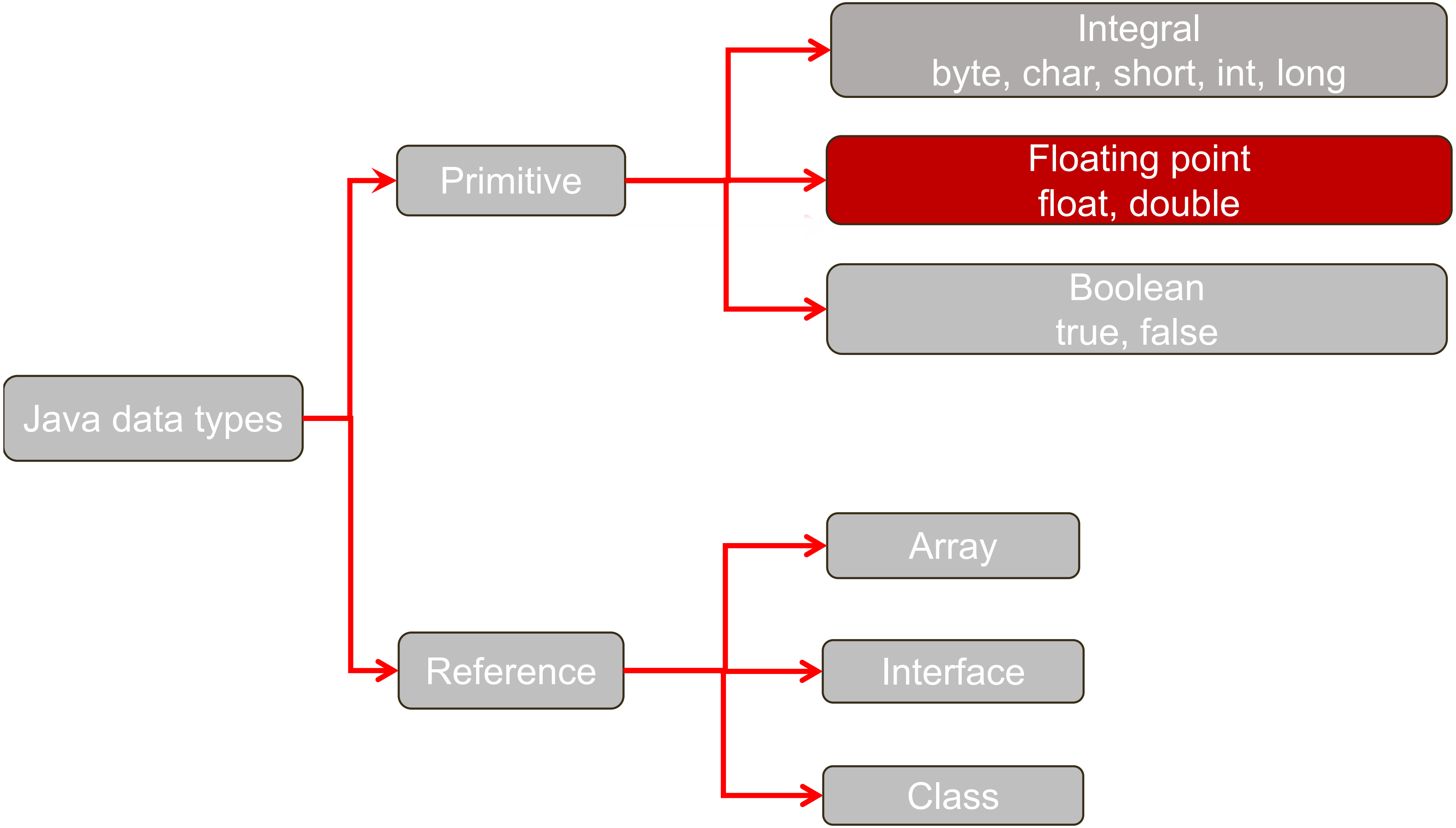
Integer Data Types

Type	Size	Min Value	Max Value
byte	8 bits	-128	+127
short	16 bits	-32768	+32767
int	32 bits	-2147483648	+2147483647
long	64 bits	- 2^64	+2^64

Integers (int)

- Integer data types store whole numbers
    - The number of students
    - The number of pixels
    - The number of books sold

Java data types



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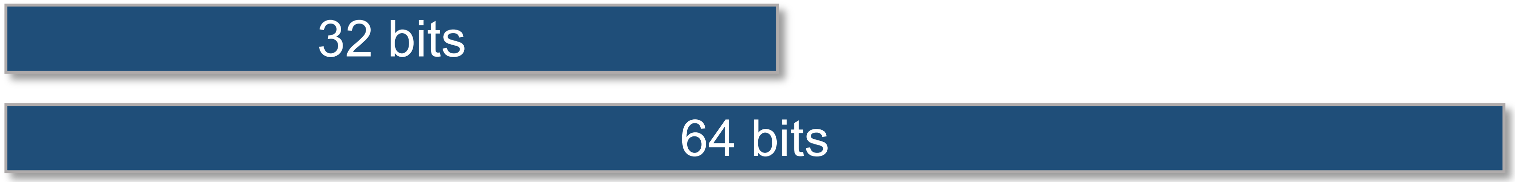
Floating-Point Types

- To represent real (decimal) numbers
  - 18.0 12.87 4. .8 12.654981

- float
- double



32 bits

64 bits

Floating-point types

- Floating points can also have an exponent value

Java Notation	Scientific Notation
1.7453E-12	1.7453 x 10^{-12}
3.6524E4	3.6524 x 10^{4}
7E20	7 x 10^{20}

Floating point literal

- The default literal that a complier would assume is of type `double`.
- To write literal of type float, end the number with the letter F (or f)

Literal	Type
0.0	double
0.0f	float
2.001E3F	float
1.8E2	double

Floating Point Precision

- float and double data types store an approximation of a ‘real’ number. PC’s have special math FPU
- floats use 32 bits of storage, doubles use 64 bits.
- Try the following small piece of code
  - *double x = 5.02;*
  - *double y = 0.01;*
  - *double z = x + y;*
  - *System.out.println (z);*
- Result will be something like 5.02999999….
- Inherent problem with any real arithmetic – use integers for precision.
- Use ‘*double*’ – only use ‘*float’* to reduce memory requirements – e.g. large ‘array of real numbers

Variable name

- Start with letter (A to Z or a to z)
- Can contain letters or digits
- Can contain _ or $
- Any length name – be sensible!
- Java syntax is case sensitive.
- Conventions
  - camelCase (CamelCase for class names!)
  - snake_case

Declaring variables

```
int length;
int breadth;
int area;
```

```
int length, breadth, area;
```

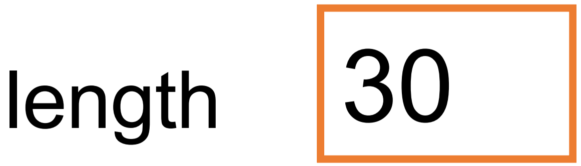
The Assignment Statement

```
length = 20;
```

- `=`
- “is assigned the value”
- The variables named **`length`** is assigned the value 20

Assignment Statement

```
int length;

length = 20;

length = 30;
```



length

30

Program

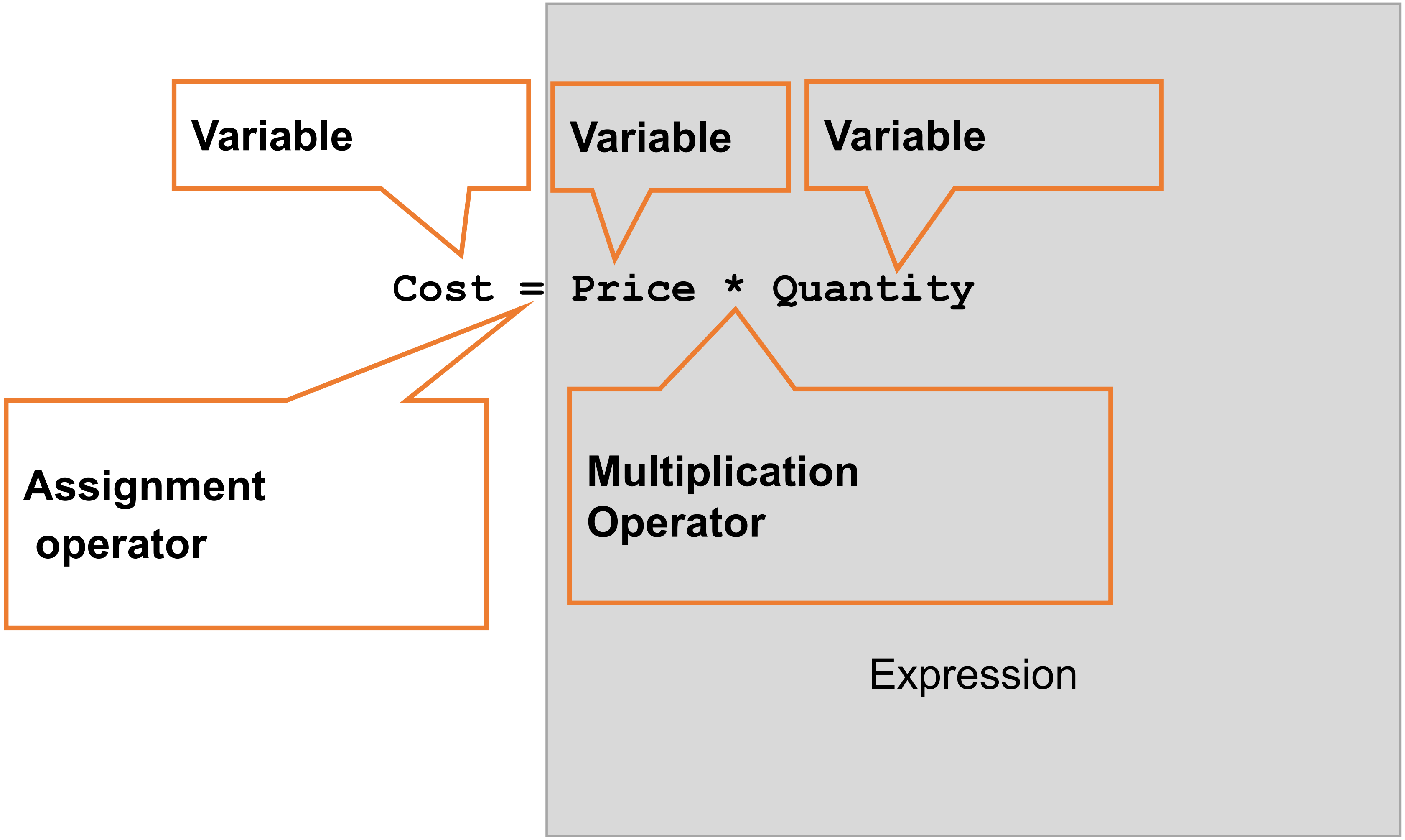
```
public class Calculation {
  public static void main(String[] args) {
     int length;
     int width;
     int area;

     length= 20;
     width= 10;
     area=length*width;
   System.out.println ("Area is "+ area);
   }
}
```

Calculations and operations

- Variable = expression;

```
area = length * width;
```

Operators



Variable
Variable
Variable
Cost = Price * Quantity
Assignment operator
Multiplication Operator
Expression

Arithmetic Operators

Operator	Meaning	Precedence
()	parenthesis	0
*****	multiply	1
/	divide	1
%	remainder	1
+	add	2
-	subtract	2

Example of precedence

```
Total = 10 + 15 * 2 / 4
Total = 10 + 15 * 2 / 4
Total = 10 + 30 / 4
Total = 10 + 7.5
Total = 17.5
```

Example of precedence

$$X= \frac{a + b}{a - b}$$

Algebraic

$X= a + b / a - b$

Java Code

$X= (a + b) / (a - b)$

Java Code

Type Conversion

```
int someInt;    //can only hold int values
double someDouble; // can only hold double values
```

- if we try:

```
someDouble = 12;
```

Java refuses to store anything other than **`double`** value in **`someDouble`**. The complier converts `12` to **`12.0`** and then stores it into **`someDouble`**

Type Conversion

```
int someInt;    //can only hold int values
double someDouble; // can only hold double values
```

- if we try:

```
someInt = 4.8;
someDouble = 12;
```

The Fractional part is truncated(cut-off) so the results are:

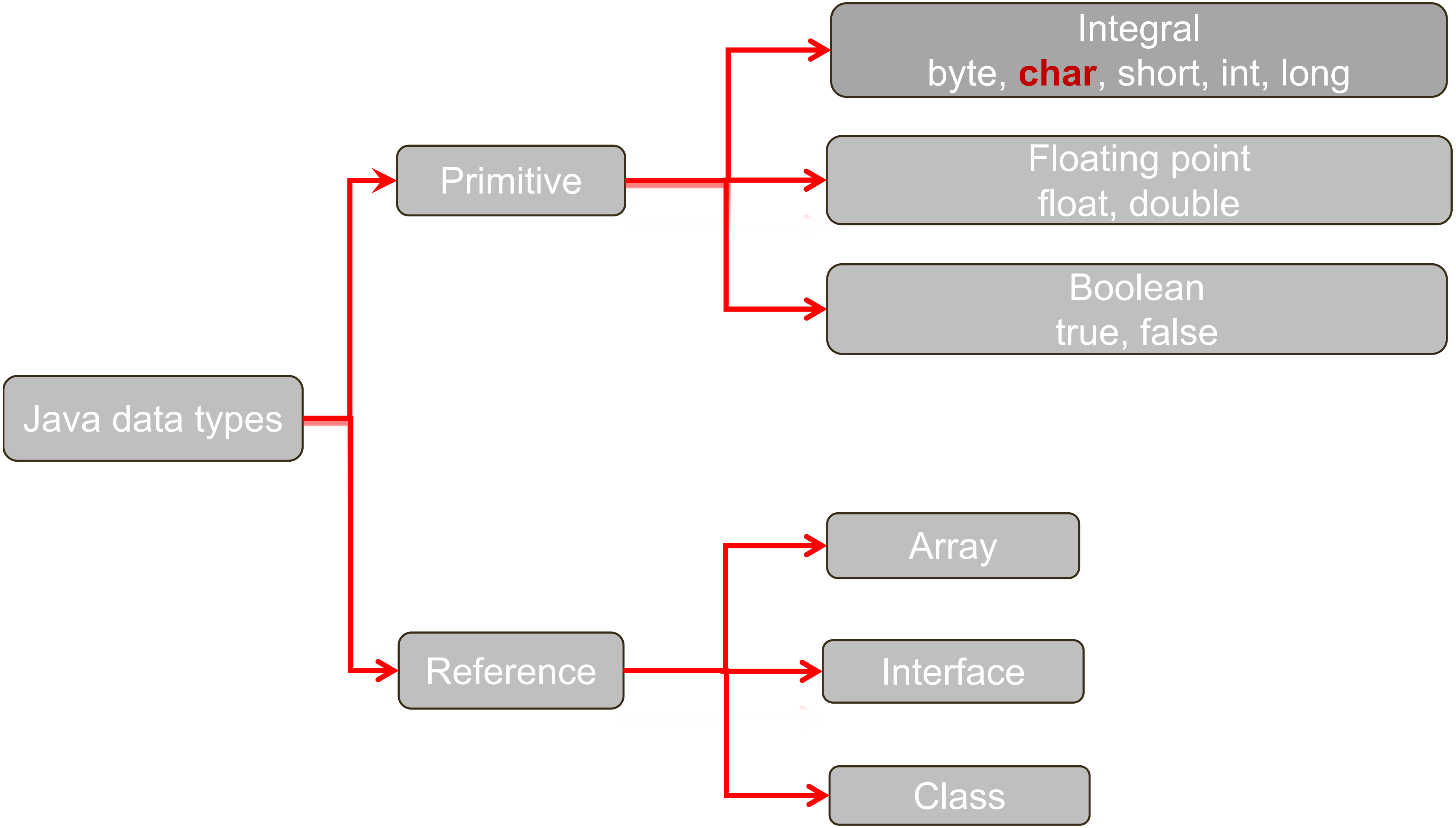
```
someDouble => 12.0;
someInt => 4;
```

Type Casting

- Type casting is the explicit conversion of a value from one data type to another

```
someDouble = (double) (3 * someInt + 2);
someInt = (int)(5.2 / 4.5 - 2.3);
```

Java data types



Character Data Type

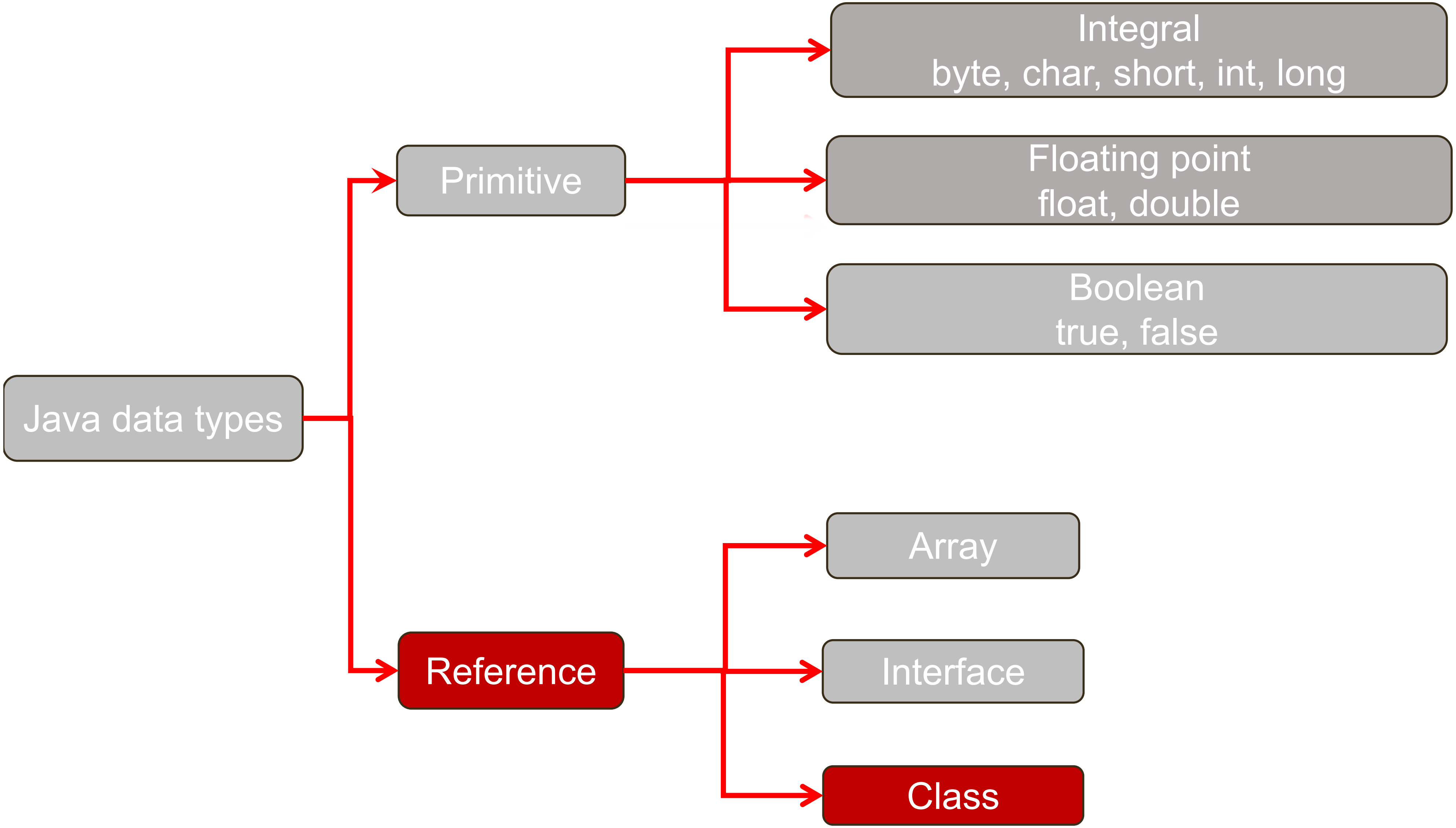
- Java has a character data type: `char`
- `char` variable holds a single character

```
char letter = 'A';
char numChar = '4';
```

  - Special characters
    - `char tab = ‘\t’;`

- Chars require 2 bytes of storage to allow space for other character sets

Java data types



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Simple Strings

- Java has a String – a class, not a simple type.
- For now, we can declare a string :

```
String s = “Hello World ”;
```

- Strings can be concatenated with the ‘+’ sign e.g:

```
String t = “from Cranfield”;
System.out.println (s + t);
System.out.println ( s + “from Cranfield”);
```

String type

- **`System.out.println ()`** – library method with several different versions provided, each expecting different parameter type :

```
i = 7;
System.out.println (“Hello number ”);      // String version
System.out.println (i);                  // Integer version
```

- Most classes have an inherent ‘toString()’ method :

```
System.out.println (Integer.toString(i)); // OK
```

Displaying variables

String

Variable

```
System.out.println(“Answer is = “ + cost);
```

String concatenation operator

Variables and Constants

- Declaring and Initializing in One Step
  - `int x = 1;`
  - `double radius = 1.4;`
  - `float f = 1.4f;`
  - `char ch = ‘A’;`
- Constants – note keyword ‘final’
  - *final datatype CONSTANTNAME = VALUE;*
  - `final double PI = 3.14159;`
  - `final int SIZE = 3;`

Integer Maths

- Integer division deals with whole numbers

```
int  i=9;   int j = 4;     int k;     float f;
k = i / j;             // Result of 9/4 = 2 (fractional part is lost)
```

- The % operator lets us catch the remainder of an integer division. Again, result always a whole number

```
k = i % j;   // Remainder of 9 / 4 = 1.
```

- To capture a ‘real’ result, cast i or j before operation

```
f = (float) i / j;// Answer in f = 2.25
f = i / j;          // Cast after division, result = 2.00
```