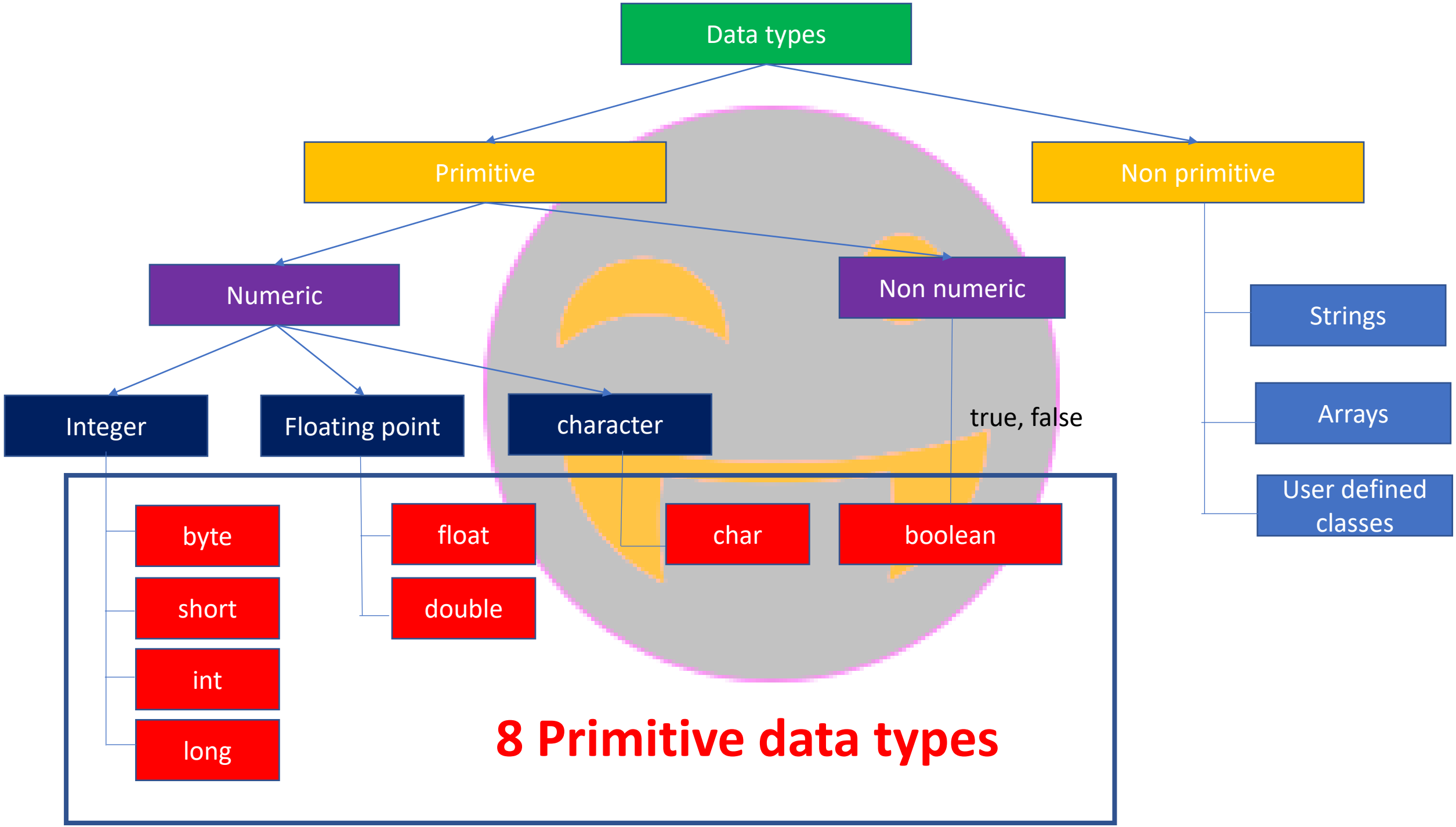
Chapter 22

Data types in Java

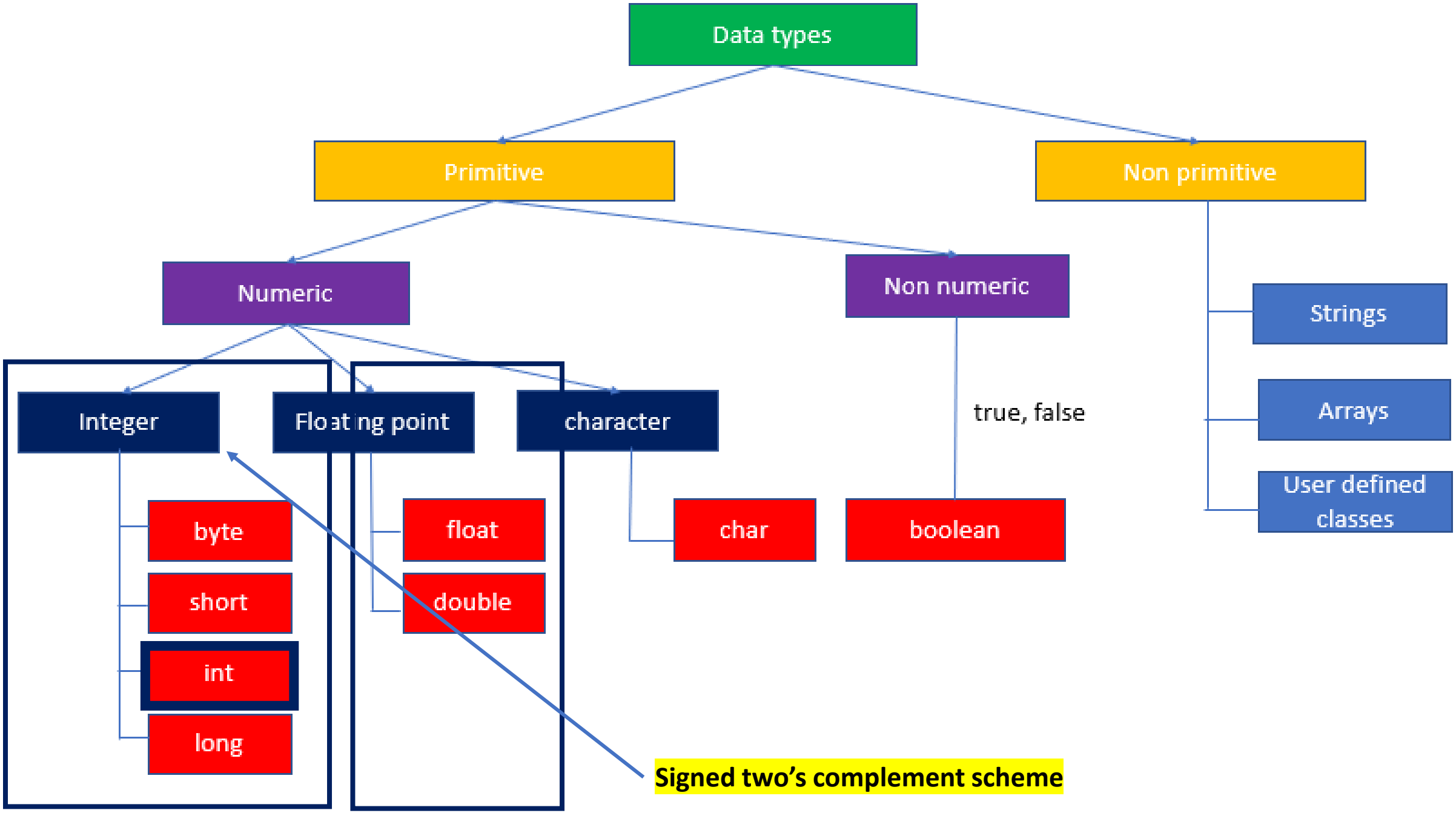
- Practical
- Floating point numbers


Data types
Primitive
Non primitive
Numeric
Non numeric
Strings
Arrays
User defined classes
Integer
Floating point
character
true, false
byte
short
int
long
float
double
char
boolean
8 Primitive data types

Integer types

Type	Bit depth	Range	Default values
byte	1 byte(8 bits)	-2^7 to 2^7-1	0
short	2 bytes(16 bits)	-2^15 to 2^15-1	0
int	4 bytes(32 bits)	-2^31 to 2^31-1	0
long	8 bytes(64 bits)	-2^63 to 2^63-1	0

Signed two's complement scheme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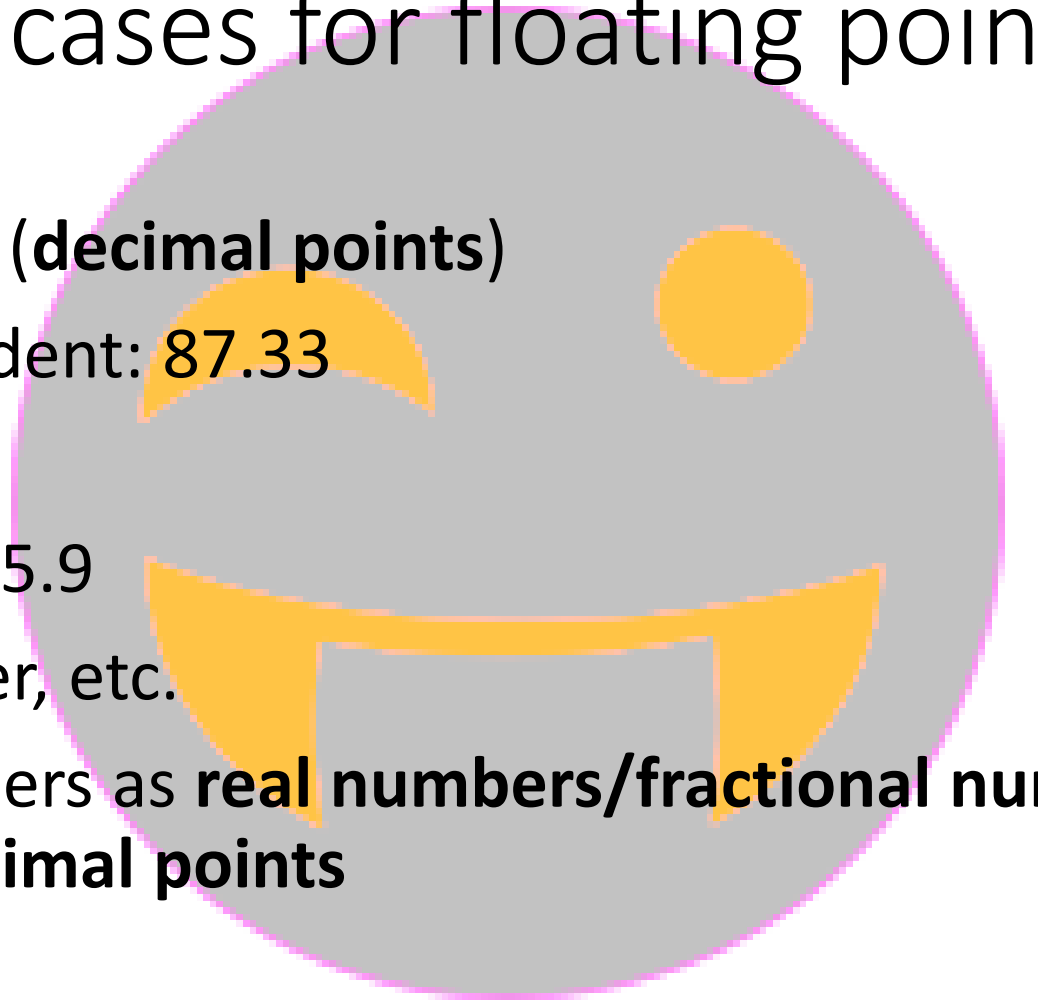
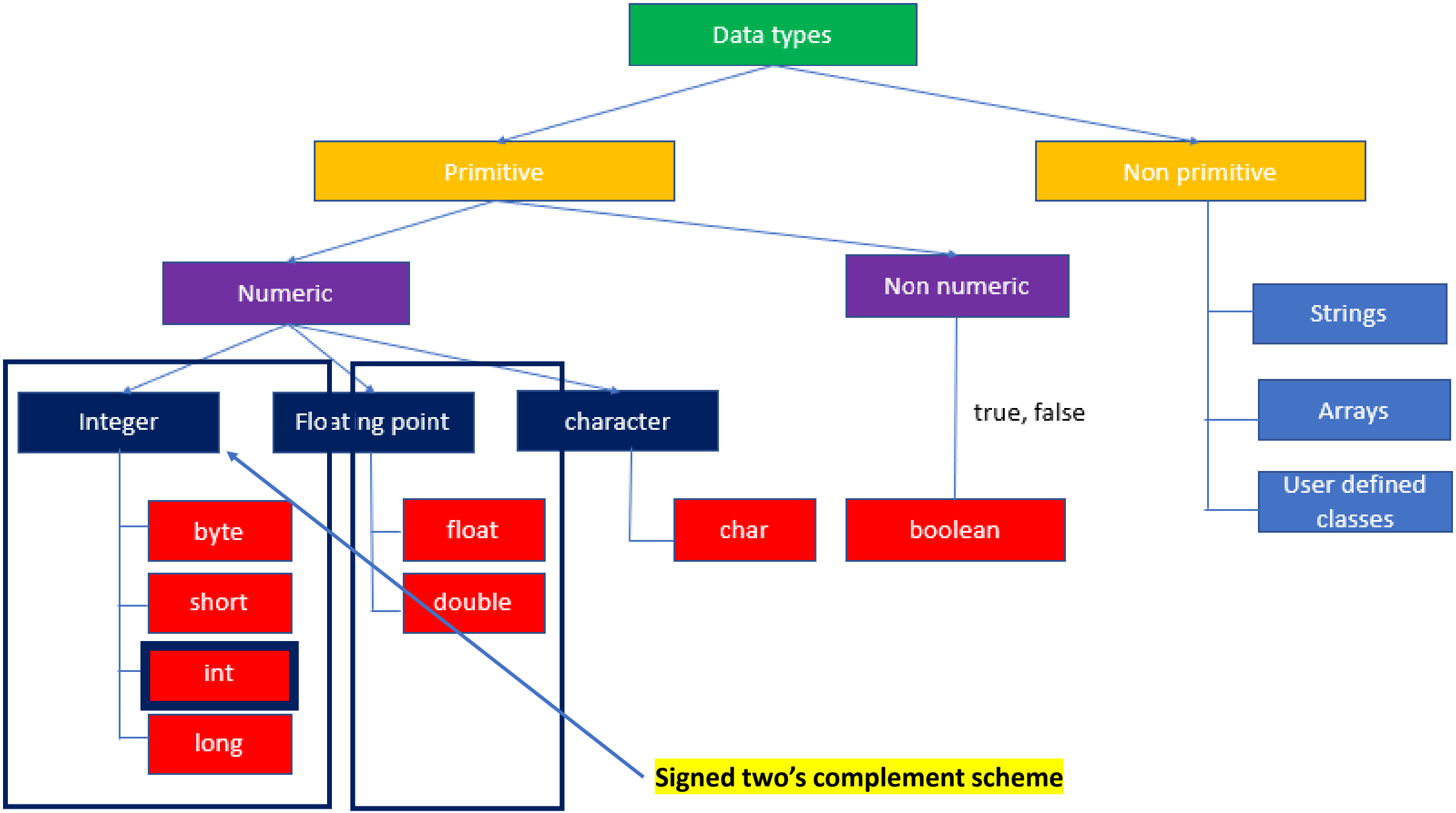
Common use cases for floating point values

- Fractional numbers (**decimal points**)
- Percentage of a student: 87.33
- Movie ratings: 4.3
- Height of a person: 5.9
- Average of a number, etc.
- We call these numbers as **real numbers/fractional numbers/floating point numbers/decimal points**

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Float

- **Uses 32 bits** to store floating point number in the IEEE 754 format
- **Single-precision** 32 bit IEEE 754 floating point
- 4 bytes of size
- -2^31 to 2^31-1
- ~~-2,14,74,83,648 to 2,14,74,83,647~~
- **-3.4E38 to 3.4E38**

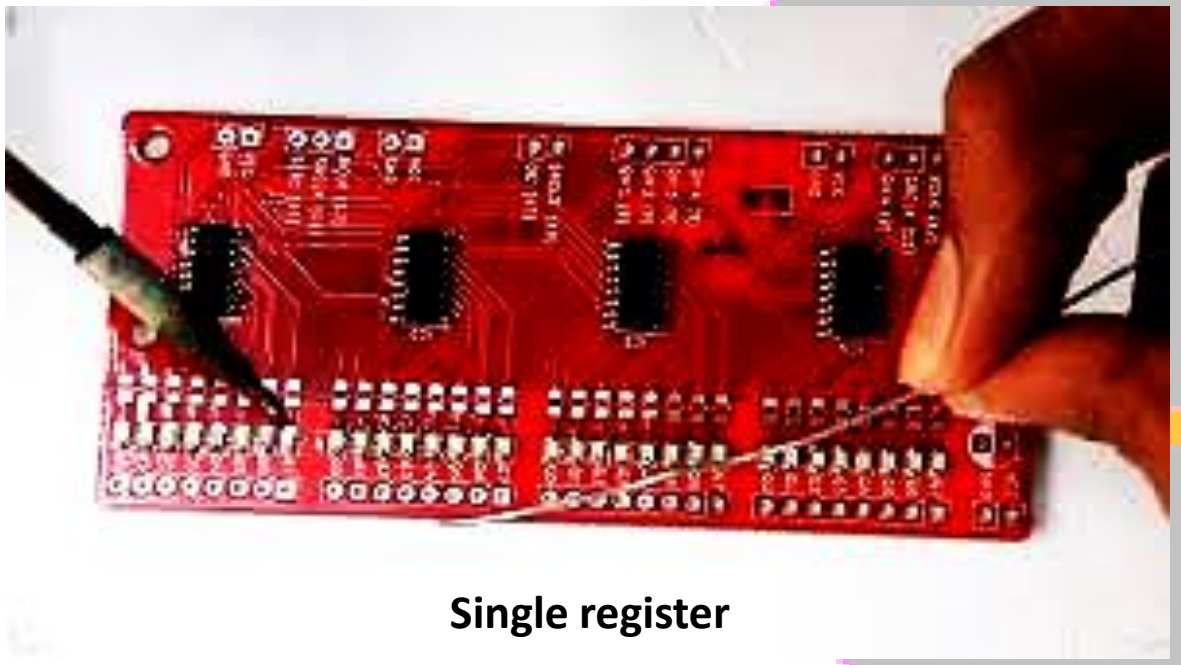
Why is it called single and double?
why the range is different?

Double

- **Uses 64 bits** to store floating point number in the IEEE 754 format
- **Double-precision** 64 bit IEEE 754 floating point
- 8 bytes of size
- -2^63 to 2^63-1
- ~~-92,23,37,20,36,85,47,75,808 to 92,23,37,20,36,85,47,75,807~~
- **-1.7E308 to 1.7E308**

Registers

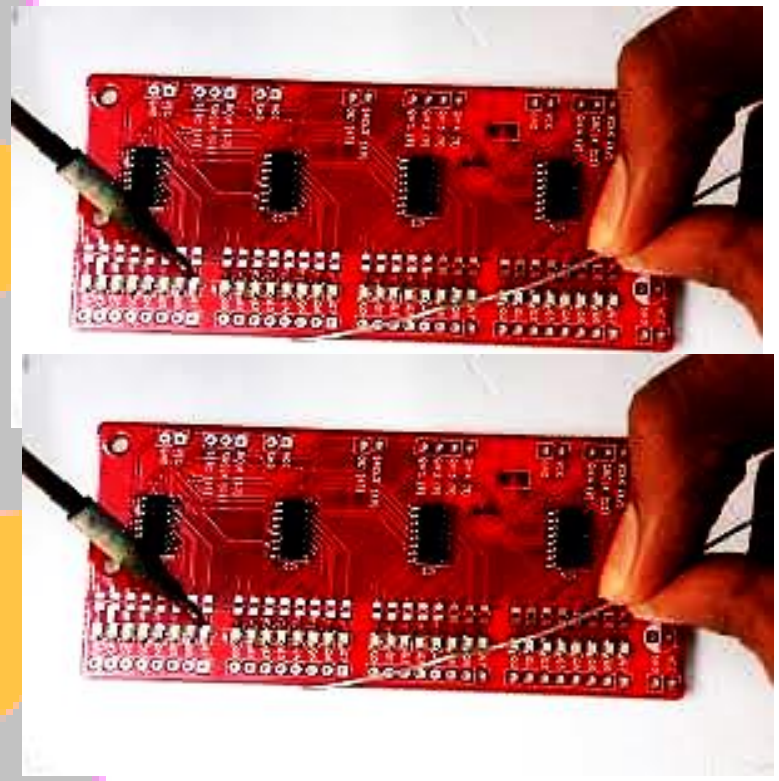
16 bit registers can represent half Precision floating point numbers



Single register

32 bit register

Single precision float will fit in one register



2 registers

64 bit register

Double precision float will fit in two registers

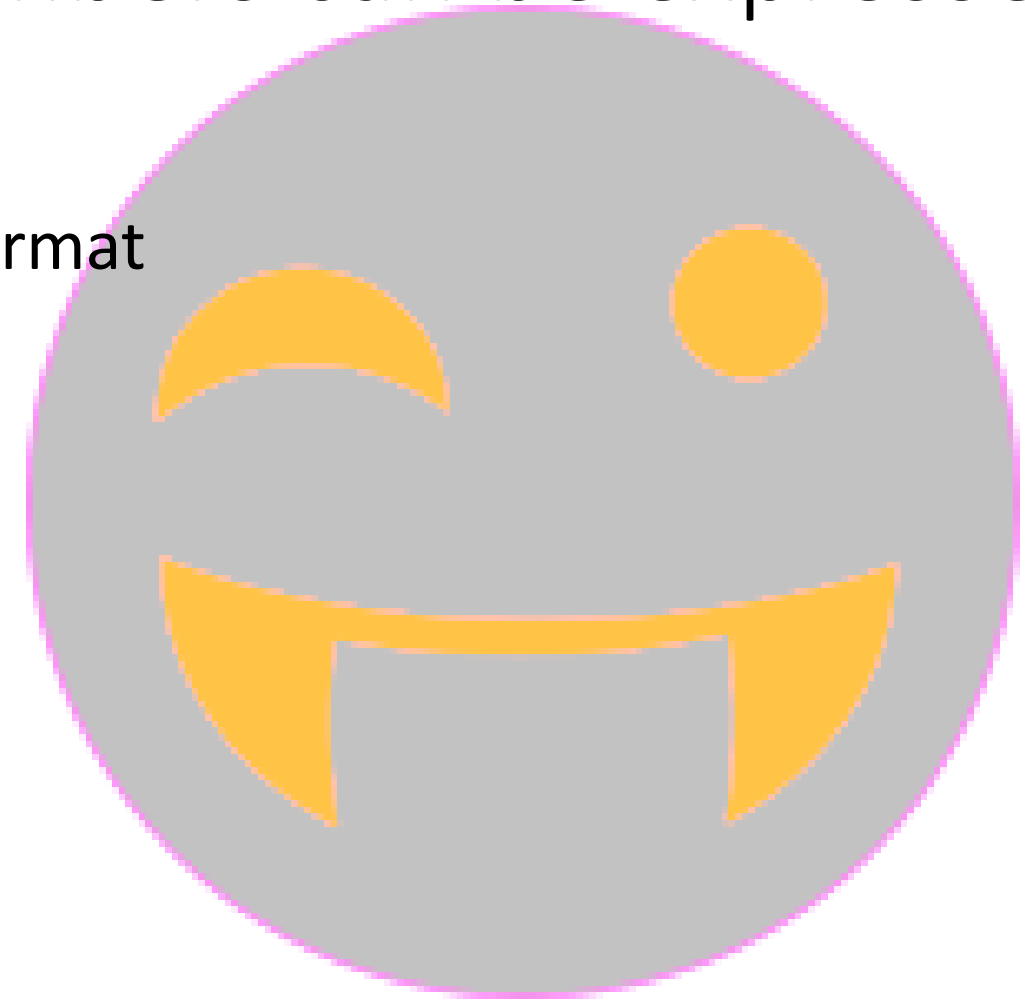
Precision

- **Precision** of a floating point value indicates how **many digits the value can have after the decimal point.**
- precision of **float is 6-7** decimals
- precision of **double is 15-16** decimals

- Definition: Single precision or double precision refer to the number of machine words (4 bytes/32 bit blocks) used to store a real number with varying degrees of accuracy

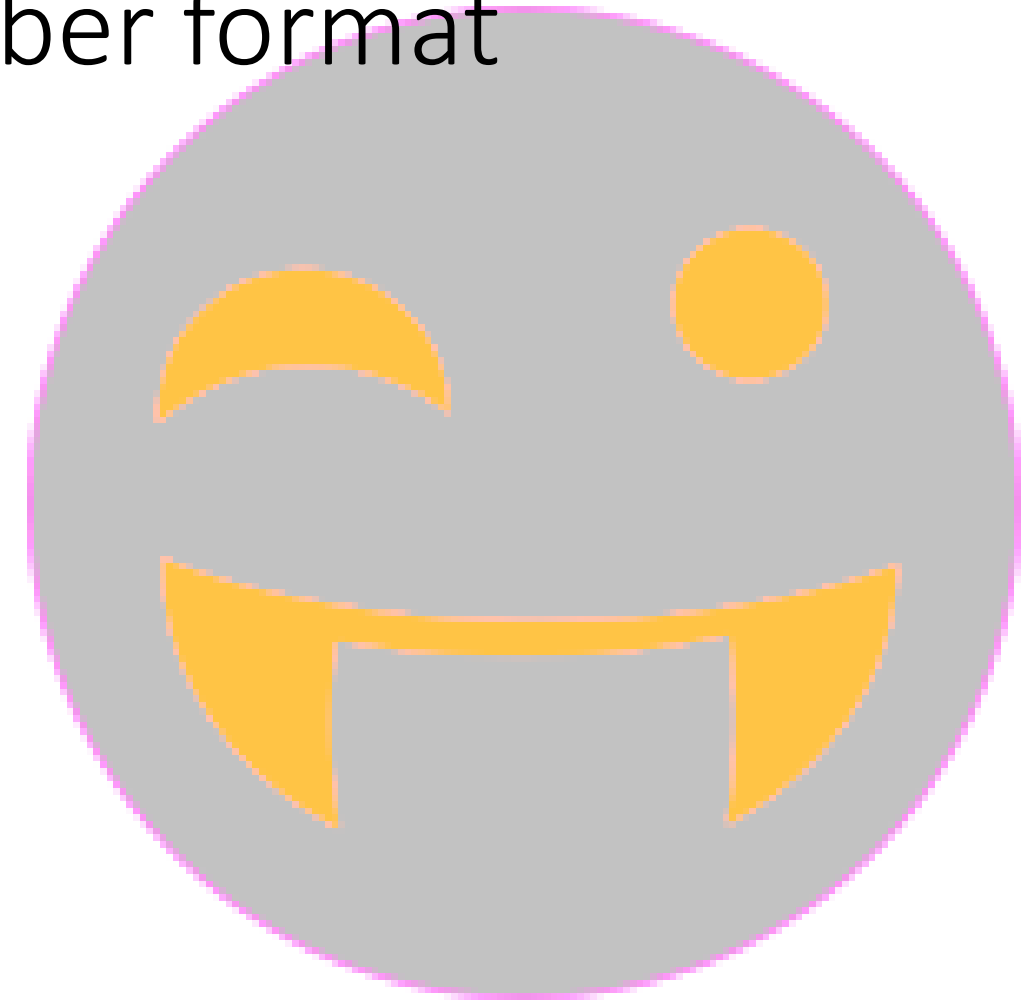
A floating numbers can be expressed in two formats

- Decimal number format
- Scientific notation



Decimal number format

- 5F or 5f
- 9.f or 9.0f or 9.F
- 2.59F



Scientific notation

- Scientific notation is used when working with large numbers
- Ex: mass of earth: 5.9700000000000000000000000
- 5.97*10^24
- How to represent this exponents in programming?
- we use scientific notation as: 5.97e24
- e/E represents **“10 to the power of”**
- 5.97*10^-24
- 5.97e+24
- 5.97e+24

34.776 × 10^6

1000000

1000000

0.000034 × 10^6

0.000034e6

5.67 × 100/100

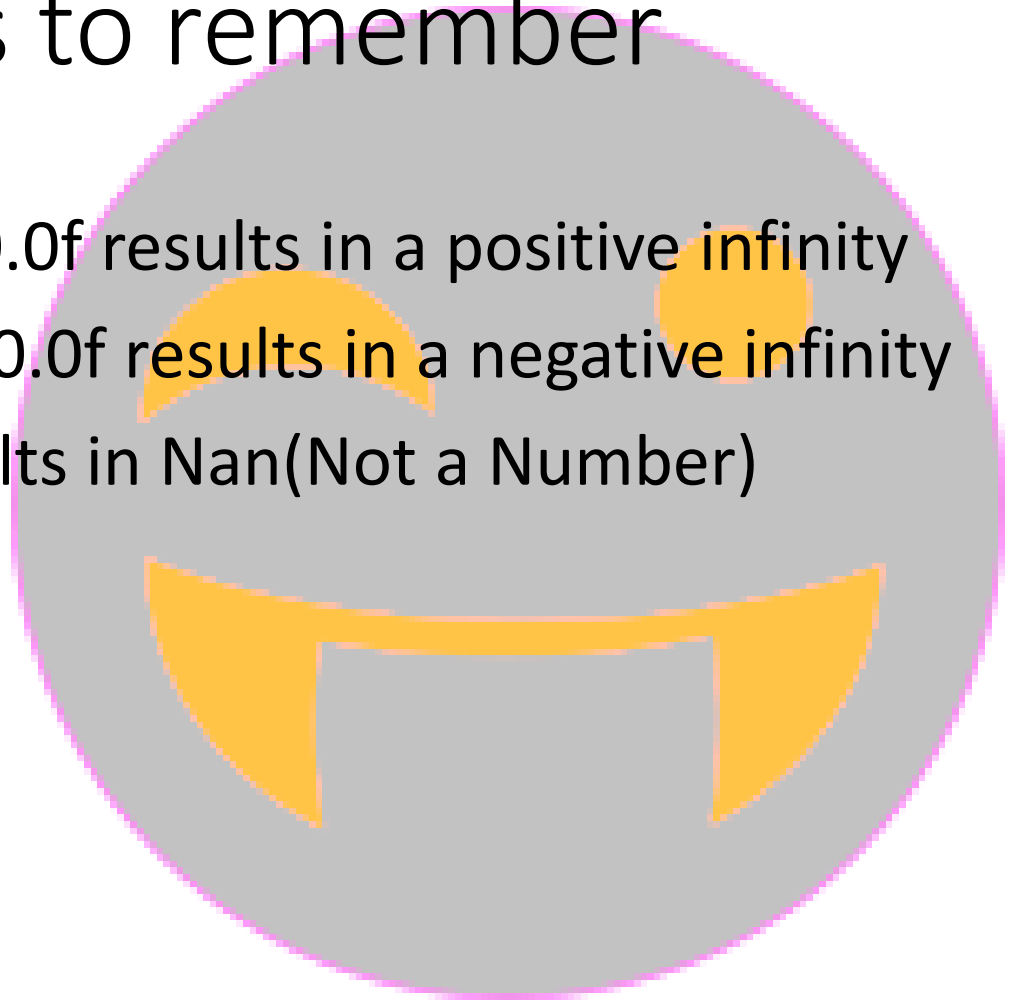
567 × 1/100

567 × 10^-2

567e-2

Special values to remember

- Dividing a float by 0.0f results in a positive infinity
- Dividing a float by -0.0f results in a negative infinity
- Dividing 0 by 0 results in Nan(Not a Number)



Float special values

float Constants	Meaning
Float.POSITIVE_INFINITY	Positive infinity of type float
Float.NEGATIVE_INFINITY	Negative infinity of type float
Float.NaN	Not a Number of type float
Float.MAX_VALUE	The largest positive value that can be represented in a float variable. This is equal to 3.4 x 10^38 approx.
Float.MIN_VALUE	The smallest positive value greater than zero that can be represented in a float variable. This is equal to 1.4 x 10^-45.

Program

```
    floatBasket = 6.838338399992 82f;
    System.out.println(floatBasket);
    floatBasket = 653e9f;
    System.out.println(floatBasket);
     float f1 = 3.25f;
float f2 = 32.5e-1f;
float f3 = 0.325e+1f ;
float f4 = 0.325e1f;
float f5 = 0.0325e2f;
float f6 = 0.0325e2f;
float f7 = 3.25e0f;

System.out.println(f1/-0f);// w  ww .j a v a2 s. c  o m
System.out.println(f2);
System.out.println(f3);
System.out.println(f4);
System.out.println(f5);
System.out.println(f6);
System.out.println(f7);
```

Float

- We can assign an integer to float data type
- Automatically converted to float
- By default fractional point values are treated as double
- Should be suffixed with f or F
- Size - 32 bits

Size: 4 bytes

Range: -3.4E38 to 3.4E38

Default value: 0.0f = 0.0

Precision: 6-7 digits

```
void floatDemo(){
    floatVar = 1.22;
    System.out.println(floatVar);
}
```

```
void floatDemo(){
    floatVar = 10;
    System.out.println(floatVar);
}
```

```
java:63: error: incompatible types: possible lossy conversion from double to float
  floatVar = 1.22;
```

Double

- By default fractional point values are treated as double
- Optionally suffixed with d or D
- We can assign an integer to double data type
- Size - 64 bits
- 1.7 double 34, 38 and 308 to remember
- E can be either upper or lower case

Size: 8 bytes

Range: -1.7E308 to 1.7E308

Default value: 0.0d

Precision: 15-16 digits

Issues with floating point values

- Avoid using float and double if you want definite results
- Perform addition and subtraction on 1.0f and 0.8f
- It is not just with Java, but with other programming languages as well
- Use **BigDecimal** if you want definite results

```java
void floatIssues(){
    heading("Float issues");
    float a = 1.0f;
    float b = 0.8f;
    float add = a+b;//good
    float sub = a-b;//issue

    BigDecimal a1 = new BigDecimal("1.0");
    BigDecimal b1 = new BigDecimal("0.8");
    System.out.println(a1.subtract(b1));
}
```

What next?

IEEE 754 scheme to store fractional numbers

చిన్న బ్రేక్ చిటికలో వచ్చేస్తా