



# Data Representation

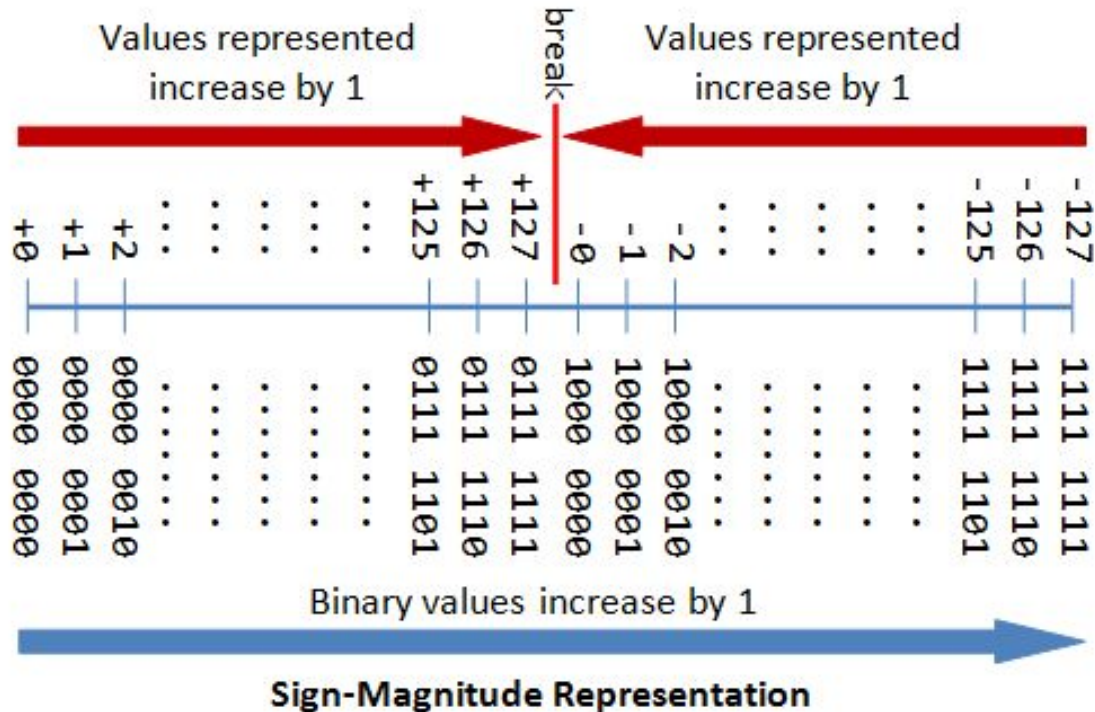
Integers, Floats, Characters



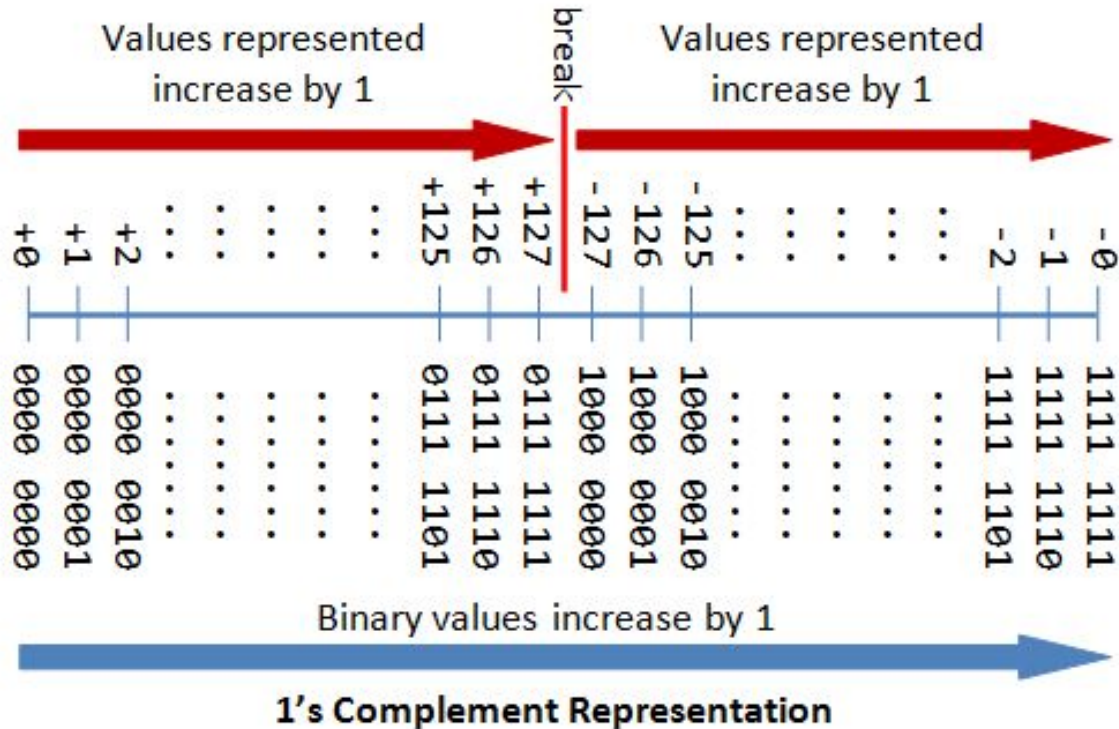


# Data Representation of Integers

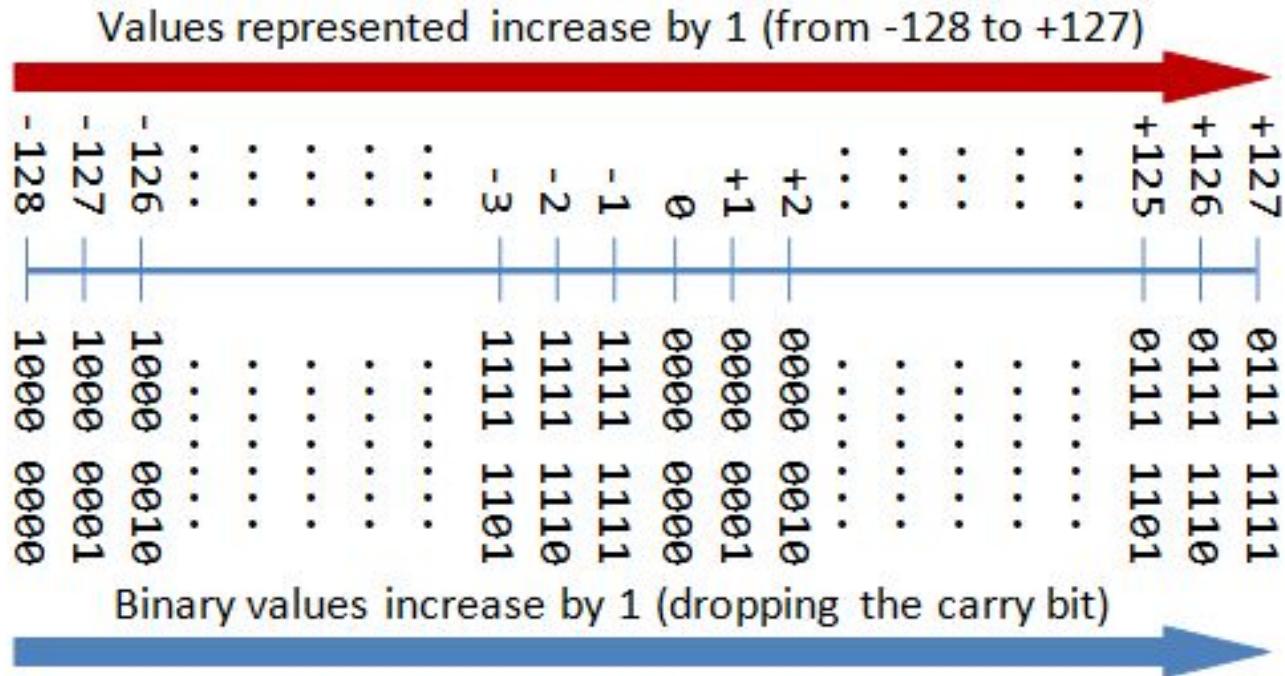
# Sign-Magnitude Representation of Integers



# 1's Complement Representation



# 2's Complement Representation



**2's Complement Representation**

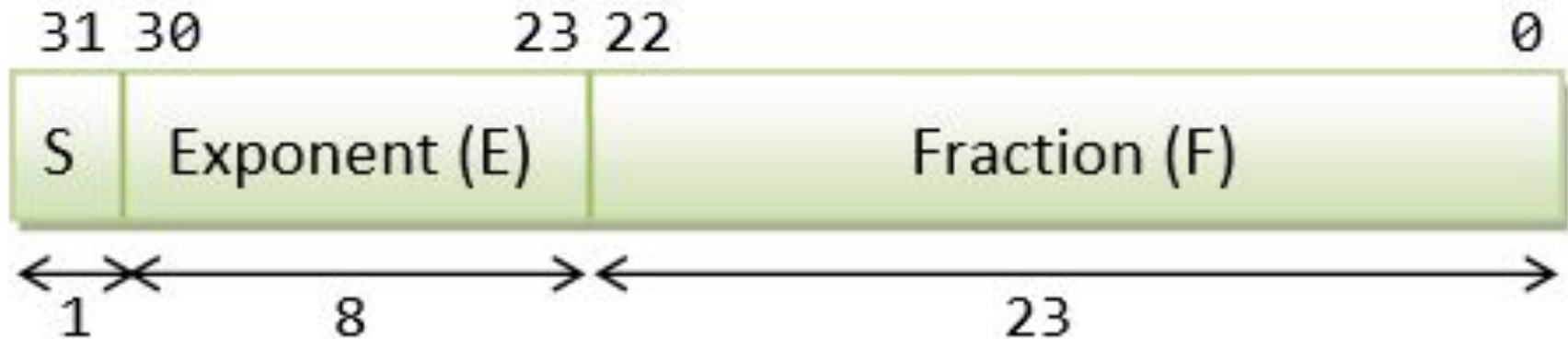
# Range of 2's Complement Integers

| n  | minimum  | maximum  |
|----|--|--|
| 8  | $-(2^7)$ $(=-128)$                             | $+(2^7)-1$ $(=+127)$   |
| 16 | $-(2^{15})$ $(=-32,768)$                       | $+(2^{15})-1$ $(=+32,767)$                                       |
| 32 | $-(2^{31})$ $(=-2,147,483,648)$                | $+(2^{31})-1$ $(=+2,147,483,647)$<br>(9+ digits)                 |
| 64 | $-(2^{63})$<br>$(=-9,223,372,036,854,775,808)$ | $+(2^{63})-1$<br>$(=+9,223,372,036,854,775,807)$<br>(18+ digits) |



# Data Representation of Floats

# IEEE-754 32-bit Floating-Point Numbers



**32-bit Single-Precision Floating-point Number**



# IEEE-754 64-bit Floating-Point Numbers



**64-bit Double-Precision Floating-point Number**

# Range of Floating Point Numbers

| Precision | Normalized N(min)  | Normalized N(max)  |
|-----------|--|--|
| Single    | 0080 0000H<br>0 00000001 000000000000000000000000B<br>E = 1, F = 0<br>$N(\min) = 1.0B \times 2^{-126}$<br>$(\approx 1.17549435 \times 10^{-38})$ | 7F7F FFFFH<br>0 11111110 000000000000000000000000B<br>E = 254, F = 0<br>$N(\max) = 1.1...1B \times 2^{127} = (2 - 2^{-23}) \times 2^{127}$<br>$(\approx 3.4028235 \times 10^{38})$ |
| Double    | 0010 0000 0000 0000H<br>$N(\min) = 1.0B \times 2^{-1022}$<br>$(\approx 2.2250738585072014 \times 10^{-308})$                                     | 7FEF FFFF FFFF FFFFH<br>$N(\max) = 1.1...1B \times 2^{1023} = (2 - 2^{-52}) \times 2^{1023}$<br>$(\approx 1.7976931348623157 \times 10^{308})$                                     |



# Data Representation of Characters

# Character Encoding System (Char-Sets)

7-Bits ASCII

(**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange)

8-Bits Latin + ASCII

**U**niversal **C**haracter **S**ystem

- UCS-2
- UCS-4

**U**nicode **T**ransformation **F**ormat (UTF-8/16/32)



# Happy Coding!