Bitwise operators

Java Bitwise Operators

- Java has six bitwise operators:

Symbol	Operator
&	Bitwise AND
|	Bitwise OR
^	Bitwise XOR
~	Bitwise NOT
<<	LEFT SHIFT
>>	RIGHT SHIFT

Java AND and OR

AND operator (&)

A	B	A & B
0	0	0
0	1	0
1	0	0
1	1	1

OR operator (|)

A	B	A | B
0	0	0
0	1	1
1	0	1
1	1	1

Java XOR and NOT

XOR operator (^)

A	B	A ^ B
0	0	0
0	1	1
1	0	1
1	1	0

NOT operator (~)

A	~A
0	1
1	0

Binary to Decimal

Decimal	Binary	Decimal	Binary
0	0000b	8	1000b
1	0001b	9	1001b
2	0010b	10	1010b
3	0011b	11	1011b
4	0100b	12	1100b
5	0101b	13	1101b
6	0110b	14	1110b
7	0111b	15	1111b

Binary to Decimal

- 0-9 are used for decimal numbers (base-10):
  - $149 = 1*10^2 + 4*10^1 + 9*10^0$
- 0-1 are used for binary numbers (base-2):
  - $1010b = 1*2^3 + 0*2^2 + 1*2^1 + *2^0 = 8 + 2 = 10$
- Example:
  - 10111b in decimal?
  - $1*2^4 + 0*2^3 + 1*2^2 + 1*2^1 + 1*2^1 = 16 + 4 + 2 + 1 = 23$
  - What is 14 in binary?
  - $8 + 4 + 2 = 1*2^3 + 1*2^2 + 1*2^1 + 0*2^0 = 1110b$

Bitwise Operator Examples

- 4-bit numbers:
  - 6 & 5 = 0110b & 0101b = 0100b = 4
  - 6 | 5 = 0110b | 0101b = 0111b = 7
  - 6 ^ 5 = 0110b ^ 0101b = 0011b = 3
  - ~6 = ~0110b = 1001b = 9
- 8-bit numbers:
  - 6 << 3 = 00000110b << 3 = 00110000b = 48 (6 * 8)
  - 48 >> 4 = 00110000b >> 4 = 00000011b = 3 (48 / 16)

Masking Operations

- Clearing bits:
  - x = 00101001b = 41
  - want to clear top 4-bits
  - x = x & 00001111b = x & 15 = 00001001b = 9
- Setting bits:
  - x = 00101001b = 41
  - want to set bottom 4-bits
  - x = x | 00001111b = x | 15 = 00101111b = 47