CS101C: Introduction to Programming (Using C)

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Week2: More operators

Today's class (11/8/2025)

- Operators
  - ~~Arithmetic (+, -, *, /, %)~~
  - ~~Relational (==, !=, >, <, >=, <=)~~
  - ~~Assignment (+=, -=, *=, /=, %, <<=, >>=, &=, ^=, |=)~~ ~~later~~
  - Increment / Decrement (++, --)
  - Special: ternary, sizeof
  - Logical (&&, ||, !)
- C program to print size of data types
- Binary to Decimal and vice-versa

Increment Decrement Operators - example program

```
int main() {
    int a=10;
    int x=a;
    printf("x++: %d\n", x++);
    printf("++x: %d\n", ++x);
    printf("x--: %d\n", x--);
    printf("--x: %d\n", --x);
}
```

Special Operators - example program

```c
int main() {
    int a=10, b=3;
    printf("Size of a: %zu\n", sizeof(a));
    int result = (a = b + 2, a * 2);
    printf("Comma operator result: %d\n", result);
    int max = (a > b) ? a : b;
    printf("max(a, b): %d\n", max);


}
```

Logical Operators - example program

```c
int main() {
    int a=10, b=3;
    printf("a && b: %d\n", a && b);
    printf("a || b: %d\n", a || b);
    printf("!a: %d\n", !a);
    printf("!b: %d\n", !b);
}
```

Sizeof Operator - example program

```
int main() {
    int a=10;
    float x=10.1;
    double d=10.123456768;
    char c='A';
    printf("Size of a: %zu\n", sizeof(a));
    printf("Size of x: %zu\n", sizeof(x));
    printf("Size of c: %zu\n", sizeof(c));
    printf("Size of d: %zu\n", sizeof(d));
}
```

Number Bases

- We use decimal (base-10), Computers use binary (base-2).
- Binary is difficult to read. So, we use Hexadecimal (base-16).
- Octal (base-8) is the other popular number format.

Number Bases - Hexadecimal

- Hexadecimal uses 16 digits: 0 to 9 and A to F. A to F represent decimal numbers 10 to 15.
- A digit in hexadecimal needs 4 bits. Therefore, a byte of information (8 bits) represents two hexadecimal digits.

• Example:

Decimal	Binary	Hexadecimal
10	1010	0xA
16	1 0000	0x10
43981	1010 1011 1100 1101	0xABCD

Integer to Binary

1. Divide integer by 2, note down remainder
2. Repeat step 1 till you get a zero in the quotient
3. Write down the remainders noted from last to first.

Binary to Integer

1. Consider the binary digits. Start from the right-most position and move towards left.
2. Multiply each binary digit with power-of-two. Starting from zero (right-most) and increment the power for each digit as you move towards left.
3. Sum all the results obtained in step 2.

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- Operators
  - ~~Arithmetic (+, -, *, /, %)~~
  - ~~Relational (==, !=, >, <, >=, <=)~~
  - ~~Assignment (+=, -=, *=, /=, %, <<=, >>=, &=, ^=, |=)~~
  - ~~Increment / Decrement (++, - -)~~
  - ~~Special: ternary, sizeof~~
  - ~~Logical (&&, ||, !)~~
  - Bitwise (&, |, ^, ~, <<, >>)
- Binary to Decimal to Hexadecimal (and combinations)

Hexadecimal to Binary

- A in binary = 1010
- AB in binary = 1010 1011.
- But when we write we use a notation

  0xA, 0xAB (read as “zero ex A B”)

  Exercise: convert 0xDEFC to binary

  Exercise: convert 0xAB4 to binary

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Exercise: convert 0xDEFC to binary 1101 1110 1111 1100

Exercise: convert 0xAB4 to binary 1010 1011 0100

Binary to Hexadecimal

- Starting from right most digit, group the binary digits in sets of 4 consecutive digits.
- Consider the binary number formed from 4 digits in each set
- Map the binary number to hexadecimal

  Example: 10011011011

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  Example: 100|1101|1011

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  4 D B

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  Example: 10011011011=0x4DB

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  Example: 10011011011=0x4DB

Exercise: what is the decimal equivalent of 10011011011?

Binary to Decimal

Exercise: what is the decimal equivalent of 10011011011?

$1*2^0+1*2^1+0*2^2+$

$1*2^3+1*2^4+0*2^5+$

$1*2^6+1*2^7+0*2^8+$

$0*2^9+1*2^{10}$

Hexadecimal to Decimal

what is the decimal equivalent of 0x4BD?

$= D*16^0+B*16^1+4*16^2$

How did we get this formula?

Refer slide 10 and replace “power-of-two” by “power-of-sixteen”

Bitwise Operators - example program

```c
int main() {
    int a=10, b=3;
    //what do these print and why?
    printf("a & b: %d\n", a & b);
    printf("a | b: %d\n", a | b);
    printf("a ^ b: %d\n", a ^ b);
    printf("~a: %d\n", ~a); //why do you see -11?
    printf("a << 1: %d\n", a << 1);
    printf("a >> 1: %d\n", a >> 1);
}
```

Bitwise Operators - analysis

10 in binary = 1010

```
int a=10;
```

1000 0000 0000 0000 0000 0000 0000 1010

a

```
int b=3;
```

1000 0000 0000 0000 0000 0000 0000 0011

b

More Assignment Operators

```
int main() {
    int a=10, b=3;
    a&=b;printf("value of a after a&=b: %d\n",a);
    a=10; a|=b; printf("value of a after a|=b: %d\n", a);
    a=10; a^=b; printf("value of a after a^=b: %d\n", a);
    a=10; a>>=1;printf("value of a after a>>=1: %d\n", a);
    a=10; a<<=1;printf("value of a after a<<=1: %d\n", a);
}
```