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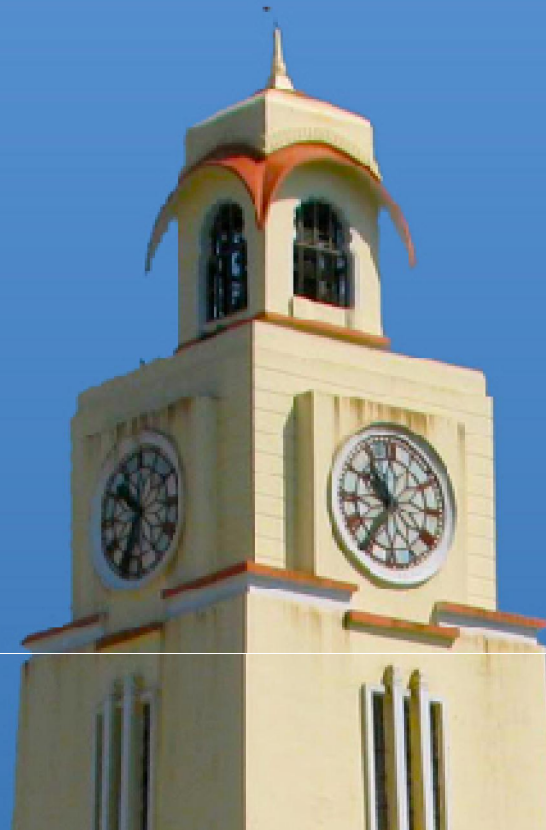
Computer Programming

Module-1 (Lecture-3)

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Topics to be Covered:

Signed Binary Representations (Signed Magnitude , 1's Complement, 2's Complement) and Arithmetic Operations, Character Data Representations

Signed Binary Representations



- To do the subtraction, we need to represent negative numbers as well
- Need to store the sign of the number
- Unsigned representation can be extended to store the sign information along the value
- How to do it?

Signed Magnitude Representation



- Append an extra bit as an left most bit
- 0 for ***Positive*** and 1 for ***Negative***
- Example:
- 01111 (+15) and 11111 (-15)

Signed Magnitude Binary Representation



Number/Representation	Signed Magnitude
000	0
001	1
010	2
011	3
100	-0
101	-1
110	-2
111	-3

What is the representation of 0?

What is the range of numbers can be represented using N bits in signed magnitude form?

Arithmetic: Signed Magnitude Representation



- Let's consider two numbers (signed magnitude) A and B
 - To subtract B from A, add B's negative to A
 - i.e. $A + (-B)$
- Let's try arithmetic for signed magnitude?

$$\begin{array}{r} 1101 \\ + 0101 \\ \hline \end{array}$$



1's Complement Representation

- Negative numbers are represented by *flipping* the bits (1 to 0 and 0 to 1) of corresponding positive number representation.
- Example with 3 bits
 - Representation of +2 is:
 - 010
 - Representation of -2 is:
 - 101



1's Complement Representation

Number/Representation	1's Complement
000	0
001	1
010	2
011	3
100	-3
101	-2
110	-1
111	-0

What is the representation of 0?

What is the range of numbers can be represented using N bits in 1's complement form?

Arithmetic: 1's Complement Representation



- Let's try the arithmetic for 1's complement numbers?

$$\begin{array}{r} 1101 \\ + 0101 \\ \hline \end{array}$$

2's Complement Representation



- Positive numbers are represented as unsigned binary numbers
- How to represent a negative number?
 - Take 1's complement of +ive number
 - Add 1 to get the negative of that
 - Example:
 - 011 (+3)
 - 100 (1's complement)
 - 101 (2's complement)



2's Complement Representation

Number/Representation	2's Complement
000	0
001	1
010	2
011	3
100	-4
101	-3
110	-2
111	-1

What is the representation of 0?

What is the range of numbers can be represented using N bits in 2's complement form?

Arithmetic: 2's Complement Representation



- Let's try arithmetic for 2's complement numbers:

$$\begin{array}{r} 1101 \\ + 0101 \\ \hline \end{array}$$

- Represent above numbers in 6 bits and perform the addition

Overflow: 2's Complement

- Let's try the following operation:

$$\begin{array}{r} 011010 \text{ (+26)} \\ + 001010 \text{ (+10)} \\ \hline \\ \hline \end{array}$$

- Observations:
 - Sign of both numbers
 - Sign of result



Data Types

- A Data Type in programming refers to:
 - a set of values associated with a common representation and operations
- e.g. Integer in C (32 bit machine)
 - Set of values (-2^{31} to 0 to $2^{31} - 1$)
 - 2's Complement Representation
 - Possible operations (+, -, *, /, %)
- Question
 - What about unsigned int?

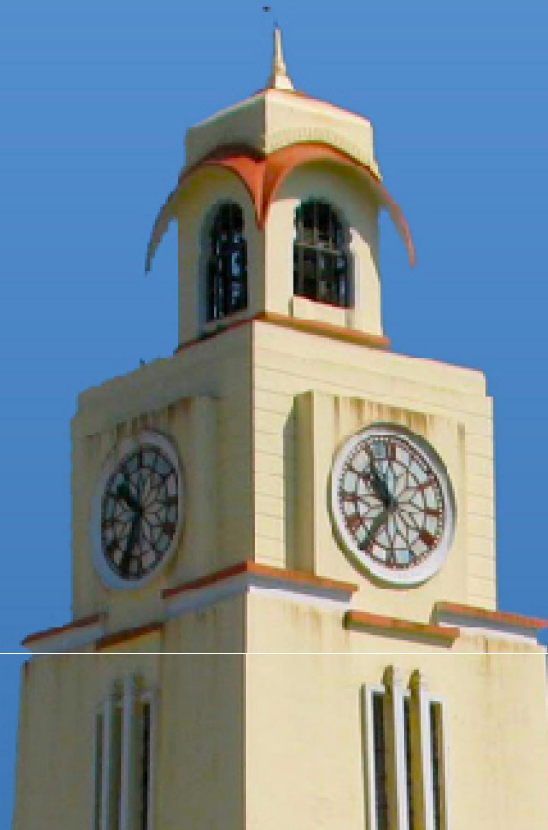


Character Representation

- Characters can also be represented by natural numbers
- Characters are represented using ***unsigned int*** in C language
 - Range is 0 to 255 (8 bits)
 - ASCII codes are used to represent the characters
 - English alphabets (Upper case and lower case), Arabic Numerals, Punctuation, special characters are mapped to the set of ***unsigned int*** values (i.e. 0 to 255)



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Thank You!