CS 225: Switching Theory

S. Tripathy IIT Patna

Previous Class

- Number Systems and Codes
 - Different Number systems (positional)
 - Conversion
 - Representation (complement)
 - Binary Arithmetic

This Class

Number Systems and Codes

- Codes
 - BCD, cyclic code etc.
 - Gray code
 - Parity and Error correcting code

Signed binary number

Positive numbers can be defined with Sign bit 0

- Ex. In 8-bit representation of +9 = 00001001
- Negative numbers can be represented in three different ways:

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Signed magnitude: -9 = 10001001
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- Signed 1's complement: -9 = 11110110
- Signed 2's complement: -9 = 11110111

- Undesired aspect in signed binary and 1 s complement method:
- representation of 0s:
 - +0 has different code from -0

Radix Complements (r-1's complement)

- r-1's Complements:
 - Diminished Radix (r-1)'s Complement
 - (r-1)'s complement of a number N with n digits is $(r^n-1) N$.

Ex.:9's complement of 346 is 999-346=653 (103 -1= 999)

 1's complement of a binary number can be determined as just replacing 1's with 0's and vice- versa..

Radix Complements (r's complement)

- Radix complement:
 - r's complement of a number N with n digits is $r^n N = (r^n 1) N + 1$.

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Ex. 10's complement of 346 is = 654 (653+1)
2's complement of 1011= 0101
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NB: complement of N is N $r^n - (r^n - N) = N$

Subtraction using r's complement

- Addition
 - Care for overflow
- Subtraction:
 - Complements:
- M and N are two n digit numbers with radix r
- To subtract N from M
 - Compute the r's complement of $N = r^n N$
 - Add M with r's complement of N i.e. M N + rⁿ

If M >= N result produce the carry rn which may be discarded so resulting M -N

If M<N result does not produce carry that may be treated as . M- N $+ r^n = r^n - (N - M)$ so the answer is r's complement of the result.

Overfl ow

- Overflow is said to occur if the result needs more than n-bits.
- If c is a carry into the sign-bit position and o is the carry from sign-bit position; then overflow is said to occur if and only if c XOR o = 1

Ex.:

Answer the following

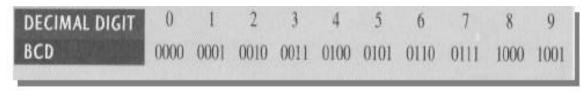
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Q1. (1010100), - (1000011), =? Use 2'complement method
                 Ans.: 10010001 =0010001 (17=84-67)
Q2. (1000011)_2 - (1010100)_2 =? Use 2'complement method
               Ans.: _{1101111} = -0010001(-17=67-84)
Q3. 1100101_2 \times 111101_2 = ?
               Ans.: 1100000010001 (101 x61 =6161)
Q4. 100101_2 \div 101_2 = ?
               Ans.: Q= 111, rem= 10 (37_{10} \div 5_{10} = Q(7), rem(2))
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Binary Coded Decimal (BCD)

To code a number with n decimal digits, we need 4n bits in BCD e.g. $(365)_{10}$ = $(0011\ 0110\ 0101)_{BCD}$

This is different to converting to binary, which is $(365)_{10} = (101101101)_2$

- Use 4-bit binary to represent one decimal digit
- Easy conversion
- Wasting bits (4-bits can represent 16 different values, but only 10 values are used). Clearly, BCD requires more bits. BUT, it is easier to understand/interpret



. Thanks