

Lecture #3c

Data Representation and Number Systems





Questions?

IMPORTANT: DO NOT SCAN THE QR CODE IN THE VIDEO RECORDINGS. THEY NO LONGER WORK

Ask at

https://sets.netlify.app/module/676ca3a07d7f5ffc1741dc65

OR

Scan and ask your questions here! (May be obscured in some slides)



10.6 2s Complement on Addition/Subtraction (1/4)

- Algorithm for addition of integers, A + B:
 - 1. Perform binary addition on the two numbers.
 - 2. Ignore the carry out of the MSB.
 - 3. Check for overflow. Overflow occurs if the 'carry in' and 'carry out' of the MSB are different, or if result is opposite sign of A and B.
- Algorithm for subtraction of integers, A B:
 A B = A + (-B)
 - 1. Take 2s-complement of B.
 - 2. Add the 2s-complement of B to A.



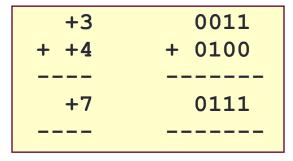
10.6 Overflow (2/4)

- Signed numbers are of a fixed range.
- If the result of addition/subtraction goes beyond this range, an overflow occurs.
- Overflow can be easily detected:
 - positive add positive → negative
 - negative add negative → positive
- Example: 4-bit 2s-complement system
 - Range of value: -8₁₀ to 7₁₀
 - $0101_{2s} + 0110_{2s} = 1011_{2s}$ $5_{10} + 6_{10} = -5_{10}$?! (overflow!)
 - $1001_{2s} + 1101_{2s} = \underline{1}0110_{2s}$ (discard end-carry) = 0110_{2s} $-7_{10} + -3_{10} = 6_{10}$?! (overflow!)

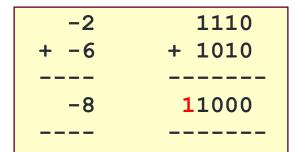


10.6 2s Complement Addition (3/4)

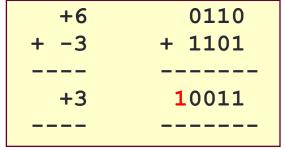
Examples: 4-bit system



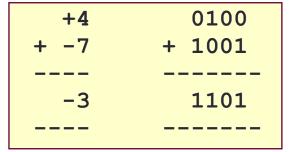
No overflow



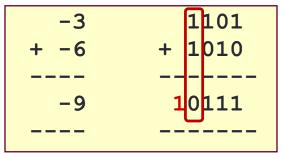
No overflow



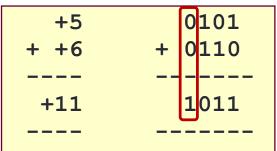
No overflow



No overflow



Overflow!



Overflow!



Which of the above is/are overflow(s)?

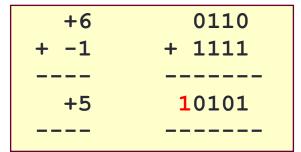
10.6 2s Complement Subtraction (4/4)

- Examples: 4-bit system
 - □ 4 − 7
 - □ Convert it to 4 + (-7)
 - □ 6 − 1
 - Convert it to 6 + (-1)

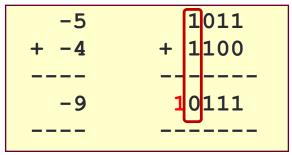
- -5-4
- Convert it to -5 + (-4)

+4	0100
+ -7	+ 1001
-3	1101

No overflow



No overflow



Overflow!

Which of the above is/are overflow(s)?



10.7 1s Complement on Addition/Subtraction (1/2)

- Algorithm for addition of integers, A + B:
 - 1. Perform binary addition on the two numbers.
 - If there is a carry out of the MSB, add 1 to the result.
 - 3. Check for overflow. Overflow occurs if result is opposite sign of A and B.
- Algorithm for subtraction of integers, A B:
 A B = A + (-B)
 - Take 1s-complement of B.
 - 2. Add the 1s-complement of B to A.



10.7 1s Complement Addition (2/2)

Examples: 4-bit system

No overflow

No overflow

No overflow

Overflow!

Any overflow?

DLD page 42 – 43 Quick Review Questions Questions 2-13 to 2-18.



10.8 Excess Representation (1/2)

- Besides sign-and-magnitude and complement schemes, the excess representation is another scheme.
- It allows the range of values to be distributed <u>evenly</u> between the positive and negative values, by a simple translation (addition/subtraction).
- Example: Excess-4 representation on 3-bit numbers. See table on the right.

Excess-4 Representation	Value
000	-4
001	-3
010	-2
011	-1
100	0
101	1
110	2
111	3

Questions: What if we use Excess-2 on 3-bit numbers? Or Excess-7?



10.8 Excess Representation (2/2)

 Example: For 4-bit numbers, we may use excess-7 or excess-8. Excess-8 is shown below.

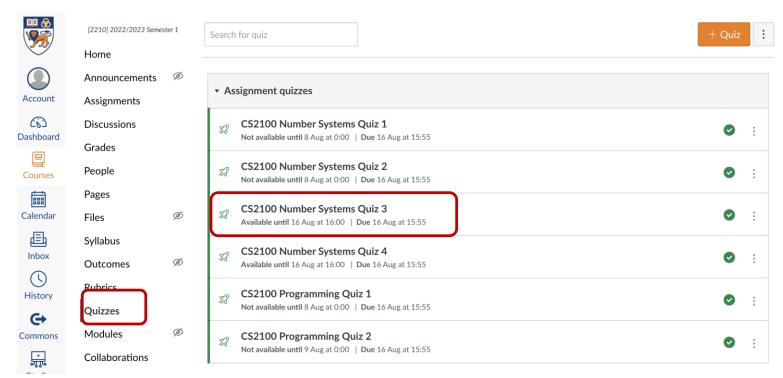
Excess-8 Representation	Value
0000	-8
0001	-7
0010	-6
0011	-5
0100	-4
0101	-3
0110	-2
0111	-1

Excess-8 Representation	Value
1000	0
1001	1
1010	2
1011	3
1100	4
1101	5
1110	6
1111	7



Quiz

- Please complete the "CS2100 C Number Systems Quiz 3" in Canvas.
 - Access via the "Quizzes" tool in the left toolbar and select the quiz on the right side of the screen.





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