COMP10002 Workshop Week 12

Outlook:

1	Representation of integers and floats
2	Ex. 13.1 and 13.2
3	QoCT surveys
4	Working with text files Design & implement 11.3
5	Design 9.3 Implement 9.3 and/or 9.11

Numeral Systems

214.39	2	1	1	.	3	9
Position	2	1	0	Dot	-1	-2
Value	2×10^2	1×10^1	4×10^0		3×10^{-1}	9×10^{-2}

$\rightarrow$ *base* = 10

Other bases: binary (base= 2), octal (base= 8) ...

$$21.3_{(10)} = 2 \times 10^1 + 1 \times 10^0 + 3 \times 10^{-1}$$

$$1001_{(2)} = 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 9_{(10)}$$

$$1021_{(2)} = ?$$

Changing Binary → Decimal

Just expand using the base=2:

$$\ldots\ b_3\ \ b_2\ \ b_1\ b_0\ .\ b_{-1}\ \ b_{-2}\ \ldots\ \ (2)$$

is $\ldots\ b_3 x 2^3 + b_2 x 2^2 + b_1 x\ 2^1 + b_0\ +\ b_{-1} x 2^{-1} + b_{-2} x 2^{-2} \ldots$

so **101001** *and* **1.101**

are $2^5 + 2^3 + 1 = 41$ *and* $1 + 2^{-1} + 2^{-3} = 1.625$

Practical advise: remember

128	64	32	16	8	4	2	1	0.5	0.25	0.125
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}

Changing Decimal → Binary [method 1]

Remember and apply the power-of-two sequence:

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}
	128	64	32	16	8	4	2	1		.5	.25	.125
13.625_{10} → 1101.101_2					8	4		1		.5		.125
109_{10} →		64	32		8	4		1				
19												
1.3125												

[method 2] Algorithm: Decimal→Binary, Integer Part

Changing integer x to binary: Just divide x and the subsequent quotients by 2 until getting zero. The sequence of remainders, in reverse order of appearance, is the binary form of x.

Example: 23

operation	quotoion	remainder
23 :2	11	1
11:2	5	1
5:2	2	1
2:2	1	0
1:2	0	1

So: $23 = 10111_{(2)}$

[method 2] Algorithm: Decimal → Binary, Fraction Part

Fraction: Multiply it, and subsequent fractions, by 2 until getting zero. Result= sequence of integer parts of results, in appearance order. Examples:

0.375				0.1		
operation	int	fraction		operation	int	fraction
.375 x 2	0	.75		.1 x 2	0	.2
.75 x 2	1	.5		.2 x 2	0	.4
.5 x 2	1	.0		.4 x 2	0	.8
				.8 x 2	1	.6
				.6 x 2	1	.2

So: $0.375 = 0.011_{(2)}$ $0.1 = 0.00011(0011)_{(2)}$

Now try convert: 6.875 to binary

Converting Decimal->Binary

$7_{(10)} = ?_{(2)}$

$130_{(10)} =$

$6.375_{(10)} =$

Representation of integers (in computers)

2-complement representation in w bits

1 sign bit: w-1 bit for:

x>=0 : 0 binary form of x

x<0 : 1 binary form of 2^{w-1} - |x| = 2^{w-1} + x

(valued -2^{w-1})

Ex: w= 4, then 2^{w-1}= 8, and only numbers from -8 to +7 can be represented.

2			-5	
2			2^{w-1} – 5 is 3	
2 in binary:	10		3 in binary:	11
In w-1 bits:	010		In w-1 bits:	011
Adding sign bit:	0010		Adding sign bit:	1011

Finding twos-complement representation in w bits for negative numbers in 3 step

Suppose that we need to find the twos-complement representation of – `x`*, where* `x` *is positive, in* `w=16` *bits. It can be done easily in 3 steps:*

1) *Find binary representation of |*`x`*| in w bits*
2) *Take the result above, inverse (flip)* `1` *to* `0` *and vice versa*
3) *Add* `1` *to the above to get the final twos-complement representation*

find the 2-comp repr of –40	**Bit sequence**			
1) bin repr of 40 in 16 bits	0000	0000	0010	1000
2) inverse	1111	1111	1101	0111
3) add 1	1111	1111	1101	1000

Note: Step 3 (adding `1`*) can be easily be done by:*

finding the right most `zero-bit`*, then*

inversing all bits from this position to the right end.

This note can be combined with steps 1-2 to make a shorter algorithm ☺

Ex: 2-complement representation in w=16 bits

Q: What are `17`, `−17`, `34`, and `−34` as 16-bit twos-complement binary numbers, when written as (a) binary digits, and (b) hexadecimal digits?

Ex. 13.1

Suppose that a computer uses w= 6 bits to represent integers. Calculate the two-complement representations for 0, 4, 19, -1, -8, and -31; Verify that 19-8 = 11;

Quiz

What is the binary form of $255_{(10)}$?

A. `1000 0000`

B. `1111 1111`

C. `1 0000 0000`

D. `1 1111 1111`

Quiz

What is the binary form of $13.625_{(10)}$?

A. `1101.101`

B. `1011.101`

C. `1101.11`

D. `1011.11`

Quiz

What is your tutor’s name?

A. Alistair

B. Anh Vo

C. Artem

D. Ahn Vo

5 min break for qoct : quality of casual teaching survey

- Please do the survey right now
- To access the survey, navigate to:

https://apps.eng.unimelb.edu.au/casmas/index.php?r=qoct/subjects

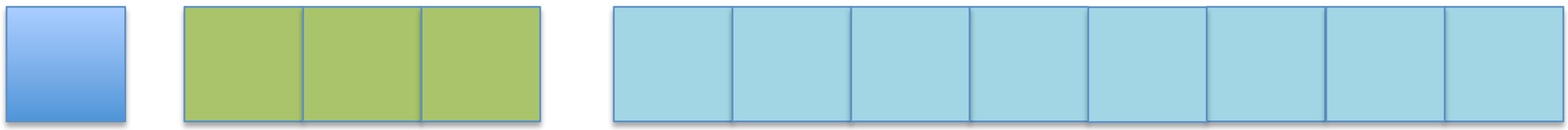
- OR just google:

  qoct

- Then choose the subject: comp10002

Representation of floats (as described in lec09.pdf)

sign e m



1 bit sign | w_e bits two-compl of e | w_m bits representation of first n bits of mantissa m

Convert /*x*/ to binary form, and transform so that:

$$|x| = \mathtt{0.b_0b_1b_2\ldots\ x\ 2^e} \quad \textit{where } \mathtt{b_0 = 1}$$

$\mathtt{e}$ is called exponent, $\mathtt{m = b_0b_1b_2\ldots}$ is called mantissa

Three components: `sign, e, m` are represented as in the diagram.

Ex. 13.2

Suppose $\mathtt{w_s}$=1, $\mathtt{w_e}$=3, $\mathtt{w_m}$=12, what's the representation of 2.0, -2.5, 7.875 ?

Representation of 32-bit float: (IEEE 754, as in floatbits.c)

w_s=1, w_e=8, w_m=23 $|x|$ = $1.b_1b_2\ldots \times 2^e$ [Note the *different transformation* of $|x|$]

---------------------------------Bit Position ---------------------------------------

1 2 9 10 32

Sign ---------------------------------- --

$e+127$ b_1 b_2 . . . $b_{22}b_{23}$

That is:

- The sign bit is 0 or 1 as previous case
- e is represented in `excess-127` format, which means e is represented as the non-negative value $e+127$ in w_e bits
- The first bit of the mantissa is omitted from the representation, and the mantissa is just $b_1b_2\ldots b_{23}$

Note: Value 0.0 does not follow the above rule. 0.0 is represented as 32 zero-bits.

Representation of 32-bit float: (IEEE 754, as in floatbits.c)

w_s=1, w_e=8, w_m=23 $\qquad |x| = 1.b_1b_2\ldots \times 2^e$

Example: x= 3.5

In binary: x= 11.1= 1.11 x 2^1

→ sign bit: 0

→ e=1 is represented as e+127= 128 in 8 bits

→ e is represented as 1000 0000

→ mantissa: 110 0000 0000 0000 0000 0000

→ Final representaion:

0100 0000 0110 0000 0000 0000 0000 0000

or 4 0 6 0 0 0 0 0 $_{(16)}$

Working with text files. Ex 11.3

The Unix `tee` command writes its `stdin` through to `stdout` in the same way that the `cat` command does. But it also creates an additional copy of the file into each of the filenames listed in the command-line when it is executed.

Implement a simple version of this command.

Hint: you will need an array of files all opened for writing.

Design 9.3

Write a program that deals four random five-card poker hands from a standard 52-card desk:

```
$ ./poker
player 1:   3-S, Ac-C, Qu-D, 4-H, Qu-H
              . . .
```

(all 4 players)

Then, modify your program to allow you to estimate the probability that a player obtains a simple pair (2 cards with the same face value) in their initial hand. Compute that probability using 40,000 hands dealt from 10,000 shuffled desks.

...

Design 9.3

Implement: 11.2 ,   9.3 OR   9.11

Possible follow-up subjects next year:

sem1: comp20007 – Design of Algorithms

sem2: comp20003 – Algorithms & Data Structures