Higher Computing Notes

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Chapter 1

Computer Systems

1.1 Data Representation

1.1.1 Two's Complement

Decimal to Binary

To create the binary of -120, there are 3 steps.

1. Convert the positive number into binary

   0111 1000 (120)

2. Invert all the bits (0's to 1's and 1's to 0's)

   1000 0111

3. Add 1 to the right of the number (Least Significant Bit)

$$\begin{array}{r} 1000\ 0111 \\ +\ 0000\ 0001 \\ \hline 1000\ 1000 \end{array}$$

Binary to Decimal

To convert a tow's complement number from binary to decimal, simply write out the column headers except with the most significant bit as negative, then add up all the numbers with a 1.

-128	64	32	16	8	4	2	1	
1	0	0	0	1	0	0	0	= -128 + 32 = -120

Min and Max Limits

To calculate the maximum and minimum numbers that can be stored using the two's complement system, use the following formulae:

From -2^{n-1} to $(2^{n-1}) - 1$

1.1.2 Floating Point Representation

Binary Fractions

To store binary fractions, we simply add extra column headers to the right of the decimal point by dividng by 2.

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}

To convert a fixed point binary to decimal, we just add up the column headers as before.

Because the computer can't store decimal points in binary, we have to use floating point representation to store real numbers.

Storing Floating Point Numbers

A floating point number is split up into 3 parts - the sign, the mantissa and the exponent. The sign determines whether it is a negative number or not (1 for a negative and 0 for positive just as in two's complement). The mantissa is the whole number without the decimal point. This is left-aligned and padded with 0's. The exponent is used to tell the computer the position of the decimal point in the mantissa. This right aligned and padded with 0's at the start.

	Sign	Mantissa	Exponent
24 bits =	1 bit	15 bits	8 bits
32 bits =	1 bit	23 bits	8 bits
64 bits =	1 bit	52 bits	11 bits

Converting Real Numbers to Fixed Point Binary

To convert a real number like 250.03125 to fixed point binary, we must:

1. Convert the first part of the number into binary (before the decimal point)

   250.03125
   250 = 111 1010

2. Convert the second part of the number into binary by multiplying until it equals 1

0.03125	* 2 = 0r0.0625	= 0.00001
0.0625	* 2 = 0r0.125	
0.125	* 2 = 0r0.25	
0.25	* 2 = 0r0.5	
0.5	* 2 = 1r0	↓

3. Now join the two parts together to get:

   1111010.00001

Converting Fixed Point Binary to Floating Point

We start with a fixed point binary number such as 11.001011 to convert to 24 bit floating point representations:

1. We first move the decimal point out of the number to the left and then pad it out on the right to form the mantissa.

   11.001011
   110010110000000

2. We then convert the number of spaces the dcimal point moved to form the exponent

   It moved 2 spaces so the exponent is 0000 0010

3. We then choose the sign and fill out the table

Sign	Mantissa	Exponent
0	110 0101 1000 0000	0000 0010

If the number is a smaller number (below 0), then the decimal point must be moved to the right so that is just to the left of the firs 1. Because the decimal point has been moved in the opposite direction, then the exponent will be a negative number and must be stored using the two's complement system.

Bit Allocation

The higher the number of bits stored in the mantissa, the higher the precision of the number. The more numbers after the decimal point, the greater the precision.

Increasing the exponent increases the range of numbers that can be stored as the decimal point can be moved more places to the right and left.

Single precision is a 32 bit floating point number (1 bit sign, 23 bits mantissa, 8 bits exponent) and double precision is 64 bits (1 bit sign, 52 bits mantissa, 11 bits exponent).

1.1.3 Storing Text

ASCII

ASCII is a method of storing text digitally. Each letter on a keyboard has it's own ASCII code which was originally stored with 7 bits but was increased to 8 bits to store more characters for more languages and symbols (known as extended ASCII). ASCII stands for the American Standard Code for Information Interchange.

The first 32 codes are known as control codes which cannot be printed such as backspace, delete and escape.

A character set is the term for a certain way of storing text on a computer. There are lots of different character sets for different languages. ASCII is one character set and Unicode is another.

Unicode

The problem with ASCII is that there wasn't enough space to store every letter of every language's alphabet. Unicode was invented to fix this by using more bits so it could store more letters and symbols.

Unicode is known as UTF-8, UTF-16 and UTF-32, storing 8, 16, 32 bits for each character.

The first 128 values of Unicode are the same as ASCII and then goes up to 137,439 characters!

1.1.4 Graphics

Vector Graphics

Advantages :

- Do no lose quality when scaled
- Require less sotrage space
- Objects are easily moved/manipulated
- Resolution independent

Disadvantages :

- Cannot be edited at pixel level
- Cannot show photo realistic scenes easily
- Will usually require special applications to open

Bitmapped Graphics

Advantages :

- Can edit down to the individual pixel
- Adding extra detail to the picture does not increase the file size
- Can create photo realistic images

Disadvantages :

- Have a very large file size as every pixel is stored
- When scaled larger, pictures pixelate as they are resolution dependent

Chapter 2

Software Design and Development

Hello world