ECE3310
Data Structure

Midterm
Resubmission of Question 3, 4, 6, and 8

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19 March 2020

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3.a

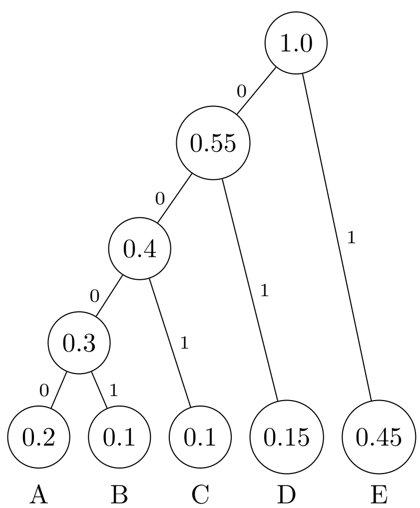
Character	Huffman Code
A	011
B	000
C	001
D	010
E	1

Table 1: Huffman Code for Tree 1

3.b

$EL1 = 0.2 \times 3 + 0.1 \times 3 + 0.1 \times 3 + 0.15 \times 3 + 0.45 \times 1 = 2.1$

3.c Tree 2



3.d

Character	Huffman Code
A	0000
B	0001
C	001
D	01
E	1

Table 2: Huffman Code for Tree 2

3.e

$EL2 = 0.2 \times 4 + 0.1 \times 4 + 0.1 \times 3 + 0.15 \times 2 + 0.45 \times 1 = 2.25$

3.f

EL1 do not agree with EL2. The length for the characters differs for different tree built with the same character and frequency, as the configuration of the characters changes between different trees, the reduction of length to node of higher frequency character would skew EL to a lower value and vice versa, therefore it is reasonable that EL1 does not necessarily agree with EL2 as the increase in length to A with frequency 0.2 and the increase in length to B and C skewed EL to a higher value that cannot be offset by the reduction in length to D.

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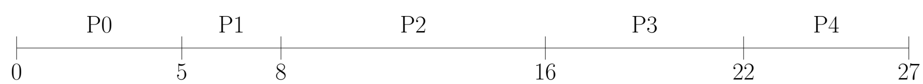
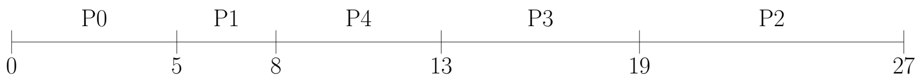
4.a FCFS



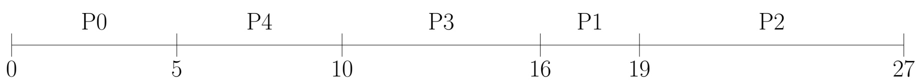
Process	Arrival Time	Execution Time	Service Time	Wait Time
P0	0	5	0	$0 - 0 = 0$
P1	1	3	5	$5 - 1 = 4$
P2	2	8	8	$8 - 2 = 6$
P3	3	6	16	$16 - 3 = 13$
P4	4	5	22	$22 - 4 = 18$

4.b SJN



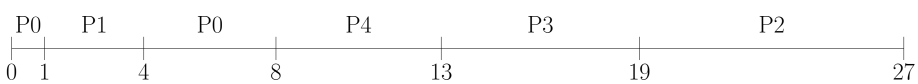
Process	Arrival Time	Execution Time	Service Time	Wait Time
P0	0	5	0	$0-0=0$
P1	1	3	5	$5-1=4$
P2	2	8	19	$19-2=17$
P3	3	6	13	$13-3=10$
P4	4	5	8	$8-4=4$

4.c Priority Scheduling



Process	Arrival Time	Execution Time	Priority	Service Time	Wait Time
P0	0	5	1	0	$0-0=0$
P1	1	3	2	16	$16-1=15$
P2	2	8	1	19	$19-2=17$
P3	3	6	3	10	$10-3=7$
P4	4	5	4	5	$5-4=1$

4.d Shortest Remaining Time



Process	Arrival Time	Execution Time	Service Time	Wait Time
P0	0	5	0,4	$(0-0)+(4-1)=3$
P1	1	3	1	$1-1=0$
P2	2	8	19	$19-2=17$
P3	3	6	13	$13-3=10$
P4	4	5	8	$8-4=4$

4.e Round Robin with Quantum = 3

P0	P1	P2	P3	P4	P0	P2	P3	P4	P2
0–3	3–6	6–9	9–12	12–15	15–17	17–20	20–23	23–25	25–27

Process	Arrival Time	Execution Time	Service Time	Wait Time
P0	0	5	0,15	$(0-0)+(15-3)=12$
P1	1	3	3	$3-1=2$
P2	2	8	6,17,25	$(6-2)+(17-9)+(25-20)=17$
P3	3	6	9,20	$(9-3)+(20-12)=14$
P4	4	5	12,23	$(12-5)+(23-15)=15$

4.f Round Robin with Quantum = 2

P0	P1	P2	P3	P4	P0	P1	P2	P3	P4	P0	P2	P3	P4	P2
0–2	2–4	4–6	6–8	8–10	10–12	12–13	13–15	15–17	17–19	19–20	20–22	22–24	24–25	25–27

Process	Arrival Time	Execution Time	Service Time	Wait Time
P0	0	5	0,10,19	$(0-0)+(10-2)+(19-12)=15$
P1	1	3	2,12	$(2-1)+(12-4)=9$
P2	2	8	4,13,20,25	$(4-2)+(13-6)+(20-15)+(25-22)=17$
P3	3	6	6,15,22	$(6-3)+(15-8)+(22-17)=15$
P4	4	5	8,17,24	$(8-4)+(17-10)+(24-19)=16$

6

6.a

As n-bytes signed type uses one bit for the sign, 8n bits is used to represents 2^{8n-1} negative values, 1 zero and $2^{8n-1}-1$ positive values. Therefore int, a signed 4 bytes range from $-(2^{(4Bytes\times 8bits)-1}) = 2^{31} = -2147483648$ to $2^{(4Bytes\times 8bit)-1}-1 = 2^{31}-1 = 2147483647$

6.b

The maximum of a single precision is when sign bit is 0 (positive), the 8 bits exponent is at its maximum ($254-127=127$ as defined in IEEE 754) and the 23 bits mantissa at its maximum (all bits as 1). The maximum number can then be calculated as follow:

$$(1+\sum_{i=1}^{23}\frac{1}{2^i})\times 2^{127} = 3.4028234663852885981170418348451692544\times 10^{38}$$

The minimum would be almost the same except with the sign bit being 1:

$$-3.4028234663852885981170418348451692544 \times 10^{38}$$

The minimum (denormal) positive number is when both the exponent ($1-127 = -126$) and mantissa (2^{-23}) is at its minimum, the value is then:

$$2^{-126} \times 2^{-23} = 2^{-149} \approx 1.4013 \times 10^{-45}$$

The mantissa increments at a value of $2^{-23} \approx 10^{-7}$, which means it can provide 7 digits of precision.

6.c

As n-bytes signed type uses one bit for the sign, 8n bits is used to represents 2^{8n-1} negative values, 1 zero and $2^{8n-1} - 1$ positive values. Therefore long, a signed 8 bytes range from $-(2^{(8Bytes \times 8bits)-1}) = 2^{63} = -9223372036854775808$ to $2^{(8Bytes \times 8bits)-1} - 1 = 2^{63} - 1 = 9223372036854775807$

6.d

The maximum of a double precision is when sign bit is 0 (positive), the 11 bits exponent is at its maximum ($2046 - 1023 = 1023$ as defined in IEEE 754) and the 52 bits mantissa at its maximum (all bits as 1). The maximum number can then be calculated as follow:

$$(1 + \sum_{i=1}^{52} \frac{1}{2^i}) \times 2^{1023} \approx 1.79769 \times 10^{308}$$

The minimum would be almost the same except with the sign bit being 1:

$$\approx -1.79769 \times 10^{308}$$

The minimum (denormal) positive number is when both the exponent ($1 - 1023 = -1022$) and mantissa (2^{-52}) is at its minimum, the value is then:

$$2^{-1022} \times 2^{-52} = 2^{-1076} \approx 4.941 \times 10^{-324}$$

The mantissa increments at a value of $2^{-52} \approx 2 \times 10^{-16}$, which means it can provide around 16 digits of precision.

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8.a

The maximum of a quadruple precision is when sign bit is 0 (positive), the 15 bits exponent is at its maximum ($32766 - 16383 = 16383$ as defined in IEEE

754) and the 112 bits mantissa at its maximum (all bits as 1). The maximum number can then be calculated as follow:

$$(1 + \sum_{i=1}^{112} \frac{1}{2^i}) \times 2^{16383} \approx 1.1897 \times 10^{4932}$$

The minimum would be almost the same except with the sign bit being 1:

$$\approx -1.1897 \times 10^{4932}$$

The minimum (denormal) positive number is when both the exponent ($1 - 16383 = -16382$) and mantissa (2^{-112}) is at its minimum, the value is then:

$$2^{-16382} \times 2^{-112} = 2^{-16494} \approx 6.475175 \times 10^{-4966}$$

The mantissa increments at a value of $2^{-112} \approx 2 \times 10^{-34}$, which means it can provide around 34 digits of precision.

8.b

The maximum of an octuple precision is when sign bit is 0 (positive), the 19 bits exponent is at its maximum ($524286 - 262143 = 262143$ as defined in IEEE 754) and the 236 bits mantissa at its maximum (all bits as 1). The maximum number can then be calculated as follow:

$$(1 + \sum_{i=1}^{236} \frac{1}{2^i}) \times 2^{262143} \approx 1.6113257175 \times 10^{78913}$$

The minimum would be almost the same except with the sign bit being 1:

$$\approx -1.6113257175 \times 10^{78913}$$

The minimum (denormal) positive number is when both the exponent ($1 - 262143 = -262142$) and mantissa (2^{-236}) is at its minimum, the value is then:

$$2^{-262142} \times 2^{-236} = 2^{-262378} \approx 2.248 \times 10^{-78984}$$

The mantissa increments at a value of $2^{-236} \approx 10^{-73}$, which means it can provide around 73 digits of precision.

8.c

In report 1 the following values of 50! was obtained using different tools:

Tools	Value of 50!
Excel	3.04141E+64
MATLAB	3.041409320171338e+64
Calculator	3.0414093201713378043612608166065e+64

As Calculator have the most number of digits of 50!, it seems to be the case that it have the highest precision (32 decimal digits $\approx$ quadruple precision). However, as it only have half the number of decimal digits precision as octuple precision, it is unlikely that calculator, and other tools that have lower precision than it, have the same or higher than octuple precision.