

Solutions to Problem 3 of Homework 9 (8 points)

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Due: Tuesday, November 24

Design optimal Huffman codes for the following frequencies f_0, \dots, f_7 . In each case, draw the Huffman tree incrementally, until you arrive at your final solution. After you finish, which Huffman code is more “balanced”: “arithmetic” or “geometric”?

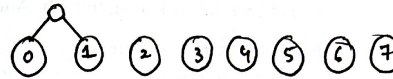
(a) (4 pts) Arithmetic: $f_i = 10 + i$, for $i = 0 \dots 7$.

Solution:

	0	1	2	3	4	5	6	7
f_i	10	11	12	13	14	15	16	17

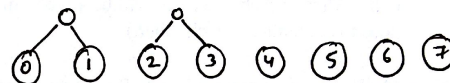
Merge 0 and 1.

	2	3	4	5	6	7	01
f_i	12	13	14	15	16	17	21



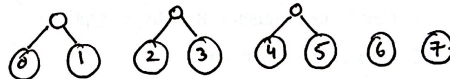
Merge 2 and 3

	4	5	6	7	01	23
f_i	14	15	16	17	21	25



Merge 4 and 5

	6	7	01	23	45
f_i	16	17	21	25	29



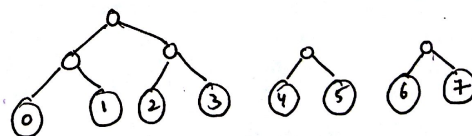
Merge 6 and 7

	01	23	45	67
f_i	21	25	29	33



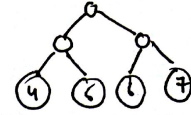
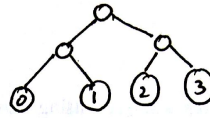
Merge 01 and 23

	45	67	0123
f_i	29	33	46



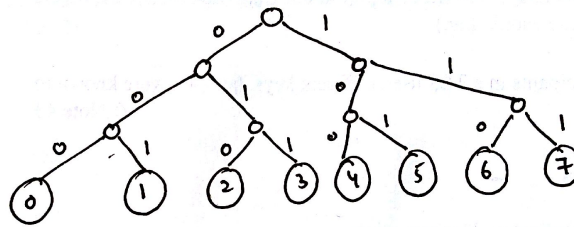
Merge 45 and 67.

f_i 0123 4567
 46 62



Merge 0123 and 4567.

\therefore The final tree is



0 \leftarrow 000 , 1 \leftarrow 001 , 2 \leftarrow 010
 3 \leftarrow 011 , 4 \leftarrow 100 , 5 \leftarrow 101
 6 \leftarrow 110 , 7 \leftarrow 111

□

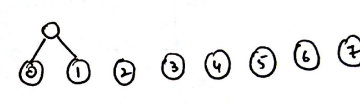
(b) (4 pts) Geometric: $f_i = 10 \cdot 2^i$, for $i = 0 \dots 7$.

Solution:

	0	1	2	3	4	5	6	7
f_i	10	20	40	80	160	320	640	1280

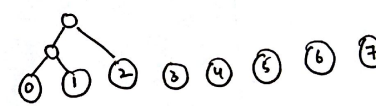
Merge 0 and 1.

	0	1	2	3	4	5	6	7
f_i	30	40	80	160	320	640	1280	



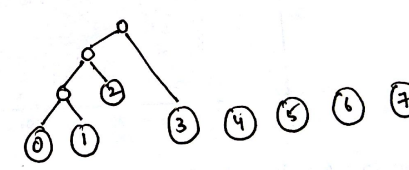
Merge 01 and 2

	0	1	2	3	4	5	6	7
f_i	70	80	160	320	640	1280		



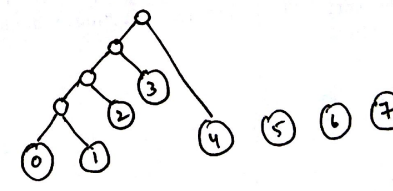
Merge 012 and 3

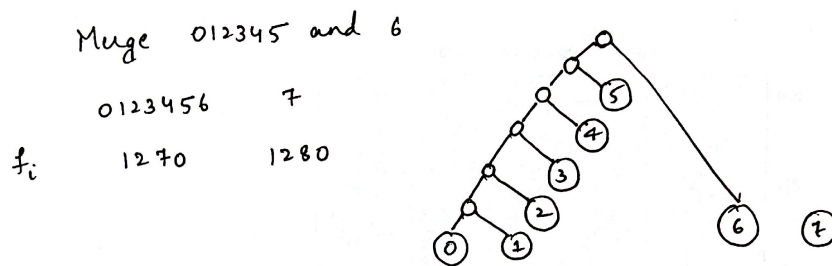
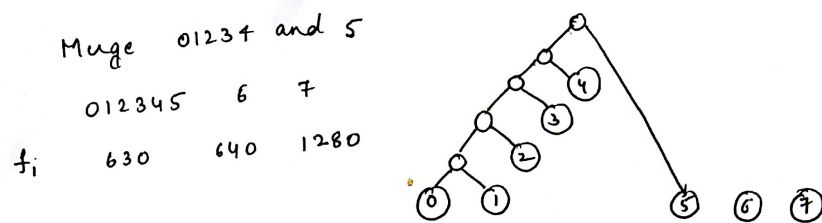
	0	1	2	3	4	5	6	7
f_i	150	160	320	640	1280			



Merge 0123 and 4

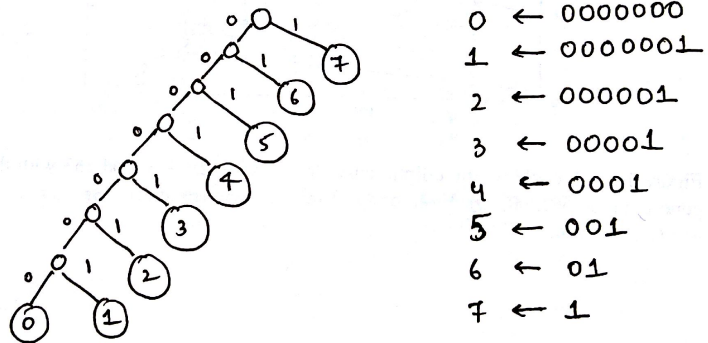
	0	1	2	3	4	5	6	7
f_i	310	320	640	1280				





Merge 0123456 and 7.

\therefore The final tree is



The Huffman code for arithmetic is more balanced than that of geometric

□