CST Ib, CST II(G) and Diploma

Data Structures and Algorithms

by

Martin Richards

mr@cl.cam.ac.uk

http://www.cl.cam.ac.uk/users/mr/

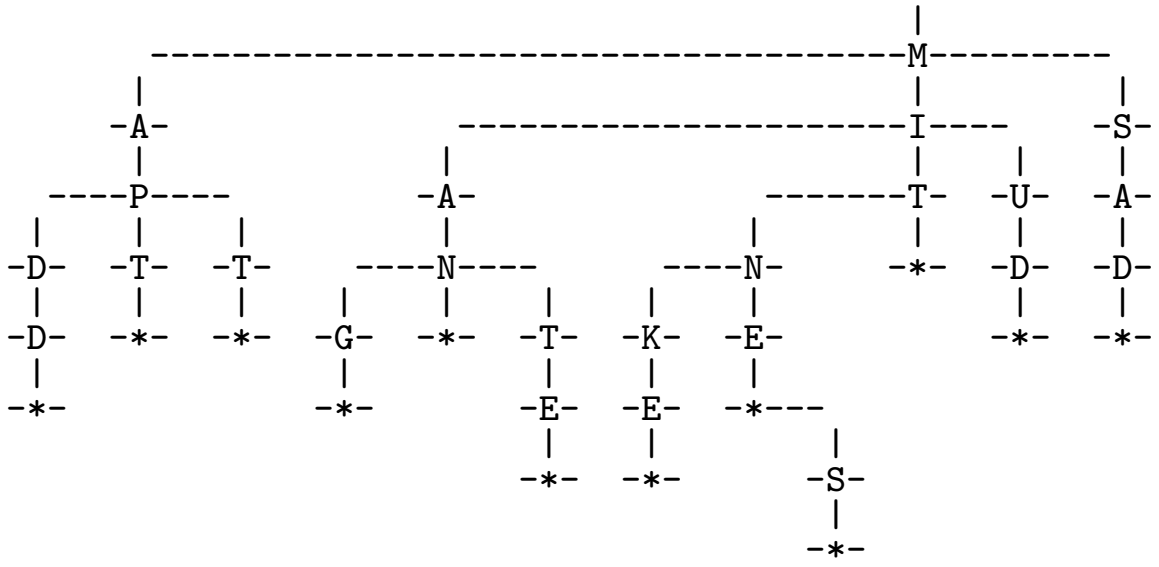
University Computer Laboratory
New Museum Site
Pembroke Street
Cambridge, CB2 3QG

Ternary Trees

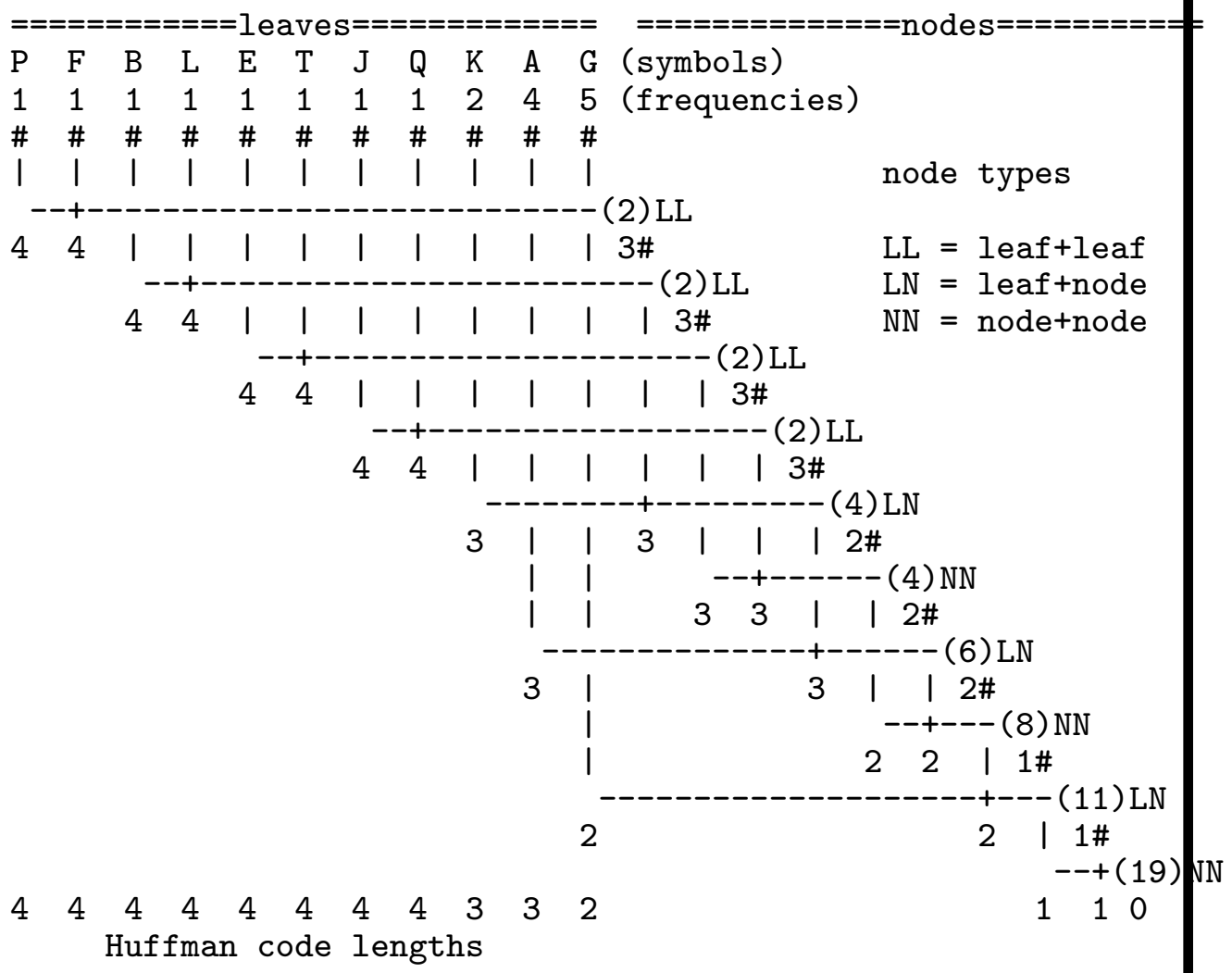
Adding the word:

MIT, SAD, MAN, APT, MUD, ADD, MAG, MINE, MIKE, MINT, AT, MATE, MINES

produces the following tree:



Huffman


==========leaves==========
==========nodes==========
P F B L E T J Q K A G (symbols)
1 1 1 1 1 1 1 1 2 4 5 (frequencies)
node types
(2)LL
LL = leaf+leaf
LN = leaf+node
NN = node+node
(2)LL
(2)LL
(2)LL
(4)LN
(4)NN
(6)LN
(8)NN
(11)LN
(19)NN
4 4 4 4 4 4 4 4 3 3 2 1 1 0
Huffman code lengths

Huffman (cont.)

Symbol	Frequencies	code length	Huffman codes		
0	0	-			
.	.	.			
.	.	.			
A	4	3		101	
B	1	4	0111		
C	0	-			
D	0	-			
E	1	4	0110		
F	1	4	0101		
G	5	2			11
H	0	-			
I	0	-			
J	1	4	0100		
K	2	3		100	
L	1	4	0011		
M	0	-			
N	0	-			
O	0	-			
P	1	4	0010		
Q	1	4	0001		
R	0	-			
S	0	-			
T	1	4	0000		
.	.	.			
.	.	.			
255	0	-			
Smallest code for each length:			0000	100	11
Number of codes for each length:			8	2	1

Huffman (cont.)

```
nibble
 0000  -4       m-=4;       if(m<1)  m+=23;   )
 0001  -3       m-=3;       if(m<1)  m+=23;   )
 0010  -2       m-=2;       if(m<1)  m+=23;   )
 0011  -1       m-=1;       if(m<1)  m+=23;   )
                                              )  len[s++] = m;
 0100  M  bbbb  m+=bbbb+4; if(m>23) m-=23;   )
 0101  +1       m+=1;       if(m>23) m-=23;   )
 0110  +2       m+=2;       if(m>23) m-=23;   )
 0111  +3       m+=3;       if(m>23) m-=23;   )

 1000  R1     ) use a sequence of these to encode
 1001  R2     ) an integer n = 1,2,3,... then
 1010  R3     )
 1011  R4     )         for(i=1; i<=n; i++) len[s++] = m;

 1100  Z1     ) use a sequence of these to encode
 1101  Z2     ) an integer n = 1,2,3,... then
 1110  Z3     )
 1111  Z4     )         for(i=1; i<=n; i++) len[s++] = 0;
```

Huffman (cont.)

```
zero to  65                Z1   Z4  Z3        (+65)
                            1+4*(4+4*3)       = 65
         65 len[A]=3       +3
         66 len[B]=4       +1
zero to  69                Z2
         69 len[E]=4  )
         70 len[F]=4  ) R2
         71 len[G]=2       -2
zero to  74                Z2
         74 len[J]=4       +2
         75 len[K]=3       -1
         76 len[L]=4       +1
zero to  80                Z3
         80 len[P]=4  )
         81 len[Q]=4  ) R2
zero to  84                Z2
         84 len[T]=4       R1
zero to 256                Z4   Z2   Z2  Z2   (+172)
                            4+4*(2+4*(2+4*2)) = 172
stop
```