CS510 Intro to Multimedia Networking: Homework #2

Due on October 7, 2015 at 8:00am

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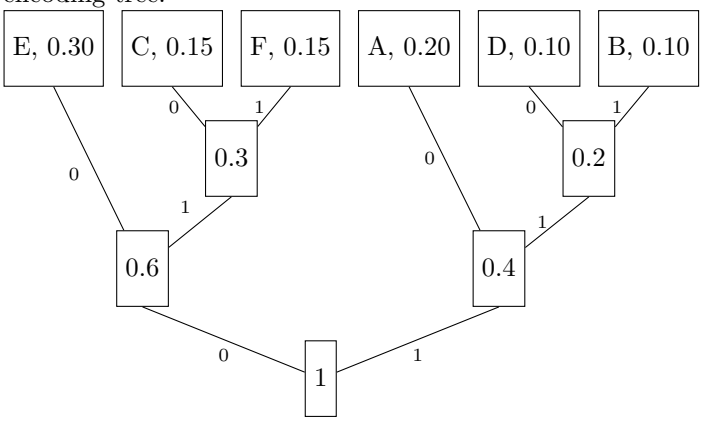
Problem 1

Suppose we are using Huffman Compression on the following symbols and their probabilities. What is the expected compression ratio (for a randomly generated sequence with the same probabilities), assuming that the original symbols are 8-bits in length.

Knowing the distribution we can estimate an approximate size of encoded string. First we need to build the encoding tree.



- A 10
- B 111
- C 010
- D 110
- E 00
- F 011

Considering a random text that contains 100 characters, each character 8bits $100 * 8 = 800$ bits in total. With Huffman compression we get $20 * 2 + 10 * 3 + 15 * 3 + 10 * 3 + 30 * 2 + 15 * 3 = 250$ bits, so compression ratio $3.2 : 1$, or around 70%.
However this calculation doesn't account for the size of encoding table.

Problem 2

USB1 bandwidth is approximately 11 megabits per second. Suppose we have a camera that we have attached to our computer that is capable of capturing 640x480 pixel video at 30 fps.

(a) What is the maximum frame rate that we can achieve over this channel?
frame size $= 640 \times 480 \times 3 = 921600$ bits
Bandwidth $= 11 \times 10^6 = 11000000$ bits
Maximum fps $= \dfrac{Bandwidth}{framesize} = \dfrac{11000000}{921600} \approx 11.93576$
Answer: maximum frame rate ≈ 11.93576 **fps**

(b) What compression ratio would we need to achieve 30fps?
One frame size at 30 fps is $640 \times 480 \times 3 \times 30 = 27648000$
To be able to transmit it over USB we have to compress it to $\frac{27648000}{11000000} \approx 2.514$ times.
Answer: 2.514 times

(c) What is the maximum sized 4:3 aspect ratio video that can be captured over the USB channel?
Maximum number of pixels we can translate over the given USB $= \frac{11000000}{30 \times 3} \approx 122222.222$
where $x \times y = 122222.222$ and $\frac{4}{3} = \frac{x}{y}$,
Solving for : $x = \frac{4}{3} \times y$
$\frac{4}{3} \times y \times y = 122222.222$
$\frac{4}{3} \times y^2 = 122222.222$
$y^2 = \frac{3}{4} \times 122222.222$
$y^2 = \frac{3}{4} \times 122222.222$
$y^2 = 91666.666$
$y = \sqrt{91666.666}$
$y \approx 302.765$

And $x = \frac{302.765 * 4}{3} \approx 403.686$
Answer: Max sized aspect $\approx 403 : 302$

Problem 3

A B C A C A B C B A B

w	k	dictionary entries	output
	A		
A	B	< 256 > AB	A
B	C	< 257 > BC	B
C	A	< 258 > CA	C
A	C	< 259 > AC	A
C	A	exists	
CA	B	< 260 > CAB	< 258 >
B	C	exists	
BC	B	< 261 > BCB	< 257 >
B	A	< 262 > BA	B
A	B	exists	
AB			AB

Problem 4

Decompress:
F A B _ L < 257 > _ C < 261 > < 264 > T < 257 >

w	k	entry	dictionary	output
F	F	F		F
F	A	A	< 256 > FA	A
A	B	B	< 257 > AB	B
B	_	_	< 258 > B_	_
_	L	L	< 259 > _L	L
L	< 257 >	AB	< 260 > LA	AB
AB	_	_	< 261 > AB_	_
_	C	C	< 262 > _L	C
C	< 261 >	AB_	< 263 > CA	AB_
AB_	< 264 >	AB_A	< 264 > AB_A	AB_A
AB_A	T	T	< 265 > AB_AT	T
T	< 257 >	AB	< 266 > TA	AB

Output string: FAB_LAB_CAB_AB_ATAB