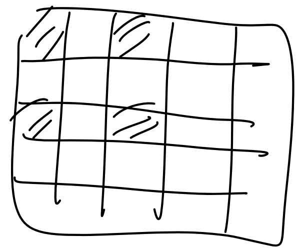
2.

the cutoff freq. of windows match the characteristic of human hearing

3.

$$\hat{x}[n] = \begin{cases} 1 & n = 2 \\ 0 & \text{otherwise} \end{cases}$$



$$Z(\hat{x}[n]) = \log(X(z)) = z^{-2}$$

$$X(F) = \exp(z^{-2})$$

$$x[n] = \begin{cases} \dfrac{1}{\Gamma\left(\frac{2+n}{2}\right)} & n \text{ is even} \\ 0 & n \text{ is odd} \end{cases}$$

#

4.

(a) speed of sound = 340 m/s at 15°C

if fundamental freq = 250 Hz $\Rightarrow L = \frac{1}{2}\lambda = \frac{1}{2} \cdot \frac{340}{250} = 0.68$ m

(b)

freq. of La is 440 Hz

$\Rightarrow L = \frac{1}{2}\lambda = \frac{340}{2 \cdot 440} = 0.386$m

5.

(a)

1. more concentration at frequency.
2. for each note, the frequency is fixed.
3. repeated the melody.

(b)

1. the color is fixed within a region.
2. edges are easier to approximate by lines & arcs.

6.

(a)

Generally, sound with $f \cong 3000$ Hz is most sensitive to our ears

$\Rightarrow$ (ii) is the loundest

(b)
(iii)

(7.)

(a)
1. DCT is always real output, while DFT need calculate complex number.
2. DCT is independent of the input, while KLT isn't.

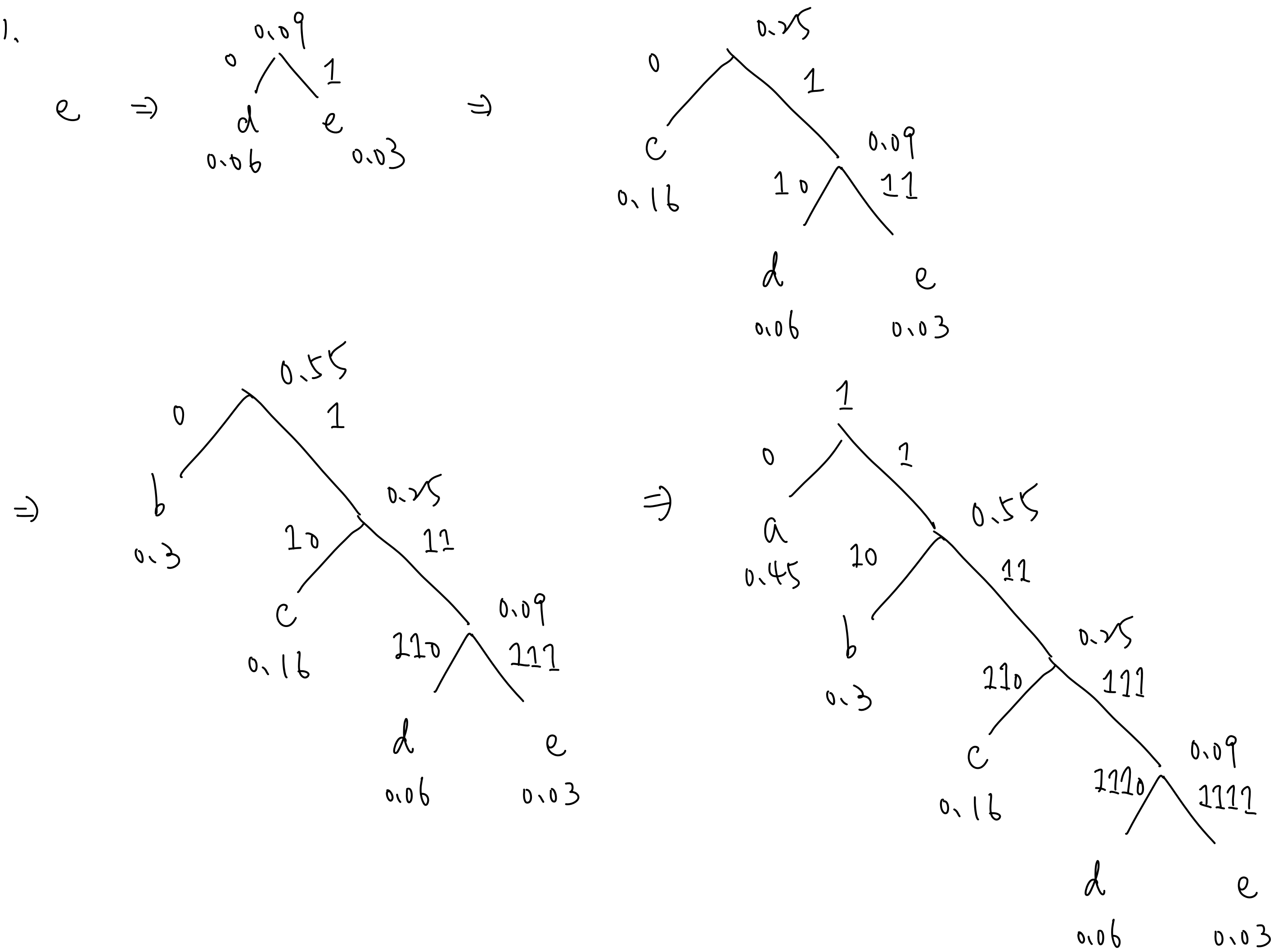
(b)
1. Enable to capture local charactoristic.
2. Memory reduced
3. Low complexity: $O(MN\log MN) \xrightarrow[\text{reduce}]{} O(MN)$

(8.)

(a). $0.45 \cdot \ln \frac{1}{0.45} + 0.3 \cdot \ln \frac{1}{0.3} + 0.16 \cdot \ln \frac{1}{0.16} + 0.06 \cdot \ln \frac{1}{0.06} + 0.03 \cdot \ln \frac{1}{0.03}$

$= 1.2877$

(b).



(c)

$$0.45 \cdot 1 + 0.3 \cdot 2 + 0.16 \cdot 3 + (0.06 + 0.03) \cdot 4$$

$$= 1.89$$

1.

origin

recovery

ref: free dog image in pixabay

extra (3, 8)

$$x[n] = \begin{cases} 1 & n=0 \\ 3 & n=1 \\ 2 & n=2 \\ 0 & \text{else} \end{cases} \Rightarrow X(z) = 1 + 3z^{-1} + z^{-2}$$

$X(z)$ has zero at $z = \frac{-3 \pm \sqrt{5}}{2}$ $\Rightarrow$ $\frac{-3-\sqrt{5}}{2}$ is out of $|z|=1$

$\frac{-3+\sqrt{5}}{2}$ is in $|z|=1$

$$\Rightarrow X(z) = \left(1 - \frac{-3+\sqrt{5}}{2} z^{-1}\right)\left(1 - \frac{2}{-3-\sqrt{5}} z\right) \cdot z^{-1} \left(\frac{+3+\sqrt{5}}{2}\right)$$

$$\Rightarrow A = \frac{3+\sqrt{5}}{2} \qquad a_1 = \frac{-3+\sqrt{5}}{2} \qquad b_1 = \frac{2}{-3-\sqrt{5}} = \frac{-3+\sqrt{5}}{2}$$

$$\hat{x}[n] = \begin{cases} \log \frac{3+\sqrt{5}}{2} & n=0 \\ -\frac{\left(\frac{-3+\sqrt{5}}{2}\right)^n}{n}, & n>0 \\ \frac{\left(\frac{-3+\sqrt{5}}{2}\right)^n}{n}, & n<0 \end{cases}$$

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