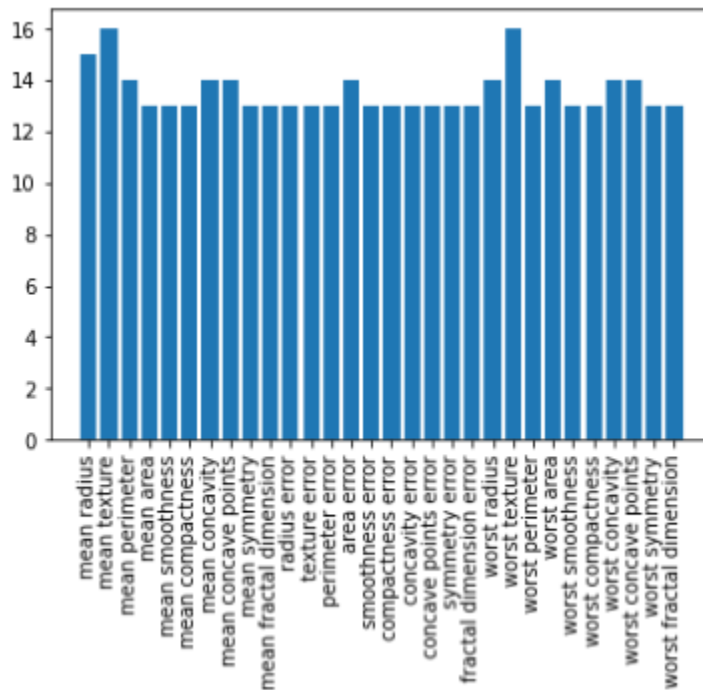# Part1

1. Gini of data is 0.4628099173553719, Entropy of data is 0.9456603046006401

2. (1) 0.9230769230769231, 0.9230769230769231 (2) 0.9230769230769231, 0.9090909090909091

3.

4. (1) 0.9090909090909091, 0.9300699300699301 (2) 0.9440559440559441, 0.951048951048951

Part2

1. let $J_1 = \sum_{n=1}^{N} W_n^{(m)} I(y_m(x_n) \neq t_n)$,

$J_2 = \sum_{n=1}^{N} W_n^{(m)}$

$E = (e^{\frac{\alpha_m}{2}} - e^{-\frac{\alpha_m}{2}}) J_1 + e^{-\frac{\alpha_m}{2}} J_2$

Differentiate E w.r.t α_m to 0

$\frac{dE}{d\alpha_m} = \frac{d}{d\alpha_m}(e^{\frac{\alpha_m}{2}} - e^{-\frac{\alpha_m}{2}}) J_1 + e^{-\frac{\alpha_m}{2}} J_2 = 0$

$\Rightarrow (\frac{e^{\frac{\alpha_m}{2}}}{2} + \frac{e^{-\frac{\alpha_m}{2}}}{2}) J_1 - \frac{e^{-\frac{\alpha_m}{2}}}{2} J_2 = 0$

$\Rightarrow (e^{\frac{\alpha_m}{2}} + e^{-\frac{\alpha_m}{2}}) J_1 = e^{-\frac{\alpha_m}{2}} J_2$

$\Rightarrow (e^{\alpha_m} + 1) J_1 = J_2$

$\Rightarrow e^{\alpha_m} = \frac{J_2 - J_1}{J_1}$

$\Rightarrow \alpha_m = \ln(\frac{1}{\varepsilon_m} - 1) = \ln\frac{1-\varepsilon_m}{\varepsilon_m}$ #

2. (1) A's misclassification rate $= \frac{100}{800} + \frac{100}{800} = \frac{1}{4}$

B's misclassification rate $= \frac{200}{800} = \frac{1}{4}$ #

(2) for A's 1st leaf node, $P(C_1) = \frac{300}{400} = \frac{3}{4}$, $P(C_2) = \frac{100}{400} = \frac{1}{4}$

" 2nd leaf node, $P(C_1) = \frac{100}{400} = \frac{1}{4}$, $P(C_2) = \frac{300}{400} = \frac{3}{4}$

$C_A(T) = \frac{1}{4}\ln(\frac{1}{4}) + \frac{3}{4}\ln(\frac{3}{4}) + \frac{3}{4}\ln(\frac{3}{4}) + \frac{1}{4}\ln(\frac{1}{4}) + 2\lambda$

$= \frac{2}{4}(-2\ln 2 + 3\ln 3 - 6\ln 2) + 2\lambda = 3\ln 3 - 4\ln 2 + 2\lambda$

for B's 1st leaf node, $P(C_1) = \frac{200}{600} = \frac{1}{3}$, $P(C_2) = \frac{400}{600} = \frac{2}{3}$

" 2nd leaf node, $P(C_1) = 1$, $P(C_2) = 0$

$C_B(T) = \frac{1}{3}\ln(\frac{1}{3}) + \frac{2}{3}\ln(\frac{2}{3}) + 2\lambda$

$= \frac{1}{3}(-\ln 3 + 2\ln 2 - 2\ln 3) + 2\lambda = -\ln 3 + \frac{2}{3}\ln 2 + 2\lambda$

Tree B is lower than tree A #

3. $SSE = (t_1 - t)^2 + (t_2 - t)^2 + \cdots + (t_n - t)^2$

$\quad = nt^2 - 2t_1 t - 2t_2 t - \cdots - 2t_n t + (t_1^2 + t_2^2 + \cdots + t_n^2)$

$\dfrac{d\,SSE}{dt} = 2nt - 2t_1 - 2t_2 - \cdots - 2t_n = 0$

$\quad t = \dfrac{t_1 + t_2 + \cdots + t_n}{n}$ #