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HW 2 Write Up

Part 1.)

1.)

a.)

Entropy(Y) = H(Y)

P(y = +) = $\frac{12}{21}$ P(y = -) = $\frac{9}{21}$

$(-\frac{12}{21}\log_2\frac{12}{21}) - (\frac{9}{21}\log_2\frac{9}{21}) = 0.985$

b.)

X_1	+	-
T	7	1
F	5	8

$\frac{8}{21}H(\frac{7}{8}, \frac{1}{8}) + \frac{13}{21}H(\frac{5}{13}, \frac{8}{13}) = 0.802$

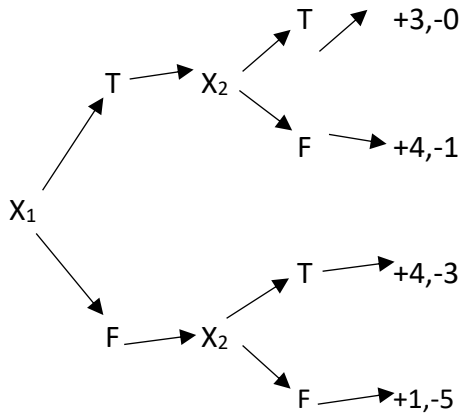
X_2	+	-
T	7	3
F	5	6

$\frac{10}{21}H(\frac{7}{10}, \frac{3}{10}) + \frac{11}{21}H(\frac{5}{11}, \frac{6}{11}) = 0.9403$

Information Gain $_{x1}$ = 0.985 – 0.802 = 0.183

Information Gain $_{x1}$ = 0.985 – 0.9403 = 0.085

c.)



2.)

a.) P(A = yes) = $\frac{3}{5}$ P(A=No) = $\frac{2}{5}$

b.)

μ_1 = 208 μ_2 = 4.0260

σ_1 = 145.2 σ_2 = 1.326

$$A = \text{yes} \begin{bmatrix} 0.0551 & 1.247 \\ -0.957 & 0.569 \\ -1.0192 & -0.6533 \end{bmatrix}$$

μ_1 = -0.6404 μ_2 = 0.388

σ_1 = 0.6035 σ_2 = 0.963

$$A = \text{no} \begin{bmatrix} 0.647 & -1.295 \\ 1.274 & 0.1313 \end{bmatrix}$$

μ_1 = 0.9605 μ_2 = -0.581

σ_1 = 0.4434 σ_2 = 1.0086

c.)

$P(A|R) = P(A) * P(F_1|A) * P(F_2|A) = 0.0574$

$P(!A|R) = P(!A) * P(F_1|!A) * P(F_2|!A) = 0.0232$

Based on this information we can predict we will get an A.

3.)

Keep part of our training data to use as the validation set. We can use this to tune the flexibility of our k parameters by using cross validation.

Other detailed work included at the bottom as I ran out of time converting my written work into text.

Part 2:

```
My thetas: [ 2.16611957  3.80987174 -2.57116189]

SKlearn Thetas [ 23.65086457  71.20787484 -33.85885804]

My plot is in green, sklearn is in red
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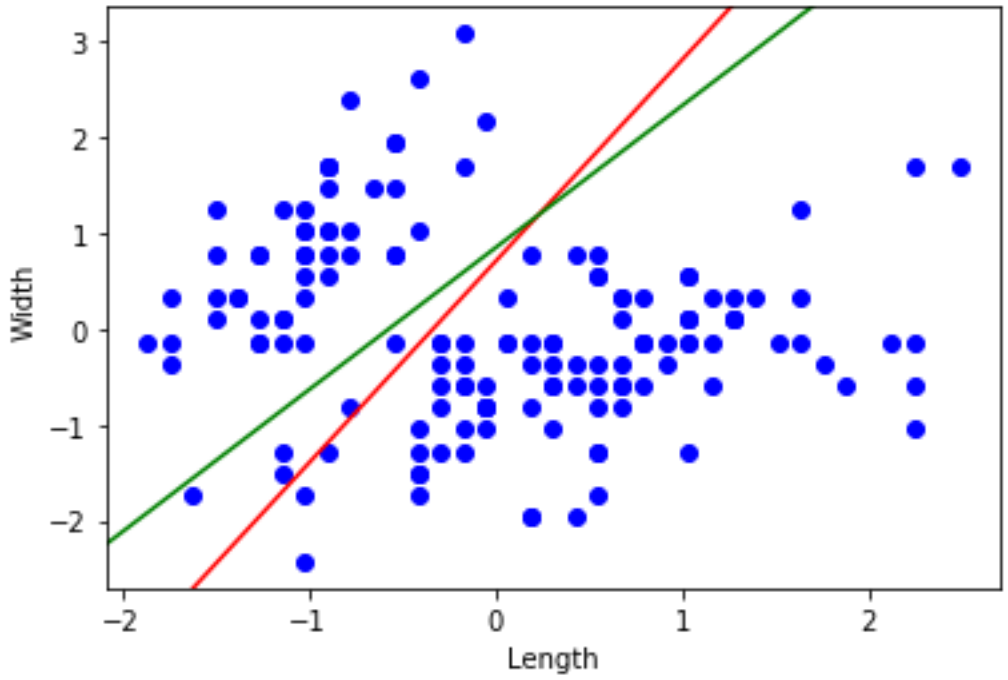


3.)

For classification I used the sigmoid function with a 0.5 threshold as described in the Slack.

My accuracies generally ranged from 87-90 percent.

```
Accuracy: 0.8852672750977836
Precision: 0.8461538461538461
Recall: 0.8631051752921536
f-measure: 0.8545454545454545
```

4.)

```
Accuracy 0.7079530638852672
Precision: 0.5761856710393541
Recall: 0.9532554257095158
f-measure: 0.7182389937106917
```

1.)

y	x_1	x_2	Count
+	T	T	3
+	T	F	4
+	F	T	4
+	F	F	1
−	T	T	0
−	T	F	1
−	F	T	3
−	F	F	5

a.) Entropy (y) $= H(y)$

$$H(y) = -\sum_{i=1}^{K} P(y=y_i) \log_2 P(y=y_i)$$

$P(y=+) = \frac{12}{21}$ $\quad P(y=-) = \frac{9}{21}$

$$\left(\frac{-12}{21} \log_2 \frac{12}{21}\right) - \left(\frac{9}{21} \log_2 \frac{9}{21}\right) \approx \boxed{0.985}$$

b.) x_1

	+	−	
T	7	1	$\frac{7}{8}, \frac{1}{8}$
F	5	8	$\frac{5}{13}, \frac{8}{13}$

$P(x_1 = T, y = +) = \frac{7}{8}$
$P(x_1 = T, y = -) = \frac{1}{8}$
$\Big\} \frac{8}{21}$

$P(x_1 = F, y = +) = \frac{5}{13}$
$P(x_1 = F, y = -) = \frac{8}{13}$
$\Big\} \frac{13}{21}$

$$rem_{x_1} = \frac{8}{21} H\left(\frac{7}{8}, \frac{1}{8}\right) + \frac{13}{21} H\left(\frac{5}{13}, \frac{8}{13}\right)$$

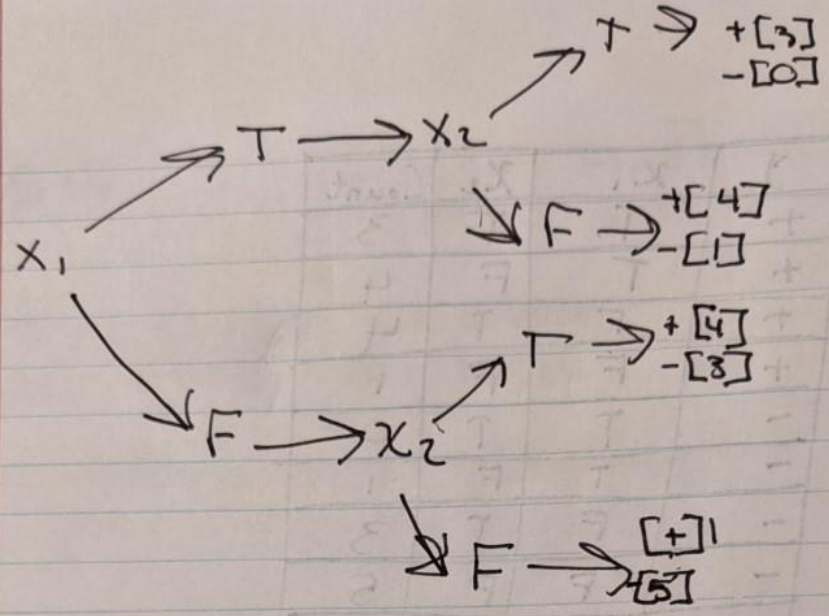
$$= 0.802$$

$$rem_{x_2} = \frac{10}{21} H\left(\frac{7}{10}, \frac{3}{10}\right) + \frac{11}{21} H\left(\frac{5}{11}, \frac{6}{11}\right) = 0.940$$

Information Gain $x_1 = .985 - 0.802 = 0.183$

Information Gain $x_2 = .985 - .940 = .045$

c.)



2.) a.) $P(A = \text{Yes}) = 3/5$, $P(A = \text{No}) = 2/5$

b.) $\mu_1 = 208$ $\mu_2 = 4.0260$ ~~$\sigma_1 = 145.2154$ $\sigma_2 = 1.3256$~~

$\sigma_1 = 145.2$ $\sigma_2 = 1.326$

$$\frac{\sqrt{(216-208)^2 + (69-208)^2 + (302-208)^2 + (60-208)^2 + (393-208)^2}}{N}$$

$$\frac{\sqrt{64 + 19321 + 8836 + 21904 + 34225}}{4}$$

$\approx$ 145.2

$A = y_{cs}$

$$\begin{bmatrix} 0.0551 & 1.247 \\ -0.9572 & 0.569 \\ -1.0192 & -0.653 \end{bmatrix}$$

$$\mu_1 = -0.6404 \quad \sigma_1 = \quad 0.0551 + 0.6404 = 0.4837$$

$$-0.9572 + -1.0192 = 0.1004$$

$$\mu_1 = -0.6404 \quad \sigma_1 = .60315 = 0.1435$$

$$\mu_2 = 0.388 \quad \sigma_2 = 0.963$$

$1.247 - 0.388 = 0.859^2 = 0.7379$

$0.569 - 0.388 = 0.181^2 = 0.0328$

$-0.653 - 0.388 = -1.041^2 = 1.084$

$A = N_0$ $\begin{bmatrix} 0.647 & -1.295 \\ 1.274 & 0.1313 \end{bmatrix}$

$M_1 = 0.9605$ $\sigma_1 = 0.4434$

$M_2 = -0.5819$ $\sigma_2 = 1.0086$

$(0.647 - 0.9605)^2 = \sqrt{0.0983} = 0.4434$

$(1.274 - 0.9605)^2 = \sqrt{0.0983}$

$-1.295 + .581 = -0.714^2 = \sqrt{\frac{1}{0.5098}}$

$0.1313 + 0.881 = 0.7123^2 = \sqrt{0.5074} = 1.0086$

c.) $P(A|R) \propto P(A) \times P(F_1|A) \times P(F_2|A)$

$= \frac{3}{5} \times 0.2312 \times 0.4141 = 0.0574$

$P(\neg A|R) \propto P(\neg A) \times P(F_1|\neg A) \times P(F_2|\neg A) = \frac{2}{5} \times 0.2347 \times 0.2457 = 0.0230$

$0.05 > 0.02$ so should get A.