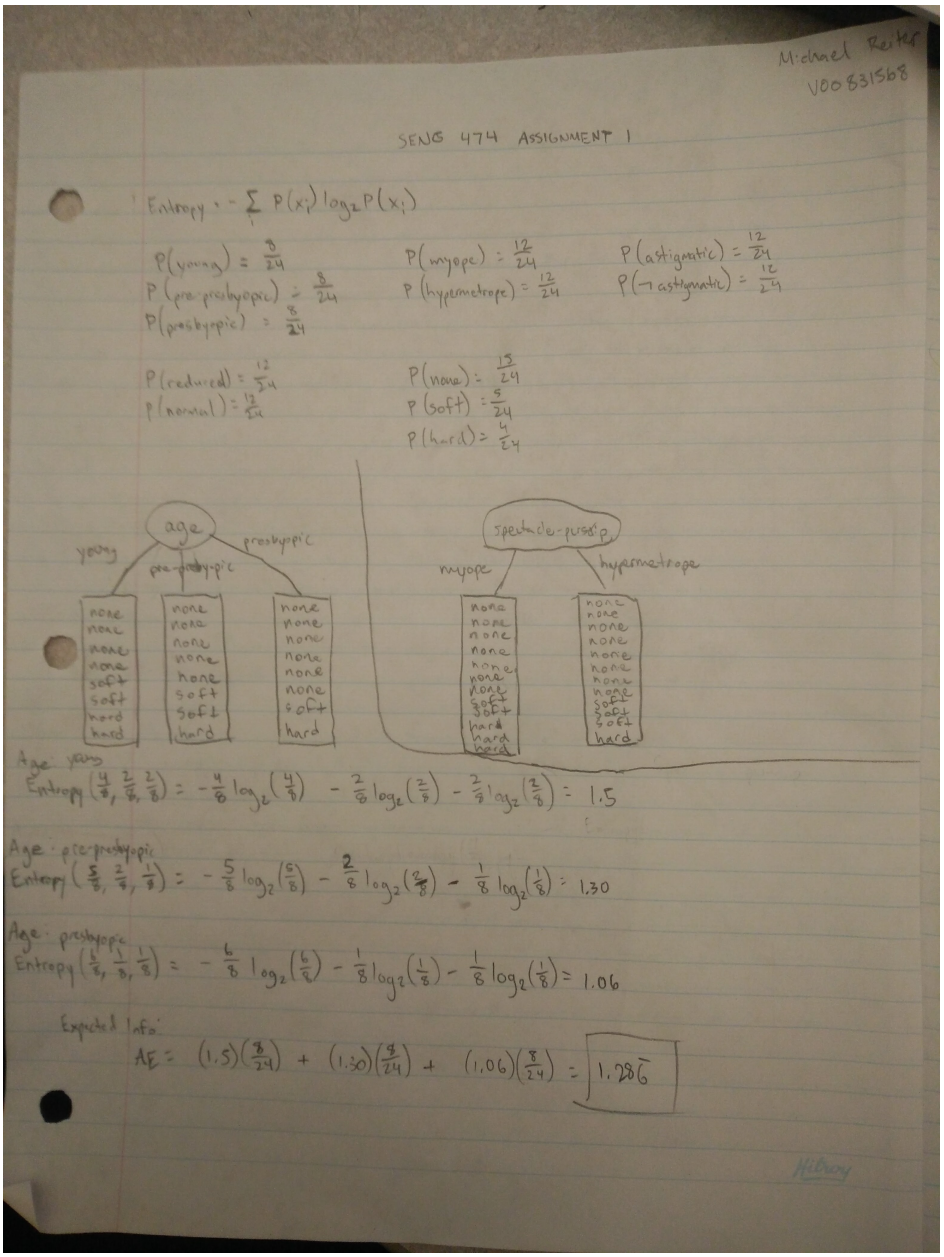
Michael Reiter
V00831568

SENG 474 Assignment 1

1. a)



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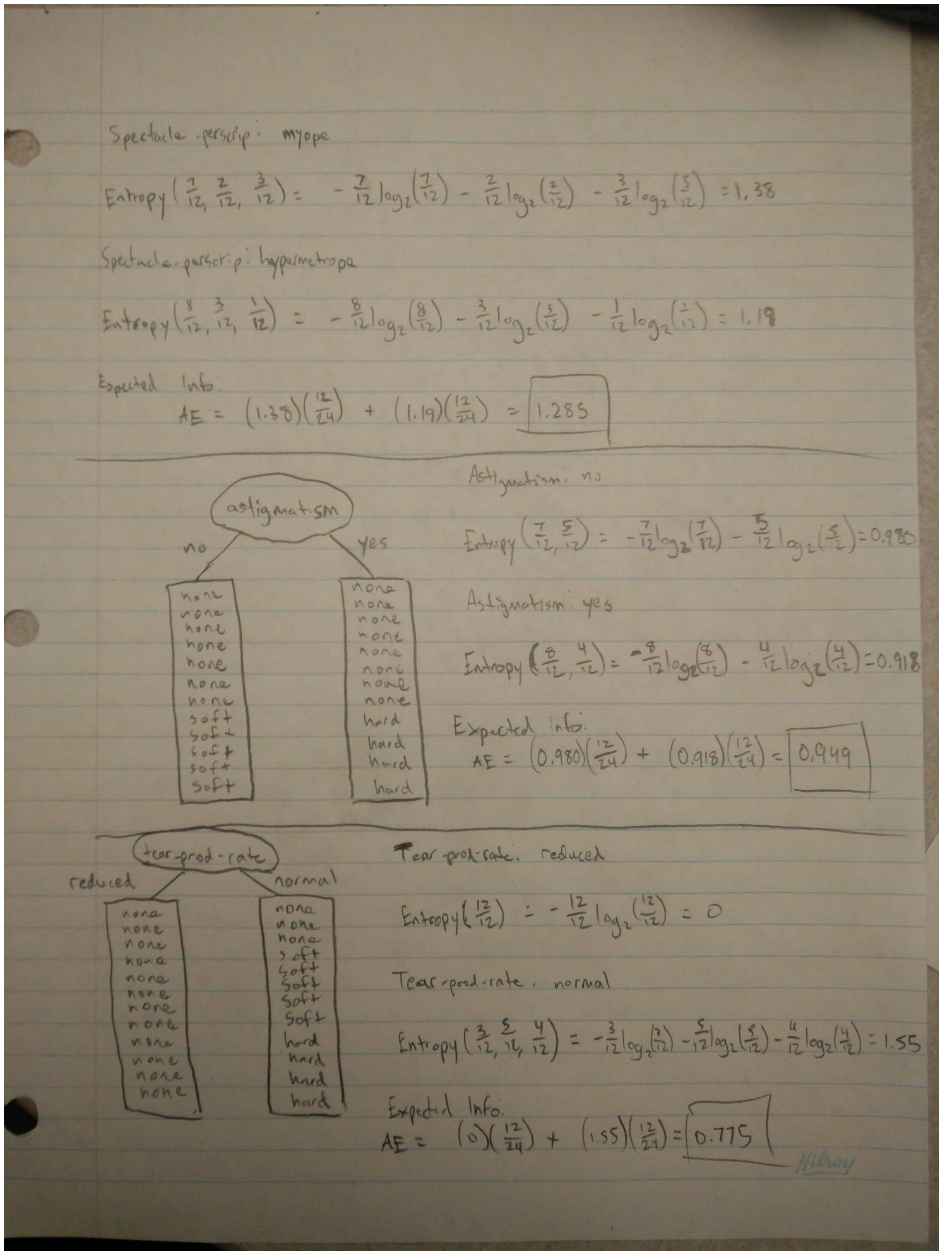

Spectacle-perscrip: myope

$$\text{Entropy}\left(\frac{7}{12}, \frac{2}{12}, \frac{3}{12}\right) = -\frac{7}{12}\log_2\left(\frac{7}{12}\right) - \frac{2}{12}\log_2\left(\frac{2}{12}\right) - \frac{3}{12}\log_2\left(\frac{3}{12}\right) = 1.38$$

Spectacle-perscrip: hypermetrope

$$\text{Entropy}\left(\frac{8}{12}, \frac{3}{12}, \frac{1}{12}\right) = -\frac{8}{12}\log_2\left(\frac{8}{12}\right) - \frac{3}{12}\log_2\left(\frac{3}{12}\right) - \frac{1}{12}\log_2\left(\frac{1}{12}\right) = 1.19$$

Expected info:

$$AE = (1.38)\left(\frac{12}{24}\right) + (1.19)\left(\frac{12}{24}\right) = \boxed{1.285}$$

Astigmatism: no

$$\text{Entropy}\left(\frac{7}{12}, \frac{5}{12}\right) = -\frac{7}{12}\log_2\left(\frac{7}{12}\right) - \frac{5}{12}\log_2\left(\frac{5}{12}\right) = 0.980$$

Astigmatism: yes

$$\text{Entropy}\left(\frac{8}{12}, \frac{4}{12}\right) = -\frac{8}{12}\log_2\left(\frac{8}{12}\right) - \frac{4}{12}\log_2\left(\frac{4}{12}\right) = 0.918$$

Expected info:

$$AE = (0.980)\left(\frac{12}{24}\right) + (0.918)\left(\frac{12}{24}\right) = \boxed{0.949}$$

Tear-prod-rate: reduced

$$\text{Entropy}\left(\frac{12}{12}\right) = -\frac{12}{12}\log_2\left(\frac{12}{12}\right) = 0$$

Tear-prod-rate: normal

$$\text{Entropy}\left(\frac{3}{12}, \frac{5}{12}, \frac{4}{12}\right) = -\frac{3}{12}\log_2\left(\frac{3}{12}\right) - \frac{5}{12}\log_2\left(\frac{5}{12}\right) - \frac{4}{12}\log_2\left(\frac{4}{12}\right) = 1.55$$

Expected info:

$$AE = (0)\left(\frac{12}{24}\right) + (1.55)\left(\frac{12}{24}\right) = \boxed{0.775}$$

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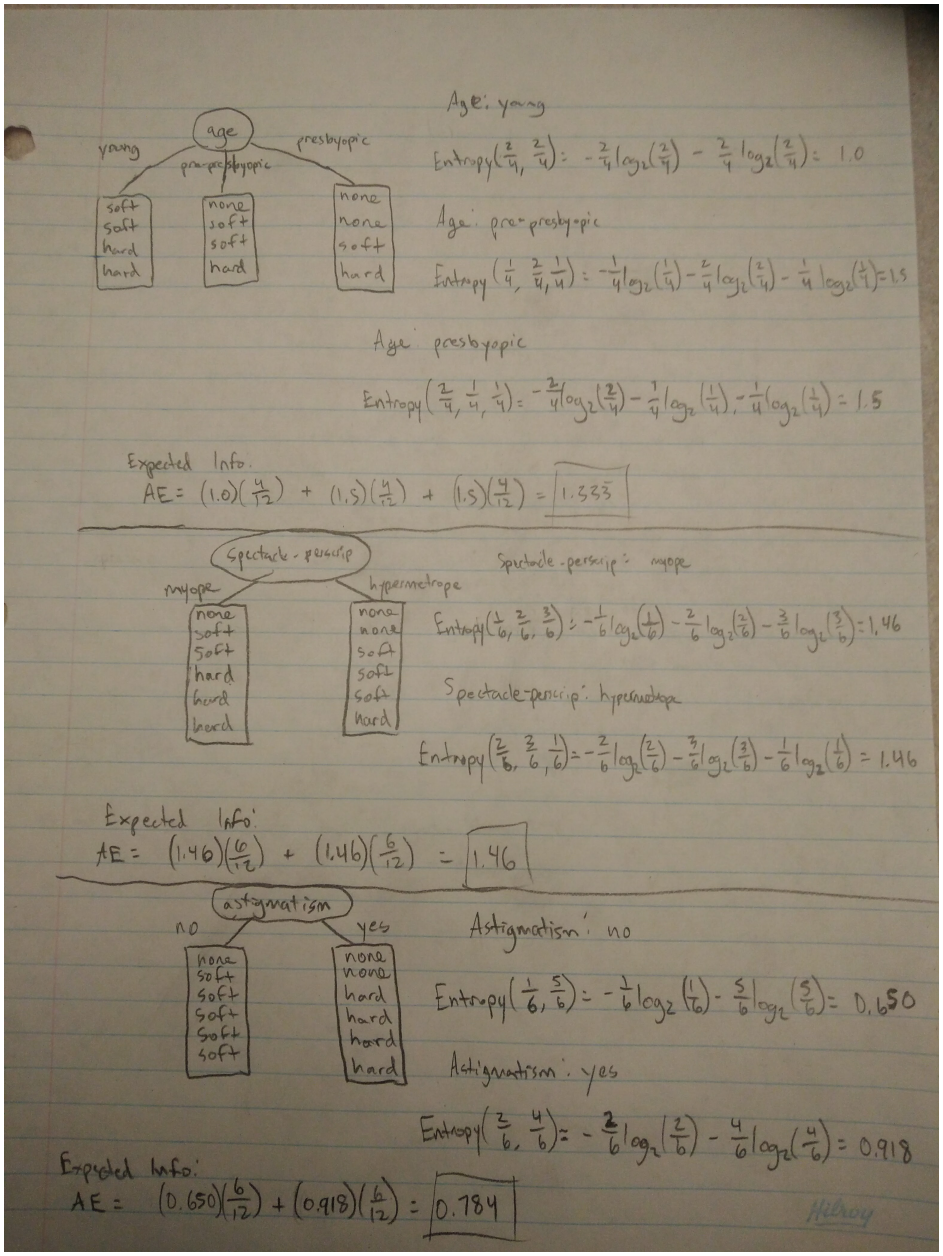

Age: young

$\text{Entropy}(\frac{2}{4}, \frac{2}{4}) = -\frac{2}{4}\log_2(\frac{2}{4}) - \frac{2}{4}\log_2(\frac{2}{4}) = 1.0$

Age: pre-presbyopic

$\text{Entropy}(\frac{1}{4}, \frac{2}{4}, \frac{1}{4}) = -\frac{1}{4}\log_2(\frac{1}{4}) - \frac{2}{4}\log_2(\frac{2}{4}) - \frac{1}{4}\log_2(\frac{1}{4}) = 1.5$

Age: presbyopic

$\text{Entropy}(\frac{2}{4}, \frac{1}{4}, \frac{1}{4}) = -\frac{2}{4}\log_2(\frac{2}{4}) - \frac{1}{4}\log_2(\frac{1}{4}) - \frac{1}{4}\log_2(\frac{1}{4}) = 1.5$

Expected Info.

$AE = (1.0)(\frac{4}{12}) + (1.5)(\frac{4}{12}) + (1.5)(\frac{4}{12}) = \boxed{1.333}$

Spectacle-prescrip: myope

$\text{Entropy}(\frac{1}{6}, \frac{2}{6}, \frac{3}{6}) = -\frac{1}{6}\log_2(\frac{1}{6}) - \frac{2}{6}\log_2(\frac{2}{6}) - \frac{3}{6}\log_2(\frac{3}{6}) = 1.46$

Spectacle-prescrip: hypermetrope

$\text{Entropy}(\frac{2}{6}, \frac{3}{6}, \frac{1}{6}) = -\frac{2}{6}\log_2(\frac{2}{6}) - \frac{3}{6}\log_2(\frac{3}{6}) - \frac{1}{6}\log_2(\frac{1}{6}) = 1.46$

Expected Info:

$AE = (1.46)(\frac{6}{12}) + (1.46)(\frac{6}{12}) = \boxed{1.46}$

Astigmatism: no

$\text{Entropy}(\frac{1}{6}, \frac{5}{6}) = -\frac{1}{6}\log_2(\frac{1}{6}) - \frac{5}{6}\log_2(\frac{5}{6}) = 0.650$

Astigmatism: yes

$\text{Entropy}(\frac{2}{6}, \frac{4}{6}) = -\frac{2}{6}\log_2(\frac{2}{6}) - \frac{4}{6}\log_2(\frac{4}{6}) = 0.918$

Expected Info:

$AE = (0.650)(\frac{6}{12}) + (0.918)(\frac{6}{12}) = \boxed{0.784}$

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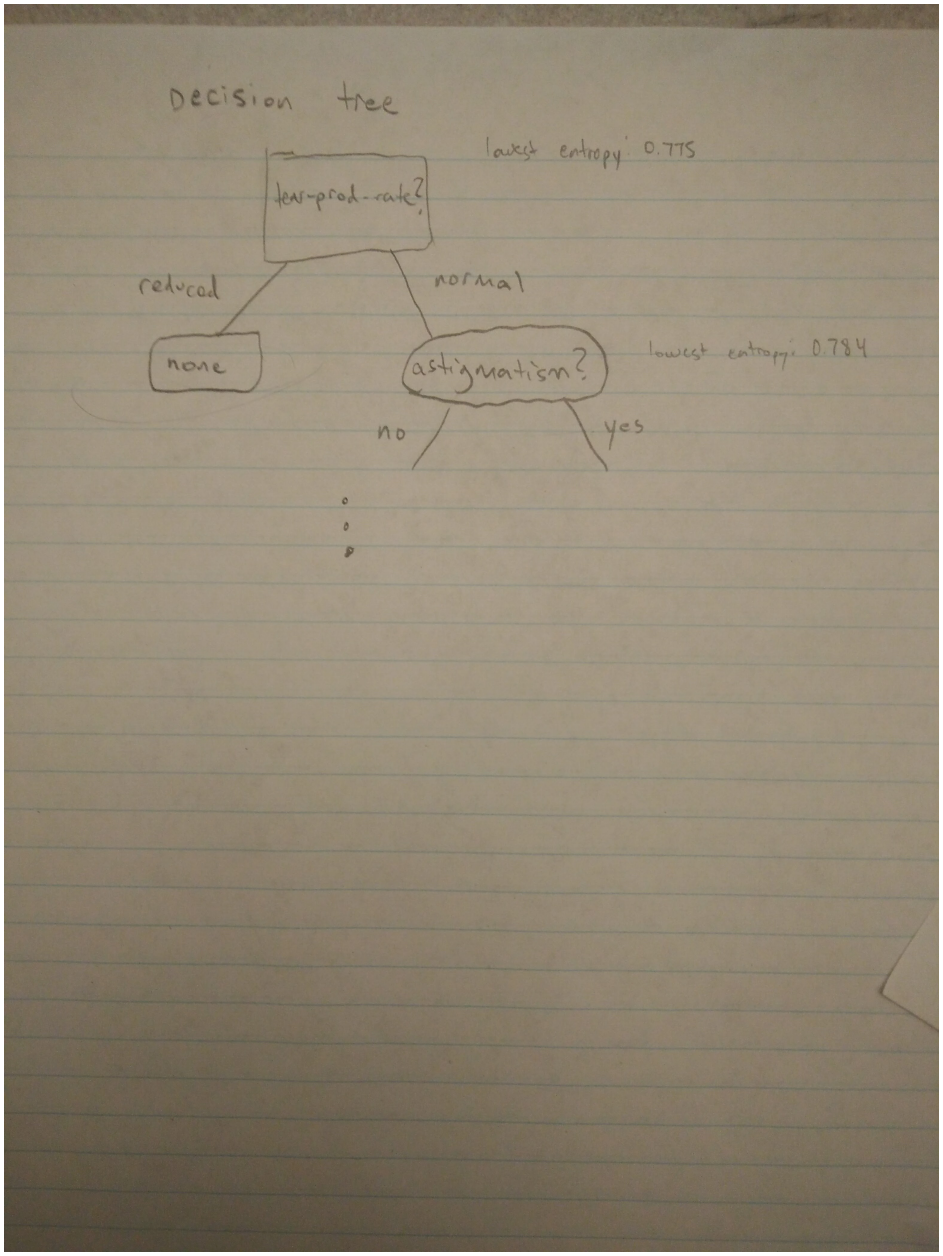

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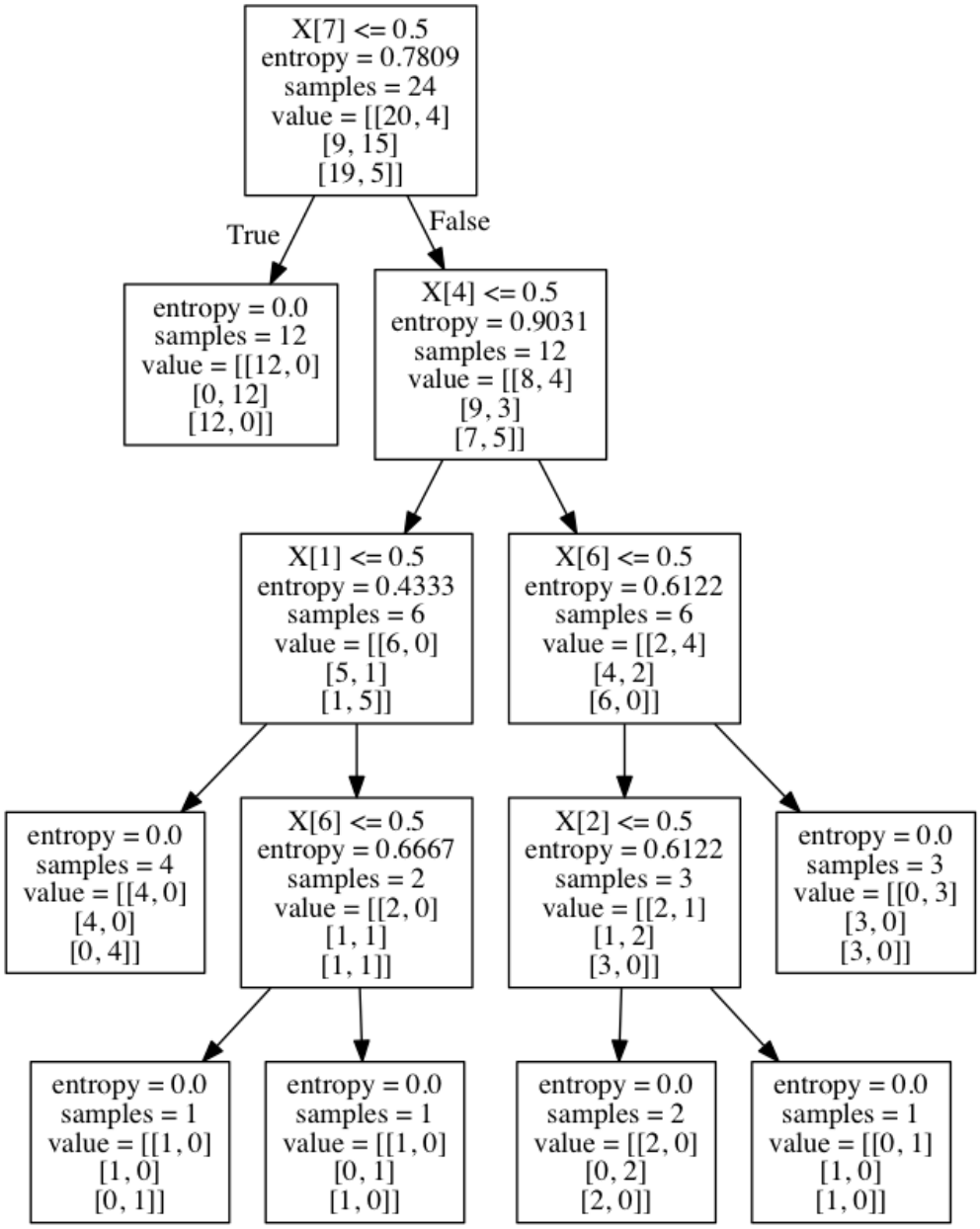
1. b)



This is a decision tree generated by the following code.

```
from util2 import Arff2Skl
from sklearn import tree
cvt = Arff2Skl('contact-lenses.arff')
label = cvt.meta.names()[-1]
X, y = cvt.transform(label)
dtc = tree.DecisionTreeClassifier(criterion='entropy')
dtc.fit(X, y)
tree.export_graphviz(dtc)
```

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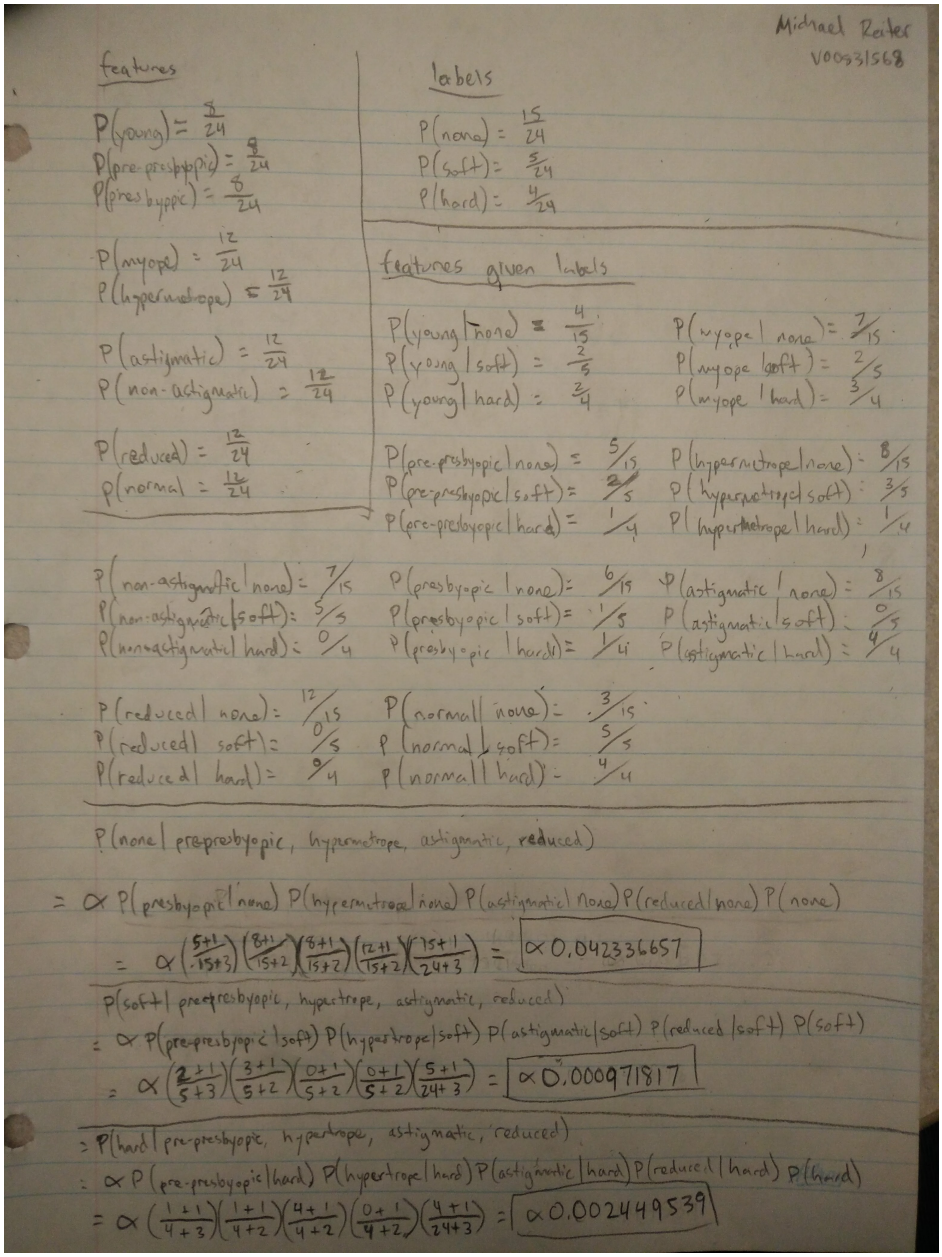
In my tree, the root level entropy was 0.775. In the scikit-learn generated tree, the root level entropy was 0.7809. These trees differ because scikit-learn uses a different algorithm to generate it than I did. I used ID3, but it used CART. Essentially, these algorithms differ in the way they split. CART tries to balance the tree (and ensure it's binary), while ID3 does not.

2.



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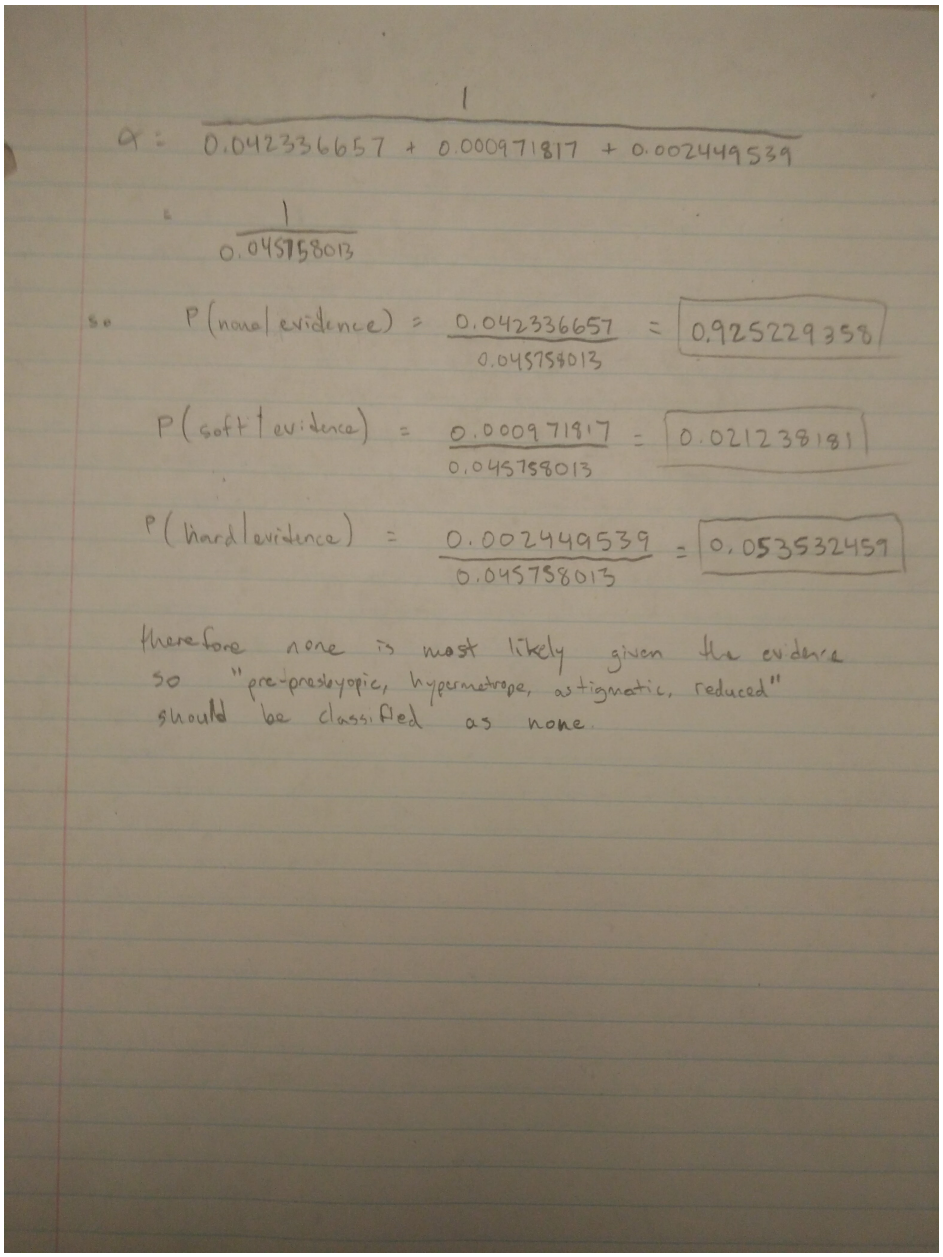

$$\alpha = \frac{1}{0.042336657 + 0.000971817 + 0.002449539}$$

$$= \frac{1}{0.045758013}$$

so $P(\text{none} \mid \text{evidence}) = \frac{0.042336657}{0.045758013} = \boxed{0.925229358}$

$P(\text{soft} \mid \text{evidence}) = \frac{0.000971817}{0.045758013} = \boxed{0.021238181}$

$P(\text{hard} \mid \text{evidence}) = \frac{0.002449539}{0.045758013} = \boxed{0.053532459}$

therefore none is most likely given the evidence so "pre-presbyopic, hypermetrope, astigmatic, reduced" should be classified as none.

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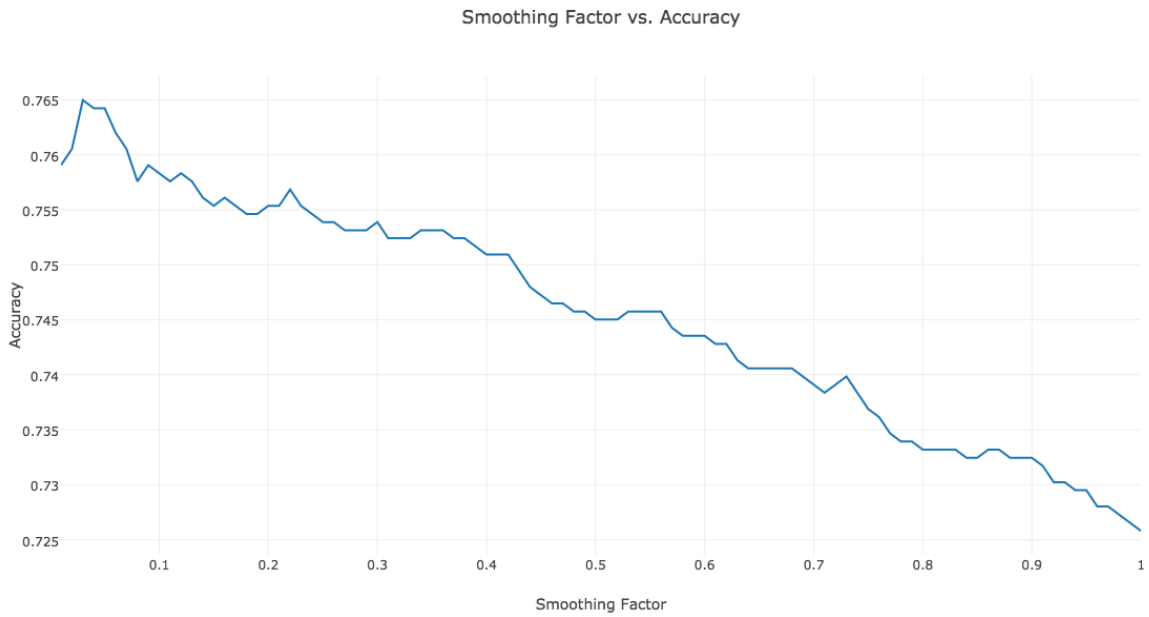
3.

a) See uploaded code

b)



This is a plot of smoothing factor (0.01 through 1.0 in increments of 0.01). It is clear that a smoothing factor of 0.03 is optimal. It produces a maximum accuracy of 0.765 given the fetch20_newsgroups dataset included in scikit-learn.