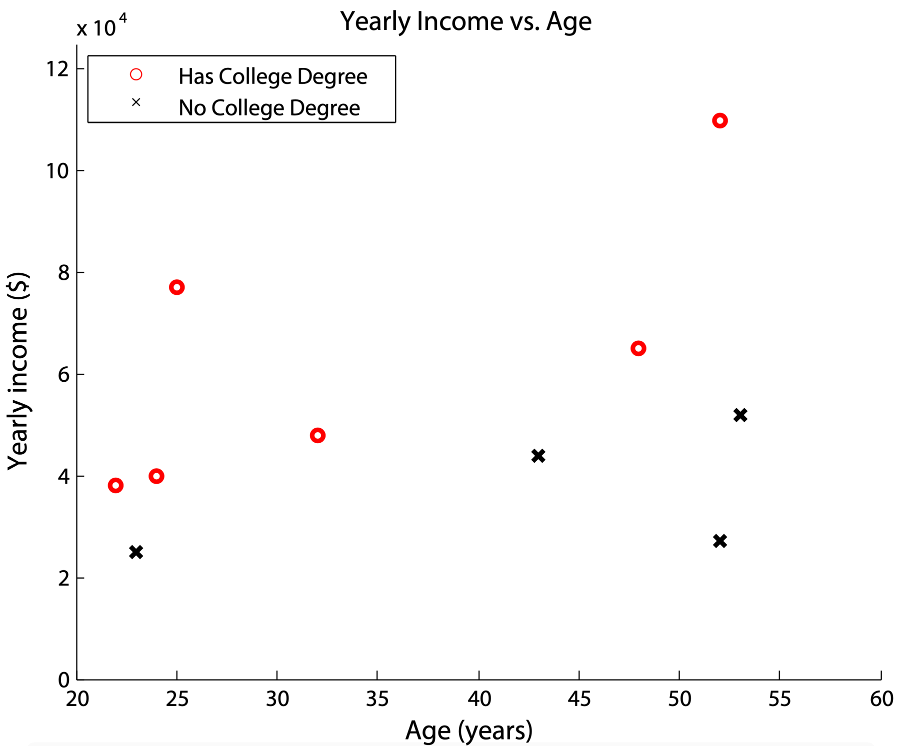
1. Consider the problem of predicting if a person has a college degree based on age and salary. The table and graph below contain training data for 10 individuals.

Age	Salary	College Degree
24	40,000	Yes
53	52,000	No
23	24,000	No
25	77,000	Yes
32	48,000	Yes
52	108,000	Yes
22	38,000	Yes
43	44,000	No
52	27,000	No
48	67,000	Yes



a. (3 points) Build a decision tree for classifying whether a person has a college degree by greedily splitting attributes that maximize information gain (Assume that the threshold for each split is the middle value of the attribute in the current subset). Show the information gain at each split and draw the decision boundary of your learned tree in the figure.

b. (2 points) A multivariate decision tree is a generalization of univariate decision trees, where more than one attribute can be used in the decision rule for each split. That is, splits need not be orthogonal to a feature's axis.

For the same data, provide a multivariate decision tree where each decision rule is a linear classifier that makes decisions based on the sign of $\alpha x_{age} + \beta x_{income} - 1$.

Draw your tree including the α, β and the information gain for each split. Draw the decision boundary.

c. (1 points) Draw the decision boundaries for the 1-nearest neighbor classifier assuming that we are using standard Euclidean distance to compute the nearest neighbors.

2. In this problem we'll use Naive Bayes to predict whether a person has a cold given the symptoms Headache, Cough, Sore Throat. Imagine we have observed the following data:

Disease	Headache	Cough	Sore Throat
$Cold$	T	T	T
$Cold$	T	T	T
$Cold$	T	F	F
$\neg Cold$	F	F	F
$\neg Cold$	F	F	F
$\neg Cold$	T	T	T

a. (2 points) Remember that when using Naive Bayes, we make the assumption that all features are conditionally independent given the target value. Factorize the joint probability P(Cold, Headache, Cough, Sore Throat) using this assumption.

b. (2 points) Using no Laplacian smoothing, what is P(Cold|¬Headache, Cough, Sore Throat)?