CS 229 ASSIGNMENT 4:

Discriminative Learning, Bayes Nets and k-NN

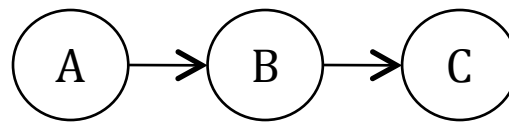NAME: Xiaopeng Xu   KAUST ID: 129052

Answers to question 1–3 are in attachment 1.

Question1: (15 points) Fisher's criterion (Exercise 4.5 of Bishop's book)

By making use of (4.20), (4.23), and (4.24), show that the Fisher criterion (4.25) can be written in the form (4.26).

Question2: (15 points) Bayes Net - Proofs

Given this Bayes net

Prove that C is conditionally independent of A, given B. You should use the definition of joint probabilities for a Bayes net.

Question3: (50 points) Bayesian Network

We are going to take the perspective of an instructor who wants to determine whether a student has understood the material, based on the exam score. Figure 2 gives a Bayes net for this. As you can see, whether the student scores high on the exam is influenced both by whether she is a good test taker, and whether she understood the material. Both of those, in turn, are influenced by whether she is intelligent; whether she understood the material is also influenced by whether she is a hard worker.
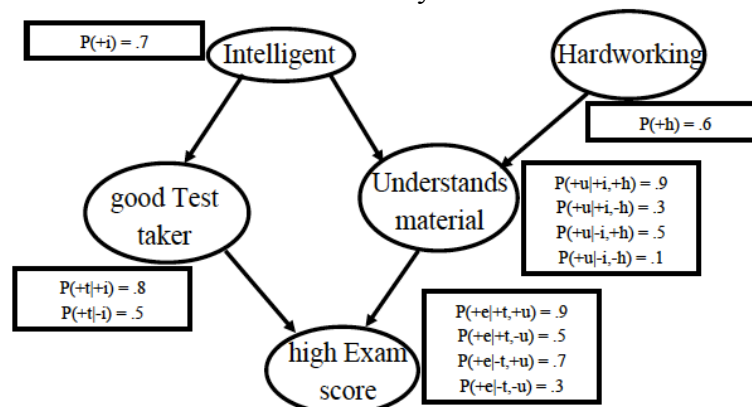

Figure 2 A Bayesian network representing what influences an exam score

(1) (**20 points**) Using variable elimination (by hand!), compute the probability that a student who did well on the test actually understood the material, that is, compute P(+u| + e).

(2) (**30 points**) For the above Bayesian network, label the following statements about conditional independence as true or false. For this question, you should consider only the structure of the Bayesian network, not the specific probabilities. Explain each of your answers.

   1) T and U are independent.
   2) T and U are conditionally independent given I, E, and H.
   3) T and U are conditionally independent given I and H.
   4) E and H are conditionally independent given U.
   5) E and H are conditionally independent given U, I, and T.
   6) I and H are conditionally independent given E.
   7) I and H are conditionally independent given T.
   8) T and H are independent.
   9) T and H are conditionally independent given E.
  10) T and H are conditionally independent given E and U.

Question4: (20 points) k-nearest neighbor

Write your k-nn code to classify

(1)   Students in data set at
     https://www.lri.fr/~xlzhang/KAUST/data/test_data_binary.txt by training data at
     https://www.lri.fr/~xlzhang/KAUST/data/logreg_data_binary.txt

(2)   Students in data set at
     https://www.lri.fr/~xlzhang/KAUST/data/test_data_3class.txt by training data at
     https://www.lri.fr/~xlzhang/KAUST/data/logreg_data_3class.txt

Report how many student labels in test data are correctly predicted.
NOTE: choose an appropriate k to reach the best prediction.
(1) For binary case, the best k chosen is 1. The resulting correctly predicted ratio is:

Total Number of test samples:
total_num = 70

Number of correctly predicted samples:
pred_true_num = 55

Ratio of correctly predicted samples:
correct_ratio = 0.7857
(2) For 3 class data set, the best k chosen is also 1. The resulting correctly predicted ratio is:

Total Number of test samples:
total_num = 120

Number of correctly predicted samples:
pred_true_num = 69

Ratio of correctly predicted samples:
correct_ratio = 0.5750