Intelligent Systems: Reasoning and Recognition

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ENSIMAG 2 Final Exam - 4 May 2021

Règles et Conditions

Il est interdit de communiquer avec tout personne autre que le Professeur Crowley entre le moment que vous commencer cette examen et le moment que vous rendez vous solutions par courrier électronique.

Vous avez le droit d'utiliser toutes notes, documents écrits ou documents trouvés en ligne, mais il faut citer toutes vos sources. Vous êtes encouragé à utiliser les documents disponibles sur le site Web du cours. Vous pouvez répondre aux questions en anglais ou en français, mais vous devez illustrer vos réponses avec des mathématiques et des dessins, le cas échéant.

Votre examen terminé doit être soumis en un seul fichier .pdf nommé <VotreNomDeFamille>-ENSI2-SIRR-EXAM.pdf et envoyé par courrier électronique à James.Crowley@grenoble-inp.fr.

Vous pouvez utiliser un logiciel d'édition tel que LaTex ou MS Word, mais sachez que la plusieurs des questions nécessitent l'écriture de mathématiques. Vous pouvez également écrire vos réponses sur papier et envoyer une copie numérisée ou photographiée au format .pdf. Les copies numériques, ainsi que vos réponses écrites, doivent être claires et lisibles.

Rédigez et signez l'attestation suivante à la fin de votre examen:

Je, <votre nom complet>, certifie que je n'ai pas communiqué avec une autre personne ni été aidé par une autre personne pour compléter cet examen. Je reconnais que toutes infraction à cette condition constituerait une violation des règles d'intégrité académique de Grenoble INP et pourrait être passible de sanctions, y compris d'éventuels échec de l'examen ou expulsion.

Rules and Instructions

You may not communicate with any person by any means while completing this exam.

You have the right to use any notes, written material or on-line material. You are encouraged to use the documents available on the course web site. You may answer questions in English or in French, but you must illustrate your answers with mathematics and drawings when appropriate.

Your completed exam should be submitted as a single .pdf file named <YourFamilyName>-ENSI2-SIRR-EXAM.pdf and sent by email to James.Crowley@grenoble-inp.fr.

You may use a document typesetting program such as LaTex or MS Word, but beware that some questions require writing mathematics. Alternatively you may write out your answers on paper and send a scanned or photographed copy as a .pdf. Your written answers must be clear and legible.

Write out and sign the following attestation at the end of your exam: "I, <your full name>, certify that I have not communicated with, or been assisted by, any other person in completing this exam. I acknowledge that violation of this condition would constitute a violation of the academic integrity rules of the Grenoble INP and could be subject to penalties, including possible failure or expulsion."

EXAM Questions

1) (4 points) Compare and contrast the definitions of intelligence given by A. Turing and A. Newell. Compare these to your own view on the definition of intelligence.

2) (2 points) The ROC curve for a classifier passes through the point (0.3, 0.7). Is it possible to determine the probability of error for the classifier from this information? If yes, give the formula. If no, explain why.

3) (2 points) You have been hired to write a program that uses Nilsson's GRAPHSEARCH algorithm to provide the fastest route through a subway (metro) network. What cost function would you propose? Can you propose a heuristic for which the search is optimal? If yes, show that the heuristic satisfies the conditions for optimality. If no, explain why not.

4) (6 points) You are responsible for an International Masters program. You wish to use the academic results of admitted students from previous years to predict the grade point average (GPA) for applicants to your program. As training data, you have the name of the home university, the GPA at the home university and the GPA in your program for a population of students in past years of your program. GPAs are rounded to integer scores in the range 0 to 20.

a) Explain how to use histograms to predict the most likely GPA in your program from the identity and GPA at the home university for an applicant. Give the formulas for estimating the most likely GPA. What is the probability of error for this prediction? How is the accuracy of the prediction affected by the number of prior students?

b) Explain how to use a Normal probability density function to predict the most likely GPA in your program from the identity and GPA at the home university for an applicant. Give the formulas for estimating the most likely GPA as well as for estimating the mean and covariance using the data from past students.

5) (6 points) Using Keras, Pytorch or any other convenient programming language, write a program for a 3-layer fully connected neural network to classify MNIST digits. The first layer should have 784 units using RELU activation. The second layer should have 196 units using RELU activation. The third should be composed of 10 units using Softmax activation. Train using the MNIST training data with Categorical Cross Entropy and an Adam Optimizer. Print the accuracy and loss for the resulting network using the MINST test data.

IMPORTANT: IF you reuse code from another source, cite your source!

a) Show the code for your network.

b) Show the accuracy for training for 10 epochs using a batch size of 64 as well as the accuracy for the resulting classifier when tested with the MNIST test data.