Intelligent Systems: Reasoning and Recognition

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ENSIMAG 2 Practice Exam

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.

Écrivez votre nom complet sur chaque page et numérotez toutes les pages. Votre examen terminé doit être retourné sous forme de fichier .pdf envoyé par email à James.Crowley@grenoble-inp.fr.

Vous pouvez utiliser un logiciel d'édition tel que LaTex ou MS Word, mais sachez que la plupart 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 l'Univ. Grenoble Alpes 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.

Write your full name on every page and number all pages. Your completed exam should be submitted as a .pdf file 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 most 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 Univ. Grenoble-Alpes and could be subject to penalties, including possible failure or expulsion."

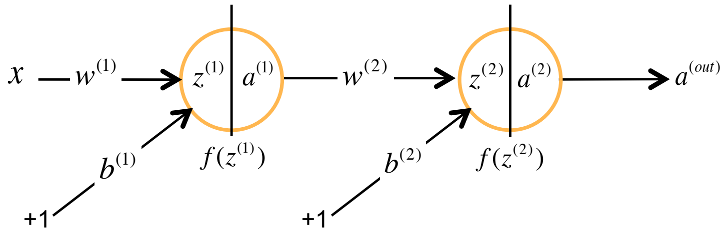
1) (4 points) What is an ROC curve? How is it computed? What does it tell you about a classifier? How can you use it to provide an objective comparison of two different classifiers?

2) (4 points) Assume the following temporal relations between intervals A, B, C and D.

Interval A before Interval B :	(A < B)
Interval B during Interval D :	(B d D)
Interval A starts Interval C:	(A s C)
Interval D overlaps Interval C :	(D o C)

a) What are the possible relations of A to D obtained by transitivity with B?
b) What are the possible relations of A to D obtained by transitivity with C?
c) What are the possible relations of A to D after constraint propagation?

3) (6 points) Back propagation is a distributed form of Gradient Descent. Consider the following two-layer network with one neural unit per layer. The network has four parameters with one input variable, X, and one output activation, $a^{(out)}=a^{(2)}$.



$$\vec{w} = \begin{pmatrix} w^{(1)} \\ b^{(1)} \\ w^{(2)} \\ b^{(2)} \end{pmatrix} \qquad \nabla C = \frac{\partial C}{\partial \vec{w}} = \begin{pmatrix} \Delta w^{(1)} \\ \Delta b^{(1)} \\ \Delta w^{(2)} \\ \Delta b^{(2)} \end{pmatrix}$$

The error for using these parameters to classify an input sample X with indicator variable y is $\delta^{(out)} = \left(a^{(out)} - y\right)$. The cost (or Loss) for this error is $C = \frac{1}{2}\left(a^{(out)} - y\right)^2$.

Note that $\delta^{(out)} = \left(a^{(2)} - y\right) = \frac{\partial C}{\partial a^{(2)}}$

a) Given that $\delta^{(2)}$ is defined as $\delta^{(2)} = \frac{\partial C}{\partial a^{(2)}} \cdot \frac{\partial a^{(2)}}{\partial z^{(2)}}$, show that $\delta^{(2)} = \delta^{(out)} \frac{\partial f(z^{(2)})}{\partial z^{(2)}}$

b) Show that $\Delta w^{(2)} = \delta^{(2)} \cdot a^{(1)}$

c) Show that $\Delta b^{(2)} = \delta^{(2)}$

d) Given that $\delta^{(1)}$ is defined as $\delta^{(1)} = \frac{\partial C}{\partial a^{(2)}} \cdot \frac{\partial a^{(2)}}{\partial z^{(2)}} \cdot \frac{\partial z^{(2)}}{\partial a^{(1)}} \cdot \frac{\partial a^{(1)}}{\partial z^{(1)}}$ show that $\delta^{(1)} = \delta^{(2)} \cdot w^{(2)} \cdot \frac{\partial f(z^{(1)})}{\partial z^{(1)}}$

e) Show that $\Delta w^{(1)} = \delta^{(1)} \cdot x$

f) Show that $\Delta b^{(1)} = \delta^{(1)}$

4) (6 points) Using Keras, Pytorch or any other convenient programming language, write a program for a 2-layer fully connected neural network to classify MNIST digits. The first layer should have 784 units using RELU activation. The second layer should be composed of 10 units using Softmax activation. Train using the MNIST training data with Categorical Cross Entropy and an Adam Optimizer. IMPORTANT: IF you reuse code from another source, cite your source!

a) Show the code for your network.
b) Show the loss and accuracy for training for 5 epochs using a batch size of 128 as well as the loss and accuracy for the resulting classifier when tested with the MNIST test data?