Exam in
Neural Networks and Learning Systems
TBMI26 / 732A55
Home exam - Part I

Date: 2021-06-09
Time: **14.00 - 16.30** (part 1) and 14.00 - 18.30 (part 2)
Teacher: Magnus Borga, Phone: 013-28 67 77

Read the instructions before answering the questions!

The full exam consists of two parts:

Part 1 Consists of ten 1-point and five 2-point questions. The questions test general knowledge and basic understanding of central concepts in the course. The answers should be short and given on the blank space after each question or in the indicated figure. **Note that this part needs to be submitted no later than 16:30!**

Part 2 Consists of four 5-point questions. These questions test deeper understanding and the ability to apply the knowledge to solve problems. All assumptions and calculations made should be presented. Reasonable simplifications may be done in the calculations. Part 2 needs to be submitted before 18.30

Students with approved extended examination time (förlängd skrivtid) may divide this extended time between the two parts at their own discretion.

Write your answers by hand and then scan them using a scanner or mobile phone, or write the answers in a separate file using a word processor. The answers may be given in English or Swedish. **If you write by hand, please write clearly using block letters! (Do not use cursive writing.) Answers that are difficult to read, will be dismissed.** The exam should be submitted before the deadline in PDF format. Each part should be handed in as one single PDF file. **Do not use 'Okular' to produce PDFs as graphical elements might disappear!** The PDF files should be named with your LiU-ID followed by a the number of the part of the exam, e.g. 'abcde132-2'.

The maximum sum of points is 20 on each part. To pass the exam (grade 3/C) at least 13 points are required on part 1. For grade 4/B, an additional 10 points on part 2 are required and for grade 5/A, 15 points are required on part 2, in addition to pass part 1.

Note that all forms of collaboration or communication with any person except the course staff is strictly forbidden during the exam!

The results will be reported by 2021-06-30.

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GOOD LUCK!

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One-point questions

1. Consider these two different training data sets:

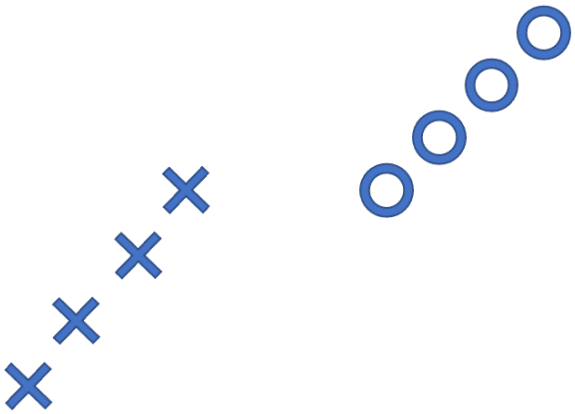
$$T_1 = \{\mathbf{x}_i\}$$

and

$$T_2 = \{\mathbf{x}_i, y_i\}$$

where $\mathbf{x}_i$ are feature vectors and y_i class labels. Which two types of machine learning problems do these sets belong to?

2. Draw $|f(\mathbf{x})| = 1$ where $f(\mathbf{x})$ is the discriminant function in a linear SVN without slack variables.



3. Which of these activation functions can be used in the output layer of a network that will be trained to separate two classes labeled -1 and 1 respectively?

- tanh
- The Fermi function ($\frac{1}{1+e^{-s}}$)
- Re-LU

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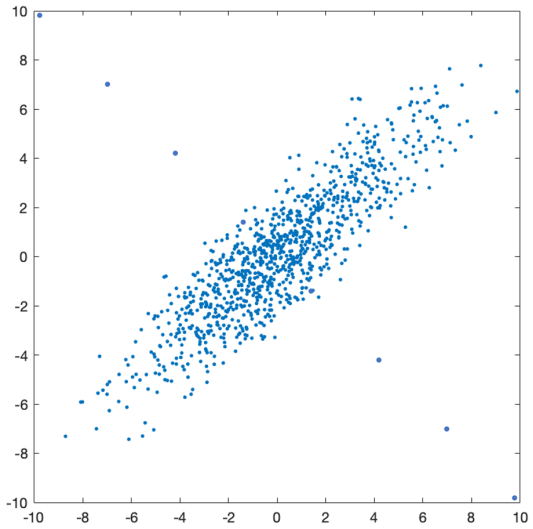
4. Draw the first principal component of the distribution in the figure below!



5. Assume we want to use a simple one-layer perceptron to predict which persons pass a certain physical test, base on the persons height and weight. How may parameters do we have to train?

6. How can a convolutional neural network (CNN) reduce the required amount of training data compared to a fully connected neural network?

7. Segmentation and classification of images are two different tasks, but explain why image segmentation actually also is a classification task!

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8. What is it called when you generate more training data by for example rotating and translating the original data and what is the purpose of this process?

9. Assume we have a non-linear mapping $\varphi(\mathbf{x})$ to a high-dimensional feature space Φ and ϕ is a matrix whose columns i are the feature vectors φ_i in Φ . Define the kernel matrix $\mathbf{K}$ whose components $K_{ij} = k(\mathbf{x}_i, \mathbf{x})$ in terms of the matrix ϕ.

10. Draw an example of a data set where a k-NN classifier will assign a sample to class 0 if k is 1 or 5 and to class 1 if $k = 3$

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Two-point questions

11. You have tested a classifier that classifies objects in three different classes: 1, 2, and 3. Assume there were A items from class 1, B items from class 2, and C items from class 3; where A, B, and C, were all > 3. All items were classified correctly except for 3 items from class 3 that were classified into class 2. Write the confusion matrix (1p) and state the accuracy of the classifier (1p).

12. What are the two main building blocks called in Generative Adversarial Networks? (1p) Briefly explain the tasks of these two building blocks (1p)

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13. Mention two examples of the expectation-maximization (EM) algorithm and describe the parameters that are estimated in both examples.

14. Mention an assumption that is made about the data distributions in Linear Discriminant Analysis (LDA) and draw an example with linearly separable classes where this assumption does not hold.

15. Besides the training data, two other data sets are often used in machine learning. What are they called and what is the purpose of each of these datasets?