UiT THE ARCTIC UNIVERSITY OF NORWAY

FYS-2021 - Exercise Set 5

Logistic Linear Discrimination and Experiment Design and Analysis
Department of Physics and Technology
Faculty of Science and Technology

From book:

10.2, 10.7

Problem 1

Note that the algorithms given in the book are very slow and inefficient. It is usually expected that the code is "vectorized". E.g. the nested loops:

```
for t = 0,...,N
  for j = 0,...,d
    $o^t = o^t + w_j x_j^t$
```

Should be written as a matrix multiplication:

Assume you have a weight vector $\boldsymbol{w} = [w_1, \dots, w_d]^{\mathrm{T}}$ and a matrix $\mathbf{X}$ with the number of samples along the first (vertical) axis and the feature dimensions along the second (horisontal) axis:

$$\mathbf{X} = \begin{bmatrix} x_1^1 & \dots & x_d^1 \\ & \vdots & \\ x_1^N & \dots & x_d^N \end{bmatrix} = \begin{bmatrix} \boldsymbol{x}^1 \rightarrow \\ \vdots \\ \boldsymbol{x}^N \rightarrow \end{bmatrix}$$

then we can write the above for loop as a matrix multiplication like so:

```
$\boldsymbol{o}$ = np.dot($\boldsymbol{X}$,$\boldsymbol{w}$)
```

The above operation will return the same output as the first pseudocode, but is ***much*** more efficient.

(1a) Implement your own, vectorised, version of the logistic discrimination algorithm. It might help if you first write it as pseudocode before you do the actual implementation!

It is possible to write the entire algorithm given in the books figure 10.6 as one single for loop!

Note that this is challenging! If you find this too challenging, you *may* iterate over the samples. However, do not iterate over the dimensions of the features!

In the file `tictac_end.csv`, the end configurations 958 different tic-tac-toe games are provided. Each row represents a different outcome, with the first element being 1 if player × won, and 0 otherwise. The rest of the row represents the board, such that, when reshaped to a 3×3 array, the original board is recovered.

(1b) Test your classifier using the tic-tac-toe end-game dataset. Report the confusion matrix and the classification accuracy.

(1c) OPTIONAL: From Alpaydin Chapter 10.8 (not in the syllabus). Implement your own logistic discrimination-by-regression algorithm, and test this in the same manner as above. Are there any notable differences between the two? Why/why not?