Introduction to Machine Learning

TDDE01 - Lab3

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I. Introduction

As part of the TDDE01 course, Introduction to Machine Learning, the students are obliged to complete a series of three labs in order to complete the course. The purpose of this lab is to learn more about kernel methods and neural networks.

II. Assignment 1 - Kernel Methods

The first lab assignment of this lab is about kernel methods. Given two files *stations.csv* and *temps50k.csv* containing information about weather stations and temperature measurements at different days and times from SMHI, the task is to implement a kernel method to predict the hourly temperatures for a specific date and time given by the user. The forecast should predict temperatures from 04:00 to 24:00 with two hour intervals. The kernel should be the sum of three kernels where the condition for the kernels are the following:

1) First kernel to account for the distance from one station to point of interest.
2) Second kernel to account for the distance between day of measurement and the day of interest.
3) Third kernel to account for the distance between hour of day and the hour of interest.

In this assignment, the Gaussian Kernel is selected and has the following formula:

$$k(u) = exp(-||u||^2)$$

The above kernels after computation (see Appendix) gives the following plot for:

- Date = ”2013-11-04”
- Latitude, Longitude = (58.4274, 14.826)
- h_distance = 100 000 (m)
- h_date = 25 (day)
- h_time = 3 (hour)

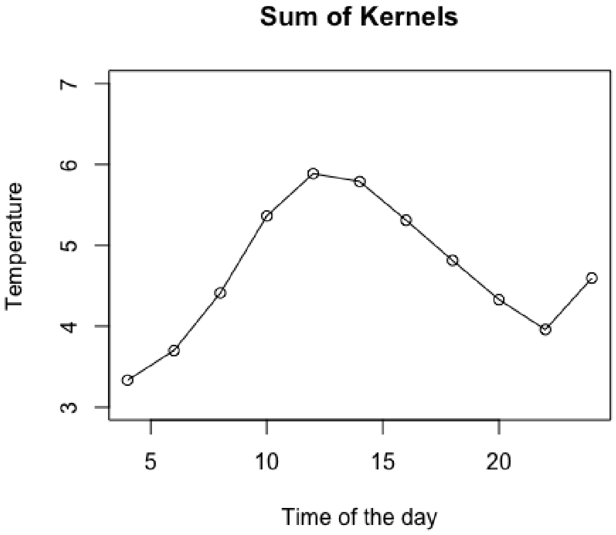

Fig. 1. Sum of Kernels

TODO
Discuss about chosen widths and why we choose that.. Plots. SMHI Plots. Sum of kernels = independent of each other. Multiply is not, therefore multiply should be more accurate.

III. Assignment 2 - Neural Network

The last assignment of this lab involves neural networks. The task is to train a neural network to learn the trigonometric sine function. The first task is to sample 50 points uniformily in the interval [0,1], apply sine function to each point and then divide the data into training and validation sets. In order to train the neural network we need to initialize weight in the interval [-1,1] and use the function *neuralnet* provided in the *library(neuralnet)*. The function *neuralnet* uses the backpropagation algortihm to train the neural network. We will use a neural network with a single hidden layer of 10 units. Our task is to provide a neural network with the most appropriate threshold value. The most appropriate threshold value is when the MSE is the lowest when predicting on the validation set. The following plot shows us the chosen threshold:

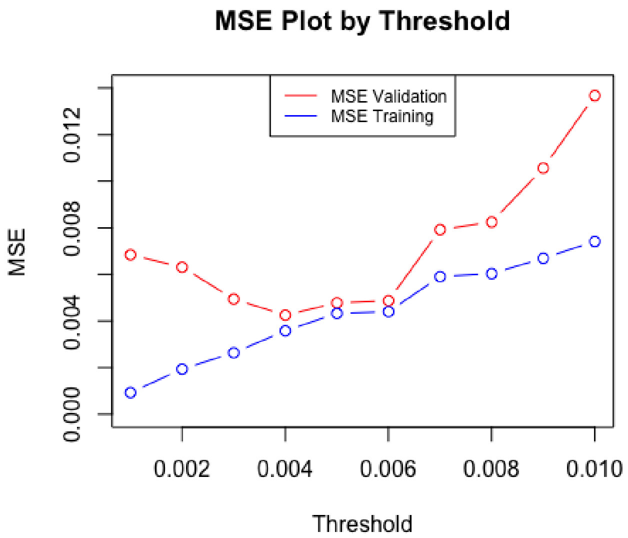

Fig. 2. MSE Plot by Threshold

TODO

The MSE of validation is... The validation set to stop gradient descent.. avoid overfitting. Stop gradient descent when partial derivatives of the error function are below a given threshold value. The chosen threshold value according to the plot is 0.004. The final neural network is presented below:

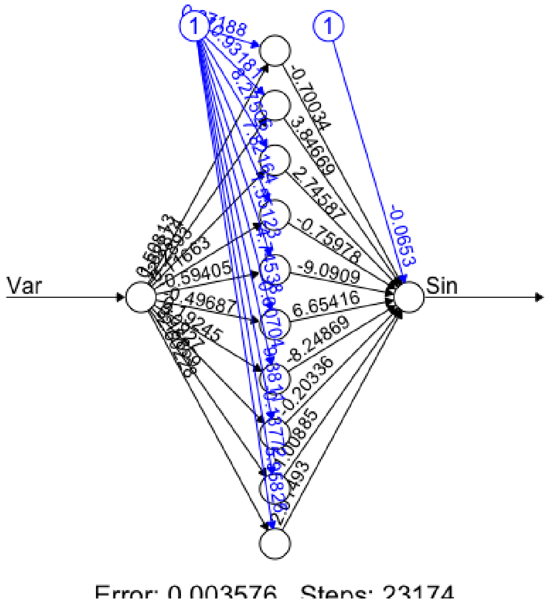

Fig. 3. Chosen Neural Network

The plot below is the prediction with the neural network and the true data:

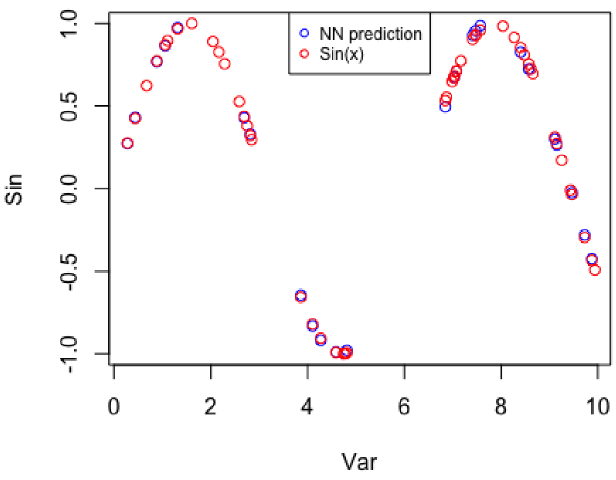

Fig. 4. Chosen Neural Network