Time Series Analysis & Recurrent Neural Networks

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Exercise 1

To be uploaded before the exercise group on Wednesday, May 4th, 2022

Task 1: Weather
The file "dailyweather.csv" contains daily measurements of the temperature, humidity, and air pressure on the balcony of Manuel's parents during the last five years.

1. Are any of the time series correlated with each other, and if so, how strongly?

2. Plot the first return-map of the time series of the temperature. Do you notice any trend? What if you plot the return map for days that are a month apart?

3. Do you notice a trend in the temperature, e.g. can you observe the climate changing over time?

Task 2: Detrending and autocorrelation
The file 'investment.xls'contains scaled quarterly United States private investment per capita rates over the years 1948-1989.

1. By using linear regression, remove the trend from the datasets (Hint: There are in-built functions/packages in matlab and python that can do this for you).

2. Examine (loosely) whether the time series with the linear trend removed is stationary. Is the time series (of the original series before regression) of first differences stationary? How about the time series of second-order differences?

3. Compute the autocorrelation function of the detrended time series. Can you find periodic business cycles (corresponding to peaks in the autocorrelation function)? [Note: please write the autocorrelation function yourself.]

Task 3: AR models

1. Create your own AR time series of length $T = 200$ and order $p = 4$, with the following coefficients given: $a_0 = 0, a_1 = -.8, a_2 = 0, a_3 = 0$, and $a_4 = .4$, with $\epsilon_t \sim N(0, 1)$, i.e. the noise process drawn from a standard normal distribution, and with the initial value of the time series being $x_0 = 0$.

2. Plot the time series in time as well as the first return-map (a plot displaying x_t and x_{t+1} against each other). What do you notice?