Time series prediction: methods to predict variables as a function of time

Data: We are given the values of some variable $f(t_i)$ for different time points $t_1, t_2, \ldots, t_{k-1}$. We want to predict $f(t_k)$ at time t_k.

ARIMA

Standard popular statistical model for time series prediction. Briefly ARIMA performs linear regression on a moving window.

Regression:

Learn a regression model on the input data. For example:

- Linear regression
- Ridge (kernel) regression
- Support vector regression
- Decision trees
- Random forest

Suppose we have time series data. We are given values t_i at time i and we want to predict t_i from previous values of t_j for $j = 0$ to $i-1$. For example see below.

$t_0, t_1, t_2, t_3, t_4, t_5, t_6, t_7$ and we want to predict t_8.

In a regression approach we form the training data:

Training	Label
0	t0
1	t1
2	t2
3	t3
4	t4
5	t5
6	t6
7	t7

Test	
8	t8 (to be predicted)

Binning:

By binning regression target values we can transform our problem into a classification one.

Long short term memory (LSTM) encoding:

Rearrange data into a form where we use previous data patterns to predict the next time point

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We can simply using linear regression. Or we can be clever and try to convert this into an LSTM form. We choose a window of a fixed size, let's say 3 in this example. Now we create a new dataset shown below:

Training	Labels
t0 t1 t2	t3
t1 t2 t3	t4
t2 t3 t4	t5
t3 t4 t5	t6
t4 t5 t6	t7

Test	
t5 t6 t7	t8 (to be predicted)

Now I have feature vectors of length 3 and a label. So now my data is somewhat richer if I use any regression model. Previously it was one dimensional and now it's three dimensional.

Recurrent neural networks

Like a typical feed forward neural network except there are connections to adjacent nodes

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LSTM neural networks

Like recurrent neural networks but use special LSTM nodes

Making several time predictions into the future

We can try to make several predictions at the same time by either making one prediction at a time and use the prediction to augment the data or we use a multi-label output classifier