Reading Summary of “Hidden Markov Model for Stock Trading”

Many forecast models require stationary input time series, but finance data is nonstationary.

The goal is to apply HMM models to forecast stock prices.

Multiple independent variables: open, low, high, and closing prices of the S&P 500. Limited number of states of HMM to 6 to keep it simple. Criteria used to pick the best HMM model were Akaike information criterion, Bayesian information criterion, Hannan-Quinn information criterion, and the Bozdogan Consistent Akaike Information Criterion. Closing price was predicted.

AIC: 2k (=number of estimated parameters) - 2 ln (Likelihood(model)
BIC: ln(n) k - 2 ln (Likelihood(model))
HQIC: -2 ln (Likelihood (model)) + 2k ln (ln (n))
CAIC: -2 ln (Likelihood(model)) + k (ln (M) + 1)

Assumptions of HMM:

1. Observations generated from hidden states
2. Hidden states are finite, Markov
3. Transition matrix is constant
4. p(Observation[t] | State[t])

Goals one could achieve w/ HMM:

1. Given observations O, and model, calculate p(O|model) - forward/backward algorithm
2. Given O and model, find maximum likelihood hidden states that generated O - Viterbi algorithm
3. Given O, calibrate model - Baum-Welch algorithm - an expectation maximization algorithm

Algorithm assumptions:

1. Gaussian distribution for each state
2. K = N*N + 2*N - 1, where N is number of states used in HMM

The HMM was calibrated using the Baum-Welch algorithm, then parameters calculated the probability of the observations (likelihood), to calculate the criteria.

This was for 1 ten-year sample of the data. The data was shifted one month forward, and this process was repeated, 120 times; initially the data ranged from Jan 1997 to Dec 2006, and at the end ranged from Nov 2006 to Nov 2016.

This was done for N=2...6, and N=4 was found to be the best (lowest criteria score per data block over all data blocks)

The HMM was then trained on prices from Jan 1950 to Oct 2006 to predict stock prices from Nov 2006 to Nov 2016. It accurately predicted stock prices around the 2008-2009 economic crisis.
The model performance was evaluated using absolute percentage error, average absolute error, average relative percentage error, and RMS error. The efficiency was calculated as the ratio 1 - (HMM's error)/(HAR's error), where HAR is the historical average return.

Lastly, the model was used to conduct trades. A trade cost $7.00.

"If the predicted stock return is positive for the next month, we will buy the stock this month and will sell it if the next predicted return is negative. We assume that we buy and sell with closing prices. If HMM predicts that the stock price will not increase the next month, then we will do nothing."