9 Machine Learning and Real-world Data (av308)

You are a member of a thinktank advising the government on financial policy issues. You are asked to develop a model to predict the effect of inflation on interest rates. The government has various mechanisms of controlling inflation, and the banking sector responds to the changes in inflation rates.

The historical data collected has three options for changes in inflation, increase (`inc`), decrease (`dec`), hold (`hold`), and categorizes interest rates as high (`high`) medium (`med`), low (`low`). The data over 7 time periods is as follows:

timestep	1	2	3	4	5	6	7
inflation changes	hold	dec	dec	hold	inc	hold	dec
interest rates	med	med	low	low	med	high	med

You decide to use a first-order hidden Markov model (HMM), modelling the changes in inflation as the hidden states and the interest rate as the observations.

(*a*) Define and estimate the components of an appropriate HMM for this application, without smoothing. Assume that all hidden states are equally likely to start the sequence. Ignore the end state. [4 marks]

(*b*) Assume the interests rates are currently high. How do you reduce them in consecutive time periods from high, to medium and then to low? In other words, which is the most probable sequence of inflation changes that results in the sequence of observations: `high medium low`? [6 marks]

(*c*) Using the HMM parameters you have estimated, answer the following questions, explaining your answers.

(*i*) Is it possible for the interest rates to change from low to high in consecutive time periods?

(*ii*) Are low interests rates more likely to remain low or to increase to medium ones? [4 marks]

(*d*) Given that your goal is to build a realistic model of the relation between inflation changes and interest rates, describe three shortcomings of the HMM developed above. [6 marks]