

School of Computing and Information Systems
The University of Melbourne
COMP30027 Machine Learning (Semester 1, 2021)

Tutorial: Week 10

1. Hidden Markov Models (HMMs) are best used when the observables are a **univariate time series**: we are just observing a single variable, which changes over time due to some factor that can be estimated from previous observations.
 - (a) Recall the two main assumptions (Markov, output independence) that are built into an HMM.
 - (b) Could we construct the HMM in such a way to relax these assumptions? What would the model look like, and what is the major downside?
 - (c) Could we build an HMM for a **multivariate time series**, where we have a number of observed variables for a given (hidden) state?
2. **Natural language processing** is one common application for HMMs: we have a single observation (a “word”) that varies over time (a “sentence” or “document”), where each observation is associated with some property (like “part of speech”).

Consider the following HMM: $\Pi[J, N, V] = [0.3, 0.4, 0.3]$

A	J (adj)	N (noun)	V (verb)
J	0.4	0.5	0.1
N	0.1	0.4	0.5
V	0.4	0.5	0.1

B	<i>brown</i>	<i>leaves</i>	<i>turn</i>
J	0.8	0.1	0.1
N	0.3	0.4	0.3
V	0.1	0.3	0.6

- (a) How might we go about obtaining the values in the matrices Π , A , and B given above, in a **supervised** context?
- (b) Use the **forward** algorithm to find the probability of the “sentence” *brown leaves turn*.
- (c) Use the **Viterbi** algorithm to find the most likely state sequence for the sentence *brown leaves turn*.