**Small Problem 3: Discrete-time Discrete-observation HMM**

**Queries:**Query 1: The MAP state sequence.

Query 2: Smoothing: For each time step , the marginal distribution , where is the output sequence.

Query 3: Filtering: For each time step , compute the marginal distribution , where is the vector of outputs from time 1 up to the current time .

**Metrics:**Metric 1 (for query 1 only):   
Minimum Hamming distance between the predicted and the given MAP state sequences. Notice that there are 18 true MAP state sequences provided in this solution.

Metric 2 (for queries 2 and 3):

1. Total variation distance between the true and computed marginal posteriors at each time step.
2. The mean and variance of the per-step total variation distance computed across all time steps.

**Ground Truth:**The answers to the queries are in the attached spreadsheet (problem-3-solution.xlsx). The Excel format file is represented by three CSV files, one for each query, i.e. map, smoothing, and filtering.

**TODO:**Compute Metric 1 for Query 1.  
Compute Metrics 2a and 2b for Queries 2 and 3. The provided Matlab evaluation code uses the following command line:

matlab -nospash -nojvm -nodisplay -nodesktop -r

"TVDScoreHMM(<number-of-states>, <number-of-timesteps>,

<ground-truth-path>,<input-path>,<output-path>)"

The output will be a CSV file written to <output-path>.

Note that the Matlab program for Metric 1 is compatible with [GNU Octave](https://www.gnu.org/software/octave/).

Submit the metric and your code as described in the main CP4 problem description document, e.g. PPAML-Challenge-Problem-4.pdf.

**Ground Truth Details:**This discrete-time Discrete-observation HMM problem was solved using [Kevin Murphy’s Bayes Net Toolbox (BNT)](https://github.com/bayesnet/bnt) for MATLAB (Murphy, 2001).