# ASSIGNMENT 5

Apoorva Singh

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## 1
# Hidden Markov model

Hidden Markov models (HMMs) are a formal foundation for making probabilistic models of linear sequence 'labeling' problems1,2. They provide a conceptual toolkit for building complex models just by drawing an intuitive picture. They are at the heart of a diverse range of programs, including gene finding, profile searches, multiple sequence alignment and regulatory site identification. Hidden Markov models are known for their applications to thermodynamics, statistical mechanics, physics, chemistry, economics, finance, signal processing, information theory, pattern recognition - such as speech, handwriting, gesture recognition, part-of-speech tagging, musical score following, partial discharges and bioinformatics. In an analysis problem, given a sequence, and inference can be hidden state path. There are potentially many state paths that could generate the same sequence. We find the one with the highest probability.

- Example

Drawing balls from hidden urns

In its discrete form, a hidden Markov process can be visualized as a generalization of the urn problem with replacement (where each item from the urn is returned to the original urn before the next step). Consider this example: in a room that is not visible to an observer there is a genie. The room contains urns X1, X2, X3, ... each of which contains a known mix of balls, each ball labeled y1, y2, y3, ... . The genie chooses an urn in that room and randomly draws a ball from that urn. It then puts the ball onto a conveyor

belt, where the observer can observe the sequence of the balls but not the sequence of urns from which they were drawn. The genie has some procedure to choose urns; the choice of the urn for the nth ball depends only upon a random number and the choice of the urn for the (n  1)th ball. The choice of urn does not directly depend on the urns chosen before this single previous urn; therefore, this is called a Markov process. It can be described by the upper part of Figure 1.

The Markov process itself cannot be observed, only the sequence of labeled balls, thus this arrangement is called a "hidden Markov process". This is illustrated by the lower part of the diagram shown in Figure 1, where one can see that balls y1, y2, y3, y4 can be drawn at each state. Even if the observer knows the composition of the urns and has just observed a sequence of three balls, e.g. y1, y2 and y3 on the conveyor belt, the observer still cannot be sure which urn (i.e., at which state) the genie has drawn the third ball from. However, the observer can work out other information, such as the likelihood that the third ball came from each of the urns.