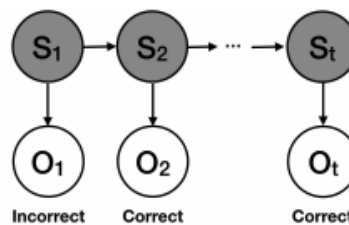


## HMM Programming

In this project, you will create a 2-state Hidden Markov Model (HMM) for student learning prediction. Your task is to implement a system that trains on student assignment data to predict the student learning outcome in the test set.

**Data** You are given a dataset in CSV format that represents each student with a unique StudentID. Each student data includes a sequence of steps, identified by StepID. Your observation at each step is the presence of seven knowledge components (KCs) involved in a step, and whether the action taken by the student was correct (1) or incorrect (0).

**Model** The figure below shows the graphical representation of the HMM model that you are going to implement. There are two types of hidden knowledge states: *learned* or *unlearned*. At each step, you are given a binary observation as the action being correct or incorrect. The initial state distribution, state transition probability, and emission probability are learned from the student observation sequence in the training data.



This model assumes that the student's knowledge state at time  $t$  is only dependent on the previous knowledge state at time  $t - 1$ . Also, their performance at each step is only dependent on the current knowledge state.

For each of the KCs, train an HMM model that applies EM (Expectation Maximization) and iteratively update the model parameters until a maximized probability of observing the training sequence is achieved. To initialize the HMM model, assume that the probability of initially being unlearned is 0.5. Also, once a student is in the learned state, there is 0.09 chance that they unlearn, and a student in unlearned state will stay unlearned with a 0.86 chance.

**Report** In your report, include the following:

- Report your observation from the HMM model parameters after training as compared to the initial parameters.
- Report your observation from changing the initial parameters of the HMM model.
- Report your observation from comparing parameters of HMMs trained for different KCs.