Hhm Application in Socrates App

Project Overview

Socratese app aims to empower East African university and high school students to think critically and bridge individual & local wisdom with global academic discourse through innovative prompted writing exercises. The platform will feature three core components: personal narrative journaling, concept-based study sessions, and philosophical debate/argument modules.

HMM Application: Modeling Student Cognitive Engagement States

Observations

The model would use measurable data from student interactions with the platform:

- **Writing metrics**: Word count, sentence complexity, vocabulary diversity, response time per prompt
- **Engagement patterns**: Session duration, frequency of platform visits, completion rates of writing exercises
- **Content analysis**: Semantic coherence scores, use of critical thinking indicators (questions, counterarguments, evidence citations)
- **Behavioral indicators**: Time spent on reflection prompts, revision frequency, peer interaction levels

Type of HMM Problem

This represents an **unsupervised learning problem** where we need to discover hidden cognitive states without prior knowledge of what these states are. Since we don't know the hidden states in advance, this is a **structure learning task** that requires both parameter estimation and state discovery.

Training Algorithm

Known Values at Start:

- Observable student behaviors and writing metrics
- Temporal sequences of student interactions
- Basic demographic information (education level, subject focus)

Unknown Values to Learn:

- Number of optimal hidden cognitive states
- Transition probabilities between cognitive states
- Emission probabilities linking observations to hidden states
- Initial state distribution

Parameter Updates

The training algorithm will update three key HMM parameters:

1. **Transition Matrix (A)**: Probabilities of moving between cognitive engagement states (e.g., from "surface learning" to "deep reflection")

2. **Emission Matrix (B)**: Probabilities of observing specific behaviors given each hidden cognitive state

3. **Initial State Distribution (π)**: Likelihood of students beginning sessions in each cognitive state

The model would use the Baum-Welch algorithm for parameter estimation, iteratively refining these parameters to maximize the likelihood of observed student behavior sequences. This would enable the platform to identify when students are in different cognitive states (such as "struggling with concepts," "actively synthesizing ideas," or "ready for advanced challenges") and adapt prompts accordingly to optimize learning outcomes.