African Leadership University

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ThinkForge

Application of Hidden Markov Model (HMM) in the ThinkForge Capstone Project

Capstone idea

ThinkForge is a proposed web-based platform designed to support African high school graduates as they transition to higher education. The platform will offer tailored guidance, scholarship information, and academic support by tracking student interactions and adapting to their needs. Through personalized engagement, ThinkForge aims to help students set goals, make informed decisions, and avoid risky behaviors during this critical stage.

Observations (measurable data)

The HMM would use time-series behavioral data captured from each student's interaction with the platform, including:

- Number of logins and session durations

- Pages visited (e.g., scholarship, academic planning, goal-setting)

- Frequency of downloads and form submissions

- Drop-off points or inactivity periods

Type of HMM problem
This is an unsupervised HMM task. The true mental or motivational states of users such as Motivated, Exploring, Confused, or Disengaged are not labeled and must be inferred from the observed data. The goal is to discover these hidden states and model their progression.

Training algorithm
The HMM can be trained using the **Baum-Welch algorithm** (an Expectation-Maximization approach), where:

- **Known values**: Sequences of user interaction logs (observations over time)

- **Unknown values**:

(1) Hidden state transitions (e.g. how likely a user is to go from Motivated to Confused)

(2) Emission probabilities (e.g. how likely a Disengaged user is to drop off or avoid key resources)

Parameter updates
 The training process would iteratively estimate and update:

- **Transition probabilities** (between hidden states)

- **Emission probabilities** (likelihood of each observation given a hidden state)

- **Initial state probabilities** (starting condition for a new user)

By applying HMMs and continuously learning from user behavior as well as modeling student states with HMMs, ThinkForge can detect signs of disengagement early and trigger proactive, personalized interventions. This predictive intelligence will ensure a smooth and supported transition to higher education, reducing dropout risks and empowering each learner to stay on track.