Application of Hidden Markov Model in Smart Health Insurance Recommendation System

The Smart Health Insurance Recommendation System aims to provide personalized health insurance plan recommendations in Rwanda using machine learning. A Hidden Markov Model (HMM) can enhance this system by modeling user behavior and health needs over time to recommend optimal insurance plans.

Observations

The HMM would use measurable data from user profiles and interactions, including demographic data (age, income, family size, location), health-related data (frequency of medical visits, chronic conditions, past claims), and behavioral data (insurance plan inquiries, enrollment history, payment patterns). For example, a sequence might include a user's medical visit frequency over 12 months, encoded as numerical or categorical states (e.g., low, medium, high utilization).

Type of HMM Problem

Since the hidden states (e.g., underlying health risk profiles or insurance preference states) are not known in advance, this is an unsupervised learning HMM task. These hidden states could represent categories like "low-risk, cost-sensitive," "high-risk, comprehensive coverage seeker," or "undecided, exploring options," learned from patterns in the observation sequences.

Training Algorithm

- Known Values at Start: Initial observations (user profile and behavioral data sequences) and an assumed number of hidden states (e.g., 3–5 states based on expected user segments). The initial transition matrix, emission probabilities, and prior probabilities are randomly initialized or set using heuristic estimates (e.g., uniform distributions).

- Unknown Values to Learn: The hidden states, transition probabilities between states (e.g., likelihood of moving from "low-risk" to "high-risk"), emission probabilities (likelihood of observations given a state), and initial state probabilities.

The training algorithm updates the following HMM parameters:

1. Transition probabilities (A matrix): governs the likelihood of moving between hidden states (e.g., from low-risk to high-risk profiles).
2. Emission probabilities (B matrix): model the probability of observing specific data (e.g., medical visit frequency) given a hidden state.
3. Initial state probabilities (π): indicates the starting probability of each hidden state.

By modeling temporal patterns in user health and insurance interactions, the HMM can predict future needs and recommend plans that align with inferred risk profiles, improving personalization and user-provider alignment in Rwanda's health insurance landscape.