

Project proposal

Probabilistic Finite-State Chatbot: Combining Stochastic Automata and Language Processing

Group Members:

Dean Worrels - U35612522

Timon Stacy - U70537881

Roy Ibarra - U37666031

Introduction

Computers typically recognize language using a finite-state machine (FSM), where each input leads to a consistent predetermined output. However, a probabilistic automata (PA) can extend the normal capacities of a FSM by applying probabilistic state transitions, allowing for more dynamic and varied outputs. This allows for the PA to generate responses that are not strictly deterministic, but stochastically influenced as well. This project will make a finite-state chatbot that uses probabilistic transitions to create a stochastic language model that allows for varied and unpredictable responses.

Implementation & Approach

The first step in designing the chatbot is to model it as a Probabilistic Automaton, similar to a Non-deterministic Finite Automaton but with probabilistic transitions. The bot will have multiple states representing different conversation topics, greetings, questions, the given topic, and a fallback state for unrecognized inputs. Each state will also have varied sub-states, to provide varied responses.

The probability of transitions between these sub-states will be determined by two aspects, the stochastic language model, which provides different probabilities to words and phrases the bot can respond to. Each word varies the probability of the transitions between the subsets. And the previous output, influencing the probability of the later transitions.

Evaluation Methods

Monte Carlo Simulations

Monte Carlo simulations are useful in generating a large number of random scenarios that follow a predetermined probabilistic model to estimate the likelihood of various outcomes. In our case, each Monte Carlo iteration represents a path the chatbot might take, this allows us to determine which states are visited and whether transitions align with related probabilities, and how varied the chatbot's responses are.

Comparison: Deterministic vs Probabilistic Chatbots

There are two main types of chatbots used online nowadays. Deterministic and probabilistic. To be clear on what's the difference, a deterministic chatbot has a strict set of outputs it's going to produce based on the user's input. Many can say that it lacks a "personality" with the outputs being straightforward and not changing over time. On the contrary, probabilistic chatbots can seem to "change" over time due to its many responses it can have given the same input. Each different output for the same input from the user has a probability that it will get displayed to the user, hence the name probabilistic chatbot. Nowadays companies use probabilistic chatbots over deterministic ones because they better engage with the user and provide a better overall user interaction. The one disadvantage that probabilistic chatbots have compared with deterministic is that it is harder to maintain due to it requiring more computing power and training (if it learns from itself over time) and sometimes outputting a false / incorrect answer.

For our project we will be evaluating our probabilistic model, by comparing it to a similar deterministic version.