Homework 3 – Stock Prediction

Arya Rahmanian

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CodeSkulptor Link: <https://py3.codeskulptor.org/#user309_HNZj91GxqS_16.py>

1. **Question 3.A.i: In terms of *m* and/or *n*, how many pieces of data should comprise each state in the resultant Markov chain?**

In the Markov chain function, each state in the resultant Markov chain is a sequency of elements with a length equal to the order of the Markov chain. So, if the order of the Markov chain is m, then each state will contain m pieces of data. This means that each key in the dictionary used for the markov\_chain function will have m pieces of data.

1. **Question 3.A.ii: In terms of *m* and/or *n*, what is the maximum possible number of states that you could end up with in your Markov chain (*i.e.*, in the case where there are no repeats)? Why? Please be as clear and specific as possible in your explanation. You should only count states for which there is a "next" value in the input list.**

A state in Markov chain is defined by a sequence of m consecutive elements from the input data so the order of said Markov chain is m.

If the length of the input data is n, then each state of length m can start from a position in the list that can contain m consecutive elements. The valid starting positions are from index 0 to n – m, so the maximum number of states where we could end up with in our Markov chain is n – m. If a starting position is greater than n – m, it cannot form a state because there is no valid next element after n.

1. **Question 3.A.iii: Without using iteration, how could you extract a single state of the correct length? Provide a Python expression for extracting the sequence of elements that will be used to comprise the state starting at position i in the original list. Your expression should work for any arbitrary value of i that is greater than or equal to zero and less than your answer to Question 3.A.ii.**

To get a single state of the correct length *m* starting at position *i,* we would do this:

state = data[i: i + m]

1. **Question 3.B.i: Explain how you will use the inputs (model and last) to predict the first piece of future data. In particular, you should address how you will access the appropriate probabilities and how you will use those probabilities to select the future datum. Please be as clear and precise as possible!**

First, we need to find the probabilities for the next state. The input, model, is a Markov chain represented as a dictionary where each key is a tuple representing a state with length *m* and the value is another dictionary that has the next states and the transition probabilities. To predict the first of the *p* future pieces of data, we start with locating the current state, last, in the model to retrieve its transition probabilities. We then select the next state based on these probabilities. To do this, we generate a random value between 0 and 1 and compare it to the cumulative probabilities derived from the transition probabilities. By determining which cumulative range the random value falls into, we can select the appropriate next state accordingly.

1. **Question 3.B.ii: Imagine that pis greater than or equal to 2. How will you construct the state that will be used to make the second prediction? As a part of your explanation, please include a concrete example (*i.e.*, sample inputs + the first prediction generated + the state used to make the second prediction).**

To construct a state for the second prediction, we will take the last *m* – 1 elements from the previous state and append the newly predicted value. This ensures that each state always has *m* elements and reflects the newest information.

m = 2, p = 3, last = [1, 2], model = {(1, 2): {0: 0.5, 3: 0.5}, (2, 0): { 1: 1.0 }}

First prediction:

Current state: last = [1,2]. So model of (1,2) has two possible next states: {0: 0.5, 3: 0.5 }. We will randomly select 3. So, our first prediction is 3.

New state is now: [2, 3]. If this state exists, we would use its probabilities to predict the next piece of data. If it doesn’t, we will randomly choose a value from 0 to 3.

1. **Question 3.B.iii: In the event that a state is not found in the model, what Python function call could you make to generate a random integer between 0 and 3, inclusive? Please indicate not only the name of the function, but the input(s) that you will use.**

random.randint(0, 3)