Data visualization

COSC 480B

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Lecture 21

Hidden Markov models

Overview

- Defining interpretive models
- Using Markov chains to model data
- Inferring hidden state using a hidden Markov model

Overview

Exercise 1

What makes a model interpretable may be slightly subjective. What’s your criteria for an interpretable model?

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ANSWER

We like to refer to mathematical proofs as the de facto explanation technique. If one were to convince another about the truth of a mathematical theorem, then a proof that irrefutably traces the steps of reasoning is sufficient.

Example of a not-so-interpretable model

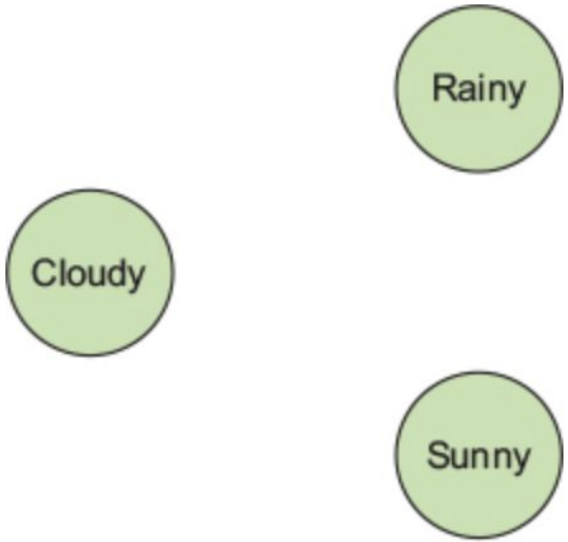
- One classic example of a black-box machine-learning algorithm that's difficult to interpret is image classification.
- You'll learn how to solve the problem of classifying images in next lectures
- It's difficult to ask an image classifier why it made the decision that it did.
- Machine learning sometimes gets the notoriety of being a black-box tool that solves a specific problem without revealing how it arrives at its conclusion.
- The purpose of this chapter is to unveil an area of machine learning with an interpretable model.
- Specifically, you'll learn about the HMM and use TensorFlow to implement it.

Markov model

- Andrey Markov was a Russian mathematician who studied the ways systems change over time in the presence of randomness.
- For example, maybe a gas particle in Europe has barely any effect on a particle in the United States. So why not ignore it?
- The mathematics is simplified when you look only at a nearby neighborhood instead of the entire system.
- This notion is now referred to as the Markov property.

Markov model

Weather conditions (states) represented as nodes in a graph



Markov model

Exercise 2

A robot that decides which action to perform based on only its current state is said to follow the Markov property. What are the advantages and disadvantages of such a decision-making process?

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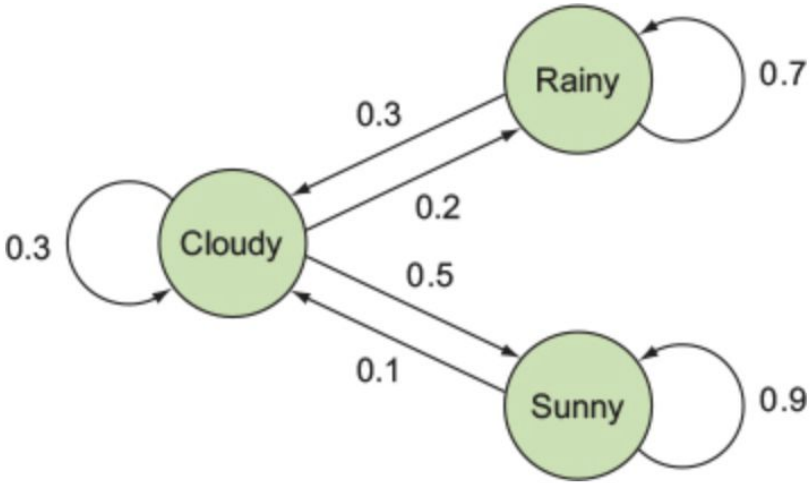
ANSWER

The Markov property is computationally easy to work with. But these models aren’t able to generalize to situations that require accumulating a history of knowledge. Examples of these are models in which a trend over time is important, or in which knowledge of more than one past state gives a better idea of what to expect next.

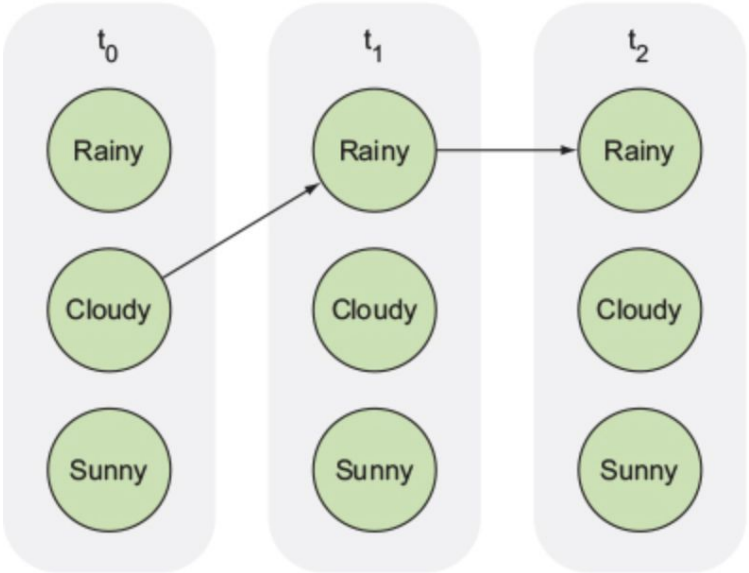
Markov model

Transition probabilities between weather conditions are represented as directed edges.



Markov model

A trellis representation of the Markov system changing states over time



Markov model

A transition matrix conveys the probabilities of a state from the left (rows) transitioning to a state at the top (columns).