Markov Chains

Introduction and applications in software development

PID_00266367

Marcel Serra Julià

Universitat Oberta de Catalunya

Marcel Serra Julià

I got my degree in Mathematics at the Universitat Autònoma de Barcelona (UAB) in 2009 and did my eHealth Masters at the McMaster University (Canada) in 2011. While I did my graduate training I was also a teaching assistant in the Department of Computer Sciences at the McMaster University. In 2012, I developed my professional career as a Software Developer working for several companies in the digital sector in the Barcelona area, including Mascoteros (a marketplace for the pet industry) and YaEncontre (a real estate website). In these companies I specialized in web development with Symfony, a popular PHP framework based on MVC architecture. The rapidly changing digital industry was a catalyst which led me to look to new technologies such as Big Data, Computer Vision and Computational Modeling. As a result of my expertise and motivation for research I am currently working as a Data Manager at ICTA (Institut de Ciència i Tecnologia Ambiental, UAB).

The assignment and creation of this UOC Learning Resource have been coordinated by the lecturer: Cristina Cano Bastidas (2020)

First edition: February 2020

Av. Tibidabo, 39-43, 08035 Barcelona
Publishing: FUOC

Introduction

This module focuses on mathematical modelling using Markov Chains. Markov Chains are a mathematical tool originally used in the field of probability. Because of that, some of their popular applications are gambling problems and the Random Walk problem. This said, Markov Chains can also be applied in a wide range of fields such as natural sciences, technology and market analyses.

The interpretation of Markov Chains as dynamic systems without memory allows its usage to be extended beyond probability. Markov Chain models are said not to have memory because they can predict a future state of a system without having information about the past states. Therefore, Markov Chains only need the transition rules between states and the current state to be able to predict a future state of a system. All the techniques we have studied in linear algebra (such as Diagonalization) will be very useful here because the transition rules of Markov Chains will be represented by matrices.

Markov Chains can be used in natural sciences to study population dynamics. Problems such as migration of people between cities or bird flight between different geographical locations are but some examples. Markov Chains are broadly applied in technology. Among many other examples, Markov Chains are used in the study of networks, in queueing analysis or in algorithms to sort results on search engines. Markov Chains are also used in business to make stock market predictions or to study the evolution of market shares in different companies.

All these problems can be modelled with the transition matrix of the Markov Chain. We will look at each specific characteristic of Transition Matrices to better understand and tackle the problems posed in this section.

Objectives

1. To understand the concept of Markov Chains and to use them to model real world problems. To be able to draw states diagrams and transform them into transition matrices.
2. To understand how the concepts and techniques relative to Linear Algebra that we have learnt in this course are used to study and solve Markov Chain problems.
3. To learn how to take advantage of mathematical software to solve Markov Chain problems.
4. To be able to solve a problem using Markov Chains in a use case using real or realistic data.