Chapter 15
Student Retention Performance Using Absorbing Markov Chains

Dennis M. Crossen
La Salle University, USA

ABSTRACT

Performance models are well established in the literature. More specifically, student performance has been of growing concern at all levels. To confront the challenges, researchers have collected data, monitored performance criterion, developed quantitative models, and analyzed patterns to formulate theories and adaptive measures. At the university level, many students' performance deficiencies are keenly noticed and actualized for a variety of reasons. Some reasons may include transition from a home-reporting educational environment to an autonomous setting; lack of a friendly support system; or a host of behavioral circumstances which exacerbate latent academic deficits. One such technique for reviewing student performance can be employed and analyzed using absorbing Markov chains. The use of Markov Chains can provide quantitative information such the characterization potential delays (latency points) within and throughout the system, prediction of probabilistic metrics which define transitions between each stage of a defined state, and adaptability options for enrollment outcomes for use by school administrators. Furthermore, Markov chains can be employed to determine the impact on system resources such as limitations in faculty schedules, classroom assignments, and technology availability. Managers, administrators and advisors may find this information useful when notified of such limitations. This paper is of value to a broad audience such as researchers, managers, and administrators since it augments standard approaches of the Markov model. The blend of stochastic mathematics, applications of stochastic methods and retention theory, as well as the inclusion of adaptive sensitivity analysis are effective performance measures. Therefore, applications in Markov chains and subsequent forecasting models are of contemporary values in educational performance. Each of these concepts and methods contribute to a broader consideration of Markov properties in a branch of mathematics known as Markov Decision Processes (MDP). These types of processes allow researchers the ability to adjust parameters based on rewards, sets of actions, and discount factors. The cases outlined in this paper may be helpful when considering reductions in recidivism rates, improving policies to diminish recidivism, and increasing enrollment options using Markov analysis.

DOI: 10.4018/978-1-5225-0654-6.ch015

INTRODUCTION

Performance models are conceptual constructions used to describe simple or complex systems using mathematical methods. These models are a corresponding form of a conceptual or originating abstraction which serve to simplify understanding or provision for differing viewpoints under study. Developing such models are cognitive activities (Lee & Wagenmakers, 2014) which are of practical consideration in many branches of science and research. Moreover, modeling can be realized using computer programs, drawings, physical structures, or structural formulations. Conceptual models are commonly applied in wide varieties of scientific research and are beneficial toward understanding the framework for adaptations for improving performance.

In geology, for example, laboratory and field observations are assembled in order to develop idealized performance models. Assembling a proper blend of variables can form the basis for understanding a phenomenon, ascertaining recurring patterns of behavior, or highlighting existing theories (Wolf, 1976). In the field of digital forensics, cloud deployment models have been used to differentiate public and private cloud activity to alter data collection processes, adapt identification protocols, and analyze results to determine potential criminal activities (Martini & Choo, 2012). These research efforts are assisting law enforcement agencies in their struggles to understand cyber-crime using ever-improving data mining strategies. Conceptual models are also used in Lean Six Sigma deployment. Hilton (2012) proposed a conceptual model which attempts to ascertain a relationship between technical and interpersonal skills, levels of influence in the organization, and organizational competencies (amongst others). In all cases, these models are designed to quantify phenomenon so that planned adaption or understanding is realized in order to improve performance.

Developing a conceptual model is typically one of the first initiatives of planned research activities. A researcher bears the responsibly for defining the most important characteristics and variables to be used in the study (Wolf, pp.14-15). In doing so, mathematical models are used to frame conditions such as behavior, interrelationships, and patterns. It is not surprising that mathematical models are used in research since the language of mathematics extends beyond culture and linguistics. This paper provides analysis of student retention conditions using absorbing Markov chains. This technique is used in an effort to understand the performance characteristics of students in a university environment. Two cases are proposed that ascertain useful statistics for:

1. Decreased recidivism of existing freshman; and
2. Increased enrollment of incoming freshman.

Organization of this Chapter

This paper provides analysis of performance metrics as they relate to:

1. Stochastic processes, discrete mathematical structures, and Markov models;
2. Student retention models; and
3. Forecasting metrics.