Applied Stochastic Modeling
Group assignment

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Introduction

The goal of this hand-in assignment is to apply the topics in the book in real-life situations, in this case to the call center of an emergency medical service (EMS). The aim is two-fold: (i) it shows the practical aspects of applying queueing models to real settings, and (ii) it requires you to think about assumptions and performance analysis of different queueing models.

The total length of the paper should be between 3 and 6 pages in conventional formatting (for instance, A4, single spaced, 11 pt font size), excluding possible tables and figures. The deadline for turning in the assignment is *Sunday December 4*. The assignment should be turned in via blackboard. Below, you may first find some background information and the problem statement, followed by the contents that are required for the assignment.

Background and problem statement

Ambulance care is of paramount importance in today's society. When an accident occurs that involves emergency medical service (EMS), there will be a call generated by someone. Most of the calls are made to the national emergency number by a civilian (112 in most European countries, and 911 in American countries) and is received at the Emergency Medical Call Center (EMCC).

Before we turn to the goal of this assignment, we first describe the process of how such an emergence call is handled. When the call operator - also referred to as the EMS dispatcher - answers, he/she will start a triage procedure to estimate the sincerity of the emergency call, and labels it with a priority. Also additional information will be asked, such as the victims name, age, current location and medical background (if available). The dispatcher will also ask for the name and telephone number of the person who makes the call, so that the dispatcher can reestablish the line if the phone connection is accidentally terminated. There are cases where people place a call, while the situation does not require EMS care, for example because the person can go to a first aid post by his or hers own means of transportation. If necessary the dispatcher gives instructions to the person who called in to tide over until an EMS vehicle arrives to take over the first aid. Finally, EMS dispatch personnel have information about the current location of all EMS vehicles in their domain at all time using GPS and cellular communication networks that are regulated by computers. After the triage procedure, the dispatcher contacts an available EMS vehicle according to certain guidelines, and sends it to the location where the call originates from.

The goal of this assignment is to determine appropriate staffing levels for the EMCC. Hence, the question is how many EMS dispatchers should be staffed throughout the week for a swift response. The target commonly used for the time between a call is generated

and the time a call is addressed (i.e., the time an EMS dispatcher picks up the phone) is 6 seconds.

To address this question, a dataset is provided of call records from June 1, 2015, until July 31, 2015. The data contains time stamps of *arrival*, *pick up*, and *hang up*. Based on this data, the assignment is to determine methods to calculate appropriate staffing levels.

Out of scope Data analysis is clearly required to motivate the model (and parameters) you are going to use. A detailed forecasting method is, however, outside the scope of this assignment. Moreover, it is sufficient to provide appropriate staffing levels; determining actual shifts also falls outside the scope of this assignment

Contents of the paper

The headings below should be part of the paper.

Data analysis Some analysis of the data is required, for instance to support the model assumptions being made. This includes both the arrival process as well as the call handling times. We note that advanced forecasting methods fall *outside* the scope of this paper.

Model considerations The staffing levels may be determined with a single model (and approach). However, selecting an appropriate model and/or solution approach is not always evident. Therefore, we want you to discuss some options; being able to select the 'best' model is a major element of this assignment. Specifically, based on the data analysis and knowledge about queueing models, you should specify *three* models/approaches that may be used to determine appropriate staffing levels. For these models/approaches the following should be indicated:

- Motivate why the model/approach is appropriate;

- Specify how the model can be analyzed (or approach should be implemented). Approximations are possible, and often necessary. Note that only one model/approach needs to be actually implemented (see below);

- Drawbacks of the specific model/approach.

Since queueing models can be difficult to analyze, using approximation is also a valid approach. Moreover, you are free to use any literature available. A useful reference is [1].

Calculate staffing levels Use (at least) one model/approach to determine the required staffing levels throughout the week.

Discussion Conclude your findings and discuss strengths and limitations of your approach.

References If appropriate, provide the literature you used, and refer to this in the body of the paper.

References

[1] L.V. Green, P.J. Kolesar, and W. Whitt (2007). Coping with time-varying demand when setting staffing requirements for a service system. *Production and Operations Management* **16**, 13-39.