IEOR 8100: Topics in IEOR: Stochastic Models in Service Engineering

Instructors: This course is co-taught by Professor Ward Whitt and Dr. Galit Yom-Tov

Contact Information:

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Time and Place: The course will be given in the spring semester 2012, meeting on Wednesdays at 1:30pm for about two hours in Room 317 Mudd.

Course Description:

This course will focus on stochastic models of service systems. One goal is to help students learn about that application context. A second goal is to focus on a class of mathematical models and analysis techniques that have proven useful in that application context. As is almost always the case in operations research, these models and analysis techniques have many other applications, so that the course can be useful even if you are primarily interested in other applications.

This course provides an introduction to the theory behind Service Engineering, as applied mainly in healthcare (hospitals) and tele-services (e.g., call centers). Many topics are relevant and interesting for both applications, e.g., staffing of nurses in hospital and call center agents in call centers. Of special interests are topics that involve multi-disciplinary aspects such as queueing theory, statistics, game theory and psychology. There will be a focus on service system data. Students will be encouraged to become familiar with the data resources, such as available at the SEE-Laboratory at the Technion.

From the mathematical perspective, the course focuses on multi-server queues, and networks of such multi-server queues. Important customer behavior includes balking (deciding upon arrival not to wait), reneging or abandoning (leaving after waiting a while), retrying (coming back later after balking or reneging) and returning (coming back for additional service). There may be multiple types of customers and customer service representatives (agents) with different sets of skills. Automatic call distributors provide the capability of skill-based routing, but there remains an opportunity to improve the routing.

Consistent with the instructors’ recent research, the course we will pay special attention to many-server queues. One main topic is staffing to cope with time-varying arrival rates. A second main topic is many-server heavy-traffic limits, in which both the arrival rate and the number of servers approach infinity. Three different limiting regimes emerge, depending on the way these variables approach infinity: (i) the quality-driven (QD) regime, (ii) the efficiency-driven (ED) regime and (iii) the quality-and-efficiency-driven (QED) regime. These limits yield useful approximations.
**Target Audience:**

This course is intended for doctoral students in IEOR and related fields. Since the course has a significant focus on stochastic models, students are expected to have completed an introductory course on stochastic models at the level of the first-year doctoral course IEOR 6711, Stochastic Models I. Yet, it is possible for students without this prerequisite to take the course after consulting with the instructors.

**Student Requirements:**

This course is a research course, giving students the opportunity to conduct independent research. That goal makes it possible for students to participate with a variety of backgrounds. The main task is a course project, which can be conducted individually or in small groups. The course project will culminate in both a written report and an oral presentation. The instructors will suggest possible projects, but students choose their own project within the broad domain of the course.

The students will also be asked to give one or more lectures about papers that students will choose or be assigned.

There will be no exams.

**Course structure:**

The course will have 3 parts: In the first part, the instructors will give lectures. In the second part, student will present various research papers. In the third part, at the end of the course, students will give project presentations. There may be visiting lectures as well.

The lectures at the beginning will provide an introduction to service engineering, emphasizing how data elevate research in that area, mathematical models, and mathematical analysis of those models. To benefit from those lectures, some background is needed in the theory of probability and stochastic processes, but interesting research can be done without much background.

Students are encouraged to participate in our companion course IEOR 4615, where students will be working with call center data from Avishai’s data archive iat the Technion.

**Other topics** include: time-dependent arrival rates, offered-load (infinite-server) models, overflow processes, skill-based routing, staffing, resource pooling, real-time congestion prediction, demand forecasting and simulation.
Background Reading: (No required textbook)

Textbooks on Services:

- Brad Cleveland and Julia Mayben, *Call Center Management On Fast Forward, Succeeding in Today's Dynamic Inbound Environment*, Published in 1997 by Call Center Press, A division of ICMI, Inc., P.O. Box 6177, Annapolis, Maryland 21401, 281 pages, ISBN 0-9659093-0-1

Overview Papers:

- W. Whitt, "Stochastic models for the design and management of customer contact centers: some research directions," March 2002. [Postscript PDF]

Background Introductory Queueing Textbooks


Background on Stochastic-Process Limits

Initial Lecture Topics:

1. Introduction to service engineering
2. The Importance of Queueing Models
3. Fitting Queueing Models To Data
4. Predicting Queueing Delays
5. Time-varying arrivals: stabilizing performance over time. Offered load and Erlang-R.

Possible Project Topics:

For the research topics, there are many options. Please discuss your ideas with one of the instructors. The research may be original research, reading some research papers or part of a book and reporting on that, or some combination of those.

The research topic could be theoretical or practical.

Here are some suggested topics, with one or two candidate references. These are only intended to be illustrative. There are many other good topics.

Possible Papers for Students Lectures:

Queueing in healthcare


Empirical/Statistical studies in queueing


**Behavioral or psychological issues in queueing**


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**Delay announcements queueing systems**


**Queues with time-varying arrival rates.**

