Dynamic Control of a Single Server System when Jobs Change Status

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From health care to maintenance shops, many systems must contend with allocating resources to customers or jobs whose initial service requirements or costs change when they wait too long. We present a new queueing model for this scenario and use a Markov decision process formulation to analyze assignment policies that minimize holding costs. We show that the classic $c\mu$ rule is generally not optimal when service or costs requirements can change. Even for a two-class customer model where a class 1 task becomes a class 2 task upon waiting, we show that additional orderings of the service rates is needed to ensure the optimality of simple priority rules. We then show that seemingly-intuitive switching curve structures are also not optimal in general. We study these scenarios and provide conditions under which they do hold. Lastly, we show that results from the two-class model do not extend to when there are $n \geq 3$ customer classes. More broadly, we find that simple priority rules are not optimal. We provide sufficient conditions under which a simple priority rule holds. In short, allowing service and/or cost requirements to change fundamentally changes the structure of the optimal policy for resource allocation in queueing systems.

Biography

Gabriel was born (and raised) in Mayagüez, Puerto Rico and received his BS (2008) in Mathematics from the University of South Florida. Gabriel is a President's Postdoctoral Fellow in the Center for Healthcare Engineering and Patient Safety at the University of Michigan. He graduated from Cornell with a PhD from the Center for Applied Mathematics under the mentorship and guidance of Dr. Mark E. Lewis. His research focuses on developing frameworks using queueing theory, Markov decision processes, simulation, and other Operations Research techniques, that can help identify effective and practical policies for resource allocation in healthcare settings. His recent research projects include "Emergency Medical Service Allocation in response to Large Scale Events" and "Optimal Control of an Emergency Room Triage and Treatment Process." He has been awarded the 2013 Zellman Warhaft Commitment to Diversity Graduate Student Award from Cornell's Diversity Program in Engineering; Cornell/Sloan Fellowship, 2011-2014; and National Defense Science and Engineering Graduate Fellowship, 2008-2011.