Industrial and Systems Engineering Seminar

A Market Discovery Algorithm to Estimate a General Class of Non-parametric Choice Models

Wednesday, November 20

3:15 PM – Refreshments before the Seminar

3:30 PM – Graduate Seminar

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We propose an approach for estimating customer preferences for a set of substitutable products using only sales transactions and product availability data. The underlying demand framework combines a general, non-parametric discrete choice model with a Bernoulli process of arrivals over time. The discrete choice model is defined by a discrete probability mass function (pmf) on a set of possible preference rankings of alternatives (including the no-purchase alternative), and is compatible with any random utility model. When faced with a choice set, a consumer is assumed to purchase the available option that ranks highest in her preference list – or not purchase at all if no product ranks higher than the no-purchase alternative.

The problem we address is how to jointly estimate the arrival rate and the pmf of the rank-based choice model under a maximum likelihood criterion. Since the potential number of customer types is factorial, we propose a "market discovery" algorithm that allows us to start with a parsimonious set of customer types and enlarge this initial set by progressively and automatically generating new types that provably increase the likelihood value. The approach is based on column generation ideas from mathematical programming and requires solving a sequence of mixed integer programs (MIPs) to identify new customer types to add. Once a new customer type is added, we re-estimate the pmf and repeat the procedure.

We address both the cases where demand is uncensored and censored, and illustrate the procedure with synthetic and industry data. Our numerical experiments confirm the potential of our proposal to rapidly identify a good set of customer types and produce corresponding maximum likelihood estimates.

This is joint work with Garrett van Ryzin, Graduate School of Business, Columbia University, New York.

Bio: Gustavo Vulcano is Associate Professor at the Leonard N. Stern School of Business, New York University. He obtained his B.S. (1994) and M.S. (1997) in Computer Science at the University of Buenos Aires, Argentina; and his Ph.D. (2003) in Decision, Risk and Operations from the Graduate School of Business, Columbia University. His main research interests include pricing and revenue management. He is currently working on consumer choice and strategic consumer behavior in revenue management settings. Gustavo is also Associate Editor for the INFORMS Management Science and Operations Research journals.