

NSF-IMA Industrial Mathematics Clinic

Prospectus of Projects

Business: C.H. Robinson

E-Commerce - Fresh Supply Chain (Perishable):

Business Sponsor - Gina Garven

Motivated by the recent trends in just in time delivery of fresh produce and meal enablement programs like Blue Apron, we propose the following two questions:

(i) How might the traditional retail stores evolve to be the fulfillment center for fresh e-commerce order delivery within 1-2 hours?

(ii) How to manage perishable inventory for meal enablement plans and how does the marketing of recipes affect the inventory policy.

Autonomous Trucks" The possible impact to USA for hire trucking:

Business Sponsor - Brent Schoenrock

In the very near future, we will see autonomous and semi-autonomous trucks for freight. Examples for initial roll out might include: truck only highways, platooning and intra-state rural highways. What is the impact on the smaller carrier community as Autonomous Trucks are employed? While at first glance, one may say that the large trucking companies will cannibalize the small carriers; there are several effects to consider that make the answer non-trivial. Two important effects that make the single owner-drivers better off are the ability to work for longer hours and market fragmentation.

Digital Freight Matching:

Business Sponsor - Kevin Abbott

The US Trucking industry is aggregated through transportation brokers (also known as 3PL's). The industry is currently testing and implementing automated matching of truckload carriers to freight offered by the shipping community. The more common approach to the employment of this new technology is in the transactional market where capacity and shipments are traded in real time. For this project, in particular we are interested in providing higher long-term value as compared to short-term transactional gains obtained from outside options. Using historical and real-time demand data the matching system can achieve a good balance of trucks across the transportation network. What is the design of a matching system that can (i) limit the risk of transport disruptions for shippers and (ii) ensure a high yield in a multi-leg weeklong rotation for carriers?

Business: Transdev

On-Demand, Dynamic, Shared Modes for Public Transit in New Orleans:

Business Sponsor – Carl Allen

Public transit agencies are struggling with decreasing funding streams from governments (transit systems generally receive 60-80% subsidy), rising costs, increasing service needs from federally mandated ADA/paratransit services, and increasing service quality and responsiveness expectations from customers. Technology has enabled new on-demand, dynamically routed modalities to become the new normal in private mobility (e.g. Uber, Lyft, and other TNCs), but public transit agencies need to figure out a way to introduce such modalities into their bus & rail transit networks in a way that:

1. Provides at a minimum a commensurate level of service (as measured by the extent that existing customer demand is met with equal average wait times, ride times, and walking time & distance),
2. Is LESS EXPENSIVE to operate than traditional transit bus service (using smaller and more fuel-efficient vehicles, routing efficiently, and only operating when there is demand),
3. Hopefully nonetheless provides BETTER service (measured as indicated above),
4. Hopefully can even EXPAND SERVICE areas and the times when service is available, and

Meeting the minimum requirements in #1 & #2 above, such a new modality should be able to REPLACE existing fixed route bus service in some areas in addition to being a more economical way for agencies to expand service by filling gaps in time and space and/or extending networks further afield. And if #3 & #4 above are satisfied, these new modalities should SUPPORT the rest of a fixed-route bus & rail transit system and generate more ridership, thereby helping transit agencies to meet their social goals of providing sustainable mobility for more people, reducing congestion, and reducing pollution.

The New Orleans Regional Transit Authority (NORTA) struggles with the issues described here and wants to be able to identify where fixed route bus service can be replaced and augmented using a new on-demand mode. It hopes to be able to save money, expand service in time & space, increase service levels, and improve the customer experience to gain new ridership to the NORTA system.

Business: General Mills

Out of Stock Prediction:

Business Sponsor – Aahnik Baruah

Retail shelves are out of stock (OOS) 8% of the year leading to revenue loss for General Mills and retailers. Several reasons cause OOS instances such as unexpected demand, poor sales forecast, service issues, etc. Furthermore, an item can be OOS on shelf but may be available in the store backroom. General Mills wants to find major drivers of the problem and predict shelf OOS instances .

Promotional Forecasting

Business Sponsor – Aahnik Baruah

General Mills wants to accurately predict product demand during promotions at retailers. The demand changes by region, time of promotion, retailer and several other factors. Currently, we use Nielsen volume data to forecast promotional demand. The objective of this project is to explore if a combination of retailer POS data and Nielsen attributes lead to more accurate forecasts.

Reserving Inventory at General Mills Customer Service Facilities

Business Sponsor – Christine England

General Mills wants to develop capabilities that enable us to reserve/match inventory to demand from customers. A Capable to Promise or Capable to Match system is difficult and expensive to implement within traditional ERP systems. The objective of the project is to develop a capability that provides results that closely match a CTP or CTM system without disrupting inventory flow.

Transportation Forecasting

Business Sponsor – Christine England

General Mills products are transported on 11,000 lanes from plants to our customer service facilities and finally to retailer distribution centers. We rely on carrier partners for transfer of goods. To keep costs low and ensure truck availability, we require a scalable, statistical model to predict truckloads on a daily/weekly basis on each lane enabling us to better plan truck requirements

Business: Microsoft

From Flight Plans to Flight Policies: Safe and Efficient Aircraft Routing under Uncertain Winds

Business Sponsor – Ashish Kapoor

The efficiency of air transport is sensitive to winds encountered over the course of a flight. Pilots typically travel at a constant recommended airspeed for their craft based on engines, altitude, and weight. Given a fixed airspeed, tail winds and headwinds increase and decrease the groundspeed of planes, respectively. Pilots, in collaboration with air traffic control, and in accordance with airline policies, establish and modify flight plans to avoid turbulence and to seek favorable winds. Typically, flight plans are filed at the outset of a flight and largely followed over the course of a trip. The wind forecasts are often coarse and quickly get outdated given the dynamic nature of the environment. Finding an optimal flight path under such unknown or partially observed wind field is a challenging and an important task in aviation. Deriving an optimal strategy is challenging as the pilot of an aircraft essentially faces a tradeoff between exploration and exploitation. In order to make inferences about the latent wind, the pilot needs to pick actions that can drive itself around the space to gather information. Such exploration can be beneficial as more accurate knowledge of the environment promises more accurate estimation of the cost of trajectories. However, such actions come at a cost, especially if these information foraging actions make the aircraft deviate from its mission. Thus, it is important for the pilot to make the right decisions about when/where to explore and when to exploit.

Business: eBay

Price-Demand Curve

Business Sponsor – Yoni Acriche

For eBay, a company that connects millions of buyers and sellers around the world daily, overcoming data structuring and information discovery challenges is crucial to building successful new products. As the company works on its transformation program to improve its platform for buyers and sellers, it is investing in predictive technology in order to build the world's most comprehensive product catalog and pricing guide.

This project will focus on identifying the probability of sale for each given item on the site. This model, referred to as 'Price-Demand Curve' (PDC), is key to eBay's pursuit for giving accurate pricing recommendations. This effort will help the company to enhance trust in the platform, and provide support for additional complimentary products.

In addition to improving the current baseline solution that will be presented during the workshop, we see a number of potential areas for further research:

1. Estimating the probability for sale for extreme cases which are not seen directly in historical data.
2. Using the probability for sale in order to create automatic price tunes.
3. Estimating the effect of price recommendations for retailers with large quantities.
4. Estimating the impact of price recommendations on the market as a whole.

Business: IBM

Staffing Marketplace

Business Sponsor – Anshul Sheopuri

Staffing talent with the right skills is a significant challenge in the US economy. Universities invest significant resources in outplacement services. Companies spend significant time finding the right people. An ecosystem that encourages different entities to participate is needed where all parties (students, universities, companies) have an incentive to participate, and the barriers to entry are low.

Business: Koopid

New Customer Service Models for the Digital World

Business Sponsor – Venky Krishnaswamy, Ajita John

Koopid is building a next generation, internet-scale contextual conversations service that seamlessly combines digital experiences with human engagement to enable enterprises to transact business with their customers and partners with unprecedented agility.

In such context, the following questions are important to Koopid: given an expected customer request rate and a number of servicing agents, what is the optimal routing policy that minimizes the overall service time and maximizes the utility of the agents. A second question that is of interest is that, given the types of service needs of customers and request rates for these types, what staffing decisions are optimal for an enterprise. Finally, how will routing and staffing decisions change as customers become more skilled and automated handling of services requests by bots become more effective.

Business: Mayo Clinic

Towards a New Healthcare Consumer Demand Theory

Business Sponsor – Kal Pasupathy, Bill Crown

Traditionally, health care delivery research is based on clinical and claims data, which are primarily driven by clinician behavior. Such research is typically performed in silo's or at the institutional level. The consumer/patient behavior is assumed, but typically not explicitly modeled (Crown 2016). For instance, studies use insurance co-payments and deductibles as a measure of consumer behavior while relative prices to other goods/services are ignored. Consumer income is not included in such modeling efforts. This is a lost opportunity to model and study consumer demand and utility theory by combining claims data with other socioeconomic data that is available. By combining patient-level data, patient behavior can be explicitly modeled and studied to inform treatment adherence, medication use, bundled payment and payment reform questions. OptumLabs provides a rich warehouse of insurance claims, electronic health records and consumer behavior data (Wallace, Shah et al. 2014). Specific methods to be explored include econometrics, machine learning, game theory, etc.

Business: Hourcar

One-Way Transportation

Business Sponsor – Paul Schroeder

In 2013, car2go (c2g) entered the Minneapolis market, expanding to St. Paul in 2014. After reducing service areas twice in 2015-16, c2g exited the Twin Cities market at the end of 2016. c2g continues to provide one-way service in a variety of other markets, but these have different density patterns than the Twin Cities. The question we want to answer is, “Is one-way carsharing a viable model here, or is it a model that cannot work given density and other factors?” One way carsharing involves short trips with less per-trip revenue. It is also labor-intensive: it requires two-person teams to move cars from “cold zones” to “hot zones.” And in addition to density issues, there are also political factors in play: one-way carsharing all but requires parking contracts with municipalities, and acquiring these contracts opens the contractor up to scrutiny, especially in terms of service area. It might be theoretically possible to define a profitable one-way service area, but if the municipalities require a much wider and less profitable area be served in return for the parking contract, the venture might be doomed at the outset. Another option is “one-way station-based” carsharing, which Zipcar is using in some other markets. In this scenario, members reserve a car parked at a hub and also select a destination, either the same station (for round trip) or a different, vacant station (for one-way). This removes the need to negotiate parking contracts with municipalities.

New Rate Plan:

Business Sponsor – Paul Schroeder

Hourcar’s current rate structure offers two main options for carsharing: the Voyager Plan, where members pay \$8.50 per hour and get the first 100 miles per day for free, and the Neighborhood Plan, where members pay \$6.75 per hour plus \$.35 per mile. Members of both plans also pay an annual membership fee of \$55. We are interested in exploring the feasibility of a new plan under which members would pay a much lower hourly rate plus a higher per-mile charge. They would also pay a higher annual fee. The big idea of the plan is that by lowering the rate users are paying while the car is idle, members will be incentivized to use the service for different tasks, such as going out to eat or to a movie. Parking the car for an hour or two would only cost about as much as a parking meter in this scenario. We would like to analyze the potential risks and benefits of this plan from a variety of angles. What would happen if only certain customer groups migrated to the new plan? What are the potential risks and rewards?

Business: Best Buy

Retail Analytics

Business Sponsor – Lisa Cotter