ORMS TOMORROW

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MINI POSTER COMPETITION
Winning Entries

STUDENT CHAPTER SPOTLIGHT
University of Massachusetts - Amherst

U.S. FOSTER CARE SYSTEM
Resource Allocation



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Letter from the Lead Editor

Dear OR/MS Community Members,

I am pleased to share with you the Fall/Winter 2022 edition of OR/MS Tomorrow!

This summer, our team welcomed several new members, who rapidly caught up and, together with the rest of the team, diligently worked during this fall to deliver this great issue! They are:

- Gulten Busra Karkili, as social media coordinator
- Madhulika Chilla and Gauri Vaidya, as staff writers
- Haokun Du, Farzin Ahmadi, and Vasilis Pavlopoulus, as editors

I also thank our departing member, Jessica Leung, for her outstanding service and contributions to our magazine, serving as lead editor since 2020. Jessica left a mark in our magazine and on all the team members that interacted with her. She led amazing issues and kicked off the mini-poster competition. She departed and left me some gigantic shoes to fill. We all wish you the best!

The following issue discusses a myriad of topics in different OR/MS and student-related interest areas . We start with the more traditional areas. First, we discuss how firms are being strategic (or not) about becoming cybersecurity resilient. We continue with a review of a last-mile delivery trend: crowd-shipping. Then, we switch gears toward non-traditional OR/MS applications. First, we examine how OR/MS ideas have indirectly influenced nature reserve design. Second, we discuss the resource allocation problem in the U.S. foster care system. Here, we move to a group of articles spotlighting students: a discussion about mental health in graduate school, a guide on INFORMS student chapters, and an interview with the INFORMS student chapter at the University of Massachusetts - Amherst. We conclude this issue by featuring our mini poster competition's results and winning entries in our last article.

Submissions for the Spring/Summer 2023 issue are welcomed. Contact us via email at orms_tomorrow@mail.informs.org!

I hope you enjoy this issue.

Sofia Perez-Guzman

OR/MS Tomorrow Editorial Team

This issue wouldn't have been possible without the effort of our editorial team members:

Editorial Staff Writers
Saeedeh Dehghani, Abigail Lindner, Mihir Mehta, Kimia Vahdat, Madhulika Chilla, Gauri Vaidya

Editorial Board Members
Abtin Ijadi Maghsoodi, Yassine Yaakoubi, Haokun Du, Farzin Ahmadi, Vasilis Pavlopoulus

Production Editor
Nandan Kumar Singh

Webmaster
Harsh Anand

Social Media Coordinators
Kara Combs, Gulten Busra Karkili

Faculty Advisor
Prof. David Czerwinski

After two years or so of pandemic and virtual gatherings, this October, our team had the great pleasure to meet during the 2022 INFORMS Annual Meeting. We organized a meet-up of current and previous members. Some of us had the opportunity to catch-up with old friends, while some others met in person for the first time. Sharing with you our excitement, see below some photos of our *OR/MS Tomorrow Member Meet-Up at the 2022 Annual INFORMS Meeting*.



From left to right: Prof. David Czerwinski, Kara Combs, Piyal Sarkar, Mihir Mehta, Jessica Leung, Haokun Du, Amira Hijazi, Sofia Perez-Guzman, Gulten Busra Karkili, and Farzin Ahmadi



Armagan Ozbilge and Kimia Vahdat



Are Firms Ready for Strategic Cybersecurity Resilience?



Nandan Kumar Singh
Indian Institute of Management
Visakhapatnam

Myth: *Resilience is mainly an operational consideration.* **Reality:** *Resilience is strategic.* — *Harvard Business Review* (6)

Modern supply chains are becoming more digitalized and reliant on real-time communication of numerous devices such as sensors, robotics, and drones (8). Thanks to the advancement of industry 4.0 technologies[1], the trend is only growing stronger. However, such advancement is not without pitfalls. Tang and Veelenturf (13) list cyberattacks, faulty data, safety regulations, and privacy issues as the primary risks associated with these technologies. Indeed, increased digitalization and reliance on cyber-devices expose firms to cyberattack risks. A premeditated attack on specific targets, such as the electricity grid, could create a domino effect that results in disruptions and financial losses beyond any firm's wild imaginations.

Global cybercrime was estimated to cost approximately 6 trillion US dollars in 2021[2], which is equivalent to a shocking number of 190,000 US dollars per second (12). According to Accenture's cybersecurity report (5), the average number of cyberattacks per company has increased by 31% since 2020. Luckily, companies are responding accordingly. Security investment is increasing, with IT security budgets reaching up to 15% of the total IT spending, which is five percent higher than reported in 2020. The expenditures are meant to mitigate the negative effect of disruption due to cyberattacks, aiming at one or more of the three dimensions of disruption, namely, (i) the probability of disruption, (ii) the financial impact of disruption, and (iii) the time required to uncover security breaches or attacks. To get a better understanding on how robust cybersecurity benefits the companies, one can first think of the opposite case: what if the companies have essentially zero defense against cyberattacks? To that end, the next section focuses on the three dimensions of disruption. It also suggests how investment in cybersecurity is not homogeneous or as simple as inputting more money and resources without strategic considerations.

[1] Industry 4.0 technologies include but are not limited to additive manufacturing (AM), drones, the internet of things (IoT), blockchain, advanced robotics, and artificial intelligence (AI). For interested readers, I refer to Olsen and Tomlin (7) for a more detailed review.

[2] The costs are associated with data damage and destruction, theft of intellectual property, theft of financial and personal data, restoration and deletion of hacked data and systems, and reputational harm.

Three dimensions of disruption

Potential disruptions are often categorized by two dimensions in traditional risk management literature: likelihood of occurrence (disruption probability) and magnitude of impact (consequences or financial impact). The high-probability, high-impact disruptive events (HH) (for example, oil companies suffer substantial losses every time a hurricane moves through the Gulf of Mexico) and low-probability, high-impact disruptive events (LH) (for example, 1986 Chernobyl meltdown and Hurricane Katrina in 2005) should be treated very differently by risk managers (10). Sheffi (9) introduces the third dimension *detection lead time* and emphasizes the importance of detecting disruption quickly.

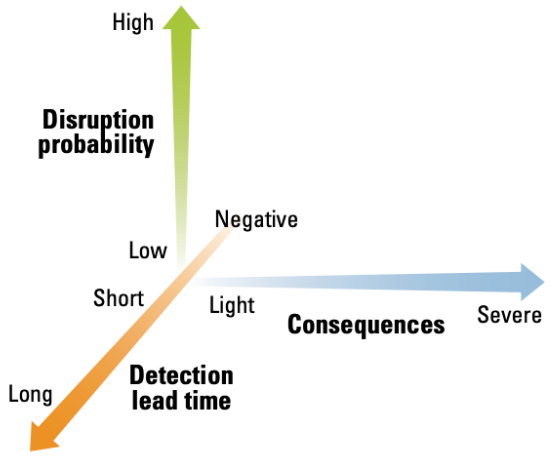


Figure 1: Three dimensions of disruption

Source: Sheffi (9)

The three dimensions of disruption are defined below:

1. **Disruption probability** denotes the likelihood of a particular disruption.
2. **Consequence** denotes the impact (or severity) of the disruption once it occurs.
3. **Detection lead time** is defined as the lead time between anticipating the occurrence of a disruptive event and the event's first impact on the company. It is the amount of warning time during which a company can prepare for the disruption and mitigate its (potential) effects.

The detection lead time plays a significant role in cyberattacks-related disruptions because the faster the firm identifies the attack and estimates the financial impact, the earlier they can execute on recovery. Detection lead times can either be *positive* (when the attack vector (virus/trojan/malware) is detected in advance of its impact on the firm's business), *zero* (when attack vector is detected at the moment it hits the firm business), or *negative* (if the attack vector is only recognized after the attack has taken place) (9). For example, Google recently blocked the world's largest DDoS attacks (3), demonstrating a case of positive detection lead time; whereas Stuxnet, a malicious computer worm discovered in 2010, is an example of negative detection lead time, for the virus was developed as early as 2005 (14).

The Cyber quadrant

Based on the three dimensions of disruption, one may imagine a company with great cyber defense system being able to lower disruption probability, minimize disruption consequences, and have longer detection lead time. However, is this what a company should always aim for? While the aforementioned company may be more immune to outside disruptions, extreme cyber defense system can itself be disruptive to a company's operations, as I will show later in this section.

A **cyber-resilient** organization integrates cybersecurity abilities, business continuity, and enterprise resilience. It incorporates security throughout the business ecosystem and employs flexible security strategies to respond quickly to threats, allowing it to minimize damage while continuing to operate under attack. As a result, the cyber-resilient organization may securely deploy innovative offerings and business models across the entire value chain, bolster customer trust, and confidently expand.

Accenture identifies four levels of cyber resilience (refer to figure 2) based on two dimensions - (i) *cybersecurity resilience* and (ii) *business strategy alignment*. A strong cybersecurity resilience entails the ability to stop a cyberattack (lower disruption probability), lessen the impact of an attack (consequence), and discover a breach earlier (detectability). A strong business strategy alignment prioritizes business objectives (e.g. shorter launch time, more market share, cost reduction, business growth, innovating products/services, and entering new markets) and aligns cybersecurity forces accordingly. (5) The four levels of cyber resilience are described below:

1. **Cyber Champions:** Cyber Champions thrive in protecting their assets and are the best at it. They have strong cybersecurity resilience and closely aligned business strategies.
2. **Business Blockers:** Business Blockers take a security-first approach and prioritize security over their business strategies.
3. **Cyber Risk Takers:** Cyber Risk Takers take a business-first approach and place less emphasis on cybersecurity strategy. They are more likely to reach or even exceed business objectives, but their business-centric behavior makes them susceptible to cyber risk.
4. **The Vulnerable:** The Vulnerables are the least concerned about cybersecurity and have weak cybersecurity resilience.



Figure 2: The Cyber Quadrant

Source: Kelly et al. (5)

Cyber-resilience performance criteria

Kelly et al. (5) introduce four cyber-resilience performance criteria. They are explained below:

1. **Better at stopping the attack.** This implies reduction in the disruption probability. The company should invest in mitigation measures to have positive detection lead time, so as to reduce the probability of successful attack. Cyber champions perform better than others; on average, out of six cyberattacks, only one breaches the security. (5)

2. **Finding breaches faster.** This indicates an increase in the detection lead time. Cyber champions can identify 55 percent of the breaches within a day, while the business blockers and cyber risk takers can respectively identify 50 and 30 percent of the breaches within a day. (5)

3. **Fixing breaches faster.** This means reducing the time to recover (TTR). Simchi-Levi et al. (11) define TTR as the time *"it would take for a particular node in the supply chain — a supplier facility, a distribution centre, or a transportation hub — to be restored to full functionality after a disruption"*. Similarly, TTR in cyber-resilience can be defined as the time the system/server will take to recover from the cyber-attack. Cyber champions fix 100 percent of the breaches within 15 days, whereas the vulnerables and cyber risk takers can only fix 30 percent of the breaches within a 15-day time frame. (5)

4. **Reducing the impact of breaches.** This requires a reduction in the severity of the cyberattacks' impact. Cyber champions have 72 percent of the breaches with no impact, whereas the business blockers and cyber risk takers have 64 and 23 percent, respectively. (5)

Path to strategic cyber-resilience

In this section, we focus on the strategic pathways for the vulnerables and cyber risk takers, who have weak cybersecurity resilience, to achieve strategic cyber-resilience based on their positions and needs.

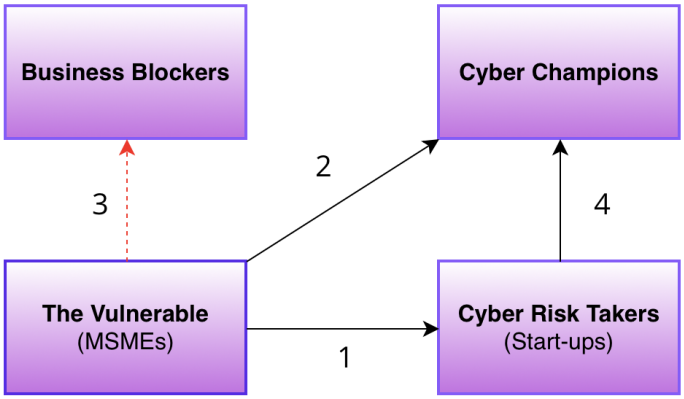


Figure 3: Strategic Pathways to Cyber-resilience

1. Most start-ups can be categorized as cyber risk takers because they adopt a business-first approach. Our interaction with the founders of the tech start-ups based on emerging technologies, such as AM, AI, and IoT, reveals that they are not much concerned about cybersecurity at the initial stage. They believe that the market is emerging and they will consider prioritizing cybersecurity only after the market becomes mature. However, even after the market matures and the firms are no longer a start-up, they keep overlooking cybersecurity in their operations. For example, on September 15, 2022, a cyberattack on Uber compromised many of Uber's internal systems. The New York Times (4) reported that the attacker almost got complete control over Uber, including Uber's source code, internal systems, and emails. It is not the first time Uber has been under cyberattack. In 2016, an attacker stole information of 57 million riders and drivers accounts, and Uber paid a ransom of 100,000 US dollars to delete the copy of the respective data (4). We may see an end to Uber's negligence on cybersecurity. After the September 15, 2022 attack, Uber started to hire for multiple cybersecurity positions (1). Organizations, such as Uber, can achieve better business outcomes and gain a competitive advantage in the race to cyber-resilience by aligning their cybersecurity efforts with their business strategy. The start-ups' business niche is highly competitive and has many hidden rivals. There is a great chance that one successful attack will damage the firm's reputation substantially and drive it out of the market. Hence, firms should seek to become cyber champions along with the market's maturity to avoid the aforementioned situation (follow path 4).

2. The innovative micro, small, and medium enterprises (MSMEs)[3] can be normally categorized to the vulnerables as they are neither cybersecurity resilient nor have great business strategy alignment. Such vulnerability is partially justified, as the attackers usually have less incentive to launch a cyberattack on these MSMEs. Consequently, they may be safe to remain vulnerable or should seek to become cyber risk takers (follow path 1) by considering cybersecurity while defining their business objective, rather than following path 3 to become business blockers. As have pointed out before, a great cybersecurity system may be disruptive to the company's business and is not always desired. As these MSMEs are striving to survive, a great emphasis on cybersecurity may hinge on their abilities to explore the potential markets. However, if they desire to become cyber champions and continue to thrive, the correct strategy should be putting relatively equal weight/priority on business alignment and cybersecurity resilience (follow path 2).

Acknowledgment

Many thanks to Ryan M. LaSalle *Senior Managing Director, Accenture Security* for responding to my queries on *"The state of cybersecurity resilience 2021"* report and providing input on *cyber-resilience*.

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[3] For more details on innovative MSMEs, please refer to ETRise (2).



Crowd-Shipping: A New Trend in Last Mile Deliveries



Saeedeh Dehghani Firoozabadi
Université du Québec à Montréal

When was the last time you wanted to send a parcel to another country? For me, it was a couple of months ago when I tried to send a birthday gift to my friend. Like always, I checked post office prices. They were crazy, and the delivery times were too long. Thoroughly disappointed, I googled for a cheap and fast miracle! I found some websites where you can find people traveling along the same route who can transport your parcel. Wow, that's amazing! There is always a traveler, which is much cheaper than post office prices. I do believe it should be greener. Overall, it was an excellent idea. Do we have it in other types of deliveries, like urban deliveries?

I continued reading about this and found similar websites for urban parcel deliveries and daily grocery shopping. Starting with Google Scholar, I discovered that, in literature, these kinds of deliveries are named "Crowd-Shipping." Crowd-shipping is a type of delivery where non-professional drivers or commuters are engaged in delivery activities. A crowd-shipping system can be based on non-professional drivers or a mixture of crowd and professional drivers.

Compared with standard delivery systems, crowd-shipping is a cheap, fast, and sustainable type of delivery. It is an innovative socio-economical last-mile delivery concept. Its association with sharing economies has made it very popular (1). However, each new system has its challenges.

In a crowd-shipping system, the drivers are not committed to doing their delivery tasks. So, the system might not seem reliable (1). Although different platforms try to deal with this, the unreliability rate is not negligible (2). Therefore, using professional drivers as a backup plan is needed to maximize responsiveness. In addition, the unreliability of occasional couriers (non-professional drivers) brings uncertainty. Operations re-

search tools help manage these systems. Optimization techniques, such as two-stage stochastic optimization, can significantly support decision-makers in dealing with challenges like uncertainty.

Some researchers have used two-stage stochastic optimization to solve different types of crowd-shipping problems. The work by Torres et al. (4) is an excellent example of this topic. Their work is one of the most comprehensive ones. They proposed a crowd shipping platform where a retailer sells products of various sizes from a central depot. Some of these products are time-sensitive, some require a delivery signature, and some might fail to do the delivery. They formulated the problem as a vehicle routing problem with a stochastic supply of crowded vehicles and time windows. They also developed a two-stage stochastic set-partitioning formulation. The first stage was to determine the customers that have been assigned the occasional couriers. The second stage reveals the rejected delivery tasks to determine the required professional drivers' routes.

The model then developed to dynamically assign routes to vehicles. They also calculated an upper bound for the maximum number of crowd vehicles that help predict courier drivers (CD) and propose a branch and price algorithm and column generation heuristic to rapidly provide feasible solutions for large instances of the problem. Their results showed that the obtained value of using the proposed model is 21% of the total delivery cost. Therefore, using crowd-shippers will result in significant cost reduction. Also, there is a trade-off between CD's compensation and engagement. However, they showed that low CD's compensation may result in up to 28% of cost reduction. They also showed that by considering CD's rational behavior, we could let them choose their route rather than assigning them. However, irrationality may lead to 4% cost increase.

Solving a crowd-shipping problem is complex. While the shipper wants to minimize his expenses, he also needs to increase the compensation of crowd drivers to increase their willingness to do delivery tasks and diminish uncertainty. Furthermore, customers look for a cheap, fast, and reliable system. Managing these three objectives in a dynamic environment is challenging and developing fast algorithms to solve real-world instances is necessary.

Finally, crowd-shipping is a new transportation concept requiring extensive quantitative work to plan and evaluate its viability in different scenarios. Using crowd vehicles entails various sources of uncertainty that affect distribution planning. For example, the transportation capacity that non-professional drivers can bring to the last-mile delivery system may vary daily. Moreover, the probability of a driver accepting or rejecting a route depends on the other delivery offers.

This article reviews the application of crowd shipping and provides an example of how stochastic programming helps solve these problems. Since very few studies have investigated the stochastic variants of crowd-shipping, there is much room for research. Most studies assume that the compensation amount (fixed or variable) is an input parameter of the problem (see for example (3). Hence, future studies can consider deciding on the optimal compensation level, which makes the problem of the domain of revenue management. Moreover, most studies consider compensation as a criterion for accepting or rejecting a route (see for example (1)). Exploring other criteria, such as deviation from the actual driver route, provides an area for future research.

While I am writing this article, my package has been delivered to my loved one and a courier driver is ringing the bell to deliver my groceries. All thanks to cheap and sustainable crowd-shipping services!

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Improving Nature Reserve Design



Abigail Lindner
Worcester Polytechnic Institute

In the Fall 2019 issue of OR/MS Tomorrow, then-editorial board member Zulqarnain Haider wrote an article on the potential for mathematical optimization to help preserve biodiversity. The term biodiversity, defined as the diversity of life on Earth, is central to maintaining the health of both human and non-human communities. However, a consensus view of how life's complexity supports the stability of planet health has remained elusive for decades (3). One central area Haider recognized as particularly relevant to the operations research (OR) optimization study is conservation planning (see Alagador and Cerdeira (1)). Identifying and protecting nature reserves are among the conservation planning tasks. This article considers a specific nature reserve design project in China to better understand where operations research could help conservation efforts.

The Importance of Nature Reserves

Technological advancements in the 19th and 20th centuries radically transformed economic and social landscapes. Counter to rises in GDP and human health, these advancements have had the unintended consequences of endangering the well-being of ecosystems and the species that depend on natural resources that human consumption and encroachment are rapidly depleting. In response, national governments have established protected areas, also known as conservation areas. As defined by the International Union for Conservation of Nature, a protected area is a "clearly defined geographical space that is recognized, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with its associated ecosystem services and cultural values." A nature reserve

is one such protected area. In demarcating land for nature reserves, we acknowledge humans' responsibility to protect the ecosystems that human pressures may threaten. The regions set apart as nature reserves often contain a rich level of biodiversity and shelter endangered species, and so play an important ecological role.

Organization of Nature Reserves

In 1971, UNESCO began the intergovernmental Man and the Biosphere (MAB) Programme for improving human-natural environment relationships (2; 4). The program responds in part to the common situation of development and conservation conflict, with advancements in the former reducing the efficiency of the latter as human communities push closer and closer to protected areas (2). A MAB Reserve has three semi-concentric zones: the core zone, the buffer zone, and the experimental zone (5; 6). The core zone serves conservation needs and excludes human activity; the experimental zone serves human economic and societal development needs; and the buffer zone softens the impacts of the experimental zone on the core zone (2; 4).

In the spirit of this program, the Chinese government has mandated reserve zoning since 1994. Zoning ordinances that reduce human activity in the experimental zone and keep intense human activity from creeping into the core zone could be effective in line conservation-development balancing act if implemented well. However, unfortunately, many nature reserve managers in China have observed shortcomings in their current conservation zoning (2; 4; 5; 6). Examples of inefficiencies or failures in existing nature reserves include zoning based on human settlement rather than functional suitability (2; 4) and weak enforcement of human activity restrictions in the non-experimental zones (2; 6). To ensure that nature reserves are fulfilling their conservation goals, managers must have a better understanding of the needs and distribution of the animals that the reserves are designed to protect, the needs and distribution of the human settlements in the outlying buffer and experimental zones, and whether the resources provided in each of these zones are sufficient. In these regards, tools from the field of operations research can help.

Improving Nature Reserve Zoning: Pheasants in Baihuashan

The Baihuashan National Nature Reserve (BNNR) lies on the southwestern side of Beijing. As the capital of China, Beijing is an unexpected location, perhaps, for a nature reserve. Still, the mountains bordering Beijing and the provinces to its west are some of the few places where the brown-eared pheasant, Crossoptilon mantchuricum, lives. (It would not be foolish to assume that this bird has brown feathers about its head, but it would be wrong.) Unfortunately, isolation, deforestation, and poaching have made the species vulnerable to endangerment; hence, the criticality of nature reserves that encompass the mountainous northern regions that the pheasant favors. In addition to the BNNR, seven other nature reserves exist in Shaanxi, Shanxi, and Hebei Provinces to protect the brown-eared pheasant.

The BNNR covers 214.4 square kilometers (about 82.7 square miles) of land, of which 31.44% constitutes the core zone, 22.45% comprises the buffer zone, and 46.11% constitutes the experimental zone. Its brown-eared pheasant population is small, totaling about 200 individuals, and the species' management system in Beijing is relatively new, having been established in 2008. Recently, Song et al. (4) set out to determine the distribution of the pheasant population within the BNNR and to identify any gaps in the reserves' functional zones. They wanted to determine whether the established core zone was optimally organized to conserve the brown-eared pheasant. To accomplish these goals, Song et al. (4) used line transect sampling to estimate the abundance of the species. They identified the environmental variables influencing whether a pheasant was happy living in a particular spot. Predictive models combined the observational population data and the experimental environment data to predict the presence of the brown-eared pheasant across the reserve. Based on these predictions, the researchers divided the BNNR into "presence" zones deemed suitable for a brown-eared pheasant's habitat and "absence" zones assumed unsuitable.

By comparing the predictions with reality, Song et al. (4) discovered that 50% of the habitats suitable for brown-eared pheasants were in the established core zone. Regarding the remaining 50% distributed between the buffer zone and the experimental zone - about 13% and 37%, respectively. As one can guess, it is certainly not optimal for the experimental zone, which has the highest human activity, to contain over one-third of the suitable habitat. As such, the next step was to propose a redrawing of the zones that would increase the percentage of suitable habitat that the core zone encompassed while also not too severely reducing the areas of the equally essential buffer and experimental zones. In modeling a new zoning plan, the researchers wanted to "[minimize] habitat fragmentation and [maximize] connectivity among suitable habitats." In the end, by taking into account the data and predictive modeling on the habitat requirements of the brown-eared pheasant, they did produce such a plan, rethinking zone boundaries so that over 85% of the suitable areas fell into the core zone.

The term "operations research" doesn't appear anywhere in the research paper. Nevertheless, the application of OR ideas is obvious. As technology is helping us collect better and more accessible data on the state of the planet, it is not unlikely that OR will be called upon to engage further with conservation problems like these (1).

Conclusion

Protected areas are critical for balancing the drive of human development with the responsibility to conserve the natural world and the species whose habitats are threatened. Satisfying both needs is challenging, but in the work of Song et al. (4) at the Baihuashan National Nature Reserve, we see the potential for operations research to help resolve this ecology-economy conflict and strengthen conservation efforts.

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The U.S. Foster Care System: A Resource Allocation Perspective



Abigail Lindner
Worcester Polytechnic Institute

Foster care can be defined as situations where children are placed by a competent authority for the purpose of alternative care in the domestic environment of a family other than the children's own family that has been selected, qualified, approved and supervised for providing such care (11)

In the United States, over 400,000 children reside in foster care at a time. Since its validation as a state-operated child welfare service over a century ago, the U.S. foster care system has evolved considerably as societal norms and political influences have changed and fields like developmental psychology have grown. Goals, however, have stayed the same.

One of the first goals is protection and care for children who, for whatever reasons, are unable to reside with their biological families. A second goal is eventual settlement of those children in permanent placements. For the latter, reunification with the biological family has been the top priority for a number of decades. Where reunification is not possible and kin are unable or unavailable to care for the child, adoption is oftentimes the next

recourse. In these cases, the child is said to have a *permanency plan of adoption*.

The fulfillment of these goals requires sufficient resources, proportionate distribution of those resources to children in foster care and their families, consistent communication between all stakeholders, and, where reunification fails and adoption has been deemed appropriate for the child, efficient matching between children who need families and families who want to adopt them. Legislation in the late twentieth century and early twenty-first century aimed at alleviating roadblocks to achieving these goals has helped to some extent - providing funding, pioneering programs, collecting national data to inform policy - but challenges remain. Many of the challenges come down to limited resources: social services, foster families, staff, time, etc.

In recent decades, operations research has come into play to meet these challenges. Such research includes assessment of housing subsidies on foster care placement and family stability (8), prediction of average lengths of stay based on analysis of dozens of cultural and socioeconomic factors (10), and evaluation of risk factors to guide casework decisions (2). Long accustomed to dealing with problems in business and transportation, operations research is primed with the tools to address two of the main problems in the foster care system - allocating finite resources and matching children who have permanency plans of adoption with the right families.

The foster care system in the United States is a complex and important institution. In the interest of assessing both problems with as much detail as they deserve, we will be dividing this discussion into two parts. In this issue (Fall/Winter 2022), we will cover the operations research involved in foster care resource allocation. In the next issue (Spring/Summer 2023), we will describe parent-child matching.

Resource Allocation

Each state has a responsibility to provide resources and services to children in their foster care systems, to the families who foster, and to the biological families to support the health and well-being of the child and, when possible, the reunification of the child to their original family. Between and within states, the number and type of resources and services varies. In addition to caregivers and social services staff, the finite resources needing to be allocated may include mental health services, substance use treatment, healthcare, special education classes, vocational training, and in-home parenting services (7).

A common hindrance in foster care is the paucity and expense of services. However, eliminating services is not an option, as they are crucial to stabilizing the children and families involved and shortening the amount of the time that children stay in out-of-home placements. With over 400,000 children in the system on any given day, though, efficiently and accurately identifying which children and/or families need which services is difficult.

Sounds like a problem for operations research, right?

To consider the problem of resource allocation in the U.S. foster care system, we will focus on two undergraduate projects written by students from my current academic institution. The first takes a national view and the second focuses on a single state.

The Children's Bureau within the U.S. Department of Health & Human Services has in place several systems to collect data on children involved in the child welfare system. Two of these are the National Child Abuse and Neglect Data System (NCANDS) and the Adoption and Foster Care Analysis and Reporting System (AFCARS).

- NCANDS collects data on all child maltreatment reports that received investigations or assessment responses in the 50 States, the District of Columbia, and Puerto Rico. State and regional agencies voluntarily submit NCANDS child file data, which includes "demographics of children and their perpetrators, types of maltreatment, investigation or assessment dispositions, risk factors, and services provided as a result of the investigation or assessment" (1).
- AFCARS is a federally-mandated system. It collects "case-level information on all children in foster care and those who have been adopted with title IV-E agency involvement" (4). Title IV-E is an amendment to the Social Security Act, a piece of twentieth century legislation that provided social welfare to Americans.

In U.S.-based studies on the child welfare system that use either or both of these datasets, it is important to bear in mind that they are notoriously coarse. For instance, regarding NCANDS, one study notes that the data does not indicate "whether a service is given multiple times to a family or a child. The only indication is whether a service has ever been received" (6).

A Nationwide Project

In the first study, Diefendorf et al. (2019) (6) used key child identifiers to combine NCANDS and AFCARS datasets from 2010 to 2015, resulting in a national sample of about 147,000 children who had been discharged from foster care and a survey of 60 data points. The goal was to create a model that predicted the number of days that a child would reside in foster care based on child and family demographic characteristics, child and family risk factors, and child- and family-level services received.

With approximately 1,700 features to use in the predictive

model, the researchers executed a two-phase approach, first eliminating the majority of insignificant factors using a Least Absolute Shrinkage and Selection Operator (LASSO) regression technique and then assessing the remaining factors via a linear regression model. Records from 2010-2014 were used for the LASSO and linear tests and records from 2015 were used for the predictive and optimization models.

In the end, the model included fifty-three predictors, each with a 0.005 significance level. An adjusted R-squared of 0.706 suggested that the model fit the data well, though it had a large margin of error - about 20%. The researchers estimated total time in care for each child using the predictive model, and from there developed an optimization model to minimize the total days spent in care based on service allocation.

The actual days spent in care for the entire sample was 6,411,901. Using the optimization model, they found that, in the worst-case scenario, a total of 6,327,684 days total might be spent in care, amounting to a savings of 84,217 days altogether or an average of 5.2 days per child. In the most likely scenario, a total of 5,913,547 days might be spent in care, amounting to a savings of 498,347 days altogether or an average of 31 days per child. In addition to the psychological benefit for children of spending less time in out-of-home placements, optimized service allocation would have financial benefits, with over 98 million dollars saved in the worst-case scenario and over 585 million dollars saved in the most likely scenario, based on an average of $70 per child per day in foster care.

Just the Texans Now

Building off Diefendorf et al. (2019) (6), Barrameda et al. (2020) (3) attempted to narrow implementation by focusing analysis on children under 2 from urban areas of Texas who were placed in foster care because of parental substance abuse and had reached permanent discharge. These specifications reduced their population size to 3,173 cases.

The researchers used linear regression to estimate the impacts of a variety of services, then used integer linear programming to optimize service allocation and develop an algebraic model. NCANDS and AFCARS were, again, the main sources of data. In addition, they incorporated environmental risk factors, including county-level crimes rates, unemployment rates, and other statistics found through the U.S. Census Bureau and the Bureau of Labor Statistics. Their predictive model eventually accounted for 157 factors.

The actual total time spent in care was 1,278,050 days; the model underestimated by about 0.3%, predicting 1,274,406 days. The researchers found that an optimized reallocation of services, with the constraint that all services available were allocated, could reduce total time in care by 44,794 days, or about 15.3 days per child. If the constraint to use all services were relaxed, the time savings came out to about 23.2 days per child.

Despite the potential for operations research to benefit the foster care system by optimizing service use and minimizing days spent in care, as demonstrated in these two undergraduate projects, to date little peer-reviewed research exists on this topic.[4] Nevertheless, we do have examples from other social service projects that demonstrate the application of operations research for similar problems, such as in humanitarian logistics (5; 12; 13).

Resource allocation within the foster care system is an important problem open to the input of skilled operations research practitioners who are eager to understand the field, explore the data, and develop models that child welfare professionals can easily implement into their day-to-day operations, learning from the work done in different contexts.

Conclusion & Upcoming Discussion

With almost half a million children to serve on any given day, child welfare professionals and caregivers in the U.S. foster care system have a lot to balance. Nationwide, it is a regular challenge to distribute resources and services within quantity constraints while also meeting the behavioral, emotional, mental, and physical needs of children, their biological families, and their foster families.

As reunification remains the primary goal of the child welfare system for many (or most) state administrators, the Office of the Assistant Secretary for Planning and Evaluation (9) optimized service allocation could be important in facilitating the return of children to their families by shortening the amount of time spent in care, as suggested in the student projects Diefendorf et al. (2019) (6) and Barrameda et al. (2020) (3).

Unlike resource allocation, parent-child matching has received a decent amount of attention from operations research professionals. When a social worker decides that a child would be best served by adoption rather than reunification, kinship placement, guardianship, or long-term foster care, an often-long process of matching the child to the right prospective adoptive family begins. The role of OR in parent-child matching algorithms will be the subject of the next article, which will appear in the Spring/-Summer 2023 edition of *OR/MS Tomorrow*.

[4] One NSF-funded research project, conducted by investigators at SUNY at Buffalo and incomplete as of writing, is focused on developing a service recommendation algorithm for the foster care system. See further details on the NSF award page.

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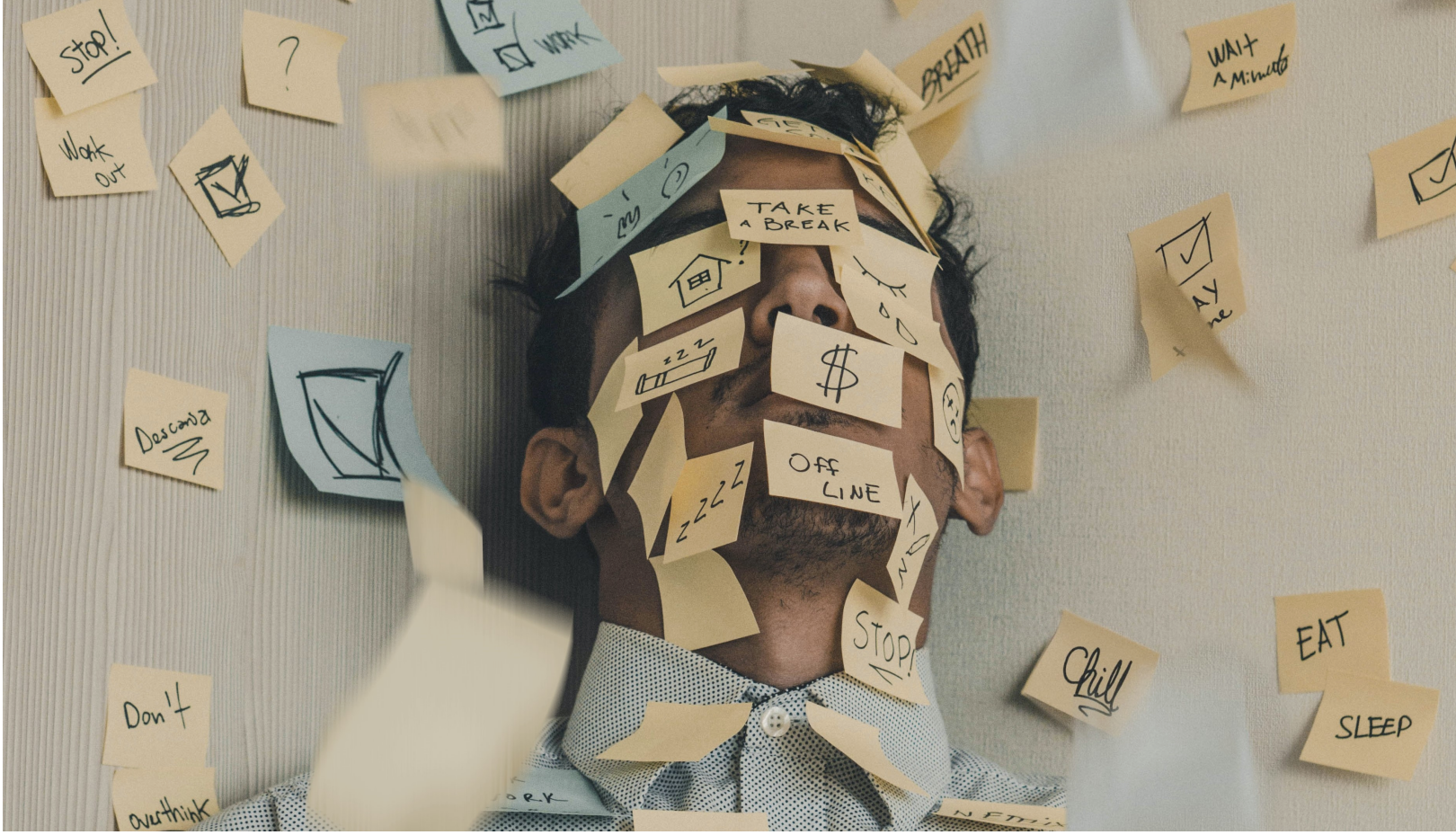
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What Nobody Likes to Discuss, But We Are All Starting to Care About: Mental Health in Graduate School



Sofia Perez-Guzman
Rensselaer Polytechnic Institute



Kimia Vahdat
North Carolina State University



Vasilis Pavlopoulos
Washington State University

Mental health issues of university-affiliated people have gained attention only fairly recently. The reasoning behind this neglect is possibly a belief held by many: that academic work is less stressful than industry life. While it is hard to argue which one is more stressful due to the problem's subjective nature, we argue that it is indeed vital to emphasize graduate students' challenges related to mental health-related problems. It will be self-explanatory once the relevant evidence is shown in the later sections of this article.

Mental health includes our emotional, psychological, and social well-being. It also relates to how we feel, think, perceive things, and, eventually, act. Within graduate school, anxiety and depression are always the obstacles that one needs to overcome, be it the subject is networking, acquiring information, creating academic profiles, assembling CVs and resumes, or even just broader issues of striking a work-life balance or handling learning and research pressures. As current or former graduate students, we know it too well, either from discussions with peers or reflections on our own experiences.

Despite being a serious matter, mental health in the academic spectrum is a problem that has only recently received people's attention. According to Evans et al. (6), there is an increased discussion of the topic. Yet, there is still a long way to go. Although it may be impossible to eliminate all mental health-related problems of all graduate students, it is still possible to provide helpful plans or tools to graduate students, staff, and faculty to effectively navigate the mental health battles that arise in academic environments. To achieve that, it is critical to find the roots of the problem and understand what is going on currently.

Factors associated with mental health problems in graduate students

Based on Reddy et al. (17), the stress factors that historically affect graduate students are (1) marital stress, (2) exam anxiety, (3) work (current/future) stress, and (4) peer competition. Regardless of the source(s) of stress, its influence on our health system is identical. Common psychological results from stress include anxiety, depression, behavioral problems (i.e., negative evaluation of the future), irritability, psychosis for success, and trauma (fear of failure). It goes without saying that stress is commonly associated with mental health issues in graduate students and that there are many matters that one could feel stressed about in graduate school.

Other factors associated with mental health issues in graduate school include: (1) not having work-life balance (as reported by nearly 40% of the respondents in Woolston (21)); (2) working excessive amounts of time, e.g., according to Woolston (21), 76% worked more than 40 hours and around half agreed that their institution had a long-hour culture; (3) lack of sleep, e.g., 28% of the respondents reported losing sleep over worriness (13); (4) toxic work environments, e.g., 21% of the surveyed students in Else (5) experienced harassment or discrimination; (5) imposter syndrome, the never-ending self-doubt of one's abilities despite the actual evidence that demonstrates the person's achievements (16), e.g., respondents in North America from Woolston (21) were more likely to struggle with imposter syndrome than those in other regions of the world; (6) job and financial insecurity (13), e.g., it was listed as one of the two top sources of emotional strain in Woolston (21), where the respondents did not feel well prepared for a satisfying career after their Ph.D.

Symptoms from mental health problems that affect graduate students

Although several degrees of severity are at play, graduate students' most common mental health issues are depression, anxiety, stress, burnout, and emotional exhaustion. A 2015 report from the Graduate Assembly of the University of California at Berkeley showed that between 42% and 48% of 790 surveyed graduate students in STEM suffered from depression (2). Another 2015 study from the Graduate and Professional Student Council of the University of Arizona surveyed 157 doctoral students and found that half of them suffered from increased stress (19). Published in 2017, Levecque et al. (13) sampled over 3,500 Ph.D. students in Belgium and found that "32% of Ph.D. students are at risk of having or developing a common psychiatric disorder, especially depression," and that it is a significantly higher probability than for the general population. The authors also found that high job demands substantially increase such risk. A 2019 survey sampled over 6,300 early-career researchers around the world and found that 36% of them had "sought help for anxiety or depression caused by their Ph.D. studies" (21). According to Li (14), "graduate students are six times more likely to experience depression and anxiety than the general population". From the surveys mentioned earlier, mental health problems (and, of course, the symptoms they cause) are undoubtedly common among graduate students; however, we need more systematic review and more thorough research to draw attention from the general public and policymakers. More crucially, the surveys leave room to question how many more graduate students suffered from mental health issues but did not seek help. Failure to acknowledge mental health problems' prevalence could result in students' unwillingness to seek help and further exacerbate their problems.

Diversity and mental health problems

Socio-demographic differences also play a role in the Ph.D. students' mental health (9). Levecque et al. (13) found that the odds of experiencing at least two psychological symptoms were 34% higher for female Ph.D. students than for males and that the odds of having at least four symptoms were 27% higher. Furthermore, several studies (12; 4; 3) reported that LGBTQ+ college students face more mental health challenges than their non-LGBTQ+ peers, including, but not limited to, stress, anxiety, burnout, and depression. According to Gewin (9), minorities and marginalized groups (including international students) can suffer from increased academic burnout. Forbes-Mewett and Sawyer (7) interviewed professionals working with international students in Australia and found that international students struggle with "adjusting to unfamiliar academic practices; developing skills to manage everyday life in a different cultural context; and both recognizing and seeking professional help for mental health problems". Although some of the previous studies and results are not directly related to graduate students, it is reasonable to infer that minority graduate students may encounter very similar mental health challenges as undergraduate students or junior faculty do. In short, mental health issues have unbalanced effects on different demographic groups, and minorities are more prone to be targeted.

Mental health in the COVID-19 era

Mental health issues were certainly aggravated during the Covid-pandemic, as one would expect. Research aimed to test the effects of the pandemic on university students found that there was a unanimous increase in scores for anxiety (42.5%), depression (74.3%), suicidal intention (93.5%), and loss of value in life (67.5%) (11). In line with this research, we find a stream of papers in the literature that supports that the Covid-pandemic strengthens the factors that affect students' mental health. According to Zhai and Du (22), suspending in-person classes and the "evacuation" (a term coined to describe the phenomenon where the universities were closed and students returned to their "home" countries) led many students to lose their jobs. The uncertainty for their future in a changing world prevented students from managing academic routines regularly.

How does it look for OR/MS students?

Overall, there is significant data, research, and findings regarding the mental health of higher-education students. A great focus of these is on undergraduates, with some emphasis on graduate students. The bulk of the studies is not discipline-specific. This is partially justified, as Levecque et al. (13) did not find significant differences among disciplines in the risk of having or developing mental health problems. However, for those who are not convinced that disciplines are irrelevant regarding mental health problems, we refer the readers to Arnold et al. (1); Wilkins-Yel et al. (20); Limas et al. (15), where they concern STEM graduate students. To the best of the authors' knowledge, we do not find research reporting results specifically for OR/MS graduate students. It may be challenging to achieve since OR/MS is broad and spans multiple disciplines. Interestingly enough, OR/MS students have excellent tools (e.g., big data analytics and machine learning algorithms) to study this further. Encouraging this, public data sets such as http://go.nature.com/2nqjndw could be a great starting point.

What should and can be done?

Spreading awareness about mental health and relevant resources among graduate students is the essential first step toward addressing the issue of widespread mental health problems in graduate schools. There are often free counseling sessions offered by universities that many miss due to a lack of resources (8).

We list some suggestions to overcome anxiety and/or depression below; you may already be using some of these tools without realizing it.

1. Take time off work and allow your mind to relax every few months. You may have discovered thus far that your mind works faster and more efficiently when well-rested. So, don't underestimate the value of a long weekend vacation!

2. Find a support group and talk to them. People often assume that there is something wrong with them when facing struggles. However, when we share our problems with peers, good chances are that we find out that everyone is struggling with the same issues. Studies have shown that 50% of the Ph.D. students in Belgium have experienced some form of psychological distress (10). Talking with peers brings out a sense of community. It shifts the focus from "What is wrong with me?" to "Everyone struggles. I am not alone."

3. Always compare yourself with yourself. It is easy to compare your situation (e.g., where you are in your research and how your courses are going) with your colleagues. Resist that temptation! Remind yourself of where you started, focus on your own achievements, and write down three things you have achieved and are proud of since you began your graduate degree.

4. Commit to regular physical activities. Research has shown that exercises reduce the symptoms of anxiety and depression and improve self-esteem (18). If you are interested in group fitness, bringing your peers together for a group activity is best so you can vent and exercise!

Graduate school entails the most mentally challenging and overwhelming task and activity we have ever done in our lives: our dissertation research. And on top of that, the billion other things we must do during graduate school to keep up to speed: become experts in technical skills, improve our soft skills, network and communicate our work, serve our academic communities, meet our teaching/research responsibilities, and the list continues. It actually seems surprising that not all graduate students struggle with mental health, given all the pressure. But graduate school does not need to kill us in the process. We can thrive in graduate life with the right tools, mechanisms, and support systems. Graduate students must seek help while the institutions and their staff provide the plans to help us succeed. The question is: are we all ready to commit to this?

Finally, we note that the mental health issues of graduate students (and even staff and junior faculties, for that matter) are not only the responsibility of the university. In general, they have direct and indirect consequences on the overall welfare of our society, given that the former and current graduate students engage with the society in all walks of life. Policymakers can and should play a significant role in introducing intervention

strategies for graduate students. Forming graduate students associations and properly funding them to hold group activities for the students is one example. Also, making sure students have financial support from the graduate school, which can in turn reduce the mental burden, is another possible intervention. Lastly, screening students quarterly for their mental health, especially diagnosing early symptoms of depression and anxiety, can empower the academia to step-in as necessary. Such interventions can only happen when the issue has attracted enough attention; hopefully it will not be too little, too late.

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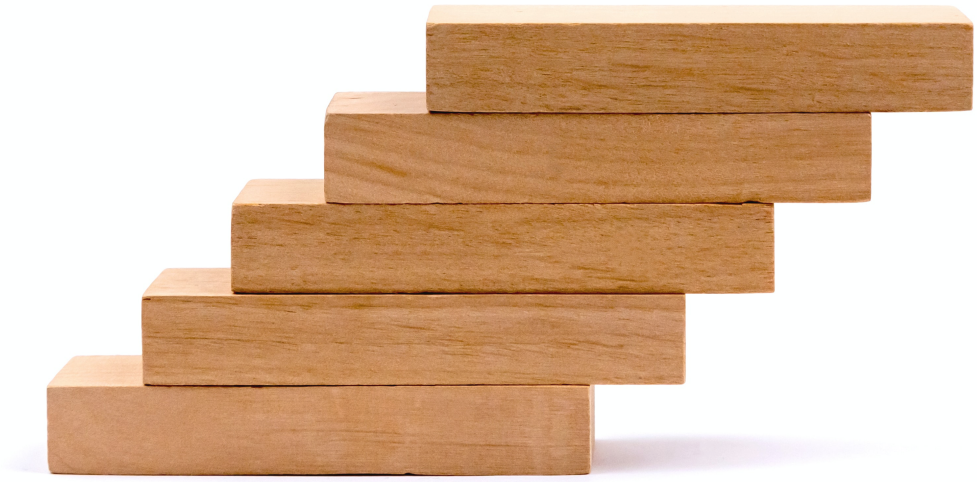
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A Comprehensive Guide on INFORMS Student Chapters



Gulten Busra Karkili
University of Massachusetts Amherst



Farzin Ahmadi
Johns Hopkins University

If you are a graduate student interested in Operations Research, you likely are either an active member of an INFORMS Student Chapter or familiar with their activities. But if you have only heard the name of these student organizations and want to learn more about their activities, the following guide is just the right piece for you to read. We gathered a summary of the keynotes by reading the sources provided by INFORMS. We added real-life examples by heeding the voices of some active Chapter members who are achieving extraordinary things.

Let's start on the right foot: What is an INFORMS Student Chapter? According to the INFORMS website, Student chapters are essential components of any large national (and increasingly, international) associations like INFORMS. Student chapters make it possible to keep a close, regular association with other students in your department or university. These student organizations are suitable formations for students interested in operations research and management science to come together. By joining an INFORMS Student Chapter (from now on will be referred to as a "Chapter"), a student can have great opportunities to meet other students with similar research interests, faculty members, researchers, and OR/MS practitioners from the industry. These interactions are made possible mainly due to the events organized by Chapter members where they can invite such personalities to give talks at their universities or field trips where they can observe a practice in person.

Like other student organizations, Chapters also function thanks to a well-decided division of labor between different positions. Each Chapter must have a Faculty Advisor as the official representative, who must be an INFORMS member and a faculty member at the Chapter's host institution. Faculty Advisors work as an efficient connection between the INFORMS office and the Chapter. Each Chapter has a President (or Chair) and Vice President (Vice Chair). They are responsible for the management and communication among members, administration and planning of the meetings and events, and the conversations between the Faculty Advisor and the members. Treasurer and Secretary are other vital positions that may also be combined into one title, and functions such as Webmaster, Planning Committee, and Newsletter Editor can be included based on the unique needs of each Chapter. All members, especially the Presidents, can use the latest INFORMS Officer Guide as a checklist while deciding the positions and learning the requirements.

It is always a good idea to seek out your institution's Chapter. If your institution does not currently have an active chapter, start the process of establishing or revitalizing a student chapter for your institution. The first step in starting a new chapter is to complete the online student chapter application. Once the new chapter application has been verified and approved by the INFORMS Membership and Communities Department, your up-

coming Chapter will need a faculty advisor who is a member of INFORMS and recognized to provide secure intellectual leadership, a slate of officers, a petition signed by ten or more interested INFORMS members in good standing and a set of Chapter Bylaws adopted by the interested members to be approved by the Chapters/Fora Committee. After gathering these documents, they can be submitted to the INFORMS Membership and Communities Department. After that and some possible extra communication, through a course of several weeks, the Chapters/Fora Committee, which is the body that oversees INFORMS chapters, will review and vote electronically on new petitions over a period of several weeks. Finally, the Subdivisions Council will review and vote on the petition. The entire process may take about 10-12 weeks after the point of submission of documents.

Provided that the Subdivisions Council and the Board of Directors have not deactivated the Chapter, revitalizing a chapter is a reasonably straightforward process organizationally. After submitting the same application form, the Membership and Communities Department verifies and approves the application. You can document a faculty advisor who is a member of INFORMS, a reactivation petition signed by ten or more interested INFORMS members in good standing, and a slate of officers. Then, the package can be submitted to the INFORMS Membership and Communities Department for review. This process may take 2-3 weeks.

INFORMS student chapters enjoy a variety of leadership resources. The INFORMS Speakers Program allows Student Chapters and Regional Chapters to have the financial support to invite external speakers for technical talks in operations research. As long as they are well planned, well reported, and within a reasonable budget, time, and resource constraints (which are what OR/MS students are great at!), the sky is the limit for chapter events. Chapters are very suitable for students to get creative, take responsibility, and work in harmony with other members of their institutions. In addition to the speakers' program, chapters can enjoy the benefits of the INFORMS mentor match, which is a benefit just for members and helps members find and connect with others. Existing INFORMS student chapters have creatively conducted various events for their communities, including panel talks, webinars, workshops, and many other activities.

Each year, active student chapters turn in an INFORMS Annual Student Chapter Activity Report by May 31st. In this report, students document Communications (Social Media, Website, etc.), Special Events and Initiatives, Community Service, and Operations (Elections, Meetings, etc.). A Student Chapter Awards Committee will evaluate eligible reports submitted by the deadline. Submissions are rated based on overall impact and reach. The student chapters in the top four categories will be awarded at the Annual Meeting by the following classification: Summa Cum Laude - highest class, Magna Cum Laude - 2nd highest class, Cum Laude - 3rd highest class, and Honorable Mentions. This year, the University of South Florida Student Chapter, University of Michigan Student Chapter, University at Buffalo Student Chapter, Galileo University Student Chapter, and Northeastern University Student Chapter formed the Summa Cum Laude class of student chapters owing to their dedication to chapter excellence. INFORMS encourages students to be engaged with their community by forming, revitalizing, and participating in their institution's chapters. Students have shown to be more than capable of holding recurrent and consistent events that can engage the OR/MS community and benefit them. We hope this summarized guide can motivate you to enjoy the benefits of being a member of an office to an INFORMS student chapter.





Spotlight Interview with the University of Massachusetts - Amherst INFORMS Student Chapter



Harsh Anand
The University of Virginia



Gulten Busra Karkili
University of Massachusetts Amherst

It was an honor for ORMS Tomorrow to interview the leadership of the UMass Amherst INFORMS Student Chapter. As part of our quest to gain a deeper understanding of the goals and motivations of the Chapter, past accomplishments, and future directions, we interviewed three key individuals:



Professor Anna Nagurney
Faculty Advisor



Paola Pimentel Furlanetto
Chapter President



Ogechi Vivian Nwadiaru
Chapter Secretary

Can you tell us about the UMass INFORMS Student Chapter?

Prof. Nagurney: UMass Amherst INFORMS Student Chapter was founded in 2004. At that time, we had a wonderful cohort of Ph.D. students in Management Science at the Isenberg School including my Ph.D. student, Tina Wakolbinger. She had come from Austria, and I had met her when she was a student in my classes at SOWI – the University of Innsbruck, Austria, where I held a Distinguished Fulbright in 2002. Together, we got the Chapter started and approved by INFORMS, and Tina became the first President of the UMass Amherst INFORMS Student Chapter. From the very beginning, the goal was to be very inclusive and promote Operations Research and the Management Sciences across campus and beyond through our Speaker Series and activities while building a welcoming community. The Chapter's members over the years have come from the Isenberg School of Management and the College of Engineering as well as from other parts of the campus. Over the years, many friendships have been formed, as well as a few marriages! The networks continue to provide support even as our students become alumni and as they pursue their professional careers. This includes academic careers or as practitioners in different fields, from high tech and consulting to healthcare, as examples.

What are the goals of this Chapter, and what motivates the members most?

Prof. Nagurney: Students come, study, learn, complete their research and degrees, and graduate. The success of a student chapter depends on continuity and the "passing of the baton." Interests may change as well as responsibilities and the level of dedication. Still, I would say that love for the discipline of Operations Research and the Management Sciences and its great applications is the tie that binds us across the colleges and schools that make up the University of Massachusetts Amherst. The primary goal of the UMass Amherst INFORMS Student Chapter is stated brightly on its homepage: "to encourage interest in the field of operations research and the management sciences and to provide a means of communication between people having an interest in the management sciences and operations research." I do think that the chapter, since 2004, has excelled in this dimension.

Paola: Goals are to spread awareness about OR/MS and create a venue for collaboration. I am particularly committed to "building bridges", always seeking to attract people to INFORMS Chapter and help them succeed. This can be achieved through excellence in their research, speaking, listening to talks, learning to network, and in their social and personal lives by fostering a relaxed environment to forge friendships and decompress from academic pressure.

Ogechi: The Chapter's goal is to advance its members' professional goals in an environment that fosters collaboration and creativity. Through the chapter, members are prepared to take on roles in academia and industry to solve challenges at the frontier of the discipline. In addition, we can network and connect with senior professionals in the field and become aware of pressing industry challenges. One thing that keeps the chapter motivated is the people and their shared passion for OR/MS. This could be manifested through optimization board game nights, our regular speaker series or practice events that allow us to sharpen our academic knives for the Annual INFORMS meeting.

How are the previous Chapter members doing in their academic careers, and how did the Chapter contribute to that?

Prof. Nagurney: Many of the former members, especially the Ph.D. students from the Isenberg School, have assumed academic positions not only in the US but also in Canada, Europe, and even Australia. What I find incredibly inspiring is that many continue to receive professional accolades in the form of research and teaching awards and are making excellent progress in moving up the ranks in academia to even Full Professor! For example, Tina Wakolbinger, whom I had mentioned earlier, achieved the rank of Full Professor at the Vienna University of Economics and Business in Austria only three years after her Ph.D. She is the Deputy Head of the Institute for Transport and Logistics Management and the Head of the Research Institute for Supply Chain Management there.

Our chapter alums have attained academic appointments at numerous universities and colleges, including Carnegie Mellon University, the University of Connecticut, the University of Nebraska, York University, the University of Sydney, IESEG School of Management Paris, WPI, the SUNY system, the Penn State system, Virginia Tech, Babson College, Bentley University, Old Dominion University, Texas A&M Commerce, the University of San Francisco, Adelphi University, Pace University, the University of Richmond, among others. Some of our chapter alums began their academic careers as postdocs at McGill University, Northwestern University, and Mass General – Harvard Med.

An excellent positive feature of the Chapter has been the hosting of speakers. We have made use of the outstanding INFORMS Speaker Series Program. Students get to meet luminaries in our profession and enjoy lunch with the speaker in groups. We have fond memories of hosting: Radhika Kulkarni, Cynthia Barnhart, John Birge, Sheldon Jacobson, Ellis Johnson, Dimitris Bertsimas, Les Servi, Dick Larson, Arnie Barnett, Brenda Dietrich, Mary Helander, Dietrich Braess, Michael Johnson, Jack Levis (virtually), Tinglong Dai (virtually), to name just a few.

Through networking with such outstanding INFORMS role models, students learn a great deal, and several students have even used the contacts made to obtain letters for promotion and tenure! They get to see them at INFORMS conferences, which is also very special.

Paola: They are doing so well that it can be intimidating! Just to name a few past officers that are star scholars: Dr. Deniz Besik, Dr. Destenie Nock (a Minority Issues Forum Paper Competition finalist at the 2022 INFORMS Annual Meeting!), Dr. Charalampos Sipetas, and Dr. Katerina Deliali. I had the pleasure and luck to overlap with most of them, but I met Destenie later at the 2021 INFORMS Annual Meeting through recommendations from our mutual Ph.D. advisor, Dr. Erin Baker. Their sharpness, commitment, and humbleness are astonishing. They encourage and make you feel like you belong to this research community.

Ogechi: Graduated members currently boast of illustrious careers, taking up positions as tenure-track associate professors immediately upon graduation at well-renowned universities, where they continue to mentor current members. The Chapter's Faculty Advisor mentors members of the Chapter and ensures we can interact with a curated list of industry professionals through the speaker series. I believe this has helped with both exposure and inspiration. Furthermore, chapter members often take classes together in the early stages of their graduate program, which helps forge strong bonds and camaraderie. Hence, growth opportunities are easily shared in a collaborative spirit.

Is there anything this Chapter does differently, pushing the boundaries of traditional Chapter events and tasks? How did the members come up with those ideas?

Prof. Nagurney: I believe that one of our greatest strengths is that we seek out thought leaders to come and share their experiences and findings with us. For example, we have hosted Tom Vanderbilt, the author of the best-selling book "Traffic," who drove up from NYC to make it just in time to speak at the Isenberg School at 11 AM, and news TV crews were waiting. I was waiting with bated breath, but he showed up with just minutes to spare. We were also the first from North America to invite Dietrich Braess of Braess Paradox (and other accomplishments) fame. He published his famous article in 1968. He gave an amazing talk and stayed with us for a few days. Interestingly, Braess, Wakolbinger, and I translated the Braess (1968) article from German to English. The translation was published in the INFORMS journal Transportation Science, along with an accompanying preface article by David Boyce and me on the fascinating history behind the paradox. (As an aside, Tom Vanderbilt interviewed me about the Braess Paradox, and credit is given in his book.)

Paola: Our Speaker Series is outstanding, and we owe a gratitude to Dr. Anna Nagurney and the Isenberg School of Business. The research caliber and broad network of Dr. Nagurney allow us to connect with top researchers. Specifically, in the context of covid and remote speakers, we implemented "Watch Parties" where healthy students (negative-tested or asymptomatic) would meet and share lunch over the seminar.

Ogechi: As long as I have been a part of the Chapter, we have evolved from hosting "tune-up events" where members can practice communication skills in preparation for the Annual INFORMS Meeting to hosting game nights using games that can be interpreted as OR/MS games. We have also leveraged social media tools to showcase chapter events and activities.

What are the expectations of the members for the future of this Chapter?

Prof. Nagurney: I will do my best to support the expectations of future members.

Paola: Continually improve and professionalize our processes. The Chapter is relied upon for self-motivated service and friendship between office boards. A lot of the knowledge is transmitted by one-to-one interactions with past officers. We want to take training, recruiting, and operations to an enterprise level in order to facilitate board transitions as well as further train our members for the job market.

Ogechi: We want to attract more members from underrepresented backgrounds and advocate for equity. In addition, we would like to ensure that our most critical assets – our people – are prioritized. We hope to continue supporting our members in advancing their professional goals.

What are the key activities that the Chapter conducts throughout the year?

Prof. Nagurney: Speakers have been a mainstay of the student chapter along with various social events and professional panels on the job market, careers in academia and industry, etc. Annually, we have an INFORMS Conference Tune-up at which the students who will be presenting at the yearly conference get to practice their presentations and field questions from the audience. This is always a terrific event and enjoyable for everyone since we learn about the great research being done in OR/MS on different parts of campus. Field trips have also been very successful, whether to ISO (Independent System Operator) New England or to orchards to pick fruit. Volunteer activities in the form of helping out with food distribution at the Amherst Survival Center or collecting supplies and funds for victims of dis-

asters have been meaningful and impactful activities. Students seize opportunities as they arise and try to make a positive difference.

Paola: Seminars via Speaker Series, game nights, outreach events, practice sessions for the INFORMS Annual Meeting, field trips, and end-of-the-semester networking party. Some of these got disrupted due to Covid-19, but we are working on returning to the pre-pandemic activity levels. We are also planning to introduce informal coffee hours so our members can practice pitch, recruiting, and networking throughout the UMass Amherst campus.

Ogechi: We also host seasonal events such as a spring hike or cookout and conduct community outreach by organizing high school outreach events and recruiting new members with university tabling events.

How do you recruit new members and the leadership board? What key personality traits do you see in students when recruiting?

Prof. Nagurney: I do not engage in recruiting students for the leadership board. This is a student chapter that I have had the honor and privilege of serving as the Faculty Advisor of since 2004 – for an amazing 18 years. In fact, I had an outstanding offer from another university around that time and almost left UMass Amherst. However, I decided to stay (UMass counteroffered) and felt that there was a void. This led, in part, to the motivation for starting the chapter with having speakers come to campus being an important component.

Serving on the leadership board of the student chapter helps in the development of students' leadership and organizational skills, as well as communication and time management skills. Plus, such service is appreciated very much by colleges and organizations when a student is on the job market (and often is something discussed during interviews many students have told me). Not everyone is suited for a chapter leadership post. The best leaders I have found are excellent communicators; are very responsible and also are wonderful at building community and esprit de corps. OR skills in logistics are also very useful in planning for and in setting up various events and social activities. Of course, dedication and focus are very important alongside with being empathetic, kind and well-mannered.

Paola: Personal connection with current offers and referrals from professors play a big role. We would love to reach a membership level that we would need to run electoral campaigns (something to aim for as we ramp recruiting!). At the moment, most grads that show interest can be recommended for an officer position.

Ogechi: We recruit new members through university tabling events, communicating with all departments with shared interests, and sharing our events with other departments and programs. Our priority is to recruit students interested in engaging with colleagues and collaborating.

Has the Chapter returned to normal since the pandemic? What is making this transition difficult?

Prof. Nagurney: Last year, our speaker series were virtual, as were several of the activities (but not all). With more individuals with boosters and with greater knowledge surrounding the transmission of the coronavirus, I expect that there will be more face-to-face activities. At UMass Amherst, we have returned to face-to-face teaching. Hosting speakers virtually did allow for audience participation from many corners of the planet, and some activities, for various reasons, will likely be virtual.

Paola: We are getting there. The issue is a lot of the knowledge got lost as many pre-pandemic officers and more active members graduated (as mentioned in Question 5). Processes and documentation are helping us do more.

Ogechi: I would say we are still in a transition period. It is exciting to have activities in-person. However, it will take some time to return to the new normal. We had to adapt our activities to an online format during the pandemic. Now, many people are struggling with readjusting to being in a room where we are not just jumping from one Zoom room to the other. For ease of participation, we may retain an online or hybrid format for upcoming events.

Could you highlight some of the achievements of the Chapter in recent years?

Prof. Nagurney: I do believe that the UMass Amherst INFORMS Student Chapter is one of such chapters that has been in operation the longest. We have been recognized with an annual award from INFORMS ever since INFORMS started giving out such awards in 2007. I am especially delighted that several of the Chapter Officers over the years have been recognized with the Judith B. Liebman Award, and I was honored to receive the Moving Spirit Award from INFORMS in my role as Faculty Advisor.

I think that sustaining the Chapter over such a period of time speaks to its strength in community building through its various activities. For example, pre-pandemic, our end-of-the-semester parties with international cuisine were not to be missed, with many faculty and some students even bringing their children.

We would always bring Ukrainian foods such as varenyky (called pierogies by some) and kovbasa (kielbasy), as well as pastries. We had a special event marking the Chapter's 10th anniversary with alums even preparing touching videos of remembrances.

Paola: Keeping strong throughout the pandemic, we were among the prized Chapters in 2020 and 2021!

Ogechi: We are recognized annually by INFORMS for our activities and student engagement through the Annual Student Chapter Awards. Also, our Chapter alum, Dr. Destenie Nock, currently an assistant professor at Carnegie Mellon University, received an honorable mention for the Minority Issues Forum (MIF) Early Career Award at the INFORMS Annual Meeting this year, in addition to being a finalist for the paper competition.

Is there anything else you would like to share with us that has not been covered by the previous questions?

Prof. Nagurney: Starting and maintaining a student chapter does take energy and effort and certainly some financial support, so one may have to be entrepreneurial, but the rewards and memories are definitely worth it. It is heartwarming to see so many former members of the UMass Amherst Student Chapter who every year come to INFORMS Student Chapter Award ceremonies at the annual INFORMS meeting to support present members!

Paola: I want to add my statement as President about UMass INFORMS:

UMass INFORMS Student Chapter brings together students working on Operations Research & Analytics from across the UMass Amherst campus. This means creating a venue for collaboration, support, and friendship among the College of Engineering, the College of Information and Computer Science, and the Isenberg School of Management. Such schools are geographically apart; however, they often have overlapping interests. UMass INFORMS is here to bridge the distance, creating seminars and events that are of interest to multiple colleges. As president, I work with faculty, staff, and students to make sure our Chapter is fulfilling its goals. I bring my experience in engineering R&D and project management to support and motivate our members. Together we learn and, most importantly, make meaningful life-long connections.

Ogechi: I am grateful for the Chapter. I arrived during the pandemic, and being an active member of the Chapter has helped me personally and professionally.



Figure 4: UMass-Amherst Student Chapter Gathering at the 2022 Annual INFORMS Meeting. From left to right: Dr. Laura Albert, Christian G. Hernández-Negrón, Paola Pimentel Furlanetto, Vivian Ogechi Nwadiaru, Dr. Anna Nagurney, and Gulten Busra Karkili



OR/MS Tomorrow Mini Poster Competition 2022

Congratulations to the winners!

Following the 2020 and 2021 successes, the OR/MS Tomorrow mini poster competition came back this fall. This competition, supported by the Seth Bonder Foundation, seeks to nurture student researchers in developing the skills to summarize and articulate their research ideas effectively and efficiently. This year, the submissions competed at the graduate level. We received several high-quality submissions, including machine learning and optimization techniques applied in health care, sustainability, food security, and more. Thank you all for your excellent work and for submitting it to our competition.

The competition was open to all students, including current INFORMS members and non-members. Candidates were required to design one letter-sized page to communicate their research topic to the broader audience in the OR/MS community. A group of judges chose the winners based on the novelty of the topic, maturity of the content, quality of the information, engagement, and aesthetics. In addition to cash prizes, the winning posters are published in this OR/MS Tomorrow Fall/Winter 2022 issue. All winners will receive an electronic certificate celebrating their achievements. Non-INFORMS members winners will receive a free one-year INFORMS student membership. Last, all participants will receive feedback from the judges to support the student's future work and communication skills.

Winning entries:

First: "The Impact of Considering Equity in Optimization for Urban Planning"
Drew Horton, University of Colorado Denver

Second: "Content Promotion for Online Content Platforms with the Diffusion Effect"
Yunduan Lin, University of California Berkeley

Honorable Mention: "The Blockchain Newsvendor: Value of Freshness Transparency and Smart Contracts"
Chenghuai Li, Duke University

First place: **Drew Horton** - Author's acknowledgment: Emily Speakman, Daphne Skipper, Tom Logan

The Impact of Considering Equity in Optimization for Urban Planning

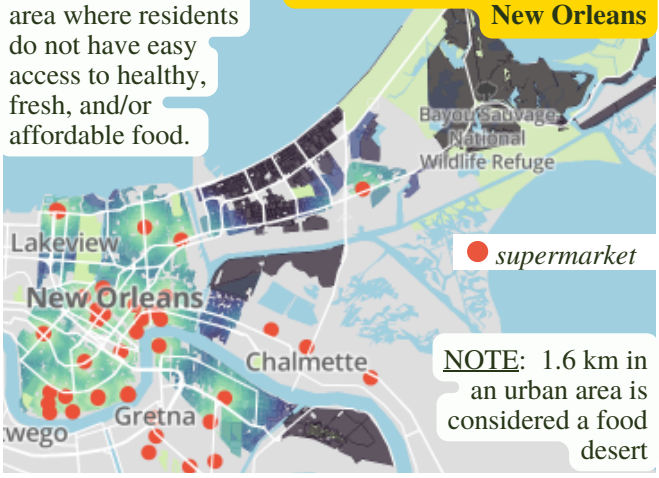
If we want to increase the number of a given amenity in a city, where should they be placed to maximize population access?

Well known "facility location model" can be used to find new locations for amenities that minimize the population weighted mean distance.

Problem: Intervention strategies, such as minimizing population weighted distance to grocery stores, further ignore the communities traveling the furthest as outliers in the solution.

Food Desert: An area where residents do not have easy access to healthy, fresh, and/or affordable food.

Case Study: Supermarkets in New Orleans



To address food deserts, and existing inequities, we propose an approach that not only minimizes population weighted distance, but also takes into account inequality.

We look to Environmental Justice literature [1] [2] to find a different objective function.

Kolm-Pollak Equally Distributed Equivalent (EDE)

$$\Xi = -\frac{1}{\kappa} \ln \left[\frac{1}{|R|} \sum_{r \in R} e^{-\kappa z_r} \right]$$

- Incorporates both the center and the spread of the distribution of the individual experiences
- Captures the experience of an "average" individual more accurately than the population mean

Downfall: nonlinearity of the Kolm-Pollak EDE makes optimizing over it non trivial.

Theorem 1 [3]: Linear Proxy of the Kolm-Pollak EDE

$$\sum_{r \in R} \sum_{s \in S} y_{r,s} p_r e^{-\kappa d_{r,s}} \quad \text{(LP)}$$

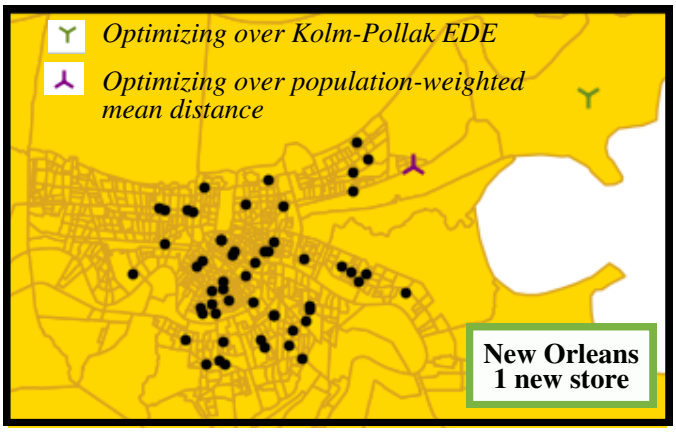
Optimizing (LP) in a Facility Location Model gives the same solution as optimizing the Kolm-Pollak EDE.

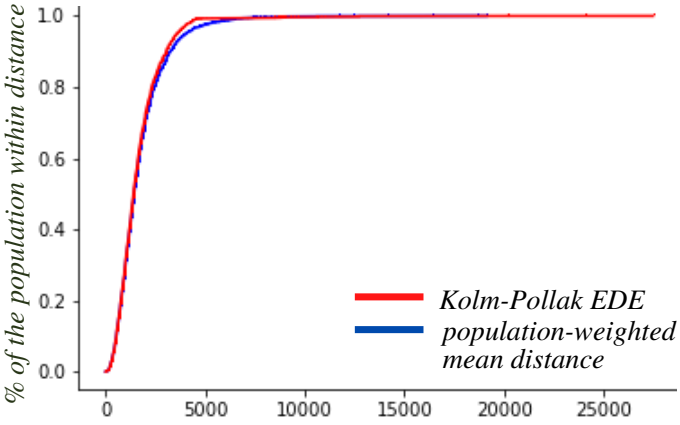
(LP) is linear, therefore the computational burden is no more than the existing traditional approaches

Computational Results

We have results for supermarket access in the largest 500 cities in the United States.

Question 1: *If you can open additional amenities, where should they go to best improve equitable access?*





Distance Traveled in meters to nearest supermarket

- Mean distance does not increase much when optimizing over Kolm-Pollak EDE
- Maximum distance any area must travel to a supermarket is significantly reduced with Kolm-Pollak Formulation

Question 2*: If you want to provide a given level of equitable access, what is the minimum number of additional amenities that you need? (and where should you place them?)*

Questions 1 and 2 are equivalent in terms of the mathematical formulations, however, from a policy making standpoint the answer to question 2 is a stronger result.

Example: We calculate the **mean level of equitable access** of the 500 largest U.S. cities, 2.6 km. New Orleans is currently ranked 493. However, we found that to achieve the mean access, they only need to add **one new store.**

Conclusion: Optimize over the Kolm-Pollak EDE in a facility location whenever equity is a factor.

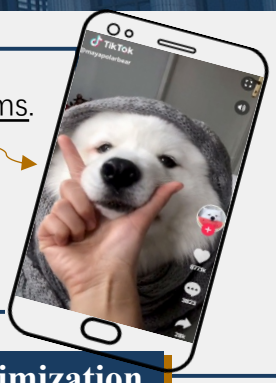
References: https://sites.google.com/view/miniposter-references/

Second place: **Yunduan Lin** - Author's acknowledgment: Mengxin Wang; Max Shen; Heng Zhang; Renyu Zhang

Content Promotion for Online Content Platforms with the Diffusion Effect

1. Introduction

Content promotion policy plays a prominent role in online content platforms.
We study the **diffusion-based promotion strategy.** Such as TikTok



Content clicks come from
- Direct platform promotion
- Diffusion effect from other users (usually ignored in previous literature)

2. Diffusion Model

Our model is adapted from **Bass Diffusion Model**

p : promotional coef.
q: diffusion coef.
m: market share

Promotion prob. # of cumulative adopters

$$a_t = p(m - A_{t-1})x_t + \frac{q}{m}A_{t-1}(m - A_{t-1})$$

New Innovators: Adopters targeted by promotion

New Imitators: Adopters not targeted by promotion

3. Promotion Optimization

Objective: Maximize the total adoptions.
Two-stage Decision
(1) Candidate set V + (2) Promotion prob. $\boldsymbol{x}$

(1)
$$\max_{V\subseteq\mathcal{V}:|V|\le K}$$

(2) embed diffusion
$$\max_{\mathbf{0}\le\boldsymbol{x}\le\mathbf{1}} \sum_{v\in V} A_{v,L}(x_v)$$
$$\text{s.t.} \sum_{v\in V} x_v = 1$$

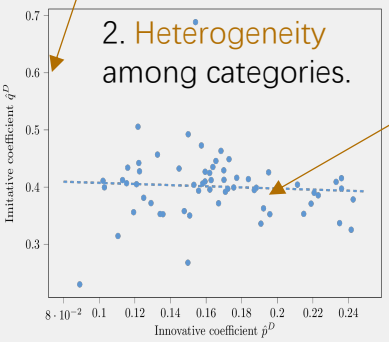
Submodular: adaptive greedy algorithm

4. Experiment Results from a Large-scale Video Sharing Platform

Dataset: one of the largest video-sharing platforms in China.
46,444 short videos; **518,646** users; **20** days (7/1/2020-7/20/2020).

Diffusion power of online videos

1. Significantly stronger innovative effect than the consumer products.



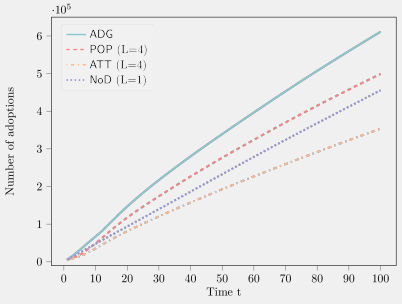
3. Slight negative correlation between p and q.

Non-triviality of the promotion problem

Distribution of estimated parameters p and q

Performance of Adaptive Greedy Algorithm

Common benchmarks in industry:
Candidate by popularity (POP) **+22.48%**
Candidate by attractiveness (ATT) **+72.86%**
Promotion without diffusion (NoD) **+34.14%**



Algorithm performance compared with benchmarks