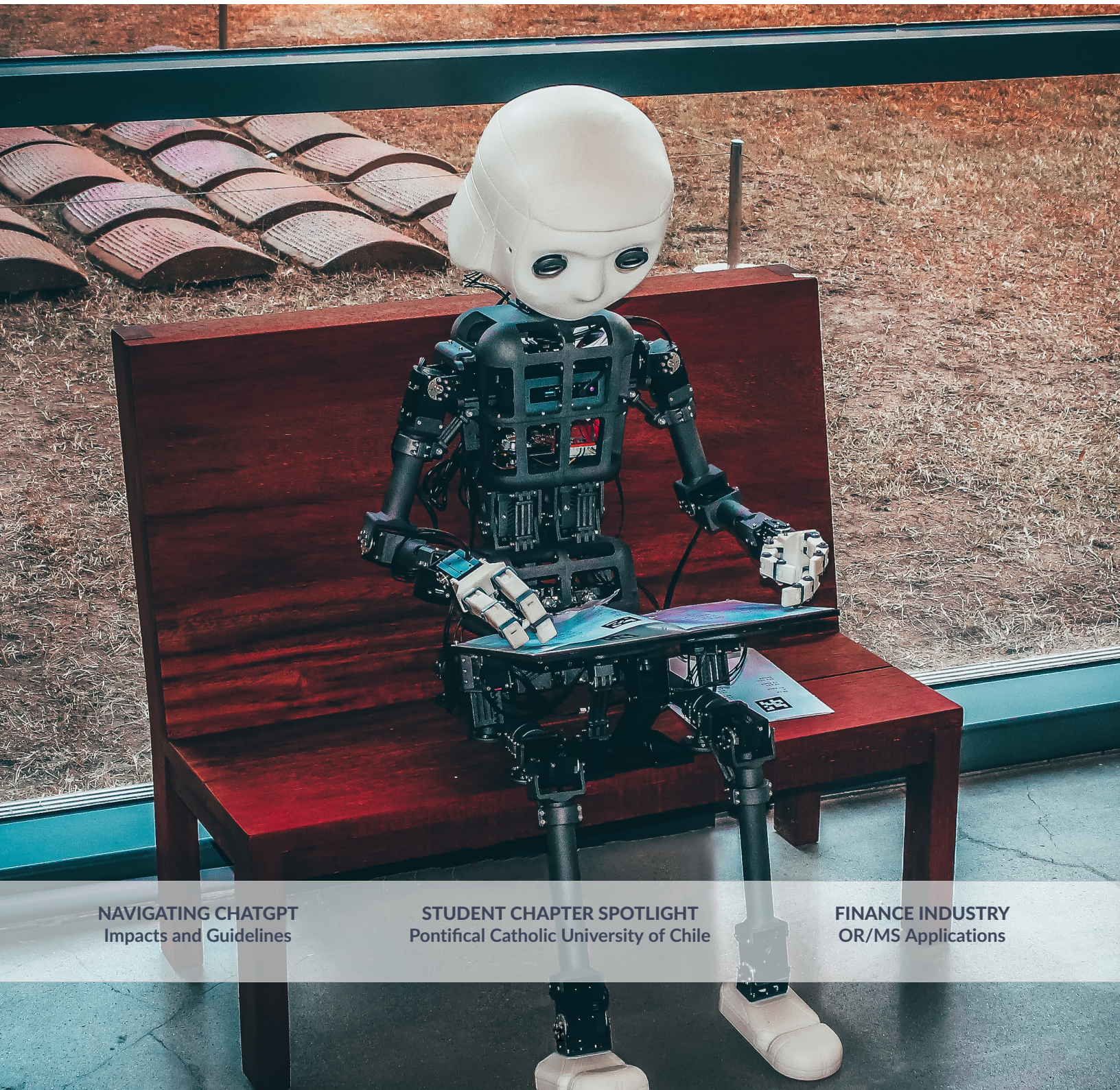
ORMS TOMORROW

informs | SPRING / SUMMER 2023



NAVIGATING CHATGPT
Impacts and Guidelines

STUDENT CHAPTER SPOTLIGHT
Pontifical Catholic University of Chile

FINANCE INDUSTRY
OR/MS Applications



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Letter from the Lead Editors

Dear OR/MS Community Members,

We are pleased to share the Spring/Summer 2023 edition of OR/MS Tomorrow!

In early spring, our team welcomed several new members, who rapidly caught up and, together with the rest of the team, diligently worked during this semester to deliver this fantastic issue! They are:

- Yiwen Wang, as webmaster
- Valentina Castañeda-Torres and Xiaoyu Ma, as production editors
- Paula A. Penagos-Rodriguez and Zihan Zhang, as social media coordinators
- Soham Agarwal and Alexander Scarcelli, as staff writers
- Sen Li and Amir Moadab, as editors

Our team also had some mixing around, and some of our previous members are moving to different roles:

- Nandan Kumar Singh, from production editor to staff writer
- Harsh Anand, from webmaster to editor
- Kara Combs, from social media coordinator to co-lead editor

Last but not least, we thank our departing members for their great service and contributions to our magazine: Abtin Ijadi Maghsoodi, Mihir Mehta, and Kimia Vahdat. We missed you during the production of this issue, but we wish you all a bright future!

In this issue, we (re)started a few new initiatives. We start our issue by bringing back to life our acclaimed and very-much-missed crossword puzzle! Make sure you read our articles, complete the puzzle, and submit your responses for a chance to win cash prizes! We continue with the official kick-off announcement of the 2023 Mini Poster competition!! Make sure you start preparing your mini poster and be ready to submit it in October.

Our articles discuss a myriad of topics in different areas. We continue our mental health series with a book review of "Managing your Mental Health during your PhD" by Zoe J. Ayres and an article about procrastination, filled with tips on surviving your last semester. Last issue, we started an industry series, which we continue in this issue by discussing OR/MS applications in the finance industry, predictive analytics in the healthcare industry, and the implementation of data analytics for demand and supply management. Then, we move to the second part of the U.S. foster care system series: the parent-child matching problem.

Following that, we, of course, had to talk about ChatGPT and its use in research and teaching environments. For this, we interviewed Professor Tinglong Dai from Johns Hopkins Carey Business School and Professor Matthieu Gruson from the University of Quebec in Montreal. In this issue, we also took a trip to South America to spotlight the award-winning INFORMS Student Chapter at the Pontifical Catholic University of Chile. We approach the end of our issue with the debut write-up of our new "Where are our alumni?" series showcasing our departed member, Dr. Yue Wang, incoming assistant professor at the University of Arizona

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

Did you know about our website? Check it out at www.informs.org/Publications/OR-MS-Tomorrow! You can check this issue's individual articles, browse all our previous issues, and meet our editorial staff.

Stay tuned with all of our updates, events, and more by following us on our socials. Find us on Facebook, Twitter, and LinkedIn!

We hope you enjoy this issue.

Sofia Perez-Guzman and Kara Combs

OR/MS Tomorrow Spring/Summer 2023 Editorial Team

This issue wouldn't have been possible without the effort of our Spring/Summer 2023 editorial team members:

Editorial Staff Writers
Saeedeh Dehghani, Abigail Lindner, Nandan Kumar Singh, Madhulika Chilla, Gauri Vaidya, Soham Agarwal, Alexander Scarcelli

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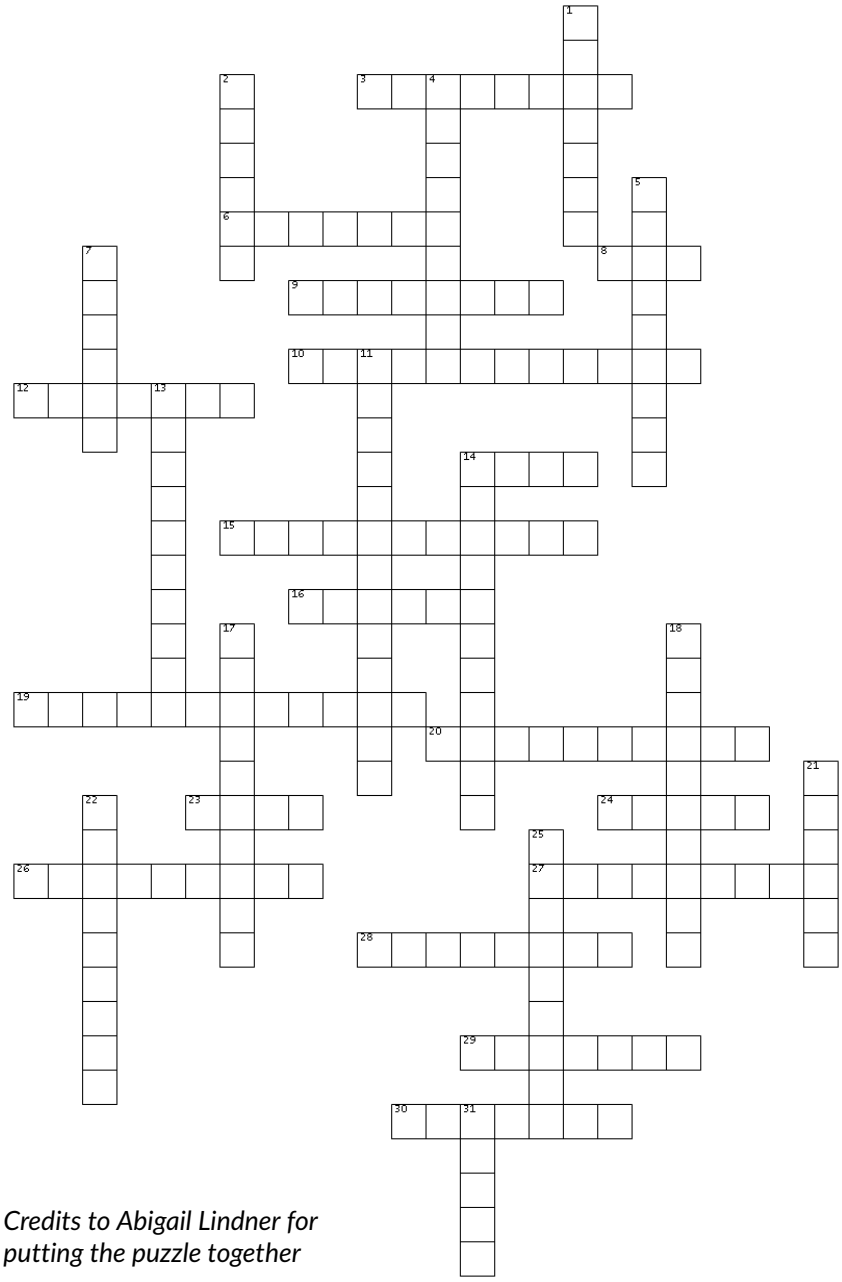
Co-lead Editors
Sofia Perez-Guzman, Kara Combs

Faculty Advisor
Prof. David Czerwinski

OR/MS Tomorrow 2023 Crossword Puzzle

Instructions: Fill out the puzzle below according to the clues provided. Use all the articles in this issue (hint: check the letter from the lead editors!) to find the answers. Submit your solution to orms_tomorrow@mail.informs.org by **Sep. 15th, 2023**.

Prizes: All the correct entries will enter a draw. We will select **four (4) winners**, who will receive a **$75 cash prize**, **recognition** in our social media, and will be **spotlighted** in the following Fall/Winter issue.



Credits to Abigail Lindner for putting the puzzle together

ACROSS

3. Assets with guaranteed future returns are called _____
6. Lack of motivation, energy, and increased stress are symptoms of this
8. Acronym for a Pennsylvania service for hard-to-place children
9. A course outline
10. A parent-child matching algorithm could be caseworker-driven or _____
12. MATTERS One section of the book Managing Your Mental Health During Your PhD (2 words)
14. Faculty advisor of an INFORMS student chapter in Chile
15. The Q world of mathematical finance wants to _____ the present
16. The P world of mathematical finance wants to model the _____
19. The type of algorithmic design approach needed in child welfare
20. A collection of data points over time (2 words)
23. _____ demand is a component in the standard formula for calculating inventory
24. Characteristics of realistic goals can be remembered with this acronym
26. Economist who introduced Modern Portfolio Theory
27. One of the reasons PhD students procrastinate is _____ overload
28. A studying technique based on 25-minute intervals
29. University where A2 will be an assistant professor
30. A new and controversial AI chatbot

DOWN

1. Our former social media coordinator (2 words)
2. A powerful optimization solver
4. A theoretically powerful, convex risk measure: expected _____
5. "The need is there. The _____ is now."
7. Demand _____ is a main S&OP process step
11. Profit margins have traditional been meager in this industry
13. A run of an experimental model
14. A possible root cause of the 2008 Recession in the United States was overreliance on _____ (3 words)
17. Academic process for which more and better AI detection tools are needed (2 words)
18. Process to determine the accuracy of a simulation model
21. Minimum font size for mini poster
22. A linear combination of assets
25. An INFORMS student chapter goal
31. A type of forecasting model



OR/MS Tomorrow Mini Poster Competition 2023

Share your research idea with the world... on one page!

It is that time of the year… the OR/MS Tomorrow mini poster competition is back! Submit your poster now!

About it: The competition seeks to nurture student researchers in developing the skills to summarize and articulate their research ideas effectively and efficiently. Thanks to the generous support from the Seth Bonder Foundation, OR/MS Tomorrow is running the 2023 mini poster competition for a fourth year!

Eligibility: The competition is open to all students, including current INFORMS members and non-members. Candidates are required to design one letter-sized page to communicate their research topic to the broader audience in the OR/MS community. We accept submissions in three groups: undergraduate, master's, and Ph.D. students.

Criteria: Winners will be chosen from each group based on the novelty of the topic, maturity of the content, quality of the information, engagement, and aesthetics.

Prizes:

- The first-place winner in each group will receive $200 USD, and their poster will be featured in the Fall/Winter 2023 issue of OR/MS Tomorrow.
- The second-place winner in each group will receive $100 USD.
- Honorable mention in each group will receive $50 USD.
- Non-INFORMS member winners will also receive a free one-year INFORMS student membership.
- For undergraduate students entering the competition as a team, the cash prize will be divided among all team members.
- All winners receive an electronic certificate celebrating their achievements.

Submission Deadline: **ET 11:59 pm October 29th, 2023.**

Submission requirements:

- The mini poster must be original.
- The poster must be submitted as a PDF file with a **MINIMUM** font size of 12 pt. Posters with smaller font sizes will have a score penalization.
- Portrait orientation is preferred.
- The author must be a student at the time of submission and provide a letter from their advisor or a certificate of current enrollment to indicate their enrollment as an undergraduate, master's, or Ph.D. student.
- Undergraduate students can submit individually or as a team of at most five (5) students. Still, the submission must go under the name of only one author. The remaining students' names can be added at the end of the submission form.
- Master's and Ph.D. students must submit only single-author posters. Collaborators or advisors can be acknowledged at the end of the submission form.
- Submissions are limited to one poster per student or group of students.
- Judging is blind, so the author must **NOT** include their name, address, email, or any other identifying information or acknowledgments on the poster itself.

Submit your poster here!

Check out the 2020, 2021, and 2022 Fall/Winter issues to see the previous mini poster competition winners in our OR/MS Tomorrow Recent Issues page.

If you have questions about the competition, feel free to contact orms_tomorrow@mail.informs.org.



Book Review: *Managing Your Mental Health During Your PhD: A Survival Guide*



Abigail Lindner
Worcester Polytechnic Institute

Earning a PhD is no walk in the park, but you might wonder: How much of the challenge is inherent to the process and how much is external? How much is unavoidable - just part of the deal - and how much is the product of an off-balance system?

A senior scientist in industry now, Zoë J. Ayres knows of the stresses faced by students and scholars in academic environments, having studied analytic science with a PhD in electrochemical sensor development and spent several years in postdoctoral positions. In the introduction, she acknowledges the dearth of materials, scholarly or otherwise, on the mental health of PhD students and postdoctoral researchers, and reflects on the need for greater, better conversation on the systemic challenges in academia that exacerbate it.

The author's aim in *Managing Your Mental Health During Your PhD: A Survival Guide* is related to this need: "[I]n this book," Ayres writes, "I hope to explore well beyond the typical, trite 'eat well' conversation when it comes to mental health, and talk about the behind the scenes of doing a PhD that is so often missing." Ayres (2022) While focused on helping PhD students, she also invites PhD advisors and the friends and families of PhD students to engage with the guide so that they might better understand what to be alert for (and how to support) their students' and PhD-aspiring friends' mental health.

Ayres divides the book into four parts:

1. Defining the Problem
2. Mindset Matters
3. Environmental Stressors
4. Seeking Help

In "Defining the Problem," Ayres lays out the current state of affairs for PhD students, drawing from her personal experience, the experiences of others who shared their stories with her, and surveys conducted by both universities and third parties. She provides an overview of the arguments to come for why a high proportion of PhD students, compared to the general population, experience mental health struggles, honing in on the research culture that has developed in the modern university.

Through "Mindset Matters" and "Environmental Stressors," Ayres covers a wide range of topics related to the research cul-

ture and general system of academia that she sees as responsible for the “majority of additional strain" foisted on PhD students, in addition to predisposition, inadequate preparation and support, and unavailability or inappropriateness of help. Each issue, separated into its own subsection, has at most one page (front and back) devoted to it - an intentional organizational decision by Ayres to make the guide more accessible to time-strapped PhD students.

Ayres starts by proposing ways in which a PhD student can, while working inside the existing academic culture, practice self-care. She is conscientious in acknowledging that self-care is not all that there is to maintaining positive mental health - there are more factors at play than whether you eat well, exercise enough, and keep a balanced schedule - but these foundational tools play a significant part in alleviating the stressors of PhD life. Topics include establishing a healthy sleep schedule, setting boundaries, maintaining productivity while avoiding burnout, and beating back imposter syndrome.

From these recommendations, Ayres segues into a discussion of the issues in academia that contribute to mental and emotional stressors that self-care cannot fix and that need not exist in the PhD experience, noting that “so often in academia it is the working environment that can make academia difficult to navigate," contrary to the common lie that mental health struggles can be chalked up to a personal lack of resilience rather than to the environment. In these sections especially, Ayres includes excerpts from conversations she had with other current and former PhD aspirants, highlighting the treatment and reception of a diverse sample of students in their academic environments.

I found this section of the book the most fascinating; while the previous section on self-care was helpful and immediately applicable, “Environmental Stressors" introduced me to a number of previously unexplored ideas and data points. Ayres runs through various forms of discrimination that, unfortunately, arise as much in academia as they do outside of it, and how a student can navigate through them until institutions work toward real cultural change. Then, given the incredible importance of the PhD supervisor in a student’s success, Ayres devotes an entire chapter to the student-supervisor relationship, highlighting conflicts and red flags that may hinder or harm the student as they progress through their program.

In the last section, “Seeking Help," Ayres recommends ways to start the conversation about mental health in academia, advocate for yourself in your institution, connect with communities that exist to herald these issues and support the students dealing with them, and recognize when external assistance, such as medication and/or therapy, may be needed.

While desiring a whole-system change in academia and a reality in which there is “no need for a PhD ‘Survival Guide,’" Ayres understands that transformations of attitudes and cultures will take longer than hoped; so, in the meantime, she wrote this book to present the statistics and stories to raise awareness, and the resources and options to aid in management, of student mental health on the PhD journey. At 200 pages, *Managing Your Mental Health During Your PhD* is a slim volume, designed to not discourage already-busy PhD students with sheer size. Balancing brevity and detail, Ayres could not cover every bit of ground, but, for readers interested in reading more about a specific topic touched on in the book, she has sizable reference pages at the end of each chapter as well as a web page, www.zjayres.com/phdresources, that she regularly updates based on inputs from PhD students, former and current, worldwide.

Because the book covers so many topics, the reading can be dense at times; I highly recommend 1) re-reading sections and 2) not trying to read the entire book all at once. Ayres notes, too, in the introductory sections, that she intends the book to be a resource - a guide, like a car manual, that you reference when needed.

Managing Your Mental Health During Your PhD is a valuable addition to the library of any PhD student, regardless of background, as well as undergraduates who may be considering a PhD. Despite its small size, it manages to address a rich variety of issues affecting the experiences of PhD students, and encourages readers to think more, and discuss with others, about the challenges in academia and what can be done, either at an individual level or at an institutional level, to change them for the better. Ayres overviews several dark topics through the book, but emphasizes throughout that those who are struggling are not alone and that thriving, not just surviving, is possible.

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Going through the Last Semester and Procrastination



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Procrastination is a common problem faced by many students during their academic journey. However, the issue becomes particularly acute for PhD students in their final year, as they approach the deadline for submission of their dissertation. Despite being aware of the gravity of the situation, many PhD students procrastinate and struggle to complete their work in a timely and efficient manner. In this article, we will explore the reasons behind procrastination among PhD students, its impact on their academic performances, and strategies to overcome the issue.

Reasons behind Procrastination

Procrastination is a complex issue, and its underlying reasons can vary from person to person. Some common factors that contribute to procrastination among PhD students are:

1. Emotional Overload: The final year of a PhD program can be overwhelming, with a significant amount of work to be completed in a limited amount of time. This can make it difficult for students to know where to start or how to stay motivated. Where does it lead? Depression, low energy, and pessimism. Interestingly, pessimism and negative feelings are not the only ones that lead to procrastination. According to an experimental investigation by Sigall et al. (2000), extremely optimistic participants are more likely to procrastinate in initiating an aversive task. An examination of their expectations indicates that they thought they could delay and still finish the task before the deadline. Henceforth, positive or negative emotional overload can lead to procrastination.

2. Fear of Failure: The fear of failure is connected to both low self-efficacy and self-esteem (Judge and Bono, 2001). PhD students may fear that their dissertation will not be good enough and compare themselves with the success stories of their peers. This fear of failure can be paralyzing and prevent students from making progress. In particular, individuals who hold irrational beliefs may experience a lack of confidence in their abilities (that is low self-efficacy) and may also believe that any failure to meet expected standards is a reflection of their personal worth (which is low self-esteem).

3. Lack of Structure: PhD students have a lot of freedom in how they manage their time, which can be both a blessing and a curse. Without clear guidance, it can be challenging to maintain focus and make progress. It has been shown by Steel (2007) that PhD students who have lack of structure and clear set of goals tend to work hard only during the time close to the deadlines. Steel and König (2006) suggest that a clear goal setting (e.g., a calendar with clear deadlines or anything else that helps the goals to be clear) may effectively increase work effort.

4. Burnout: PhD students often work for long hours, and they can become burned out and exhausted. This can lead to a lack of motivation, energy, and increased stress. Steel (2007) argues that this type of procrastination is under the spectrum of "Neuroticism". Neuroticism refers to the tendency to experience negative emotions such as worrying, trait anxiety, or negative affect. Some studies show that academic procrastination can be a stress-coping technique, though not desirable (e.g., Valenzuela et al., 2020). Therefore, students that experience a lot of stress are more likely to procrastinate.

5. Perfectionism: Some scholars suggest that personality traits can be among efficient predictors of procrastinating behavior

(e.g., Nazari et al., 2021). Many PhD students hold themselves to very high standards, which can lead to an excessive focus on the minutiae of their research. This can result in spending too much time on insignificant details. Although perfectionists do not appear to unduly delay initiating tasks, they may still delay completing them as they strive to meet their own onerous standards (Çapan, 2010).

Impact of Procrastination

This discussion might have triggered your interest in learning about the implications of this phenomenon. Some of us might have already correlated ourselves with the general categories of the reasons for procrastination, but for all of us, it is important to understand the magnitude of the impact that procrastination has on PhD Students, both in terms of their academic performance and their mental health. Some consequences of procrastination include:

1. Delayed Graduation: Procrastination can lead to missed deadlines and delayed graduation. While some students voluntarily choose to postpone their graduation to protect their mental health, for others, a delayed graduation can be more stressful and even demoralize them (Ho et al., 2020).
2. Poor Quality Work: When PhD students procrastinate, they may rush to complete their work just prior to the deadline, which results in poor quality (Sims, 2014).
3. Stress and Anxiety: Procrastination can lead to high levels of stress and anxiety, which can have a negative impact on students' mental health (Chee et al., 2021). It is crucial for PhD students to prioritize their mental health and well-being. Untreated mental health problems can lead to academic burnout, decreased motivation, and impaired cognitive function; all of which can hinder a student's ability to complete their doctoral program successfully.
4. Impaired Productivity: When PhD students procrastinate, they waste a lot of time and energy, which can impair their overall productivity (Schmidt and Hansson, 2018). Impaired productivity is not only related to incomplete or poor-quality work; but more importantly, it may lead to missed opportunities for networking, research, and other academic pursuits. In other words, procrastination could potentially lead to delays in important tasks, which could result in wasted time and lost opportunities.

Strategies to Overcome Procrastination

The impacts of procrastination are considerable and it bears the question: how do we overcome our tendency towards procrastination? In this section, we will discuss several useful tips to overcome procrastination. Hopefully, some of them will be useful in helping you develop a strategic treatment to reduce or even relieve its negative consequences.

1. Break Tasks into Smaller Pieces: Rather than trying to tackle a large project all at once, break it down into smaller, more manageable pieces. This can make the task feel less overwhelming and help maintain motivation. There are many techniques one can follow. Make a list of all the tasks that need to be completed, and then break each task down into smaller steps. This will help you to see the progress you are making and give you a sense of accomplishment as you complete each step. Another compliment technique is the *Pomodoro* technique (Cirillo, 2018). This technique involves breaking down the work into 25-minute intervals, followed by a 5-minute break. After four 25-minute intervals, take a longer break. This helps to break up the work into smaller, more manageable pieces. Use the 5-minute rule. If a task can be completed in five minutes or less, do it immediately. This will help you reduce the number of small tasks that may build up and become overwhelming if left unattended. Focus on one task at a time; trying to multitask can lead to procrastination and reduced productivity. Instead, focus on one task at a time and give it your full attention until it is completed.

2. Set Realistic Goals: Set realistic goals for each day, and track progress towards those goals. This can help to maintain focus and provide a sense of accomplishment. In other words, set "Specific, Measurable, Achievable, Relevant, and Time-bound (SMART)" goals for each task (Robins, 2014). This will help to clarify what needs to be done and create a sense of urgency to complete the task. The strategy works through what is referred to as the "achievement motivation". The term depicts the drive/desire to accomplish goals or attain success, and it can be influenced by both intrinsic and extrinsic factors. Intrinsic motivation concerns the internal desire to engage in an activity because it is inherently enjoyable, interesting, or fulfilling. When individuals are intrinsically motivated, they tend to experience less procrastination because they find the task itself to be engaging and rewarding. Extrinsic motivation, on the other hand, refers to external factors that motivate individuals to engage in a task, such as rewards or recognition. While extrinsic motivation can also be effective in reducing procrastination, it may not be as sustainable as intrinsic motivation because the external rewards can eventually lose their appeal.

3. Create a Schedule: Create a schedule for each day, with specific times set aside for work, exercise, relaxation, and other activities. Stick to the schedule as much as possible, and adjust it as needed. To do this follow these steps: identify the activities, determine the priorities, allocate time, stick to the plan, review, and revise. A clear understanding of your capabilities and strengths helps you in develop an achievable schedule. Try to create a schedule and see how it works. If it does not work as expected, identify the bottleneck and update accordingly. You will learn more about what the best system is for you as time continues.

4. Use Positive Self-Talk: Use positive self-talk to motivate yourself! Positive self-talk involves using positive language and affirmations to encourage oneself to take action. For example, instead of saying "I can't do this," a PhD student may say "I am capable of completing this task. I will do my best. I am sure there is a way." By rephrasing negative thoughts into positive ones, students can boost their confidence and motivation, which can help to prevent procrastination (Voge, 2010).

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Applications of ORMS in the Finance Industry



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It is with profound sorrow that we commemorate the recent loss of Harry Markowitz, an eminent figure in finance. The mathematical treatment of finance was pioneered by Harry Markowitz's 1952 Paper "Portfolio Selection." This groundbreaking work established modern portfolio theory and his work continues to serve as an inspiration for researchers in finance. His Nobel Prize winning approach serves as a major benchmark for any portfolio allocation strategy.

The mathematical and scientific theory of finance developed immensely into the field that it is today, primarily in the 20^{th} century. The field gained major recognition in the 1990 Nobel Prizes in Economic Sciences, awarded to Harry Markowitz, Merton Miller, and William F. Sharpe "for their pioneering work in the theory of financial economics" Markowitz et al. (2023). In 1997, the theory was expanded upon by Robert C. Merton and Myron Scholes "for a new method to determine the value of derivatives" Merton and Scholes (2023). Their work in the field has developed the two major arms of mathematical finance, known as the P world and the Q world. In the P world, the goal is to model the future, while the Q world's goal is to extrapolate the present. Problems in the P world are focused on portfolio and risk management, while Q world problems are often option pricing problems. Quantitative Finance is now a huge area of research, being featured in many top journals such as Management Science and Operations Research. Researchers investigate new ways to describe market behavior, prescriptive methods for portfolio management, asset pricing, and more. In this article, we describe how prescriptive analytic methods can form the bedrock of a mathematical approach to portfolio management.

Introduction

The problem of portfolio management is defined as finding a set and quantity of stock shares to buy to achieve an optimal return. There is a need to *prescribe* a portfolio $\mathcal{P}$ that is "optimal" for the investor and their goals. Mathematically, we have that stocks (or assets more generally) $S_1, ..., S_n$ yield returns $R_1, ..., R_n$ over a certain investment time period (see Ruppert, 2004, Chapter 3 and 5). Based on these returns, the goal of portfolio managers is to find a linear combination

$$w_1 R_1 + \cdots + w_n R_n = R_p \tag{1}$$

such that portfolio managers are "happy", meeting their investment goals. While investors buy assets, it is much more common to think about the problem in terms of total returns, as shown in Equation (1). The manager's "happiness" is typically achieved through yielding a certain expected return μ_p at a given risk level σ_p. Here, w_i represents the *weight* of the i^{th} asset. $w_i > 0$ translates to being *long* in the asset, $w_i = 0$ means that the investor does not own the asset and $w_i < 0$ is equivalent to being *short* in the asset. Here, we assume that a portfolio

manager wishes to invest all of their funds into stocks. Portfolio managers then have the constraint that

$$\sum_{i=1}^{n} w_i = 1 \tag{2}$$

In other words, this constraint says an investor must invest 100% of their funds into stocks. In times of economic growth, this can be achieved by selecting a portfolio that is similar to the entire market. However, during more volatile market conditions, managers aim to have more *robust* portfolios. With this goal in mind, the *Modern Portfolio Theory* (MPT), the basis for almost all quantitative portfolio management, was developed.

Markowitz's Modern Portfolio Theory

The goal of an investor is to make a profit, which is achieved through portfolio management. A *portfolio* can be viewed as a linear combination of assets as seen in Equation (1). Typically, $R_1, ..., R_n$ are perceived as random variables that provide a certain return upon each realization. Therefore, it is common for portfolio managers to consider the *expected* return from their assets. Portfolio managers often aim to minimize risk while targeting a specific return μ_p.

Letting $\mathbf{w}$ be the vector of all weights, the variance of R_p can be derived as follows:

$$\text{var}(R_p) = \mathbf{w}^\top \Omega \mathbf{w}, \tag{3}$$

where,

$$\mathbf{w} = \begin{bmatrix} w_1 & \cdots & w_n \end{bmatrix}^\top, \tag{4a}$$

$$\boldsymbol{\mu} = \begin{bmatrix} \mu_1 & \cdots & \mu_n \end{bmatrix}^\top, \tag{4b}$$

and

$$\Omega = \begin{bmatrix} \sigma_1^2 & \text{cov}(R_1, R_2) & \cdots & \text{cov}(R_1, R_n) \\ \text{cov}(R_2, R_1) & \sigma_2^2 & \cdots & \text{cov}(R_2, R_n) \\ \vdots & & \ddots & \vdots \\ \text{cov}(R_n, R_1) & \cdots & \text{cov}(R_n, R_{n-1}) & \sigma_n^2 \end{bmatrix}. \tag{4c}$$

For the optimization, it is key to note that Ω is a symmetric, positive semidefinite matrix as $\text{cov}(R_i, R_j) = \text{cov}(R_j, R_i)$.

This creates the following optimization problem.

$$\begin{aligned} \min_{\mathbf{w}} \quad & \mathbf{w}^\top \Omega \mathbf{w} \\ \text{s.t.} \quad & \sum_{i=1}^{n} w_i = 1 \\ & \mathbf{w}^\top \boldsymbol{\mu} = \mu_p \end{aligned} \tag{5}$$

Which can be solved analytically using classical optimization theory (Ruppert, 2004, Section 5.5). Since μ_p is a hyperparameter, modifying μ_p creates a set of risk minimal weights for each target return. This creates what is known as the *efficient frontier* as see in Figure 1. Note that the lower half of the parabola is marked in red. This is because investing in this half of the efficient frontier is inefficient, as we can achieve higher returns for the same level of risk shown in blue.

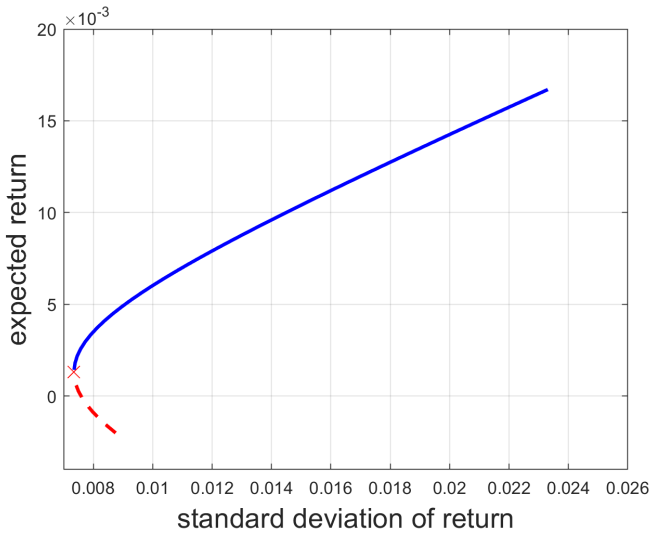


Figure 1: An example of efficient frontier

Restraining the weights further

In the original Markowitz portfolio problem, we require that the sum of the weights is 1. This means it is possible for some w_i to be negative, if there are other assets that balance this out. This can create $\mathbf{w}$ weights where there is extreme shorting present. Due to regulations known as **margin requirements** InteractiveBrokers (2023), the Markowitz problem is often augmented with the following constraint set:

$$\ell_i \leq w_i \leq u_i \quad \forall\, i \in \{1, ..., n\} \tag{6}$$

Here, ℓ_i is the *lower* limit, and u_i is the *upper* limit on how much to invest into a certain asset. When $\ell_i = 0$ for every asset, this prevents shorting under the Markowitz framework.

The Risk-free asset and Capital Asset Pricing Model

After the creation of the Markowitz framework, William Sharpe made a modification to the model based upon the existence of a *risk free* asset Sharpe (1964). A risk free asset is typically represented by a money market account offered by a large bank. The risk free asset yields a *risk free rate* r that is greater than 0. Thus, the set of portfolios of interest consists of portfolios that have a y intercept at r and are tangent to the frontier, as shown in Figure 2. The line created is known as the *capital asset line*. This requires modifying Problem 5 by removing the constraint $\sum_{i=1}^{n} w_i = 1$ and having $1 - \sum_{i=1}^{n} w_i$ invested into the risk free asset (see Ruppert, 2004, Chapter 5).

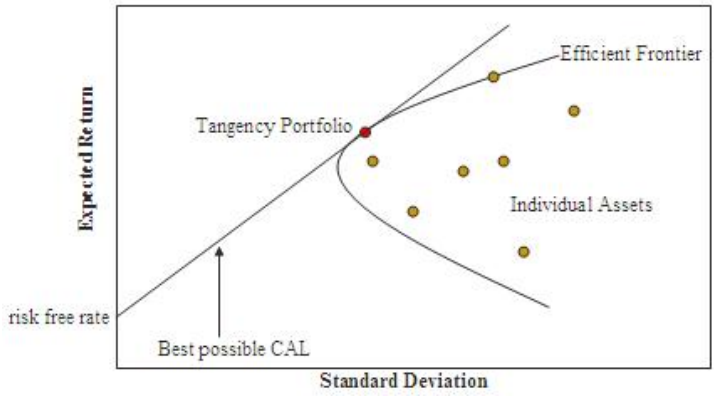


Figure 2: The Efficient Frontier with a Risk Free Asset. Source: Wikimedia (2005)

The derivation of the tangency portfolio can be found in Section 5.5.4 of Ruppert (2004).

(Post) Modern Portfolio Theory

MPT is primarily used as a benchmark for institutions when developing and testing more complex trading strategies McClure (2022). In fact, the CFA (Certified Financial Advisor) Institute claims that "(MPT) has now become the prominent paradigm for communicating and applying principles of risk and return in portfolio management" CFA (2023a).

In the following years, much work has been done to relax the assumptions made by Markowitz and Sharpe to develop more realistic portfolio models. This has led to the development of *post* modern portfolio theory (PMPT). One aspect explored by PMPT is finding new measures of risk beyond the variance of the asset Geambasu et al. (2013); CFA (2023b). For further information on recent developments in portfolio management, we refer the reader to Gunjan and Bhattacharyya (2022). In particular, some popular risk measures include value at risk and expected shortfall. Value at Risk (VaR) is the lower quantile of the loss distribution of the profit and loss of X.

Although, value at risk is a very popular risk measure despite theoretical drawbacks, such as a lack of subadditivity Tangpi (2022); Föllmer and Schied (2016). Expected shortfall (also known as *Conditional* value at risk, CVaR) is defined as the expected loss beyond the VaR Tangpi (2022). Expected Shortfall is more theoretically powerful, as it is convex.

The Success of OR in Finance

Operations Research techniques have been particularly useful and successfully implemented in finance applications. Among different operations research techniques, mathematical programming is probably the most widely used in financial markets, while other techniques like Monte Carlo Simulation, game theory, and network models have also seen success. The primary drivers of success in the financial markets are due to generally well-defined problems with clear quantifiable objectives and constraints that lead to implementable solutions. Additionally, unlike many other operations research applications, the historical data required for applying operations research techniques to financial markets are usually available Board et al. (2003).

Operations Research techniques have the potential to be widely successful for firms that apply them. For example, Gurobi has been used for successful portfolio management by some hedge funds Gurobi (2022a,b). Due to the nature of how quantitative the markets are, it is likely that firms are utilizing operations research for their investment strategies. Some of the most quantitative firms have reported 40% returns in 2022, and others are not far behind them Lee and Kumar (2022). The average quantitative hedge fund performance in 2022 was 8.5% AURUM (2023), while the S & P 500 dipped 19% in the same time frame.

When Things go "wrong"

When we have a weight w_i that is negative, this means that we are *shorting* the asset. This means that the investor makes money when the asset *decreases* in value. Shorting comes with many risks and restrictions, and is typically quite difficult to implement in practice. This is because shorting introduces unbounded risk for certain assets Chen (2023).

Leading up to the 2008 Recession, value at risk was an extremely popular risk measure despite its theoretical drawbacks. Thus, some blame the over-reliance on VaR as one of the many root causes of the disaster Oxford (2016); Nocera (2009). Additionally, risk is often benchmarked against historical events Nocera (2009). This type of erroneous data can lead models to draw inaccurate conclusions StuartReid (2015).

As (P)MPT will give optimal solutions to the problem it is given, extreme short positions could potentially be undertaken without considering the specific firm being shorted against. This can result in significant premiums in insurance costs for such shorts. This happened to Michael Burry's short position in the housing market Lewis (2010).

Conclusion

Operations Research and prescriptive analytic techniques will only continue to become more popular in the financial services industry. As other management strategies find themselves more exposed to the market's swings, demand for robust portfolio management will remain strong. PMPT and MPT will continue to serve as a backbone and key benchmark for firms deciding on their investment strategies.

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Predictive Analytics in the Healthcare Industry



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The field of healthcare is continuously transforming, benefiting from technological advancements that have a profound impact on patient outcomes, care quality, and operational efficiency. Among these advancements, predictive analytics stands out as a groundbreaking technology with the potential to revolutionize healthcare. By leveraging the vast amounts of data available, predictive analytics provides valuable insights that empower decision-making, optimize resource allocation, and facilitate proactive interventions. This article delves into the pivotal role of predictive analytics in the healthcare industry, examines the key challenges associated with its implementation, and highlights the promising future that lies ahead.

Role of predictive analytics in healthcare

Predictive analytics uses historical data, machine learning algorithms, and statistical models to forecast future events or outcomes. In the healthcare industry, this technology enables the analysis of extensive patient data, medical records, and clinical information to generate actionable insights. By identifying patterns and trends, predictive analytics empowers caregivers to recognize potential health risks, enhance the accuracy of diagnoses and treatments, and even prevent adverse events.

Early Disease Detection and Prevention: Predictive analytics is instrumental in identifying individuals at a high risk of developing specific diseases, enabling caregivers to intervene early and effectively prevent or manage conditions. For example, by analyzing patient data including genetic information, lifestyle factors, and medical history, a predictive analytics model can identify individuals at risk of cardiovascular diseases. Healthcare professionals can then recommend preventive measures such as lifestyle modifications, medication, and regular monitoring to mitigate risks and improve patient outcomes.

Hospital Readmission Prediction: Through the analysis of patient records encompassing medical history, demographic information, and previous hospital admissions, predictive models can identify patterns and factors associated with readmissions. This information empowers healthcare providers to develop targeted care plans, provide appropriate support and resources, and reduce the likelihood of readmissions. For instance, a predictive analytics system can flag patients with chronic conditions who are at a high risk of readmission, prompting healthcare professionals to schedule follow-up appointments, offer home care services, or adjust medication regimens.

Medication Adherence and Treatment Compliance: Predictive analytics aids healthcare providers identify patients who may be at risk of non-adherence to medication regimens or treatment plans. By analyzing patient data, including medication history, socio-economic factors, and behavioral patterns, predictive models can flag individuals who are more likely to deviate from prescribed treatments. Healthcare professionals can then intervene proactively, providing additional support, education, and resources to improve medication adherence and treatment compliance. This can lead to better health outcomes and reduced healthcare costs associated with complications arising from non-adherence.

Healthcare Fraud Detection: By analyzing vast amounts of claims data, provider information, and historical patterns, predictive models can detect suspicious billing practices and anomalies indicative of fraudulent activities. For example, by comparing billing patterns to established norms, predictive analytics can identify healthcare providers who consistently bill for services that deviate significantly from their peers. This helps insurance companies and regulatory bodies identify potential fraud cases, investigate further, and take appropriate actions to mitigate fraudulent activities.

Key challenges

Data Quality and Availability: A major hurdle in healthcare predictive analytics is the reliability, accessibility, and consistency of data. Healthcare data is often unstructured and scattered across various sources like electronic health records (EHRs), medical devices, and administrative systems. Inaccurate data formats, missing values, and errors during data entry can undermine the precision and dependability of predictive models Katuri (2023). Furthermore, challenges related to data sharing and interoperability among different healthcare systems hinder the acquisition of comprehensive datasets for analysis.

Privacy and Security: The sensitive and personal nature of healthcare data raises significant concerns regarding privacy and security. Safeguarding patient confidentiality while utilizing data for predictive analytics necessitates robust security measures and strict adherence to regulations such as the Health Insurance Portability and Accountability Act (HIPAA) Maghsoodi (2023). Balancing the utility of data with patient privacy rights is an ongoing challenge that healthcare organizations must address to earn public trust and ensure compliance.

Ethical Concerns and Algorithm Bias: Predictive analytics in healthcare must navigate ethical considerations and potential biases. Biases in training data can lead to discriminatory outcomes, disproportionately affecting certain populations. The lack of diversity in training datasets can amplify biases and limit the generalizability of predictive models Insights (2019). Healthcare organizations must strive for fairness and transparency in predictive analytics, continuously monitoring and addressing biases to ensure unbiased and equitable patient treatment.

Integration and Workflow Challenges: Integrating predictive analytics into existing healthcare workflows can be complex. Predictive insights must be seamlessly incorporated into clinical decision-making processes to be truly effective. Healthcare providers may face challenges in understanding and trusting predictive models, requiring education and training to bridge the gap between data scientists and clinicians. Workflow integration also involves integrating predictive analytics with healthcare IT systems and ensuring compatibility and scalability.

Conclusion and Future Scope

In conclusion, the future of healthcare analytics presents vast opportunities to revolutionize patient care and improve operational efficiency. Advancements in technology and the availability of extensive data will position predictive analytics as a critical component in shaping the future of healthcare. One significant aspect of the future of predictive analytics lies in its integration with emerging technologies such as artificial intelligence (AI) and machine learning (ML). This combination will enable more precise and sophisticated predictions, leading to enhanced diagnostic accuracy, personalized treatment plans, and improved patient monitoring. By leveraging AI-powered predictive analytics algorithms, healthcare professionals can analyze large volumes of patient data, including genomic information, wearable device data, and real-time monitoring, to identify patterns, detect early warning signs, and predict disease progression.

Furthermore, the future of predictive analytics in healthcare will emphasize proactive and preventive care. By using predictive models, healthcare providers can identify individuals at high risk of developing diseases and intervene early to prevent their onset or progression. This shift towards proactive care not only improves patient outcomes but also helps reduce healthcare costs by avoiding expensive treatments and hospitalizations. Another crucial aspect of the future of predictive analytics is its application in population health management. Predictive analytics can assist healthcare organizations in identifying population health trends, predicting disease outbreaks, and efficiently allocating resources. By analyzing extensive datasets and identifying risk factors, public health agencies can implement targeted interventions and preventive strategies, leading to better overall population health outcomes.

However, several challenges need to be addressed to fully harness the potential of predictive analytics in healthcare. Additionally, it is important to acknowledge that algorithms and models are not infallible and require accountability and transparency Insights (2019). Establishing human intervention points is crucial to ensure appropriate decision-making. Furthermore, a strong ethical foundation guided by legislation is necessary to promote fairness and eliminate bias in the application of predictive analytics. By actively addressing these challenges and fostering collaboration among data scientists, clinicians, policymakers, and regulators, the future of predictive analytics in healthcare holds great promise for transforming healthcare delivery and positively impacting the lives of patients and populations.

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Application of Data Analytics for Demand & Supply Management



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With the emergence of the 4th Industrial Revolution, businesses around the world are striving hard to sustain themselves in highly competitive markets. The COVID-19 pandemic has made it even more challenging for industries to survive. Profit margins have traditionally been meager in the manufacturing industry and now with disruptions in the global supply chains, they are bearing additional losses on account of supply chain issues like material delays, supply-demand mismatch, and increased freight costs. In such scenarios, every penny saved becomes extremely important in sustaining the business, which is why operation efficiency is the main focus area. This is especially true for small-scale manufacturing companies which may have a very low tolerance with respect to absorbing losses. However, many of these problems, though they cannot be completely eliminated, can have their negative impact reduced substantially with the help of data analytics. Before going into data analytics, let's first briefly understand the value chain of a manufacturing business.

A manufacturing setup broadly has the following units: Sales, Job Scheduling/Planner, Procurement, Raw Material (RM) Store/Warehouse, Quality, Production, and Finished Goods (FG) Store/Warehouse. The Figure 3 explains the process flow in a manufacturing business.

In the entire process, the occurrence of the following events will result in a financial loss to the business:

- Production idle time due to delay in RM receipt or less factory loading
- Over-stocking of inventory
- Under-stocking of inventory
- Delays in job scheduling

If the above-listed issues are minimized completely, the business will be operating at maximum efficiency. This has traditionally been addressed by effective Sales & Operations Planning (S & OP) in companies. According to Meredith Hart in her article A Comprehensive Overview of Sales and Operations Planning (S & OP), "Sales and Operations Planning (S & OP) is a business management process where leadership and executive teams meet to ensure each business function is aligned to balance supply and demand Hart (2021)." The main S & OP process steps are as follows:

- Forecasting
- Demand planning
- Supply planning

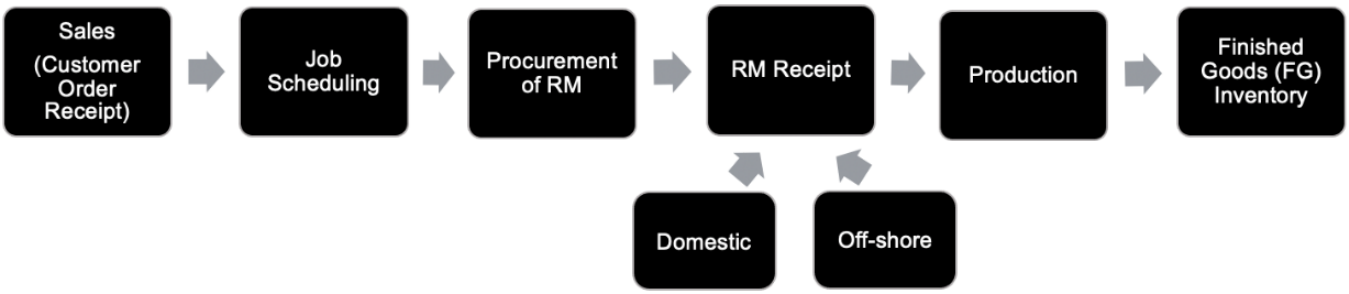


Figure 3: Process flow in a manufacturing business

Forecasting is the first step in the S & OP process and the most crucial. The better the forecast, the better the planning. Traditionally, forecasting has been mostly done via qualitative techniques like Market Research, Sales teams' judgments, historic sales, etc. However, in the post-COVID world, it is required to make manufacturing units more flexible to meet the dynamic customer demands. Therefore, the S & OP process needs to also be more dynamic. This is what is going to help them to create a competitive edge. This is where data analytics comes into the picture. This is particularly useful to small businesses who generally do not have a well-established separate Sales team responsible for generating demand forecasts and it is not even a part of the business Key Performance Indicators (KPIs) to measure forecast accuracies. Moreover, if it is a push system flow, a poor demand forecast may result in high inventory cost holdings to the companies in a scenario where the demand from their customers in the Business-to-Business (B2B) scenarios is very dynamic. If the company relies completely on order backlog (i.e. start the manufacturing process only after the order is received), the customer demand will not be met in time due to internal process lead times. Therefore, demand forecasting with fair accuracy is a must in order to make a business sustainable in the market.

This can be very easily achieved through Time Series Forecasting Methods. A time series is a collection of data points over a period of time. For example, in a manufacturing unit, a time series can be terms of daily/weekly orders (also called deliveries or sales). A time series is characterized by certain parameters namely, level, trend, and seasonality. Level describes the average value of the series, the trend is the change in the series from one period to the next, and seasonality describes a short-term cyclical behavior of the series which can be observed several times within the given series. These time series components can be used in conducting a predictive analysis, to get demand forecasts. The most commonly used univariate time series forecasting methods are regression-based and smoothing forecasting models. These include using moving averages, naive and seasonal naive forecasts, exponential smoothing, and Auto-Regressive Integrated Moving Average (ARIMA), to name a few. All these techniques can be easily implemented using R or Python inbuilt libraries. The details of the codes and libraries used are not discussed in this article, however, there is a lot of material available on the internet that can be easily modified and reused with little knowledge of Python / R programming. Data analytics and visualization software like Tableau, also have an option of visualizing the future trends in time series plots.

To evaluate which forecasting model works the best for a business, various models' outputs can be compared using metrics like Mean Absolute Percentage Error (MAPE). It is important to note here that a demand forecasting model which works the best for a certain part, may not be suitable for other parts, as their demand patterns might be different. Therefore, validation through accuracy measurement metrics like MAPE is crucial. More detailed information on time series analysis and forecasting methods can be found in the book "Data Mining for Business Analytics_ Concepts, Techniques, and Applications in R", by Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr. Shmueli et al. (2017) and "How to Choose the Right Forecasting Technique," an article by John C. Chambers, Satinder K. Mullick, and Donald D. Smith Chambers et al. (2023). Shanthababu Pandian's Time Series Analysis and Forecasting: Data-Driven Insights article on the website Analyticsvidhya Pandian (2023), can also be referred to for Python codes for developing forecasting models on real-time data.

Inventory Modeling and Supply Planning

Once the demand forecasting model is finalized for all the parts/products sold by the company, the forecasted demands can now be used as input for supply planning. Supply planning is controlled through the purchase requisitions (PRs) placed for raw material (RM) ordering. PRs are generated when the RM inventory goes below the reorder point. Inventory is controlled through Min, Max, and Reorder points. Therefore, to ensure smooth material supply for production, as well as to ensure that there is no overstocking of material, setting accurate inventory control points is crucial. For more information on inventory planning, Peter L. King's article on Understanding safety stock and mastering its equations can be referred to King (2011).

The control parameters for inventory management can be derived through the following inputs:

- Procurement Lead Time (L months)
- Demand forecasted for L months
- Standard deviation of the demand forecasted for L months
- Mean demand for L months
- A factor z associated with service level (the expected probability of not hitting a stock-out during the next replenishment cycle)
- The standard formula for calculating inventory is:

$$(Mean\ Demand) * (Lead\ time\ L) + z * (std\ dev\ of\ demand) * \sqrt{Lead\ Time\ L}$$

The first term in the above equation represents the minimum inventory required for running operations and the second term is the safety stock. Together, they will provide the target inventory level or the reorder point, i.e. if the stock goes below this point, an RM order needs to be placed. Now, the forecasted demand is obtained at the Finished Goods(FG) level, however the same can be used for getting RM requirements as well. The process flow for ordering RM can be seen in Figure 4.

This target inventory level is based on the customer demand of the next L months' forecast. It will be updated every month based on changes in customer demand patterns. Thus, with this methodology, customer deliveries can be on time and even the occasional spikes in demand can be catered through the safety stock. Moreover, as demand and supply are matched, the inventory holding costs will also be optimized.

Thus, small manufacturing companies can benefit largely from the application of some of the easy predictive modeling techniques in Sales and Operations planning.

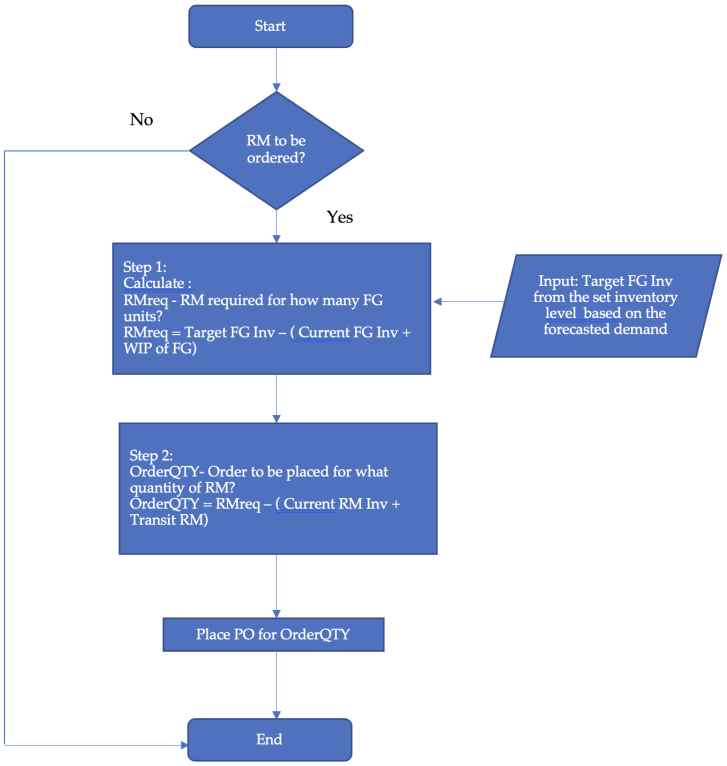


Figure 4: Process flow for ordering raw material

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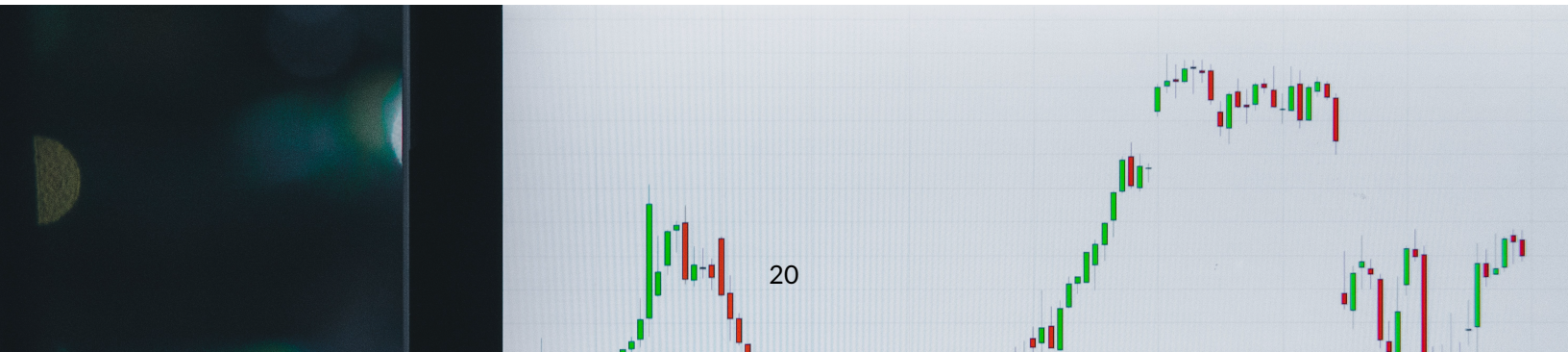
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The U.S. Foster Care System: Parent-Child Matching



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In the Fall/Winter 2022 issue of OR/MS Tomorrow, the article titled "The U.S. Foster Care System: Resource Allocation" discussed how operations research practitioners could play an important role in facilitating the distribution of finite resources among children in foster care and their respective families. (For those who have not perused the initial article of this two-part series, it is readily accessible here.)

In "Resource Allocation", we highlighted how the U.S. foster care system primarily exists to provide protection and support for children who have, due to an array of circumstances, come under its care; and to eventually settle these children in permanent placements. The projects detailed in the article demonstrated how the efficient allocation of resources could accomplish both these objectives, by ensuring necessary services are dispensed to bolster the well-being of children, and by reducing the duration of their stay in foster care.

Children and youth in the United States typically exit foster care through one of three main ways: reunification with their families of origin, adoption, or emancipation, also called "aging out". Adoption ranks as the second most prevalent exit strategy after reunification. Children who have permanency plans for adoption are matched with prospective adoptive families in a process that, over the past few decades, has been followed with the assistance of modern algorithmic technologies.

Parent-Child Matching

According to the Kids Count Data Center of the Annie E. Casey Foundation, a charitable organization in the United States dedicated to the well-being of children, over 117,000 children were awaiting adoption in the year 2020 (Center, 2021b). The most substantial age group in need of placement comprised children aged 1 to 5, followed by those aged 6 to 10 and aged 11 to 15. The criteria for determining a "fit" between a child with a permanency plan for adoption and a prospective adoptive family has seen various shifts over the past century. These evolving metrics have included parental ability based on IQ, educational attainment, and/or social class; racial or cultural alignment between the child and the prospective family [1]; the prospective family's ability to accommodate certain special needs; as well as parenting and attachment styles (Haysom et al., 2020).

Another consequential factor in matching children with families is the family preferences of the child (for example, if they want a family with both a mother and a father or with no siblings)

[1] Since the enactment of the Multiethnic Placement Act in 1994, race, color, or national origin, whether of the parent(s) or the child, can no longer serve as reasons for delaying foster care or adoptive placements in the United States.

and the child preferences of the family (for example, if they want a boy aged between 5 and 11). Algorithms designed to expedite and simplify the matching process are usually geared toward optimizing the match between the characteristics and background of the child and the characteristics and preferences of the prospective family.

Adoptive Placement Matching and Online Dating

As far as process goes, parent-child matching algorithms fall into two categories: family-driven and caseworker-driven. In the family-driven model, prospective families are notified via email about children who have been released for adoption, and they respond if they believe that a specific child could be a fitting match. In a caseworker-driven model, which involves more advanced software tools, caseworkers for children who have been released for adoption browse all available, registered prospective parents.

Olberg et al. (2021) drew comparisons between parent-child matching in the foster care system and online dating; both operate as two-sided markets without a centralized clearinghouse, relying on purely randomized, decentralized matching models Olberg et al. (2021). An essential distinction, however, is that parent-child matching possesses a centralized protocol and middlemen, the caseworkers. Despite this, approaching parent-child matching from a two-sided market perspective proves useful; viewing the process through an economic lens enables child welfare researchers to apply a game theory framework to their analysis, with the objective of determining which type of algorithmic model best serves children and families.

Both family-driven and caseworker-driven searches are inherently dynamic, involving uncertainties about compatibility and the heterogeneous preferences of agents. Based on their research about the impact of each approach on average utility in equilibrium, Olberg et al. (2021) concluded that caseworker-driven searches are often more preferable. Preference for caseworker-driven searches over family-driven searches arises because the former, by avoiding wasted search efforts, can Pareto-dominate the latter in equilibrium, while the latter can never Pareto-dominate the former. This implies that caseworker-driven searches either outperform or are on par with family-driven searches in every dimension of interest (Dreeves, 2019).

Improving Caseworker-Driven Searches

An example of a caseworker-driven search method can be found in the work of Slaugh et al. (2016). The Pennsylvania Adoption Exchange (PAE), established in 1979, aims to support the adoptive placement of hard-to-place children by drawing from comprehensive data about the children and the preferences of prospective families. The tool in use at the time of their writing contained seventy-eight pairs of child-attribute values and family preferences. A compatibility score, ranging from 0 to 100, assessed the fit between a child with a permanency plan of adoption and a prospective family being considered for the placement.

Despite its promise, the PAE was regarded as ineffective by the caseworkers who used it, as they did not trust the match recommendations generated by the system. Part of the issue was linked to implementation challenges: child welfare agencies faced difficulties coordinating algorithm design with an IT contractor and managing temporal data collection across Pennsylvania's sixty-seven counties.

Operations researchers took up the challenge to devise a more efficient system. Expanding on the PAE concept, Slaugh et al. (2016) developed a spreadsheet-based algorithm (Slaugh et al., 2016). This model included flexible weights and geographic constraints, enabling child welfare professionals to determine on a case-by-case basis which parent-child factors were more or less pressing to match and how far to look. The overall result was a computerized matching tool that ranked families according to compatibility with a given child. It was based on a discrete-event simulation of the adoption network.

The researchers conducted simulations of the new spreadsheet-based algorithm using real data from 1,853 PAE-registered children and 2,194 prospective adoptive families. These simulations revealed that the more information "matchmakers" had on families' preferences, the better the algorithm performed, increasing the adoption rate and reducing the average number of match attempts until a successful adoption. In essence, having more information about prospective families led to more successful matches and fewer failed ones.

> The simulations also revealed that broadening the search area increased the adoption rate. Given this, it is even more critical for caseworkers to have reliable algorithmic tools to assist their decision-making. Assessing the files of all the families in one county is already a substantial task; imagine the workload when expanding the scope to five counties, or ten, or all sixty-seven across Pennsylvania!

Remember the Children (and Other Humans)!

The primary takeaway from Slaugh et al. (2016) is the crucial role that quality of family information plays in improving the performance of matching algorithms and consequently, achieving more adoptive placements for children in foster care. Meanwhile, Saxena et al. (2020), after conducting an extensive literature review of fifty child welfare system decision-making algorithms, asserts that these algorithms require, alongside high-quality data, a basis in more human-centered design (Saxena et al., 2020).

As the field of Artificial Intelligence has evolved, human-centric approaches to algorithm design have gained prominence. The principle is that algorithms should "reflect realistic conceptions of user needs and human psychology" (Guszcza, 2018). In their study, Saxena et al. (2020) found that many of the algorithms ignored system factors that influenced caseworkers' decisions, such as current policies and scarce resources. The majority focused on minimizing the risk of future maltreatment for children in foster care. While undoubtedly important, this focus does not account for the overall improvement in life quality, a primary objective of caseworkers that is relatively challenging to quantify.

To bring the human element into these algorithm-influenced decisions, active engagement with domain experts, children in foster care, and parents of children in foster care is critical. Inputs from these stakeholders would expand understanding of specific values, needs, cultural and parental expectations, and socio-technical challenges that impact parent-child matching decisions.

Saxena et al. (2020) explain, "Child-welfare workers are generally not trained in statistical thinking and make decisions based on experience, intuition, and individual heuristics." Therefore, applying a human-centered theoretical approach to algorithm design would place the meaning-making process at the center of the process, contextualizing how child welfare workers perceive quantified metrics.

Said otherwise, human-centered approaches would better account for how child welfare agents navigate the foster care-to-adoption process and prospective family relationships, as well as their interaction with the numerical data that is the bread and butter of analytics. Operations researchers and management professionals have the opportunity to refine algorithmic processes to better reflect these human realities.

Conclusion & Future Research Directions

While a slim majority of children in foster care reunite with their families - between 47% and 52% from 2011 through 2020 (Center, 2021a)- reunification is not a viable option for every child. When reunification is not viable or advisable, the second most common exit type from foster care is adoption, accounting for between one-fifth and one-fourth of exits from foster care annually. Over the past few decades, algorithmic tools, as studied by Olberg et al. (2021) and Slaugh et al. (2016), have helped caseworkers "optimally" match children with permanency plans of adoption to prospective adoptive families.

While operations research (OR) cannot eliminate the necessity for foster care, it has the potential to alleviate some of the associated stress by improving data-based processes through which caseworkers and other child welfare workers make decisions for the children under their responsibility. OR practitioners bring to the table a wealth of experience in integrating quantitative and qualitative data into models, experimenting with tools to expand data capabilities, and contemplating the human-centered design of algorithms and AI, the concern for child welfare researchers like Saxena et al. (2020). This knowledge could have a substantial impact on the lives of these children and families.

In 1970, Arthur Spindler, who was affiliated with the Department of Health, Education, and Welfare (now the Department of Health and Human Services), underlined the potential of OR in child welfare, stating "The need is there. The challenge is now," (Spindler, 1970). More than five decades later, in 2023, the need persists, and the challenge remains as pertinent as ever.

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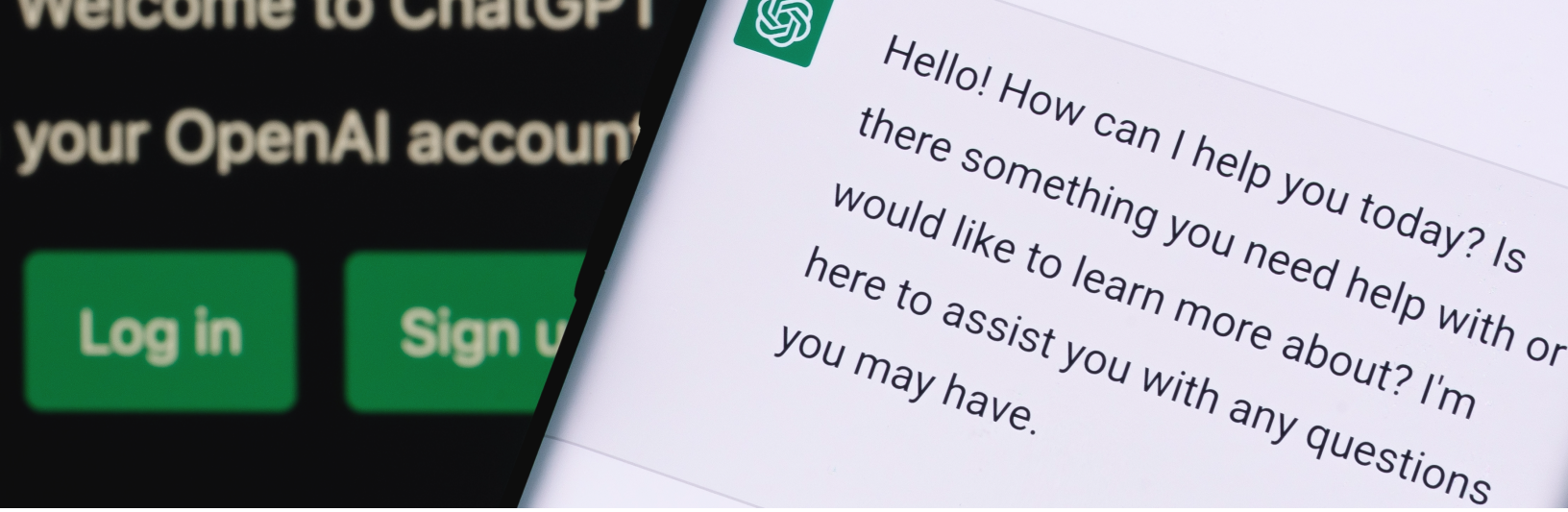
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Navigating the Use of ChatGPT in Education and Research: Impacts and Guidelines



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The emergence of generative AI tools like ChatGPT has sparked both excitement and concerns in the fields of education and research. To gain a comprehensive understanding of the implications and potential of incorporating ChatGPT into these domains, we interviewed two experts: Professor Tinglong Dai from Johns Hopkins Carey Business School and Professor Matthieu Gruson from the University of Quebec in Montreal. This article aims to combine their insights, highlighting the opportunities, challenges, and the need for guidelines surrounding the use of ChatGPT in research and teaching environments.



Professor Tinglong Dai
Johns Hopkins University



Professor Matthieu Gruson
University of Quebec

Consequences of Using ChatGPT

Both experts recognize the positive and negative consequences associated with using ChatGPT. Professor Gruson shares his experience with using ChatGPT in the context of teaching Operations Management. He disagrees with its use by undergraduate students, noting that it can produce text not aligned with basic knowledge. He states, "Students still don't have the knowledge to evaluate what has been proposed by ChatGPT, and they might mistakenly consider incorrect answers as correct." However, he believes that for graduate students who possess the necessary knowledge and critical evaluation skills, ChatGPT can be a valuable resource. Professor Dai also acknowledges the potential benefits, stating that ChatGPT can be a useful tool to assist students in their learning and researchers in their work.

However, Professor Dai also highlights several opportunities and challenges that come with the use of AI tools like ChatGPT. He states that ChatGPT can be a impactful tool to assist students and researchers in learning and academic work. He explains, "ChatGPT can provide immediate answers to students' questions, assist in brainstorming research ideas, and help users explore a wide range of knowledge." However, He also mentions, "There is a possibility of misinformation if the AI does not convey information accurately." This raises concerns about the reliability of information generated by ChatGPT, especially in educational settings where students may rely heavily on its responses. Additionally, Professor Dai points out the risk of reduced critical thinking skills if students become overly dependent on ChatGPT for answers. Moreover, the issue of trust and authenticity arises, particularly when AI-generated content is mistaken for human-generated content and vice versa.

Incorporating ChatGPT into the Classroom: Both experts acknowledge the opportunities and challenges associated with in-

corporating ChatGPT into the classroom. Professor Dai emphasizes the potential benefits, stating that ChatGPT could serve as a 24/7 teaching assistant, providing personalized learning experiences and freeing up educators' time for other aspects of teaching. However, he also mentions the need to address challenges such as ensuring the accuracy of information provided by ChatGPT and avoiding over-reliance or plagiarism issues. Professor Gruson, focusing on his Operations Management course, expresses reservations about using ChatGPT by undergraduate students due to concerns about accuracy and alignment with fundamental knowledge. However, he believes that ChatGPT could be beneficial for generating case studies and developing teaching strategies, provided transparency is maintained.

Navigating Challenges in Research: The widespread use of ChatGPT poses challenges for research institutions in terms of maintaining research integrity and authenticity. Professor Dai suggests that the publication process may need to evolve to address these challenges. He mentions the possibility of implementing greater scrutiny and AI detection tools during the peer review process to identify AI-generated content. However, he also emphasizes the need for a more extensive discussion within the scientific community to manage these changes effectively.

Guidelines for Responsible Use

Professor Dai emphasizes the importance of establishing guidelines for implementing ChatGPT in education and research. According to Professor Dai, "the use of generative AI in education and research comes with significant responsibilities." He believes that open and diverse stakeholder discussions involving educators, students, administrators, AI developers, and policymakers should take place to address the following key considerations:

Mitigating Misinformation and Bias: Professor Dai highlights the need to ensure that generative AI is used properly to avoid creating and amplifying misinformation and bias. He states, "Educators and researchers must be cautious about the accuracy and reliability of the information generated by ChatGPT, as misinformation can have far-reaching consequences." The guidelines should provide clear instructions on how to validate the information provided by ChatGPT and encourage critical evaluation.

Impact on Pedagogical Methods and Authenticity: Considering the impact of technology on traditional pedagogical methods and the authenticity of scholarly work is crucial. Professor Dai believes that policies should address these concerns. He states, "The use of AI tools like ChatGPT may impact the authenticity of scholarly work and raise questions about the role of human contribution in the research process." Guidelines should emphasize the importance of acknowledging the use of AI tools and clearly demarcating the contributions made by human researchers.

Promoting Inclusive and Equitable Learning Experiences: Professor Dai emphasizes the importance of using technology to promote inclusive and equitable learning experiences. He believes that guidelines should address how technology, including ChatGPT, can be utilized to ensure accessibility and equal opportunities for all students. Guidelines should encourage educators to provide alternative resources and support to accommodate students who may not have access to ChatGPT or prefer different learning methods.

Professor Gruson, on the other hand, provides a different perspective regarding guidelines for using ChatGPT. He mentions that his department is currently engaged in discussions on the implications of ChatGPT and what actions should be implemented. He emphasizes that faculty members have already taken measures. Professor Gruson states, "Some colleagues have decided to show their students how ChatGPT might make mistakes, while others have explicitly forbidden the use of AI tools such as ChatGPT in their syllabi." The diversity of approaches within the department underscores the need for ongoing conversations and flexibility in implementing guidelines.

Adapting Assessment Tools: To address the challenges posed by ChatGPT, educational institutions are exploring adaptations to assessment methods. Professor Dai suggests several strategies that institutions can consider, including plagiarism detection, deeper critical thinking and personal reflection, and application-based exams. Implementing plagiarism detection tools capable of identifying AI-generated text can help maintain academic integrity and ensure that students do not submit AI-generated content as their own work. Designing assessments that require deeper critical thinking and personal reflection can help students develop essential skills beyond simple recall of information. This approach encourages students to engage with the subject matter more thoughtfully. Shifting towards exams that focus on the application of knowledge rather than relying solely on information recall can provide a better measure of students' understanding and problem-solving abilities.

Professor Gruson shares his approach to adapting assessment methods in the Operations Management course as well. He mentions that the quizzes are conducted on campus computers with special software that limits students' access to the internet. Additionally, the questions are designed to include intricate details and figures that ChatGPT cannot assist with. He also suggests developing certain types of questions based on class discussions and YouTube videos to ensure student engagement and prevent reliance on AI tools alone.

Conclusion

The emergence of ChatGPT and other generative AI tools presents both opportunities and challenges in education and research. By establishing clear guidelines for responsible use, institutions can navigate these challenges effectively while harnessing the potential benefits. Adapting assessment methods can ensure academic integrity and foster critical thinking skills. Incorporating ChatGPT into the classroom can enhance learning experiences, but caution must be exercised to maintain student-teacher relationships and prevent over-reliance. Research institutions must address the authenticity and trustworthiness of AI-generated content, shaping the future of the publishing process. By recognizing and addressing these opportunities and challenges, we can navigate the use of ChatGPT in education and research, ensuring a responsible and impactful integration of AI technology.



Spotlight Interview with Pontifical Catholic University of Chile INFORMS Student Chapter



Gulten Busra Karkili
University of Massachusetts Amherst

We were very honored and excited to interview the Pontifical Catholic University of Chile INFORMS Student Chapter for our Spotlight Series. This informative and inspiring conversation took place between Massachusetts and Chile, with words traveling over five thousand miles. We interviewed five key members of the Chapter: Professor Jorge Vera as the Faculty Advisor, Josefa Valdés as the Chapter President, Cristobal Perez, Amalia Cáceres, and Pablo Barría as Chapter Members.[2]

Can you tell us a little bit about the history of the Pontifical Catholic University of Chile INFORMS Student Chapter?

Cristobal: The Industrial Engineering student chapter was established in 2016 by students from the Industrial Engineering faculty who were driven by their interest in the various domains covered by Industrial Engineering, including Operations Research, Finance, and Management, among others. Since then, the student chapter has gained immense popularity, not only within the Industrial Engineering faculty but also across all other faculties of the Engineering school at Pontificia Universidad Catolica de Chile. Presently, it stands as one of the most active student chapters and represents the largest major within the Engineering School.

Prof. Vera: The student chapter originated in 2016 as an initiative of a group of highly motivated students from the Industrial Engineering area who had a strong interest in Operations Research. These students actively participated as a support team during the Latin-Iberoamerican Congress of Operations Research, which took place in Santiago that year. As the general chair of the conference, I was able to inspire and encourage them to organize themselves into a Student Chapter. Since then, successive groups of students have continued with the same enthusiasm.

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

Cristobal: Some of the key activities that we carry throughout the year are: talks about diverse subjects related to our Major with different companies or important people that work as an Industrial Engineer, workshops, activities of distension with the

[2] In the header image are the participants Felipe Ulloa, Josefa Valdés, Shun Wei Rao, Savka Aldunce, Amalia Caceres, Pablo Barria, Marcelo Bernal, Benjamin Espinoza, Diego Hidalgo, Nelson Maraboli, Catalina Cifuentes, Florencia Villarreal, Patricio Landsberger, Sebastian Aguirre, Anuar Khamis and Professor Jorge Vera.

people that conform the Industrial Engineering faculty, National and International Congress of Operations Research, among others.

Pablo: Throughout the year, the chapter tries to cover every aspect of what Industrial Engineering is, from the academic, student, labor, and extracurricular aspects. For this reason, some key activities are talks with companies and experts, as well as recreational activities, both internal within the chapter and external with university students. Additionally, the chapter participates in activities at school and academic fairs to explain the focus it has on operational research.

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

Josefa: The goals of the Chapter are to integrate students into the field of Industrial Engineering and foster a sense of belonging within the Operations Research major. Additionally, the Chapter aims to enhance the relationship between students and faculty, creating a comfortable learning environment and facilitating knowledge exchange. Another objective is to bridge the gap between students and the professional world, providing opportunities for students to engage with industry.

Cristobal: The main goal of the chapter is to develop a sense of belonging among students, professors, and officials of the Department of Industrial Engineering at UC, creating opportunities for learning and collaboration. The Chapter aims to contribute to the personal development of individuals and align their training with the needs of the country. What motivates us the most is the ability of the Chapter to make a meaningful impact on the lives of individuals associated with the department, creating a positive experience for everyone involved.

Pablo: As a chapter, we aspire to foster the academic, professional, and personal growth of our members, while also promoting industrial engineering as a discipline. Therefore, we strive to facilitate knowledge exchange by offering leadership opportunities, fostering skill development, and encouraging engagement in service activities. This is the driving force behind the motivation of CEIINS (the Spanish acronym for *Industrial and Systems Engineering Student Chapter*) members, as it enables us to connect with external information and, in turn, inspire and support those in need, including students, the department, and our chapter.



From left to right:
Back row: *Sebastian Aguirre*, *Amalia Cáceres*, *Pablo Barria*, *Catalina Cifuentes*, *Fernando Abarzua*. Front row: *Diego Hidalgo*, *Josefa Valdés*, *Cristobal Pérez*, *Cristobal Carvallo*

How do you recruit new members and the leadership board?What key personality traits do you look for in students during the recruitment process?

Josefa: We conduct a small poll and ask each student in the chapter if they are interested in joining the leadership board. When recruiting, we look for individuals who are participative, motivating, and responsible.

Cristobal: First of all, we create a form to inquire whether the current chapter members intend to continue their membership in the following year. If they express their intention to stay, we then ask them if they are interested in joining the leadership board. After that, we conduct a vote among the interested individuals to determine the composition of the leadership board and assign specific positions. Regarding the recruitment of new members, we open our applications at the beginning of the academic year. Based on the characteristics of each applicant, we make decisions about their acceptance into the chapter and determine the commission they will be assigned to. The key personality traits we seek in potential members include motivation, pro-activity, responsibility, and empathy.

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

Pablo: The previous members of the chapter who have already graduated are now in different areas. Some are practicing their careers as engineers, while others are continuing their

specialization in the university, alongside their membership in other postgraduate student chapters. The chapter instilled in them the spirit of leadership and service to others, along with facilitating connections with companies and professors that assisted them in pursuing their chosen paths.

Amalia: It is important to note that the members of the chapter stand out for their desire to leave a mark within the university and contribute something to the community. This is why it is possible to see how all CEIINS graduates are working or studying but always striving to be part of something that unites them with the community and improves day by day thanks to what they learned in the engineering school.

Are there any changes you are planning to make in the Chapter in the near future? What are you most excited about regarding the future of this Chapter?

Josefa: We are not making big changes in our chapter, but we are focused on organizing more activities throughout the academic year. Additionally, we have plans to collaborate with other chapters from different specialties. I am excited about the potential achievements and the sense of community we can create.

Cristobal: Yes, we want to make more massive events, so we can really generate a sense of community within the members of the Industrial Engineering faculty. This really motivates us because the Chapter will be seen as an institution that unites people inside and outside the Major, giving them not only tools for their professional lives but also for their personal lives.

Pablo: Yes, there are. The idea as a chapter is to improve every year and in the near future, we plan to grow in the frequency of activities we do, contacting new companies interested in looking for new activities that help the student as a person and professional, such as on issues of mental health, personal and work life, among others. In addition, we want to create a database with material available to students to help them in their studies.

Amalia: I think our chapter stands out mainly because all of its members have a mission within the chapter. It is very important to carry out each activity or event with a common goal and the main idea of uniting students, professors, and university officials. Additionally, due to the regular meetings we hold, a sense of closeness is fostered, making it easy for any good idea to be heard and worked on until it becomes a reality.

The Pontifical Catholic University of Chile Student Chapter was recognized at the 2022 INFORMS Student Chapter Annual Awards Ceremony for its outstanding achievements, making it one of the few chapters located outside the US to win an award. What are your comments on this achievement?

Josefa: As a chapter, we are very proud of this achievement. We truly appreciate the recognition for the activities we strive to organize and our efforts in creating a better environment for the OI Major. This recognition serves as motivation for us to continue improving and giving our best in the upcoming years.

Pablo: This award is a testament to the hard work, dedication, and commitment of our members and leaders. It reflects the collective effort we have invested in promoting the OI major and making a positive impact on our academic and professional community. While receiving gratitude from students and academics is already rewarding, being recognized by INFORMS signifies that our work transcends barriers and connects us with the broader world.

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

Amalia: It could be said that the chapter's distinction lies primarily in its daily impact rather than specific achievements. While we may not have received other international awards, our group is recognized for the exceptional participation of each member in every activity and event we undertake. It is worth noting that each committee within the chapter organizes a series of activities throughout the year, ensuring our continuous engagement with the community. Notable activities include our participation in Giving Day, the celebration of national holidays, and the various talks delivered by companies and students at the engineering school.

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

Josefa: As a chapter, we have three committees/commissions: Business Connections, Community, and Academics. Each committee plays an essential role in helping us fulfill our chapter's objectives. We strive for each committee to organize various activities that foster interaction among businesses, faculty members, students, and professionals. Additionally, these activities aim to create connections that enable personal growth for everyone involved.

Amalia: I would just like to highlight the legacy that is generated from one chapter board to another. There are many members who dedicate years to CEIINS and who only leave because they have finished their university studies. But despite this, they have always managed to transmit all the knowledge, advice, and learning from one board to another in order to exceed expectations every year and create a chapter as close and complete as possible.



OR/MS Tomorrow Alumni Story: Yue Wang, PhD



Kara Combs
Air Force Institute of Technology

I have been with OR/MS Tomorrow for the last two years. Before moving into my current role as Co-lead Editor, I was one of the social media coordinators upon the graduation of my predecessor, Yue Wang. Yue served as the OR/MS Tomorrow social media coordinator for one year from May 2020 until May 2021 while attending Texas A&M University (College Station, TX). While there, she is pursuing a Ph.D. in Industrial and Systems Engineering with an emphasis on Operations Research and also worked as a Graduate Assistant Lecturer in the Wm Michael Barnes '64 Department of Industrial and Systems Engineering.



Yue Wang, PhD Candidate
Texas A&M University

Yue's research focuses on supply chain optimization, and her dissertation is "Optimization models for last-mile service operations." In her free time, she often works as a licensed Zumba instructor and certified ACE Group Fitness instructor at her local gym.

Her day-to-day involves primarily doing research, using a variety of methodologies in operations research to address optimization challenges in inventory management, transportation & logistics, and healthcare. She also teaches and mentors undergraduates as part of her job. Since Spring 2022, Yue has been working as a Graduate Assistant Lecturer within her department at Texas A&M University and teaching ISEN 370 - Production Systems Engineering. In Fall 2023, Yue will start a new chapter as a tenure-track assistant professor in the SIE department at The University of Arizona, where her research would focus on real-world applications and problems in supply chain management. Her goal is to bridge the gap by turning theoretical academic research into solutions implemented in industry.

When asked to reflect on her time as part of the *OR/MS Tomorrow* team, she immediately pointed out the professional skills and friendships she developed as a result. She was able to grow professionally by introducing herself to new ideas, learning how to provide useful feedback in a review process, and curating her ability to be a leader. These skills must be learned through real-world experience rather than in the classroom. Through this, it has strengthened her qualifications in the job market, given not all students are able to work in such a dynamic group setting while attending school. However, the most valuable part of her experience was the new friendships that evolved with other members of *OR/MS Tomorrow*. Professionally, she was mentored by senior team members, has several references to assist with job searching, and has identified potential research collaborators. Prior to joining the team, she was often given individual tasks through her coursework and job, so she felt that *OR/MS Tomorrow* was a great way to become better acquainted with working in a team. Furthermore, she learned more about the journal writing/publishing process, which is key for her future in academia.

When looking at the current state of *OR/MS Tomorrow*, Yue is happy to see how the team continues to grow and improve. She is proud to be an alumni member and looks forward to what is in store for the next generation. We appreciate Yue's volunteer service to the team and taking the time to contribute to this article. We look forward to seeing what is in store for Yue as she continues to lead the way for operations research and the management sciences!