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James J. Cochran Wagner Competition Chair, Arnold Greenland Special Issue Editor

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Introduction: 2024 Daniel H. Wagner Prize for Excellence in the Practice of Advanced Analytics and Operations Research

James J. Cochran,^{a,*} *Wagner Competition Chair*; Arnold Greenland,^b *Special Issue Editor*

^aCulverhouse College of Business, University of Alabama, Tuscaloosa, Alabama 35487; ^bSilver Spring, Maryland 20906

*Corresponding author

Contact: jjcochran@ua.edu, <https://orcid.org/0000-0002-8632-8909> (JJC); arnie.greenland@gmail.com (AG)

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Abstract. The judges for the 2024 Daniel H. Wagner Prize for Excellence in the Practice of Advanced Analytics and Operations Research selected the four finalist papers featured in this special issue of the *INFORMS Journal on Applied Analytics*. The prestigious Wagner Prize—awarded for achievement in implemented operations research, management science, and advanced analytics—emphasizes the quality and originality of mathematical models along with the clarity of written and oral exposition. This year’s winning application describes a decision support system that integrates optimization techniques and machine learning algorithms to determine the product assortment at front distribution centers (from which delivery operations are managed) and daily inventory allocations from regional distribution centers to front distribution centers across JD.com’s network in China and thus, substantially enhance order fulfillment efficiency and reduce inventory and transfer costs. The remaining three papers describe iHeartMedia’s use of mathematical optimization, song metadata, predictive analytics around song performance, and radio listenership data to create music playlists; the development of a zoning system for Ninja Van to enhance last-mile delivery efficiency and boost customer satisfaction; and the use of signature transforms to predict freight transportation marketplace rates for Amazon trucking operations.

Keywords: OR/MS analytics practice • Wagner Prize • statistical estimation • optimization • machine learning • artificial intelligence • stochastic modeling • inverse control

One way the INFORMS Section on Practice supports the fields of operations research, management science, and advanced analytics is by making practice success stories available to the profession. We are therefore pleased to present the results from the 2024 competition for the Daniel H. Wagner Prize for Excellence in the Practice of Advanced Analytics and Operations Research, an INFORMS prize administered by the Practice Section and established in memory of the late Dr. Daniel H. Wagner.

Dan Wagner earned his PhD in mathematics in 1951 from Brown University. His dissertation, “On free products of groups,” was published in 1957 in *Transactions of the American Mathematical Society* (Wagner 1957). He began his career in the U.S. Navy’s Operations Evaluation Group at the Pentagon, where he worked on operations research for naval warfare. He worked there until 1956, with a one-year leave of absence for postdoctoral research on free algebras at the Massachusetts Institute of Technology. Dan then joined Burroughs Research Center, where he directed a group of mathematicians performing analysis for the development of digital computers.

In 1957, Dan’s entrepreneurial spirit took over, and together with John D. Kettelle, he formed the partnership of Kettelle and Wagner, which was dissolved in 1963. That same year, he formed a new company, Daniel H. Wagner Associates. This company performed leading-edge work in the mathematical development of naval tactics, especially for antisubmarine warfare, detection theory, and search planning.

During his years as president and principal owner of Wagner Associates, Dr. Wagner brought many high-quality mathematicians into the operations research community. This led to significant advances in the firm’s fields of endeavor and in the delivery of significant applications to the Navy, Coast Guard, and other clients, some of which are still in service today.

After retirement from his company, Dan continued his commitment to the field of operations research, serving in various teaching and research positions at the U.S. Naval Postgraduate School and the U.S. Naval Academy. He was an active member of the Operations Research Society of America and then, INFORMS for more than 40 years.

The idea for the Wagner Prize began in April 1997 at Dan's memorial service, where many of his former colleagues gathered. Following the agreements made on that day and subsequent pledges, the firms of Metron, Daniel H. Wagner Associates, and Applied Mathematics generously donated a total of \$51,000 as an endowment to ensure the availability of a cash award in perpetuity. Each of these companies is an outgrowth in large part of Dan's early efforts.

Metron (President and Chief Executive Officer (CEO) J. Van Gurley, <http://www.metsci.com>) solves challenging technical problems through rigorous innovation grounded in first principles. It develops creative, tailored solutions through advanced mathematics, computer science, physics, and engineering.

Daniel H. Wagner Associates (President and CEO W. Reynolds Monach, <http://www.wagner.com>) specializes in innovative mathematical solutions to problems in government and business. The firm provides consulting services in operations research, mathematics, and related software development. It also offers a variety of ready-made products for financial analysis.

Applied Mathematics (President William J. Browning, <http://www.applmath.com>) develops and implements mathematical models that clients use to understand their systems and processes better, thus improving performance. Current application areas include submarine warfare, search and tracking, sensor-data fusion, search and rescue, clinical informatics, uncertainty quantification, and vineyard analytics.

We are grateful to the judges who as INFORMS volunteers, donated significant amounts of time, effort, and technical diligence to evaluate the entries and select the winner of this year's competition: James J. Cochran, University of Alabama (Committee Chair); Andrea Arias, BNSF; William J. Browning, Applied Mathematics; Allen Butler, Daniel H. Wagner Associates; Greg Godfrey, Metron; Willem-Jan van Hove, Carnegie Mellon University; Kimia Ghobadi, Johns Hopkins University; Konstantina Mellou, Microsoft; Aysu Ozel, Northwestern University; and Vera Tilson, Rochester University.

The judging committee selected semifinalists based on their abstracts and verification of success in practice. The semifinalists were invited to submit full papers. Based on these, the judging committee selected the finalists, who finalized their papers and presented their work at the 2024 INFORMS Annual Meeting. Their papers constitute this special issue. Judging of the final papers and selection of the winning entry were based on the following criteria: quality and coherence of analysis, originality of mathematical solutions, quality and clarity of writing, utility or success of the work in one or more real-world practice applications, and quality and clarity of the oral presentation.

The four finalists this year again demonstrate the diversity of successful implementations of operations

research and advanced analytics. The innovative analytical methods are varied and include optimization, statistical estimation, machine learning, inverse control, and stochastic modeling. The papers benefited from the authors' affiliations with international organizations, including finalists from China, Singapore, and the United States.

This year's winning application was submitted by a team from the University of California, Berkeley; the University of Hong Kong; and technical staff from JD.com in China. The paper presents data-driven approaches for integrated assortment planning and inventory allocation at JD.com, a leading e-commerce company. Their solution employs a two-level distribution network that includes regional distribution centers (RDCs) and front distribution centers (FDCs). The paper describes improved product selection at FDCs and methods to optimize daily inventory allocation from RDCs to FDCs. The substantial benefits to JD.com are evaluated through numerical experiments that show increased local order fulfillment rates of 0.54% and improvement in FDC demand satisfaction rates of 1.05%.

Present and past employees of the broadcast radio company iHeartMedia collaborated on a paper that describes a mathematical optimization-based engine created to conform to strategic scheduling goals and key business rules that generates 24/7 music playlists for radio stations. Utilizing song metadata, such as tempo and mood, latest song research results produced by machine learning models, and radio listenership data, the engine produces music playlists that optimize strength and diversity simultaneously. The engine has decreased subjectivity in what had previously been a highly subjective and extensively manual process. It has been successfully deployed in more than 100 stations and has shown its power in efficiently and effectively creating customized music playlists across many different music formats.

A team comprising faculty members from the University of Southern California, Michigan State University, and the University of Toronto and members of the technical staff of Ninja Van, a logistics company based in Singapore, collaborated to improve Ninja Van's last-mile delivery efficiency, delivery-worker satisfaction, and overall performance. The authors employed a novel zoning optimization framework to assign customer locations to last-mile delivery stations. Their methodology integrated additively weighted Voronoi diagrams and vehicle routing problem methods to their subgradient optimization algorithm. The paper included performance improvement estimates showing an average reduction of 6.6% in the work span for the delivery stations and a 3.5% reduction in driver delivery times. In addition to the monetary benefits from the shortened work hours and many management insights gained, the new zoning system contributed to improved worker satisfaction by balancing workloads and limiting overtime.

The challenge faced by the team from the University of California, Berkeley, and technical staff from the online retail giant Amazon was how best to forecast freight transportation marketplace rates, factors that influence shipping and supply procurement costs and directly affect the company's logistical expenses. The authors developed a new statistical approach using signature transforms, a mathematical method initially developed in the 1950s, to create a predictive model that accurately forecasts marketplace rates. Key features of the signature transform include *universal nonlinearity*, which turns complex forecasting into a simpler linear regression, and the *signature kernel*, which enables efficient comparison of time series data. This combination allowed successful seasonal pattern detection for business cycles and market variability, even during major disruptions such as COVID-19 and the Ukraine conflict. The paper also includes performance improvement estimates showing a fivefold prediction accuracy improvement, resulting in cost savings of over \$50 million annually since 2021.

All four finalists demonstrated the foundations of the Wagner Prize, high quality and originality in their technical approach, insightful and clear presentations during the INFORMS annual meeting, and finally, the clear and polished papers that constitute this special issue.

Reference

Wagner DH (1957) On free products of groups. *Trans. Amer. Math. Soc.* 84(2):352–378.

James J. Cochran is professor of applied statistics and the Mike and Kathy Mouron Chair with The University of Alabama's Culverhouse College of Business. He was editor of the *Wiley Encyclopedia of Operations Research and Management Science* and the *INFORMS Analytics Body of Knowledge*, is a member of the *INFORMS Journal on Applied Analytics* editorial board, and is a Fellow of INFORMS and a recipient of the INFORMS President's Award.

Arnold Greenland is retired and focuses primarily on grandchildren and travel. Prior to this focus, he worked for more than 46 years as an analytics professional in the roles of analyst, consultant, manager, technical executive and professor. He retired from his position as a Distinguished Engineer and Executive at the IBM Corporation in 2014 and then, as Professor of the Practice at the Smith School of Business in 2021. While he worked on a broad array of operations research and analytics methods, his last years while at IBM were focused on applying machine learning methods to uncover and prevent fraud for his clients in the public sector. He is an active member of INFORMS where he is a Fellow, and remains actively engaged in the organization, serving on several boards and committees. He has a particular interest within INFORMS in the certified analytics professional certification program and the underlying job task analysis (JTA) on which the certification is based. He was a member of the group that developed the original version of the JTA and a decade later joined a team that formulated extensive revisions. The entire team received INFORMS Service Excellence Awards for this recent work.