

KYLE E. C. BOOTH

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EDUCATION

Ph.D., Industrial Engineering (Operations Research)

2015–2020 University of Toronto, Ontario, Canada
(*Expected*) Department of Mechanical & Industrial Engineering
Supervisor: Dr. J. Christopher Beck
Awards: Distinguished Paper Award (CPAIOR2018), Distinguished Student
Paper Award (CP2016)

B.A.Sc., Mechanical Engineering

2011 University of Toronto, Ontario, Canada
Department of Mechanical & Industrial Engineering

RESEARCH

Operations research, constraint programming, combinatorial optimization, quantum computing, vehicle routing, scheduling, hybrid algorithms.

Under Review

1. **Booth, K.E.C.**, Piacentini, C., Bernardini, S., & Beck, J.C., “Persistent Target Search on Road Networks with Range-Constrained UAVs and Ground-based Mobile Recharging Vehicles”, *under review at IEEE Robotics and Automation Letters*.

Journal Publications

5. Roshanaei, V., **Booth, K.E.C.**, Aleman, D., Urbach, D., & Beck, J.C., “Branch-and-Check Approaches for Multi-Level Operating Room Planning and Scheduling”, *International Journal of Production Economics*, 220, 107433, 2020.
4. **Booth, K.E.C.**, Chan, T.C.Y., & Shalaby, Yusuf, “A Mathematical Optimization Framework for Expansion Draft Decision Making and Analysis”, *Journal of Quantitative Analysis in Sports*, 15(1), 27-40, 2019.
3. Morin, M., Castro, M.P., **Booth, K.E.C.**, Tran, T.T., Liu, C., & Beck, J.C., “Intruder Alert! Optimization Models for Solving the Mobile Robot Graph-Clear Problem”, *Constraints*, 23(3), 335-354, 2018. **Journal fast-track and winner of the Distinguished Paper Award at CPAIOR2018.**

2. **Booth, K.E.C.**, Mohamed, S.C., Rajaratnam, S., Nejat, G., & Beck, J.C., “Robots in Retirement Homes: Person Search and Task Planning for a Group of Residents by a Team of Assistive Robots”, *IEEE Intelligent Systems*, 32(6), 14-21, 2017.
1. **Booth, K.E.C.**, Tran, T.T., Nejat, G., & Beck, J.C., “Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning”, *IEEE Robotics and Automation Letters*, 1(1), 500-507, 2016.

Refereed Conference Publications

6. Bernal, D., **Booth, K.E.C.**, Dridi, R., Alghassi, H., Tayur, S., Venturelli, D., “Integer programming techniques for minor-embedding in quantum annealers”, *Proceedings of the Seventeenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR2020)*, in press, 2020.
5. Senderovich, A., **Booth, K.E.C.**, & Beck, J.C., “Learning Scheduling Models from Event Data”, *Proceedings of the Twenty-Ninth International Conference on Automated Planning and Scheduling (ICAPS2019)*, 401-409, 2019.
4. **Booth, K.E.C.**, & Beck, J.C., “A Constraint Programming Approach to Electric Vehicle Routing with Time Windows”, *Proceedings of the Sixteenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR2019)*, 129-145, 2019.
3. **Booth, K.E.C.**, Do, M., Beck, J.C., Rieffel, E., Venturelli, D., & Frank, J., “Comparing and Integrating Constraint Programming and Temporal Planning for Quantum Circuit Compilation”, *Proceedings of the Twenty-Eighth International Conference on Automated Planning and Scheduling (ICAPS2018)*, 366-374, 2018.
2. **Booth, K.E.C.**, Nejat, G., & Beck, J.C., “A Constraint Programming Approach to Multi-Robot Task Allocation and Scheduling in Retirement Homes”, *Proceedings of the Twenty-Second International Conference on Principles and Practice of Constraint Programming, (CP2016)*, 539-555, 2016. **Winner of the Distinguished Student Paper Award at CP2016.**
1. **Booth, K.E.C.**, Tran, T.T., & Beck, J.C., “Logic-Based Decomposition Methods for the Travelling Purchaser Problem”, *Proceedings of the Thirteenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research, (CPAIOR2016)*, 55-64, 2016.

Refereed Workshop Papers

2. Venturelli, D., Do, M., O’Gorman, B., Frank, J., Rieffel, E., **Booth, K.E.C.**, Nguyen, T., Narayan, P., & Nanda, S., “Quantum Circuit Compilation: An Emerging Application for Automated Reasoning”, *Proceedings of the Scheduling and Planning Applications Workshop (SPARK2019)*, Berkeley, USA, July 2019.

1. **Booth, K.E.C.**, Tran, T.T., Nejat, G., Beck, J.C., “Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning”, *Proceedings of the Workshop on Constraint Satisfaction Techniques for Planning and Scheduling (COPLAS2016)*, 1-4, London, UK, June 2016.

Refereed Extended Abstracts

2. Morin, M., Castro, M.P., **Booth, K.E.C.**, Tran, T.T., Liu, C., & Beck, J.C., “Intruder Alert! Optimization Models for Solving the Mobile Robot Graph-Clear Problem”, *Proceedings of the Fifteenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR2018)*, Front Matter, XXVII, 2018.
1. **Booth, K.E.C.**, Tran, T.T., Nejat, G., & Beck, J.C., “Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning”, *Proceedings of the Twenty-Second International Conference on Principles and Practice of Constraint Programming (CP2016)*, Journal Track, 883, 2016.

WORK EXPERIENCE

NASA Ames Research Center, USRA
Associate Scientist

Mountain View, California, USA
 2020–Present

FundThrough Inc.
Advisor, Data Science

Toronto, Ontario, Canada
 June 2018–August 2019

NASA Ames Research Center, SGT Inc.
Research Intern

Mountain View, California, USA
 2017

- Developed novel technique for solving quantum circuit compilation problems using a hybridization of temporal planning and constraint programming. **Research published in ICAPS2018.**
- Drafted technical report on promising areas for the development of hybrid classical combinatorial optimization and quantum computing algorithms.
- Provided initial sketch for a dynamic logic-based Benders decomposition (d-LBBD) technique for application to hard scheduling problems.

Toromont Industries Ltd.
Manager, Product Support

Toronto, Ontario, Canada
 2011–2014

- As a mechanical engineer and group manager, lead Caterpillar heavy-equipment product support team of roughly 20 employees.
- Designed maintenance and repair contract system for fleets of heavy equipment, utilizing life-cycle cost trending to ensure profitable product support agreements.
- Worked to successfully automate and optimize various company functions including field service vehicle dispatch and certified rebuild scheduling.

TEACHING EXPERIENCE

University of Waterloo	2019
Lecturer , MSCI 555: <i>Scheduling: Theory & Practice</i>	
Course evaluation: 88/100 (Faculty average: 68.2/100)	
Instructor evaluation: 93/100 (Faculty average: 72.9/100)	
University of Toronto	2015–2018
Teaching Assistant , MIE562: <i>Scheduling</i>	
University of Toronto	2017–2019
Teaching Assistant , MIE465: <i>Analytics in Action</i>	
University of Toronto	2016–2017
Teaching Assistant , MIE262: <i>Operations Research I - Deterministic OR</i>	

PROFESSIONAL ACTIVITIES

Session Chair: INFORMS2019

Program Committee Member: IJCAI2020, ICAPS2019, AAAI2018, PlanSOpt2018, CP2016 Doctoral Program

Invited Journal Reviewer: IEEE Access, Computers & Operations Research, Journal of Applied Soft Computing, Journal of Intelligent Social Robotics

Invited Conference Reviewer: ICRA2019, SoCS2019, SoCS2018, CPAIOR2018, ICAPS2017

RESEARCH PRESENTATIONS & INVITED TALKS

12. Booth, K.E.C., Nejat, G., & Beck, J.C., “The Social Robot Routing Problem”, *INFORMS Annual Meeting (INFORMS2019)*, Seattle, Washington, USA, October 2019.
11. Booth, K.E.C., & Beck, J.C., “A Constraint Programming Approach to Electric Vehicle Routing with Time Windows”, *Sixteenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR2019)*, Thessaloniki, Greece, June 2019.
10. Booth, K.E.C., Do, M., Beck, J.C., Rieffel, E., Venturelli, D., & Frank, J., “Comparing and Integrating Constraint Programming and Temporal Planning for Quantum Circuit Compilation”, *Twenty-Eighth International Conference on Automated Planning and Scheduling (ICAPS2018)*, Delft, Netherlands, June 2018. [\[talk\]](#)
9. Booth, K.E.C., Mohamed, S.C., Rajaratnam, S., Nejat, G., & Beck, J.C., “Robots in Retirement Homes: Person Search and Task Planning for a Group of Residents by a Team of Assistive Robots”, *Twenty-Eighth International Conference on Automated Planning and Scheduling (ICAPS2018) - Journal Presentation Track*, Delft, Netherlands, June 2018. [\[talk\]](#)
8. Roshanaei, V., Booth, K.E.C., Aleman, D., Urbach, D., & Beck, J.C., “Decomposition Methods for Multi-Level Operating Room Planning and Scheduling”, *IISE Annual Conference & Expo (IISE2017)*, Pittsburgh, Pennsylvania, United States, May 2017.

7. Booth, K.E.C., Tran, T.T., G. Nejat, & Beck, J.C., “A Constraint Programming Approach to Multi-Robot Task Allocation and Scheduling in Retirement Homes”, *Twenty-Second International Conference on Principles and Practice of Constraint Programming (CP2016)*, Toulouse, France, September 2016. [[talk](#)]
6. Booth, K.E.C., Tran, T.T., G. Nejat, & Beck, J.C., “Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning”, *Twenty-Second International Conference on Principles and Practice of Constraint Programming (CP2016) - Journal Presentation Track*, Toulouse, France, September 2016.
5. Booth, K.E.C., Tran, T.T., G. Nejat, & Beck, J.C., “Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning”, *Constraint Satisfaction Techniques for Planning and Scheduling, (COPLAS2016)*, London, England, June 2016.
4. Booth, K.E.C., “Optimization Approaches to Multi-Robot Planning and Scheduling”, *Twenty-Sixth International Conference on Automated Planning and Scheduling (ICAPS 2016) - Doctoral Consortium*, London, England, June 2016.
3. Booth, K.E.C., Roshanaei, V., Aleman, D., Urbach, D., & Beck, J.C., “Optimal Operating Room Allocation to Multiple Surgical Specialties Using Decomposition Methods”, *Canadian Operations Research Society Annual Conference, (CORS2016)*, Banff, Alberta, Canada, May 2016.
2. Booth, K.E.C., Tran, T.T., & Beck, J.C., “Logic-Based Decomposition Methods for the Travelling Purchaser Problem”, *Thirteenth International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR2016)*, Banff, Alberta, Canada, May 2016.
1. Booth, K.E.C., Tran, T.T., & Beck, J.C., “Decomposition Methods for the Travelling Purchaser Problem: A Computational Study”, *International Symposium on Artificial Intelligence and Mathematics, (ISAIM2016)*, Fort Lauderdale, USA, January 2016.

MENTORING

All students were co-advised with Professor J. Christopher Beck.

Undergraduate Thesis Students (Full year)

1. Mengli Duan, Division of Engineering Science 2018–2019
Thesis: “Task Allocation Strategies for Robotic Mobile Fulfillment Systems”.

Research Project Students (Single semester)

2. Kejie Zhao, Division of Engineering Science Summer 2017
Project: “Online Task Allocation Strategies for Autonomous Order Fulfillment”.
1. Alice Nuz, Division of Engineering Science Summer 2016
Project: “Variable State Independent Decaying Sum in Logic-based Benders Decomposition”.

HONORS & AWARDS

- Ontario Graduate Scholarship 2019–2020
- Journal presentation track, ICAPS 2019
- Ontario Graduate Scholarship 2018–2019
- APSC Graduate Student Endowment Fund Award 2018
- Journal fast-track and Distinguished Paper Award, CPAIOR 2018
- Journal presentation track, ICAPS 2018
- Edmond G. Odette Scholarship 2017–2018
- Mart Liinve Graduate Scholarship 2016–2017
- Journal presentation track, CP 2016
- Distinguished Student Paper Award, CP 2016

LEADERSHIP

The Operations Research Challenge (TORCH) Toronto, Ontario, Canada
President (2018, 2019), Chief Information Officer (2017) 2016–2019

- President of leadership team for annual hackathon (www.orchallenge.com).
- Introduced roughly 150 high school students each year to field of operations research.
- Lead initiative to automate core TORCH functions in an effort to transition competition away from paper-based entry and grading to web user interface and back-end.

University of Toronto Operations Research Group (UTORG) Toronto, Ontario, Canada
Co-President (2016-2017), Webmaster (2015-2017) 2015–2017

- Responsible for growth of student group focused on the promotion of operations research (OR) and related fields at the University of Toronto.
- Founded annual *Optapalooza* constraint satisfaction and optimization hackathon and developed associated web user interface and back-end.

OTHER ATTENDED EVENTS

6. Quantum Computing Short Course, *Air Force Institute of Technology (AFIT)* 2020
Dayton, Ohio, USA
5. Summer School on Cognitive Robotics, *Massachusetts Institute of Technology* 2017
Cambridge, Massachusetts, USA
4. Summer School on Planning and Scheduling, *ICAPS, King's College London* 2016
London, United Kingdom
3. Doctoral Consortium, *ICAPS, King's College London* 2016
London, United Kingdom
2. Master Class on Decomposition Methods, *CPAIOR* 2016
Banff, Alberta, Canada
1. Summer School on Constraint Programming, *ACP, University of Toronto* 2015
Toronto, Ontario, Canada

TECHNICAL SKILLS

Programming	C, C++, Python, MATLAB/Octave, R, PHP, Javascript
Scientific	Pandas, NumPy, Jupyter/Anaconda
Databases	MySQL, SQL, MongoDB, Amazon Redshift
Optimization	CPLEX, CP Optimizer, Gurobi, SCIP, OR-Tools, MiniZinc
Inference	Scikit-learn, XGBoost, PyTorch, TensorFlow
Environments	Linux, Windows