CURRICULUM VITÆ

PAUL A.S.WARD

1 Personal Data

Paul A.S. Ward
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1.1 Degrees

2002: Ph.D. (Computer Science), University of Waterloo
Thesis: A Scalable Partial-Order Data Structure for Distributed-System Observation
Supervisor: David J. Taylor

1993: MASc (Computer Engineering), University of Waterloo
Thesis: A Propositional Meta-Constraint System

1988: BScE (Electrical Engineering, Computer Engineering Option), University of New Brunswick
Thesis: A Bit-Serial Digital Filter Section in CMOS VLSI

1.2 Employment

2025 to Present: **Chief Technical Officer**
ThinkResult, Inc.

2023 to 05/2026: **Associate Director Software Engineering**
University of Waterloo.

2008 to Present: **Associate Professor**
Department of Electrical and Computer Engineering
University of Waterloo.

2002 to 2008: **Assistant Professor**
Department of Electrical and Computer Engineering
University of Waterloo.

1998 to Present: **Ward Research Services**
Provide technical expertise to various businesses, including legal firms McCarthy Tétrault, Green & Chercover, and Gilbert's, LLP.

2009 to 2010:	**Technical Advisor** Pravala Chief technical advisor to Pravala Focus on seamless network blending between 3G and WiFi
1998 to 2002:	**System Administrator** Shoshin Distributed Systems Group Department of Computer Science University of Waterloo
May to Sept., 1997–2000:	**Visiting Researcher** Centre for Advanced Studies IBM Toronto Laboratory
1996:	**Research Associate** Simon Fraser University Burnaby, British Columbia
1994 to 1996:	**Software Developer** Database Group IBM Toronto Laboratory
1993:	**Visiting Researcher** Weizmann Institute of Science Rehovot, Israel
1988 to 1990:	**Design Engineer** Applied Microelectronics Halifax, Nova Scotia

1.3 Awards

- ECE Distinguished Performance Award, 2008.
- IBM CAS Faculty Fellow, 2004 to 2012
- IBM CAS Fellowship, 1997 to 2000, $100,000.
- NSERC ’67 Scholarship, 1990-1992, $42,000.
- Governor General’s Medal, 1988.

2 Research and Scholarship

Current Research Interests

- Dependable and Self-Managing Systems
  - Adaptive monitoring, anomaly detection, fault localization, diagnosis, and self-recovery
  - Runtime behavioural modeling
  - Metric-correlation models for complex software systems
  - Cloud and enterprise-system observability
  - Logging, tracing, and log analysis
- Computing Education and Learning Analytics
  - Predictive modeling of student performance
  - Automated assessment and feedback systems
  - Early identification of students requiring support
  - Educational data analytics

Prior Research Contributions

- Self-Configuring and Mobile Networks
  - Delay-tolerant networks
  - Wireless mesh networks
  - Multi-interface mobile systems
  - Scalable dependable software routers
- Distributed Middleware and Service Architectures
  - Event-driven programming models
  - Service discovery and coordination
  - Blockchain and distributed ledger technologies
  - Sharding protocols and cross-shard transaction optimization

2.1 Publications

Students supervised by me are marked with (*). The convention I use for authorship is students first, then supervisors, alphabetic within those groups, unless one of the students/supervisors takes a clear lead in the work. For conference and workshop papers, the number of submitted and accepted papers is indicated as (accepted/submitted; percent accepted) where known. For online publications, the number of pages in the article is identified rather than the page numbers.

2.1.1 Articles in Refereed Journals

[J9] Masoomeh Rudafshani* and Paul A.S. Ward: LeakSpot: detection and diagnosis of memory leaks in JavaScript applications. *Software Practice and Experience* Volume 47, Number 1, pp. 97-123, January, 2017.

[J8] Kamran Jamshaid*, Paul A.S. Ward, Martin Karsten, and Basem Shihada. The efficacy of centralized flow rate control in 802.11-based wireless mesh networks. *EURASIP Journal on Wireless Communications and Networking*. Volume 2013, article number 163, 2013. 17 pages.
[J7] Kamran Jamshaid,* Paul A.S. Ward, and Martin Karsten. Mechanisms for centralized flow rate control in 802.11-based wireless mesh networks. In *Computer Networks,* Volume 56, Number 2, pp. 884-901, February, 2012.
[J6] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. System monitoring with metric-correlation models. In *IEEE Trans. on Network and Service Management,* Volume 8, Number 4, pp. 348–360, December, 2011.
[J5] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Efficient fault detection and diagnosis in complex software systems with information-theoretic monitoring. In *IEEE Transactions on Dependable and Secure Computing,* Volume 8, Number 4, pp. 510–522, August, 2011.
[J4] Mohammad A. Munawar* and Paul A.S. Ward. Using simple statistical models to adaptively monitor software systems. In the *International Journal of High Performance Computing and Networking,* Volume 7, Number 1, pp 29–39, 2011.
[J3] Mohammad A. Munawar,* Kevin Quan,* and Paul A.S. Ward. Integrating monitoring data for problem determination in business-critical software systems. In *The Journal of Autonomic and Trusted Computing*. Submitted 1st November 2007; Accepted 1st February 2008. pp 14.
[J2] Evan P.C. Jones,* Lily Li,* Jakub K. Schmidtke,* and Paul A.S. Ward. Practical routing in delay-tolerant networks. In *IEEE Transactions on Mobile Computing,* Volume 6, Number 8, pp. 943–959, August, 2007.
[J1] Mohammad A. Munawar* and Paul A.S. Ward. Better performance or better manageability? In *ACM SIGSOFT Software Engineering Notes,* Volume 30, Number 1, pp. 1–4, January 2005.

2.1.2 Articles in Refereed Conference and Workshop Proceedings

[C77] Paniz Ojaghi*, Mike Cooper-Stachowsky, and Paul A.S. Ward. Reducing LLM grading inconsistency through quality dimension refinement: A measurement-theory approach. In *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Moncton, NB, Canada, 2026. 7 pages.
[C76] Huanyi Chen* and Paul A.S. Ward. Providing High-Quality Formative Feedback for Database Assignments. In *Proceedings of the American Society for Engineering Education (ASEE) Annual Conference*, Portland, Oregon, 2024. 16 pages.
[C75] Huanyi Chen* and Paul A.S. Ward. Enhancing Automated Feedback in On-Going Assignments. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education (SIGCSE)*, 2024, 1596-1597.
[C74] Huanyi Chen* and Paul A.S. Ward. The Value of Time Extensions in Identifying Students Abilities. In *Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education (ITiCSE)*, 2023, 512-518.
[C73] Huanyi Chen* and Paul A.S. Ward. Connecting actionable feedback with course concepts using an auto-feedback framework: A case study in a database course. In *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Kelowna, BC, Canada, 2023. 10 pages.

[C72] Liuyang Ren* and Paul A.S. Ward, Bernard Wong. Toward reducing cross-shard transaction overhead in sharded blockchains. In *Proceedings of the 16th ACM International Conference on Distributed and Event-based Systems (DEBS)*, 2022, 43-54 (received best paper award).

[C71] Huanyi Chen* and Paul A.S. Ward. Clustering Students Using Pre-Midterm Behaviour Data and Predict Their Exam Performance. In *Proceedings of the 15th International Conference on Educational Data Mining (EDM)*, 2022.

[C70] Huanyi Chen* and Paul A.S. Ward. Metacognitive accuracy in homework assignments, time-limited quizzes, and learning objectives. In *Proceedings of the 30th International Conference on Computers in Education (ICCE)*, 2022. 6 pages.

[C69] Liuyang Ren*, Paul A.S. Ward, and Bernard Wong. Improving the Performance of Blockchain Sharding Protocols with Collaborative Transaction Verification. In *Proceedings of the 2021 International Conference on Blockchain (Blockchain)*, 2021. 462-469.

[C68] Sina Gholamian* and Paul A.S. Ward. On the Naturalness and Localness of Software Logs. In *Proceedings of the 18th International Conference on Mining Software Repositories (MSR)*, 2021. 155-166.

[C67] Liuyang Ren*, Wei-Ting Chen, and Paul A.S. Ward. SnapshotSave: fast and low storage demand blockchain bootstrapping. In *Proceedings of the 36th ACM/SIGAPP Symposium on Applied Computing (SAC)*, 2021. 291-300.

[C66] Sina Gholamian* and Paul A.S. Ward. What distributed systems say: A study of seven spark application logs. In *Proceedings of the 40th International Symposium on Reliable Distributed Systems (SRDS)*, 2021. 222-232.

[C65] Sina Gholamian* and Paul A.S. Ward. Logging statements' prediction based on source code clones. In *Proceedings of the 35th ACM/SIGAPP Symposium on Applied Computing (SAC)*, 2020. 82-91.

[C64] Huanyi Chen* and Paul A.S. Ward. Predicting student performance using data from an autograding system. In *Proceedings of the 29th Annual International Conference on Computer Science and Software Engineering (CASCON)*, 2019. 234-243.

[C63] Liuyang Ren* and Paul A.S. Ward. Pooled Mining is Driving Blockchains Toward Centralized Systems. In *Proceedings of the IEEE International Symposium on Reliable Distributed Systems Workshops (SRDS Workshops)*, 2019. 43-48.

[C62] Sina Gholamian*, Wojciech M. Golab, and Paul A.S. Ward. Efficient incremental data analytics with apache spark. In *Proceedings of the IEEE International Conference on Big Data (IEEE BigData)*, 2017. 2859-2868.

[C61] Riyad Parvez*, Paul A.S. Ward, and Vijay Ganesh. Combining static analysis and targeted symbolic execution for scalable bug-finding in application binaries. In *Proceedings of the 26th Annual International Conference on Computer Science and Software Engineering (CASCON)*, 2016. 116-127.

[C60] David Xi Cheng*, Wojciech M. Golab, and Paul A.S. Ward. Efficient Incremental Smart Grid Data Analytics. In *EDBT/ICDT Workshops*, 2016.

[C59] Steven B. McFadden* and Paul A.S. Ward. Improving Image Quality of Tiled Displays. In *Proceedings of the 12th International Conference on Image Analysis and Recognition (ICIAR)*, 2015. 22-29.

[C58] Paul A.S. Ward, Kshirasagar Naik, and Jakub K. Schmidtke*. Efficient Hashing for Dynamic Per-Flow Network-Interface Selection. In *Proceedings of the 28th IEEE International Conference on Advanced Information Networking and Applications (AINA)*, 2014. 441-448.

[C57] Steven B. McFadden* and Paul A.S. Ward. Towards a new image quality metric for evaluating the effects of tiled displays. In *Proceedings of the IEEE International Conference on Image Processing (ICIP)*, 2014. 561-565.
[C56] Steven B. McFadden* and Paul A.S. Ward. A new image quality assessment database for tiled images. In *Image Quality and System Performance XI (IQSP) (part of IS&T/SPIE Electronic Imaging)*, 2014. 90160X.
[C55] Giyeong Son* and Paul A.S. Ward. Opportunistic bit-rate selection in multi-vehicular networks. In *IEEE International Conference on Advanced Information Networking and Applications (AINA-2013)*. 716-723. (159/587; 28%)
[C54] Nicholas Armstrong* and Paul A.S. Ward. Just-in-time push prefetching: Accelerating the mobile web. In *IEEE International Conference on Advanced Information Networking and Applications (AINA-2013)*. 1064-1071. (159/587; 28%)
[C53] Masoomeh Rudafshani,* Paul A.S. Ward, and Bernard Wong. MemRed: Towards reliable web applications. In *Proceedings of the Workshop on Secure and Dependable Middleware for Cloud Monitoring and Management (SDMCMM '12),* December, 2012. 1-6.
[C52] Masoomeh Rudafshani* and Paul A.S. Ward. Improving the reliability and availability of browsers. In *Proceedings of the Middleware Doctoral Symposium,* December, 2012. 1-6.
[C51] Steven B. McFadden* and Paul A.S. Ward. Selecting the Proper Window for SSIM. In *SPIE Image Quality and System Performance,* January, 2012. 10 pages.
[C50] Robert Robinson* and Paul A.S. Ward. An architecture for reliable encapsulation endpoints using commodity hardware. In *IEEE Symposium on Reliable Distributed Systems,* pp. 183–192, October,, 2011. (23/88; 26%)
[C49] Miao Jiang* and Paul A.S. Ward. A game-theory model for bandwidth allocation in multi-hop wireless networks. In *IEEE International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob),* pp. 222–229, October, 2011.
[C48] Thomas Reidemeister,* Miao Jiang,* and Paul A.S. Ward. Learning to self-recover. In *Proceedings of the 6th IFIP/IEEE International Workshop on Business-driven IT Management (BDIM),* pp. 1062–1065, May, 2011.
[C47] Thomas Reidemeister,* Miao Jiang,* and Paul A.S. Ward. Mining unstructured log files for recurrent fault diagnosis. In *Proceedings of the 12th IFIP/IEEE International Symposium on Integrated Network Management (IM),* pp 377–384, May, 2011.
[C46] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Dependency-aware fault diagnosis with metric-correlation models in enterprise software systems. In *Proceedings of the 6th International Conference on Network and Service Management,* pp 134–141, October, 2010. (27/176; 15%)
[C45] Thomas Reidemeister,* Miao Jiang,* and Paul A.S. Ward. An extensible framework for repair-driven monitoring. In *Proceedings of the 6th International Conference on Network and Service Management.* October, 2010. (27/176; 15%)
[C44] Thomas Reidemeister,* Mohammad A. Munawar,* and Paul A.S. Ward. Identifying symptoms of recurrent faults in log files of distributed information systems. In *Proceedings of the 12th IEEE/IFIP Network Operations and Management Symposium (NOMS).* April, 2010.
[C43] Thomas Reidemeister,* Mohammad A. Munawar,* Miao Jiang,* and Paul A.S. Ward. Diagnosis of recurrent faults using log files. In *Proceedings of the 2009 Conference of the Center for Advanced Studies on Collaborative Research (CASCON)*. November, 2009.

[C42] Kamran Jamshaid* and Paul A.S. Ward. Gateway-assisted max-min rate allocation for wireless mesh networks. In *Proceedings of the 12th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*. pp. 38–45. ACM, October, 2009. (42/178; 24%)

[C41] Mohammad A. Munawar,* Miao Jiang,* Thomas Reidemeister,* and Paul A.S. Ward. Filtering system metrics for minimal correlation-based self-monitoring. In *Proceedings of the 3rd IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO)*. pp. 233–242. IEEE, September, 2009. (27/74; 36%)

[C40] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Automatic fault detection and diagnosis in complex software systems by information-theoretic monitoring. In *Proceedings of the 39th International Conference on Dependable Systems and Networks (DSN)*. pp. 285–294. IEEE, July, 2009. (37/177; 21%)

[C39] Mohammad A. Munawar,* Miao Jiang,* and Paul A.S. Ward. Incremental budget-constrained system modeling and tracking. In *Hot Topics in Autonomic Computing (HotAC)*. June 2009.

[C38] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. System monitoring with metric-correlation models: Problems and solutions. In *Proceedings of the 6th International Conference on Autonomic Computing and Communications (ICAC)*. pp. 13–22. ACM, June, 2009. (15/95; 16%)

[C37] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Heteroscedastic models to track relationships between management metrics. In *Proceedings of the 11th IFIP/IEEE International Symposium on Integrated Network Management (IM)*. pp. 375-381. IEEE, June, 2009. (41/125; 33%)

[C36] Paul A.S. Ward *et al.*. Wheels within wheels: Making fault management cost-effective. In *Dagstuhl Seminar on Self-Healing and Self-Adapting Systems*. May 2009.

[C35] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Detection and diagnosis of recurrent faults in software systems by invariant analysis. In *Proceedings of the 11th IEEE High Assurance Systems Engineering Symposium (HASE)*. pp. 323–332. IEEE, 2008. (41/196; 22%)

[C34] Kamran Jamshaid* and Paul A.S. Ward. Centralized feedback-driven rate-allocation mechanism for CSMA/CA-based wireless mesh networks. In *Proceedings of the 11th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*. pp. 387–394. ACM, 2008. (40/188; 21%)

[C33] Thomas Reidemeister,* Miao Jiang,* and Paul A.S. Ward. Differential tracing for self-monitoring in enterprise software systems. Accepted for poster presentation at the *2nd IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO)*.

[C32] Allen Ajit George* and Paul A.S. Ward. An architecture for providing context in WS-BPEL processes. In *Proceedings of the 2008 Conference of the Center for Advanced Studies on Collaborative Research (CASCON)*. pp. 289–303. ACM, 2008. (23/73; 32%)

[C31] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Information-theoretic modeling for tracking the health of complex software systems. In *Proceedings of the 2008 Conference of the Center for Advanced Studies on Collaborative Research (CASCON)*. pp. 236–247. ACM, 2008. (23/73; 32%)

[C30] Cecil M. Reid* and Paul A.S. Ward. Soft QoS in CSMA/CA-based wireless mesh networks. In *Proceedings of the 2008 IEEE Wireless Communications and Networking Conference (WCNC)*. pp. 2265–2270. IEEE, 2008. ISBN: 978-1-4244-1997-5

[C29] Mohammad A. Munawar,* Thomas Reidemeister,* Miao Jiang,* Allen A. George,* and Paul A.S. Ward. Adaptive monitoring with dynamic differential tracing-based diagnosis. In *DSOM 2008: the 19th IFIP/IEEE International Workshop on Distributed Systems: Operations and Management*. pp. 162–175. Springer, 2008. (14/44; 32%)

[C28] Mohammad A. Munawar,* Miao Jiang,* and Paul A.S. Ward. Monitoring multi-tier clustered systems with invariant metric relationships. In *SEAMS '08: Proceedings of the 2008 International Workshop on Software Engineering for Adaptive and Self-Managing Systems,* pp. 73–80. ACM, 2008. ISBN: 978-1-60558-037-1.

[C27] Rajesh Palit,* Paul A.S. Ward, Ajit Singh, and Sagar Naik. Energy-aware co-operative (ECO) relay-based packet transmission in wireless networks. In *Proceedings of the 2008 IEEE Wireless Communications and Networking Conference (WCNC)*. pp. 2875–2880. IEEE, 2008. ISBN: 978-1-4244-1997-5

[C26] Mohammad A. Munawar* and Paul A.S. Ward. A comparative study of pairwise regression techniques for problem determination. In *Proceedings of the 2007 Conference of the Center for Advanced Studies on Collaborative Research (CASCON*), pp. 152–166. ACM, 2007. (18/66; 27%)

[C25] Mohammad A. Munawar* and Paul A.S. Ward. Leveraging many simple statistical models to adaptively monitor software systems. In *Proceedings of the 5th International Symposium on Parallel and Distributed Processing and Applications (ISPA),* volume 4742 of *Lecture Notes in Computer Science,* pp. 457–470. Springer, 2007. ISBN: 978-3-540-74741-3. (83/244; 34%).

[C24] Lily Li* and Paul A.S. Ward. Structural Unfairness in 802.11-based Wireless Mesh Networks. In *Proceedings of the 5th Annual Communication Networks and Services Research Conference (CNSR),* pp. 213–220. IEEE Computer Society, 2007. ISBN: 0-7695-2835-X.

[C23] Mohammad A. Munawar,* Kevin Quan,* and Paul A.S. Ward. Interaction analysis of heterogeneous monitoring data for autonomic problem determination. In *The 2007 IEEE International Symposium on Ubisafe Computing,* pp. 536–542. IEEE Computer Society, 2007. ISBN: 0-7695-2847-3.

[C22] Kamran Jamshaid* and Paul A.S. Ward. Experiences using gateway-enforced rate-limiting techniques in wireless mesh networks. In *Proceedings of the 2007 IEEE Wireless Communications and Networking Conference (WCNC)*. pp. 3725–3730. IEEE, 2007. ISBN: 1-4244-0659-5.

[C21] Kamran Jamshaid,* Lily Li,* and Paul A.S. Ward. Gateway rate control of wireless mesh networks. In *Proceedings of the First International Workshop on Wireless Mesh Networks (WiMesh-Nets 2006),* in the CD *Proceedings of the 3rd International Conference on Quality of Service in Heterogeneous Wired/Wireless Networks*. ACM, 2006. ISBN: 1-59593-537-1.

[C20] Mohammad A. Munawar* and Paul A.S. Ward. Adaptive monitoring in enterprise software systems. In *SIGMETRICS 2006 Proceedings of the First Workshop on Tackling Computer Systems Problems with Machine Learning Techniques (SysML),* 2006. Electronic publication available at: http://research.microsoft.com/workshops/sysml/papers/sysml-Munawar.pdf.

[C19] Michael Jarrett* and Paul A.S. Ward. Trusted computing for protecting ad-hoc routing. In *Proceedings of the 4th Annual Communication Networks and Services Research Conference (CNSR),* , pp. 61–68. IEEE Computer Society, 2006. ISBN: 0-7695-2578-4

[C18] Vijay Dheap* and Paul A.S. Ward. Event-driven response architecture for event-based computing. In *Proceedings of the 2005 Conference of the Center for Advanced Studies on Collaborative Research (CASCON*), pp. 70–82. IBM Press, 2005. (24/80; 30%)

[C17] Mohammad A. Munawar *and Paul A.S. Ward. Better performance or better manageability? In *Design and Evolution of Autonomic Application Software, (DEAS)* pp. 1-4, 2005. ACM Press.

[C16] Paul A.S. Ward and Dwight Bedassé*. Fast convex closure for efficient predicate detection. In *Euro-Par 2005 Parallel Processing: 11th International Euro-Par Conference,* volume 3648 of *Lecture Notes in Computer Science,* pp. 30–39. Springer, 2005. ISBN: 3-540-28700-0. (121/388; 31%)

[C15] Mohammad A. Munawar* and Paul A.S. Ward. Memory-usage prediction in systems using automatic memory management. In the *3rd Proactive Problem Prediction, Avoidance and Diagnosis Conference (P3AD),* IBM Academy of Technology, 2005.

[C14] Evan P.C. Jones,* Lily Li,* and Paul A.S. Ward. Practical routing in delay-tolerant networks. In *SIGCOMM Workshop on Delay-Tolerant Networking (WDTN),* pp. 237–243, ACM Press, 2005. ISBN: 1-59593-026-4. (8/36; 22%)

[C13] Evan P.C. Jones,* Martin Karsten, Paul A.S. Ward. Multipath load balancing in multi-hop wireless networks. In *Proceedings of the IEEE International Conference on Wireless And Mobile Computing, Networking And Communications (WiMob),* Volume 2, pp. 158–166. IEEE Communications Society, 2005. ISBN: 0-7803-9181-0.

[C12] Mohammad A. Munawar* and Paul A.S. Ward. Are two interfaces better than one? In *Proceedings of the IEEE International Conference on Wireless And Mobile Computing, Networking And Communications (WiMob),* Volume 2, pp. 119–125. IEEE Communications Society, 2005. ISBN: 0-7803-9181-0.

[C11] Thomas Reidemeister,* Klemens Böhm, Erik Buchmann, and Paul A.S. Ward. Malicious behaviour in content-addressable peer-to-peer networks. In *Proceedings of the 3rd Annual Communication Networks and Services Research Conference (CNSR),* pp. 319–326. IEEE Computer Society, 2005. ISBN: 0-7695-2333-1.

[C10] Dushyant Bansal* and Paul A.S. Ward. Third-party flow control. In *Proceedings of the 3rd Annual Communication Networks and Services Research Conference (CNSR),* pp. 118–124, IEEE Computer Society, 2005. ISBN: 0-7695-2333-1.

[C9] Amol Shukla,* Lily Li,* Anand Subramanian,* Paul A.S. Ward, and Tim Brecht. Evaluating the performance of user-space and kernel-space web servers. In *Proceedings of the 2004 Conference of the Center for Advanced Studies on Collaborative Research (CASCON*), pp. 189–201. IBM Press, 2004. (24/97; 25%)

[C8] Paul A.S. Ward, Tao Huang,* and David J. Taylor. Clustering strategies for cluster timestamps. In *International Conference on Parallel Processing (ICPP),* pp. 73–81, IEEE Computer Society, 2004. ISBN: 0-7695-2197-5. (65/190; 34%)

[C7] Ann Lee* and Paul A.S. Ward. A study of routing algorithms in wireless mesh networks. In *Proceedings of the Australian Telecommunication Networks and Applications Conference (ATNAC),* pp. 465–468. ATNAC, 2004. ISBN: 0-646-44190-6

[C6] Vijay Dheap,* Mohammad A. Munawar,* Sagar Naik and Paul A.S. Ward. Parameterized neighbourhood-based flooding for ad hoc networks. In *MilCom 2003: IEEE Military Communications Conference,* Volume 2, pp. 1048–1053. IEEE, 2003. ISBN: 0-7803-8140-8.

[C5] Paul A.S. Ward and David J. Taylor. Self-organizing hierarchical cluster timestamps. In *Euro-Par 2001 Parallel Processing: 7th International Euro-Par Conference,* volume 2150 of *Lecture Notes in Computer Science,* pp. 46–56. Springer, 2001. ISBN: 3-540-42495-4. (69/207; 33%)

[C4] Paul A.S. Ward and David J. Taylor. A hierarchical cluster algorithm for dynamic, centralized timestamps. In *Proceedings of the The 21st International Conference on Distributed Computing Systems (ICDCS),* pp. 585-593, IEEE Computer Society, 2001. ISBN: 0-7695-1077-9. (69/217; 32%)

[C3] Paul A.S. Ward. A Framework for Dynamic, Centralized Dimension-Bounded Timestamps. In *Proceedings of the 2000 Conference of the Center for Advanced Studies on Collaborative Research (CASCON)*, pp. 78–87. IBM Press, 2000. (17/47; 36%)
[C2] Paul A.S. Ward. An offline algorithm for dimension-bound analysis. In *Proceedings of the 1999 International Conference on Parallel Processing (ICPP),* pp. 128–136. IEEE Computer Society, 1999. ISBN: 0-7695-0350-0. (62/194; 32%)
[C1] Paul A.S. Ward. An online algorithm for dimension-bound analysis. In *Euro-Par 2001 Parallel Processing: 5th International Euro-Par Conference,* volume 1685 of *Lecture Notes in Computer Science,* pp. 144–153. Springer, 1999. ISBN: 3-540-66443-2. (111/343; 32%)

2.1.3 Conference Papers with Refereed Abstracts

[A9] Paul A.S. Ward and Ope Salau*. Incorporating cheating assessments in modeling student learning. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Moncton, NB, Canada, 2026.
[A8] Paul A.S. Ward. Integrating professional software development practices into first-year engineering education. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Moncton, NB, Canada, 2026.
[A7] Paul A.S. Ward. Improving relational algebra query understanding with a relational algebra compiler. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Edmonton, AL, 2024.
[A6] Huanyi Chen* and Paul A.S. Ward. Scalable feedback on entity-relationship designs. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Edmonton, AL, 2024.
[A5] Paul A.S. Ward. Reducing errors in database design through structured design encoding. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Edmonton, AL, 2024.
[A4] Paul A.S. Ward and Huanyi Chen*. Engaging students through semi-automated feedback of database-design problems. *Proceedings of the Canadian Engineering Education Association (CEEA) Annual Conference*, Kelowna, BC, 2023.
[A3] Huanyi Chen* and Paul A.S. Ward. Metacognition in design and non-design questions. *Canadian Design Workshop*, 2022.
[A2] Paul A.S. Ward and Huanyi Chen*. Semi-automated feedback of entity-relationship database-design problems. *Canadian Design Workshop*, 2022.
[A1] Mohammad A. Munawar* and Paul A.S. Ward. System models for problem determination. In the *4th Proactive Problem Prediction, Avoidance and Diagnosis Conference (P3AD),* IBM Academy of Technology, 2006.

2.1.4 Patents

Patent Issued

[P2] Edwin Chan* and Paul A.S. Ward. Brokering Mobile Web Services. US Patent Number 7,904,561. Issued: March 8$^{\text{th}}$, 2011.

[P1] Kevin Quan,* Marin Litoiu, Valentina Popescu, and Paul A.S. Ward. Method for Solving Application Failures Using Social Collaboration. US Patent Number 7,904,403. Issued: March 8th, 2011.

Patent Applications

[P4] Jakub Schmidtke* and Paul A.S. Ward. Transmitting data over a plurality of different networks. US Patent Application No. 20120178487 (published July 12th, 2012). See http://www.google.com/patents/US20120178487.

[P3] Lily Li, Nicholas Armstrong,* Robert Robinson,* Jakub Schmidtke,* Tajinder Manku, and Paul A.S. Ward. Communication between client and server using multiple networks. US Patent Application No. 20120120962 (published May 17th, 2012). See http://www.google.com/patents/US2012012096.

2.1.5 Invited Lectures and Presentations

[I33] Invited Debater, The Waterloo Forum: "Will AI undermine Canadian democratic institutions?" With Dr. Jesse Hoey, Dr. Florian Kerschbaum, and Dr. Matthew Silk. University of Waterloo, September 17th, 2025.
[I32] Staying Sane in Graduate School and Beyond. Presented to Computer Science Graduate Students, University of Waterloo. September, 2018.
[I31] Recovery-Driven Autonomic Management. Queen's University, Kingston, Ontario. August 11th, 2015.
[I30] Cloud Monitoring. IBM CAS University Days, Cloud Track, IBM Toronto Lab, Markham. 24th April, 2012.
[I29] Cost-driven self-recovery. 5th International Workshop on Cloud Computing, Toronto. 8th November, 2011.
[I28] Run-time behavioural models for error detection, fault diagnosis, and self-recovery. University of Cambridge, England, 11th October, 2011.
[I27] Monitoring the Cloud. Workshop on Model-Integrated Software Service Engineering, Waterloo. 4th August, 2011.
[I26] Monitoring the Cloud. IBM CAS University Days, Cloud Track, IBM Toronto Lab, Markham. 19th April, 2011.
[I25] What does a Computer Scientist do? Talk to Waterloo Collegiate Institute Grade 11 Computer Science class. 25th February, 2011.
[I24] Paul A.S. Ward. Repair-Driven Monitoring. 4th International Workshop on Cloud Computing, Toronto. 3rd November, 2010.
[I23] Paul A.S. Ward. Proactive Failure Avoidance, Recovery and Maintenance Panel. International Conference on Dependable Systems and Networks, Chicago. 28th June, 2010.
[I22] Paul A.S. Ward. Intelligent Monitoring for Problem Determination and Resolution. 6th International Conference on Network and Service Management, Niagara Falls. 29th October, 2010.
[I21] Paul A.S. Ward. Towards a Theory of Self-Repairing Software. Workshop on Model-Integrated Software Service Engineering, Waterloo. 22nd July, 2010.

[I20] Cost-Aware and Adaptive Monitoring for Problem Determination (or: Speculative Monitoring Considered Harmful). Schloss Dagstuhl, Germany. 12 May, 2009.
[I19] Invited participant to Dagstuhl Seminar 09201: Self-Healing and Self-Adaptive Systems. Schloss Dagstuhl, Germany. 10–15 May, 2009.
[I18] Grand Challenges in Self-Management: Self-Monitoring of Large-Scale Software Systems. Workshop on Hot Topics in Autonomic Computing, International Conference on Autonomic Computing, Chicago, Illinois, USA. 2nd June, 2008.
[I17] Intelligent Monitoring for Problem Determination. Vrije Universiteit, Amsterdam, The Netherlands. 15th May, 2008.
[I16] Analyzing Event Data. Tracing and Monitoring Workshop, École Polytechnique, Montreal, Quebec, Canada. 1st May, 2008.
[I15] Service-Oriented Networks. *Lake Ontario Systems Engineering Research,* Niagara Falls, Ontario, Canada. 18th May, 2007.
[I14] The Services Network. *Communication Networks and Services,* Fredericton, New Brunswick, Canada. 14th May, 2007.
[I13] Current research in SOA. *1st IBM Rational/University Day.* Toronto, Ontario, Canada. 17th August, 2006.
[I12] Delay-tolerant networks in a highly-connected world. *Software Telecommunications Group 2006 Conference.* Waterloo, Ontario, Canada. 10th July, 2006.
[I11] Wireless mesh networks: A tutorial. *Communication Networks and Services,* Moncton, New Brunswick, Canada. 23rd May, 2006.
[I10] Self-Healing in the WebSphere Environment. CASCON Workshop on Engineering Autonomic Systems. CASCON, Toronto, Ontario, Canada. 18th October, 2005.
[I9] Fairness in Wireless Mesh Networks. IBM Toronto Lab, Toronto, Ontario, Canada. 31st August, 2004.
[I8] Fairness in Wireless Mesh Networks. STG Workshop: Knowledge Interaction Day. Waterloo, Ontario, Canada. 27th September, 2004.
[I7] Continuous Monitoring for Problem Determination. CASCON Workshop on self-managed systems. CASCON, Markham, Ontario, Canada. 4th October, 2004.
[I6] Principles and Practices of Fault-Tolerance. IBM Toronto Lab, Markham, Ontario, Canada. 19th November, 2004.
[I5] Security Essentials for Distributed Systems. IBM Toronto Lab, Markham, Ontario, Canada. 3rd December, 2004.
[I4] Automatic Subscription and Notification for Event-Driven Web Services. CASCON Workshop on Publish/Subscribe Middleware. Toronto, Ontario, Canada. 9th October, 2003.
[I3] Networking Issues in Pervasive Computing. CASCON Workshop on Pervasive Computing: Present and Future. CASCON, Toronto, Ontario, Canada. 3rd October 2002.
[I2] Scalable distributed-systems management. Kitchener/Waterloo IEEE Communications Society, Waterloo, Ontario, Canada. 21st March, 2002.
[I1] Controlled dissemination of digital information. Vrije Universiteit, Amsterdam, The Netherlands. 6th June, 2001.

2.1.6 Chapters in Books

[B3] Liuyang Ren* and Paul A.S. Ward. Distributed consensus and fault tolerance mechanisms. In *Essentials of Blockchain Technology*, Taylor & Francis, 2019. 32 pages.
[B2] Moises Goldszmidt, Miroslaw Malek, Simin Nadjm-Tehrani, Priya Narasimhan, Felix Salfner, Paul A.S. Ward, and John Wilkes. Towards a holistic approach to fault management: Wheels within a wheel. In *Dependability and Computer Engineering: Concepts for Software-Intensive Systems* pp. 1–10. IGI Global, 2012. ISBN: 1-60960-747-3.
[B1] Deyi Li, X. Shi, Paul A.S. Ward, and M.M. Gupta. A soft inference mechanism based on cloud models. In T.P. Martin and F. Arcelli Fontana, editors. *Logic Programming and Soft Computing,* pp. 163–188. Taylor & Francis, 1998. ISBN: 0-86380-225-7.

2.1.7 Preprints (arXiv / CoRR)

[P6] Huanyi Chen* and Paul A.S. Ward. Predicting student performance using data from an autograding system. *CoRR* abs/2102.01270, February 2021. Available at https://arxiv.org/abs/2102.01270.
[P5] Sina Gholamian* and Paul A.S. Ward. What Distributed Systems Say: A Study of Seven Spark Application Logs. *CoRR* abs/2108.08395, August 2021. Available at https://arxiv.org/abs/2108.08395.
[P4] Liuyang Ren, Paul A.S. Ward, and Bernard Wong. Evaluating OptChain with Bitcoin Transactions. *CoRR* abs/2109.07670, September 2021. Available at https://arxiv.org/abs/2109.07670.
[P3] Sina Gholamian* and Paul A.S. Ward. Borrowing from Similar Code: A Deep Learning NLP-Based Approach for Log Statement Automation. *CoRR* abs/2112.01259, December 2021. Available at https://arxiv.org/abs/2112.01259.
[P2] Sina Gholamian* and Paul A.S. Ward. A Comprehensive Survey of Logging in Software: From Logging Statements Automation to Log Mining and Analysis. *CoRR* abs/2110.12489, October 2021. Available at https://arxiv.org/abs/2110.12489.
[P1] Moisés Goldszmidt, Miroslaw Malek , Simin Nadjm-Tehrani, Priya Narasimhan, Felix Salfner, Paul A.S. Ward, and John Wilkes. Wheels within wheels: Making fault management cost-effective. *CoRR* / Dagstuhl Seminar on Self-Healing and Self-Adapting Systems, May 2009. Available at http://drops.dagstuhl.de/opus/volltexte/2009/2102/.

2.1.8 Technical Reports

[T12] Miao Jiang,* Mohammad A. Munawar,* Thomas Reidemeister,* and Paul A.S. Ward. Detection and diagnosis of recurrent faults by invariant analysis. Technical Report 2008-11, Department of Electrical and Computer Engineering, University of Waterloo, June, 2008.
[T11] Paul A.S. Ward, Marin Litoiu, Christiana Amza, Hausi Muller, editors. Proceedings of the Fourth International Workshop on Engineering Autonomic Software Systems, IBM Technical Report, December, 2007.
[T10] Mohammad A. Munawar,* Kevin Quan,* and Paul A.S. Ward. Interaction analysis of heterogeneous monitoring data for autonomic problem determination. Technical Report 2006-29, Department of Electrical and Computer Engineering, University of Waterloo, December, 2006.

[T9] Mohammad A. Munawar* and Paul A.S. Ward. Using statistical models to efficiently monitor software systems. Technical Report 2006-28, Department of Electrical and Computer Engineering, University of Waterloo, December, 2006.
[T8] Evan P.C. Jones* and Paul A.S. Ward. Routing strategies for delay-tolerant networks. Shoshin Technical Report, January, 2006.
[T7] Paul A.S. Ward, Dwight S. Bedassé,* Tao Huang,* Mohammad A. Munawar,* and Jia Jun Wu*. Event-Based Self-Management. Shoshin Technical Report, May, 2005.
[T6] Mohammad A. Munawar* and Paul A.S. Ward. Collection, Association for Problem Determination, and Knowledge Dissemination in Autonomic Computing. Shoshin Technical Report, October, 2003.
[T5] Vijay Dheap* and Paul A.S. Ward. High-Level Design of Event-Driven Web-Services Architecture. Shoshin Technical Report, October, 2003.
[T4] Dushyant Bansal* and Paul A.S. Ward. Improving bandwidth utilization in file-sharing peer-to-peer networks. Technical Report 2002-18, Department of Electrical and Computer Engineering, University of Waterloo, December 2002.
[T3] Paul A.S. Ward. Issues in scalable distributed-system management. Technical Report CS-2001-01, Department of Computer Science, University of Waterloo, January 2001.
[T2] Paul A.S. Ward and David J. Taylor. Centralized cluster timestamps, Technical Report CS-2000-16, Shoshin Distributed Systems Group, Department of Computer Science, University of Waterloo, October 2000.
[T1] Paul A.S. Ward. On the scalability of distributed debugging: Vector clock size. Technical Report CS98-29, Department of Computer Science, University of Waterloo, December 1998.

2.1.9 Other Dissemination

[O16] Jakub Schmidtke,* Lily Li, and Paul A.S. Ward. WiFi Everywhere. Demo to Taj Manku, CEO Pravala, August 22nd, 2009.
[O15] Rui Yan,* Thomas Reidemeister,* Igor Juristica,* and Paul A.S. Ward. Failure Diagnosis in Enterprise Software Systems using Machine Learning Methods. CASCON Technology Showcase, CASCON 2009, 3–5 November, 2009.
[O14] Thomas Reidemeister,* Miao Jiang,* Mohammad A. Munawar,* Paul A.S. Ward, and Gabriel Iszlai. Failure Detection and Root-Cause Analysis Using Log Files and Management Metrics. CASCON Technology Showcase, CASCON 2009, 3–5 November, 2009.
[O13] Thomas Reidemeister,* Mohammad A. Munawar,* Miao Jiang,* and Paul A.S. Ward. Autonomic Problem Determination of Enterprise Software Systems. Demo for CERAS Cloud Computing Workshop, IBM Toronto Lab. 9th September, 2009.
[O12] Jakub Schmidtke,* Nicholas Armstrong,* Robert Robinson,* and Paul A.S. Ward. Multi-interface Bandwidth Aggregation. Demo to Taj Manku, CEO Pravala, August 31st, 2009.
[O11] Thomas Reidemeister,* Mohammad A. Munawar,* and Paul A.S. Ward. Intelligent Monitoring for Large-Scale Software Systems. CASCON Technology Showcase, CASCON 2008, 27–30 October, 2008.
[O10] Thomas Reidemeister,* Mohammad A. Munawar,* Miao Jiang,* and Paul A.S. Ward. Adaptive monitoring for large-scale software systems. Demo for CERAS Cloud Computing Workshop, IBM Toronto Lab. 17th June, 2008.

[O9] Paul A.S. Ward. Moderator of Fourth International Workshop on Engineering Autonomic Software Systems Panel: Systems Management: An Industry Perspective, 24th October, 2007.

[O8] Thomas Reidemeister,* Mohammad A. Munawar,* Paul A.S. Ward. Problem determination in enterprise software systems. CASCON Technology Showcase, CASCON 2007, 22–25 October, 2007.

[O7] Paul A.S. Ward. Adaptive monitoring for problem resolution. *3rd International Workshop on Engineering of Autonomic Software Systems,* 23rd October, 2006.

[O6] Mohammad A. Munawar* and Paul A.S. Ward. Using Simple Statistical Models to Monitor Software Systems. CASCON 2006 Technology Showcase, CASCON 2006, 16–19 October, 2006.

[O5] Kevin Quan,* Mohammad A. Munawar,* and Paul A.S. Ward. Fault Detection with Logs. CASCON 2006 Technology Showcase, CASCON 2006, 16–19 October, 2006.

[O4] Cecil Reid,* Lily Li,* Kamran Jamshaid,* Adeolu Adeoye,* Allen George,* Giyeong Son,* and Paul A.S. Ward. WatWire: Waterloo Wireless Mesh Network Testbed. CASCON 2006 Technology Showcase, CASCON 2006, 16–19 October, 2006.

[O3] Mohammad A. Munawar* and Paul A.S. Ward. Adaptive system monitoring *1st IBM Tivoli/-University Day.* Toronto, 5th October, 2006.

[O2] Kevin Quan* and Paul A.S. Ward. Problem resolution dissemination. *1st IBM Rational/-University Day.* Toronto, 17th August, 2006.

[O1] Mohammad A. Munawar* and Paul A.S. Ward. Adaptive Monitoring of J2EE Applications. CASCON 2005 Technology Showcase, CASCON 2005, 17–20 October, 2005.

2.2 Research Funding

Principal Investigator	Title and Agency	Total Funding	Dates	My %
P. Ward	Runtime Behavioural Models for Dependable Systems (NSERC Discovery Grant)	$138,000	May'19–Apr'26	100
P. Ward	Relational Algebra Compiler (CTE Grant)	$7,500	May'22–Apr'23	100
P. Ward	Database Servers (WEEF Equipment Grant)	$15,000	Dec'20–Dec'22	100
P. Ward	Blockchain Research (Ripple Grant)	$60,000	May'19–Apr'21	100
P. Ward	Log Analysis (NSERC)	$105,000	May'18–Apr'21	100
P. Ward	Scalable Self-Healing Systems (NSERC Discovery Grant)	$110,000	May'12–Apr'17	100
P. Ward	Scalable Monitoring for Dynamic Expansion of E-Commerce to the Cloud (IBM CAS)	$10,000	Jan'12–Dec'12	100
P. Martin	Delivering Ultra-Large-Scale Services (ORF-RE)	$3,347,385	Jun'10–Sept'16	10
P. Ward	Automated Cloud Monitoring (Mitacs)	$40,000	May'10–Apr'11	100
P. Ward	Scalable Video Arrays (Christie Digital)	$72,000	Dec'11-Nov'14	100
P. Ward	Perceptual Gap Reduction in Tiled Video Arrays (Christie Digital/NSERC)	$63,000	Sept'10-Aug'13	100
P. Ward	Multi-Interface Internet Access from Mobile Devices (NSERC/Pravala)	$42,000	Sept'09–Aug'11	100
P. Ward	Multi-interface Wireless Device Prototype (NSERC/Pravala)	$42,000	Sept'09–Aug'11	100
P. Ward	Aggregation of Network Links on Mobile Devices (NSERC/Pravala)	$42,000	Sept'09–Aug'11	100
P. Ward	Autonomic Problem Determination of Enterprise Software Systems (IBM CAS)	$144,000	Jan'08–Dec'11	100

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Principal Investigator	**Title and Agency**	**Total Funding**	**Dates**	**My %**
K. Czarnecki	Model-Integrated Software Service Engineering (ORF-RE)	$3,096,479	Jul'08–Jun'13	9
P. Ward	Commodity Distributed Systems (NSERC Discovery Grant)	$90,000	May'07–Apr'12	100
P. Ward	Adaptive Monitoring for Problem Determination (IBM CAS)	$34,000	Jan'07–Dec'07	100
P. Ward	Improving Capacity and QoS in WMN (STG)	$38,855	May'06–Aug'07	100
P. Ward and K. Kontogiannis	Service Discovery and Composition of Carrier Applications (Nortel)	$80,000	Jan'06–Dec'06	50
P. Ward	Fairness and Load Balancing (STG)	$41,818	May'04–May'06	100
P. Ward	Problem Determination in Autonomic Computing (IBM CAS)	$108,000	Jan'04–Dec'06	100
R. Boutaba, C. Rosenberg, and P. Ward	Improving Wireless Mesh Networks (Nortel equipment donation)	$100,000	2004	33
P. Ward	Integrating Web Services and Mobile Computing (Microsoft Research)	$31,500	2004	100
P. Ward	Bandwidth Management in Peer-to-Peer File-Sharing Networks	$42,000	May'03–May'05	100
P. Ward	Pervasive Computing Management (NSERC Discovery Grant)	$72,000	May'03–May'07	100
M. Aagard	Programmable Hardware for Pervasive Computing (CFI/OIT)	$719,923	2003–2007	48
P. Ward	Lab Upgrade (Bell Canada)	$50,000	2002	100
P. Ward	Start-up Grant (E&CE)	$40,000	2002	100

3 Teaching

Since joining the University of Waterloo in 2001, I have taught a broad range of undergraduate and graduate courses in systems software, operating systems, distributed systems, networking, databases, and software engineering. My teaching activities have included curriculum development, creation of new undergraduate and graduate courses, redesign of core systems and software courses, supervision of undergraduate and graduate research students, and the development of automated educational tools for feedback and assessment.

My recent educational scholarship has focused on automated assessment and feedback systems, learning analytics, and predictive modeling of student performance, resulting in publications in venues including SIGCSE, ITiCSE, ASEE, EDM, and CEEA.

Highlights include:

- Over 70 undergraduate and graduate course offerings taught since 2001.
- Major contributor to the redesign of the undergraduate ECE curriculum, including expansion of software content in the core curriculum.
- Development or major revision of courses including:
  - ECE 254 (Systems Programming and Operating Systems)
  - ECE 654 (Software Reliability Engineering)
  - SE 390/490/491 (Software Engineering Design Project sequence)
  - SE 101 (Introduction to Methods of Software Engineering)
- Development and deployment of automated formative-feedback and assessment tools for programming and database courses.
- Creation of the Relational Algebra Compiler educational tool, supported through a Centre for Teaching Excellence grant.
- Supervision of 10 completed PhD students, 32 completed MASc students, numerous undergraduate research and design-project students, as well as visiting researchers and international research trainees.
- Continued active teaching and supervision while serving as Associate Director of Software Engineering (2023-2026).

3.1 Courses Taught

Courses taught are as listed in the table below. Prior to 2021 the student evaluations consist of questions pertaining to specific aspects of course delivery (q1–9) followed by an overall appraisal of the instructor (q10). Evaluations are averages of responses, out of 100. Starting in 2021 the university changed the title and measurement system from “student evaluations” to “student course perceptions” (SCP) where the questions were divided into those related to course design *vs.* implementation. At the same time, rather than change the 5-point scale into percentages, they were simply averaged as is.

2001-2020 courses:

Course	Year	Level	Title	Class Size	Evaluation q1–9	Evaluation q10
ECE 428	W02	4th yr	Computer Networks and Security	126	68	56
ECE 454	S02	4th yr	Distributed and Network Computing	97	79	74
ECE 750-5	S02	Grad.	Distributed and Network Computing (Held with ECE 454; eval. separately)	7	79	74
ECE 428	W03	4th yr	Computer Networks and Security	159	82	80
ECE 454	S03	4th yr	Distributed and Network Computing	156	73	67
ECE 720-4	W03	Grad.	Computer Networks and Security (Held with ECE 428; eval. separately)	2	82	80
ECE 750-5	S03	Grad.	Distributed and Network Computing (Held with ECE 454)	4	73	67
ECE 750-6	S03	Grad.	Pervasive Computing	15	-	-
ECE 454	S04	4th yr	Distributed and Network Computing	107	82	80
ECE 750-6	S04	Grad.	Pervasive Computing	4	-	-
ECE 428	W05	4th yr	Computer Networks and Security	90	83	81
ECE 454	S05	4th yr	Distributed and Network Computing	84	82	84
ECE 750-6	S05	Grad.	Pervasive Computing	7	-	-
ECE 750-10	W06	Grad.	Distributed Systems	7	79	83
ECE 354	S07	3rd yr	Real-Time Operating Systems	71	84	79
ECE 454	S07	4th yr	Distributed and Network Computing	82	85	86
ECE 750-10	W07	Grad.	Distributed Systems	7	86	88
ECE 354	S08	3rd yr	Real-Time Operating Systems	106	73	65
ECE 454	S08	4th yr	Distributed and Network Computing	94	78	70
SE 390	F08	3rd yr	Design Project Planning	60	82	74
ECE 750-5	S08	Grad.	Distributed and Network Computing (Held with ECE 454; eval. separately)	3	78	70
SE 490	S09	4th yr	Design Project 1	60	69	51
ECE 454	S09	4th yr	Distributed and Network Computing	65	83	75
SE 390	F09	3rd yr	Design Project Planning	80	-	-
SE 491	W10	4th yr	Design Project 2	60	-	-
ECE 750-10	W10	Grad.	Distributed Systems	6	-	-

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Course	Year	Level	Title	Size	q1–9	q10
ECE 454	S10	4th yr	Distributed and Network Computing	73	70	61
ECE 750-5	S10	Grad.	Distributed and Network Computing (Held with ECE 454; eval. separately)	3	-	-
SE 490	S10	4th yr	Design Project 1	78	-	-
SE 390	F10	3rd yr	Design Project Planning	76	76	73
SE 491	W11	4th yr	Design Project 2	78	50	62
ECE 454	S11	4th yr	Distributed and Network Computing	53	70	77
ECE 750-5	S11	Grad.	Distributed and Network Computing (Held with ECE 454; eval. separately)	14	100	97
ECE 254	S11	2nd yr	Systems Prog. and Operating Systems	3	-	-
ECE 254	F11	2nd yr	Systems Prog. and Operating Systems	108	81	83
ECE 654	S12	Grad.	Software Reliability Engineering	9	61	69
ECE 254	S12	2nd yr	Systems Prog. and Operating Systems	66	80	83
SE 390	F12	3rd yr	Design Project Planning	91	63	43
ECE 150	F13	1st yr	Fundamentals of Programming	116	80	82
ECE 150	F13	1st yr	Fundamentals of Programming	144	72	79
ECE 155	S15	1st yr	Eng Design w Embedded Systems	118	31	46
ECE 155	S15	1st yr	Eng Design w Embedded Systems	119	32	48
ECE 150	F15	1st yr	Fundmentals of Programming	156	44	61
ECE 356	F15	3rd yr	Database Systems	69	40	50
ECE 356	W16	3rd yr	Database Systems	84	61	73
ECE 150	F16	1st yr	Fundmentals of Programming	248	50	62
ECE 356	W16	3rd yr	Database Systems	84	61	73
ECE 656	W16	Grad.	Database Systems	51	49	65
ECE 650	F16	Grad.	Methods & Tools for Software Engineering	57	57	67
ECE 356	W17	3rd yr	Database Systems	108	61	74
ECE 656	W17	Grad.	Database Systems	56	76	75
ECE 150	F17	1st yr	Fundmentals of Programming	245	52	66
ECE 108	W18	1st yr	Discrete Math and Logic 1	161	33	53
ECE 150	F18	1st yr	Fundmentals of Programming	131	48	61
ECE 356	W19	3rd yr	Database Systems	64	28	44
ECE 356	W19	3rd yr	Database Systems	89	27	44
ECE 656	W19	Grad.	Database Systems	68	50	63

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Course	Year	Level	Title	Size	q1–9	q10
ECE 356	W20	3rd yr	Database Systems	147	40	57
ECE 656	W20	Grad.	Database Systems	36	64	74
ECE 654	S20	Grad.	Software Reliability Engineering	10	50	51
ECE 656	F20	Grad.	Database Systems	17	83	84

2021–present courses, with new survey system.

Course	Year	Level	Title	Class Size	SCP Imp	SCP Dsgn
ECE 356	W21	3rd yr	Database Systems	153	2.1	3.1
ECE 356	F21	3rd yr	Database Systems	225	1.9	2.7
ECE 656	F21	Grad.	Database Systems	52	1.3	1.8
ECE 656	W23	Grad.	Database Systems	34	3.4	3.1
SE 101	F23	1st yr	Intro to Methods of Software Engineering	125	2.2	2.0
ECE 356	F23	3rd yr	Database Systems	103	2.5	2.7
ECE 356	F23	3rd yr	Database Systems	92	2.3	2.6
ECE 656	W24	Grad.	Database Systems	22	3.4	3.4
SE 490	S24	4th yr	Design Project 1	36	3.2	3.3
SE 101	F24	1st yr	Intro to Methods of Software Engineering	133	2.6	1.9
SE 490	F24	4th yr	Design Project 1	86	2.7	2.7
ECE 650	W25	Grad.	Methods & Tools for Software Engineering	19	4.2	4.0
SE 491	W25	4th yr	Design Project 2	119	1.9	2.2
SE 490	S25	4th yr	Design Project 1	30	3.2	3.2
SE 490	F25	4th yr	Design Project 1	80	2.8	2.7
SE 101	F25	1st yr	Intro to Methods of Software Engineering	139	2.6	2.4
SE 491	W26	4th yr	Design Project 2	108	2.6	3.0
ECE 656	W26	Grad.	Database Systems	11	4.5	4.2

3.2 Student Supervision

- Number of PhD students completed: 10
- Number of MASc students completed: 32
- Current graduate students in progress: 2
- Students are sole-supervised by me unless otherwise noted.

3.2.1 PhD Students Completed

Name	**Date**	**Thesis**	**Next Position**
Mohammad Munawar[1]	Sept.'09	Adaptive Monitoring of Complex Software Systems	RIM, Waterloo
Kamran Jamshaid[2]	Jan.'10	Centralized Rate Allocation in Wireless Mesh Networks	KAUST, Saudi Arabia
Miao Jiang	Sept.'11	Modeling Management Metrics for Monitoring Software Systems	Google, Waterloo
Thomas Reidemeister[1]	May'12	Fault Diagnosis in Enterprise Software Systems	PostDoc, Waterloo
Hamzeh Zawawy[3]	Jul.'12	Requirements-Based Root Cause Analysis Using Log Data	RBC, Toronto
Masoomeh Rudafshani	Apr.'15	Detection and Diagnosis of Memory Leaks in Web Applications	WLU CS Instructor
Steven McFadden[2,4]	Apr.'15	Evaluating and Improving Image Quality of Tiled Displays	Synaptive Medical
Sina Gholamian[3]	Dec.'21	Logging Statements Analysis and Automation in Software Systems with Data Mining and Machine Learning Techniques	Reuters, Toronto
Liuyang Ren[5]	Aug.'22	Toward High-Performance Blockchains	Google, Waterloo
Huanyi Chen	Sept.'24	From Understanding Learning Difficulties Among Students To Providing High-Quality Automated Feedback	Huawei, Toronto

[1] Awarded IBM CAS Fellowship for support during Ph.D.
[2] Jointly supervised with K. Kontogiannis.
[3] Awarded NSERC Scholarship for support during Ph.D.
[4] Awarded Christie Digital Scholarship for support during Ph.D.
[5] Awarded Ripple Scholarship for support during Ph.D.

3.2.2 MASc Students Completed

Name	Date	Thesis	Next Position
Mohammad Munawar[6]	June'04	Multi-Interface Multi-Channel Wireless Mesh Networks	PhD, Waterloo
Vijay Dheap[7]	June'04	Event-Driven Response Architecture	IBM Rayleigh
Jiajun Wu	Oct.'04	Collecting Transaction Data in Event-Monitoring Tools	AEGON, New York
Dwight Bedassé[6]	Jan.'05	An Efficient Computation of Convex Closure on Abstract Events	IBM Jamaica
Tao Huang	Sept.'05	A Dynamic Cluster-Timestamp Creation Algorithm for Distributed-System Management	TD Securities, Toronto
Dushyant Bansal	Sept.'05	Third-Party TCP Rate Control	Microsoft
Evan Jones[7]	Apr.'06	Practical Routing in Delay-Tolerant Networks	PhD, MIT
Ann Lee	Aug.06	Achieving Fairness in Multi-channel Wireless Mesh Networks	Speilo Moncton
Kevin Quan	Dec.'06	Problem-Resolution Dissemination	IBM Toronto
Sultan Al-Ghamdi	May'07	Self-Organized Key Issuing using PGP and Identity-Based Cryptography	unknown
Lei Li[7]	May'07	The Efficacy of Source Rate Control in Achieving Fairness in Wireless Mesh Networks	D2L, Waterloo
Miao Jiang	May'07	Game-Theoretic Analysis of Wireless Mesh Networks	PhD, Waterloo
Belal Tassi	July'07	Fast and Simple Deployment of a Linux Cluster Data Warehouse	IBM Toronto
Cecil Reid[6]	Jan.'08	Achieving Soft Real-Time Guarantees for Interactive Applications in Wireless Mesh Networks	EventCo, Jamaica
Edwin Chan	May'08	QoS-aware Mobile Web-Service Discovery using Utility Functions	IBM Toronto
Allen George	Sept.'08	Providing Context in WS-BPEL Processes	OANDA, Toronto
Adeolu Adeoye	May'09	A Framework for the Self-Configuration of Wireless Mesh Networks	Alliant, New York

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Name	Date	Thesis	Next Position
Yu Xu	May'09	Problem Determination in Message-Flow Internet Services Based on Statistical Analysis of Event Logs	RIM, Waterloo
Giyeong Son	Jan.'11	Experimental Performance Evaluation of Bit-Rate Selection Algorithms in Multi-Vehicular Networks	Samsung, Korea
Robert Robinson	Feb.'11	An Architecture for Reliable Encapsulation Endpoints using Commodity Hardware	Pravala, Kitchener
Alice Yeung	Apr.'11	Delivering IBM Tivoli Provisioning Manager as a Virtual Appliance	IBM Toronto
Yi Luo	May'11	Cost-based Automatic Recovery Policy in Data Centers	unknown
Nicholas Armstrong	Sept.'11	Just-in-Time Push Prefetching: Accelerating the Mobile Web	Pravala, Kitchener
Wayne Chen	Apr.'12	Adaptive Middleware for Enterprise Cloud-Computing Integration	PWC Canada
Charles Lai	Dec.'14	Framework for Detection, Diagnosis and Recovery in Self-Healing Systems	IBM Toronto
Alfredo Cortes	Dec.'15	Asset Maintenance Optimization: Combining Device Modeling and Enterprise Asset Management for Optimized Device Maintenance Execution	IBM Toronto
Riyad Parvez[8]	Apr'16	Combining Static Analysis and Targeted Symbolic Execution for Scalable Bug-finding in Application Binaries	Blackberry, Waterloo
Xi Cheng	May'16	Anomaly Detection and Fault Localization Using Runtime State Models	Google, Toronto
Tandra Chakraborty	Sept.'16	Automated Extraction of Behaviour Model of Applications	Providius, Hamilton
Dominic So	May'17	Choosing and evaluating a unit test solution for DB2	IBM Toronto
Huanyi Chen	June'18	Predicting Student Performance Using Data from an Auto-Grading System	PhD, Waterloo

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Name	Date	Thesis	Next Position
Qiushi Jiang	Aug'19	Creating Usage Models to Identify Misbehaving Applications on Mobile Devices	Freelance Developer, Toronto

3.2.3 Graduate Students in Progress

Name	Degree	Started	Thesis
Ope Salau	MASc	Sept.'24	Assessing Code Change in Auto-Feedback Submissions
Zhifan Li	MASc	May'26	Integrating LLM Feedback in Auto-Grading

3.2.4 Undergraduate Research Supervision

Undergraduate supervision falls into three main categories (modes):

- ECE499/SE499: A design project performed under the supervision of a faculty member. It is considered equivalent to one course of work for which the student receives a grade.
- USRA/Co-op: a one-term paid full-time position in which the student works on a research project under the supervision of a faculty member. It may be partially funded by NSERC under the program "Undergraduate Student Research Assistantship" (USRA) or solely by the faculty member.
- URA (Undergraduate Research Assistantship): a one-term 10-hour per week paid research position under the supervision of a faculty member.

Name	Mode	Terms	Project
Dushyant Bansal	URA	S02	Reducing bandwidth utilization in peer-to-peer networks
Kelvin Cheng	Coop	S03	Detection of NAT devices
Lindsay Chen	Coop	S03	NS-2 simulation of wireless mesh networks
Lindsay Chen	Coop	F04	A test framework for wireless mesh networks
Daniel. Major	URA	W05	Securing instant messaging in the workplace
Manson Ng	URA	S05	TPC-W load generation for web-server analysis
Wei Zhang	URA	F05	Dynamic monitoring using agent controller
Vincent Tam	URA	S06	Load generation for adaptive monitoring

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[6] Awarded Canadian Commonwealth Scholarship for support during the MASc.
[7] Awarded NSERC PGS D after completing MASc.
[8] Jointly supervised with V. Ganesh

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Name	Mode	Terms	Project
John Laban	URA	S06	Fault injection for automated symptom generation
Allen George	USRA	S06	Integrating DTN and WMN
Dmitri Artamonov	URA	S08	Software as a Service (SaaS) for CRM
Gobi Raveendran	SE499	S11	Mobile Asynchronous Game Client
Alex Amato	SE499	S11	Mobile Asynchronous Game Server
Xi Cheng	SE499	W13	Self-Management Framework for Cloud Applications
Julian Parkin	URA	S18	Grading-assessments development
Youssef Ali	URA	F18	Grading-assessments development
Paniz Ojaghi[9]	ECE499	F25	LLM Grading Consistency
Zhifan Li	ECE499	W26	Marmoset Replacement

3.3 Capstone Project Supervision

Capstone Design Project: a 2- or 3-course sequence in which students in groups of 3–6 propose a significant design project, under the supervision of a faculty member, acquire approval for that project, implement a prototype, and present it at a public symposium.

Name	Terms	Project
Cheung, Oh, Sachithananthan, and Singh	F02–W04	ORMS: Operating Room Management System
Campagna, Jina, Mahardi, and Thangirala	F02–W04	UPPS API: The Unparalleled Parallel Processing Subsystem
Lau, Luthra, Poon, and Wong	F03–W05	PoWi: Portable Wingman
Kung, Lee, and Nguyen, Yu	F03–W05	Wireless Home Security System
Li, Mak, Woo, and Zhang	F03–W05	Cellular Travel Guide
Bouchard, Haines, Major, and Dickinson	F03–W05	WiFiEye: Willy Is Watching
Chung, Escalante, Gong, and Swanston	F05–W07	Multi-channel Wireless Routing
Adhia, Butt, Nadir, and Tsai	F05–W07	Dynamic Wireless Mesh Networks
Ford, Heidinga, Masella, Odesser, and Tan	F05–W07	Electronic Whiteboard Publication-Subscription System
Athithan, Chen, Cheryeth, Goyal, and Rahman	F06–W08	Universal Phone System with WiFi Cellular Integration

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[9] Jointly supervised with M. Cooper-Stachowsky

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Name	**Terms**	**Project**
Artamonov, Lukianchuk, Juarez, and Do	F06–W08	Brevis Small Business Management Software
Armstrong, Klassen, Robinson, and Zarnett	F07–W09	Chimera: Home Automation Defined
Bourassa, Cowen, Rodrigo, and Taylor	F11–W13	Peer-to-Peer Online Gaming Architecture
Armstrong, Ing, Pincombe, and Wong	F12–W14	Tablet Notification System
Kim, Cho, and Kim	S15–W16	Seniors' Health Monitoring
Kim, Luo, Zhong, and Zhao	S15–W16	Grocery Consumption Monitoringg
Saadat, Skinner, Vora, Seemakurti, and Ragavan	S15–W16	Recycling Bin Management
Makhlouf, Lawlor, Chau, Mumtaz, and Mostafiz	S15–W16	Animal Monitoring
Nguyen, Asogamoorthy, Huang, and Park	S15–W16	Mobile Screen Sharing
Babur, Reyhani-Masoleh, and Hashmi	S16–W17	ClubHub: Customer tracking for nightclubs
Dinh, Leung, Tong, and Wong	S16–W17	Map Hack: Map routing with predictive delay
Codispoti, Klen, McBurney, and Swiderski	F17–W19	Mental Health Support App
Hua, Su, Wong, Xing	S21–W22	TripPlanr: Travel Planning System
Barbulescu, Khanna, Nagarsheth, and Vassilev	S21–W22	MyCircle: Peer-to-peer decentralized social network
Chung-Hun, Ho, Mahto, Shah, and Tang	S23–W24	MockMe: AI-based Mock Interview Tool
Cai, Huang, Wihandi, and Xiang	S23–W24	Foodie: Personalized Restaurant Recommender

4 Service

4.1 University Service

Associate Director, Software Engineering (2023–2026)

- Undergraduate academic advising and program planning
- Student petitions
- Exchange-program advising, approvals, and curriculum mapping
- Curriculum planning and calendar revisions
- Scholarship adjudication

Engineering Representative, FAUW Board of Directors (2016–2020)

- Director, Ontario Confederation of University Faculty Associations (OCUFA)
- Representative, President's Advisory Committee on Student Mental Health
  - Contributed to university-wide report and recommendations
- Representative, Fall-Break Committee
  - Resulted in Senate approval of a full-week Fall break

Governance and Committee Memberships

- University of Waterloo Senate, 2020–2023
- Engineering Faculty Council (EFC), 2004–2006, 2013–2015, 2020–2023
- EFC Representative, Environmental Studies Faculty Council, 2004–2005
- EFC Representative, Arts Faculty Council, 2022
- ECE Graduate Studies Committee, 2022–present
- ECE Undergraduate Studies Committee and Curriculum Committee
  - multiple terms, including major curriculum revisions in 2006–07 and 2016–2018
- SE Curriculum Committee, 2008–2018, 2023–2026
- ECE Ad Hoc Committee on Graduate Courses in Software, 2019–2023

Academic and Outreach Activities (various years)

- ECE and SE representative at Ontario University Fair
- ECE and SE representative at Waterloo Open Houses
- Judge, Waterloo Engineering Competition
- Chair, PhD comprehensive exams and thesis defences
- Thesis examiner for numerous MMath, MASc, and PhD students
- Class Prof, ECE Class of 2007; SE Classes of 2012 and 2028

4.2 Professional Service

Conference Organization

- Organizer, Workshop on *Semi-Automated Feedback Systems: Current Status and Expected Developments*, Canadian Engineering Education Association (CEEA) Conference, 2023
- Co-Chair 2^{nd}–5^{th} Int'l Workshop on Engineering Autonomic Software Systems, 2005–2008.
- Co-Chair CASCON Workshop on Agile Software Development, 2006.
- Co-Chair, 1^{st} IBM Rational/University Interaction Day 2006.
- Co-Chair Workshop on Self-Managed Systems: Research and Practice, 2005.
- Local Publicity Chair for Networking 2005.
- Session Chair and panel moderator at WCNC, CASCON, the Canadian Undergraduate Technology Conference (CUTC), and other conferences.
- Program Committee Member for numerous international conferences, including CASCON, Middleware, CCGrid, CNSM, CNSR, IWCMC, PDCAT, Networking, HPCC, AdHoc-NOW, WCNC, WiMob, and others.

Reviewing

- Reviewer for numerous journals and conferences, including Electronics Letters, IEEE Communications Letters, IEEE Transactions on Parallel and Distributed Systems, IEEE Journal on Selected Areas in Communications, IEEE Network, IEEE Software, OOPSLA, ICDCS, IM, WCNC, WiMob, and others.
- Grant reviewer for NSERC Discovery and Strategic Grants and the Atlantic Canada Opportunities Agency (ACOA).

Professional Memberships and Credentials

- Professional Engineer,]New Brunswick, since 1994 (currently lapsed; reinstatement in progress)
- Member Canadian Engineering Education Association (CEEA)

Technology Transfer and Research Software

- Developed semi-automated assessment and feedback tools for database design and relational algebra, deployed in database courses and supporting ongoing educational research.
- Research on multi-interface wireless networking commercialized by Pravala Inc.
- Co-developed WatManager in collaboration with IBM Toronto Laboratory for adaptive monitoring and fault localization in WebSphere applications.
- Co-developed POET, a distributed debugging system licensed to IBM and forming the basis of IBM Object-Level Trace.
- Co-developed Active Mail, an early instant-messaging system later acquired by IBM and incorporated into Lotus Notes SameTime.

Expert Consulting

- Expert testimony in software engineering and intellectual property disputes for Green & Chercover, Gilbert's LLP, and McCarthy Tétrault.