Igor Kadota

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Research Interests

Theory: network modelling and optimization, scheduling algorithms with performance guarantees, age-of-information, machine learning, regret analysis, multi-armed bandits, Lyapunov optimization, renewal theory, and stochastic coupling.

Systems: design and implementation of beyond-5G networks, Internet-of-Things (IoT), embedded networking solutions, full-duplex, millimeter-wave (mmWave), Dynamic Spectrum Access (DSA), and Software Defined Radios (SDR).

Education

2016–2020 **Massachusetts Institute of Technology** (MIT), USA
Ph.D. in Communication Networks from MIT LIDS
Affiliated with the MIT Institute for Data, Systems, and Society (IDSS)
Thesis: Age of Information in Wireless Networks - Theory and Implementation
Advisor: Prof. Eytan Modiano
Committee: Prof. Mohammad Alizadeh, Prof. Mor Harchol-Balter, Prof. Yin Sun, and Prof. Moe Win

2014–2016 **Massachusetts Institute of Technology**, USA
M.S. in Communication Networks from MIT LIDS
Thesis: Transmission Scheduling of Periodic Real-Time Traffic in Wireless Networks
Advisor: Prof. Eytan Modiano

2011–2013 **Technological Institute of Aeronautics** (ITA), Brazil
M.S. in Telecommunications
Thesis: Kalman Filtering - Estimate of the Numbers of Active Queues in an 802.11e EDCA WLAN
Advisor: Prof. Alessandro Anzaloni

2005–2010 **Technological Institute of Aeronautics**, Brazil
B.Sc. in Electrical Engineering

Research Experience

2020–Present **Postdoctoral Research Scientist**, Columbia University, USA
Department of Electrical Engineering and affiliated with the Data Science Institute
Host: Prof. Gil Zussman

- **Develops network control algorithms** for advanced wireless systems (in particular *full-duplex*, *mmWave*, and *spectrum sharing*) using theory-based and data-driven approaches. For example, [J1] employs LSTMs, Model Predictive Control, and data provided by Ericsson from a real-world mmWave backhaul network in Sweden to develop a predictive weather-aware network rerouting algorithm;
- **Implements network control algorithms** in the NSF PAWR COSMOS city-scale wireless testbed. For example, an FPGA-embedded algorithm that adaptively configures a full-duplex microchip (developed in-house by our collaborators [C7]) aiming to minimize the self-interference measured by the SDR is being tested and integrated into COSMOS as part of the FlexICoN project;
- **Leverages machine learning for opportunistic sensing using advanced wireless systems**. For example, an ongoing project that employs traditional Signal Processing techniques together with Random Decision Forests to perform opportunistic weather sensing using a mmWave radar.

2014–2020 **Graduate Research Assistant**, MIT LIDS, USA

- **Developed network control algorithms** with provable performance guarantees (in terms of latency, throughput, and/or information freshness) for wireless networks that carry time-sensitive information using tools such as dynamic programming, multi-armed bandits, Lyapunov optimization, renewal theory, and stochastic coupling. Papers based on this research received the Best Paper Award at IEEE INFOCOM 2018 [C11] and the Best Paper Award Finalist at ACM MobiHoc 2019 [C9];
- **Built a SDR wireless testbed from the ground up**. The testbed was composed of 11 research-grade FPGA-enabled SDRs, 25 Raspberry Pis, and 3 GPU workstations. Selected and purchased the equipment, assembled the testbed, and implemented networking algorithms (see [C5] and [C6]).

Work Experience in Industry

2013–2014 **R&D Network Engineer**, Mectron - Defense and Technology, Brazil
- Optimized network layer and data link layer algorithms for a Mobile Ad-hoc NETwork (MANET) using cross-layer techniques. Collaborated with the Radio Frequency (RF) and the Application teams.

Awards and Honors

2022 **LATinE Trailblazer in Engineering Fellow** by Purdue's College of Engineering. The Fellows were "selected not only for their outstanding scholarly achievements but also for their potential impact in expanding representation and diversity in engineering".

2020 **MIT School of Engineering (SoE) Graduate Student Extraordinary Teaching and Mentoring Award** given annually by the MIT SoE to a single graduate student in "recognition of demonstrated extraordinary teaching and mentoring efforts as a teaching or research assistant".

2019–2020 **Thomas G. Stockham Jr. Fellowship** awarded annually by the MIT SoE to a single graduate student in "recognition of outstanding academic record, exceptional background, and promising future".

2019 **Best Paper Award Finalist at ACM MobiHoc 2019** among 156 paper submissions.

2018 **Best Paper Award Winner at IEEE INFOCOM 2018** among 1,606 paper submissions. This work was featured at MIT News, ACM TechNews, Science Daily, Campus Technology, etc.

2018 **MIT AeroAstro Graduate Teaching Assistantship Award** given annually by the MIT Department of Aeronautics and Astronautics to a single graduate student "who has demonstrated conspicuous dedication and skill in helping fulfill a subject's educational objectives".

2017 & 2020 Two **Best Presentation Awards** at the MIT LIDS Student Conference in 2017 and in 2020.

2011–2013 **CAPES Fellowship** from the Brazilian federal agency throughout the M.S. in ITA.

2010 **Best Senior Thesis** of the Department of Electrical Engineering of ITA in 2010. This senior thesis was developed in collaboration with Prof. Andrea Baiocchi from *University of Rome - La Sapienza* and led to the journal publication in [J6].

Mentoring and Teaching

2017–Present **Directly supervised research projects of several M.S. and undergraduate students** at Columbia University and at MIT, including:
- Lilly Clark (currently: Ph.D. at USC)
- Lisa Zahray (currently: Ph.D. at Georgia Tech)
- Muhammad Shahir Rahman (currently: Undergrad at MIT EECS) - coauthor in [C1], [C5], and [C8]
- Timothy Cardona (currently: Data Scientist at BlackRock)
- Sean Gloumeau (currently: M.S. at TU Kaiserslautern)
- Eray Unsal Atay (currently: Ph.D. at Caltech) - coauthor in [C4]
- Alexander Warren (currently: Undergrad at MIT EECS) - coauthor in [C1]
- Yosef Mihretie (currently: Undergrad at MIT EECS)
- Vijay Kalmath (currently: M.S. at Columbia CS)
- Perry Flamer (currently: M.S. at Columbia EE) - coauthor of paper in preparation on mmWave
- Saravanan Govindarajan (currently: ML Engineer at Meta) - coauthor of paper in preparation on mmWave - received the **2022 MS Research Award** from Columbia's EE Department
- Leoni Lu (currently: M.S. at Columbia EE, next: Qualcomm) - coauthor of paper in preparation on mmWave - received the **Women in Spectrum Scholarship** from the National Spectrum Consortium
- Kaya Celebi (currently: M.S. at Duke CS) - coauthor of paper in preparation on mmWave
- Aditya Jolly (currently: M.S. at Columbia EE, next: Qualcomm) - coauthor of paper in preparation on full-duplex as part of the FlexICoN project
- Azhaan Zahabee (currently: Software Engineer at Amazon) - coauthor in [R1]
- Trevor Joseph Gordon (currently: M.S. at Columbia EE) - coauthor of paper in preparation on DSA
- Asha Kiran Cherukuri (currently: M.S. at Columbia EE) - coauthor of paper in preparation on DSA

2022 **Co-advising the M.S. thesis of two students**: Aditya Jolly, on Adaptive Configuration of a Full-Duplex Microchip, and Trevor Joseph Gordon, on Implementation of Reinforcement Learning-based Dynamic Spectrum Access techniques on the NSF PAWR COSMOS wireless testbed.

2016–2022 **Gave several lectures** for graduate and undergraduate students as part of different MIT and Columbia University courses including: Communication Systems & Networks and Queueing Networks.

Spring 2017 **Created a Teaching Radio Laboratory** (from the ground up) for the MIT course Communication Systems & Networks to complement the theoretical lectures with hands-on experiments. Selected and purchased 16 teaching SDRs, and designed 5 customized experiments that closely follow the lectures.

2017–2019 **Teaching Assistant (TA) for the Radio Lab**, Communication Systems & Networks, MIT
- Led the laboratory, developed laboratory scripts, and graded assignments;
- Student evaluation of the TA was (on average) 6.9 out of 7.0;
- Received the **MIT TA award of 2018** for creating and conducting the Radio Lab;
- Received the **MIT SoE Teaching and Mentoring award of 2020**.

Summer 2017 Completed the **Kaufman Teaching Certificate Program** offered by the Teaching and Learning Lab at MIT. Some of the topics were: Designing a Course and Constructing a Syllabus, Interactive Teaching & Active Learning, and Teaching Inclusively.

Spring 2016 **Teaching Assistant**, Communication Systems & Networks, MIT
- Held weekly office hours, offered exam review sessions, and assisted in the design of problem sets and exams. Student evaluation of the TA was 6.9 out of 7.0.

2011–2012 **Volunteer Math Teacher**, Brazilian local government
- Prepared and delivered weekly classes for talented middle school students.

Publications

Citations: Total number of citations is $1,270$, the most cited publication has 339 citations, and the average number of citations per publication is 57.7 (source: Google Scholar on 12/02/2022).

Conference Proceedings

[C1] V. Tripathi, **I. Kadota**, E. Tal, M. S. Rahman, A. Warren, S. Karaman, and E. Modiano, "WiSwarm: Time-Sensitive Wireless Networking for a Collaborative Team of UAVs," in Proc. of IEEE INFOCOM, May 2023, pp. 1–10. **[Acceptance rate 19.2%]**

[C2] M. Kohli, A. Adhikari, G. Avci, S. Brent, J. Moser, S. Hossain, A. Dash, **I. Kadota**, R. Feick, D. Chizhik, J. Du, R. Valenzuela, and G. Zussman, "Outdoor-to-Indoor 28 GHz Wireless Measurements in Manhattan: Path Loss, Location Impacts, and 90% Coverage," in Proc. of ACM MobiHoc, Oct. 2022, pp. 201-210. **[Acceptance rate 19.8%]**

[C3] D. Stojadinovic, P. Netalkar, C. Bastidas, **I. Kadota**, G. Zussman, I. Seskar, and D. Raychaudhuri, "A Spectrum Consumption Model-based Framework for DSA Experimentation on the COSMOS Testbed," in Proc. of ACM MobiCom WiNTECH Workshop, Jan. 2022, pp. 77–84.

[C4] E. Atay, **I. Kadota**, and E. Modiano, "Aging Wireless Bandits: Regret Analysis and Order-Optimal Learning Algorithm," in Proc. of WiOpt, Oct. 2021, pp. 1–8.

[C5] **I. Kadota**, M. S. Rahman, and E. Modiano, "WiFresh: Age-of-Information from Theory to Implementation," in Proc. of IEEE ICCCN, Aug. 2021, pp. 1–11. [Invited paper]

[C6] **I. Kadota** and E. Modiano, "Age of Information in Random Access Networks with Stochastic Arrivals," in Proc. of IEEE INFOCOM, May 2021, pp. 1–10. **[Acceptance rate 19.9%]**

[C7] A. Nagulu, S. Garikapati, M. Essawy, **I. Kadota**, T. Chen, A. Natarajan, G. Zussman, and H. Krishnaswamy, "Full-Duplex Receiver with Wideband Multi-Domain FIR Cancellation Based on Stacked-Capacitor, N-path Switched-Capacitor Delay Lines Achieving $>+54$dB SIC Across 80MHz BW and $>+15$dBm TX Power Handling," in Proc. of IEEE ISSCC, Feb. 2021, pp. 100–102.

[C8] **I. Kadota**, M. S. Rahman, and E. Modiano, "Poster: Age of Information in Wireless Networks: from Theory to Implementation", in Proc. of ACM MobiCom, Sept. 2020, pp. 1–3.

[C9] **I. Kadota** and E. Modiano, "Minimizing the Age of Information in Wireless Networks with Stochastic Arrivals," in Proc. of ACM MobiHoc, July 2019, pp. 221–230. **[Best Paper Award Finalist] [Acceptance rate 23.7%]**

[C10] R. Talak, **I. Kadota**, S. Karaman, and E. Modiano, "Scheduling Policies for Age Minimization in Wireless Networks with Unknown Channel State," in Proc. of IEEE ISIT, June 2018, pp. 2564–2568.

[C11] **I. Kadota**, A. Sinha, and E. Modiano, "Optimizing Age of Information in Wireless Networks with Throughput Constraints," in Proc. of IEEE INFOCOM, April 2018, pp. 1844–1852. **[Best Paper Award Winner] [Acceptance rate 19.2%]**

[C12] **I. Kadota**, E. Uysal-Biyikoglu, R. Singh, and E. Modiano, "Minimizing Age of Information in Broadcast Wireless Networks," in Proc. of IEEE Allerton, Sept. 2016, pp. 844–851.

[C13] K. Kim, C. Li, **I. Kadota**, and E. Modiano, "Optimal Scheduling of Real-Time Traffic in Wireless Networks with Delayed Feedback," in Proc. of IEEE Allerton, Sept. 2015, pp. 1143–1149.

Journals

[J1] **I. Kadota**, D. Jacoby, H. Messer, G. Zussman, and J. Ostrometzky. "Switching in the Rain: Predictive Wireless x-haul Network Reconfiguration," ACM Measurement and Analysis of Computing Systems, vol. 6, no. 3, pp. 1–25, Dec. 2022. **[ACM SIGMETRICS 2023 issue] [Acceptance rate 18.3%]**

[J2] T. Chen, S. Garikapati, A. Nagulu, A. Gaonkar, M. Kohli, **I. Kadota**, H. Krishnaswamy, and G. Zussman. "A Survey and Quantitative Evaluation of Integrated Circuit-based Antenna Interfaces and Self-Interference Cancellers for Full-Duplex," IEEE Open Journal of the Communications Society, Special issue on Full-Duplex Transceivers for Future Networks: Theory and Techniques, vol. 2, pp. 1753–1776, July 2021.

[J3] **I. Kadota** and E. Modiano, "Minimizing the Age of Information in Wireless Networks with Stochastic Arrivals," IEEE Transactions on Mobile Computing, vol. 20, no. 3, pp. 1173–1185, Mar. 2021.

[J4] **I. Kadota**, A. Sinha, and E. Modiano, "Scheduling Algorithms for Optimizing Age of Information in Wireless Networks with Throughput Constraints," IEEE/ACM Transactions on Networking, vol. 27, no. 4, pp. 1359–1372, Aug. 2019.

[J5] **I. Kadota**, A. Sinha, E. Uysal-Biyikoglu, R. Singh, and E. Modiano, "Scheduling Policies for Minimizing Age of Information in Broadcast Wireless Networks," IEEE/ACM Transactions on Networking, vol. 26, no. 6, pp. 2637–2650, Dec. 2018.

[J6] **I. Kadota**, A. Baiocchi, and A. Anzaloni, "Kalman Filtering: Estimate of the Numbers of Active Queues in an 802.11e EDCA WLAN," Elsevier Computer Communications, vol. 39, pp. 54–64, Feb. 2014.

Under Review

[R1] P. Netalkar, A. Zahabee, C. Bastidas, **I. Kadota**, D. Stojadinovic, G. Zussman, I. Seskar, and D. Raychaudhuri, "Large-Scale Dynamic Spectrum Access with Spectrum Consumption Models." [Submitted].

[R2] S. Garimella, S. Garikapati, A. Nagulu, **I. Kadota**, A. Davidson, G. Zussman, and H. Krishnaswamy, "Frequency Domain Equalization based Full Duplex Receiver with Passive Frequency Shifting N-Path Filter based BPFs achieving >53dB SIC across 160MHz BW." [Submitted].

Theses

[T1] **I. Kadota**, "Age of Information in Wireless Networks: Theory and Implementation," Ph.D. thesis, Dept. of Aeronautics and Astronautics, MIT, Sept. 2020.

[T2] **I. Kadota**, "Transmission Scheduling of Periodic Real-Time Traffic in Wireless Networks," M.S. thesis, Dept. of Aeronautics and Astronautics, MIT, Sept. 2016.

Book

[B1] Y. Sun, **I. Kadota**, R. Talak, and E. Modiano, *Age of Information: A New Metric for Information Freshness*. Morgan & Claypool, 2019.

Patent

[P1] J. Ostrometzky, G. Zussman, H. Messer, D. Jacoby, and **I. Kadota**. Predictive Weather-Aware Communication Network Management. US Patent Application No. 17/551,643. December 2021. `https://patents.google.com/patent/US20220110012A1/en`

Awarded Grants

2022 **NSF-RINGS**, "RINGS: Enabling Wireless Edge-cloud Services via Autonomous Resource Allocation and Robust Physical Layer Technologies"
- Result: Proposal awarded $\$850,000$ by the National Science Foundation (NSF)
- Role: Senior Personnel (PIs: Prof. Eytan Modiano and Prof. Gil Zussman)

2019 **ARO-DURIP**, "Wireless Networking Testbed for Low Latency Mission Critical Communications"
- Result: Proposal awarded by the Army Research Office (ARO) and SDR testbed built at MIT
- Contribution: Assisted PI Prof. Eytan Modiano in writing the proposal

Talks, Tutorials, and Lectures

2023 Wireless Networks for Mission-Critical Applications: from Theory to Adaptive Control of Microchips
- (Upcoming) Invited talk at RPI, Electrical, Computer, and Systems Engineering Department

2022 Spectrum Sharing via Consumption Models
- Invited talk at Rutgers University, WINLAB Research Review, hosted by Prof. Dipankar Raychaudhuri

2022 Full-Duplex Communication: System Design and Implementation
- Lecture in the Columbia University course "Seminar in Information and Communication Theories".

2021–2022 Wireless Networks for Emerging Time-Sensitive Applications: Theory and Systems
- Invited talk at University of Washington, Department of Electrical and Computer Engineering, hosted by Prof. Payman Arabshahi, 2022
- Invited talk at Cornell Tech and Cornell University, School of Electrical and Computer Engineering, hosted by Prof. Mert Sabuncu, 2022
- Invited talk at Columbia University, CS Systems Seminar, hosted by Prof. Asaf Cidon, 2022
- Invited talk at Yale, Department of Electrical Engineering, hosted by Prof. Steve Morse, 2021

2019–2022 WiFresh: Age-of-Information from Theory to Implementation
- Invited talk at UM6P (Morocco), CS Research Seminars, hosted by Prof. El Mehdi Amhoud and Prof. Karima Echihabi, 2022
- Invited talk at METU (Turkey), EE Graduate Seminar, hosted by Prof. Elif Uysal-Biyikoglu, 2021
- Talk at IEEE ICCCN, 2021
- Invited talk at MIT, LIDS Student Conference, 2020 [**Best Presentation Award**]
- Invited talk at UPenn, hosted by Prof. Shirin Bidokhti, 2020
- Invited talk at Harvard, ISS Seminar, hosted by Prof. Flavio du Pin Calmon, 2019
- Invited talk at WPI, ECE Graduate Seminar, hosted by Prof. D. Richard Brown, 2019
- Invited talk at MIT, hosted by the Society for Applied and Industrial Mathematics, 2019

2021 Aging Wireless Bandits: Regret Analysis and Order-Optimal Learning Algorithm
- Talk at WiOpt

2021 Age of Information in Random Access Networks with Stochastic Arrivals
- Talk at IEEE INFOCOM

2016 & 2020 Index Policies: Gittins and Whittle Indices
- Invited talk at CMU SQUALL Seminar, hosted by Prof. Mor Harchol-Balter, 2020
- Tutorial at MIT CNRG group meeting, hosted by Prof. Eytan Modiano, 2016

2020 Age of Information: Definition, Analysis, and Applications
- Lecture in the Columbia University course "Queueing Networks".

2020 Age-of-Information in Wireless Networks: Theory and Implementation
- MIT Ph.D. doctoral thesis defense

2019 Minimizing the Age of Information in Wireless Networks with Stochastic Arrivals
- Talk at ACM MobiHoc

2017–2019 Quantization: Theory and Implementation
- Lecture in the MIT course "Communication Systems & Networks".

2016–2019 The Data Link Layer: Automatic Repeat Request Protocols
- Lecture in the MIT course "Communication Systems & Networks".

2017 & 2018 Optimizing Age of Information in Wireless Networks with Throughput Constraints
- Talk at IEEE INFOCOM, 2018
- Invited talk at CMU SQUALL Seminar, hosted by Prof. Mor Harchol-Balter, 2017

2018 Stochastic Network Utility Maximization
- Lecture in the MIT course "Data Communication Networks".

2017 Minimizing Age of Information in Broadcast Wireless Networks
- Talk at MIT LIDS Student Conference [**Best Presentation Award**]

2017 Lyapunov Optimization applied to the Age of Information minimization problem
- Invited Talk at MIT LIDS Tea Talk

2015 Optimal Scheduling of Real-Time Traffic in Wireless Networks with Delayed Feedback
- Talk at IEEE Allerton

Service

2019–2022 Technical Program Committee (TPC) Member:
- IEEE INFOCOM, 2022
- WiOpt, 2021 and 2022
- IEEE INFOCOM Workshop on AoI, 2020, 2021, and 2022
- IEEE Globecom Workshop on experimental wireless platforms and testbeds, 2021
- IEEE Vehicular Technology Conference, 2019 and 2020

2016–2022 Reviewed 125+ papers and articles for 15+ journals, magazines, and conferences in the field, including:
- IEEE/ACM Transactions on Networking
- IEEE Transactions on Information Theory
- IEEE Transactions on Mobile Computing
- IEEE Transactions on Wireless Communications
- IEEE Internet of Things Journal
- Journal of Communications and Networks
- IEEE Journal on Selected Areas in Communications
- IEEE Network Magazine
- IEEE Wireless Communications Letters
- IEEE Networking Letters
- IEEE ISIT
- IFIP Performance
- ACM SIGMETRICS

2014–2020 Served in multiple student committees, one or two per term, during the Ph.D. at MIT:
- Co-Chair of the MIT Westgate Executive Committee, 2019-2020
- Co-Chair of the MIT LIDS Social Committee, twice, 2014-2015 & 2018-2019
- Member of the MIT LIDS Mentoring Committee, twice, 2017-2019
- Co-Chair of the MIT LIDS Student Conference, 2017-2018
- Host of MIT Ashdown's monthly roundtable discussions, twice, 2015-2017

2018–2022 Served in multiple outreach events, including:
- Panelist in the Career Day at Columbia Secondary School (CSS) in West Harlem, NYC, May 2022
- Class visit to Beacon High School, NYC, as part of the NSF COSMOS-NewLAW Research Experience and Mentoring for Teachers (REM/RET) program, Dec. 2021
- Panelist in the event PhD 101 hosted by MIT AeroAstro, July 2020
- Panel Moderator for the Career Panel during the LIDS Student Conference, Feb. 2018