

Lekan Molu

Robotics / Control Systems / ML

Rerum Cognoscere Causas: To know the causes of things.

Microsoft Research NYC

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Statement of Goals

Automating rote tasks has taken on higher priority in business value chains. Rigid robots have played a leading role in this economic transformation. However, rigid robots have low transportable loads, and large flexure torques which affect their positioning accuracy. To minimize positioning accuracy e.g. error magnification from shoulder out to end-effector, their joints are typically stiffened during the manufacturing process. This stiffening contributes to a high load-to-weight ratio that complicates the actuation mechanism – hindering their use in sophisticated manipulation tasks. In contrast, soft robots exhibit distributed deformation in their configuration space as well as bending and twisting capabilities, whilst possessing hyper-redundancy and flexible manipulation capabilities in delicate workspaces. Their minimal resistance to applied strain and limited load-to-weight ratio make them choice mechanisms in human-robot automation domains given their compliance and hence their safety guarantees. **My research goal** is to harness soft matter for robots, exploiting their intrinsic morphological computation properties in order to yield simplified control laws and human-friendly robot manipulation systems. I want to continue providing robust models (via analytic and AI methods) as well as controllers for soft robots that serve as better alternatives to current rigid manipulation technologies in **medicine** and **industrial automation**. I am interested in designing (1) robust models, (2) robust adaptive controllers, and (3) software frameworks that make it easier (for engineers, chemists, and biologists alike) to create, verify and validate soft continuum manipulators as designers originally envisioned.

Education

2014–2019 **PhD in Electrical and Computer Engineering**, University of Texas at Dallas, Richardson, USA.

"A Multi-DOF Soft Robot Mechanism for Patient Motion Correction and Beam Orientation Selection in Cancer Radiation Therapy." Advisors: Nick Gans (UTD) and Steve Jiang (UT Southwestern Medical Center.) | Committee Members: Drs. Mark Spong, Tyler Summers, Dinesh Bhatia, and Yonas Tadesse. | External Examiner: Prof. Phillip Anderson.

2012 **Master of Science in Engineering in Control Systems**, The University of Sheffield, Sheffield, United Kingdom. *"Autonomous Navigation of a Rotorcraft Unmanned Aerial Vehicle using Machine Vision."* Advisor: Tony J. Dodd. | Committee Members: Drs. George Panoutsos and Robin Pursehouse. | Dissertation reviewed by Mahdi Mahfouf.

Publications

Premier IEEE Robotics and Automation Society, Algorithmic Foundations of Robotics, and Medical Physics publications (WAFR, IROS, NIPS, PhysMed, and ICRA) are highly selective venues for archival papers, similar to selective IEEE journals in visibility and strong scientific/engineering communications.

Olalekan Ogunmolu. *A Constitutive Framework For The Representation of the Viscosity Solutions of Dirichlet-type Hamilton-Jacobi Equations*. Transactions on Automatic Control, 2022.

Olalekan Ogunmolu, Shaoru Chen, and George Pappas. *"Constraints-Preserving" Controllers in Large-Scale Systems*. International Journal of Robotics Research, 2022.

Olalekan Ogunmolu. *A Cauchy-type Hamilton-Jacobi Successive Approximation Scheme For Reachable Sets Computation*. In Letters to The IEEE Control Systems Society, Presentation at Conference on Decision and Control, Cancun, Mexico. 2022.

Olalekan Ogunmolu. *ComplexBRAT: Complex Backward Reach-Avoid Tubes: An Emergent Collective Behavior*. Workshop on the Algorithm Foundations of Robotics (WAFR) XV, May 2022.

- Olalekan Ogunmolu.** Kinematics and Dynamics of a Continuum Motion-Correction Mechanism for Frameless and Maskless Cancer Radiation Therapy. (Technical Report), September 2019.
- Olalekan Ogunmolu.** Xinmin Liu, Nicholas Gans, and Rodney Wiersma, [Mechanism and Constitutive Model of a Continuum Robot for Head and Neck Cancer Radiotherapy](#). *IEEE International Conference on Robotics and Automation (ICRA 2020)*, Paris, France. October 2020.
- Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [A Fast Deep Learning Approach for Beam Orientation Selection Using Supervised Learning with Column Generation on IMRT Prostate Cancer Patients](#). Submitted to *Medical Physics (An AAPM Journal)*, May 2019.
- Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [Using Supervised Learning and Guided Monte Carlo Tree Search for Beam Orientation Optimization in Radiation Therapy](#). Appeared in *Artificial Intelligence in Radiation Therapy (AIRT). Lecture Notes in Computer Science, vol 11850. Springer Cham*, 2019.
- Olalekan Ogunmolu**, Michael Folkerts, Dan Nguyen, Nicholas Gans, and Steve Jiang. [Deep BOO: Automating Beam Orientation Selection in Intensity Modulated Radiation Therapy](#). *Algorithmic Foundations of Robotics XIII, International Workshop (WAFR)*, Mérida, Mexico. December 2018.
- Olalekan Ogunmolu**, Nicholas Gans, and Tyler Summers. [Minimax Iterative Dynamic Game: Application to Nonlinear Robot Control Tasks](#). *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Madrid, Spain. October 2018. DOI: 10.1109/IROS.2018.8594037.
- Olalekan Ogunmolu**, Adwait Kulkarni, Yonas Tadesse, Xuejun Gu, Steve Jiang, and Nick Gans. [Soft-NeuroAdapt: A 3-DOF Neuro-Adaptive Pose Correction System For Frameless and Maskless Cancer Radiotherapy](#). *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Vancouver, BC, Canada. September 2017. DOI: 10.1109/IROS.2017.8206211.
- Olalekan Ogunmolu**, Nicholas Gans, and Tyler Summers. [Robust Zero-Sum Deep Reinforcement Learning](#). *arxiv PrePrints, arxiv ID:1710.00491*, Oct 2017.
- Olalekan Ogunmolu**, Xuejun Gu, Steve Jiang, and Nicholas Gans. [Nonlinear Systems Identification Using Deep Dynamic Neural Networks](#). *arxiv PrePrints, arxiv ID:1610.01439*, Oct 2016.
- Olalekan Ogunmolu**, Xuejun Gu, Steve Jiang, and Nick Gans. [Vision-based control of a soft-robot for Maskless Cancer Radiotherapy](#). *IEEE Conference on Automation Science and Engineering (CASE)*, Fort-Worth, Texas, August 2016. DOI: 10.1109/CoASE.2016.7743378.
- Olalekan Ogunmolu**, Xuejun Gu, Steve Jiang, and Nick Gans. [A Real-Time Soft-Robotic Patient Positioning System for Maskless Head-and-Neck Cancer Radiotherapy](#). *IEEE Conference on Automation Science and Engineering (CASE)*, Gothenburg, Sweden, August 2015. DOI: 10.1109/CoASE.2015.7294318.
- Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [Using supervised learning and guided Monte Carlo tree search for beam orientation optimization in radiation therapy](#). Under review at *International Conference on Medical Image Computing and Computer Assisted Intervention, XXII (MICCAI)*, Shenzhen, China. October 2019.
- Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [Deep Learning Neural Network for Beam Orientation Optimization](#). To appear in *International Conference on the use of Computers in Radiation Therapy XVI (ICCR)*, Montreal, CA. June 2019.
- Olalekan Ogunmolu**, Dan Nguyen, Xun Jia, Weiguo Lu, Nick Gans, and Steve Jiang. [Automating Beam Orientation Optimization for IMRT Treatment Planning: A Deep Reinforcement Learning Approach](#). *60th Annual Meeting of the American Association of Physicists in Medicine, Nashville, TN (AAPM)*. July 2018.
- Yara Almubarak, Joshi Aniket, **Olalekan Ogunmolu**, Xuejun Gu, Steve Jiang, Nicholas Gans, and Yonas Tadesse, [Design and Development of Soft Robots for Head and Neck Cancer Radiotherapy](#). *SPIE: Smart Structures + Nondestructive Evaluation*, Denver, CO, U.S.A. March 2018.

Abstracts:

Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [A Fast Deep Learning Approach for Beam Orientation Selection Using Supervised Learning with Column Generation on IMRT Prostate Cancer Patients](#). *Medical Physics (AAPM)* 46 (6), E237-E237, San Antonio, TX, July 2019.

Olalekan Ogunmolu, Azar Sadeghnejad Barkousaraie, Nicholas Gans, Steve Jiang, and Dan Nguyen. [An Approximate Policy Iteration Scheme for Beam Orientation Selection in Radiation Therapy](#). *Medical Physics (AAPM)* 46 (6), E386-E386 San Antonio, TX, July 2019.

Azar Sadeghnejad Barkousaraie, **Olalekan Ogunmolu**, Steve Jiang, and Dan Nguyen. [A Reinforcement Learning Application of Guided Monte Carlo Tree Search Algorithm for Beam Orientation Selection in Radiation Therapy](#). *Medical Physics (AAPM)* 46 (6), E236-E236, San Antonio, TX, July 2019.

Olalekan Ogunmolu, Nicholas Gans, and Tyler Summers. [Minimax Iterative Dynamic Game: Application to Nonlinear Robot Control Tasks](#). *IEEE International Conference on Robotics and Automation. Machine Learning for Planning and Control Workshop Extended Abstract (ICRA 2018)*, Madrid, Spain. October 2018.

Olalekan Ogunmolu, Nicholas Gans, and Tyler Summers. [Minimax Iterative Dynamic Game: Application to Nonlinear Robot Control Tasks](#). *IEEE International Conference on Robotics and Automation, Late Breaking Result Abstract* Brisbane, Australia, May 2018.

Yara Almubarak, Joshi Aniket, **Olalekan Ogunmolu**, Xuejun Gu, Steve Jiang, Nicholas Gans, and Yonas Tadesse. [Design and Development of Soft Robots for Head and Neck Cancer Radiotherapy](#). *SPIE: Smart Structures + Nondestructive Evaluation*, Denver, CO, U.S.A. March 2018.

Tyler Summers, **Olalekan Ogunmolu**, and Nicholas Gans. [Robustness Margins and Robust Guided Policy Search for Deep Reinforcement Learning](#). *IROS 2017 Abstract Only Track*, Vancouver, BC, Canada. September 2017.

Olalekan Ogunmolu, Nick Gans, Steve Jiang, and Xuejun Gu. [An Image-Guided Soft Robotic Patient Positioning System for Maskless Head-And-Neck Cancer Radiotherapy: A Proof-of-Concept Study](#). *American Association of Physicists in Medicine (AAPM) Annual Meeting*, Anaheim, CA, USA. July 2015.

Olalekan Ogunmolu. [Towards Real-Time Motion Compensation in Radio-Transparent Robotic Radiation Therapy](#). Technical Report, November 2019.

Experience

Research

- 2021 - Present **Senior Researcher**, [Microsoft Research](#), New York City, NY 10012, USA.
Reinforcement Learning Group, 300 Lafayette Street, New York City, NY 10012.
- 2019 - 2021 **Postdoctoral Scholar**, [The University of Pennsylvania](#), Philadelphia, PA, USA.
Department of Radiation Oncology, Perelman School of Medicine, University of Pennsylvania.
- Summer '19 **Visiting Postdoctoral Scholar**, [The University of Chicago](#), Chicago, IL, USA.
Department of Radiation and Cellular Oncology, Pritzker School of Medicine, The University of Chicago.
- Summer '18 **Research Intern**, [Preferred Networks](#), Otemachi, Chiyoda-ku, Tokyo, Japan.
"Preferred Networks is one of a tiny handful of Japanese 'unicorns', or technology startups valued at more than \$1 billion." – The Wall Street Journal, 10/15/2018
Research Intern within the Robotics Team. Worked on stable learning of complex robot motion-planning/manipulation tasks. Implemented Khansari-Zadeh's CLF-DM on the Tokyo Robotics 7-DoF Arm. Proposed a DP approach for better complex robot trajectory imitation.
- Fall '17 - **Research Assistant**, Medical Artificial Intelligence and Automation Laboratory, Division of Medical
Spring '19 Physics and Engineering, Radiation Oncology Department, UT Southwestern Medical Center.
Research Assistant for Dr. Steve Jiang, Barbara Crittenden Professor of Cancer Research, UTSW Department of Radiation Oncology.
Developed a multidisciplinary approach (spanning Deep learning, optimal control, dynamic programming, and game theory) in order to solve the classic beam orientation optimization (BOO) problem.

- Summer - Fall '17 **Research Assistant**, Dr. Tyler Summers, Mechanical Engineering, UT Dallas.
Dynamic Programming, Decision Theoretic Control, Machine/Reinforcement Learning.
 Developed a conservative controller for mitigating the lack of robustness in multi-stage decision policies.
- Fall '14 - Spring 19 **Research Assistant**, Dr. Nick Gans, Electrical Engineering, University of Texas at Dallas.
Control Systems, Systems Identification, State Estimation and Computer Vision.
 Conceived the prototypical testbed, procured hardware, integrated components to simulate soft robot compensating systems for patients in intensity modulated radiotherapy.
- Summer '16 **Hardware Integration Intern**, Amazon Robotics LLC.
SLAM, Software and Hardware Integration Intern.
 Helped integrate the hardware and software for the P3-DX robot used as a recreational robot in the Amazon Robotics office.
- Spring '16 **Hardware Integration Intern**, Advanced Robotics Lab, Amazon Robotics LLC.
Hardware Integration Intern.
 Wrote the codebase for the line scanners used in tracking objects in amazon warehouse assembly lines.

Teaching:

- Spring '20 - **Adjunct Instructor, RBOT 250- Robot manipulation, planning and control**, *Brandeis University*.
 Designing course outlines and teaching.
- Fall '14 - '16 **Teaching Assistant, Introduction to Robotics**, *University of Texas at Dallas*.
 Guided students during laboratories in programming the Robai Cyton 300R2 Robot and graded homeworks.
- Spring '15 **Teaching Assistant, Linear Systems (M.S. Class)**, *University of Texas at Dallas*.
 Responsible for helping Masters students with linear control theory applications; graded homeworks and midterms.
- Spring '14 **Instructor, Analysis and Design of Digital Systems**, *Adekunle Ajasin University*.
 Developed course modules, sole instructor for sophomore students, graded homeworks, designed and graded exams.
- Summer '14 **Instructor, Digital Logic Design**, *Adekunle Ajasin University*.
 Co-developed course modules, joint-instructor for junior students, graded homeworks, designed and graded exams.

Invited Talks

- Open Robotics **Soft-Robotic Position Correction Mechanisms in Intensity-Modulated Radiation Therapy**.
Open Robotics Foundation, Mountain View, CA, USA. January 2019.
- Stanford University **Robotic Radiotherapy: Automating Position Correction in Intensity-Modulated Radiation Therapy**.
 Department of Energy Resources Engineering, **Stanford University**, Stanford, CA, USA. November 2018.
- UChicago **Robotic Radiotherapy: Automating Position Correction in Intensity-Modulated Radiation Therapy**.
 Department of Radiation and Cellular Oncology, **The University of Chicago**, Chicago, IL, USA. November 2018.
- ATR CNS Labs **Minimax Iterative Dynamic Game**.
 Department of Brain Robot Interface, **Computational Neuroscience Labs, ATR**, Osaka, Japan. August 2018.
- Preferred Networks **Neural Networks and Adaptive Control**.
Preferred Networks Tech. Talk, Chiyoda-ku, Tokyo. Japan. August 2018.
- Google **SoftNeuroAdapt: A 3-DoF Neuro-Adaptive Healthcare System**.
Work presented by Nick Gans, Google Robotics, Mountain View, CA. USA. September 2017.
- UTARI, Fort Worth, TX **A Wearable Soft Robotic Modular System for Head and Neck Motion Correction in Intensity-Modulated Radiation Therapy**.
University of Texas at Arlington Research Institute, Fort Worth, Texas, USA. May 2019.
- EFSC'17 Vancouver, BC **Soft Robotic Modules as Position Correcting Mechanisms in Cancer RT**.
3rd Entrepreneurship Forum & Start-up Competition, EFSC'17, Vancouver, BC, Canada. September 2017.

- UTSW, Dallas, TX [A 3-DOF Neuro-Adaptive Patient Pose Correcting System For Frameless and Maskless Cancer Radiotherapy.](#)
Physics Research Seminar Series, Radiation Oncology Department, UT Southwestern Medical Center, Dallas, TX, USA. March 2017.
- IEEE Arlington, TX [Towards automated accurate patient positioning in maskless cancer radiotherapy.](#)
IEEE Computational Intelligence Society, UT Arlington, TX, USA. December 2015.

Awards and honors

- **Google AI Travel and Conference Grant** October 2018
- **IEEE RAS/IROS Travel Award (IROS 2018)** August 2018
- Finalist at the [3rd Entrepreneurship Forum and Startup Competition](#) August 2017
Sponsored by IEEE Robotics and Automation Society, KUKA AG, and Univ. Hamburg
- **NSF Doctoral Consortium Award (IROS 2017)** August 2017
- **Mary and Richard Templeton Graduate Fellowship** August 2017
- **ROSCon Scholarship** (Open Software for Robotics Foundation) July 2017
- President's **Teaching Excellence Award** for Teaching Assistants Nom. Feb. 2017
- **Golden Key International Honour Society** Inducted Dec. 2016
- **IEEE RAS/ISAM Travel Award (CASE 2016)** August 2016
- **Ericsson Graduate Fellowship** 2015 - 2016
- **Jonsson Scholarship** 2014 - 2015
- **Achievement Award, University of Florida** (*Declined*) Fall 2014
- **PTDF Overseas Scholarship Award, £25,500+ for one year.** (~1.7% acceptance) 2011
- **Federal Government (of Nigeria) Scholarship** (~3.6% acceptance) 2002
- **Ondo State (Nigeria) Scholarship** (~10% acceptance) 2004

Select Leadership

Editorial Leadership

- 2020-2021 **Associate Editor**, *IEEE International Conference on Robotics and Automation.*, ICRA.
- 2019-2021 **Grants Reviewer**, *National Geographic AI for Species Discovery.*

Peer Reviewing Activities (Research)

- 2022 - Present **RAL**, *IEEE Robotics and Automation Letters.*
- 2019-Present **JBHI**, *An IEEE Journal of Biomedical and Health Informatics Access.*
- 2018-Present **Automatica**, *The International Federation of Automatic Control (IFAC)*, Impact Factor: 6.355.
- 2017-Present **Access**, *IEEE Access Journal.*
- 2017-Present **NCAA**, *Springer's Neural Computing and Applications*, Impact Factor: 4.664.
- 2018-Present **CDC**, *IEEE International Conference on Decision and Control*, Flagship Control and Decision-Making Control Conference Proceedings in the World, Impact Factor: 4.09, H-index: 42.
- 2017-Present **DSCC**, *American Society of Mechanical Engineers (ASME) Dynamic Systems and Control Conference*, Conference Proceedings, H-index: 8.
- 2017-Present **ICRA**, *IEEE International Conference on Robotics and Automation*, Flagship IEEE Robotics and Automation Society Conference in the World, H5-index: 82.
- 2017-Present **IROS**, *IEEE/Robotics Society of Japan (RSJ) International Conference on Intelligent Robots and Systems*, Flagship IEEE/RSJ Conference on Robotics, H5-index: 58.
- 2017-Present **ACC**, *IEEE American Control Conference*, Premiere American Control Conference Venue, H5-index: 41.
- 2017-Present **The IFAC World Congress**, *The International Federation of Automatic Control*, A worldwide, interdisciplinary congress of scientists and engineers to share up-to-date, complete and universal view of control and analysis techniques, Impact Factor: 2.653 at 2014.

Miscellaneous

- 2017 **Invited Contributor**, *IEEE/RSJ International Conference on Robots and Intelligent Systems (IROS)*, Abstract Only Track, Vancouver, BC, Canada.
- 2017 – Now **Member**, **IEEE Robotics and Automation Society**.
- 2016–Now **Member**, *IEEE Boston*, Greater Boston, USA.
- 2015 – 2016 **Science instructor**, *IEEE Dallas Shoulder of Giants Workshops*, Dallas, TX.
Participant at IEEE Dallas Young Professionals community outreaches in promoting STEM education and awareness in the Dallas/Fort-Worth Metroplex.
- 2015 **Summer Science Program**, *University of Texas at Dallas*, Richardson, TX.
Trained high-school kids in basic robots control and programming with the Berkeley Snap! kit and arduino.
- 2012 **Workshop participant**, *ILA Berlin Airshow*, Berlin, Germany.
Selected by Cassidian (an EADS company) for the *Aerospace Systems Engineering* workshop.
- 2012 **Workshop participant**, *Farnborough International Airshow*, NE Hampshire, England.
Selected by Airbus (an EADS company) among participants at the *UAV and Fighter Aircraft* workshop.

Mentoring

Undergraduate mentoring:

- Summer 2017 Rachael Thompson. Plano High School Student. Currently an undergrad at MIT's CSAIL. Class of 2021
- 2016 - 2017 Alex Tomkovich. Computer Engineering Junior.
- Spring 2015 Grant Carr. Computer Engineering Junior.

Masters mentoring:

- 2016 – 2017 Adwait Kulkarni. Mechanical Engineering Masters student (Currently at Drov Technologies, MN).
- 2015 Ajith Venkateswaran. Computer Engineering Masters student (Currently Senior Robotics Software Engineer, Samsung Research, America).

Computing

- Programming** C++, Python, Lua, MATLAB, LabVIEW.
- Libraries** Point Cloud Library, OpenCV, Torch7, Eigen, Docker, PyTorch, OpenAI Gym, MuJoCo, Numpy, SciPy, Scikit-Learn, C++11/14 standards.
- OS** OSX, Debian, Windows.
- OSRF** ROS hydro, indigo, jade, kinetic, and melodic distros. ROS Bouncy Bolson.
- Web** HTML, Markdown, socket.io, node.js, and express.js.

Select OpenSource Projects

- Lyapunov-Learner** Python Implementation of "Learning Control Lyapunov Functions for Dynamical Systems". (Available at <https://github.com/lakehanne/LyapunovLearner>)
- Awesome-NeuroControl** A curated list of neural applications in control theory and practice. (Available at <https://github.com/lakehanne/awesome-neurocontrol>)
- Awesome-Screw Theory** A curated list of screw theory and practice in continuum, soft and semi-rigid robots. (Available at <https://github.com/lakehanne/awesome-screw-theory>)
- PCL** Fix for segfault in our-cvfh algorithm in the point-cloud library. (Available at [PR 1827](#))
- GPS** Catkinized version of Levine et. al's guided policy search algorithm in ROS Indigo (Available at <https://github.com/lakehanne/gps>). Dockerized version available at [gps-docker](#).
- Keyence** Minimal source code for retrieving profile map from the keyence LJV-7000 series line scanners. (Available at <https://github.com/lakehanne/keyence>)
- RBN** Recurrent Batch Normalization of Neural Networks in Torch7. (Available at <https://github.com/element-research/rnn>)
- DICE** Sørensen-Dice coefficients in Torch7. (Available at <https://github.com/lakehanne/nn>).

FARNNs Training of multilayer networks, simple recurrent neural networks, long short-term memory cells (with peep-hole connections), fast LSTMs, and recurrent batch normalized FastLSTMs to model the relationship between Borel measurable sets. (Available at <https://github.com/lakehanne/FARNN>)

Languages

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|----------|-------------------------------------|--|
| English | Reads, writes, and speaks fluently | <i>Lived in Nigeria, United Kingdom and United States.</i> |
| Japanese | Basic proficiency | <i>Lived in Japan for 3 months.</i> |
| Yoruba | Reads, writes, and speaks fluently. | <i>Native Nigerian Language. Spoken at home.</i> |

References

Nick Gans

Professor of Electrical Engineering
University of Texas at Dallas,
Richardson, TX, USA

Steve Jiang

Barbara Crittenden Professorship in Cancer Research
Vice Chair, Department of Radiation Oncology
Director, Div. of Medical Physics and Engineering
University of Texas Southwestern Medical Center
Dallas, TX, USA

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