Abhishek Ninad Kulkarni

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Research Interests

My primary research interests lie at the intersection of game-theoretic decision-making, formal logic (temporal, epistemic, preference), and automatic controller synthesis.

My long-term goal is to develop *cognitively realistic autonomous systems* with human-like reasoning abilities about knowledge, time, space, preferences etc. to enable them to make strategic decisions while interacting with humans and other autonomous agents.

Education

University of Florida (UF)   Gainesville, FL, USA
Ph.D. in Electrical and Computer Engineering   Aug'21 − May'23 (Expected)
Advisor: Dr. Jie Fu
Thesis: Formal Synthesis of Opportunistic and Deceptive Strategies: A Hypergame Theory Approach

Worcester Polytechnic Institute (WPI)   Worcester, MA, USA
Ph.D. in Robotics Engineering (Continued at University of Florida)   Jan'18 − Aug'21
Advisor: Dr. Jie Fu

Worcester Polytechnic Institute (WPI)   Worcester, MA, USA
M.S. in Robotics Engineering   Aug'16 − Aug'21
Advisor: Dr. Jie Fu

Vishwakarma Institute of Technology (VIT)   Pune, India
B.Tech. in Electronics and Telecommunication Engineering   Aug'12 − May'16
Advisor: Dr. Pushkar Joglekar, Prof. Milind Kamble, Prof. Milind Patwardhan, Prof. Mrunal Shidore
Thesis: Developing an Autonomous and Intelligent Robotics Platform using Cyber-Physical Systems Approach

Publications

Manuscripts In Preparation

[M2] Automata-theoretic Approach to Qualitative Planning in Stochastic Systems with Preferences over Temporal Logic Objectives
Abhishek N. Kulkarni, *and Jie Fu*
In preparation for Automatica.

[M1] Decoy Allocation Games on Graphs: Achieving Safety by Hiding the Real and Revealing the Fiction
Abhishek N. Kulkarni, *Matthew S. Cohen, and Jie Fu*
In preparation for Automatica.

Refereed Journals

[J3] Synthesizing Attack-Aware Control and Active Sensing Strategies under Reactive Sensor Attacks
Sumukha Udupa, **Abhishek N. Kulkarni**, *Shuo Han, Nandi Leslie, Charles A. Kamhoua, Jie Fu*
IEEE Control Systems Letters (L-CSS), 2023 (to appear).

[J2] Dynamic Hypergames for Synthesis of Deceptive Strategies with Temporal Logic Objectives
Lening Li, Haoxiang Ma, **Abhishek N. Kulkarni**, *and Jie Fu*
IEEE Transactions on Automation Science and Engineering (TASE), 2022.

[J1] Deceptive Labeling: Hypergames on Graphs for Stealthy Deception
Abhishek N. Kulkarni, *Huan Luo, Nandi O. Leslie, Charles A. Kamhoua, and Jie Fu*
IEEE Control Systems Letters (L-CSS), 2020.

Refereed Book Chapters

[B1] A Theory of Hypergames on Graphs for Synthesizing Dynamic Cyber Defense with Deception
Abhishek N. Kulkarni, *and Jie Fu*
Game Theory and Machine Learning for Cyber Security, Wiley-IEEE Press, 2022.

Refereed Conferences

[C9] Opportunistic Qualitative Planning in Stochastic Systems with Incomplete Preferences over Reachability Objectives
Abhishek N. Kulkarni, *and Jie Fu*
(Under review) IEEE American Control Conference (ACC), 2023.

[C8] Probabilistic Planning with Partially Ordered Preferences over Temporal Goals
Hazhar Rahmani, **Abhishek N. Kulkarni**, *and Jie Fu*
(Under review) IEEE International Conference on Robotics and Automation (ICRA), 2023.

[C7] Qualitative Planning in Imperfect Information Games with Active Sensing and Reactive Sensor Attacks: Cost of Unawareness
Abhishek N. Kulkarni, *Shuo Han, Nandi O. Leslie, Charles A. Kamhoua and Jie Fu*
IEEE Conference on Decision and Control (CDC), 2021.

[C6] Decoy Placement Games on Graphs with Temporal Logic Objectives
Abhishek N. Kulkarni, *Jie Fu, Huan Luo, Charles A. Kamhoua, Nandi O. Leslie,*
IEEE Conference on Decision and Game Theory for Security (GameSec), 2020.
Comment: This is a 20-page, single-column paper published in Springer as part of LNCS series.

[C5] Synthesis of Deceptive Strategies in Reachability Games with Action Misperception
Abhishek N. Kulkarni, *and Jie Fu*
International Joint Conferences on Artificial Intelligence (IJCAI), 2020.
Comment: Acceptance rate of IJCAI 2020 was 12.6%

[C4] Opportunistic Synthesis in Reactive Games under Information Asymmetry
Abhishek N. Kulkarni, *and Jie Fu*
IEEE Conference on Decision and Control (CDC), 2019.

[C3] A Compositional Approach to Reactive Games under Temporal Logic Specifications
Abhishek N. Kulkarni, *and Jie Fu*
IEEE American Control Conference (ACC), 2018.

[C2] [Dot matrix text recognition for industrial carton classification](#)
  Siddharth Nitin Patki, Madhuri Joshi and **Abhishek N. Kulkarni**
  IEEE International Conference on Informatics and Computing (ICIC), 2015.

[C1] [Big Data Management of a Cyber-Physical Multi-location Chemical Factory](#)
  Abhishek N. Kulkarni, *and Satish R. Inamdar*
  International Journal of Industrial Electronics and Electrical Engineering (IJIEEE), 2014.

Refereed Workshops

[W1] [Synthesis of Deceptive Cyberdefense with Temporal Logic Constraints](#)
  Abhishek N. Kulkarni, *and Jie Fu*
  Workshop on Foundations of Computer Security (FCS) 2020.

Grant-writing Experience

[G2] Multi-Class Deception for Cyber Defense: Algorithms and Experimental Validation.
  Submitted to ARO Undergraduate Research Apprenticeship Program (URAP), 2022.
  PI: Dr. Jie Fu

[G1] Low-Cost High-Tech Educational Robot as Teaching Aid.
  Funded by Board of College and University Development, Pune, India, 2014.
  PI: Prof. Milind Patwardhan, Prof. Milind Kamble, Prof. Mrunal Shidore
  Highlight: Our proposal was the only one to be approved for more funding than requested in appreciation
  of our vision and potential impact.

Note: I am not a PI on these grants. I have participated in the conception and writing of grant proposals under
supervision of PIs. The proposals are based upon my PhD and bachelor's theses.

Open-source Software

ggsolver | https://github.com/abhibp1993/ggsolver
A python package for constructing, manipulating, solving and simulating various classes of ω-regular games with
complete, incomplete and imperfect information.

Teaching Experience

Teaching Assistant and Guest Lecturer

- ECE 5934: Formal Methods in Robotics and AI.   UF, Fall'22
  Two guest lectures on 'Games on Graphs' and 'Solving games on graphs using Python'.
- RBE 595: Formal Methods in Robotics.   WPI, Spring'19
  Guest lecture on 'Games on Graphs'.
- ECE 2799: Electrical and Computer Engineering Design.   WPI, Spring'18 (B)
- ECE 2019: Sensors, Circuits and Systems.   WPI, Spring'18 (A)

Workshop Instructor

Embedded Systems using Arduino   VIT, Summer'22

- Took the initiative to plan, design and teach a 6-day, 36-hour workshop for sophomore and junior students.
- Designed the syllabus, slides, and set up labs for the workshop.
- The workshop was highly appreciated by students. Upon request, I taught the workshop one more time.

Mentoring Experience

- Sumukha Udupa, PhD student, UF.   Aug'21 − Present
  Project: Planning under Sensor Attacks. See [C7], [J3].
- Supervising 4 course-projects in ECE 5934 (Formal Methods for Robotics and AI).   Aug'22 − Dec'22
  Highlight: Helping students to formulate, solve, and simulate games on graphs using ggsolver.
- Yaru Gong, BS student, Dr. Jie Fu's Lab, WPI.   May'20 − Aug'20
  Project: Developing C++/Python bindings for ggsolver.
- Tousif Zaman, MS student, Dr. Jie Fu's Lab, WPI.   Jan'20 − May'20
  Project: Applications of Action Deception in Computer Games.
- Teja Kosuru, Dr. Jie Fu's Lab, High school student.   May'19 − Aug'19
  Project: Applications of Action Deception in Computer Games.
- Supervised 9 term-long product-design projects simultaneously in ECE 2799.   Jan'18 − Mar'18
  Highlight: Two projects supervised by me were selected among top-3 projects. Patent office at WPI selected one of the projects for its novelty.

Professional Service

Reviewer for Conferences, Journals

- IEEE TAC(2020), ACC (2020, 2021, 2022), CDC (2020, 2021), RA-L (2021), ICRA (2023)
- Wiley-IEEE Press (2020): Book Chapter for 'Game Theory and Machine Learning for Cyber Security'
- Springer QEST (2021)

External Examiner at VIT

Since 2020, I have served as an external examiner for dissertation projects and conducted oral examination for freshmen courses such as 'Design Thinking' and 'Introduction to Computer Programming'.

Leadership Roles

Department Representative and Committee Service

- Student health and wellness representative for Dr. Jie Fu's lab.   UF, Fall'21 − Present
- Senator for robotics department to Graduate Student Government.   WPI, Spring'19 − Summer'21
- Graduate student representative for robotics department.   WPI, Fall'19 − Summer'20
- Member of Arts and Science Graduate Student Advisory Council.   WPI, Fall'19 − Summer'21
- Member of Search Committee for Dean of Global School.   WPI, Spring'20 − Spring'21
- Graduate Chair for Rho-Beta-Epsilon, Robotics Honor Society.   WPI, Fall'19

Co-founder of Cognitive Robotics and Intelligent SysTems Lab (CRISTL), VIT

Roles and Responsibilities:

- Designed the hardware, firmware and software for the low-cost educational robot as proposed in grant.
- Assisted PI's to recruit and train students by organizing guest lectures and workshops.
- Supervised mini-projects from hardware design to camera-based indoor localization and motion planning.
- Assisted PI's in managing budget, procurement, writing timely reports to the funding agency.
- Planned, designed and taught a course on 'Embedded Systems using Arduino'.

Industry Experience

NodeIn Inc. (Robotics Research Intern) Fall'17
Developed provably-correct motion planning algorithm for quadcopter traveling in urban environment using formal-methods approach.

MathWorks Inc. (Hardware-Software Intern) Summer'17
Extended MATLAB's hardware support for Arduino with additional sensors.

Selected Achievements and Awards

- Dr. Glenn Yee Scholarship WPI, Fall'20
- Three-time winner of department's best project award. VIT, Spring'15 − Spring16

Among many achievements, none has given me a greater joy than receiving a call from a former student who thanked me for inspiring a passion for robotics in him!