Shana Moothedath

CONTACT

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RESEARCH INTERESTS

Bandit learning; Reinforcement learning; Control and security of cyber-physical systems; Game theory and learning; Decentralized and federated learning; Data-driven control

POSITION

Assistant Professor (July 2021 - Present)
Department of Electrical and Computer Engineering
Iowa State University of Washington, USA

Postdoctoral Research Scholar (May 2018 - June 2021)
Department of Electrical and Computer Engineering
University of Washington, Seattle, USA

EDUCATION

Postdoctoral Research Scholar (May 2018 - Present)
Department of Electrical and Computer Engineering
University of Washington, Seattle, USA
Main Focus: Dynamic Information Flow Tracking Games for Advanced Persistent Threats
Advisors: Prof. Radha Poovendran and Prof. Linda Bushnell

Ph.D. in Electrical Engineering (July 2014 - August 2018)
Indian Institute of Technology Bombay, Mumbai, India
Thesis: Optimizing Structural Linear Systems: Complexity and Approximation
Advisors: Prof. Prasanna Chaporkar and Prof. Madhu N. Belur
Excellence in Ph.D. Research Thesis Award at Indian Institute of Technology Bombay (2017-2019)

Master of Technology in Electrical Engineering (August 2012 - July 2014)
University of Kerala, Kerala, India
Thesis: On-board Trajectory Optimization of a Launch Vehicle with Splash-Down Constraint
Advisors: Renju Gangadharan and Prof. R. Lethakumari
First Rank in University of Kerala for M. Tech (2014)

Bachelor of Technology in Electrical Engineering (July 2007 - June 2011)
University of Kerala, Kerala, India

GRANTS

1. **Department of Homeland Security**: $150,000, *Federated Intrusion Response Network for Grids (FIRNet-G)*, PI: Manimaran Govindarasu, Co-PI: Shana Moothedath, 2023-2024.
2. **NSF Small**: $300,000, *Fully Decentralized (Attack-)Resilient Dynamic Low-Rank Matrix Learning*, PI: Shana Moothedath, Co-PI: Namrata Vaswani, 2022-2025.
3. **Presidential Interdisciplinary Research Initiative (PRIRI), ISU**: $150,000, *Cybersecurity for Smart Agriculture*, PI: Manimaran Govindarasu, 2023.
4. **Seed Funding**: $15,000, *Secure Decision Making for Farming Recommender Systems*, Lead: Shana Moothedath, 2023.
5. **Seed Funding**: $14,500, *Creating a testbed for sensor-based smart irrigation in vegetable production systems and its implications on cybersecurity*, Lead: Ajay Nair (Dept. of Horticulture), 2023.

Honors and Awards

Rising Star in Electrical Engineering and Computer Science, (2019)

Excellence in Ph.D. Research Thesis Award at Indian Institute of Technology Bombay (2017-2019)

Excellence in Teaching Assistantship for Multi-variable Control Systems course (2017)

Student Travel Support for Indian Control Conference (2016)

First Rank in University of Kerala for M. Tech (2014)

Graduate Scholarship by Govt. of India for graduate studies (2014-2018)

Graduate Scholarship by Govt. of India for master's studies (2012-2014)

Merit Scholarship by Govt. of India for undergraduate studies (2007-2011)

University Service

ECpE Seminar Committee (August 2022 - August 2023)
ECpE Faculty Search Committee (August 2021 - August 2022)
ECpE Seminar Committee (August 2022 - Present)

Experience

Postdoctoral Research Scholar (May 2018 - July 2021)
ONR-MURI Project
ADAPT: Analytical Framework for Actionable Defense against Advanced Persistent Threats
University of Washington, Seattle, USA
I am the postdoctoral lead for one of the thrust
Participating Universities: University of Washington, Seattle, Georgia Institute of Technology, University of Illinois at Urbana-Champaign, University of California Berkley, University of California Santa Barbara

Research Intern (September 2013 - July 2014)
Vikram Sarabhai Space Centre (VSSC-ISRO)
Department of Guidance and Navigation Control
Project: Trajectory Optimization for Launch Vehicles
Indian Space Research Organization, Trivandrum, India

Instructor at ISU:
EE 590, Introduction to Game Theory and Reinforcement Learning (Spring, 2023)
EE 475, Automatic Control Systems (Fall, 2021, 2022, 2023)
EE 425, Machine Learning: A Signal Processing Perspective (Spring 2022)

Instructor at University of Washington, Seattle:
EE 418, Network Security and Cryptography (Autumn, 2019)

Teaching Assistant: From 2014-2018, I was a teaching assistant for the following courses at EE department of Indian Institute of Technology Bombay. Responsibilities include grading assignments and exams, conducting recitations and resolving doubts, occasionally conducting lectures. I was awarded **Excellence in Teaching Assistantship** for Multi-variable Control Systems course (2017).

Multivariable Control Systems (2015-17)
Nonlinear Dynamical Systems (2016-17)
Matrix Computations (2015-16, 2018)
Control Systems (2014-15)
Introduction to Electrical and Electronics Circuit (2014)

Publications

Journal Papers:

16. Jiabin Lin, **Shana Moothedath**. Distributed Multi-Task Learning for Stochastic Bandits with Context Distribution and Stage-wise Constraints, Submitted.
15. Geethu Joseph, **Shana Moothedath**, and Jiabin Lin. Minimal Input Structural Modifications for Strongly Structural Controllability, Submitted.
14. Dinuka Sahabandu, **Shana Moothedath**, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran. A Reinforcement Learning Approach for Dynamic Information Flow Tracking Games for Detecting Advanced Persistent Threats, Submitted.
13. **Shana Moothedath** and Namrata Vaswani. Fast Decentralized Federated Low Rank Matrix Recovery from Column-wise Linear Projections. Submitted.
12. Dinuka Sahabandu, **Shana Moothedath**, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran. RL-ARNE: A Reinforcement Learning Algorithm for Computing Average Reward Nash Equilibrium of Nonzero-Sum Stochastic Games. To appear in *IEEE Transactions on Automatic Control*, 2023.
11. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran. Stochastic Dynamic Information Flow Tracking Game using Supervised Learning for Detecting Advanced Persistent Threats. in *Automatica*, vol. 159, 2024.
10. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, and Radha Poovendran. Dynamic Information Flow Tracking for Detection of Advanced Persistent Threats: A Stochastic Game Approach. To appear in *IEEE Transactions on Automatic Control*.
9. RaviTeja Gundeti, **Shana Moothedath**, and Prasanna Chaporkar. Feedback Robustness in Structured Closed-loop System. *European Journal of Control*, vol 57, pp: 95-108, 2021.
8. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, and Radha Poovendran. A Game Theoretic Approach for Dynamic Information Flow Tracking to Detect Multi-Stage Advanced Persistent Threats. *IEEE Transactions on Automatic Control*, vol 65, issue. 12, pp: 5248-5263, 2020.
7. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. Optimal Network Topology Design in Composite Systems for Structural Controllability. *IEEE Transactions on Control of Network Systems*, vol 7, issue. 3, pp: 1164-1175, 2020.
6. Aishwary Joshi, **Shana Moothedath**, and Prasanna Chaporkar. Minimum Cost Feedback Selection in Structured Systems: Hardness and Approximation Algorithm. In *IEEE Transactions on Automatic Control. IEEE Transactions on Automatic Control*, vol 65, issue. 12, pp: 5517-5524, 2020.
5. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. Approximating Constrained Minimum Cost Input-Output Selection for Generic Arbitrary Pole Placement in Structured Systems. *Automatica*, vol. 107, pp: 200-210, 2019.
4. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. Optimal Selection of Essential Interconnections for Structural Controllability in Heterogeneous Subsystems. *Automatica*, vol. 103, pp: 424-434, 2019.
3. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. Sparsest Feedback Selection for Structurally Cyclic Systems with Dedicated Actuators and Sensors in Polynomial Time. *IEEE Transactions on Automatic Control*, vol. 64, no. 9, pp: 3956-3963, 2019.
2. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. Minimum Cost Feedback Selection for Arbitrary Pole Placement in Structured Systems. *IEEE Transactions on Automatic Control*, vol. 63, no. 11, pp: 3881-3888, 2018.
1. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. A Flow-Network Based Polynomial-Time Approximation Algorithm for the Minimum Constrained Input Structural Controllability Problem. *IEEE Transactions on Automatic Control*, vol. 63, no. 9, pp: 3151-3158, 2018.

0. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. A Maximum Likelihood Based Offline Estimation of Student Capabilities and Question Difficulties. *Perspectives in Education*, vol. 34, no. 4, pp: 99-115, 2016.

Conference Papers: (Peer Reviewed)

27. Jiabin Lin, Shana Moothedath, and Namrata Vaswani, Fast and Sample Efficient Multi-Task Representation Learning in Stochastic Contextual Bandits, Submitted to *International Conference on Machine Learning (ICML)*, 2024.
26. Shana Moothedath, and Namrata Vaswani, Fast Decentralized Multi-Task Representation Learning , Submitted to *International Conference on Machine Learning (ICML)*, 2024.
25. Jiabin Lin and Shana Moothedath, Multi-Task Learning for Stochastic Bandits with Stage-Wise Constraintss, Submitted to *IEEE International Symposium on Information Theory (ISIT)*, 2024.
24. Sharu Jose and Shana Moothedath, Thompson Sampling for Stochastic Bandits with Noisy Contexts: An Information-Theoretic Regret Analysis, Submitted to *Uncertainty in Artificial Intelligence (UAI)*, 2024.
23. Jiabin Lin and Shana Moothedath, Federated Learning for Heterogeneous Bandits with Unobserved Contexts, Submitted to *IEEE International Symposium on Information Theory (ISIT)*, 2024.
22. Shana Moothedath and Namrata Vaswani, Decentralized Low Rank Matrix Recovery From Column-wise Projections by Alternating GD and Minimization, In *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2024.
21. Jiabin Lin, Karuna Anna Sajeevan, Bibek Acharya, Shana Moothedath, Ratul Chowdhury, Distributed Stochastic Contextual Bandits for Protein Drug Interaction, In *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2024.
20. Ahmed Ali Abbasi, **Shana Moothedath** and Namrata Vaswani, Fast Federated Low Rank Matrix Completion. In *Fifty-Ninth Annual Allerton Conference on Communication, Control, and Computing*, 2023.
19. **Shana Moothedath** and Namrata Vaswani, Comparing Decetralized Gradient Descent Approaches and Guarantees. In *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2023.
18. Jiabin Lin and **Shana Moothedath**, Distributed Stochastic Bandits with Hidden Context. In *European Control Conference (ECC)*, 2023.
17. Jiabin Lin and **Shana Moothedath**, Distributed Stochastic Bandit Learning with Delayed Context Observation. In *European Control Conference (ECC)*, 2023.
16. Jiabin Lin and **Shana Moothedath**i, Feature Selection in Distributed Stochastic Linear Bandits. In *American Control Conference (ACC)*, 2023.
15. **Shana Moothedath**, Namrata Vaswani, Dec-AltProjGD: Fully-Decentralized Alternating Projected Gradient Descent for Low Rank Column-wise Compressive Sensing. In *Conference on Decision and Control (CDC)*, Mexico, December, 2022.
14. Jiabin Lin, Xian Yeow Lee, Talukder Jubery, **Shana Moothedath**, Soumik Sarkar, and Baskar Ganapathysubramanian, Stochastic Conservative Contextual Linear Bandits. In *Conference on Decision and Control (CDC)*, Mexico, December, 2022.
13. **Shana Moothedath**, Namrata Vaswani, Fully Decentralized and Federated Low Rank Compressive Sensing. In *American Control Conference (ACC)*, Atlanta, USA, June, 2022.
12. **Shana Moothedath**, Xian Yeow Lee, Talukder Jubery, Baskar Ganapathysubramanian, Soumik Sarkar, A Conservative Stochastic Contextual Bandit Based Framework for Farming Recommender Systems. In *AAAI Workshop on AI for Agriculture and Food Systems (AIAFS)*, Virtual Conference, February, 2022.
11. Dinuka Sahabandu, **Shana Moothedath**, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran, Quickest Detection of Advanced Persistent Threats: A Semi-Markov Game Approach. In *International Conference on Cyber-Physical Systems (ICCPS)*, Sydney, Australia, April, 2020.

10. Dinuka Sahabandu, **Shana Moothedath**, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran, Stochastic Dynamic Information Flow Tracking Game with Reinforcement Learning. In *Conference on Decision and Game Theory for Security (GameSec)*, Stockholm, Sweden, October, 2019.
9. Dinuka Shabandu, **Shana Moothedath**, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, and Radha Poovendran. Dynamic Information Flow Tracking Games for Simultaneous Detection of Multiple Attackers. In *IEEE Conference on Decision and Control (CDC)*, Nice, France, December, 2019.
8. Shruti Misra, **Shana Moothedath**, Hossein Hosseini, Joey Allen, Linda Bushnell, Wenke Lee, and Radha Poovendran. Learning Equilibria in Stochastic Information Flow Tracking Games with Partial Knowledge. In *IEEE Conference on Decision and Control (CDC)*, Nice, France, December, 2019.
7. Dinuka Shabandu, **Shana Moothedath**, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, and Radha Poovendran. A Game Theoretic Approach for Dynamic Information Flow Tracking with Conditional Branching. In *American Control Conference (ACC)*, pp: 2289-2296, Philadelphia, USA, July, 2019.
6. **Shana Moothedath**, Prasanna Chaporkar, and Aishwary Joshi. Optimal Network Topology Design in Composite Systems with Constrained Neighbours for Structural Controllability. In *American Control Conference (ACC)*, pp: 2078-2083, Philadelphia, USA, July, 2019.
5. Kumar Yashashwi, **Shana Moothedath**, and Prasanna Chaporkar. Minimizing Inputs for Strong Structural Controllability. In *American Control Conference (ACC)*, pp: 2048-2053, Philadelphia, USA, July, 2019.
4. **Shana Moothedath**, Kumar Yashashwi, and Prasanna Chaporkar. Target Controllability for Structured Systems. In *European Control Conference (ECC)*, pp: 3484-3489, Naples, Italy, June, 2019.
3. **Shana Moothedath**, Dinuka Shabandu, Andrew Clark, Sangho Lee, Wenke Lee, and Radha Poovendran. Multi-stage Dynamic Information Flow Tracking Game. In *Conference on Decision and Game Theory for Security (GameSec)*, pp: 80-101, Seattle, USA, 2018.
2. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. A Randomized Algorithm for the Minimum Cost Constrained Input Selection for State Space Structural Controllability. In *European Control Conference (ECC)*, pp: 483-488, Limassol, Cyprus, 2018.
1. Saurabh Kumar, **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. An MCMC based Course to Teaching Assistant Allocation. In *International Conference on Network, Communication and Computing (ICNCC)*, pp: 131-134, Kyoto, Japan, 2016.
0. **Shana Moothedath**, Prasanna Chaporkar, and Madhu N. Belur. A Maximum Likelihood Based Offline Estimation of Student Capabilities and Question Difficulties. In *International Association for Educational Assessment Conference (IAEA)*, Cape Town, South Africa, 2016.
-1. **Shana Moothedath**, Renju Gangadharan and R. Letha Kumari. On board trajectory Optimization of a Launch Vehicle with Splash Down Constraint. In *IEEE International Conference on Magnetics, Machines & Drives*, pp:1-6, Kerala, India, 2014.

Posters

7. **Shana Moothedath**, Xian Yeow Lee, Jiabin Lin, Talukder Jubery, Baskar Ganapathysubramanian, Soumik Sarkar, A Conservative Stochastic Contextual Bandit Based Framework for Farming Recommender Systems. In *AAAI Workshop on AI for Agriculture and Food Systems (AIAFS)*, Virtual Conference, February, 2022.
6. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, Radha Poovendran. Multi-Stage Dynamic Information Flow Tracking Game for Advanced Persistent Threats. **Invited Poster** in Workshop on Analysis and Control

of Complex Networks: State of the Art and Research Directions, *American Control Conference*, Philadelphia, USA, July 2019 and *ONR-MURI Mid-Review Meeting*, Washington DC, USA, April 2019.

5. Dinuka Sahabandu, **Shana Moothedath**, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, Radha Poovendran. A Game Theoretic Approach for Resource Efficient Dynamic Information Flow Tracking. In Poster Session, *ONR-MURI Mid-Review Meeting*, Washington DC, USA, April 2019.
4. Shruti Misra, **Shana Moothedath**, Hossein Hosseini, Joey Allen, Linda Bushnell, Wenke Lee, Radha Poovendran. Learning Equilibria in Stochastic Information Flow Tracking Games with Partial Knowledge. In Poster Session, *ONR-MURI Mid-Review Meeting*, Washington DC, USA, April 2019.
3. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, Radha Poovendran. Multi-Stage Dynamic Information Flow Tracking Game for Advanced Persistent Threats. In iREDEFINE Workshop, *ECEDHA Conference*, Arizona, USA, March 2019.
2. **Shana Moothedath**, Dinuka Sahabandu, Joey Allen, Andrew Clark, Linda Bushnell, Wenke Lee, Radha Poovendran. Multi-Stage Dynamic Information Flow Tracking Game. In Meet the Faculty Candidate Poster Session, *IEEE Conference on Decision and Control*, Florida, USA, December 2018 and in Poster Session, *Western USA ECE Departments Heads Association (WECEDHA)*, Seattle, USA, November, 2018.
1. **Shana Moothedath**, Saurabh Kumar, Prasanna Chaporkar, and Madhu N. Belur. Solving Allocation Problems using Markov Chain Monte Carlo Technique. In Poster Session, *Indian Control Conference*, Hyderabad, India, January 2016.

Selected Talks & Tutorials

Invited talk at Indian Institute of Technology, Kharagpur, organized by IEEE Kharagpur section, Women in Engineering (WIE), and Control System Society.

Invited talk at INFORMS 2022, Predictive Analytics for Game Theory session.

Invited talk on 'A Game and Control Framework for Modeling and Mitigating Advanced Persistent Threats on Cyber Systems' at *TrAC AI Seminar Series* at the Iowa State University, February, 2022.

Invited talk on 'ADAPT: Analytical Framework for Actionable Defense against Advanced Persistent Threats' during the *Workshop on Secure and Resilient Control Systems* at the IEEE Conference on Decision and Control, Miami Beach, Florida, December, 2018 (co-presented with Prof. Radha Poovendran).

Talk on 'Dynamic Information Flow Tracking Games to Detect Advanced Persistent Threats' during the *ONR-MURI Mid-Review Meeting*, Washington DC, April, 2019 (co-presented with Prof. Radha Poovendran).

Talk on 'Optimal Network Topology Design in Composite Systems with Constrained Neighbours for Structural Controllability' during the *American Control Conference*, Philadelphia, July, 2019.

Talk on 'Minimizing Inputs for Strong Structural Controllability' during the *American Control Conference*, Philadelphia, July, 2019.

Talk on 'Multi-stage Dynamic Information Flow Tracking Game' at *Conference on Decision and Game Theory for Security*, Seattle, USA, October, 2018.

Talk on 'A Maximum Likelihood Based Offline Estimation of Student Capabilities and Question Difficulties' at *42nd International Association for Educational Assessment (IAEA) Conference*, Cape Town, South Africa, August, 2016.

Tutorial on 'Application of Pandas for some allocation problems' at *SciPy India 2015*, Indian Institute of Technology Bombay, Mumbai, India, December, 2015.

Talk on 'On-board Trajectory Optimization of a Launch Vehicle with Splash-Down Constraints' at *4th Annual International Conference on Emerging Research Areas*, Kottayam, India, July, 2014.

Mentoring

Mentoring: **ISU**
PhD students: 2
Undergraduate research students: 5
Senior design: 6

University of Washington, Seattle (UW)
PhD students: 2

Indian Institute of Technology Bombay (IITB)
Dual degree students (undergrad+master's) : 2
Undergraduate research students: 1

David Ntako (Undergraduate student, Iowa State University, Fall 2023)
Annie Huynh (Undergraduate student, Iowa State University, Fall 2023)
Suaib Al Sufi (Ph.D. student, Iowa State University, Spring 2023)
Jiabin Lin (Ph.D. student, Iowa State University, Fall 2021- Present)
Caleb Deboef (Undergrad student, Iowa State University, Spring 2023)
Aditi Nachnani (Undergraduate student, Iowa State University, Spring 2022)
Dinuka Sahabandu (Ph.D. student, UW, Seattle)
Shruti Misra (Ph.D. student, UW, Seattle)
Kumar Yashashwi (Dual-degree student, IIT Bombay)
Aishwary Joshi (Dual-degree student, IIT Bombay)
RaviTeja Gundeti (Undergraduate student, IIT Bombay)

Outreach Activities

CyMath: Math tutoring for school kids
Volunteer: Spring 2023
Tutor: Fall 2023
Details here: https://cymath.iastate.edu/

CyPy: Python boot camp for undergrads
Organizer and Instructor
Details here: https://shanazuhara.wixsite.com/mysite/cypy

Professional Activities

Funding Panels
NSF CPS
NSF CPS-SaTC
NSF-NIH

Editorial Services
Associate Editor: Indian Control Conference, 2023.
Session Chair: American Control Conference, 2023
Conference Technical Program Committee Member: Conference on Decision and Game Theory

for Security, 2019- 2023
Conference Technical Program Committee Member: Symposium on Control, Communication and Embedded System for Robotics (SOCCER), Silchar, India, 2020

Journal Reviewer
IEEE Transactions on Automatic Control (IEEE-TAC)- 21 papers; Automatica- 5 papers; IEEE Transactions on Control of Network Systems (IEEE-TCNS)- 4 papers; IEEE Transactions on Information Forensics and Security (IEEE-TIFS)- 4 papers; IEEE Transactions on Circuits and Systems (IEEE-TCAS)- 1 paper; IEEE Control Systems Letters (L-CSS) - 3 papers; International Journal of Robust and Nonlinear Control - 1 paper; Systems & Control Letters; IET Control Theory & Applications - 1 paper, IEEE Open Journal of Control Systems (IEEE-OJCYS) - 3 papers

Conference Reviewer
IEEE Conference on Decision and Control (CDC); ACM International Conference on Cyber-Physical Systems (ICCPS); American Control Conference (ACC); European Control Conference (ECC); Conference on Decision and Game Theory for Security (GameSec); International Symposium on Circuits and Systems (ISCAS); Indian Control Conference (ICC); National Conference on Technological Trends

Member
Institute of Electrical and Electronics Engineers (IEEE)
Association for the Advancement of Artificial Intelligence (AAAI)
