

Department of Electrical and Computer Engineering,  
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**Research Keywords:** Network Science, Stochastic Modeling, Optimization, Responsible Computing/ML

## EDUCATION

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### Carnegie Mellon University, Pittsburgh, PA:

Aug '18 - Jul '24 (Expected)

- PhD Candidate, Electrical and Computer Engineering  
Advisor: Osman Yağan, Electrical and Computer Engineering  
Thesis Committee Members: Giulia Fanti (CMU), Carlee Joe-Wong (CMU), Chai Wah Wu (IBM Research)

### Indian Institute of Technology (IIT) Bombay, India:

Jul '13 - Jul '18

- B.Tech & M.Tech in Electrical Engineering (Communications and Signal Processing)  
Advisors: Sharayu Moharir, Electrical Engineering and Ankur A. Kulkarni, Systems and Control Engineering
- Minor in Design, Industrial Design Centre

## HONORS/AWARDS

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- **Best Paper Award**, IEEE International Conference on Communications (ICC) [News Story](#) '21
- **Graduate Student Service Award**, Annual Celebration of Education, CMU. [News Story](#)  
(Awarded annually to 1 graduate student/team across the university for exemplary service) '24
- **Graduation Day Award**, Information Theory and Applications (ITA) Workshop. '24
- **Rising Stars in EECS, Georgia Tech** '23
- **Rising Stars in EECS, MIT** '21
- **Dowd Fellowship** (Awarded to **top 3** applicants in the College of Engineering), CMU [News Story](#) '20  
Led an interdisciplinary collaboration with IBM Research Center & Princeton University on modeling contagions.
- **Cadence Diversity in Technology Scholarship** '23
- **Unsung Hero Award** for contributions to **Diversity, Equity, and Inclusion**, ECE, CMU '22
- **Advanced Graduate Ambassadorship, Institute for Advanced Study (IAS)**, Princeton [News Story](#) '22  
Secured funds (\$3000) (PI) to organize the **Pittsburgh Women in Math and Computing Symposium**
- **CyLab Seed Grant** (\$50000) (Co-PI), Amplifying Privacy and Scalability in Decentralized Learning, CMU '24
- Invited to present at the **Stochastic Networks, Applied Probability, and Performance (SNAPP)** Seminar  
(among 4 graduating students selected to present for *outstanding* research contributions) '23
- **Seed Grant** (\$5000) (Co-PI), IDeaS Center for Informed Democracy and Social-cybersecurity, CMU '23
- Selected to attend the **10<sup>th</sup> Heidelberg Laureate Forum** '23
- **Presidential Fellowship**, CyLab Security & Privacy Institute, CMU [News Story](#) '20, '23
- Selected to visit **Institute for Advanced Study** for the "The Mathematics of Machine Learning" program '22
- **Knight Fellowship**, IDeaS Center for Informed Democracy and Social-cybersecurity, CMU '20, '22, '23
- **Lee-Stanziale Ohana Endowed Fellowship**, Electrical and Computer Engineering, CMU '22
- **David H. Barakat & LaVerne Owen-Barakat CIT Dean's Fellowship**, CMU '19
- **Excellence in Research and Mentorship**, Department of Electrical Engineering, IIT Bombay '18  
(awarded to 1 student in the graduating batch)
- **Excellence in Teaching Assistantship**, Department of Electrical Engineering, IIT Bombay '18
- **All India Rank 6** (amongst **1.1 Million** students) in All India Engineering Entrance Examination '12

## PUBLICATIONS

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### In Peer-reviewed journals & conference proceedings

- **Spreading Processes with Mutations over Multi-layer Networks**  
M. Sood, A. Sridhar, R. Eleteby, C. W. Wu, S. A. Levin, H.V. Poor, O. Yağan,  
**Proceedings of the National Academy of Sciences, 2023.** [News Story](#).
- **Tight Bounds for Connectivity of Random K-out Graphs**  
M. Sood, O. Yağan,  
*IEEE International Conference on Communications (ICC), 2021.* **(Best Paper Award).** [News Story](#).
- **Existence and Size of the Giant Component in Inhomogeneous Random K-out Graphs**  
M. Sood, O. Yağan,  
*IEEE Transactions on Information Theory, 2023.*
- **On the Minimum Node Degree and  $k$ -connectivity in Inhomogeneous Random K-out Graphs**  
M. Sood, O. Yağan,  
*IEEE Transactions on Information Theory, 2021.*
- **The Interplay of Clustering and Evolution in the Emergence of Epidemics on Networks**  
M. Sood, R. Eleteby, C. W. Wu, O. Yağan,  
*IEEE International Conference on Communications (ICC), 2023.*
- **On the Connectivity and Giant Component Size of Random K-out Graphs Under Node Deletions,**  
E. Elumar, M. Sood, O. Yağan,  
*IEEE International Symposium on Information Theory (ISIT), 2021.*
- **On the Size of the Giant Component in Inhomogeneous Random K-out Graphs**  
M. Sood, O. Yağan,  
*IEEE International Conference of Decision and Control (CDC), 2020.*
- **$k$ -Connectivity in Random Graphs induced by Pairwise Key Predistribution Schemes**  
M. Sood, O. Yağan,  
*IEEE International Symposium on Information Theory (ISIT), 2020.*
- **Towards  $k$ -connectivity in Heterogeneous Sensor Networks under Pairwise Key Predistribution**  
M. Sood, O. Yağan,  
*IEEE Global Communications Conference (GLOBECOM), 2019.*
- **Pricing and Commission in Two-Sided Markets with Free Upgrades**  
M. Sood, S. Moharir, A. A. Kulkarni,  
*Springer Lecture Notes in Computer Science (LNCS), Volume 11227, 2018.*
- **Pricing in Two-sided Markets in the Presence of Free Upgrades**  
M. Sood, S. Moharir, A. A. Kulkarni,  
*IEEE International Conference on Communication Systems & Networks (COMSNETS), 2018.*
- **Platform Competition for Throughput in Two-sided Freelance Markets**  
M. Sood, A. A. Kulkarni, S. Moharir,  
*IEEE International Conference on Signal Processing and Communications (SPCOM), 2018.*

### Under review

- **On the Robustness, Connectivity and Giant Component Size of Random K-out Graphs,**  
E. Elumar, M. Sood, O. Yağan,  
*under review with IEEE Transactions on Information Theory.*

## RESEARCH EXPERIENCE

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### **Network Design & Performance Analysis for Reliable Distributed Inference** Aug '18 - ongoing

Mentor: O. Yağan, CMU ECE & Cylab, CMU

- Proposed and analyzed models for constructing sparse, distributed networks with formal connectivity guarantees.
- Demonstrated improvement in connectivity and robustness over classical models like Erdős-Rényi graphs.
- Investigating new graph algorithms to improve privacy-scalability trade-offs in decentralized learning.

### **Decentralized Content Moderation & Polarization in Online Social Networks** Aug '23 - ongoing

Mentors: G. Fanti and O. Yağan, CMU ECE & Cylab, CMU

- Developing a framework to investigate risks of extreme polarization and emergence of echo chambers under decentralized moderation algorithms that provide users with greater control over how their content is filtered.

### **Heterogeneous Network Models for Controlling Spreading Phenomena** Sep '20 - ongoing

Mentors: C. W. Wu, IBM TJ Watson Research Center

S. A. Levin, Department of Ecology and Evolutionary Biology, Princeton University

H. V. Poor, Department of Electrical Engineering, Princeton University

O. Yağan, Electrical and Computer Engineering & Cylab, CMU

- Formulated models to delineate risk factors for contagion spread under contact patterns resulting from different policy interventions such as lockdowns.
- Derived key epidemiological metrics for the spread of evolving contagions on multiplex networks.
- Investigating the impact of clustering on the spread of contagions over clustered social networks.

*Led a 2+ years long interdisciplinary project published in PNAS working with collaborators at IBM Research Center and Princeton University.*

### **Machine Learning Research Intern, Bosch Center for Artificial Intelligence, USA** May '22 - Aug '22

Mentors: W. S. Lin and I. Batalov, Robust and Safe Deep Learning Group, Bosch AI, Pittsburgh

- Proposed sensor fusion and one-class classification techniques to detect tampering in electric mobility systems.
- Implemented a deep-learning pipeline leveraging multimodal robustness to develop a physics-informed classifier.

### **Platform Competition and Optimal Pricing in Two-Sided Matching Markets, IIT Bombay** Jan '17 - Jun '18

Mentors: S. Moharir, Department of Electrical Engineering, IIT Bombay

A. A. Kulkarni, Systems and Control Engineering, IIT Bombay

- Analyzed two-sided markets with multiple platforms and service classes under unknown supply/demand.
- Modeled platform competition and derived the Nash Equilibria for throughput and revenue competition games.

*Resulted in 3 publications and the Excellence in Research Award at IIT Bombay; [Master's Thesis](#)*

### **Data Visualization Intern, Information Design Lab, IIT Bombay** Dec '14 - Jun '16

Mentor: V. Rajamanickam, Industrial Design Centre, IIT Bombay

- Organized over 150 cognitive biases into tractable categories with illustrative examples for a learning toolkit.
- Designed an interactive visual timeline investigating the correlation of the court proceedings against a former state minister and election statistics.

## TEACHING EXPERIENCE

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- **Future Faculty Program Fellow**, Eberly Center for Teaching Excellence & Educational Innovation, CMU  
Completed training in pedagogy & centering DEI in course design. ([Transcript](#)) Sept '20 - Dec '23

- **Guest Lecturer, Electrical and Computer Engineering, CMU**

Taught multiple lectures covering both core concepts and state-of-the-art research developments to graduate and undergraduate students.

- 18-665/18-465 (CMU): Advanced Probability & Statistics for Engineers

Spring '23

- 18-755 (CMU): Networks in the Real World

Fall '22, Fall '23

- EE-706 (IITB): Communication Networks Spring '18
- **Graduate Teaching Assistant & Recitation Leader, Electrical and Computer Engineering, CMU**
  - 18-665/18-465: Advanced Probability & Statistics for Engineers Spring '20
  - 18-751: Applied Stochastic Processes Spring '19
- **Research Mentorship**

Mentored students in research projects on network science and data science.

  - Hejin Gu (M.S., ECE, CMU '23)
  - Rachana Murali Narayanan (Integrated B.S./M.S. in ECE, CMU '23)
  - Arindam Ghosh (M.S., ECE, CMU '19)
- **Graduate Teaching Assistant, Electrical Engineering, IIT Bombay**
  - EE-706: Communication Networks (**awarded excellence in teaching assistantship**). Spring '18
  - EE-759: Applied Mathematical Analysis in Engineering Fall '17
  - Mathematical Preliminaries for Electrical Engineers Jul'17
- **Science Communication Fellow**, Phipps Conservatory and Botanical Gardens Summer '20

Undertook training in effective strategies for communicating scientific research to a broad audience.

## TALKS

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- *Network Design and Performance Analysis for Reliable Inference in Distributed Systems*
  - Information Theory and Applications Workshop (ITA). Feb '24
  - Stochastics Networks, Applied Probability and Performance (SNAPP) Seminar. Dec '23
- *Building Resilient Computing & Societal Systems*
  - EECS Rising Stars, Georgia Tech, Atlanta. Nov '23
  - Vector Institute for Artificial Intelligence, Toronto. Oct '23
- *Random Graph Models for Efficient Network Design in Decentralized Systems*
  - System and Hardware Security, Cylab Partner's Conference, CMU. Oct '23
- *The Interplay of Clustering and Evolution in the Emergence of Epidemics on Networks*
  - Communication Theory Symposium, IEEE International Conference on Communications (ICC). May '23
- *Epidemic Spreading of Contagions with Mutations on Multi-layer Contact Networks*
  - Contagion on Complex Social Systems, Department of Applied Mathematics, CU Boulder. Aug '22
  - Bosch Center for Artificial Intelligence. Aug '22
  - Dowd Fellowship Seminar, CMU. Nov '21
  - International Conference on Network Science (Netsci) 2021. Jul '21
  - Center for Informed Democracy & Social-cybersecurity Conference, CMU. Jul '21
  - Center for Informed Democracy & Social-cybersecurity Summer Institute, CMU. Jun '21
  - Computing Research Association's Widening Participation (CRA-WP) Grad Cohort for Women. Apr '21
- *Designing Secure and Reliably Connected Ad-hoc Networks with Random K-out Graphs*
  - IoT Security & Privacy, CyLab Partners Conference. Oct '22
  - IoT Security & Privacy, CyLab Partners Conference. Oct '21
- *Tight Bounds for the Probability of Connectivity in Random K-out Graphs*
  - Communication Theory Symposium, IEEE International Conference on Communications (ICC). Jun '21
- *On the Size of the Giant Component in Inhomogeneous Random K-out Graphs*
  - IEEE International Conference of Decision and Control (CDC). Dec '20
- *Transmission Dynamics of Infectious Diseases over Contact Networks: Implications for Intervention Policies*
  - Dowd Fellowship Seminar, CMU. Nov '20
- *Transmission Dynamics of Misinformation over Coupled Social Networks*
  - Center for Informed Democracy & Social-cybersecurity, Annual Conference, CMU. Nov '20

- *k-Connectivity in Random Graphs induced by Pairwise Key Predistribution Schemes*  
· IEEE International Symposium on Information Theory (ISIT). Jun '20
- *Towards k-connectivity in Heterogeneous Sensor Networks under Pairwise Key Predistribution*  
· Communication Theory and Networking Symposium, IEEE Global Communications Conference. Dec '19
- *Pricing in Two-Sided Markets in the Presence of Free Upgrades*  
· IEEE International Conference on Communication Systems and Networks. Jan '18

## Travel Awards

- EECS Rising Stars, Georgia Tech, Atlanta. '23
- IEEE International Conference on Communications (ICC 2023), Rome. '23
- Complex Systems Summer School, Santa Fe Institute, Santa Fe. '23
- Mathematics of Machine Learning, Institute for Advanced Study, Princeton. '22
- Contagion on Complex Social Systems, Applied Mathematics, University of Colorado, Boulder. '22
- Deep Learning Theory Summer School, Simon's Institute, University of California, Berkeley. '22
- CMU GSA/Provost Office Conference Funding for IEEE ICC 2021. '21
- Computing Research Association's Committee on Widening Participation, Grad Cohort for Women. '21
- CMU ECE GHC Scholarship for Grace Hopper Celebration of Women in Computing. '20
- Women in Data Science & Mathematics (WiSDM), ICERM, Brown University. '19

## SERVICE

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*Awarded the Unsung Hero Award for contributions to diversity, equity, and inclusion, CMU and the Certificate of Excellence of the Academic Mentorship Program, IIT Bombay.*

## Professional Service

- **Lead Organizer**, the inaugural Pittsburgh Women in Mathematics and Computing Symposium (WMCS) funded by the Institute for Advanced Study (IAS) Women and Mathematics Program. [\[News Story\]](#). Aug '22 - Feb '23
- Served on the inaugural ECE Student Council for Faculty Hiring, CMU. Spring '23
- Served on the ECE Diversity Committee to develop the **Peer Mentors Program**, CMU. Fall '21 - Spring '22
- Served on the CMU ECE Energy & Information Systems (EIS) Seminar Seminar Committee Fall '19
- **Area Chair**, Workshop on Information-Theoretic Methods for Rigorous, Responsible, and Reliable Machine Learning (ITR3 @ ICML-21) ICML 2021.
- **Reviewer**, IEEE Transactions on Networking, IEEE Transactions on Network Science & Engineering, IEEE Transactions on Information Theory, Journal of Communications and Networks, IEEE Transactions on Communications.

## Selected Outreach & Mentorship

- Secured a **\$3000** grant for organizing outreach activities and invited to present at 2024 Joint Mathematical Meetings by the IAS Women and Mathematics Program. '22
- **K-12 Outreach:** Served as volunteer and workshop host for outreach programs in mathematics and engineering.
  - Math Carnival with the IAS, Princeton Public Library May '22
  - CMU Society of Women Engineers (SWE) Middle School Day Mar '20, Mar '21
  - CMU SWE High School Day Feb '22
- Organized art-fundraisers supporting over **5000 meals** at the Greater Pittsburgh Food Bank. Aug '21 - Aug '22
- Led and taught watercolor painting workshops to support accessible art programs at Pittsburgh Center for Arts & Media and Creative Citizens Studios. Nov '22 - ongoing

- Worked with the Allegheny County Department of Human Resources to contextualize the use of ML models to allocate rental aid to those most at risk of homelessness, Data Science & Public Policy Lab, CMU. *April '22*
- **Department Academic Mentor** to 11 undergraduate students, IIT Bombay. *Apr' 16 - Jun '18*
- Initiated art classes for children of migrant labourers at Aman Daycare Centre, formulated class curriculum and organized an art exhibition showcasing their artworks, IIT Bombay. *Apr' 15 - Apr '18*

## GRADUATE COURSEWORK

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- **Machine Learning Foundations:** Introduction to Machine Learning (PhD), Foundations of Privacy, Statistical Machine Learning, Foundations of Cloud & Machine Learning Infrastructure.
- **Probability and Statistics:** Applied Mathematical Analysis, Probability Theory, Advanced Concentration Inequalities, Markov Chains & Queueing Systems, Information Theory & Coding.
- **Networks, Optimization, and Algorithms:** Optimization, Graph Theory, Game Theory, Network Economics, Communication Networks, Algorithms in the Real World.
- **Technical Writing and Visualization:** Technical Writing for Engineers: Genre & Linguistic Foundations, Methodologies of Visualization, Basics of Visual Communication.

## REFERENCES

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### **Prof. Osman Yagan**

Research Professor,  
Carnegie Mellon University

### **Prof. Giulia Fanti**

Assistant Professor,  
Carnegie Mellon University

### **Prof. H. Vincent Poor**

Michael Henry Strater University Professor of Electrical  
and Computer Engineering,  
Princeton University

### **Dr. Chai Wah Wu**

Principal Research Scientist,  
IBM T. J. Watson Research Center

### **Prof. Carlee Joe-Wong**

Robert E. Doherty Career Development Professor,  
Carnegie Mellon University