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RESEARCH INTERESTS	Design and analysis of experiments, causal inference, statistical network modeling, behavioral science, computational social science, public health, machine learning, Bayesian inference	
EMPLOYMENT	<b>Massachusetts Institute of Technology, US</b> Schmidt Science Fellow at the Institute for Data, Systems, and Society      October 2023 – PIs: Prof Dean Eckles, MIT Sloan; Prof Elchanan Mossel, MIT Mathematics  <b>Imperial College London, UK</b> EPSRC Doctoral Prize Fellow in Mathematics      October 2022 – September 2023 Graduate Teaching Assistant in Mathematics      October 2018 – December 2019  <b>Harvard University, US</b> Predoctoral Fellow in Systems Biology at the Wyss Institute      August 2016 – July 2018  <b>Xerox Research Center India, India</b> Research Intern in Multimedia Analytics      May – July 2015	
EDUCATION	<b>Imperial College London, UK</b> PhD in Mathematics      October 2018 – September 2022 PI: Prof Nick S Jones Thesis: Sparse and partially observed large-scale networks: Analytic statistics, behaviour, and structural inference  <b>Indian Institute of Technology Delhi, India</b> BTech in Computer Science and Engineering      2012 – 2016 PI: Prof Sumeet Agarwal Thesis: Causal computational models for gene regulatory networks	
HONORS	Yael Naim Dowker Prize <i>for the best Mathematics PhD thesis</i> 2024 Schmidt Science Fellowship <i>for the world's best emerging scientists to pursue a postdoctoral fellowship</i> 2023 EPSRC Doctoral Prize Fellowship <i>for the very best newly qualified PhDs receiving EPSRC doctoral funding</i> 2022 Doris Chen Mobility Award <i>for PhD students with exceptional potential to take their research abroad</i> 2022 Imperial-TUM Global Fellows Programme      2019 Cargill Global Scholars Award <i>for academic excellence &amp; leadership</i> 2014 IIT Delhi Institute Medal <i>for obtaining highest overall GPA</i> 2013 IIT Delhi Merit Semester Scholarship      2012, 2013	
PUBLICATIONS	<ul style="list-style-type: none"> <li>Rubin, J., <b>Loomba, S.</b>, &amp; Jones, N. S. (2023, November). Geodesic Distributions Reveal How Heterophily and Bottlenecks Limit the Expressive Power of Message Passing Neural Networks. <i>The Second Learning on Graphs Conference</i>, <a href="https://openreview.net/forum?id=PEV1n6psEH">https://openreview.net/forum?id=PEV1n6psEH</a>. We provide a statistical perspective on MPNN performance by decomposing it into signal and noise sensitivity and showing that the former relates to higher-order homophily.</li> <li><b>Loomba, S.*</b>, Maertens, R., Roozenbeek, J., Götz, F., van der Linden, S., &amp; de Figueiredo, A. (2023). Ability to detect fake news predicts sub-national variation in COVID-19 vaccine uptake across the UK. <i>medRxiv preprint</i>, doi:10.1101/2023.05.10.23289764.</li> </ul>	

\*Corresponding author

Using a psychometrically-validated test of misinformation susceptibility, we show that belief in fake news is credibly associated with lower actual COVID-19 vaccine uptake.

- Götz, F., Maertens, R., **Loomba, S.**, & van der Linden, S. (2023). Let the Algorithm Speak: How to Use Neural Networks for Automatic Item Generation in Psychological Scale Development. *Psychological Methods*, doi:10.1037/met0000540

We leverage recent advances in transformer-based neural language models that generate human-like text, like GPT, for automatic item generation for psychological scales.

- Kite, K. A., **Loomba, S.**, Elliott, T. J., Yongblat, F., Lightbown, S. L., Doyle, T. J., Gates, L., Alber, D., Downey, G. A., McCurdy, M. T., Hill, J. A., Super, M., Ingber, D. E., Klein, N., & Cloutman-Green, E. (2022). FcMBL magnetic bead-based MALDI-TOF MS rapidly identifies paediatric blood stream infections from positive blood cultures. *PLOS ONE*, doi:10.1371/journal.pone.0276777

We show that broad-range pathogen binding properties of an engineered FcMBL enable more accurate identification of patient positive cultures than the state-of-the-art.

- **Loomba, S.**, & Jones, N. S. (2021). Geodesic statistics for random network families. *arXiv preprint*, arxiv:2111.02330. (74 pages)

We derive an analytic distribution of shortest path lengths in sparse conditionally independent edge models, yielding new results on percolation and path-based centralities.

- **Loomba, S.**<sup>†</sup>, de Figueiredo, A.<sup>†</sup>, Piatek, S. J., de Graaf, K., & Larson, H. J. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature Human Behaviour*, 5(3), 337-348, doi:10.1038/s41562-021-01056-1.

Through a randomized study, we show that even brief exposure to COVID-19 vaccine misinformation can reduce the intention to definitely vaccinate by as much as 6.2%.

- Novak, R., Lin, T., Kaushal, S., Sperry, M., Vigneault, F., Gardner, E., **Loomba, S.**, Shcherbina, K., Keshari, V., Dinis, A., Vasan, A., Chandrasekhar, V., Takeda, T., Turner, J., Levin, M., & Ingber, D. (2022). Target-agnostic discovery of Rett Syndrome therapeutics by coupling computation and a CRISPR-enabled *in vivo* disease model. *bioRxiv preprint*, doi:10.1101/2022.03.20.485056.

We combine computational modeling with *in vivo* screening in a CRISPR-edited *Xenopus laevis* tadpole model of Rett syndrome to carry out target-agnostic drug discovery.

- Gandhi, A., Biswas, A., Shrivastava, K., Kumar, R., **Loomba, S.**, & Deshmukh, O. (2016, March). Easy Navigation through Instructional Videos using Automatically Generated Table of Content. In *Companion Publication of the 21st International Conference on Intelligent User Interfaces* (pp. 92-96). ACM, doi:10.1145/2876456.2879472.

We demonstrate a pipeline to automatically generate a table of content for video lectures, using saliency scores of visual and spoken words for topic-based segmentation.

## PATENTS

- Cartwright, M. J., Super, M., Ingber, D. E., Grant, J., Scott, J., Duffy, S. C., & **Loomba, S.** (2021). Methods for detection of microbes and microbe components. *International Publication No. WO 2021/201949 A2*.

Technology licensed to *BOA Biomedical*, with the aim of rapid detection of active infection from a blood sample within 1 hour, which is crucial for treating sepsis.

- Barhate, S. S., **Loomba, S.**, Gandhi, A., Biswas, A., Negi, S., & Deshmukh, O. D. (2019). Method and system for generation of a table of content by processing multimedia content. *U.S. Patent No. US 10,296,533 B2*.

Technology licensed to *VideoKen* for automated video content navigation

- Gandhi, A., Biswas, A., Deshmukh, O. D., & **Loomba, S.** (2018). Method and system for content processing to determine pre-requisite subject matters in multimedia content. *U.S. Patent Publication No. US 2018/0060984 A1*.

Technology licensed to *VideoKen* to create course structures for effective learning

## GRANTS

### Synergistic Discovery and Design (SD2)

DARPA/I20, HR001117S0003, \$2M

September 2017

PI: Prof James J Collins

Co-authored research proposal for data-driven discovery and design of biological circuits.

Contributed about half of each of the writing, conceptual and methodological content.

<sup>†</sup>Equal contribution

Designed core algorithmic pipeline to generate testable circuit designs: going from high-throughput omics data to inferred network structures, to functional network motifs, down to operable biological circuits in traditional and novel host organisms.

Developed sequence and circuit embedding models of *E. coli* and yeast for motif discovery.

## PRESENTATIONS

## ORAL

- **Loomba, S.** (2024, March). Social covariation and spillovers using geo-aggregated network data. Talk at *MIT Sloan Marketing Seminar*.
- **Loomba, S.<sup>†</sup>**, Happenhofer, J.<sup>†</sup>, Hoffmann, T., Agarwal, S., Jones, N. S. (2023, July). Inferring socio-physical networks and social Gini indices from aggregated data. Oral presentation at *NetSci Satellite Symposium on Statistical Inference for Network Models*.
- **Loomba, S.** (2023, June). Fake news and global health. Panel discussion at *The London University Diplomatic Summit*.
- **Loomba, S.<sup>†</sup>**, Happenhofer, J.<sup>†</sup>, Hoffmann, T., Agarwal, S., Jones, N. S. (2022, July). Global mapping of a “social Gini” index using socio-physical connectivity kernels inferred from large-scale social network data. Oral presentation at *8th International Conference on Computational Social Science*.
- **Loomba, S.** (2021, November). Misinformation and the pandemic: a tale of two contagions. Invited talk at *Students for Global Health Conference 2021*.
- **Loomba, S., & Jones, N. S.** (2021, July). Geodesic statistics for random network families. Oral presentation at *Networks 2021 (Joint Sunbelt and NetSci Conference)*.
- **Loomba, S., & Jones, N. S.** (2020, July). Scalable statistics for social networks of entire societies. Oral presentation at *Sunbelt XL Conference*.
- **Loomba, S., & Jones, N. S.** (2020, March). Stochastic block models as a social connectivity kernel. Talk at *CMPH Seminar, Imperial College London*.
- **Loomba, S.** (2018, August). Mathematical Representations For Biological Systems. Talk at *DAIR Seminar, Indian Institute of Technology Delhi*.

## POSTER

- **Loomba, S.** (2023, July). Causal inference in sparse partially observed large-scale networks. Poster Presentation at *International School and Conference on Network Science*.
- **Loomba, S.** (2023, July). Causal inference in sparse and partially observed large-scale social networks. Poster Presentation at *9th International Conference on Computational Social Science*.
- **Loomba, S., Hoffmann, T., & Jones, N. S.** (2019, July). Social Access Statistic: Linking Social Connectivity to Health Outcomes. Poster presentation at *5th International Conference on Computational Social Science*.
- **Loomba, S., & Garrod, M.** (2019, July). How Far Would You Go? Comparing Urban Access in 10 Global Cities. Poster presentation at *NetMob 2019*.

## IMPACT

**Generated viable drug candidate(s) for treatment of a monogenic disease**

Created *NeMoCAD*, a Network Model for Causally Aware Discovery, that learns from gene-regulation and perturbative drug-gene interaction data to query for desirable therapeutic states; discovered a new therapeutic for Rett Syndrome which was validated in mouse models. *Software licensed to Unravel Biosciences*

**Impacted public health policy on health misinformation**

Research on the impact of COVID-19 vaccine misinformation on vaccine uptake has seen considerable impact on pandemic research (1600+ citations), and on policymaking: the US Surgeon General’s health misinformation advisory cites our work, and I delivered a video message for the UN on the impact of misinformation on our ability to end the pandemic.

## POPULAR PRESS

**UN Verified** Is online misinformation threatening our ability to end the pandemic?

**Reuters** Misinformation could prompt people to turn against COVID-19 vaccines: study

**BBC** Covid vaccine: Rumours thrive amid trickle of pandemic facts

**The Times** Herd immunity put at risk by a few lies about Covid vaccine

**The Quint** Exposure to Misinformation Reduces COVID Vaccine Acceptance: Study

**Hindustan Times** Misinformation may hit vaccination drive: Study

## ONGOING RESEARCH

### **Causal inference in partially observed networks**

Collaborators: Dean Eckles (MIT Sloan), Elchanan Mossel (MIT Mathematics)

We are describing a statistical theory for inference of causal effects in the case of networked treatment units wherein inter-unit connections are only partially observed. Grounded in Boolean functional analysis, our goal is to allow applied researchers to design optimal experiments for inferring the causal estimand of their interest, like higher order spillover effects.

### **Disentangling dyadic and triadic social network effects**

Collaborators: Dean Eckles (MIT Sloan), Arnab Sarker (MIT IDSS)

Higher-order interactions in social networks are often conflated with dyadic interactions but can produce drastically different network dynamics. Using a large-scale survey sample, we elicit data on triadic interactions between individuals to understand the social and spatial mechanisms that drive them, and study their qualitative differences from dyadic interactions.

### **Cross-cultural impact of misinformation on beliefs about democratic values, climate change, and vaccine acceptance**

Collaborators: Simon J. Piatek & Heidi J. Larson (LSHTM), Martin Wiegand (UCL)

Through a large-scale randomized trial in Nigeria, Germany, and Poland, we have studied the impact of misinformation exposure on a variety of important attitudes. In particular, we find that misinformation negatively impacts belief in liberal democratic values across all three countries, with individual-level heterogeneity in the impact across political affiliations.

### **Mapping inequality in access to social connections via a “social Gini” index**

Collaborators: Nick S. Jones & Johannes Hapenhofer (Imperial), Till Hoffmann (Harvard), Sumeet Agarwal (IIT Delhi)

We have developed a rational theory for a “social Gini” index which quantifies the distance between people based on how surprising it is to see a social connection between them. Our aim is to map this index sub-nationally for the UK, US, and India. For that, we are building a Bayesian statistical model that learns from data on spatially aggregated friendship counts.

## TEACHING

Introduction to applied Bayesian inference (Imperial-X)

April 2023

Developed and delivered two lectures and coursework problems:

January – March 2023

Methods for Data Science (Years 3 & 4, MSc)

### GRADUATE TEACHING (TUTORIALS)

Methods for Data Science (Years 3 & 4, MSc)

October – December 2019

Mathematical Computation in Python (Year 1)

January – March 2019

Probability and Statistics II (Year 2)

October – December 2018

## SERVICES

### REVIEWING

Physical Review E

2019 –

Scientific Reports

2019 –

New Journal of Physics

2021 –

Proceedings of the National Academy of Sciences

2021 –

Vaccine

2021 –

Social Network Analysis and Mining

2021 –

Healthcare in Low-resource Settings

2022 –

Mathematical Modelling of Natural Phenomena

2022 –

Science

2022 –

Epidemics

2023 –

Journal of Physics: Complexity

2023 –

### PC MEMBER

SFE-TSDM at IEEE International Conference on Data Mining

2021

ADVISEES	Jonathan Rubin	PhD in Computing, Imperial College London	2023 –
		Year 4, MSci in Mathematics, Imperial College London	2022 – 2023
	Amelia French	Year 4, MSci in Mathematics, Imperial College London	2021 – 2022
	Kushal Kejriwal	Year 2, Dual degree in Electrical Engineering, IIT Bombay	2021
	Siddharth Chandak	Year 2, BTech in Electrical Engineering, IIT Bombay	2019
	Katie Collins	Year 1, Bachelors in Brain and Cognitive Sciences, MIT	2017
PROGRAMMING SKILLS	Programming and scientific computing: Python, R, MATLAB, C++, C		
	Machine learning and statistical inference frameworks: Stan, TensorFlow, PyTorch, scikit-learn		