

Network Science Institute
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Brennan Klein

research complex systems || network science || statistics || data for justice || public health

affiliations &
experience

Current

Northeastern University

Associate Research Scientist. Sep. 2023 – present. Boston, MA.
at the [Network Science Institute](#);
joint appointment at the [Institute for Experiential AI](#);
director of the [Complexity & Society Lab](#), Oct. 2022 – present.

Harvard University

Data for Justice Fellow. Jul. 2022 – present. Cambridge, MA.
at the [Institute on Policing, Incarceration & Public Safety](#),
in The Hutchins Center for African & African American Research.

VERSES

Senior Research Scientist. Feb. 2022 – present. Los Angeles, CA.
at [VERSES AI Research Lab](#).

Previous

Northeastern University

Postdoctoral Researcher. Jan. 2021 – Aug. 2023. Boston, MA.
in the [Laboratory for the Modeling of Biological & Socio-technical Systems](#),
based at the [Network Science Institute](#).

education

Northeastern University

PhD in *Network Science*, 2015 – 2020. Boston, MA.

Advisor: Professor Alessandro Vespignani – Director, Network Science Institute.

Dissertation: [Constructing, comparing, and reconstructing networks](#). Nov. 19, 2020.

Committee: Alessandro Vespignani, Samuel Scarpino, Tina Eliassi-Rad, Laurent Hébert-Dufresne.

Swarthmore College

BA in *Cognitive Science & Psychology*, 2009 – 2014. Swarthmore, PA.

Advisor: Professor Frank Durgin – Professor of Psychology, Perception & Cognition Lab.

Thesis: *Angular expansion and the large-scale horizontal-vertical illusion*. Apr. 24, 2014.

grants &
fellowships

current, Robert Wood Johnson Foundation - Data Visualization of Structural Racism and Place: *Structural Racism and the Impact of Drug-Free Zone Laws*. \$256,575. **Klein, B.** (Co-Director) & Terry, B.M. (Co-Director); Sep. 1, 2023 - Aug. 30, 2024.

current, Hutchins Center for African and African American Research, Harvard University. *Data for Justice Fellowship*. \$98,750. **Klein, B.**; Jul. 1, 2022 – Jun. 30, 2024.

previous, John Templeton Foundation: *Toward a teleology of complex networks*. \$875,690. **Klein, B.** (Co-I), Vespignani, A. (PI), & Scarpino, S.V. (Co-I); Dec. 1, 2020 – Nov. 30, 2023.

previous, NetSeed: Network Science Institute Seed Grant Program: *Pymdp Development Fellowships*. \$10,000. **Klein, B.**; Nov. 1, 2022 – May 31, 2023.

previous, Tides Foundation (Google.org): *COVID-19 Global.health*. \$316,491, subcontracted through Boston Children's Hospital. **Klein, B.** (Co-PI; previous Co-PI: Scarpino, S.V.); Oct. 1, 2020 – Dec. 30, 2022.

previous, Salesforce.com: *Northeastern University COVID-19 Modeling*. \$50,000. **Klein, B.** (Co-PI; previous Co-PI: Scarpino, S.V.); Aug. 17, 2020 – Aug. 16, 2021.

previous, National Defense Science & Engineering Grant (NDSEG). \$239,696 (stipend & tuition). **Klein, B.**; Sep. 1, 2017 – Dec. 1, 2020.

preprints & publications

Working papers & preprints (* = corresponding author; ¹ = first author; blue text = hyperlink)

Ramstead^{*1}, M.J.D., Albarracin^{*1}, M., Kiefer, A., **Klein, B.**, Fields, C., Friston, K., & Safron, A. (under review, *Neuroscience of Consciousness*). The inner screen model of consciousness: Applying the free energy principle directly to the study of conscious experience. psyArXiv: [10.31234/osf.io/6afs3](https://arxiv.org/abs/10.31234/osf.io/6afs3).

Klein, B.^{*1}, Hartle, H., Shrestha, M., Zenteno, A.C., Barros Sierra Cordera, D., Nicolás-Carlock, J.R., Bento, A.I., Althouse, B., Gutierrez, B., Escalera-Zamudio, M., Reyes-Sandoval, A., Pybus, O., Vespignani, A., Díaz-Quinonez, J.A.^{*}, Scarpino, S.V.^{*}, & Kraemer, M.U.G.^{*} (under review, *PNAS Nexus*). Spatial scales of COVID-19 transmission in Mexico. arXiv: [2301.13256](https://arxiv.org/abs/2301.13256).

Published works

2024:

Demekas, D.¹, Heins, C., & **Klein, B.**^{*} (2024). An analytical model of active inference in the Iterated Prisoner's Dilemma. In: Buckley, C.L., et al. *Active Inference*. IWAI 2023; Ghent, Belgium. *Communications in Computer and Information Science*, vol 1915. Springer, Cham. doi: [10.1007/978-3-031-47958-8_10](https://doi.org/10.1007/978-3-031-47958-8_10).

Klein, B.¹, LaRock, T.¹, McCabe, S.¹, Torres, L.¹, Friedland, L.¹, Kos, M.¹, Privitera, F., Lake, B., Kraemer, M.U.G., Brownstein, J.S., Gonzalez, R., Lazer, D., Eliassi-Rad, T., Scarpino, S.V., Vespignani, A., & Chinazzi, M.^{*} (2024). Characterizing the collective physical distancing of the United States during the first nine months of the COVID-19 pandemic. *PLOS Digital Health* 3(2): e0000430. doi: [10.1371/journal.pdig.0000430](https://doi.org/10.1371/journal.pdig.0000430).

Friston, K.^{*1}, Ramstead, M.J.D.^{*1}, Kiefer, A.B., Tschantz, A., Buckley, C., Albarracin, M., Pitliya, R.J., Heins, C., **Klein, B.**, Millidge, B., Sakthivadivel, D.A.R., St Clere Smithe, T., Koudhal, M., Tremblay, S.E., Petersen, C., Fung, K., Fox, J., Swanson, S., Mapes, D., & René, G. (2024). Designing ecosystems of intelligence from first principles. *Collective Intelligence*, 3(1). doi: [10.1177/26339137231222481](https://doi.org/10.1177/26339137231222481).

2023:

- Klein, B.** (2023). A consolidated framework for quantifying interaction dynamics. *News & Views commentary in Nature Computational Science*. doi: [10.1038/s43588-023-00520-4](https://doi.org/10.1038/s43588-023-00520-4).
- Klein, B.^{*1}**, Ogbunugafor, C.B.^{*}, Schafer, B.J., Bhadriraja, Z., Kori, P., Sheldon, J., Kaza, N., Sharma, A., Wang, E.A., Eliassi-Rad, T., Scarpino, S.V.^{*} & Hinton, E.^{*} (2023). COVID-19 amplified racial disparities in the U.S. criminal legal system. *Nature*. 617 (7960), 344–350. doi: [10.1038/s41586-023-05980-2](https://doi.org/10.1038/s41586-023-05980-2).
- Ramstead, M.J.D.¹, Sakthivadivel, D.A.R.^{*1}, Heins, C., Koudahl, M.T., Millidge, B., Da Costa, L., **Klein, B.**, & Friston, K. (2023). On Bayesian mechanics: A physics of and by beliefs. *Royal Society Interface Focus*, issue on *Making and Breaking Symmetries in Mind and Life*. 13(3): 20220029. doi: [10.1098/rsfs.2022.0029](https://doi.org/10.1098/rsfs.2022.0029).
- Heins, C.^{*1}, **Klein, B.**, Demekas, D., Aguilera, M., & Buckley, C.L. (2023). Spin glass systems as collective active inference. *Communications in Computer and Information Science*, vol 1721. IWAI 2022; Grenoble, France, with ECML/PKDD. Springer, Cham. (received prize: *Best Conference Paper*). doi: [10.1007/978-3-031-28719-0_6](https://doi.org/10.1007/978-3-031-28719-0_6).
- Klein, B.^{*1}**, Zenteno, A.C.^{*}, Joseph, D., Zahedi, M., Hu, M., Copenhaver, M.S., Kraemer, M.U.G., Chinazzi, M., Klompas, M., Vespignani, A., Scarpino, S.V.^{*}, & Salmasian, H.^{*} (2023). Forecasting hospital-level COVID-19 admissions using real-time mobility data. *Communications Medicine*. 3(24). doi: [10.1038/s43856-023-00253-5](https://doi.org/10.1038/s43856-023-00253-5).

2022:

- Rissaki, A.¹, Scarone, B.¹, Liu, D.¹, Pandey, A., **Klein, B.**, Eliassi-Rad, T., & Borkin, M. (2022). BiaScope: Visual unfairness diagnosis for graph embeddings. *IEEE Visualization in Data Science (VDS)*, Oklahoma City, OK, USA. 27–36 doi: [10.1109/VDS57266.2022.00008](https://doi.org/10.1109/VDS57266.2022.00008).
- Klein, B.^{*1}**, Generous, N.¹, Chinazzi, M., Bhadriraja, Z., Gunashekar, R., Kori, P., Li, B., McCabe, S., Green, J., Lazer, D., Marsicano, C., Scarpino, S.V., & Vespignani, A.^{*} (2022). Higher education responses to COVID-19 in the United States: Evidence for the impacts of university policy. *PLOS Digital Health*. 1(6), e0000065, 1–18. doi: [10.1371/journal.pdig.0000065](https://doi.org/10.1371/journal.pdig.0000065).
- Heins, C.^{*1}, Millidge, B., Demekas, D., **Klein, B.**, Friston, K., Couzin, I., & Tschantz, A.^{*} (2022). pymdp: A Python library for active inference in discrete state spaces. *Journal of Open Source Software*. 7(73), 4098. doi: [10.21105/joss.04098](https://doi.org/10.21105/joss.04098). Open review: joss-reviews/issues/4098. Extended tutorial on *arXiv*: [2201.03904](https://arxiv.org/abs/2201.03904).
- Klein, B.^{*1}** & Harris, D.A. (2022). Letter to the Editor: Examining the robustness of 3ft versus 6ft of physical distancing in schools: A reanalysis of van den Berg et al. (2021). *Clinical Infectious Diseases*. 1058–4838. doi: [10.1093/cid/ciac187](https://doi.org/10.1093/cid/ciac187).
- Klein, B.^{*1}**, Swain, A.¹, Byrum, T., Scarpino, S.V., & Fagan, W. (2022). Exploring noise, degeneracy, and determinism in biological networks with the *einet* package. *Methods in Ecology and Evolution*. 13, 799–804. doi: [10.1111/2041-210X.13805](https://doi.org/10.1111/2041-210X.13805).

2021:

- Klein, B.^{*1}**, Hoel, E., Swain, A., Griebenow, R., & Levin, M. (2021). Evolution and emer-

- gence: Higher-order information structure in protein interactomes across the tree of life. *Integrative Biology*. 13(12), 283–294. doi: [10.1093/intbio/zyab020](https://doi.org/10.1093/intbio/zyab020).
- Klein, B.**^{*1}, Holmér, L., Smith, K.^{*}, Johnson, M., Swain, A., Stolp, L., Teufel, A., & Kleppe, A.^{*} (2021). A computational exploration of resilience and evolvability of protein-protein interaction networks. *Communications Biology*. 4 (1352). doi: [10.1038/s42003-021-02867-8](https://doi.org/10.1038/s42003-021-02867-8).
- Trujillo, K.L.^{*1}, Shere, A., **Klein, B.**, Ognyanova, K., Lazer, D., Baum, M.A., Safarpour, A.C., Perlis, R.H., Druckman, J., Santillana, M., Quintana, A., Uslu, A., Green, J., Lin, J., Qu, H., & Pippert, C.H. (2021). The COVID States Project #69: Student attitudes about university COVID-19 policies. Survey report: [10.31219/osf.io/dtxv3](https://doi.org/10.31219/osf.io/dtxv3).
- Baliatti, S.¹, **Klein, B.**, & Riedl, C.^{*} (2021). Optimal design of experiments to identify latent behavioral types. *Experimental Economics*. 24, 772–799. doi: [10.1007/s10683-020-09680-w](https://doi.org/10.1007/s10683-020-09680-w).
- Kraemer, M.U.G.^{*1}, Hill, V.¹, Ruis, C.¹, Dellicour S.¹, Bajaj, S.¹, McCrone, J., Baele G., Parag, K.V., Lindstrom Battle, A., Gutierrez, B., Jackson, B., Colquhoun, R., O’Toole, Á., **Klein, B.**, Vespignani, A., The COVID-19 Genomics UK (CoG-UK) consortium, Volz, E., Faria, N.R., Aanensen, D., Loman, N.J., du Plessis, L., Cauchemez, S., Rambaut A.^{*}, Scarpino, S.V.^{*}, & Pybus, O.G.^{*} (2021). Spatio-temporal invasion dynamics of SARS-CoV-2 lineage B.1.1.7 emergence. *Science*. 368 (6490), 493–497. doi: [10.1126/science.abj0113](https://doi.org/10.1126/science.abj0113).
- McCabe, S.¹, Torres, L., LaRock, T., Haque, S.A., Yang, C-H., Hartle, H., & **Klein, B.**^{*} (2021). netrd: A library for network reconstruction and graph distances. *Journal of Open Source Software*. 6 (62), 2990. doi: [10.21105/joss.02990](https://doi.org/10.21105/joss.02990). Open review: joss-reviews/issues/2990.
- Nande, A.¹, Sheen, J.¹, Walters, E., **Klein, B.**, Chinnazi, M., Gheorghe, A., Adlam, B., Shinnick, J., Tejeda, M., Scarpino, S.V., Vespignani, A., Greenlee, A., Schneider, D., Levy, M.Z.^{*}, & Hill, A.^{*} (2021). The effect of eviction moratoria on the transmission of SARS-CoV-2. *Nature Communications*. 12 (2274), 1–13. doi: [10.1038/s41467-021-22521-5](https://doi.org/10.1038/s41467-021-22521-5).
- 2020:**
- Hartle, H.¹, **Klein, B.**^{*1}, McCabe, S., Daniels, A., St-Onge, G., Murphy, C., & Hébert-Dufresne, L. (2020). Network comparison and the within-ensemble graph distance. *Proceedings of the Royal Society A*, 476: 20190744. Included in special feature: *A Generation of Network Science* doi: [10.1098/rspa.2019.0744](https://doi.org/10.1098/rspa.2019.0744).
- T Byrum, T., Swain, A., **Klein, B.**, & Fagan, W. (2020). einet: Effective information and causal emergence. R package version 0.1.0. <https://CRAN.R-project.org/package=einet>.
- Klein, B.**¹ & Hoel, E.^{*} (2020). The emergence of informative higher scales in complex networks. *Complexity*. 8932526. doi: [10.1155/2020/8932526](https://doi.org/10.1155/2020/8932526).
- Kraemer, M.U.G.^{*1}, Yang, C-H., Gutierrez, B., Wu, C-H., **Klein, B.**, Pigott, D.M., du Plessis, L., Faria, N.R., Li, R., Hanage, W.P., Brownstein, J.S., Layan, M., Vespignani, A., Tian, H., Dye, C., Pybus, O.G.^{*}, & Scarpino, S.V.^{*} (2020). The effect of human mobility and

control measures on the COVID-19 epidemic in China. *Science*. 368 (6490), 493–497. doi: [10.1126/science.abb4218](https://doi.org/10.1126/science.abb4218).

2017:

Pilny, A.*¹, Poole, M.S., Reichelmann, A., & **Klein, B.** (2017). A structural group decision-making perspective on the commons dilemma: Results from an online public goods game. *Journal of Applied Communication Research*. 45(4), 413–428. doi: [10.1080/00909882.2017.1355559](https://doi.org/10.1080/00909882.2017.1355559).

2016:

Klein, B.¹, Li, Z., & Durgin, F.H.* (2016). Large perceptual distortions of locomotor action space occur in ground-based coordinates: Angular expansion and the large-scale horizontal-vertical illusion. *Journal of Experimental Psychology: Human Perception and Performance*, 42(4), 581. doi: [10.1037/xhp0000173](https://doi.org/10.1037/xhp0000173).

2013:

Li, Z.¹, Sun, E., Strawser, C.J., Spiegel, A., **Klein, B.**, & Durgin, F.H.* (2013). On the anisotropy of perceived ground extents and the interpretation of walked distance as a measure of perception. *Journal of Experimental Psychology: Human Perception and Performance*, 38(6), 1582. doi: [10.1037/a0029405](https://doi.org/10.1037/a0029405).

2012:

Durgin, F.H.*¹, **Klein, B.**, Spiegel, A., Strawser, C.J., & Williams, M. (2012). The social psychology of perception experiments: Hills, backpacks, glucose and the problem of generalizability. *Journal of Experimental Psychology: Human Perception and Performance*, 39(2), 477. doi: [10.1037/a0027805](https://doi.org/10.1037/a0027805).

awards & honors

recipient, René Thom Young Researcher Award, Complex Systems Society of France; 2023.
fellowship, Institute on Policing, Incarceration & Public Safety; 2022.
recipient, Student Travel Award, Conference on Complex Systems; 2019.
recipient, PhD Network Travel Award, Northeastern University; 2019.
recipient, [Huntington 100](#) Award, Northeastern University; 2019.
recipient, Best Talk Pitch 1st Prize (\$500 for [netrd](#)), NetSci Society Young Initiatives; 2019.
member, Monash University [Networks of Excellence](#); 2018 – .
recipient, Best Paper Award, Northeast Regional Conference on Complex Systems; 2018.
recipient, National Defense Science & Engineering Grant (NDSEG); 2017–2020.
honorable mention, NSF Graduate Research Fellowship Program (GRFP); 2016.
winner, SwatTank Business Competition (\$3,000 for [Wall.it](#)), Swarthmore College; 2014.
recipient, Comm. Development Grant (\$10,000 for [SwatDeck](#)), Swarthmore College; 2013.
recipient, Rensselaer Medal, for distinguished students in mathematics and science; 2009.
winner, College Prowler National Admissions Essay Competition; 2009.

selected invited talks

“[Data, Dynamics & Justice: How the pandemic shaped U.S. prisons](#)”. Department of Epidemiology & Behavioral and Social Sciences Seminar Series. *School of Public Health* at Brown University. Providence, RI. (Sep. 25, 2023).

- Network Comparison and Graph Distances: A Primer and Open Questions; guest lecture in Professor Tina Eliassi-Rad's course, *Machine Learning with Graphs* at Northeastern University. Boston, MA. (Sep. 22, 2023).
- "COVID-19 amplified long-standing racial disparities in the US criminal legal system". *Institute for Computational and Experimental Research in Mathematics* workshop "Data Science and Social Justice: Networks, Policy, and Education". Providence, RI. (Jul. 27, 2023).
- "Network Science, Network Visualization, and Python". Invited tutorial to the *Oxford Martin Programme on Pandemic Genomics*. University of Oxford. Oxford, UK. (Jun. 28, 2023).
- "A network science for complexity & society". Keynote lecture accepting the René Thom Young Researcher Award at the *French Regional Conference on Complex Systems* (FRCCS 2023). Le Havre, France. (Jun. 1, 2023).
- "How COVID-19 amplified long-standing racial disparities in the US criminal legal system". Computational Social Science Seminar Series at the *MIT Media Lab*; Cambridge, MA (Apr. 26, 2023).
- "Introduction to Data Science, Data, and Visualization". Pre-conference school at the *North-east Regional Conference on Complex Systems*, SUNY Buffalo; Buffalo, NY (Mar. 30, 2022).
- "Pandemic mass incarceration: How COVID-19 worsened racial inequities in the U.S. carceral system". *Introduction to Computational Social Science* course of Professor Morgan Frank; Department of Informatics and Networked Systems, University of Pittsburgh; Pittsburgh, PA (Feb. 1, 2022).
- "Networks were the future (now we're playing catch up)". *Modeling with Discrete Dynamical Systems* class of 850 cadets at West Point; West Point, NY (Oct. 13, 2021).
- "Data on the reach and disparities of COVID-19". Digital Humanities Office Hours; *NULab for Texts, Maps, & Networks*, Northeastern University; Boston, MA (Oct. 6, 2021).
- "Large scale datasets of collective behavioral responses to the COVID-19 pandemic". *NULab for Texts, Maps, & Networks*, Northeastern University; Boston, MA (Nov. 18, 2020).
- "Toward a teleology of complex networks". *Functional Imaging Laboratory*. Theoretical Neurobiology Meeting of Professor Karl Friston, University College London. London, United Kingdom (Nov. 14, 2019).
- "The emergence of (informative) scaling in random networks". *Department of Evolutionary and Adaptive Systems*. Artificial Life Reading Group Lecture, University of Sussex. Brighton, UK (Nov. 13, 2019).
- "Constructing, reconstructing, and comparing networks". *Department of Collective Behaviour*. Laboratory of Professor Iain Couzin, University of Konstanz & Max Planck Institute for Animal Behavior. Konstanz, Germany (Oct. 23, 2019).
- "The structure is the story: How the right representation can bring forth new theories in complex systems". *Center for Research & Interdisciplinarity*. Paris, France (Oct. 17, 2019).
- Biostatistics and Hypothesis Testing; guest lecturer in Professor Samuel Scarpino's course, Northeastern University (Oct. 2-4, 2019).
- "Finding the characteristic scale of causation in biological systems". *Tufts Center for Regenerative and Developmental Biology*. Laboratory of Professor Michael Levin. Tufts University, Medford, MA (Dec. 12, 2018).

“Does minimizing surprise entail purposefulness? Emergent teleology and parallels to the philosophy of natural selection”. Heins, C. & Klein, B. (joint). *Workshop on Causation & Complexity in the Conscious Brain*. Aegina, Greece (Sep. 30, 2018).

“Sufficient causes, necessary effects: Coarse-grained networks are often more informative models of complex systems”. *Complex Systems Lab*. Laboratory of Professor Dani Bassett, University of Pennsylvania, Philadelphia, PA (Aug. 9, 2018).

“From network dynamics to algebraic topology in cortical microcircuits”. *Princeton Neuroscience Institute*. Princeton University, Princeton, NJ (Mar. 15, 2018).

selected
conference
presentations

(* = presenter)

“An analytical model of active inference in the Iterated Prisoner’s Dilemma”. Demekas, D., Heins, C.*, & **Klein, B.** at the International Workshop on Active Inference 2023. Ghent, Belgium. (Sep. 14, 2023).

“COVID-19 amplified racial disparities in the U.S. criminal legal system”. **Klein, B.*** at the International Conference on Computational Social Science (IC2S2). Copenhagen, Denmark. (Jul. 20, 2023).

“Ensembles of reconstructed networks from dynamics”. **Klein, B.***, Hartle, H., & Laber, M. at NetSci. Vienna, Austria. (Jul. 13, 2023).

“Complexity & Inequity: The COVID-19 pandemic amplified long-standing racial disparities in the U.S. carceral system”. **Klein, B.***, Ogbunugafor, C.B., Schafer, B.J., Bhadriraja, Z., Kori, P., Sheldon, J., Kaza, N., Sharma, A., Wang, E.A., Eliassi-Rad, T., Scarpino, S.V. & Hinton, E. at the Complex Systems for the Most Vulnerable satellite event of the Conference on Complex Systems (CCS). Mallorca, Spain. (Oct. 20, 2022).

“Spin glass systems as collective active inference”. Heins, C.*, **Klein, B.**, Demekas, D., Aguilera, M., & Buckley, C.L. at the International Workshop on Active Inference 2022. Grenoble, France. (Sep. 19, 2022). *recipient, Best Paper Award*.

“Higher education responses to COVID-19 in the United States: Evidence for the impacts of university policy”. **Klein, B.***, Generous, N., Chinazzi, M., Bhadriraja, Z., Gunashekar, R., Kori, P., Li, B., McCabe, S., Green, J., Lazer, D., Marsicano, C., Scarpino, S.V., & Vespignani, A. at the Conference on Complex Systems (CCS). Lyon, France. (Oct. 25, 2021).

“Reshaping a nation: Mobility, commuting, and contact patterns during the COVID-19 outbreak”. **Klein, B.***, LaRock, T., McCabe, S., Torres, L., Friedland, L., Kos, M., Privitera, F., Lake, B., Kraemer, M.U.G., Brownstein, J.S., Lazer, D., Eliassi-Rad, T., Scarpino, S.V., Vespignani, A., & Chinazzi, M. at the COVID-19 Satellite at Sunbelt. (virtual, Jul. 20, 2020).

“Optimizing the design of rugged landscapes to maximally distinguish models of search behavior in humans”. Fulker, Z.*, **Klein, B.**, & Riedl, C. at the Northeast Regional Conference on Complex Systems (poster). Buffalo, NY (Apr. 1, 2020).

“Local edge perturbation to quantify community persistence in complex networks”. **Klein, B.*** & McCabe, S. at NetSci (poster). Burlington, VT (May 30, 2019).

- “Comparing methods for reconstructing networks from time series data by comparing methods for measuring network similarity”. **Klein, B.***, Hartle, H., Torres, L., McCabe, S., Yang, C-H., LaRock, T., Shugars, S., Gallagher, R., Sakharov, T., Davis, J., Robertson, R., Mattsson, C., St-Onge, G., Murphy, C., Saffo, D., Mistry, D., Heins, C., Almeida, L., Haque, S., Towlson, E., Zhang, Q., Shrestha, M., Ruf, S., Gates, A., Chinazzi, M., Coronges, K., Riedl, C., Dunne, C., Lippner, G., Eliassi-Rad, T., Vespignani, A., & Scarpino, S.V. at NetSci. Burlington, VT (May 29, 2019). *recipient*, 1st Prize: Best Talk Pitch.
- “First Annual Collabathon at the Network Science Institute”. **Klein, B.*** & Coronges, K.* (joint) at the NetSciEd satellite at NetSci. Burlington, VT (May 27, 2019).
- “I would not be surprised...”. **Klein, B.*** & Heins, C.* (joint) at the *Complexity from Cells to Consciousness: Free Energy, Integrated Information, and Epsilon Machines* satellite at the Conference on Complex Systems (CCS). Thessaloniki, Greece (Sep. 27, 2018).
- “Causal structure as a network: Quantifying certainty in complex systems”. **Klein, B.*** & Hoel, E. at the *Workshop on Causality & Information Flow* at the International Conference on Complex Systems (ICCS). Boston, MA (Jul. 26, 2018).
- “Quantifying causal structure and causal emergence in complex networks”. **Klein, B.*** & Hoel, E. at NetSci. Paris, France (Jun. 15, 2018).
- “Modeling firms responses to information about illicit market activity”. **Klein, B.*** & De Vries, I. at the *NetCrime* satellite at NetSci. Paris, France (Jun. 12, 2018).
- “Quantifying the causal structure of complex networks”. **Klein, B.*** & Hoel, E. at the Northeast Regional Conference on Complex Systems. Binghamton, NY (Apr. 13, 2018). *recipient*, Best Student Paper Award, sponsored by the journal *Complexity*.
- “Dynamics of the opioid crisis in the United States”. **Klein, B.***, Strong, K., Salvalaggio, G., Toba, L., & Cavanagh, M. at the Northeast Regional Conference on Complex Systems. Binghamton, NY (Apr. 13, 2018).
- “Quantifying the causal structure of networks”. **Klein, B.*** & Hoel, E. at CompleNet (poster & lightning talk). Boston, MA (Mar. 7, 2018).
- “Modeling firms responses to information about illicit market activity”. De Vries, I.* & **Klein, B.** at CompleNet. Boston, MA (Mar. 6, 2018).
- “Toward the optimal design of social network experiments”. **Klein, B.***, Baliotti, S., & Riedl, C. at CompleNet. Boston, MA (Mar. 5, 2018).
- “Optimal design for online social experimentation”. Baliotti, S.*, **Klein, B.**, & Riedl, C., at the Code@MIT conference. Boston, MA (Oct. 27, 2017).
- “Uncertainty, satisficing, & optimal decision-making in complex landscapes”. **Klein, B.*** & Riedl, C. at Code@MIT (poster & lightning talk). Cambridge, MA (Oct. 15, 2016).

professional
service

Core developer, **CoarselNet**: an open-sourced Python package for coarse-graining complex networks (<https://github.com/gabriele-di-bona/CoarseNet>).

Core developer, **pymdp**: a Python software package for creating agent-based models under an active inference / partially-observed Markov Decision Process framework (<https://github.com/infer-actively/pymdp>). Director, **Pymdp Fellowship** (as of Sep. 2022),

which funds early career researchers to use and further develop pymdp for short-term research projects.

Core developer, **netrw**: an open-sourced Python package for network rewiring dynamics (<https://github.com/netsiphd/netrw>).

Core developer, **einet**: an R software package for calculating effective information and causal emergence in networks (<https://cran.r-project.org/package=einet>).

Core developer, **netrd**: an open-sourced Python package that includes 20 techniques for reconstructing networks from time series data, 21 graph distance measures, and 7 ways to simulate dynamical processes on networks (<https://github.com/netsiphd/netrd>).

Organizer, **NetSI Lecture Series in Complexity**, Spring 2023.

Software development and visualization, **Bayesian Models of Action and Perception**, MIT Press: Python code for generating the visualizations in a forthcoming Bayesian modeling textbook by Wei Ji Ma, Konrad Kording, and Daniel Goldreich.

Member, **Northeastern University Response Team on COVID-19** (Jan. 2020 – Jan. 2023); analyzing data about human mobility in response to the COVID-19 pandemic. Mobility dashboard: <https://covid19.gleamproject.org/mobility>.

Co-author (with Professor Cynthia Siew, *National University of Singapore*), proposal for the  (**network**) emoji in Unicode's official list of emojis (under review, *Unicode Foundation*).

Co-founder, *Chair* (2017-'19), *Outgoing Chair* (2019-'22), Society of Young Network Scientists (SYNS).

Co-organizer: “**I'd like to learn from...**”, a nomination-network themed lecture series featuring presentations from six junior researchers in network science and a **Paper Unwind** with presentations from Professors Austin Benson, Puck Rombach, and Hyejin Youn (*NetSci 2019*).

Co-organizer: **My Favorite Line of Code** featuring presentations from students and Professors Marta Gonzalez, Simon DeDeo, and Esteban Moro (*ICCS 2018*).

Co-organizer: **Publishing in Network Science: Navigating the Maze** featuring a paper writing masterclass by Federico Levi (editor at *Nature Physics*) and a **Paper Unwind** with presentations from Professors Yamir Moreno, Sonia Kéfi, and Stefano Battiston (*NetSci 2018*).

Co-organizer: **Learning, Teaching, and Doing Complex Systems for Young Researchers** featuring tutorials in data science and complex systems from Professors Bruno Gonçalves and Alfredo Morales, as well as panel discussions from Professors Pamela Mischen, Andreas Pape, David Schaffer, Stephen Uzzo, and Hiroki Sayama (*NERCCS 2018*).

Co-organizer: **Paper Unwind** featuring presentations from Professors Tina Eliassi-Rad, Daniel Larremore, and Aaron Clauset (*CompleNet 2018*).

Co-organizer: **SYNS Symposium** featuring presentations from Profs. László Barabási, Brooke Foucault-Welles, Peter Mucha, Kathryn Coronges, Patricia Mabry, Hiroki Sayama, Kevin Chan, Stephen Uzzo, Catherine Cramer, Roberta Sinatra, Alessandro Vespignani, Santo Fortunato, Dani Bassett, Vittoria Colizza, and *Nature Physics* editor, Federico Levi (*NetSci 2017*).

Reviewer, for the following 31 journals:

Animal Microbiome; Communications Physics; Entropy; Frontiers in Applied Mathematics and Statistics; Frontiers in Public Health; iScience; International Workshop on

Active Inference; JMIR Public Health and Surveillance; Journal of American College Health; Journal of Combinatorial Optimization; Journal of Complex Networks; Journal of Machine Learning Research; Journal of Open Source Software; Journal of Physics: Complexity; Journal of the Royal Society Interface; Mathematical Biosciences; Mathematical Biosciences and Engineering; Nature Biotechnology; Nature Computational Science; Network Neuroscience; Neural Computation; New Journal of Physics; Philosophies; PLOS Computational Biology; PLOS Digital Health; PLOS One; Proceedings of the National Academy of Sciences; Proceedings of the Royal Society: A; Royal Society Open Science; Scientific Data; Scientific Reports.

Program committee member, for the following conferences:

- NetSci (2024).
- NetSciX (2022, 2023).
- Conference on Complex Systems (2023, 2024).
- International Conference on Complex Networks & Applications (2023, 2024).
- International Workshop on Active Inference (2022, 2023).
- MultiNet: Future Directions in Multilayer Network Science (2022, 2023, 2024).
- Workshop on Complex Networks in Banking and Finance (2024).

advising &
mentorship

*Supervision & Funding (bold text = current supervision; * = funded; $\rightleftharpoons$ = visiting / internship)*

Complexity & Society Lab, Northeastern University

- **Almostafa Mohamed**; PhD student, Physics at Northeastern University; Jan. 2024 – .
- **Erik Weis***; Research assistant; Oct. 2023 – .
- **Moritz Laber***; PhD student, Network Science at Northeastern University; Sep. 2022 – .
- **Janne de Rooij*** $\rightleftharpoons$; MS student, Mathematics at TU Eindhoven; Mar. 2024 – .
- **Eline Bouwmeesters*** $\rightleftharpoons$; MS student, Mathematics at TU Eindhoven; Sep. 2023 – .
- Yicheng Zhang $\rightleftharpoons$; MS student, Bioinformatics at Northeastern; May 2023 – Dec. 2023.
- Harrison Hartle* PhD, Network Science; Northeastern University; May 2021 – Aug. 2023.
- Conor Heins*; Software developer / research assistant; Aug. 2021 – Nov. 2023.
- Daphne Demekas*; Software developer / research assistant; Aug. 2021 – Nov. 2023.
- Robert Passas; MS student, Comp. Sci. at Northeastern University; Jan. 2021 – Dec. 2022.
- Marissa Sumathipala; Research assistant, Research Science Institute; Jun. 2017 – Aug. 2017.
- Rucha Joshi; Research assistant, Research Science Institute; Jun. 2017 – Aug. 2017.
- Berke Saat; Research assistant, Research Science Institute; Jun. 2016 – Aug. 2016.

Institute on Policing, Incarceration & Public Safety, Harvard University

- **Brein Mosely***; PhD, Education at Harvard University; Sep. 2022 – .
- **Oghenetega Ogodo***; MS student, Urban Planning at Harvard University; Sep. 2022 – .
- **Christina Steele***; PhD student, Psychology at Harvard University; Sep. 2022 – .
- **Gabe DiAntono***; Undergraduate student at Harvard University; May 2023 – .
- **Arush Sharma**; High school research assistant; Jun. 2022 – .
- **Saawan Duvvuri**; High school research assistant; Jun. 2023 – .
- Josh Rosenblum*; Undergraduate student at Harvard University; May 2023 – Aug. 2023.
- Nitish Kaza, High school research assistant; Jun. 2021 – Aug. 2022.

Dissertation & Thesis Committees

- Rebecca Creed; PhD student, Mech. Engineering at Vanderbilt University; 2024. “An information entropy based approach to quantify uncertainty in network response states”.

teaching experience

Graduate and undergraduate courses

- NETS 8941 - *Network Science Literature Review*; graduate-level course in Network Science, Northeastern University (Spring 2022; Spring 2023; Spring 2024).
- NETS 7976 - *Network Reconstruction and Inference from Dynamics*; graduate-level directed study course, Northeastern University (Spring 2024).
- NETS 7976 - *Reasoning Under Uncertainty & Probabilistic Machine Learning*; graduate-level directed study course, Northeastern University (Fall 2023).
- NETS 5116 - *Complex Networks and Applications*; graduate-level course in Network Science, Northeastern University (Fall 2022, Fall 2023).
- NETS 7976 - *Information Theory & Bayesian Inference in Complex Systems*; graduate-level directed study course, Northeastern University (Fall 2022).

workshops & conferences

- Complex Networks Winter Workshop 2023, Dec. 18-22. Québec City, Canada.
- International Conference on Complex Networks & Applications, Nov. 28-30, Menton, France.
Session Chair: Diffusion & Epidemics.
- Summit on Future Directions in Higher-Order Network Science, Nov. 6-10, Zaragoza, Spain.
- AccelNet-MultiNet Collabathon 2023, Nov. 6-8, Jaca, Spain.
- International Workshop on Active Inference 2023, Sep. 13-15. Ghent, Belgium.
- IC²S² 2023, Jul. 17-20. Copenhagen, Denmark.
- NetSci 2023, Jul. 10-14. Vienna, Austria.
- French Regional Conference on Complex Systems 2023, May 31-Jun. 2. Le Havre, France.
- Conference on Complex Systems 2022, Oct. 17-21. Mallorca, Spain.
- Future Directions in Multilayer Network Science, Jul. 14-16, Boston, MA. AccelNet-MultiNet Collabathon 2022, Jul. 17-20, Portland, ME.
- Northeast Regional Conference on Complex Systems 2022, Mar. 30-Apr. 1. Buffalo, NY.
- Conference on Complex Systems 2021, Oct. 25-29. Lyon, France.
- Sunbelt 2020 – COVID-19 Satellite, Jul. 20-22. *virtual*.
- Northeast Regional Conference on Complex Systems 2020, Apr. 1-3. Buffalo, NY.
- Complex Networks Winter Workshop 2019, Dec. 15-21. Québec City, Canada.
- Santa Fe Institute Complex Systems Summer School 2019, Jun. 9-Jul. 5. Santa Fe, NM.
- NetSci 2019, May 27-31. Burlington, VT.
Co-organizer: Society of Young Network Scientists pre-conference event.
- Complex Networks Winter Workshop 2018, Dec. 15-21. Québec City, Canada.
- Causality & Complexity in the Conscious Brain 2018, Sep. 29-30. Aegina, Greece.
- Conference on Complex Systems 2018, Sep. 23-28. Thessaloniki, Greece.

Satellite co-organizer with Conor Heins: *Complexity from Cells to Consciousness: Free Energy, Integrated Information, and Epsilon Machines*, featuring keynote speakers Professors Karl Friston and Jessica Flack, with invited speakers Professors Martin Biehl, Erik Hoel, William Marshall, Jayne Thompson, Mile Gu, Felix Pollack, Jakob Hohwy, and Rosalyn Moran.

International Conference on Complex Systems 2018, Jul. 22-27. Cambridge, MA.

Co-organizer: Society of Young Network Scientists pre-conference event.

NetSci 2018, Jun. 11-15. Paris, France.

Co-organizer: Society of Young Network Scientists pre-conference event; Design co-chair.

Northeast Regional Conference on Complex Systems 2018, Apr. 11-13. Binghamton, NY.

Co-organizer: Society of Young Network Scientists pre-conference event.

ComNet 2018, Mar. 5-8. Boston, MA.

Co-organizer: Society of Young Network Scientists pre-conference event.

NECSI Winter School on Complex Systems 2018, Jan. 1-12. Cambridge, MA.

Code@MIT 2017, Oct. 27-28, Cambridge, MA.

NetSci 2017, Jun. 11-15. Indianapolis, IN.

Co-organizer: first Society of Young Network Scientists Symposium.

Code@MIT 2016, Oct. 14-15. Cambridge, MA.

Simons Institute's Information Theory Boot Camp 2015, Jan. 13-16. Berkeley, CA.

Vision Science Society Conference 2014, May 16-21. St. Pete Beach, FL.

Vision Science Society Conference 2013, May 10-15. Naples, FL.

Vision Science Society Conference 2012, May 11-16. Naples, FL.

selected
popular
media

[Teleology, perception, complex systems with Brennan Klein](#). Podcast appearance on *Too Lazy to Read the Paper*, with Sune Lehmann. Oct. 6, 2022.

[Evolutionary novelty addressed in protein-protein interaction networks](#). *Nature Portfolio - Ecology & Evolution*, with April S. Kleppe. Dec. 2, 2021.

[Protect international students, flatten the curve](#). *Arizona Daily Star*. Jul. 8, 2020.

[Closing schools will save lives. Keeping them open is a public health hazard](#). *Arizona Daily Star*. Mar. 15, 2020.

[Swatties, surprise, and a new paradigm of interdisciplinary scientific thought](#). *Swarthmore College Alumni Magazine*. Spring, 2019.

[Stories from Network Science PhDs: Interviews with Brennan Klein & Sarah Shugars](#). Podcast appearance on *Human Current*. Sep. 27, 2018.

[SwatDeck, diversity, and the science of networks](#). *Behavioral Scientist*. 2015.

[When a theory is too good to be true: Fallacies in perception research](#). *Behavioral Scientist*. 2013.

[The ubiquity of metaphor](#). *Behavioral Scientist*. 2013.

I make art under the pseudonym JK Rofling (jkrrofling.com). Exhibitions:

* *Networked*, exhibition at The Nook Gallery || Los Angeles, CA, Jul. – Aug. 2019.

* *Only Connections*, exhibition at the Somerville Public Library || Somerville, MA; Jul. 2018.