Dr Elizaveta Semenova

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Research appointments

2022 – present **Schmidt Futures AI2050 Early Career Fellow**, Department of Computer Science, University of Oxford
2022 – present **Junior Research Fellow**, Kellogg College, Oxford
2022 – present **Postdoctoral researcher**, Department of Computer Science, University of Oxford
2021 – 2022 **Research Associate in Mathematics**, Department of Mathematics, Statistics Section, Imperial College London

- ➤ Modelling spatial data by leveraging deep generative models (VAEs) to power faster Bayesian inference.
- ➤ Developing adaptive survey design approach allowing to increase efficiency of surveys, lower the cost of data collection and bias (in collaboration with US Census).
- ➤ Performing applied epidemiology work to inform public policy as a response to the COVID-19 pandemic: (i) analysis of global genomic surveillance disparities; (ii) investigating paediatric disease severity

2019 – 2021 **PostDoc Fellow in Bayesian Machine Learning**, AstraZeneca, Cambridge, UK

- ➤ Developing a Bayesian neural network for toxicity prediction to communicate uncertainty and prevent overfitting of biological data.
- ➤ Predicting drug toxicity by incorporating scientific knowledge into Bayesian ML models.
- ➤ Fitting flexible concentration-response curves of a novel drug modality using Gaussian Processes.
- ➤ Developing models of COVID-19 testing regimes to inform internal company's testing policy.

Qualifications

2014 – 2019 **PhD in Epidemiology** (*summa cum laude*), Swiss Tropical and Public Health Institute, University of Basel, Switzerland: *Bayesian modelling of large spatio-temporal disease surveillance and environmental data*.
2003 – 2008 **Diploma in Mathematics** (first class honours), Moscow State University, Moscow, Russia

Publications

My research interests include Bayesian inference, spatiotemporal statistics, deep generative modelling, epidemiology, drug discovery and mathematics. I have published 16 papers; in disciplines where order matters (i.e. not mathematics), I am first (or joint first) author on 4 and corresponding author on 3 ($*$ denotes joint authorship and † denotes corresponding author).

Peer reviewed publications

1. A. Brito*, **E. Semenova***, G. Dudas*, G. Hassler, C. Kalinich, M. Kraemer, S. Hill, O. Pybus, C. Dye, S. Bhatt, *et al.*, Global disparities in SARS-CoV-2 genomic surveillance, *Nature Communications*, 2022.
2. J. W. Firman, M. T. Cronin, P. H. Rowe, **E. Semenova**, and J. E. Doe, The use of Bayesian methodology in the development and validation of a tiered assessment approach towards prediction of rat acute oral toxicity, *Archives of toxicology*, 1–14, 2022.
3. **E. Semenova***,†, Y. Xu*, A. Howes, T. Rashid, S. Bhatt, S. Mishra, and S. Flaxman†, Priorvae: Encoding spatial priors with variational autoencoders for small-area estimation, *Journal of the Royal Society Interface*, **19**, (191), 20220094, 2022.
4. L. Grinsztajn, **E. Semenova**, C. C. Margossian, and J. Riou, Bayesian workflow for disease transmission modeling in Stan, *Statistics in Medicine*, 1–26, 2021.
5. L. H. Mervin, S. Johansson, **E. Semenova**, K. A. Giblin, and O. Engkvist, Uncertainty quantification in drug design, *Drug discovery today*, **26**, (2), 474–489, 2021.
6. S. Mishra, S. Mindermann, M. Sharma, C. Whittaker, T. A. Mellan, T. Wilton, D. Klapsa, R. Mate, M. Fritzsche, M. Zambon, J. Ahuja, A. Howes, X. Miscouridou, G. P. Nason, O. Ratmann, **E. Semenova**, G. Leech, J. F. Sandkühler, C. Rogers-Smith, M. Vollmer, H. J. T. Unwin, Y. Gal, M. Chand, A. Gandy, J. Martin, E. Volz, N. M. Ferguson, S. Bhatt, J. M. Brauner, S. Flaxman, and The COVID-19 Genomics UK (COG-UK) Consortium, Changing composition of SARS-CoV-2 lineages and rise of delta variant in england, *EClinicalMedicine*, **39**, 101064, 2021.
7. L. Scott, N.-Y. Hsiao, S. Moyo, L. Singh, H. Tegally, G. Dor, P. Maes, O. G. Pybus, M. U. Kraemer, **E. Semenova**, *et al.*, Track Omicron's spread with molecular data, *Science*, **374**, (6574), 1454–1455, 2021.

8. **E. Semenova**†, M. L. Guerriero, B. Zhang, A. Hock, P. Hopcroft, G. Kadamur, A. M. Afzal, and S. E. Lazic, Flexible fitting of PROTAC concentration-response curves with changepoint Gaussian Processes, *SLAS Discovery*, **26**, (9), 1212–1224, 2021.
9. P. Vel'misov, Y. A. Tamarova, and **E. Semenova**, Asymptotic equations of gas dynamics: Qualitative analysis, construction of solutions, and applications, *Journal of Mathematical Sciences*, **259**, (3), 309–325, 2021.
10. S. E. Lazic, **E. Semenova**, and D. P. Williams, Determining organ weight toxicity with Bayesian causal models: Improving on the analysis of relative organ weights, *Scientific reports*, **10**, (1), 1–12, 2020.
11. **E. Semenova**†, D. P. Williams, A. M. Afzal, and S. E. Lazic, A bayesian neural network for toxicity prediction, *Computational Toxicology*, **16**, 2020.
12. D. P. Williams, S. E. Lazic, A. J. Foster, **E. Semenova**, and P. Morgan, Predicting drug-induced liver injury with Bayesian machine learning, *Chemical research in toxicology*, **33**, (1), 239–248, 2019.
13. G. Crippa, **E. Semenova**, and S. Spirito, Strong continuity for the 2d Euler equations, *Kinetic and Related Models*, (4), 685–689, 2018.
14. P. A. Velmisov, U. J. Mizher, and **E. P. Semenova**, Asymptotic study of nonlinear viscous gas flows, in *AIP Conference Proceedings*, AIP Publishing LLC, vol. 2048, 2018, pp.040012.
15. P. A. Velmisov, A. V. Ankilov, and **E. P. Semenova**, Mathematical modeling of aeroelastic systems, in *AIP Conference Proceedings*, AIP Publishing LLC, vol. 1910, 2017, pp.040010.
16. P. A. Velmisov, A. V. Ankilov, and **E. P. Semenova**, Dynamic stability of deformable elements of one class of aeroelastic constructions, in *AIP Conference Proceedings*, AIP Publishing LLC, vol. 1789, 2016, pp.020021.

Under revision

1. **E. Semenova**, S. Dalmini, and P. Vounatsou, Modelling Log-Gaussian Cox Processes on fine spatio-temporal scale, *Spatial and Spatio-temporal epidemiology (under revision)*, 2022.

Pre-prints

1. S. Flaxman, C. Whittaker, **E. Semenova**, T. Rashid, R. Parks, A. Blenkinsop, H. J. T. Unwin, S. Mishra, S. Bhatt, D. Gurdasani, *et al.*, Covid-19 is a leading cause of death in children and young people ages 0-19 years in the united states, *medRxiv*, 2022.

Book chapters

1. S. K. Ashenden, A. Bartosik, P.-M. Agapow, and **E. Semenova**, Introduction to artificial intelligence and machine learning, *The Era of Artificial Intelligence, Machine Learning, and Data Science in the Pharmaceutical Industry*, 15–26, 2021.

Technical writing

1. L. Badillo, **E. Semenova**, and L. Kilpatrick, *Julia ecosystem contributor's guide*, 2021.

Grants and awards

2023 Nordic ProbAI'23 summer school, Travel grant to deliver a lecture.
2022 Schmidt Futures AI2050 Early Career Fellowship ($ 270'000).
2022 The International Congress of Toxicology, Travel grant to deliver a lecture (£ 700).
2022 Nordic ProbAI'22 summer school, Travel grant to deliver a lecture (£ 800).
2022 UK-China collaborative workshop: AI for Climate, Environment and Sustainability, Travel grant (£ 500).
2021 Google Season of Docs (GSoD) bursary to contribute Julia documentation ($ 3000)
2020 AstraZeneca R&D, Postdoc of the Year award

Invited talks and lectures

2023, Jun 15 Lecture "Bayesian workflow", Nordic Probabilistic AI (ProbAI) summer school, Trondheim, Norway (upcoming)
2023, Mar 01 Talk at "Variational inference, from theory to practice" Minisymposium of SIAM Conference on Computational Science and Engineering, Amsterdam (upcoming)
2022, Nov 18 Talk at Autonomous Intelligent Machines and Systems seminar, Oxford
2022, Oct 25 Talk "How can deep generative modelling help with spatial statistics?", Infectious Disease Epidemiology seminar series, Imperial College London
2022, Sep 18 Talk "Capturing uncertainty in toxicity profiling models", XVIth International Congress of Toxicology, Maastricht, Netherlands
2022, Aug 21 Lecture "Mathematics and Statistics for Machine Learning", Deep Learning Indaba , Tunis, Tunisia
2022, Aug 19 Talk at Uniq+, DeepMind social lunches in Oxford
2022, Aug 5 Talk "Encoding spatial priors with VAEs for geospatial modelling", 5th Workshop on Tractable Probabilistic Modeling at Unceritainty in Artificial Intelligence (UAI) conference, Eindhoven, Netherlands
2022, Jun 26 Talk at Oxford Computational Statistics and Machine Learning (OxCSML) seminar
2022, Jun 13 Lecture "Bayesian workflow", Nordic Probabilistic AI (ProbAI) summer school, Helsinki, Finland
2022, Apr 25 Lecture "Bayesian modelling of spatial data", Cambridge's first machine learning research event for undergraduates, University of Cambridge, UK
2022, Feb 10 Talk "Encoding spatial priors with VAEs for geospatial modelling", *University of Lancaster, CHICAS seminar*, remote

Contributed talks and poster presentations

2023 **E. Semenova**, S. Mishra, S. Bhatt, S. Flaxman, H. J. Unwin "Spatial statistics with deep generative modelling: flexible and efficient disease mapping with MCMC and deep learning", *BayesComp 2023, Bayesian Inference of Epidemics*, Levi, Finland
2022 **E. Semenova**, S. Mishra, S. Bhatt, S. Flaxman, H. J. Unwin "Mapping malaria prevalence in Kenya by reconciling changes in administrative boundaries using MCMC and Deep Learning", *American Society of Tropical Medicine & Hygiene*, annual meeting (remote)
2021 L. Grinsztajn, **E. Semenova**, C. Margossian, J. Riou "Bayesian workflow for disease transmission modeling in Stan", *Berlin Bayesians Meetup*, (remote)
2020 **E. Semenova**, "Building an ordered logistic regression model for toxicity prediction" (talk), *PyMCon conference*, remote
2020 **E. Semenova**, A. Afzal, D. Williams, S. Lazic, "Bayesian Neural Networks for toxicity prediction" (talk), *Applied Machine Learning Days (AMLD) conference*, Lausanne
2019 **E. Semenova**, D. Williams, S. Lazic, "Predicting severity of drug-induced liver injury with uncertainty" (poster), *AwayDay conference*, University of Cambridge
2019 **E. Semenova**, D. Williams, S. Lazic, "A Bayesian multi-layered model to predict mechanisms, types, and severity of drug-induced liver injury" (poster), *StanCon-2019 conference*, Cambridge
2017 **E. Semenova**, P. Vounatsou, "Fitting large-scale Log-Gaussian Cox Process model with an efficient sampling algorithm" (poster), *46th SpeedUp Workshop on "Uncertainty Quantification and HPC"*, Bern
2016 **E. Semenova**, "Point Pattern Analysis for Malaria Surveillance" (talk), Malaria Modelling Group's seminar, Basel,
2016 **E. Semenova**, P. Vounatsou, "Early Warning Platform for Malaria Surveillance and Response" (talk), *Swiss Academy for development*, *Research Fair "Transcending the Silos to Prevent Crises"*, Bern
2014 **E. Semenova**, G. Crippa, "The Euler equation: stability and continuity in 2D" (talk), *Analysis seminar*, Geneva

Organisation, outreach and public engagement

- Co-organizer of the ICLR'23 First Workshop on "Machine Learning & Global Health"
- Co-organizer of NeurIPS'22 workshop "Gaussian Processes, Spatiotemporal Modeling, and Decision-making Systems"
- Co-organizer of Gaussian Process seminar series (2022 - present)
- Data Science ambassador of the Faculty of Natural Sciences at Imperial College London (2022 - present)
- Guest at the podcast "Learning Bayesian Statistics"; among the top popular episodes on the channel (2020)
- Organising committee of PyPharma conference (2019)
- Basel Computational Methods for Research Community, Meetup organiser (2017-2019)
- Speaker at Women Techmakers Leads Summit Europe (Google), Madrid (2018)

Esteem indicators

- Reviewer for PharML conference and journals 'Geospatial Health', 'Parasite epidemiology and control', 'Tropical medicine and international health', 'Journal of the Royal Statistical Society: Series A (JRSSA)'
- Member of European Women in Mathematics (EWM), International Society for Bayesian Analysis (ISBA)
- Hackathons: invited jury member (Basel Hack), winner (Hack Zurich & Crack the Hack) (2017-2018)

Teaching, supervision and mentoring

- Hands-on workshops at conferences and meetups
  - "Bayesian Scientific Computing and Probabilistic Programming: inside and outside the "black box"", SIAM Computational Science and Engineering, Amsterdam, Netherlands (2023)
  - "Bayesian modelling of spatial data", Cambridge University, guest lecture and mentorship round table (2022)
  - "Hands-on Bayesian Machine Learning: embracing uncertainty" (in Julia). Over 100 participants; the most popular workshop at the conference. Applied Machine Learning Days (AMLD), Lausanne, Switzerland (2020)
  - "Bayesian Inference with Python", PyPharma conference, Basel (2019)
  - "Machine Learning for news (using NLP): theory, applications and visualization in Python", Lausanne (2018)
  - "Bayesian Statistics with R and Stan", R-Lausanne Meetup (2018)
- Research Supervision
  - Co-supervising a PhD student on malaria mapping in sub-Saharan Africa using modern computational tools (2022).
  - Supervising a PhD mini-project (3 months) on identifiability of Bayesian statistical models (2022).
  - Co-supervising an MSc project estimating the number of orphans in Kenya due to Covid (2022)
  - Co-supervising an MSc project using RKHS for GP to estimate mobility patterns in the US (2022)
  - Co-supervising an MSc project on PriorVAE and graph representation learning (2022)
- Academic teaching
  - Substitution lecturer in Bayesian modelling and biostatistics. A course taught to Epidemiology and Infectious biology MSs: theory and hands-on practicals. Groups of about $\sim$20 people (2014-2019).
  - Weekly marking of problem sheets and discussion of solutions for two graduate courses: Harmonic Analysis and Partial Differential Equations, groups of $\sim$15 students (2012-2014).
  - Bi-weekly grading and in-person presentation of solutions in Calculus to mathematics and physics undergraduates, groups of $\sim$30 (2012-2014)
- Mentorship
  - AISTATS2022, mentoring PhD applicants (2022)
  - Mentorship round tables for undergradute students in mathematics and CS, Cambridge University (2022)

Skills

General programming	R, Python, Git, Julia
Probabilistic programming	Stan, PyMC3, Numpyro, Turing.jl
Languages	Russian (native), English & German (working proficiency), Italian & French (beginner)

PhD Thesis

My PhD thesis *"Bayesian modelling of large spatio-temporal disease surveillance and environmental data"* is under embargo until March 2023. The chapters (beyond Introduction and Discussion) which it conatins are as follows:

1. **E. Semenova**, S. Dalmini, and P. Vounatsou, Modelling Log-Gaussian Cox Processes on fine spatio-temporal scale, 2019.
2. **E. Semenova** and P. Vounatsou, A comprehensive modelling approach for Bayesian analysis of marked point patterns, 2019.
3. **E. Semenova** and P. Vounatsou, Delineating hotspots on the map of schistosomiasis prevalence in Togo, 2019.
4. **E. Semenova** and P. Vounatsou, Restoring missing data in remote sensing imagery via scalable spatio-temporal kriging, 2019.
5. **E. Semenova** and P. Vounatsou, Wombling methodology to identify hotspots on gridded disease surfaces, 2019.

Previous work experience

2017 – 2018 **Board Member and Educator**, women++ (www.womenplusplus.ch), Zurich, Switzerland

- ➤ Ideated and organized the first female-friendly hackathon in Switzerland for over 100 participants. In 2019 it was included into the list of 80 most important diversity-related initiatives in Europe.
- ➤ Designed and tutored a series of programming workshops; organized tech- and career-related professional training, and networking events to foster entrepreneurship and leadership.

2016 – 2016 **R Developer**, remote

- ➤ Created R-scripts and web services enabling statistical analysis of clinical data.

2012 – 2014 **Teaching Assistant in Mathematics**, University of Basel, Switzerland

- ➤ Harmonic Analysis, Partial Differential Equations, Calculus (graduate and undergraduate levels)

2010 – 2011 **Actuarial Consultant**, PriceWaterhouse Coopers, Moscow, Russia
2008 – 2010 **Actuary**, Zurich Insurance Company, Russia / Germany /Switzerland

- ➤ Statistical data analysis, data mining, risk modelling, pricing tool development, due diligence