

YORDAN P. RAYKOV

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EDUCATION

Aston University, Birmingham

2013 - 2017

PhD Statistical Machine Learning

Department of Mathematics

- Title: A deterministic inference framework for discrete nonparametric latent variable models
- My PhD focuses on developing scalable algorithms for inference in Bayesian nonparametric models and applying them to real-world problems. I have developed novel, faster, and easy to interpret inference algorithms for Dirichlet process mixtures, hierarchical Dirichlet processes, and infinite hidden Markov models that can significantly extend their use in practice. Furthermore, in the area of parametric pattern recognition and signal processing I have proposed novel implementations of highly used pattern recognition techniques such as K-means algorithm and Viterbi decoding. Applications of my work include novel system for behaviour extraction from accelerometer data and subtyping Parkinson's disease from various sources of medical data.
- Examined by: Prof Magnus Rattray and Dr Dan Cornford
- Supervisor: Max A. Little, Department of Mathematics, Nonlinearity and Complexity Research Group, Aston University.

University of Leicester

2010 - 2013

BSc Mathematics with Management,

- First Class Honours - Final year average: 85.0
- Final Year Project: SmartLearn initiative - creating software for interactive and entertaining mathematical courses.

Sofia High School of Mathematics

2003 - 2010

Advanced training in Mathematics and Computer science

WORK EXPERIENCE

University of Nottingham (September 2021 - current): Transitional Assistant Professor

Permanent faculty R&T position in the School of Mathematical Sciences with significant research focus on Responsible and Trustworthy AI.

Aston University (Rolls Royce Digital Academy)(September 2018 - September 2021): Lecturer

Permanent faculty R&T position with a significant focus on the design of industry focused distance learning courses in statistical machine learning and AI.

UCB Pharma (Aston University host)(September 2016 - September 2018): Research Fellow

My responsibilities involved the design and development of machine learning methods for processing data from one of the first home-based studies for passive monitoring of Parkinson's disease. The post included extended visits in Radboud University Medical Center, Aalborg University and John Hopkins.

ARM (January 2016 - May 2016):

Research Intern

I worked directly with Emre Ozer on emerging IoT applications first as an intern and later as an external collaborator (**Intern award**)

PUBLICATIONS

Recent submissions

Timmermans, N.A., Terranova, R., Soriano, D.C., Cagnan, H., **Raykov, Y.P.**, Bucur, I.G., Bloem, B.R., Helmich, R.C., Evers, L.J.W., 2025 A generalizable and open-source algorithm for real-life monitoring of tremor in Parkinson's disease, npj Parkinson's Disease, (available at www.yordanraykov.net/research-projects), (**accepted**).

Soriano, D.C., **Raykov, Y.P.**, Timmermans, N.A., West, T., Post, E., Little, M.A., Helmich R.C., Bloem B.R., Evers, L.J.W., Cagnan, H., 2025 Advancing Parkinson's Disease Management: Leveraging Wearable Sensors for Real-World Tremor Monitoring and Medication Response Evaluation, npj Parkinson's Disease, (available at www.yordanraykov.net/research-projects), (**accepted**).

Veldkamp, K.I., Evers, L.J.W., van Laarhoven, T.M., **Raykov, Y.P.**, Little M.A., Bloem B.R., Brouwer, M.A., Thannhauser, J., 2025, Heart rate monitoring using wrist photoplethysmography in Parkinson's disease: feasibility and relation with autonomic dysfunction, npj Parkinson's Disease, (available at www.yordanraykov.net/research-projects), (under review).

Raykov, Y.P., Luo, H., Strait, J., KhudaBukhsh, W.R., 2025. Kernel-based estimators for functional causal effects, Journal of Machine Learning Research, available at <https://arxiv.org/abs/2503.05024>, (under review).

Fai Po, H., Houben, A.M., Haeb, A.C., **Raykov, Y.P.**, Tornero, D., Soriano, J., Saad, D., 2025, Analysis of Developing Cortical Neuronal Networks Using Visual Informatics, Neural Networks, (available at <https://arxiv.org/abs/2502.20862>), (under review).

Raykov, P.P., Correia, M., Tsvetanov, K., Henriques, R.N., Del Cerro León, A., Bracher-Smith, M., Escott-Price, V., **Raykov, Y.P.** and Henson, R.N., 2025. Complementary MR measures of white matter and their relation to cardiovascular health and cognition, npj Scientific Reports, (**accepted**), available at <https://www.biorxiv.org/content/10.1101/2025.02.08.637219v1.abstract>.

Journal publications

Post, E., Laarhoven, T.V., **Raykov, Y.P.**, Little, M.A., Nonnekes, J., Heskes, T.M., Bloem, B.R. and Evers, L.J., 2025. Quantifying arm swing in Parkinson's disease: a method accounting for arm activities during free-living gait. Journal of Neuroengineering and Rehabilitation, 22(1), p.37.

Evers, L.J., **Raykov, Y.P.***, Heskes, T.M., Krijthe, J.H., Bloem, B.R. and Little, M.A., 2025. Passive Monitoring of Parkinson Tremor in Daily Life: A Prototypical Network Approach. Sensors (Basel, Switzerland), 25(2), p.366.

Farooq, A., **Raykov, Y.P.***, Raykov, P. and Little, M.A., 2024. Adaptive Latent Feature Sharing for Piecewise Linear Dimensionality Reduction. Journal of Machine Learning Research, 25(135), pp.1-42.

Raykov, Y.P. and Saad, D., 2022. Principled machine learning. IEEE Journal of Selected Topics in Quantum Electronics, 28(4: Machine Learning in Photonic Communications and Measurement Systems), pp.1-19. (**invited paper**)

Raykov, Y.P., Evers, L.J., Badawy, R., Bloem, B.R., Heskes, T.M., Meinders, M.J., Claes, K. and Little, M.A., 2021. Probabilistic modelling of gait for robust passive monitoring in daily life. IEEE Journal of Biomedical and Health Informatics, 25(6), pp.2293-2304.

Qarout, Y., **Raykov, Y.P.** and Little, M.A., 2020. Probabilistic modelling for unsupervised analysis of human behaviour in smart cities. Sensors, 20(3), p.784. (**Best paper award from Advances in Biomedical Sciences 2021**)

Poorjam, A.H., Kavalekalam, M.S., Shi, L., **Raykov, Y.P.**, Jensen, J.R., Little, M.A. and Christensen, M.G., 2021. Automatic quality control and enhancement for voice-based remote Parkinson's disease detection. *Speech Communication*, 127, pp.1-16.

Evers, L.J., **Raykov, Y.P.**, Krijthe, J.H., Silva de Lima, A.L., Badawy, R., Claes, K., Heskes, T.M., Little, M.A., Meinders, M.J. and Bloem, B.R., 2020. Real-life gait performance as a digital biomarker for motor fluctuations: the Parkinson@ Home validation study. *Journal of Medical Internet Research*, 22(10), p.e19068.

Krzak, M., **Raykov, Y.P.**, Boukouvalas, A., Cutillo, L. and Angelini, C., 2019. Benchmark and parameter sensitivity analysis of single-cell RNA sequencing clustering methods. *Frontiers in Genetics*, 10, p.1253.

Badawy, R., **Raykov, Y.P.**, Evers, L.J., Bloem, B.R., Faber, M.J., Zhan, A., Claes, K. and Little, M.A., 2018. Automated quality control for sensor based symptom measurement performed outside the lab. *Sensors*, 18(4), p.1215.

Raykov, Y.P., Boukouvalas, A. and Little, M.A., 2016. Simple approximate MAP inference for Dirichlet processes mixtures. Special issue on Bayesian nonparametrics, *Electronic Journal of Statistics*, 10(2), pp.3548-3578.

Raykov Y.P., Boukouvalas, A., Baig, F. and Little, M.A., 2016. What to do when K-means clustering fails: a simple yet principled alternative algorithm. *PloS one*, 11(9), p.e0162259.

Conference and white papers

Claes, K., Ticcinelli, V., Badawy, R., **Raykov, Y.P.**, Evers, L.J. and Little, M.A., 2022. TSDF: A simple yet comprehensive, unified data storage and exchange format standard for digital biosensor data in health applications. <https://arxiv.org/abs/2211.11294>.

Qarout, Y., **Raykov, Y.P.** and Little, M.A., 2021. Few-shot time series segmentation using prototype-defined infinite hidden Markov models. <https://arxiv.org/abs/2102.03885>.

Poorjam, A.H., **Raykov, Y.P.**, Badawy, R., Jensen, J.R., Christensen, M.G. and Little, M.A., 2019, May. Quality control of voice recordings in remote Parkinson's disease monitoring using the infinite hidden Markov model. In *ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)* (pp. 805-809). IEEE.

Leech, C., **Raykov, Y.P.**, Ozer, E. and Merrett, G.V., 2017, March. Real-time room occupancy estimation with Bayesian machine learning using a single PIR sensor and microcontroller. In *2017 IEEE Sensors Applications Symposium (SAS)* (pp. 1-6). IEEE.

Raykov, Y.P., Ozer, E., Dasika, G., Boukouvalas, A. and Little, M.A., 2016, September. Predicting room occupancy with a single passive infrared (PIR) sensor through behavior extraction. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 1016-1027). (**Nominated for best paper at UbiComp 2016**)

Raykov, Y.P., Boukouvalas, A. and Little, M.A., 2015, Iterative collapsed MAP inference for Bayesian nonparametrics. In *NIPS 2015 Workshop on Bayesian Nonparametrics: The Next Generation*.

Raykov, Y.P., Boukouvalas, A. and Little, M.A., 2015, MAP for Exponential Family Dirichlet Process Mixture Models. In *NIPS 2015 Workshop on Scalable Inference*.

PhD thesis

Raykov, Y., 2017. A deterministic inference framework for discrete nonparametric latent variable models: learning complex probabilistic models with simple algorithms (Doctoral dissertation, Aston University), (**Best thesis in Faculty award**).

PATENT

Estimating a number of occupants in a region

2017

Contributors: Raykov, Y.P., Özer, E. and Dasika, G.S.

ARM

Audio-based congestion biomarkers from breathing sounds

2025

Contributors: Raykov, Y.P., Shepard, C., Kotak, D., Gratiot, A.

Eupnoos

AWARDED FUNDING

Digital Clinical Trial Platform for Integrative Mental Health Management in Chronic Pain, Funder: NIHR, Call: UK-Korea Collaborative Research, Duration: 12 months. Funding: £90,000, Years: 2025-2026.

Investigating the therapeutic efficacy of median nerve electrical stimulation for Parkinson's disease tremor, Funder: Parkinson's UK, Role: co-I, Duration: 24 months. Funding: £460,527, Years: 2024-2026.

Changing rhythms of Parkinson's disease, Funder: Michael J Fox Foundation, Role: co-PI, Duration: 36 months. Funding: \$750,000, Years: 2022-2025.

Establishing a Korean-UK consortium to predict treatment response in major depression using mechanistic early response markers, Funder: MRC UK, Role: co-PI, Duration: 12 months. Funding: £50,000, Years: 2023-2024.

Machine learning assisted screening of high-quality antibodies for human therapeutics applications, Funder: Innovate UK, Role: PI, Duration: 30 months. Funding: £250,000, Years: 2022-2024.

Transitional Assistant Professor - ECR buyout and Agile project fund, Funder: EPSRC, University of Nottingham, Duration: 48 months. Funding: £200,000, Years: 2021-2025.

Gait and tremor detection for Parkinson's patients in free-living, Funder: Michael J Fox Foundation, Duration: 24 months, Funding: \$300,000, Years: 2019-2021.

IoT Platform for monitoring and assistance of people and animals, Funder: Innovate UK, Duration: 36 months, Funding: £275,000, Years: 2019-2022.

Predicting and understanding debtors' behavior, Funder: Innovate UK, Duration: 30 months, Funding: £220,000, Years: 2018-2020.

Free-living gait biomarkers for Parkinson's disease, Funder: UCB Pharma, Duration: 4 months, Funding: £35,000, Years: 2018-2019.

RECENT HIGHLY RANKED UNAWARDED SUBMISSIONS

Modern Functional Data Learning for Passive Health Monitoring, Funder: NSF, Call: NSF 23-614: Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science, Role: co-PI, Duration: 48 months. Funding: \$201,157, Team: Prof Sebastian Kurtek, Dr Hengrui Luo, Dr Justin Strait, Dr Wasiur R. KhudaBukhsh, Years: 2025-2029.

Learning what drives long-term disease progression with the next generation of wearable technology, Funder: UKRI, Call: Future Leaders Round 8, Duration: 48 months. Funding: £1,345,475, Years: 2024-2028.

PANELS, REVIEWING AND ORGANIZATION

Funding panelist: **Michael J Fox Foundation** Calls: Personalized Approaches for Understanding, Assessing, and Improving Gait in Parkinson's Disease Research Program; Freezing of Gait program

Workshop Organization: NIHR Nottingham BRC - Neuro-modulation Network Event 2025
Team Science Programme 2025, NIHR

SIAM Optimization, Organized session on Optimization in Biological Sciences, 2023

Alan Turing Network - Advances in inference for disease spread models 2022

Royal Society and UCB Pharma funded Biomedical Signal Processing - Digital monitoring advances, 2018

Digital monitoring consortium network fund (University of Oxford, Imperial College London, University of Nottingham, Radboudumc, University of Birmingham) 2021-2024

Peer review:

EPSRC Mathematical Sciences and Digital Information Technology grants (New Investigator Awards, Senior Fellowship Awards)

Neural Information Processing Systems (NeurIPS), International Conference on Learning Representations, AISTATS, Bayesian Analysis, Journal of Computational and Graphical Statistics, IEEE Signal Processing Letters, IEEE Journal of Biomedical and Health Informatics, Knowledge and Information Systems (KAIS), Soft Computing, Sensors, Journal of Neural Engineering, PLoS One Comp Bio, PLoS One, npj Scientific Reports, Journal of Parkinson's disease.

SELECTED PRESENTATIONS AND WORKSHOPS

Royal Statistics Society International Conference, 2025, Edinburgh, UK. Nonparametric estimation of functional causal effects. (Invited talk)

MRC Cognition and Brain Unit Invited tutorial, 2025, Cambridge, UK. Advances in causal inference estimation and semi-parametric causal models. (Invited session)

BIOREME Advancing Lung Diagnostic Technologies, 2025, Sheffield, UK. Shape-informed symptom detection of airway obstruction disease. (Keynote)

Society for Mathematical Biology Annual Meeting, 2024, Seoul, Republic of South Korea. Robust estimation of time-dependent causal functions: a case study of calibrating pharmacokinetic models with digital outcomes. (Invited talk)

Korea University Anam Hospital, 2024, Seoul, Republic of South Korea. Estimating effect of progression and medication on digital biomarkers. (Invited talk)

Oxford Brain Networks Dynamics Unit Seminar Series, 2024, Oxford, UK. Causal effect estimation in digital monitoring of Parkinson's disease. (Invited talk)

Donders Institute, Radboudumc, 2024, Nijmegen, Netherlands. Causal effect estimation in digital monitoring of Parkinson's disease. (Invited talk)

Durham Statistics and Probability Seminar Series, 2023, Durham, UK. Sparse Factor analysis priors for piecewise linear dimensionality reduction. (Invited talk)

CompStats, 2023, London, UK. Adaptive Latent Feature Sharing for Piecewise Linear Dimensionality Reduction. (Invited talk)

Society for Mathematical Biology Annual Meeting, 2023, Columbus, Ohio, USA. Prototype-based learning of neural networks: mediator informed symptom detection. (Invited talk)

SIAM Optimization, 2023, Seattle, Washington, USA. Prototype-based learning of neural networks: mediator informed symptom detection. (Invited talk)

CMStatistics, 2022, London, UK. Robustifying mixture models via MMD-based likelihood. (Invited talk)

Leeds Statistics Seminar Series, 2022, Leeds, UK. Modeling batch effects in single-cell clustering with controlled random measures. (Invited talk)

PPMI Digital Monitoring Working Group, 2021, Virtual. Passive monitoring of gait and tremor in Parkinson's disease. (Invited talk with Prof Bastiaan R. Bloem)

Moving Disorders Society International Congress, 2021, Virtual. Passive monitoring of bradykinetic gait and dyskinesia. (Joint keynote with Prof Walter Maetzler)

2021 World Meeting of the International Society for Bayesian Analysis, 2021, Virtual. Accurately training latent variable models using the assumption of misspecification. (In contributed session of Approximate and Flexible inference)

2021 World Meeting of the International Society for Bayesian Analysis, 2021, Virtual. Accurately training latent variable models using the assumption of misspecification.

12th Conference on Bayesian Nonparametrics, June 2019, Oxford, UK. Incorporating Contextual Information in Time Series Modelling: AI-iHMM. (poster)

Conference on Advances in Data Science, May 2019, Manchester, UK. Probabilistic Modelling of Gait for Remote Passive Monitoring Applications. (poster)

NeurIPS, BNP@NeurIPS Workshop, December 2018. Adaptive Probabilistic Principal Component Analysis. (spotlight)

NeurIPS, ML4Health Workshop, December 2018. Probabilistic Modelling of Gait in Passive Monitoring Applications.

Data Analytics for Future Cities Research, July 2018, Danang, Vietnam. Passive and Active Monitoring for Remote Diagnosis of Parkinson's Disease. (Invited)

ARM Summit, September 2017, Cambridge, UK. Non-invasive Real-time Occupancy Estimation using Single PIR Motion Sensor.

ARM Summit, September 2017, Cambridge, UK. Unified Framework for Quality Control of Behavioural Clinimetric Tests. (poster)

Behavioural Signal Processing Workshop, July 2017, Birmingham, UK. Unsupervised Learning for Sensor Data Collected Outside the Lab. (Invited)

Scalable Statistical Inference Workshop, Isaac Newton Institute, July 2017, Cambridge, UK. Exploring Statistical Principles for Scaling of Deterministic MAP-based Algorithms. (poster, travel award)

11th Conference on Bayesian Nonparametrics, June 2017, Paris, France. Efficient Block Inference for Bayesian Nonparametric Models. (ISBA travel award)

Conference on Advances in Data Science, May 2017, Manchester, UK. Non-invasive Real-time Occupancy Estimation using Single PIR Motion Sensor. (poster)

ACM International Joint Conference on Pervasive and Ubiquitous Computing, September 2016, Heidelberg, Germany. Predicting Room Occupancy with a Single Passive Infrared (PIR) Sensor through Behavior Extraction.

BNP: The Next Generation Workshop @ NIPS, December 12, 2015, Montreal, Canada. Iterative MAP Inference for Bayesian Nonparametric Models. (poster)

NIPS Workshop on Nonparametric Methods for Large Scale Representation Learning, December 11, 2015, Montreal, Canada. MAP for Exponential Family Dirichlet Process Models. (NIPS travel award)

Research Students' Conference in Probability and Statistics, August 2015, Leeds, UK. Scalable Inference for Hierarchical Dirichlet Processes.

35th Dynamics Days Europe, September 2015, Exeter, UK. Approximate Maximum A-Posteriori Inference for the Infinite Hidden Markov Model. (Invited)

10th Conference on Bayesian Nonparametrics, June 2015, Raleigh, NC, USA. Fast Approximate MAP Inference for Bayesian Nonparametrics. (ISBA travel award)

Research Students' Conference in Probability and Statistics, April 2014, Nottingham, UK. Nonparametric Clustering Techniques and Applications.

Annual Meeting, Oxford Parkinson's Disease Research Center, April 2014, Oxford University Hospital, UK. Discovering PD Phenotypes with Dirichlet Process Mixtures. (Invited)

Workshop on Big Data in Cancer, February 2014, University of Warwick, UK. Nonparametric Analysis of the ELSA Study.

Workshop on Bayesian Computation, December 2013, University of Reading, UK. Multi-level Clustering with Dirichlet Processes.