

Yordan P. Raykov

TRANSITIONAL ASSISTANT PROFESSOR

Statistics and Probability group, School of Mathematical Sciences, University of Nottingham, Nottingham, UK

☎ (+44) 0747-5797-744 | ✉ yordan.raykov@gmail.com

Personal Statement

Early career academic with contributions in theory and applications of statistical machine learning. My main contributions are developing flexible statistical modelling pipelines extending the state of the art in Bayesian nonparametrics and scalable probabilistic machine learning. I have made significant contributions to the application areas of wearable health monitoring and other Internet of Things (IoT) monitoring applications.

Education

Aston University

Birmingham, UK

PHD IN MACHINE LEARNING (FUNDED BY EPSRC)

2013 - 2016

- *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. I have also designed an occupancy estimation system for office spaces that uses a single passive infrared sensor. The implementation of the system has been possible due to developed novel scalable nonparametric segmentation algorithms which can run in real-time on heavily resource-constrained microcontroller boards. *Examined by: Magnus Rattray and Dan Cornford*
- *Supervisor:* Max A. Little, Department of Mathematics, Aston University.

University of Leicester

Leicester, UK

BSC IN MATHEMATICS WITH MANAGEMENT

2010 - 2013

- **First Class Honours**
- *Modules included:* Generalized Linear Models, Operational Research, Game theory, Actuarial Sciences, Differential Equations, Signal Processing.
- *Final Year Project:* SmartLearn initiative - creating software for interactive and entertaining mathematical courses. (Ranked in the top 3 final year projects)

Sofia High School of Mathematics

Sofia, Bulgaria

ADVANCED TRAINING IN MATHEMATICS AND COMPUTER SCIENCE

2003 - 2010

- Mathematics: **Excellent**
- Further Mathematics: **Excellent**
- Computer Science: **Excellent**

Work experience

University of Nottingham

Nottingham, UK

ASSISTANT PROFESSOR

Sep. 2021 - (current)

Horizon transitional fellow in Digital economy and welfare. My role sits between the Statistics and Probability group and the Digital economy section of the Horizon Institute. As such my responsibilities involve leading research at the intersection of statistical machine learning methodology and applied research facilitating digital health, precision medicine and machine learning assisted drug discovery.

Aston University

Birmingham, UK

LECTURER

Apr. 2018 - Sep. 2021

My responsibilities include leading independent and more often collaborative research in the area of statistical machine learning. Among other tasks, my post requirements include: leading independent research; dissemination of research outcomes; applying for internal/external funding; consulting businesses; supervision of postgraduate students and research associates. Part of my responsibilities also includes design and delivery of different online and on-campus machine learning courses at both undergraduate and postgraduate level.

Aston University

POSTDOCTORAL RESEARCH ASSOCIATE

My responsibilities involved 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 PD@Home study has been coordinated by Radboud University Nijmegen in Netherlands. As a part of the study Parkinson's patients have been instructed to wear various electronic devices with embedded sensors while performing their normal daily activities. Over a period of 6 months a large set of unsupervised passive monitoring data has been collected with limited amount of video recordings for validation of patients activities. The methods I develop are currently being used to automate the quality control of the collected data and provide insights for clinicians to the daily behaviours of the patients which are most descriptive for the progression of the disease.

Birmingham, UK

Sep. 2016 - 2018

ARM

RESEARCH INTERN

I was part of the Research and Development team in ARM headquarters in Cambridge, UK. I was assigned a project related to my previous research on the topic of occupancy estimation in office environments. My responsibilities involved: collecting principled and diversified data sets, testing known machine learning methods, evaluating the feasibility of occupancy estimation using a single passive infrared sensor. In my four months at ARM, I developed a novel machine learning approach (i.e. lead contributor to a patent), to solve the occupancy estimation problem and to create a prototype of a new human counting system.

Cambridge, UK

Jan. 2016 - Apr. 2016

Selected talks and presentations

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 2017, Sep 2017, Cambridge, UK. *Non-invasive real-time occupancy estimation using single PIR motion sensor*.

ARM Summit 2017, Sep 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 at Isaac Newton Institute for Mathematical Sciences, 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, Sep 2016, Heidelberg, Germany. *Predicting room occupancy with a single passive infrared (PIR) sensor through behavior extraction*.

Bayesian Nonparametrics: The Next Generation workshop at NIPS, Dec 12, 2015, Montreal, Canada. *Iterative MAP inference for Bayesian nonparametric models*. (poster)

Nonparametric Methods for Large Scale Representation Learning workshop at NIPS, Dec 11, 2015, Montreal, Canada. *MAP for Exponential Family Dirichlet Process Models*. (NIPS travel award)

Research Students' Conference in Probability and Statistics, Aug. 2015, Leeds, UK. *Scalable inference for hierarchical Dirichlet processes*.

35th Dynamics Days Europe, Sep 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 at 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, Feb 2014, University of Warwick, UK. *Nonparametric analysis of the ELSA study.*

Workshop on Bayesian Computation, Dec 2013, University of Reading, UK. *Multi-level clustering with Dirichlet processes.*

Publications

Qarout, Y., **Raykov, Y.P.** and Little, M.A., 2021. Few-shot time series segmentation using prototype-defined infinite hidden Markov models. (pre-print at arXiv:2102.03885.)

Raykov, Y. P., Evers, L. J.W., Badawy, R., Bloem, B., Meinders, M. J., Claes, K., Little M. A., Probabilistic modelling of gait for robust passive monitoring in free living daily life, *Journal of Biomedical and Health Informatics*, 2020, (available at <https://ieeexplore.ieee.org/document/9258382>)

Farooq, A., **Raykov, Y. P.***, Raykov, P., Little M. A., Controlling for sparsity in sparse factor analysis models: adaptive latent feature sharing for piecewise linear dimensionality reduction, 2020, (in review) *Journal of Machine Learning Research*, pre-print at <https://arxiv.org/abs/2006.12369>

Evers, L. J. W., **Raykov, Y. P.**, Krijthe, H. J., Silva de Lima, A. L., Badawy, R., Claes, K., Heskes, T., Little, M. A., Meinders M. J., Bloem, R. B., 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.

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.

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

Poorjam, A. H., Kavalekalam, M. S., Shi, L., **Raykov, Y. P.**, Jensen, J. R., Little, M. A., Christensen, M. G., 2020. Automatic Quality Control and Enhancement for Voice-Based Remote Parkinson's Disease Detection, *Speech Communication*

Poorjam, A.H., **Raykov, Y.P.**, Badawy, R., Jensen, J.R., Christensen, M.G. and Little, M.A., 2019, April. 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.

Farooq, A., **Raykov, Y.P.***, Evers, L.J., Little, M.A., 2018. Adaptive probabilistic principal component analysis, BNP@NeurIPS (All of Bayesian nonparametrics) Workshop at NeurIPS 2018

Raykov, Y.P., Evers, L.J., Badawy, R., Bloem, B.R., Faber, M.J., Claes, K. and Little, M.A., 2018. Probabilistic modelling of gait for remote passive monitoring applications, *to appear in ML4Health Workshop at NeurIPS 2018*

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.

Leech, C., **Raykov, Y.P.**, Ozer, E., Merrett, V.G., Real-time Room Occupancy Estimation with Bayesian Machine Learning using a Single PIR Sensor and Microcontroller, 2017. IEEE proceedings of Sensor Applications Symposium.

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.

Raykov, Y.P., Ozer, E., Dasika, G., Boukouvalas, A. and Little, M.A., 2016. 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). ACM.

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

Raykov, Y.P., Boukouvalas, A., Little M.A., 'MAP for Exponential Family Dirichlet Process Mixture Models', NIPS 2015 Workshop on 'Nonparametric Methods for Large Scale Representation Learning'

Patents

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

U.S. Patent Application 15/182,901.

ESTIMATING A NUMBER OF OCCUPANTS IN A REGION.

Arm, 2017

Funded projects as an investigator

- **The digital fingerprint of Parkinson's disease progression: development of a motor and a non-motor biomarker based on continuous, real-life monitoring. (2022-2024)** (funded by Michael J Fox Foundation, PI Prof Bastiaan R. Bloem, Radboudumc) \$800,000 collaborative project with Radboudumc, Oxford Parkinson's disease center, Google Verily, UCB Pharma and University of Birmingham. My involvement is as 0.4 FTE co-PI responsible for managing and aiding the development of machine learning pipelines for modelling gait and tremor pathologies, as well as, contextual factors affecting them in clinical trials.
- **Gait and tremor detection for Parkinson's patients in free living. (2019-2021)** (funded by Michael J Fox Foundation 0.4 FTE) funded project aimed at developing and validation of gait and tremor modelling in free living.
- **Gait and tremor detection for Parkinson's patients in free living. (2018)** (funded by UCB Pharma) funded secondment (0.6 FTE, 4 months) with aim to build proof-of-concept framework for modelling symptom fluctuations of Parkinson's patients using wearable devices.
- **IoT Platform for monitoring and assistance of people and animals. (2018-2021)** (funded by Innovate UK) 3 year KTP project aiming to build algorithmic framework that runs in real time on a Raspberry Pi hardware. The project is in collaboration with RowAnalytics and machine learning algorithms will inform a decision system making personalized health recommendations.
- **Few shot learning framework for 3-D structure prediction of proteins. (2019)** 6 months project with Syndial ltd. The project aimed to implement proof-of-concept of a prototype system for the accurate prediction of spatial constraints in 3-D protein folding applications.
- **Predicting and understanding debtors behaviour. (2018-2020)** (funded by Innovate UK) 2.5 year KTP project aiming to improve predictive performance of Rimilia's AI engine. We are using transactions data from large UK and US based companies customers of Rimilia to design algorithm framework better at prediction of debtors payments and behaviours. This project has been nominated for the National KTP awards 2021.

Peer-review Activity

Reviewer for: Neural Information Processing Systems (NeurIPS), AISTATS, IEEE Signal Processing Letters, Knowledge and Information Systems (KAIS), Soft Computing, Sensors, Journal of Neural Engineering, PLoS One

Selected Honours & Awards

INTERNATIONAL

Atos IT challenge

Birmingham, UK

FINALIST

2017

My team Astonish qualified as one of the 17 finalist out of the 77 teams that participated in the annual Atos IT challenge in 2017 with topic Blockchains.

International Mathematics Tournament of the Cities

Sofia, Bulgaria

WINNER

2007

The tournament of the cities is an annual competition co-organized by the Union of the Bulgarian Mathematicians and the Russian academy of science.

DOMESTIC

John Smith Research Prize

Birmingham, UK

FIRST PRIZE

2015

The John Smith Prize is an annual research competition for Aston Mathematics PhD students.

Inter-House Maths Olympiad

1ST PLACE

Leicester, UK

both in 2012 and 2013

Annual competition organized by University of Leicester for undergraduate and postgraduate students in the Department of Mathematics.

National Ranklist for top performing students in Informatics

Bulgaria

TOP 20 NATIONWIDE

2006

This is a ranklist reflecting the results from multiple national competitions in the field of Informatics and Computer Science.

National Mathematics Olympiad

Sofia, Bulgaria

FINALIST

2002-2007, 2009-2010

This is the biggest national Olympiad for mathematics in Bulgaria. My performance has varied in consecutive years, but I have consistently qualified for the final round with exception of one year when I did not attend a round.

Ivan Salabashev

Sofia, Bulgaria

2ND PLACE

2005

This is a national mathematics tournament organized in Bulgaria every year.