

# Zoltán Szabó

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Research Associate Professor

### Contact Information

Center for Applied Mathematics (CMAP) *E-mail:* [zoltan.szabo@polytechnique.edu](mailto:zoltan.szabo@polytechnique.edu)  
École Polytechnique *Web:* <http://www.cmap.polytechnique.fr/~zoltan.szabo/>  
Route de Saclay, 91128 Palaiseau, France

### Research Interest

- Theory: information theory,<sup>1</sup> kernel methods, statistical machine learning, empirical processes.
- Applications: remote sensing (sustainability), distribution regression, hypothesis testing, structured sparsity, independent subspace analysis and its extensions, collaborative filtering, face emotion recognition and face tracking, natural language processing.

### Employment

<b>École Polytechnique, CMAP</b> , Palaiseau, France Research Associate Professor	2016–
<b>University College London, CSML</b> , London, United Kingdom <b>Gatsby Unit</b> Research Associate (with Prof. Arthur Gretton)	2013–2016
<b>Eötvös Loránd University, School of Computer Science</b> , Budapest, Hungary <b>Department of Software Technology and Methodology</b> Research Fellow	2009–2013
Assistant Research Fellow	2008–2009
<b>Department of Information Systems</b> Assistant Professor	2007–2008

### Professional Activities

#### Reviewing for Journals

Journal of Multivariate Analysis	2017–
Machine Learning Journal	2016–
Annals of Statistics	2016–
IEEE Signal Processing Letters	2015–
Statistics and Computing	2015–
Statistical Analysis and Data Mining	2014–
IET Computer Vision	2014–
International Journal of Computer Vision	2014–
IEEE Transactions on Information Theory	2013–
IEEE Transactions on Pattern Analysis and Machine Intelligence	2013–
Journal of Machine Learning Research	2013–
Progress in Artificial Intelligence	2013–
Entropy	2012–
IEEE Transactions on Neural Networks and Learning Systems	2012–
Signal, Image and Video Processing	2012–
IEEE Transactions on Signal Processing	2009–
Neurocomputing	2009–

<sup>1</sup>ITE toolbox: <https://bitbucket.org/szzoli/ite/>, [https://bitbucket.org/szzoli/ite\\_in\\_python/](https://bitbucket.org/szzoli/ite_in_python/).

IEEE Transactions on Neural Networks	2007–2011
<b>Program Chairing</b>	
Data Science Summer School (DS <sup>3</sup> ) (co-organizers: Eric Moulines, Erwan Scornet, Emmanuel Bacry, Aldjia Mazari)	2017
<b>Area Chairing, Senior Program Committee Member</b>	
International Conference on Machine Learning (ICML)	2018
International Conference on Artificial Intelligence and Statistics (AISTATS)	2018
Conference on Uncertainty in Artificial Intelligence (UAI)	2017
International Conference on Machine Learning (ICML)	2017
International Conference on Artificial Intelligence and Statistics (AISTATS)	2017
Conference on Uncertainty in Artificial Intelligence (UAI)	2016
<b>Reviewing Grant Applications</b>	
Swiss National Science Foundation (SNF)	2017-
<b>Reviewing for Conferences</b>	
International Conference on Learning Representations (ICLR-2018)	2017
Conference on Learning Theory (COLT)	2017
Advances in Neural Information Processing Systems (NIPS)	2017
Advances in Neural Information Processing Systems (NIPS)	2016
International Conference on Machine Learning (ICML)	2016
Advances in Neural Information Processing Systems (NIPS)	2015
Advances in Neural Information Processing Systems (NIPS)	2014
International Conference on Machine Learning (ICML)	2012
International Conference on Latent Variable Analysis and Signal Separation (LVA/ICA)	2012
International Joint Conference on Artificial Intelligence (IJCAI)	2011
International Joint Conference on Neural Networks (IJCNN)	2011
European Conference on Complex Systems (ECCS)	2011
European Signal Processing Conference (EUSIPCO)	2011
European Conference on Complex Systems (ECCS)	2009
<b>Reviewing for Workshops</b>	
NIPS: ‘Challenges in Machine Learning: Gaming and Education’	2016
<b>Organizing</b>	
Conference (Workflow Chair)	
International Conference on Artificial Intelligence and Statistics (AISTATS) (co-workflow chair: Rodolphe Jenatton)	2016
Workshop	
NIPS: ‘Learning on Distributions, Functions, Graphs and Groups’ (co-organizers: Florence d’Alché-Buc, Krikamol Muandet, Bharath K. Sriperumbudur)	2017
NIPS: ‘Adaptive and Scalable Nonparametric Methods in Machine Learning’ (co-organizers: Aaditya Ramdas, Bharath K. Sriperumbudur, Han Liu, John Lafferty, Mladen Kolar, Samory Kpotufe)	2016
NIPS: ‘Modern Nonparametrics 3: Automating the Learning Pipeline’ (co-organizers: Arthur Gretton, Mladen Kolar, Samory Kpotufe, Han Liu, Andrew G. Wilson, Le Song, Eric Xing)	2014
ML Journal Club (co-organizers: Erwan Scornet, Alain Virouleau)	2017–
ML External Seminars @ Gatsby Unit	2014–2016
<b>Committee Member</b>	

@ Data Science Master: M.Sc. internship defense (École Polytechnique)	Sept. 27, 2017
@ Data Science Master: M.Sc. internship defense (Télécom ParisTech)	Sept. 27, 2017
@ Data Science Master: M.Sc. internship defense (École Polytechnique)	Sept. 4-5, 2017
@ Ph.D. Defense: Romain Brault (Télécom ParisTech)	July 3, 2017
Thesis title: Large-scale Operator-Valued Kernel Regression	

### Referent Professor

Camille Jandot's M.Sc. internship (Télécom ParisTech)	Apr.–Sept., 2017
Title: Modelling Space Time Series with Operator-Valued Kernels – Application to Detection of Epidemics	

### Session Chairing

Paris Summit on Big Data (ParisBD)	2017
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## Publications

### Peer-Reviewed Journal Articles and Conference Papers

- [1] Wittawat Jitkrittum, Wenkai Xu, Zoltán Szabó, Kenji Fukumizu, and Arthur Gretton. A linear-time kernel goodness-of-fit test. In *Advances in Neural Information Processing Systems (NIPS)*, Long Beach, CA, U.S., 4-9 December 2017. (best paper award = top 0.09%).
- [2] Wittawat Jitkrittum, Zoltán Szabó, and Arthur Gretton. An adaptive test of independence with analytic kernel embeddings. In Doina Precup and Yee Whye Teh, editors, *International Conference on Machine Learning (ICML)*, volume 70, pages 1742–1751, Sydney, Australia, 6-11 August 2017. PMLR. (25.46% acceptance rate).
- [3] Zoltán Szabó, Bharath Sriperumbudur, Barnabás Póczos, and Arthur Gretton. Learning theory for distribution regression. *Journal of Machine Learning Research*, 17(152):1–40, 2016.
- [4] Wittawat Jitkrittum, Zoltán Szabó, Kacper Chwialkowski, and Arthur Gretton. Interpretable distribution features with maximum testing power. In D. D. Lee, M. Sugiyama, U. V. Luxburg, I. Guyon, and R. Garnett, editors, *Advances in Neural Information Processing Systems (NIPS)*, pages 181–189, Barcelona, Spain, 5-10 December 2016. Curran Associates, Inc. (full oral presentation = top 1.84%).
- [5] Zoltán Szabó, Bharath Sriperumbudur, Barnabás Póczos, and Arthur Gretton. Minimax-optimal distribution regression. In *International Society for NonParametric Statistics (ISNPS) Conference*, Avignon, France, 11-16 June 2016.
- [6] Bharath K. Sriperumbudur and Zoltán Szabó. Optimal rates for random Fourier features. In C. Cortes, N. D. Lawrence, D. D. Lee, M. Sugiyama, and R. Garnett, editors, *Advances in Neural Information Processing Systems (NIPS)*, pages 1144–1152, Montréal, Canada, 7-12 December 2015. Curran Associates, Inc. (contributed equally; spotlight presentation – 3.65% acceptance rate).
- [7] Heiko Strathmann, Dino Sejdinovic, Samuel Livingstone, Zoltán Szabó, and Arthur Gretton. Gradient-free Hamiltonian Monte Carlo with efficient kernel exponential families. In C. Cortes, N. D. Lawrence, D. D. Lee, M. Sugiyama, and R. Garnett, editors, *Advances in Neural Information Processing Systems (NIPS)*, pages 955–963, Montréal, Canada, 7-12 December 2015. Curran Associates, Inc. (poster presentation – 17.46% acceptance rate).
- [8] Mijung Park, Wittawat Jitkrittum, Ahmad Qamar, Zoltán Szabó, Lars Buesing, and Maneesh Sahani. Bayesian manifold learning: The locally linear latent variable model. In C. Cortes, N. D. Lawrence, D. D. Lee, M. Sugiyama, and R. Garnett, editors, *Advances in Neural Information Processing Systems (NIPS)*, pages 154–162, Montréal, Canada, 7-12 December 2015. Curran Associates, Inc. (poster presentation – 17.46% acceptance rate).

- [9] Wittawat Jitkrittum, Arthur Gretton, Nicolas Heess, Ali Eslami, Balaji Lakshminarayanan, Dino Sejdinovic, and Zoltán Szabó. Kernel-based just-in-time learning for passing expectation propagation messages. In *Conference on Uncertainty in Artificial Intelligence (UAI)*, pages 405–414, Amsterdam, Netherlands, 12-16 July 2015.
- [10] Zoltán Szabó, Arthur Gretton, Barnabás Póczos, and Bharath Sriperumbudur. Two-stage sampled learning theory on distributions. In *International Conference on Artificial Intelligence and Statistics (AISTATS)*, pages 948–957, San Diego, California, USA, 9-12 May 2015. (oral presentation – 6.11% acceptance rate).
- [11] Balázs Pintér, Gyula Vörös, Zoltán Szabó, and András Lőrincz. Wikifying novel words to mixtures of Wikipedia senses by structured sparse coding. In Ana Fred and Maria De Marsico, editors, *Pattern Recognition Applications and Methods*, volume 318 of *Advances in Intelligent and Soft Computing*, pages 241–255. Springer, 2015.
- [12] Zoltán Szabó. Information theoretical estimators toolbox. *Journal of Machine Learning Research*, 15:283–287, 2014.
- [13] László Jeni, András Lőrincz, Zoltán Szabó, Jeffrey F. Cohn, and Takeo Kanade. Spatio-temporal event classification using time-series kernel based structured sparsity. In David Fleet, Tomas Pajdla, Bernt Schiele, and Tinne Tuytelaars, editors, *European Conference on Computer Vision (ECCV)*, volume 8692 of *Lecture Notes in Computer Science*, pages 135–150, Zürich, Switzerland, 6-12 September 2014. Springer International Publishing Switzerland.
- [14] Balázs Pintér, Gyula Vörös, Zoltán Szabó, and András Lőrincz. Explaining unintelligible words by means of their context. In *International Conference on Pattern Recognition Applications and Methods (ICPRAM)*, pages 382–387, Barcelona, Spain, 15-18 February 2013.
- [15] Balázs Pintér, Gyula Vörös, Zsolt Palotai, Zoltán Szabó, and András Lőrincz. Determining unintelligible words from their textual contexts. *Procedia - Social and Behavioral Sciences*, 73:101–108, 2013. (Proceedings of the 2nd International Conference on Integrated Information (IC-ININFO 2012), Budapest, Hungary, 30 August – 3 September).
- [16] Zoltán Szabó and András Lőrincz. Distributed high dimensional information theoretical image registration via random projections. *Digital Signal Processing*, 22(6):894–902, 2012.
- [17] Balázs Pintér, Gyula Vörös, Zoltán Szabó, and András Lőrincz. Automated word puzzle generation using topic models and semantic relatedness measures. *Annales Universitatis Scientiarum Budapestinensis de Rolando Eötvös Nominatae, Sectio Computatorica*, 36:299–322, 2012.
- [18] László A. Jeni, András Lőrincz, Tamás Nagy, Zsolt Palotai, Judit Sebők, Zoltán Szabó, and Dániel Takács. 3D shape estimation in video sequences provides high precision evaluation of facial expressions. *Image and Vision Computing*, 30(10):785–795, 2012.
- [19] Balázs Pintér, Gyula Vörös, Zoltán Szabó, and András Lőrincz. Automated word puzzle generation using topic models and semantic relatedness measures. In Zoltán Csörnyei, editor, *Joint Conference on Mathematics and Computer Science (MaCS)*, Siófok, Hungary, 9-12 February 2012.
- [20] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Collaborative filtering via group-structured dictionary learning. In Fabian Theis, Andrzej Cichocki, Arie Yeredor, and Michael Zibulevsky, editors, *International Conference on Latent Variable Analysis and Signal Separation (LVA/ICA)*, volume 7191 of *Lecture Notes in Computer Science*, pages 247–254, Tel-Aviv, Israel, 12-15 March 2012. Springer-Verlag, Berlin Heidelberg.
- [21] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Separation theorem for independent subspace analysis and its consequences. *Pattern Recognition*, 45(4):1782–1791, 2012.

- [22] Barnabás Póczos, Zoltán Szabó, and Jeff Schneider. Nonparametric divergence estimators for independent subspace analysis. In *European Signal Processing Conference (EUSIPCO) – Special Session on Dependent Component Analysis*, pages 1849–1853, Barcelona, Spain, 29 August – 2 September 2011. (ISSN: 2076-1465).
- [23] Zoltán Szabó and Barnabás Póczos. Nonparametric independent process analysis. In *European Signal Processing Conference (EUSIPCO)*, pages 1718–1722, Barcelona, Spain, 29 August – 2 September 2011. (ISSN: 2076-1465).
- [24] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Online group-structured dictionary learning. In *IEEE Computer Vision and Pattern Recognition (CVPR)*, pages 2865–2872, Colorado Springs, CO, USA, 20-25 June 2011.
- [25] Zoltán Szabó. Autoregressive independent process analysis with missing observations. In Michel Verleysen, editor, *European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning (ESANN)*, pages 159–164. d-side, 28-30 April 2010. (ISBN 2-930307-10-2).
- [26] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Auto-regressive independent process analysis without combinatorial efforts. *Pattern Analysis and Applications*, 13(1):1–13, February 2010.
- [27] Zoltán Szabó and András Lőrincz. Complex independent process analysis. *Acta Cybernetica*, 19:177–190, 2009.
- [28] Zoltán Szabó and András Lőrincz. Controlled complete ARMA independent process analysis. In *International Joint Conference on Neural Networks (IJCNN)*, pages 3038–3045, 14-19 June 2009. (IEEE Catalog Number: CFP09IJS-CDR; ISBN: 978-1-4244-3553-1; ISSN: 1098-7576).
- [29] Zoltán Szabó and András Lőrincz. Fast parallel estimation of high dimensional information theoretical quantities with low dimensional random projection ensembles. In Tülay Adalı, Christian Jutten, João Marcos T. Romano, and Allan Kardec Barros, editors, *International Conference on Independent Component Analysis and Signal Separation (ICA)*, volume 5441 of *Lecture Notes in Computer Science*, pages 146–153, Berlin Heidelberg, 15-18 March 2009. Springer-Verlag.
- [30] Zoltán Szabó. Complete blind subspace deconvolution. In Tülay Adalı, Christian Jutten, João Marcos T. Romano, and Allan Kardec Barros, editors, *International Conference on Independent Component Analysis and Signal Separation (ICA)*, volume 5441 of *Lecture Notes in Computer Science*, pages 138–145, Berlin Heidelberg, 15-18 March 2009. Springer-Verlag.
- [31] Zoltán Szabó and András Lőrincz. Post nonlinear hidden infomax identification. In *Joint Conference of Hungarian PhD students*, pages 52–58, 2008.
- [32] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Undercomplete blind subspace deconvolution via linear prediction. In Joost N. Kok, Jacek Koronacki, Ramon Lopez de Mantaras, Stan Matwin, Dunja Mladenič, and Andrzej Skowron, editors, *European Conference on Machine Learning (ECML)*, volume 4701 of *Lecture Notes in Artificial Intelligence*, pages 740–747, Berlin Heidelberg, 17-21 September 2007. Springer-Verlag.
- [33] Zoltán Szabó, Barnabás Póczos, Gábor Szirtes, and András Lőrincz. Post nonlinear independent subspace analysis. In Joaquim Marques de Sá, Luís A. Alexandre, Wlodzislaw Duch, and Danilo P. Mandic, editors, *International Conference on Artificial Neural Networks (ICANN)*, volume 4668 of *Lecture Notes in Computer Science - Part I*, pages 677–686, Berlin Heidelberg, 9-13 September 2007. Springer-Verlag.
- [34] Barnabás Póczos, Zoltán Szabó, Melinda Kiszlinger, and András Lőrincz. Independent process analysis without a priori dimensional information. In Mike E. Davies, Christopher J. James, Samer A. Abdallah, and Mark D. Plumbley, editors, *International Conference on Independent*

*Component Analysis and Signal Separation (ICA)*, volume 4666 of *Lecture Notes in Computer Science*, pages 252–259, Berlin Heidelberg, 9-12 September 2007. Springer-Verlag.

- [35] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Undercomplete blind subspace deconvolution. *Journal of Machine Learning Research*, 8:1063–1095, 2007.
- [36] András Lőrincz and Zoltán Szabó. Neurally plausible, non-combinatorial iterative independent process analysis. *Neurocomputing - Letters*, 70(7-9):1569–1573, 2007.
- [37] Zoltán Szabó and András Lőrincz. Independent subspace analysis can cope with the „curse of dimensionality”. *Acta Cybernetica (+Symposium of Intelligent Systems 2006)*, 18:213–221, 2007.
- [38] Zoltán Szabó and András Lőrincz. Multilayer kercep tron. *Journal of Applied Mathematics*, 24:209–222, 2007.
- [39] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Cross-entropy optimization for independent process analysis. In Justinian Rosca, Deniz Erdogmus, José C. Principe, and Simon Haykin, editors, *International Conference on Independent Component Analysis and Blind Source Separation (ICA)*, volume 3889 of *Lecture Notes in Computer Science*, pages 909–916. Springer, 5-8 March 2006.
- [40] Zoltán Szabó and András Lőrincz.  $\epsilon$ -sparse representations: Generalized sparse approximation and the equivalent family of SVM tasks. *Acta Cybernetica*, 17(3):605–614, 2006.
- [41] György Hévízi, Mihály Biczó, Barnabás Póczos, Zoltán Szabó, Bálint Takács, and András Lőrincz. Hidden markov model finds behavioral patterns of users working with a headmouse driven writing tool. In *International Joint Conference on Neural Networks (IJCNN)*, 26-29 July 2004. (IJCNN2004 CD-ROM Conference Proceedings, Paper No. 1268. IEEE Catalog Number: 04CH37541C, ISBN: 0-7803-8360-5).

## Workshop Papers

- [1] Wittawat Jitkrittum, Zoltán Szabó, Kenji Fukumizu, and Arthur Gretton. A fast goodness-of-fit test with analytic kernel embeddings. In *Greek Stochastics Workshop – Model Determination*, Milos, Greece, 14-17 July 2017.
- [2] Zoltán Szabó and Éric Moulines. Locally-adaptive kernel tests. In *Data Learning and Inference (DALI)*, Tenerife, Spain, 17-20 April 2017.
- [3] Wittawat Jitkrittum, Zoltán Szabó, and Arthur Gretton. The finite-set independence criterion. In *UCL Workshop on the Theory of Big Data*, London, UK, 28 June 2017.
- [4] Wittawat Jitkrittum, Zoltán Szabó, and Arthur Gretton. An adaptive test of independence with analytic kernel embeddings. In *Probabilistic Graphical Model Workshop*, Tokyo, Japan, 24 February 2017.
- [5] Heiko Strathmann, Dino Sejdinovic, Samuel Livingstone, Ingmar Schuster, Maria Lomeli Garcia, Zoltán Szabó, Christophe Andrieu, and Arthur Gretton. Kernel techniques for adaptive Monte Carlo methods. In *Greek Stochastics Workshop on Big Data and Big Models*, Tinos, Greece, 10-13 July 2016.
- [6] Wittawat Jitkrittum, Zoltán Szabó, Kacper Chwialkowski, and Arthur Gretton. Distinguishing distributions with interpretable features. In *International Conference on Machine Learning (ICML): Data-E cient Machine Learning workshop*, New York, 24 June 2016.
- [7] Bharath Sriperumbudur and Zoltán Szabó. Optimal uniform and  $L^p$  rates for random Fourier features. In *Theory of Big Data Workshop*, London, UK, 6-8 January 2016. (contributed equally).
- [8] Wittawat Jitkrittum, Arthur Gretton, Nicolas Heess, Ali Eslami, Balaji Lakshminarayanan, Dino Sejdinovic, and Zoltán Szabó. Just-in-time kernel regression for expectation propagation. In

*International Conference on Machine Learning (ICML) – Large-Scale Kernel Learning: Challenges and New Opportunities workshop*, Lille, France, 10-11 July 2015.

- [9] Zoltán Szabó, Bharath Sriperumbudur, Barnabás Póczos, and Arthur Gretton. Distribution regression - make it simple and consistent. In *Data, Learning and Inference workshop (DALI)*, La Palma (Canaries, Spain), 10-12 April 2015.
- [10] Wittawat Jitkrittum, Arthur Gretton, Nicolas Heess, Ali Eslami, Balaji Lakshminarayanan, Dino Sejdinovic, and Zoltán Szabó. Kernel-based just-in-time learning for passing expectation propagation messages. In *Data, Learning and Inference workshop (DALI)*, La Palma (Canaries, Spain), 10-12 April 2015.
- [11] Zoltán Szabó, Arthur Gretton, Barnabás Póczos, and Bharath Sriperumbudur. Consistent vector-valued distribution regression. In *UCL Workshop on the Theory of Big Data*, London, UK, 7-9 January 2015.
- [12] Zoltán Szabó, Arthur Gretton, Barnabás Póczos, and Bharath Sriperumbudur. Simple consistent distribution regression on compact metric domains. In *UCL-Duke Workshop on Sensing and Analysis of High-Dimensional Data (SAHD)*, London, UK, 4-5 September 2014.
- [13] Zoltán Szabó, Arthur Gretton, Barnabás Póczos, and Bharath Sriperumbudur. Learning on distributions. In *Kernel methods for big data workshop*, Lille, France, 2 April 2014.
- [14] Zoltán Szabó. Information theoretical estimators toolbox. In *Advances in Neural Information Processing Systems (NIPS) – Workshop on Machine Learning Open Source Software 2013: Towards Open Workflows*, Harrahs and Harveys, Lake Tahoe, Nevada, United States, 10 December 2013.
- [15] András Lőrincz, László A. Jeni, Zoltán Szabó, Jeffrey Cohn, and Takeo Kanade. Emotional expression classification using time-series kernels. In *IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW): IEEE International Workshop on Analysis and Modeling of Faces and Gestures (AMFG)*, pages 889–895, Portland, Oregon, 23-28 June 2013.
- [16] Balázs Pintér, Gyula Vörös, Zoltán Szabó, and András Lőrincz. Automated word puzzle generation via topic dictionaries. In *International Conference on Machine Learning (ICML) – Sparsity, Dictionaries and Projections in Machine Learning and Signal Processing workshop*, Edinburgh, Scotland, 30 June 2012.
- [17] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Online dictionary learning with group structure inducing norms. In *International Conference on Machine Learning (ICML) – Structured Sparsity: Learning and Inference workshop*, Bellevue, Washington, USA, 2 July 2011.
- [18] Zoltán Szabó and András Lőrincz. Towards independent subspace analysis in controlled dynamical systems. In *ICA Research Network International Workshop (ICARN)*, pages 9–12, 25-26 September 2008.
- [19] Zoltán Szabó and András Lőrincz. Real and complex independent subspace analysis by generalized variance. In *ICA Research Network International Workshop (ICARN)*, pages 85–88, 18-19 September 2006.

## Symposium Papers

- [1] Bharath K. Sriperumbudur and Zoltán Szabó. Optimal uniform and  $L^p$  rates for random Fourier features. Quinquennial Review Symposium, 23 September 2015. (contributed equally).
- [2] Mijung Park, Wittawat Jitkrittum, Ahmad Qamar, Zoltán Szabó, Lars Buesing, and Maneesh Sahani. Bayesian manifold learning: Locally linear latent variable model (LL-LVM). Quinquennial Review Symposium, 23 September 2015.

- [3] Zoltán Szabó. Independent subspace analysis in case of missing observations. In *Symposium of Intelligent Systems*, 20 November 2009.

### **Invited Talks, Invited Posters**

- [1] Coming. French Excellence Summer School, presentation, July 2018.
- [2] Characteristic tensor product kernels. Conference of the International Society for Non-Parametric Statistics (ISNPS), Salerno, Italy, presentation, 11-15 June 2018.
- [3] Coming. Machine Learning & Computational Biology Lab, ETH Zürich, presentation, 26 February 2018.
- [4] Tensor product kernels: Independence and beyond. Google Brain, Mountain View, presentation (1 hour), 1 December 2017.
- [5] Tensor product kernels: Characteristic property and beyond. Advanced Methods Group, Cubist Systematic Strategies, New York, presentation (90 minutes), 28 November 2017.
- [6] Independence with tensor product kernels. Yahoo Research, New York, presentation (1 hour), 28 November 2017.
- [7] Kernel-based dependency measures and hypothesis testing. Machine Learning Department, Carnegie Mellon University, presentation (80 minutes), 27 November 2017.
- [8] Tensor product kernels: Characteristic property and universality. Research Seminar, Sfs, ETH Zürich, presentation (45 minutes), 3 November 2017.
- [9] Characteristic tensor kernels. CREST Statistics Seminar, ENSAE, presentation (75 minutes), 9 October 2017.
- [10] Manifold learning and classification for EEG analysis. Summer School on Mathematical and Computational Methods for Life Sciences, presentation (3 hours), 27 July 2017.
- [11] Data-efficient independence testing with analytic kernel embeddings. PASADENA Seminar, Télécom ParisTech, presentation (1 hour), 17 May 2017.
- [12] Distribution regression: A simple technique with minimax-optimal guarantee. Parisian Statistics Seminar, Henri Poincaré Institute, presentation (1 hour), 27 March 2017.
- [13] A linear-time adaptive nonparametric two-sample test. Signal Processing and Machine Learning Seminar, Marseilles, presentation (1 hour), 24 March 2017.
- [14] Minimax-optimal distribution regression. Probability and Statistics Seminar, Orsay, presentation (1 hour), 16 March 2017.
- [15] T-testing: A linear-time adaptive nonparametric technique. Machine Learning Seminar, Télécom ParisTech, presentation (1 hour), 2 February 2017.
- [16] Distribution regression. New Directions for Learning with Kernels and Gaussian Processes Dagstuhl Seminar, presentation (30 minutes), 1 December 2016.
- [17] Adaptive linear-time nonparametric t-test. Facebook AI Research, Paris, France, presentation, 21 November 2016.
- [18] Distinguishing distributions with maximum testing power. Realeyes, Budapest, Hungary, presentation (1 hour), 24 August 2016.
- [19] Optimal regression on sets. eResearch Domain launch event, London, UK, poster, 29 June 2016.



- [20] Hypothesis testing with kernels. International Workshop on Pattern Recognition in Neuroimaging (PRNI), Trento, Italy, presentation (1 hour), 22-24 June 2016.
- [21] Kernel-based learning on probability distributions. University of California, San Diego, presentation (30 minutes), 25 April 2016.
- [22] Distribution regression with minimax-optimal guarantee. MASCOT-NUM, presentation (45 minutes), 25 March 2016.
- [23] Performance guarantees for kernel-based learning on probability distributions. Special Symposium on Intelligent Systems, MPI, Tübingen, presentation (20 minutes), 16 March 2016.
- [24] Optimal rates for the random Fourier feature technique. École Polytechnique, presentation (2 hours), 14 March 2016.
- [25] Learning theory for vector-valued distribution regression. CMStatistics 2015, presentation (35 minutes), 12 December 2015.
- [26] Optimal uniform and  $L^p$  rates for random Fourier features. Pennsylvania State University, presentation (1 hour), 4 December 2015.
- [27] Optimal rates for the random Fourier feature method. Statistical ML Reading Group, Carnegie Mellon University, presentation (1 hour), 1 December 2015.
- [28] Distribution regression: Computational and statistical tradeoffs. ML Lunch Seminar, Carnegie Mellon University, presentation (50 minutes), 30 November 2015.
- [29] Distribution regression: Computational and statistical tradeoffs. Princeton University, presentation (1 hour), 26 November 2015.
- [30] Optimal rates for random Fourier feature approximations. University of Alberta, presentation (1 hour), 24 November 2015.
- [31] Optimal rates for random Fourier feature kernel approximations. AMPLab, UC Berkeley, presentation (1 hour), 20 November 2015.
- [32] Performance guarantees for random Fourier features - limitations and merits. Neil Lawrence's lab, University of Sheffield, presentation (1 hour), 25 June 2015.
- [33] Regression on probability measures: A simple and consistent algorithm. Centre for Research in Statistical Methodology Seminars, Department of Statistics, University of Warwick, presentation (1 hour), 29 May 2015.
- [34] Vector-valued distribution regression - keep it simple and consistent. Computational Statistics and Machine Learning reading group, Department of Statistics, University of Oxford, presentation (50 minutes), 1 May 2015.
- [35] A simple and consistent technique for vector-valued distribution regression. Artificial Intelligence and Natural Computation seminars, University of Birmingham, presentation (50 minutes), 26 January 2015.
- [36] Consistent vector-valued regression on probability measures. Bernhard Schölkopf's Lab, MPI for Intelligent Systems, Tübingen, presentation (1 hour), 15 January 2015.
- [37] Vector-valued distribution regression: A simple and consistent approach. Statistical Science Seminars, UCL, presentation (1 hour), 9 October 2014.
- [38] Distribution regression - the set kernel heuristic is consistent. CSML Lunch Talk Series, UCL, presentation (1 hour), 2 May 2014.

- [39] Consistent distribution regression via mean embedding. University of Hertfordshire, presentation (1 hour), 5 March 2014.
- [40] Dictionary learning: Independence, structured sparsity and beyond. Gatsby Unit, UCL, presentation (45 minutes), 23 April 2013.
- [41] Dictionary optimization problems and their applications. Eötvös Loránd University, Day of Science, presentation (40 minutes), 22 November 2012.
- [42] Recommender systems, applications in education. Child's Play with Adult's Mind, Conference, Budapest University of Technology and Economics, presentation, 22 March 2012.
- [43] Collaborative filtering via group-structured dictionary learning. Eötvös Loránd University, Innovation Day, poster, 23 February 2012.
- [44] Beyond independent subspace analysis. INRIA, SIERRA project-team, presentation (90 minutes), 17 January 2012.
- [45] Hedging with Lasso. Morgan Stanley, presentation, 9 September 2011.
- [46] Interpreting natural language: applications of group-structured dictionary learning. Eötvös Loránd University, Faculty of Informatics, Neumann's Day, poster, 12 May 2011.
- [47] Interpreting words: an application of (structured) sparse coding. Eötvös Loránd University, Faculty of Informatics, Neumann's Day, poster, 12 May 2011.
- [48] Online group-structured dictionary learning. Eötvös Loránd University, Faculty of Informatics, Neumann's Day, poster, 12 May 2011.
- [49] Structured sparsity and non-convex sparsity-inducing methods. Morgan Stanley, presentation, 9 May 2011.
- [50] Online group-structured dictionary learning. Eötvös Loránd University, TÁMOP Research Seminar, presentation, 28 January 2011.
- [51] Online group-structured dictionary learning. Machine Learning at Budapest, presentation, 22 November 2010.
- [52] Online structured dictionary learning and its applications. Eötvös Loránd University, Problem Solving Seminar for Applied Mathematicians, presentation, 5 November 2010.
- [53] Nonparametric regression, Lasso. Eötvös Loránd University, Problem Solving Seminar for Applied Mathematicians, presentation, 12 November 2009.
- [54] Analysis and prediction of time series with missing data. Morgan Stanley, Speaker Series Event, presentation, 9 October 2009.
- [55] Analysis and prediction of time series with missing data. Morgan Stanley - BME Financial Innovation Centre Kick-off & Workshop, presentation, 15 June 2009.
- [56] Independent subspace analysis; tensor-SVD, tensorfaces; blind subspace deconvolution. Eötvös Loránd University, Problem Solving Seminar for Applied Mathematicians, presentation, 19 October 2007.
- [57] Exploration of behavioral patterns and its applications in human-computer interaction. Info Savaria (Szombathely), presentation, 14-16 April 2005.
- [58] Recognition of behavioral patterns and its potentials of human-computer interaction. Info ÉRA (Békéscsaba), presentation, 14-16 April 2004.

- [59] Adaptive human-computer interaction via face and gaze tracking. Eötvös Loránd University, Faculty of Informatics, Neumann's Day, presentation, 6 November 2003.

## Technical Reports

- [1] Zoltán Szabó and Bharath Sriperumbudur. Characteristic and universal tensor product kernels. Technical report, 2017. (<http://arxiv.org/abs/1708.08157>).
- [2] András Lőrincz, Viktor Gyenes, Zsolt Palotai, Balázs Pintér, Zoltán Szabó, and Gyula Vörös. Innovation engine for blogspaces (EOARD - US Air Force Research Laboratories). Technical report, Eötvös Loránd University, Budapest, 2011. (<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA550367>).
- [3] Zoltán Szabó. Towards nonstationary, nonparametric independent process analysis with unknown source component dimensions. Technical report, Eötvös Loránd University, Budapest, 2010. (<http://arxiv.org/abs/1008.1393>).
- [4] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Separation theorem for  $\mathbb{K}$ -independent subspace analysis with sufficient conditions. Technical report, Eötvös Loránd University, Budapest, 2006. (<http://arxiv.org/abs/math.ST/0608100>).
- [5] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Separation theorem for independent subspace analysis with sufficient conditions. Technical report, Eötvös Loránd University, Budapest, 2006. (<http://arxiv.org/abs/math.ST/0603535>).
- [6] Zoltán Szabó, Barnabás Póczos, and András Lőrincz. Separation theorem for independent subspace analysis. Technical report, Eötvös Loránd University, Budapest, 2005. ([http://www.gatsby.ucl.ac.uk/~szabo/publications/szabo05separation\\_TR.pdf](http://www.gatsby.ucl.ac.uk/~szabo/publications/szabo05separation_TR.pdf)).
- [7] Zoltán Szabó and András Lőrincz.  $L_1$  regularization is better than  $L_2$  for learning and predicting chaotic systems. Technical report, Eötvös Loránd University, Budapest, 2004. (<http://arxiv.org/abs/cs/0410015>).

## Theses

- [1] Zoltán Szabó. *Group-Structured and Independent Subspace Based Dictionary Learning*. PhD thesis, Eötvös Loránd University, Budapest, 2012.
- [2] Zoltán Szabó. *Separation Principles in Independent Process Analysis*. PhD thesis, Eötvös Loránd University, Budapest, 2009.
- [3] Zoltán Szabó. Retina based sampling in face component recognition. Master's thesis, Eötvös Loránd University, Budapest, 2003.

## Education

Eötvös Loránd University, Budapest, Hungary

School of Computer Science

Department of Software Technology and Methodology

Ph.D. (Computer Science; summa cum laude) 2009

Ph.D. Candidate (Computer Science) 2008–2009

Department of Information Systems

Ph.D. Student (Computer Science) 2004–2007

Faculty of Natural Sciences, Applied Mathematics

Ph.D. (summa cum laude) 2012

Ph.D. Candidate 2009–2012

Ph.D. Student 2003–2006

## Teaching Experience (g–graduate, u–undergraduate)

### Lecturing

Structured Data: Learning, Prediction, <u>Dependency</u> , <u>Testing</u> (g) (with Prof. Florence d'Alché-Buc, Prof. Slim Essid)	Spring, 2018
Statistical Models in Biology and Physics (g)	Spring, 2018
Advanced Machine Learning (MSc Big Data For Business - X/HEC) (g) (with Prof. Erwan Le Pennec, Prof. Stéphane Canu)	Spring, 2018
Structured Data: Learning, Prediction, <u>Dependency</u> , <u>Testing</u> (g; ca. 95 students) (with Prof. Florence d'Alché-Buc, Prof. Slim Essid, Prof. Arthur Tenenhaus)	Spring, 2017
Functional Data Analysis (g; special course)	Fall, 2016
Advanced Topics in Machine Learning - Theory of RKHS (g; ca. 60 students) (with Prof. Arthur Gretton, Kacper Chwialkowski)	Spring, 2015–2016
Adaptive Modelling, Introduction to Kernel Methods (g; ca. 20 students) (with Prof. Arthur Gretton, Heiko Strathmann, Wittawat Jitkrittum)	Spring, 2015–2016
Reinforcement Learning (g; ca. 45 students in each semester) (joint lecturing with Prof. András Lőrincz)	Spring, 2009–2013
Artificial Neural Networks (g; ca. 45 students in each semester) (joint lecturing with Prof. András Lőrincz)	Fall, 2008–2012
Image Processing, Speech Recognition, Applications of Artificial Intelligence (g; ca. 25 students in each semester)	2007–2008
Introduction to Mathematics (u; ca. 25 students in each semester)	2006–2007
Symbolic Programming (u; ca. 25 students in each semester)	2004–2006

### Grant

A postdoc/1 year @ Labex DigiCosme (joint work with Prof. Florence d'Alché-Buc, Prof. Arthur Tenenhaus)	2017
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### Memberships

Member of the PASCAL2 Network of Excellence	2008–2013
Member of the John von Neumann Computer Society	2007–2013

### Projects (Eötvös Loránd University)

EIT ICT Labs (dictionary learning, structured sparse methods, kernel techniques):	2013
<ul style="list-style-type: none"> <li>• Playful Learning on the Cloud</li> <li>• Travel Dashboard</li> <li>• Computers as Social Actors</li> <li>• Medical Cyber-Physical Systems</li> </ul>	
EuroSurge (EU FP7; natural language processing, structured sparsity, recommender systems)	2012–2013
U.S. Air Force (Innovation Engine for Blogspaces; natural language processing, structured sparsity, dictionary learning)	2007–2011

Morgan Stanley (financial time series: prediction, hedging)	2008–2011
KMOP (constrained local models)	2011
TÁMOP (recommender systems)	2010–2012
Archi-Data (financial time series: prediction)	2009–2011
PERCEPT (Perceptual Consciousness - Explication and Testing; EU FP6; infomax identification)	2007–2010

## Academic Honors, Awards

Bronze Medal of the Pro Patria et Scientia Award of Hungarian Ph.D. Students	2008
Scientist of the Year Award of the School of Computer Science	2007
Outstanding Student Award of the Faculty of Natural Sciences	2003

## Scholarships

Scholarship of the John von Neumann Computer Society (intelligent systems)	2005–2012
Scholarship of the Bliss Foundation	2004
Scholarship of the Eötvös Loránd University	2003

## Other Services

### Mentoring

#### PostDoc:

László Jeni (Carnegie Mellon University), Topic: Extensions of Constrained Local Models, Facial Expression Recognition.	2011–2013
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#### Ph.D.:

Balázs Pintér, Gyula Vörös, Topic: Structured-Sparse Coding and Dictionary Learning in Natural Language Processing.	2011–2013
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#### M.Sc.:

Máté Csákvári, Zoltán Tóser, Topic: Educational Games (Information Theory, Dictionary Learning).	2012–2013
András Sárkány, Topic: Hedging via Sparse Coding.	2011–2013

#### Problem Solving Seminar for Applied Mathematicians:

Gergő Hammer, Topic: Self-Similar Structures for Financial Prediction.	2011 Autumn – 2012 Spring
Mária Mészáros, Dávid Retek, Topic: Online Structured Dictionary Learning and Its Applications.	2009 Autumn – 2010 Spring
Kitti Korbács, Nóra Villányi, Gabriella Merész, Topic: Tensor Textures.	2007 Autumn – 2008 Spring
Kata Péter, Anikó Márton, Topic: Temporal Independent Subspace Analysis of Facial Features.	2007 Autumn – 2008 Spring

### Supervision

Gabriella Merész (M.Sc., Applied Mathematician), Topic: Prediction of Financial Time Series via ARMA-GARCH Methods.	2012
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### Co-supervision with Prof. András Lőrincz of the national student competitor

Zoltán Milacski (M.Sc., 2 <sup>nd</sup> prize), Topic: Recurrent Reinforcement Learning in High-Frequency Algorithmic	2012–2013
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Trading.

### Thesis Reviewing

Gábor Matuz (M.Sc.), Budapest University of Technology and Economics, 2010  
Title: Adaptive Algorithms in Multiagent Environments.  
Kornél Kovács (Ph.D.), University of Szeged, 2008  
Title: Various Kernel Methods with Applications.

### Reviewing (Scientific Competitions) – Computer Science

Hungarian National Scientific Student Competition and Conference 2013  
Scientific Student Competition and Conference 2012  
Hungarian National Scientific Student Competition and Conference 2005

### Competition and Problem Solving Seminar During M.Sc.

#### Scientific Student Competition and Conference:

Localization of Facial Components via Retina Based Sampling ( $2^{nd}$  prize) 2002  
Supervisor: Botond Szatmáry.

#### Problem Solving Seminar for Applied Mathematicians:

Skin Detection Algorithms, 2001 Autumn – 2002 Spring  
Supervisor: Prof. András Lőrincz.

### Languages

- English (fluent), Spanish (basic), Hungarian (native).
- Programming languages: Matlab/Octave, Python, Maple, L<sup>A</sup>T<sub>E</sub>X, HTML.