Ivan S. Klyuzhin, PhD

Curriculum vitae

Postdoctoral Research Fellow
Department of Medicine, Division of Neurology
University of British Columbia
Vancouver, BC, Canada

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AREAS OF SPECIALIZATION

Medical image analysis, Image reconstruction, Quantitative nuclear imaging, Image denoising and enhancement, Predictive models of disease progression, Feature selection, Regularized regression, Dimensionality reduction, Artificial neural networks, Neural pathways, Functional brain patterns, Parkinson's disease, Neurodegeneration.

EDUCATION

Doctor of Philosophy February 2017
Physics (Medical Physics)
Department of Physics and Astronomy, University of British Columbia, Vancouver, BC, Canada
Thesis: Deformable motion correction and spatial image analysis in positron emission tomography
Available at: https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0340673

Bachelor's/Master's of Science Combined July 2006
Physics (Medical Physics)
Department of Physics, Ural Federal University (Ural State University), Yekaterinburg, Russia
Department of Bioengineering, University of Washington, Seattle, WA, USA

Minor degree May 2005
Technical translation (English)
Department of Linguistics, Ural Federal University, Yekaterinburg, Russia

PROFESSIONAL EXPERIENCE

University of British Columbia, Vancouver, BC

Department of Medicine, Division of Neurology 03/2017 – current
Postdoctoral research fellow

- Initiated and led several research projects that focused machine-learning based image analysis and enhancement: sparse regularized regression using PCA and LASSO, feature selection using generative disease models, 4D image enhancement using a deep autoencoder.
- Authored or co-authored multiple peer-reviewed publications and conference presentations.
- Regularly interacted with physicians to bring state-of-the-art image analysis methods into clinical research.
- Interviewed and supervised co-op students and interns; oversaw progress and future work planning.
- Implemented effective time management and task management practices.
- Contributed to multiple within-institutional and international collaborations and discussions.
- Co-authored a successful application for grant extension.

Department of Physics and Astronomy 01/2010 — 02/2017
PhD student, Research/teaching assistant

- Developed a new algorithm for 3D image reconstruction using unorganized point clouds with Voronoi call basis functions.
- Investigated the ability of depth-sensing cameras to track motion of small laboratory animals.
- Developed algorithms to denoise depth data (flicker artifact removal, missing patch imputation).
- Developed a pipeline to generate animated, deformable digital phantoms of rodents and other small animals.
- Pioneered application of texture and shape-based spatial image analyses in Brain PET imaging.
- Authored or co-authored original research articles that were published in top journals in the field (IEEE TMI, JCBFM, Neuroimage).
- 3 years of teaching assistant experience, including two courses as head teaching assistant.

MetaOptima Technology Inc., Vancouver, BC 01/2014 – 09/2015
Research and development project manager

- Led company's effort in developing image analysis algorithms and 3D visualization tools.
- Developed a robust strategy for internal validation and testing of in-house developed algorithms.
- Managed several ongoing R&D efforts: image-based search, similar image search and retrieveal, image registration, shadow removal, artefact removal, contrast enhancement, object segmentation, and others.
- Planned and coordinated regular R&D meetings with focus on clear timelines and measurable outcomes.
- Interacted with front-end and back-end development teams to implement R&D solutions in the market-ready product.
- Advised the CEO/CTO on the benefits and risks associated with investing resources into R&D of a particular technological capability.
- Interviewed job applicants for the R&D engineer position.
- Presented company's research at international scientific conferences.
- Developed successful grant and fellowship applications.

University of Washington, Seattle, WA 08/2005 – 09/2009
Department of Bioengineering
Visiting scientist

- Developed and tested a novel microfluidic device for water purification: brought an experimental concept to a proof-of-principle prototype.
- Engineered and constructed an experimental video-tracking apparatus with integrated, programmable digital controller.
- Developed a solution characterization pipeline that included several analytical chemistry and material science techniques: osmometry, UV-VIS spectroscopy, ICP-mass spectrometry, fluorescent/optical/confocal microscopy, turbidity analysis, infrared imaging.
- Developed a new technique to synthesize micrometer-size polymer gels.
- Supervised a team of undergraduate students.

AWARDS AND ACHIEVEMENTS

- 1st Place poster presentation award, Postdoctoral research day, University of British Columbia Postdoctoral Association, 2018 (Poster title), Vancouver, BC, Canada
  ('Use of a 4D Deep Autoencoder to Denoise Dynamic PET Data')
- IEEE Medical Imaging Conference trainee awards (refereed) (2011, 2012, 2014, 2015)
- Featured poster, IEEE Medical Imaging Conference, 2015, San Diego, CA, USA
  ('Development of a Digital Unrestrained Mouse Phantom with Non-Periodic Deformable Motion')
- 2nd Place poster award in Data analysis and Management, Society of Nuclear Medicine and Molecular Imaging Annual Meeting, 2013, Vancouver, BC, Canada
  ('Investigating the effect of inter-modality ROI shape on the correlation between clinical and image-derived data in PET studies of Parkinson's disease')

- University of British Columbia graduate award (2010-2014), Vancouver, BC, Canada
- Izakov's Award for Outstanding Student Work in the Field of Biological and Medical Physics (2004), Ural State University, Yekaterinburg, Russia

CO-AUTHORED GRANT APPLICATIONS (FUNDED)

Michael J. Fox Foundation grant 09/2017 – 12/2017
Novel quantification paradigm in Parkinson's disease neurochemical imaging:
Application of deep learning techniques to DaTSCAN SPECT images to improve the prediction of early cognitive decline in Parkinson's disease.

Mitacs Accelerate Cluster fellowship 06/2014 – 09/2015
Dermoscopy imaging and automated analysis for skin cancer screening

NSERC Engage fellowship 01/2014 – 06/2014
An interactive 3D visualization tool for personalized, mobile-based system for skin cancer screening

COMMUNITY ENGAGEMENT AND SERVICE

Mentor 09/2018 – current
UBC Undergraduate research opportunities, Research EXperience (REX) program
Project title: Training of deep convolutional neural nets to extract radiomic signatures of tumors (pdf).

Paper reviewer 03/2017 – current
Journals: IEEE Transactions on Radiation and Plasma Medical Sciences, Neuroimage: Clinical, Nuclear Instrumentation Methods in Physics Research
Subjects: Deep learning-based image enhancement, imaging instrumentation design, radiomics, predictive models.

Abstract reviewer 04/2016
2016 World Molecular Imaging Congress, New York, NY, USA
Category: Computer Applications and Postprocessing.

Volunteer data scientist 01/2019 – current
Data for Good Vancouver
Provide pro bono data analytics services to registered charities, non-governmental and not-for-profit organizations.

TECHNICAL EXPERTISE

Languages: Matlab, Python, C/C++, Objective-C (iOS Application framework), JavaScript (beginner), HTML.
Major libraries and frameworks: Tensorflow, Keras, Numpy, OpenCV, Eigen, OpenGL, WebGL.
Other: Blender, LabView (beginner), Microsoft Kinect API, TEX/LATEX, ImageJ, Bash, AWS.

PUBLICATIONS

- Tang, J., Yang, B., Shenkov, N. N., Klyuzhin, I. S., Fotouhi, S., Davoodi-Bojd, E., Lu, L., Soltanian-Zadeh, H., Sossi, V., Rahmim, A. (2019). **Artificial neural network based prediction of outcome in Parkinson's disease patients using DaTscan SPECT imaging features**. Molecular Imaging and Biology, in press.
- Fu, J. F., Klyuzhin, I., Liu, S., Shahinfard, E., Vafai, N., McKenzie, J., ... Sossi, V. (2018). **Investigation of serotonergic Parkinson's disease-related covariance pattern using [11C]-DASB/PET**. NeuroImage: Clinical, 19, 652–660. https://doi.org/10.1016/j.nicl.2018.05.022
- Sossi, V., Cheng, J.-C., Klyuzhin, I. S. (2018). **Imaging in neurodegeneration: movement disorders**. IEEE Transactions on Radiation and Plasma Medical Sciences, 1–1. https://doi.org/10.1109/TRPMS.2018.2871760
- Klyuzhin, I. S., Fu, J. F., Hong, A., Sacheli, M., Shenkov, N., Matarazzo, M., ... Sossi, V. (2018). **Data-driven, voxel-based analysis of brain PET images: Application of PCA and LASSO methods to visualize and quantify patterns of neurodegeneration**. PloS One, 13(11), e0206607. https://doi.org/10.1371/journal.pone.0206607
- Klyuzhin, I. S., Fu, J. F., Shenkov, N., Rahmim, A., Sossi, V. (2018). **Use of Generative Disease Models for Analysis and Selection of Radiomic Features in PET**. IEEE Transactions on Radiation and Plasma Medical Sciences, 1–1. https://doi.org/10.1109/TRPMS.2018.2844171
- Klyuzhin, I. S., Sossi, V. (2017). **PET Image Reconstruction and Deformable Motion Correction Using Unorganized Point Clouds**. IEEE Transactions on Medical Imaging, 36(6), 1263–1275. https://doi.org/10.1109/TMI.2017.2675989
- Klyuzhin, I. S., Gonzalez, M., Shahinfard, E., Vafai, N., Sossi, V. (2016). **Exploring the use of shape and texture descriptors of positron emission tomography tracer distribution in imaging studies of neurodegenerative disease**. Journal of Cerebral Blood Flow and Metabolism, 36(6), 1122–1134. https://doi.org/10.1177/0271678X15606718
- Rahmim, A., Salimpour, Y., Jain, S., Blinder, S. A. L., Klyuzhin, I. S., Smith, G. S., ... Sossi, V. (2016). **Application of texture analysis to DAT SPECT imaging: Relationship to clinical assessments**. NeuroImage: Clinical, 12, e1–e9. https://doi.org/10.1016/j.nicl.2016.02.012
- O'Rourke, C., Klyuzhin, I., Park, J. S., Pollack, G. H. (2011). **Unexpected water flow through Nafion-tube punctures**. Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 83(5). https://doi.org/10.1103/PhysRevE.83.056305
- Klyuzhin, I. S., Ienna, F., Roeder, B., Wexler, A., Pollack, G. H. (2010). **Persisting water droplets on water surfaces**. Journal of Physical Chemistry B, 114(44), 14020–14027. https://doi.org/10.1021/jp106899k
- Klyuzhin, I., Symonds, A., Magula, J., Pollack, G. H. (2008). **New method of water purification based on the particle-exclusion phenomenon**. Environmental Science and Technology, 42(16), 6160–6166. https://doi.org/10.1021/es703159q
- Shklyar, T. F., Safronov, A. P., Klyuzhin, I. S., Pollack, G., Blyakhman, F. A. (2008). **A correlation between mechanical and electrical properties of the synthetic hydrogel chosen as an experimental model of cytoskeleton**. Biophysics, 53(6), 544–549. https://doi.org/10.1134/S0006350908060146

CONFERENCE PRESENTATIONS

– **2018**

- I. S. Klyuzhin, J.-C. Cheng, C. Bevington, V. Sossi, **Use of a 4D Deep Autoencoder to Denoise Dynamic PET Data**, 2018 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Sydney, Australia, 2018.
- J.-C. Cheng, C. W. J. Bevington, A. Rahmim, I. S. Klyuzhin, J. Matthews, R. Boellaard, V. Sossi, **Dynamic PET reconstruction utilizing a spatiotemporal 4D de-noising kernel**, 2018 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Sydney, Australia, 2018.
- C. W. J. Bevington, J.-C. Cheng, I. S. Klyuzhin, V. Sossi, **De-noising and DA release: effect of denoising on the ability to identify voxel level neurophysiological response**, 2018 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Sydney, Australia, 2018.
- M. R. Salmanpour, M. Shamsaee, A. Saberi Manesh, S. Setayeshi, E. Taherinezhad, I. S. Klyuzhin, J. Tang, V. Sossi, A. Rahmim, **Machine learning methods for optimal prediction of outcome in Parkinson's disease**, 2018 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Sydney, Australia, 2018.
- K. H. Leung, M. R. Salmanpour, A. S. Manesh, I. S. Klyuzhin, V. Sossi, A. K. Jha, M. G. Pomper, Y. Du, A. Rahmim, **Using deep-learning to predict outcome of patients with Parkinson's disease**, 2018 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Sydney, Australia, 2018.
- J. Fu, I. Klyzhin, E. Shahinfard, J. Mckenzie, N. Neilson, T. Baumeise, S. McCormick, J.-C. Cheng, A. Felicio, M. McKeown, A. J. Stoessl, V. Sossi, **Clinical Correlates of Complementary Spatial Patterns in [11]C-DTBZ, [11]C-MP, [11]C-RAC, and [11]C-DASB PET Images Revealed by Multiset Canonical Correlation Analysis in Parkinson's Disease**, Proc. Intl. Symp. on Functional Neuroreceptor Mapping of the Living Brain (NRM), London, UK, July 2018.
- I. S. Klyuzhin, N. Shenkov, A. Rahmim, V. Sossi, **Use of deep convolutional neural networks to predict Parkinson's disease progression from DaTscan SPECT images**, Society of Nuclear Medicine and Molecular Imaging Annual Meeting, Philadelphia, PA, USA; J. Nucl. Med., vol. 59 (suppl. 1): 29, 2018.

– **2017**

- I. Klyuzhin, N. Vafai, E. Shahinfard, V. Sossi, **The impact of parameter bound selection in the simplified reference tissue method on the accuracy and quality of parametric images**, 2017 Society of Nuclear Medicine and Molecular Imaging Annual Meeting, Denver, CO, USA; J Nucl Med.,vol. 58 (suppl. 1): 359, 2017.
- N. Shenkov, I. Klyuzhin, S. Fotouhi, E. Davoodi-Bojd, H. Soltanian-Zadeh, A. Rahmim, V. Sossi, **A metric to quantify DaTSCAN tracer uptake in subjects with Parkinson's disease computed without MRI-based regions of interest**, 2017 Society of Nuclear Medicine and Molecular Imaging Annual Meeting, Denver, CO, USA; J. Nucl. Med., vol. 58 (suppl. 1): 291, 2017.
- I. Klyuzhin, J. Fu, N. Shenkov, N. Vafai, E. Shahinfard, J. McKenzie, N. Neilson, K. Dinelle, M. Sacheli, J. Stoessl, A. Rahmim, V. Sossi, **Striatal Neurodegeneration Patterns in Parkinson's Disease Identified using PET Imaging and PCA**, 2017 Organization of Human Brain Mapping Annual Meeting, Vancouver, BC, Canada.
- J. Fu, I. Klyuzhin, S. Liu, E. Shahinfard, N. Vafai, N. Heffernan, J. Mckenzie, M. Sacheli, H. F. Wehrl, M. J. McKeown, A. J. Stoessl, V. Sossi, **Altered Serotonergic Network Connectivity in Parkinson's Disease and LRRK2 Mutation Subjects**, 2017 Organization of Human Brain Mapping Annual Meeting, Vancouver, BC, Canada.
- I. Klyuzhin, M. Sacheli, N. Vafai, E. Shahinfard, B. Lakhani, J. Neva, J. Fu, J. McKenzie, N. Neilson, K. Dinelle, L. Boyd, A. Stoessl, V. Sossi, **Correlation analysis between dopamine release in striatal sub-regions and motor impairment in Parkinson's disease subjects**, 2017 International Congress

of Parkinson's Disease and Movement Disorders, Vancouver, BC, Canada; Mov Disord. 2017; 32 (suppl 2).

- N. Shenkov, I. Klyuzhin, A. Rahmim, V. Sossi, **A neuroimaging-based model for disease progression in Parkinson's disease**, 2017 International Congress of Parkinson's Disease and Movement Disorders, Vancouver, BC, Canada; Mov Disord. 2017; 32 (suppl 2).

– **2016**

- M. A. Sacheli, B. Lakhani, J. L. Neva, D. K. Murray, N. Vafai, J. McKenzie, N. Neilson, K. Dinelle, I. S. Klyuzhin, L. A. Boyd, V. Sossi, A. J. Stoessl, **Aerobic exercise can induce dopamine release in Parkinson's disease: [11C]Raclopride PET study**, 2016 Neuroscience Meeting, Program No. 415.28. San Diego, CA: Society for Neuroscience, Nov 14, 2016.
- I. Klyuzhin, J. Fu, N. Shenkov, A. Rahmim, V. Sossi, **Sub-regional pattern analysis of heterogeneous PET tracer distribution employed for disease assessment**, 2016 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, Strasbourg, France, Nov 2, 2016.
- I. Klyuzhin, V. Sossi, **Nuclear Emission-based Imaging in the Study of Brain Function**, Fall Meeting of the APS Division of Nuclear Physics, Vancouver, BC, Oct 16, 2016.
- J. Fu, N. Vafai, E. Shahinfard, N. M. Neilson, J. Mckenzie, R. Mabrouk, I. Klyuzhin, A. J. Stoessl, V. Sossi, **Investigation of Parkinson's Disease Related Covariance Pattern in the Serotonergic System using [11C]-DASB/PET**, Proc. Intl. Symp. on Functional Neuroreceptor Mapping of the Living Brain (NRM), Boston, MA, Jul 15, 2016.
- R. Mabrouk, I. Klyuzhin, E. Shahinfard, N. Vafai, J. Fu, S. Blinder, M. Walker, A. Rahmim, V. Sossi, **Exploring feature-based approaches to assess neuroinflammation in patients with Parkinson's disease: a PBR28 PET imaging study**, Proc. Intl. Symp. on Functional Neuroreceptor Mapping of the Living Brain (NRM), Boston, MA, Jul 14, 2016.
- A. Rahmim, Y. Salimpour, S. Jain, S. Blinder, I. Klyuzhin, G. Smith, Z. Mari, and V. Sossi, **Application of texture analysis to DaTscan images for enhanced assessment of progression in Parkinson's disease**, Annual Meeting of the Society of Nuclear Medicine and Molecular Imaging (SNMMI), San Diego, CA, Jun 11-15, 2016.
- A. Rahmim, Y. Salimpour, S. Blinder, I. Klyuzhin, V. Sossi, **Optimized Haralick texture quantification to track Parkinson's disease progression from DAT SPECT images**, Annual Meeting of the Society of Nuclear Medicine and Molecular Imaging (SNMMI), San Diego, CA, Jun 11-15, 2016.

– **2015**

- I. Klyuzhin, G. Stortz, V. Sossi, **Development of a Digital Unrestrained Mouse Phantom with Non-Periodic Deformable Motion**, 2015 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, San Diego, CA, Nov 6, 2015.
- I. S. Klyuzhin, S. Blinder, R. Mabrouk, A. Rahmim, V. Sossi, **Investigation of Texture Quantification Parameters for Neurological PET Image Analysis**, 2015 IEEE Nuclear Science Symposium and Medical Imaging (NSS/MIC) Conference Record, San Diego, CA, Nov 4, 2015.
- I. Klyuzhin, M. Sadeghi, V. Sossi, M. S. Atkins, **Comparison of the spatial heterogeneity features for classification of dermoscopic lesion images**, World Dermatology Congress, Vancouver, BC, Jun 6, 2015.
- I. Klyuzhin, M. Razmara, N. Hazar, V. Sossi, M. Sadeghi, **Feasibility of using 3D body visualization on smartphones for personalized mapping of skin lesions**, World Dermatology Congress, Vancouver, BC, Jun 8, 2015.
- A. Benam, M. Sadeghi, I. S. Klyuzhin, M. S. Atkins, **A hybrid color and structure analysis for automated detection of arborising vessels in dermoscopy images**, World Dermatology Congress, Vancouver, BC, Jun 8, 2015.
- I. Klyuzhin, M. Sadeghi, V. Sossi, M. S. Atkins, **Evaluation of methods to quantify color non-uniformity in dermoscopic images**, World Dermoscopy Congress, Vienna, Apr 16, 2015.

- A. Benam, M. Sadeghi, I. Klyuzhin, M. S. Atkins, **DermSocial: Dermoscopy made social: a mobile and web tool for dermoscopy training and practice**, World Dermoscopy Congress, Vienna, April 16, 2015.
- I. Klyuzhin, M. Sadeghi, S. Atkins, V. Sossi, **Using Moment Invariants as Measures of Lesion Color Asymmetry**, 2015 American Academy of Dermatology Annual Meeting, San Francisco, CA, May 8, 2015.

– **2014**

- G. Stortz, M. D. Walker, I. Klyuzhin, V. Sossi, **Advanced Arc Correction to Improve Sinogram Consistency and Increase Contrast in Analytic and Statistical PET Reconstruction**, 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Seattle, WA, Nov 8, 2014.
- I. S. Klyuzhin, E. Shahinfard, M. Gonzalez, V. Sossi, **Feasibility of Using Geometric Descriptors of Tracer Distribution for Disease Assessment**, 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Seattle, WA, Nov 8, 2014.
- S. A. L. Blinder, I. Klyuzhin, M. E. Gonzalez, A. Rahmim, V. Sossi, **Texture and Shape Analysis on High and Low Spatial Resolution Emission Images**, 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Seattle, WA, Nov 8, 2014.
- I. S. Klyuzhin, G. Stortz, V. Sossi, **PET Image Reconstruction with Correction for Non-periodic Deformable Motion**, 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Seattle, WA, Nov 8, 2014.

– **2013 and earlier**

- I. Klyuzhin, M. Gonzalez, V. Sossi, **Investigating the effect of inter-modality ROI shape on the correlation between clinical and image-derived data in PET studies of Parkinson's disease**, Annual Meeting of the Society of Nuclear Medicine and Molecular Imaging (SNMMI), Vancouver, BC, May 1, 2013.
- I.S. Klyuzhin, M. Gonzalez, V. Sossi, **Fully-Automated Segmentation of the Striatum in the PET/MR Images Using Data Fusion**, 2012 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Anaheim, CA, Oct 27, 2012.
- I. S. Klyuzhin, K. Dinelle, V. Sossi, **PET Image Reconstruction and Motion Correction using Direct Backprojection on Point Grids and Clouds**, 2011 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC) Record, Valencia, Spain, Oct 23, 2011.
- I. S. Klyuzhin, V. Sossi, **PET Image Reconstruction Using Point-Based Filtered Backprojection**, 2011 Joint AAPM/COMP Meeting, Vancouver, BC, Jul 31, 2011.
- B. Chai, I. Klyuzhin, L. Marshall, K. Nagornyak, K. Ovchinnikova, R. Stahlberg, A. Wexler, H. Yoo, Q. Zhao, G. H. Pollack, **Unexpectedly critical role of hydrophilic surfaces on nearby water**, 3rd Annual Conference on the Physics, Chemistry and Biology of Water, West Dover, VT, Oct 16, 2008.
- B. Chai, I. S. Klyuzhin, L. Marshall, K. Nagornyak, K. Ovchinnikova, R. Stahlberg, A. Wexler, H. Yoo, Q. Zhao, G. H. Pollack, **Long-range water Structuring at Hydrophilic Interfaces**, Third Annual Conference on the Physics, Chemistry and Biology of Water, West Dover, VT, Oct 16, 2008.
- F. Blyakhman, I. Klyuzhin, G. Pollack, A. Safronov, T. Shklyar, **Possible role of the cytoskeleton in creating the cell's electrochemical potential: a synthetic gel model**, 4th world Congress of Cellular and Molecular Biology, Poitiers, France, October 07 – 12, 2005.