IVAN NAZAROV

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EDUCATION

Skolkovo Institue of Science and Technology, CDISE *November 2020*
PhD. studies, Applied Mathematics, Computer Science and Engineering.

National Research University Higher School of Economics *June 2016*
MSc., Applied Mathematics and Information Science. Fields: Data science

National Research University Higher School of Economics *June 2007*
BSc., Economics. Fields: Mathematical methods of analysis in Economics

PROJECT AND ACADEMIC EXPERIENCE

Artificial Intelligence Research Institute September 2021 - Present
Research Fellow *Moscow*

· **Reinforcement Learning Research 2021/09-present** Research topics include adaptive computation in deep networks with applications to hierarchical RL, skill discovery and learning hierarchical policies in reinforcement learning. Collaboration on the project related manager-worker communications for goal-conditioned policies in RL.

- presentations and consultaion on the topics of options discovery, planning and MCTS, inverse dynamics models for feature representation and intrinsic motivation
- proposing hypotheses and experimental setups for testing existing approaches and combinations thereof on Minigrid, ATARI, MiniHack and Nethack environments
- implementation and development of tools,[1] small frameworks,[2] and recurrent transformer architectures (Nethack), vector-quantized VAEs for manager-worker communication (ATARI, Minigrid)

· **NetHack challenge 2021/09-2021/11** Active participation and development of the winning solution "Raph" for the NetHack Challenge at the the 2021 NeurIPS competition track. The solution featured a skill-based reinforcement learning agent, which used options approach to hierarchical RL and combined both algorithmic and neural policies.

- implementation of diagnostic toolbox for debugging the solution[3]
- in-depth study of the Nethack's inner-workings, peculiarities and documentation in order to simplify the agent's interface and propose features for the neural policy

[1] https://github.com/ivannz/plyr
[2] https://github.com/ivannz/nle_toolbox
[3] https://github.com/ivannz/nle_toolbox

- optimization of the algorithmic backend of the solution, including data representation and shortest path algorithms
- writing a short report, which outlines the structure of the solution and the motivation for the use of hardcoded algorithmic policies

Sberbank, AI Lab December 2020 - September 2021
Senior ML Researcher *Moscow*

· **Technical research report 2020/12-2021/09** Research and methodological support and consultation for developing a method for remote diagnostics of respiratory illnesses using audio recordings of respiratory sounds (breath and cough)

- development of bootstrap-based method for evaluation of performance in counterfactual setting
- preparation of extensive literature review of machine learning of audio data at the intersection with medical applications
- writing and editing introduction, borader impact, review, and methodology sections of the paper

Skoltech, CDISE September 2016 - November 2020
ML Researcher / PhD. student *Moscow*

· **Project customers** include *Sberbank, Huawei, Bosch, Datadvance, and Airbus.*

· **Research paper 2020/08 - present**: Research into deep neural network pruning based on the second-order information. Derivation and study of fast procedures for forward and backward greedy pruning based on the Optimal Brain Surgeon and related methods.

- Full cycle design, validation and implementation of the method with supporting functionality for implicit Hessian-vector access[4]
- Extensive research into the sub-optimality guarantees for approximate solutions of combinatorial search problems and their relation to the proposed procedure

· **Research paper 2020/05 - present**: Research into ways to extend the Deep Weight Prior beyond independent kernel-slice assumption[5]

- Development and documentation of the core architecture for the full pipeline for experimentation and reporting
- Numerically stable implementation of the Tensor-Ring Induced Prior[6]
- Extensive experimentation with the implicit priors and gradient estimators needed them (IWAE, SGVB)

[4] `https://github.com/ivannz/BrainSurgeon`
[5] `https://arxiv.org/abs/1810.06943`
[6] `https://arxiv.org/abs/1910.13148`

- **Research paper 2019/11 - 2020/06**: Research into Bayesian methods for sparsification of complex-valued neural networks. Implementation of complex-valued neural networks extension to pytorch, with seamless integration onto existing experimental pipelines.
  - Full cycle design, validation and implementation of the complex-valued tensor extension to pytorch[7]
  - Extension of variational dropout and automatic relevance determination to complex-valued neural networks based on original research
  - Development of automated experimentation framework for the experiments, and extensive large scale experimentation and validation of the proposed technique
  - Findings published in the proceedings of and presented at ICML 2020
- **Project 2019/04 - 2019/09**: Research and experimentation on neural Digital Signal Predistortion for wireless radio frequency transmitters. Implementation of a custom torch-based large scale experimentation framework for rapid prototyping, fast verification and unified reporting.
  - Data investigation and analysis with large scale experiments
  - Research, development and analysis of alternative neural architectures
  - Presentation of the findings to the customer, research outcome negotiations
- **Project 2018/09 - 2018/12**: Development of a matrix factorization library with temporal regularization for demand and inventory forecasting.
  - Design, validation and implementation of various forecasting approaches
  - Data investigation, visualization and analysis
  - Preparation of relevant sections of the final report
  - Presentation of findings at various events (BigData Conference 2018)
- **Project 2018/05 - 2018/06**: Development of a library for inductive matrix completion with group-sparse regularizer.
  - Design, prototyping and implementation of a sparse group lasso regularized matrix completion library with side-channel information
  - Preparation of various section of a scientific paper detailing the algorithm and the findings on practical biomedical tasks
  - Publication of the findings in the Journal of *Computational Mathematics and Mathematical Physics*
- **Project 2018/04 - 2018/07**: Feasibility study and research for medium term oil price forecasting with advanced machine learning.

[7] `https://github.com/ivannz/cplxmodule`

- negotiations on the structure and content of the news stream from Thomson Reuters for neural event embedding model
- collection and selection of economic data for forecasting of multivariate oil price time series
- team and task scope management
- preparation of the final report and executive summary, and presentation of the findings
- extensive experimentation and forecasting using recurrent neural networks, classical time series and machine learning models

· **Project 2017/11 - 2017/12**: Estimation of the effects from the publication of weekly report from the US Department of Energy and contents therein on the intraday oil price futures dynamics.

- statement, design and implementation of the optimization problem for estimation of sparse event effects
- conducting numerical experiments
- composing the final report and presentation to the customer

· **Project 2017/09 - 2017/11**: Project on detection of anomalous road surface conditions on a spatially distributed dataset of micro-meteorological data.

- derivation and prototyping of an algorithm for decentralized machine learning for detection of thin ice layer on the surface of a tarmac
- development of routines for computing and extensive numerical experimentation with the goal to study the sensitivity to hyper-parameters and effects on detection properties
- preparation of the report with comparison of the decentralized solution against independent and centralized models in terms of prediction performance, computational resources and network traffic volumes

· **Project 2016/11 - 2017/05**: Design and validation of anticipatory binary signals for an early warning system in aerospace industry. Chief responsibilities:

- design and implementation of data processing pipeline on small scale AWS EC2 clusters over S3 data storage
- upgrade and optimization of the library module for selection of predictive binary signals
- data mining and feature analysis, design and execution of computational experiments
- presenting the results of data analysis and selected predictive signals to the client

IITP RAS, laboratory 10 September 2015 - September 2016
Researcher Intern *Moscow*

· **Project 2015/08 - 2016/09**: development of a statistical library for predictive maintenance and early warning systems with applications to aerospace industry. Chief responsibilities:

- analysis and solution of applied data analytic cases necessary to secure *TRL5* certification approval
- refactoring, design and development of the architecture and alternative interface of the library
- improvement and efficient implementation of select ML algorithms in the library
- preparing and conducting a comprehensive tutorial session on the usage of the library for the client

· **Project 2015/11 – 2016/06**: Collaboration on a library for long term economic forecasting and simulation for efficient economic planning in coal mining industry. Chief responsibilities:

- analysis, development and testing of the macroeconomic model
- design and implementation of an R package for the library
- preparation of comprehensive user manual for the package

· **Auxiliary projects**: Collaboration in research of the applicability of the state-of-the-art online learning algorithms to optimal portfolio composition problem for exchange traded funds. Responsibilities:

- implement online learning and expert aggregation algorithms
- design and conduct numerical simulation experiments
- prepare comprehensive reports on comparison study results

· **Master thesis** on *"Conformalized Multidimensional Linear Modelling and Anomaly Detection"* – a general distribution-free method for constructing confidence sets with valid statistical guarantees. Obtained evidence in favour of conformal confidence regions for kernel ridge regression in applied tasks, in part due to less restrictive assumptions. Achieved objectives:

- derived new formulae needed for a computationally efficient conformal prediction procedure for kernel ridge regression
- conducted an exhaustive simulation study aimed at comparing conformal confidence regions over nonlinear regression models against Bayesian intervals of Gaussian Process Regression
- proposed a non-parametric method for model selection on conformal predictions and a novel approach to novelty detection in unsupervised setting
- research paper published in proceedings of ICMLA 2016

Published or Accepted Papers

[1] I. Nazarov and E. Burnaev. Bayesian Sparsification of Deep C-valued Networks. In proc. of the 37th *International Conference on Machine Learning*, vol. 119, 7230-7242. PMLR 2020.

[2] I. Nazarov, B. Shirokikh, M. Burkina, G. Fedonin, and M. Panov. Sparse Group Inductive Matrix Completion. *Computational Mathematics and Mathematical Physics*, 61(2), 2021.

[3] E. Burnaev and I. Nazarov. Conformalized Kernel Ridge Regression. In *2016 15th IEEE International Conference on Machine Learning and Applications (ICMLA)*, pages 45–52, Dec. 2016. doi: 10.1109/ICMLA.2016.0017.

[4] D. Volkhonskiy, I. Nazarov, and E. Burnaev. Steganographic generative adversarial networks. In *Twelfth International Conference on Machine Vision (ICMV 2019)*, volume 11433, page 114333M. International Society for Optics and Photonics, Jan. 2020. doi: 10.1117/12.2559429.

[5] E. A. Sosnina, S. Sosnin, A. A. Nikitina, I. Nazarov, D. I. Osolodkin, and M. V. Fedorov. Recommender Systems in Antiviral Drug Discovery. *ACS Omega*, 5(25):15039–15051, June 2020. ISSN 2470-1343. doi: 10.1021/acsomega.0c00857. Publisher: American Chemical Society.

[6] R. Rivera, I. Nazarov, and E. Burnaev. Towards forecast techniques for business analysts of large commercial data sets using matrix factorization methods. *Journal of Physics: Conference Series*, 1117:012010, Nov. 2018. ISSN 1742-6596. doi: 10.1088/1742-6596/1117/1/012010. Publisher: IOP Publishing.

[7] R. Rivera-Castro, I. Nazarov, Y. Xiang, I. Maksimov, A. Pletnev, and E. Burnaev. An Industry Case of Large-Scale Demand Forecasting of Hierarchical Components. In *2019 18th IEEE International Conference On Machine Learning And Applications (ICMLA)*, pages 134–139, Dec. 2019. doi: 10.1109/ICMLA.2019.00029.

[8] R. Rivera-Castro, I. Nazarov, Y. Xiang, A. Pletneev, I. Maksimov, and E. Burnaev. Demand Forecasting Techniques for Build-to-Order Lean Manufacturing Supply Chains. In H. Lu, H. Tang, and Z. Wang, editors, *Advances in Neural Networks – ISNN 2019*, Lecture Notes in Computer Science, pages 213–222, Cham, 2019. Springer International Publishing. ISBN 978-3-030-22796-8. doi: 10.1007/978-3-030-22796-8_23.

[9] R. Rivera-Castro, A. Pletnev, P. Pilyugina, G. Diaz, I. Nazarov, W. Zhu, and E. Burnaev. Topology-Based Clusterwise Regression for User Segmentation and Demand Forecasting. In *2019 IEEE International Conference on Data Science and Advanced Analytics (DSAA)*, pages 326–336, Oct. 2019. doi: 10.1109/DSAA.2019.00048.

[10] V. Ishimtsev, A. Bernstein, E. Burnaev, and I. Nazarov. Conformal k-NN Anomaly Detector for Univariate Data Streams. In *Conformal and Probabilistic Prediction and Applications*, pages 213–227. PMLR, May 2017. ISSN: 2640-3498.

TEACHING EXPERIENCE

Teaching 2020/04 - 2020/05: Preparing and delivering practical tutorials on the software engineering tools for the course on Foundations of Data Science.

- Overcoming fear of Git version control and Github: overview of branch and commit manipulation with exercises on the typical everyday pipeline[8]
- Practical packaging in Python: setup script, package structure, and building python extensions[9]

Teaching 2019/08/26 - 2019/09/06: Volunteering and teaching at Machine Learning Summer School at Skoltech. Teaching activities include preparing and delivering a practical seminar on Bayesian Neural Networks, Uncertainty quantification and Active Learning [10]

[8] `https://github.com/ivannz/fds2020-git`

[9] `https://github.com/ivannz/fds2020-packaging`

[10] `http://bdl101.ml/`

Teaching 2019/06 - 2019/07: Preparation of a course on practical version control with Git, managing small-scale software development, useful devops practices, and principle approaches to architecture and design for software engineering tasks in machine learning and data science.

Teaching 2019/03: Preparation and teaching of three seminars covering the topics of classification and regression for Machine Learning further education course for Sberbank.

Teaching 2018/07, 2018/11: Preparation and teaching of four seminars covering the topics of classification (imbalanced and multi-class), anomaly detection and time series forecasting for the staff of Gazprom Neft.

Teaching 2018/02 - 2018/04: Teaching assistant on ML2018 course. Chief responsibilities included:

- preparation, verification and proof-reading of study materials (homeworks, exams)
- organization and team management, course content validation, deadline management
- communication and consultation on projects, assignments and exams

Teaching 2017/12: Preparation of a practical seminar on classification and multiclass meta-algorithms for extended education course on Machine Learning for Sberbank staff.

Teaching 2017/02 - 2017/04: Teaching assistant on ML2017 course. Responsibilities included grading the exam, consulting students on projects, and preparation of four seminars: on ensemble methods, on quadratic problems in support vector machines, and on elements of statistical learning.

WORK EXPERIENCE

GlowByte Consulting May 2013 - August 2015
Business analyst *Moscow*

· **Project 2014/03 - 2015/08**: design and implementation of business logic for database objects for a data warehousing solution during the migration of the accounting database and ledger of a top Russian bank to new corporate record management system

· **Project 2013/04 - 2014/02**: architect and lead developer of the statistical computations module for market simulations within a software complex for monitoring the financial market by the Central Bank of Russia

the Institute for Financial Studies January 2010 - April 2013
Junior Analyst *Moscow*

· Econometric studies, statistical estimation and design of mathematical models, scenario analysis, forecasting, visualization of data, interpretation and reporting of research results (in Eviews and R)

- Preparation of regular analytic commentaries on the current macroeconomic events
- Industry studies and analysis of economic trends for informed executive decision making
- Participation in the project on energy economics: "The present and the future of Gazprom and strategy of Russia as a major international gas supplier" (manuscript published under title "Gazprom: An Energy Giant and its Challenges in Europe", ISBN-13 978-1137461094)

Prepared analytic materials

1. "Transit of natural gas: the bargaining model" (Application of game theory to the issue of gas transit; "Economics and Mathematical methods", Issue 4, October – December 2010);
2. "Application of the extreme value theory to evaluation of market risk", 2010 (estimation of VAR and CVAR with GARCH-type models; for internal use);
3. "Exploration of latent volatility regimes in oil price dynamics", 2011 (Application of Markov Switching Autoregressive model; for internal use);
4. "Skill of luck: performance of open-ended mutual funds in Russia", 2012-2013 (estimation 4 factor CAPM model, and bootstrap simulation study; for internal use);
5. "Index of Financial Stress (Russia)", 2011-2012 (development of index's structure and calculation methodology);
6. A number of macroeconomic commentaries for the corporate website, 2010-2013 ("CBR can't handle the inflation", "Is the US going off the cliff?" etc.);
7. Shale gas in Pennsylvania, 2013 (Analysis of the current events and trends of the local gas industry; for internal use);
8. "Russian gas industry" and "Russian gas market" (two chapters in English of the monograph published in 2014).

ADDITIONAL INFORMATION AND SKILLS

Theoretical knowledge of and vast experience in solving practical problems in the field of data analysis and machine learning, and in application of numerical algorithms

Experience with architecture and design of advanced Python libraries, software development and release management, and proficiency in Git version control

Efficient solution of applied mathematical and statistical tasks, data analysis and design of numerical experiments in R and/or using the typical Python ML stack (numpy, scipy, matplotlib, scikit-learn)

Necessary skills for designing and developing an industry-grade solution for simulation modelling, statistical estimation, forecasting and analysis of financial time series

Abstract approach to design and problem solving, efficient data visualization and automated data collection

TECHNICAL STRENGTHS

Computer Languages	Python, SQL, C, R
Tools	GIT, LaTeX, MS Office, Eviews
Databases	Oracle, Teradata, MSSQL

Machine Learning and data analysis stack: numpy, scikit-learn, Cython, PyTorch, Tensorflow, pandas etc.