IVAN NAZAROV

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SUMMARY

Nine years of experience in machine learning research and applied projects with industrial customers, including Sberbank, Huawei, Bosch, Datadvance, and Airbus

Completed PhD studies in applied mathematics and computer science with findings published in international journals and conferences[1]

Advanced deep learning, machine learning and data analysis skills (mlops, version control, pytorch, jax, tensorflow, scikit-learn, pandas)

Advanced python skills (C extensions, multiprocessing, packaging)[2]

Curiosity, creativity, collaborative spirit, and ability to work in multi-disciplinary teams with diverse backgrounds

Fluent English

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

WORK AND ACADEMIC EXPERIENCE

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

· **(2022/06 − present)** "ML-RL Applications in Industrial Operations Research And General Combinatorial Optimization Problems"

- planning and leading research in a small team, interaction with business partners

- evaluation of IL and DQN approaches to learning branching rules in SCIP/Ecole to allocation problem with composite cost structure and quota constraints

- experimenting with neural route generation for CVRP on real realistic roadmap networks

· **(2021/10 − 2021/12)** "Contrastive Learning for Event Sequences with Self-Supervision" (SIGMOD'22: ICMD)

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[1] `https://scholar.google.ru/citations?user=lF5HI3QAAAAJ`
[2] `https://github.com/ivannz`

- improving the paper's scientific standing and reinterpeting the experimental results

- aligning the discussion with the tested hypothesis and contributing to rebuttal process

· **(2021/09 − 2022/07)** "Interpretable Manager-worker Goal-conditioning in Hierarchical RL"

- research into skill discovery and hierarchical policy learning in RL, learnable messaging with discrete latent embeddings, intrinsic motivation mechanisms for exploration, adaptive computation in deep networks, planning via models or tree search

- implementation and testing of new architectures, including recurrent transformers (Mini-Hack, NetHack), vector-quantized VAEs for manager-worker communication (ATARI, Minigrid)

- implementation and development of tools[3] and small frameworks[4] required for streamlining numerical experiments

· **(2021/09 − 2021/11)** the 1st place solution at the NetHack Challenge at the the 2021 NeurIPS competition track (team "Raph", a high-level algorithmic state machine controlling low-level RL sub-policy)

- development of diagnostic and policy debug toolbox[5]

- optimization of the algorithmic backend of the solution, including data representation and path finding algorithms

- writing and editing a report on the motivation and structure of the solution

Sberbank, AI Lab   December 2020 - September 2021
Data Science Research Lead   *Moscow*

· **(2020/12 − 2021/09)** "Project Achoo: a practical model and application for COVID-19 detection from recordings of breath, voice, and cough" (IEEE Journal of Selected Topics in Signal Processing, 2, 2022) – diagnostics of respiratory illnesses from audio recordings

- writing and editing the research paper, evaluating broader impact and composing methodology sections, consulting the team on validation protocols, proposing experimental setups and better research questions

- proposed a bootstrap-based method for counterfactual evaluation of audio recognition

- extensively reviewed ML approaches in medical applications and remote diagnostics based on respiratory sounds

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

· **(2020/08 − present)** "Hessian-based Method for Precise Neural Network Pruning" (thesis research) – deep neural network pruning based on local second-order approximation of the loss surface

- derivation and research of fast procedures for forward and backward greedy pruning based on the Optimal Brain Surgeon and related methods

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[3]https://github.com/ivannz/plyr
[4]https://github.com/ivannz/nle_toolbox
[5]https://github.com/ivannz/nle_toolbox

- derivation of fast numerical procedures for matvec, inverse matvec and diagonals for Hessians in implicit "sandwich" form[6]

- extensive research into the suboptimality of approximate solutions of sparse leading eigenvector problem and its relation to the proposed procedure

· **(2020/05 − 2020/09)** "Generalization of the Deep Weight Prior Beyond Independent Kernel-slice Assumption for Few-Shot Learning"

- planning and managing research, preparing presentations of findings

- implementation of experimentation framework for scalable experiments with TRIP, implicit VAE, and Variational Mixture of Posteriors priors, study of IWAE and SGVB gradient estimators with local reparameterizaiton tricks[7]

- Developed a stable implementation of TRIP MoG prior for extra-high-dim mixtures.

· **(2019/11 − 2020/06)** "Bayesian methods for sparsification of complex-valued neural networks" (thesis research, ICML 2020)

- novel contribution in the form of a theoretical generalization of Variational Dropout and Automatic Relevance Determination to complex-valued neural networks based on original research, and a novel natural PolARD variational posterior for C-valued random variables which lifts zero re-im correlation assumption

- end-to-end development of complex-valued neural networks extension to torch, with seamless integration onto existing experimental pipelines[8]

- development of automated experimentation framework for extensive experimentation and validation of the proposed pruning method[9]

· **(2019/04 − 2019/09)** "Neural Digital Signal Predistortion for 5G Radio Frequency Transmitters" – neural models for autoregressive adaptive signal modification to diminish amplifier's non-linearities while preserving nominal SNR and latency

- implementation of a custom large scale experimentation framework for rapid prototyping, fast verification and unified reporting (pytorch lightning and wandb)

- implementation of tools for estimating the arithmetic complexity of the developed neural networks

- evaluation of alternative neural architectures, extensive experimentation with complex-valued networks for I/Q signal processing

· **(2018/09 − 2018/12)** "Matrix Factorization Library with Temporal Autoregressive Regularization for Stock Forecasting" – evaluation of a matrix factorization method with latent AR(p) factors processes and graph-regularized loadings

- implementation of a library for temporal matrix factorization and forecasting for multivariate time series (python+numba)[10]

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[6] https://github.com/ivannz/BrainSurgeon
[7] https://github.com/ivannz/MarkovDWP
[8] https://github.com/ivannz/cplxmodule
[9] https://github.com/ivannz/cplxpaper
[10] https://github.com/ivannz/trmf

- contribution to the final report and presentation of findings at BigData Conference 2018, Moscow

· **(2018/05 – 2018/06)** "Inductive Matrix Completion with Feature Selection" (thesis research, Journal of Computational Mathematics and Mathematical Physics, July 2021) – matrix completion algorithm with side-channel information and sparse group-lasso regularizer

  - designing and implementing a block descent algorithm for the biconvex problem with ADMM sub-steps (python, cython, c, blas)[11]

  - deriving generalization upper bound for sparse recovery with side channel info based on Rademacher complexity

  - writing and editing the research paper detailing the algorithm, applying the method on biomedical benchmarks

· **(2017/06 – 2017/10)** "Steganographic Generative Adversarial Networks" (ICMV 2019) – image GAN with steganalyzer adversary

  - development of the differentiable LSB stego-embedding layer

  - implementation of proper stego-security validation protocol

  - proof-of-concept experiments with non-image GANs on generating 1d stego-containers

· **(2018/04 – 2018/07)** "Medium Term Oil Price Forecasting from News Streams with Time Series Analysis"

  - specification of the news stream content for a neural event and triplet embedding model, selection of economic data relevant to forecasting oil price time series

  - data preprocessing and feature extraction with Holt-Winters, Hodrick-Prescott and ell-1 trend filter,[12] experiments with recurrent networks for multivariate forecasting with exogenous data

  - preparation of the final report and executive summary of the findings

· **(2017/11 – 2017/12)** "Estimation of the Effects of Weekly US DoE Reports on Intraday Oil Futures"

  - development of a convex optimization problem for estimation of sparse event effects with application to real market and report data

  - conducting numerical experiments, composing the final report and presentation to the customer

· **(2017/09 – 2017/11)** "Detection of Anomalous Road Surface Conditions in Spatially Distributed Micro-meteorological Dataset"

  - theoretical extension of the support vector machine problem to a decentralized private-public dataset setup

  - implementation of this algorithm in CVXOPT and python for numerical experiments and sensitivity analysis

  - reporting the findings with comprehensive comparison and analysis on toy problems

· **(2016/11 – 2017/05)** "Early Warning System for Aerospace"

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[11]https://github.com/ivannz/SGIMC
[12]https://github.com/ivannz/l1_tf

- research into engine telemetry for feature engineering

- design and implementation of data processing pipeline on small scale AWS EC2 cluster

- developed optimized mining algorithm for anticipatory binary signals (scikit-learn, cython)

Institute for Information Transmission Problems RAS, laboratory 10   September 2015 - September 2016

Researcher Intern   *Moscow*

· **(2015/08 - 2016/09)** "A statistical library for predictive maintenance and early warning systems with applications to aerospace industry"

- implementation of novel data mining algorithms in python and numpy

- redesign of the architecture and alternative interfaces of the library

- industrial data analysis as part of securing TRL5 certification

- writing documentation, tutorials, and presenting findings

· **(2015/11 − 2016/05)** "A library for long term economic forecasting and simulation for efficient economic planning in coal mining industry"

- development and testing of multivariate heteroskedastic time series macroeconomic model (in R)

- contributing to the report with description of the underlying econometrics and simulation methodology

· **(2015/11 − 2016/04)** "Online learning algorithms in portfolio composition problem for exchange traded funds"

- research on online learning algorithms and online expert aggregation

- implementation of a testbed for strategy evaluation on historical market data

- reporting the experimental findings

· **(2015/04 − 2015/12)** "Numerical study of the Crossing Tree for Self-similar Processes"

- development of fast crossing tree builder for sample paths in cython with python interface

- implementation fast sampling of univariate Gaussian processes with a given autocorrelation function using FFT

- setting up numerical experiments on paths of monofractal scale-invariant processes

- writing the scientific paper

· **(2016/01 − 2016/06)** "Conformalized Multidimensional Linear Modelling and Anomaly Detection" (master thesis, ICMLA 2016) – a general distribution-free method for constructing confidence sets with valid statistical guarantees in application to Gaussian Process regression.

- 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

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

· **(2014/03 – 2015/08)** design and implementation of business logic and select database objects
  for a data warehousing solution during the migration of the database and accounting ledger of
  a top Russian bank to new corporate record management system.
· **2013/04 - 2014/02** Core developer of the statistical computations module for market sim-
  ulations within a software solution for financial market monitoring for the Central Bank of
  Russia

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

· Application of statistical and econometric models, forecasting and visualization in Eviews and R,
  interpretation and communication of findings. Publication of regular short analytic comments
  on the current macroeconomic events, research and analysis of economic trends for informed
  executive decision making.

  - "The present and the future of Gazprom and strategy of Russia as a major international
    gas supplier" (english, manuscript published under title "Gazprom: An Energy Giant and
    its Challenges in Europe", ISBN-13 978-1137461094) Coauthored two chapters "Russian
    gas extraction industry" and "Russian gas market"

  - "Transit of natural gas: the bargaining model" – application of game theory to gas transit
    through Ukraine (Economics and Mathematical methods, October - December 2010)

  - Internal research: "Application of the extreme value theory to evaluation of market risk"
    estimation of VAR and CVAR with GARCH-type models. "Exploration of latent volatility
    regimes in oil price dynamics" application of Markov Switching autoregression. "Skill of
    luck: performance of open-ended mutual funds in Russia" – four factor CAPM model with
    bootstrap simulation study on the alpha; "Shale gas in Pennsylvania (2013)" – analysis of
    the recent events and trends; developing the methodology for "Index of Financial Stress
    (Russia)"

TEACHING EXPERIENCE

(2020/04 - 2020/05) "Foundations of Data Science" at Skoltech – a course on the software
tools and best development practices for machine learning

  - practical tutorial on "Overcoming fear of Git" – overview of branch and commit manipu-
    lation with exercises on the typical everyday pipeline[13]

  - practical tutorial on "Packaging Python Code", covering the basics: the setup script,
    package structure, and building python extensions (C, cython)[14]

  - contributing to tutiroals on managing small-scale software development, useful devops
    practices, and principled approaches to architecture and design for software engineering
    tasks in machine learning and data science

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[13]https://github.com/ivannz/fds2020-git
[14]https://github.com/ivannz/fds2020-packaging

(2019/08/26 - 2019/09/06) "Machine Learning Summer School 2019" at Skoltech

- preparing and delivering a seminar on "Bayesian Neural Networks, Uncertainty quantification and Active Learning"[15]
- volunteering with organization and helping the participants

(2017/12, 2019/03) "Machine Learning further education course" at Sberbank University

- preparation and delivery of seminars covering basic classification and regression, and multiclass meta-algorithms

(2018/07, 2018/11) Preparation and teaching of four seminars covering on the essentials of imbalanced and multi-class classification, anomaly detection and simple time series analysis and forecasting for the staff of Gazprom Neft

(2018/02 - 2018/04) Chief teaching assistant on "Machine Learning 2018" course at Skoltech

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

(2017/02 - 2017/04) Teaching assistant on "Machine Learning 2017" course at Skoltech

- exam and homework grading, consulting students with their projects
- preparation of practical seminars on ensemble methods, and theoretical seminars on quadratic problems in support vector machines and elements of statistical learning

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

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[15]https://github.com/ivannz/mlss2019-bayesian-deep-learning and http://bdl101.ml/

Selected Published Research

[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.