

PETR KARNAKOV, PhD

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SUMMARY

Research scientist with over 10 years of experience in developing software and numerical algorithms for simulation and control of complex physical systems. Diverse skills in software engineering, high-performance computing, and machine learning. Proven ability to advance even well-established areas.

EXPERIENCE

Research Associate

📅 2023–2024

Harvard University, United States

- Developed a machine learning framework ODIL for solving inverse and control problems that accelerates physics-informed neural networks by 100 000 times
- Designed a model-based optimal control algorithm that outperforms reinforcement learning
- Built a device for contactless manipulation in fluids
- Technology used: Python, TensorFlow, JAX, robotics

Head Instructor

📅 2022

Harvard University, United States

- Delivered a graduate course on numerical methods for 80 students, leading a team of 5 assistants
- Created reproducible visual materials

Scientific Assistant / Researcher

📅 2016–2022

ETH Zurich, Switzerland

- Developed a distributed multiphysics solver Aphros for simulating flow with bubbles in electrochemical reactors
- Proposed a curvature estimation algorithm improving low-resolution accuracy over state-of-the-art method
- Proposed an algorithm for efficient simulation of foams
- Performed the largest simulations of foaming by breakup and mixing of air in water with 10 000 bubbles on 2000 compute nodes on a supercomputer
- Analyzed data and derived reduced-order models from large-scale simulations of cavitation
- Identified effects of interventions in epidemic data throughout Europe using Bayesian inference
- Technology used: C++, Python, MPI, OpenMP, OpenCL

Research Engineer

📅 2013–2016

FRC ICT, Novosibirsk, Russia

- Developed simulation software for multiphase flow and fracture mechanics applied in petroleum industry
- Technology used: C++, Fortran

COLLABORATIONS & LEADERSHIP

- Completed 5 common projects with 9 researchers within the lab at ETH Zurich and Harvard University
- Closely collaborated with 10 researchers from external groups at EPFL, MIT, UZH, and TUM
- Mentored 3 graduate and 4 undergraduate students
- Assisted 15 external users of Aphros and ODIL
- Contributed to open-source simulation software basilisk with a critical patch
- Participated in the Blueprint program by venture firm The Engine for prospective startup founders

EDUCATION

PhD Mechanical Engineering

📅 2021

ETH Zurich, Switzerland

MSc Mechanics and Mathematical Modeling

📅 2016

Novosibirsk State University, Russia

BSc Mechanics

📅 2014

Novosibirsk State University, Russia

SKILLS

Programming

C++, Python, JavaScript, OpenGL, Fortran, x86 assembly

High Performance Computing

MPI, OpenMP, OpenCL, CUDA, HDF5, vectorization

Mathematics

Numerical methods, linear algebra, optimization

Machine Learning

TensorFlow, JAX, reinforcement learning, stochastic methods, Bayesian inference, neural networks

Robotics

3D printing, CAD, computer vision, FPGA

Visualization & Simulation

Matplotlib, ParaView, Ansys Fluent, COMSOL

Development Tools

Git, Unix shell, CMake, Docker, CI/CD

Presentation & Publishing

LaTeX, HTML, Keynote, reveal.js

Communication

Published 15 peer-reviewed [articles](#), including 9 as first author. Presented 8 talks at international conferences.

Languages

English (fluent), Russian (native), German (beginner)

OPEN-SOURCE PROJECTS

Aphros

🐙 github.com/cselab/aphros

Distributed multiphysics solver in C++ with MPI for simulating flow with bubbles in electrochemical reactors.

ODIL

🐙 github.com/cselab/odil

Python framework for solving inverse problems for physical models using TensorFlow and JAX.

autodiff

🐙 github.com/pkarnakov/autodiff

Automatic differentiation framework in C++ with GPU support through OpenCL and CUDA.

HONORS & AWARDS

- 2nd prize in MassRobotics Form&Function challenge: device for contactless manipulation with fluids (2024)
- Work on foam simulation covered by 8 news outlets, including Physics World, Phys.org, and C&EN (2022)
- Gallery of Fluid Motion Award for video on foam simulation, American Physical Society (2019)
- Scholarships from BP and Baker Hughes (2014)

HOBBIES & INTERESTS

Classical choral singing, musical instruments, political philosophy, and running.