

Dr. Pavel Dvurechensky

Curriculum Vitae

Institutskiy, 9
141700, Dolgoprudniy, Moscow Region
Russia

+79035723732

✉ p.dvurechensky@phystech.edu

Date of birth: April 10, 1987

Academic Vitae

- 2012–now **Research assistant**, *Moscow Institute of Physics and Technology (MIPT), Laboratory of Structural Methods of Data Analysis in Predictive Modeling (PreMoLab)*, Moscow, Russia.
Developing algorithms for convex optimization problems (including saddle-point and stochastic optimization problems) within Russian Government Grant 11.G34.31.0073 (head Prof. Dr. V. Spokoiny), RFBR projects 13-01-12007 ofi_m (head Prof. Dr. Yu. Nesterov) and 14-01-00722-a (head Dr. A. Gasnikov).
- 2010–2013 **PhD in mathematics**, *Moscow Institute of Physics and Technology (MIPT)*, Moscow, Russia.
- 2009–2013 **Research assistant**, *Moscow Institute of Physics and Technology (MIPT), Department of Mathematics*, Moscow, Russia.
Developing and programming algorithms for linear and nonlinear differential games within the Government projects 02.740.11.0194 (head Prof. Dr. E. Polovinkin), 16.740.11.0128 (head Prof. Dr. G. Ivanov), 14.132.21.1347 (head myself), and RFBR projects 10-01-00139-a (head Prof. Dr. E. Polovinkin) and 13-01-00295-a (head Prof. Dr. E. Polovinkin).
- 2008–2010 **Master's Diploma**, *Moscow Institute of Physics and Technology (MIPT)*, Moscow, Russia.
Grade 4.9/5.0 (Graduated with honors (distinction))
- 2004–2008 **Bachelor's Diploma**, *Moscow Institute of Physics and Technology (MIPT)*, Moscow, Russia.
Grade 4.9/5.0 (Graduated with honors (distinction))

PhD Thesis

- title *Algorithms for constructing of epsilon-optimal strategies for nonlinear differential games on a plane*
- supervisors Prof. Dr. Grigory E. Ivanov

description The work is devoted to construction of quasi-optimal strategies for nonlinear antagonistic differential games on a plane. Two types of games were considered:

1. the goal of the first player is to bring the controlled system to the given set (which can be non-convex) at a fixed moment of time and the goal of the second player is the opposite.
2. the goal of the first player is to bring the controlled system to the given set (which can be non-convex) *as soon as possible* and the goal of the second player is the opposite.

The main achievement of this work consists in developing algorithms for approximate solution of these two problems. A concept of Minkowski operators was introduced as a generalization of concepts of Minkowski sum and difference of two sets. The error of the developed algorithms was estimated and numerical experiments were performed. It turned out that each algorithm outperforms the existing ones both theoretically and practically.

Master's Thesis

title *Application of identification methods to the model of oscillations in spatial economics*
supervisors RAS Corresponding Member, Prof. Dr. Yury S. Popkov

Bachelor's Thesis

title *Oscillations in a model of spatial economics*
supervisors RAS Corresponding Member, Prof. Dr. Yury S. Popkov

Research Interests

- Algorithms for large-scale and huge-scale convex optimization
- Algorithms for saddle-point problems
- Algorithms for stochastic optimization problems
- Algorithms for differential games

Research experience

2012–now **Research assistant**, *Moscow Institute of Physics and Technology (MIPT), Laboratory of Structural Methods of Data Analysis in Predictive Modeling (PreMoLab)*, Moscow, Russia.

- Algorithms for linear differential games
 - We developed efficient algorithms for linear convex-concave and strongly convex-concave differential games. The algorithms are based on Yu. Nesterov's primal-dual methods for finite-dimensional saddle-point problems and have rates of convergence which are the same as the lower bounds respectively for classes of convex-concave and strongly convex-concave saddle-point problems in finite dimensional problems despite the fact that we considered problems in Hilbert space. This was a joint work with Prof. Dr. Yurii Nesterov and Prof. Dr. Vladimir Spokoiny.
- First-order methods for convex problems
 - We develop a new gradient method for a wide class of convex problems with stochastic inexact oracle. The concept of this oracle was introduced in a series of papers by O. Devolder, F. Glineur and Yu. Nesterov. It turns out that many known problems belong to this class. Examples are smooth, non-smooth and stochastic convex optimization problems. Our method allows to solve them and works in accordance to the lower complexity bounds for the considered class of problems. This is a joint work with Dr. Alexander Gasnikov.
- Zero-order methods for convex problems
 - We work in the framework of random gradient-free methods, considered by Yu. Nesterov in 2012, and analyze how the error in the function value affects the rate of convergence of gradient and fast gradient schemes. This is a joint work with Dr. Alexander Gasnikov.
- Learning of web-page ranking algorithm
 - We consider a random walk model for web-pages ranking which is based on a Markov chain. Stationary distribution of this Markov chain is considered as a vector of pages ranks. We assume that transition probabilities in this Markov chain depend on some parameters which characterize web-pages and links attractiveness for internet surfers. The problem is to find the correct value of these parameters using the pages ranking scores given by a pool of experts. It turned out that zero-order methods work well in this context but it is necessary to study how the error in the function value affects their rate of convergence. As a result we developed an algorithm which allows to solve this problem. Our complexity estimates for this method show that it is better than existing ones. This is a joint work with Dr. Alexander Gasnikov and Dr. Maxim Zhukovskii.

2009–2013 **Research assistant**, *Moscow Institute of Physics and Technology (MIPT), Department of Mathematics, Moscow, Russia.*

- Theoretical studies of algorithms for nonlinear differential games with goal set within my PhD research.
- Software development for constructing stable bridge and optimal strategies for linear and nonlinear differential games using C++.
- Writing of grant proposals.
- Experience as the head of the Government's program project 14.132.21.1347.

Languages

Language 1	Russian	<i>Native</i>
Language 2	English	<i>Fluent</i>

Computer skills

category 1	Matlab
category 2	C/C++

Refereed Articles

P. Dvurechensky, A. Gasnikov. Stochastic Intermediate Gradient Method for Convex Problems with Inexact Stochastic Oracle. In *Proceedings of 38th IITP RAS IITP RAS Conference & School "Information Technology and Systems - 2014", Nizhny Novgorod, Russia, 2014*, pp. 386-392.

P.E. Dvurechensky, G.E. Ivanov. Algorithms for Computing Minkowski Operators and Their Application in Differential Games. In *Computational Mathematics and Mathematical Physics*, 2014, Vol. 54, No. 2, pp. 235–264.

P. Dvurechensky, Yu. Nesterov, V. Spokoiny. Primal-dual methods for solving infinite-dimensional games. In *Journal of Optimization Theory and Applications*, 2013, e-print: http://www.optimization-online.org/DB_HTML/2013/09/4047.html. Manuscript accepted for publication.

P. Dvurechensky, G. Ivanov. Algorithm for constructing of optimal strategy in nonlinear differential game with non-fixed terminal time. In *Proceedings of Moscow Institute of Physics and Technology*, 2012, Vol. 4, No 4, pp. 51-61. (in Russian).

P. Dvurechensky. Algorithm for constructing of optimal strategies for differential game with goal set and non-fixed terminal time. In *Proceedings of Second Conference "Theory and Practice of System Analysis", Rybinsk, Russia, 2012*, pp. 14-24. (in Russian).

P. Dvurechensky, G. Ivanov. Algorithm for constructing of optimal strategies in nonlinear differential game using convolution. In *Proceedings of Moscow*

Institute of Physics and Technology, 2011, Vol. 3, No 1, pp. 61-67. (in Russian).

Submitted Articles and Technical Reports

P. Dvurechensky, A. Gasnikov. Stochastic Intermediate Gradient Method for Convex Problems. In *Doklady Mathematics (Doklady Akademii Nauk)*, 2014. Manuscript submitted for publication.

P. Dvurechensky, A. Gasnikov, Yu. Nesterov. Stochastic Gradient Methods with Inexact Oracle. In *Automation and Remote Control*, arXiv preprint arXiv:1411.4218 (in Russian), 2014. Manuscript submitted for publication.

P. Dvurechensky, A. Gasnikov. Stochastic Intermediate Gradient Method for Convex Problems with Inexact Stochastic Oracle. arXiv preprint arXiv:1411.2876, 2014.

P. Dvurechensky, A. Gasnikov, M. Zhukovskii. Random walk based web page ranking functions learning with gradient-free optimization methods. *AISTATS 2015*, arXiv preprint arXiv:1411.4282, 2014. Manuscript submitted for publication.

Miscellaneous Publications

P. Dvurechensky, A. Gasnikov, A. Lagunovskaya. Gradient-free optimization methods with ball randomization. In *Abstracts of V International Conference on Optimization Methods and Applications (OPTIMA-2014)*, Petrovac, Montenegro, 2014, p.59.

P. Dvurechensky, A. Gasnikov. Optimization methods for problems with inexact oracle in Hilbert space. In *Abstracts of International Conference "Systems Dynamics and Control Processes" dedicated to the 90th Anniversary of Academician N.N.Krasovskii, Ekaterinburg, Russia*, 2014, p. 52. (in Russian).

P. Dvurechensky, G. Ivanov. Minkowski operators and their application for differential games. In *Abstracts of International Conference "Systems Dynamics and Control Processes" dedicated to the 90th Anniversary of Academician N.N.Krasovskii, Ekaterinburg, Russia*, 2014, p. 66. (in Russian).

P. Dvurechensky, Yu. Nesterov, V. Spokoiny. Application of convex optimization methods for solving strongly convex-concave saddle-point optimal control problems. In *Proceedings of 56th conference of Moscow Institute of Physics and Technology, Moscow*, 2013, Vol. 1, pp. 117 – 118. (in Russian).

P. Dvurechensky, G. Ivanov. Algorithm for constructing of optimal strategies in differential game with goal set and non-fixed terminal time. In *Abstracts of*

International Conference "Dynamical Systems: Stability, Control, Optimization" (DSSCO'13), Minsk, 2013, pp. 113-114. (in Russian).

P. Dvurechensky, Yu. Nesterov. Primal-dual optimization methods for solving optimal control problems with saddle-point structure. In *Abstracts of reports of VII International Conference on Operations Research (ORM 2013), Moscow, 2013, Vol. 1, pp. 53-55.*

P. Dvurechensky, Yu. Nesterov. Primal-dual optimization methods for finding saddle-points in differential games. In *Abstracts of reports of IV International Conference on Optimization Methods and Applications (OPTIMA-2013), Petrovac, Montenegro, pp. 49-50.*

P. Dvurechensky. Algorithm for constructing of optimal strategies for time minimization differential game with goal set. In *Proceedings of 55th conference of Moscow Institute of Physics and Technology, Moscow, 2012, Vol. 1, pp. 19-20. (in Russian).*

P. Dvurechensky, Yu. Nesterov. Application of convex optimization methods for solving saddle-point optimal control problems. In *Proceedings of 55th conference of Moscow Institute of Physics and Technology, Moscow, 2012, Vol. 1, pp. 145. (in Russian).*

Conference talks

38th IITP RAS Conference & School "Information Technology and Systems - 2014", Nizhny Novgorod, Russia, 2014, ordinary talk.

VI Traditional School for Young Researchers "Control, Information, Optimization", Moscow, 2014, young lecturer with talk "Gradient Methods for Convex Problems with Stochastic Inexact Oracle".

V International Conference on Optimization Methods and Applications (OPTIMA-2014), Petrovac, Montenegro, 2014, ordinary talk.

International Workshop "Advances in Optimization and Statistics", Moscow, 2014, ordinary talk "Stochastic Intermediate Gradient Method for Convex Problems with Inexact Stochastic Oracle".

International Conference "Dynamical Systems: Stability, Control, Optimization" (DSSCO'13), Minsk, Belarus, 2013, ordinary talk.

56th conference of Moscow Institute of Physics and Technology, Moscow, 2013, ordinary talk.

VII International Conference on Operations Research (ORM 2013), Moscow, 2013, ordinary talk.

IV International Conference on Optimization Methods and Applications (OPTIMA-2013), Petrovac, Montenegro, 2013, ordinary talk.

V Traditional School for Young Researchers "Control, Information, Optimization", Moscow, 2013, ordinary talk "Primal-dual optimization methods for solving optimal control problems with saddle-point structure".

International Workshop "Advances in Optimization and Statistics", Berlin, 2013, ordinary talk "Application of primal-dual optimization methods for solving saddle-point optimal control problems".

55th conference of Moscow Institute of Physics and Technology, Moscow, 2012, ordinary talk.

IV Traditional School for Young Researchers "Control, Information, Optimization", Moscow, 2012, ordinary talk "On one algorithm for constructing of optimal strategy in nonlinear differential game with non-fixed terminal time".