Yury Demidovich

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Google Scholar profile

RESEARCH INTERESTS

Stochastic Optimization and its applications to Machine Learning, Randomized and Distributed Optimization Methods, Federated Learning, Graph and Hypergraph Theory, Random Grraphs, Extremal Combinatorics, Combinatorial Geometry, Probability Theory, selected topics of Computer Science, Machine Learning, Discrete Optimization.

EDUCATION

1. Doctoral Programme, Moscow Institute of Physics and Technology, Faculty of Innovations and High Technology, Department of Discrete Mathematics. Thesis "Graphs and Hypergraphs Colorings in Extremal Combinatorics and Combinatorial Geometry", 2021. Advisors: Dmitry A. Shabanov, Andrey M. Raigorodskii.
   Official information about the thesis defense on the 24th of December 2021 (in Russian)

2. M.Sc. in Mathematics, Lomonosov Moscow State University, Faculty of Mechanics and Mathematics, Department of Mathematical Statistics and Random Processes. Thesis "Chromatic Numbers of Rational Spaces with Minkowskii Metric", 2017. Advisor: Andrey M. Raigorodsii.

EMPLOYMENT HISTORY

1. Junior Researcher, Laboratory of Advanced Combinatorics and Networks Applications, MIPT, September 2018 — December 2021.

2. Junior Researcher, Laboratory of Combinatorial and Geometric Structures, MIPT, September 2019 — December 2021.

3. Assistant, Department of Discrete Mathematics, MIPT, 2019 — July 2022.

4. Senior Engineer, Huawei, Math Modeling Lab, Discrete Optimization group, October 2021 — March 2022.

5. Deep Learning Engineer, Samsung Artificial Intelligence Center, March 2022 — August 2022.

6. Postdoctoral Fellow, KAUST, Optimization and Machine Learning Lab, August 2022 — present.

TEACHING

- Department of Innovations and High Technology, MIPT

    1. Probability theory, Spring of 2021.

2. Basics of Probability and Measure Theory, Fall of 2020, 2021.
3. Combinatorics and Number Theory, Fall of 2019, 2020, 2021.
4. Discrete Mathematics, Spring of 2020, 2021, 2022.
5. Convex Optimization, Fall of 2019.

- Department of Bioengineering and Bioinformatics, Lomonosov MSU.
  Combinatorics, seminars, Fall of 2017, 2018, 2019.
- Yandex Data Analysis School.
  Teaching assistant, Discrete Analysis, Fall of 2018, 2019; Statistics, Spring of 2019.
- Small Department of Mechanics and Mathematics, Lomonosov MSU.
  Olympiad Mathematics for pupils, 2014-2015.

LANGUAGES

Russian (native), English (advanced).
Diploma of a completion of a course on Academic English for advanced students, Lomonosov Moscow State University, Department of Mechanics and Mathematics.

MATHEMATICAL SKILLS

Optimization, Combinatorics, Discrete Mathematics, Number Theory, Measure Theory, Probability Theory, Graph Theory, Linear Algebra, Set Theory, Calculus, Statistics, Numerical Approximations, Differential Equations, Discrete Optimization.

GRANTS AND AWARDS

1. Grant number 075-15-2019-1926 of the Government of the Russian Federation (Megagrant), Junior Investigator, 2020-2021.
2. Grant number 19-31-90016 of the Russian Foundation of Basic Research, Principal Investigator, 2019-2022.
3. Simons-IUM Foundation Award, stipend for young researchers, Principal Investigator, 2021.
4. Grant number NSh-2540.2020.1, Leading Scientific Schools, Junior Investigator, 2020-2021.
5. Grant number 20-31-70039 of the Russian Foundation of Basic Research, Junior Investigator, 2019-2021.
6. Grant number 18-01-00355 of the Russian Foundation of Basic Research, Junior Investgator, 2016-2018.
7. Moscow State University Excellence Scholarship for undergraduate students, 2015, 2017.

MOST SIGNIFICANT PUBLICATIONS

1. Y. Demidovich, Y. Panichkin, M. Zhukovskii, "Reconstruction of graph colourings". https://arxiv.org/abs/2308.01671

   Research impact: Given a graph G, when is it possible to reconstruct with high probability a uniformly random colouring of its vertices in r colours from its k-deck, i.e. a set of its induced (coloured) subgraphs of size k? In this paper, we reconstruct random colourings of lattices and random graphs. We prove the "two-point concentration" result for the minimum size of subgrids that determine the entire colouring holds true in any dimension $d \geq 2$. We also prove that with high probability a uniformly random r-colouring of the vertices of the random graph $G(n, 1/2)$ is reconstructible from its full k-deck if $k \geq 2\log_2 n + 8$ and is not reconstructible if $k \leq \sqrt{2\log_2 n}$. We further show that the colour reconstruction algorithm for random graphs can be modified and used for graph reconstruction: we prove that with high probability $G(n, 1/2)$ is reconstructible from its full k-deck if $k \geq 2\log_2 n + 11$ (while it is not reconstructible with high probability if $k \leq 2\sqrt{\log_2 n}$). This significantly improves the best known upper bound

2. Y. Demidovich, G. Malinovsky, I. Sokolov, Peter Richtárik, "A Guide Through the Zoo of Biased SGD", NeurIPS 2023. https://arxiv.org/abs/2305.16296

   Research impact: Stochastic Gradient Descent (SGD) is arguably the most important single algorithm in modern machine learning. Although SGD with unbiased gradient estimators has been studied extensively over at least half a century, SGD variants relying on biased estimators are rare. Existing literature on BiasedSGD lacks coherence since each new paper relies on a different set of assumptions, without any clear understanding of how they are connected, which may lead to confusion. We establish connections among the existing assumptions, and presenting a comprehensive map of the underlying relationships. Additionally, we introduce a new set of assumptions that is provably weaker than all previous assumptions, and use it to present a thorough analysis of BiasedSGD in both convex and non-convex settings, offering advantages over previous results.

3. Y. Demidovich, M. Zhukovskii, "Tight asymptotics of clique-chromatic numbers of dense random graphs", Journal of Graph Theory (2023). https://doi.org/10.1002/jgt.22927

   Research impact: In 2017 Alon and Krivelevich conjectured that whp clique-chromatic number of $G(n, 1/2)$ equals $(\frac{1}{2} + o(1))\log_2 n$. In this paper we prove even more: whp it is equal to $\frac{1}{2}\log_2 n - \Theta(\ln\ln n)$.

4. Y. Demidovich, A. Skorkin, M. Zhukovskii, "Cycle saturation in random graphs", SIAM Journal on Discrete Mathematics, 37(3) (2023). https://epubs.siam.org/doi/10.1137/21M1456479

   Research impact: For a graph F, Erdős, Hajnal and Moon raised a question of finding the minimum number of edges in an edge-maximal F-free graph on n vertices. The asymptotics

of the F-saturation number of the binomial random graph $G(n,p)$ for constant $p \in (0,1)$ is known for complete graphs $F = K_m$ and stars $F = K_{1,m}$. This paper is devoted to the case when the pattern graph F is a simple cycle C_m. We prove that, for $m \geq 5$, whp the saturation number is equal to $n + \Theta\left(\frac{n}{\ln n}\right)$. For $m = 4$, we find $c = c(p)$ such that whp the lower bound for the saturation number is equal to $\frac{3}{2}n(1+o(1))$ and the upper bound is equal to $cn(1+o(1))$.

5. Y. Demidovich, D. Shabanov, "On the Chromatic Numbers of Random Hypergraphs", Doklady Mathematics, 102, 380–383 (2020). doi.org/10.1134/S1064562420050312

   Research impact: The asymptotic behavior of the chromatic number of the binomial random hypergraph is one of the central topics in random graph and hypergraph theory. We show that when $k \geq 4$, n tends to infinity, $p = p(n)$ is a function, which does not decrease too slowly, the chromatic number of a binomial random hypergraph $H(n,k,p)$ is concentrated in two or three consecutive values, which can be found explicitly as functions of n, p and k.

6. Liudmila Prokhorenkova, Dmitry Baranchuk, Nikolay Bogachev, Yury Demidovich, Alexander Kolpakov, "Graph-based Nearest Neighbor Search in Hyperbolic Spaces", ICLR'22. OpenReview
   Research impact: The nearest neighbor search (NNS) problem is widely studied in Euclidean space, and graph-based algorithms are known to outperform other approaches for this task. However, hyperbolic geometry is found to be very useful for data representation in various domains, including natural language processing, computer vision, and information retrieval. In this paper, we show that graph-based approaches are also well suited for hyperbolic geometry.

CONFERENCE TALKS

1. Yu.A. Demidovich, M.E. Zhukovskii, "Cycle saturation in random graphs", EUROCOMB 2021, Barcelona, Spain, 6-10 September (2021).

2. Yu.A Demidovich, D.A. Shabanov, "On the chromatic number of a random hypergraph in the non-sparse case", Conference of World-Class International Mathematical Centers, Sirius, Sochi, Russia, August (2021).

3. Yu.A. Demidovich, "Two-colorings of uniform simple hypergraphs", MIPT 63, Dolgoprudnyi, Russia, November (2020).

4. Yu.A. Demidovich, D.A. Shabanov, "Extremal problem for doubly stochastic matrices and application to the chromatic number of a random 3-uniform hypergraph", The 5th International Conference on Stochastic Methods (ICSM-5), Moscow, Russia, 23-27 November (2020).

5. Yu.A. Demidovich, "Property B_k-problem for uniform simple hypergraphs", 10-th International Conference Probabilistic Methods in Discrete Mathematics, Petrozavodsk, Russia, 22-26 May (2019).

6. Yu.A. Demidovich, "On some generalization of property B problem of an n-uniform hypergraph", Extremal Combinatorics and discrete geometry, Maykop, Russia, 20-23 December (2018).

7. Yu.A. Demidovich, "On some generalization of property B problem for a uniform hypergraph", The Second Russian-Hungarian Combinatorial Workshop, Budapest, Hungary, 26-29 June (2018).

LIST OF PUBLICATIONS

1. Y. Demidovich, G. Malinovsky, E. Shulgin, P. Richtárik, "MAST: Model-Agnostic Sparsified Training".
   https://arxiv.org/abs/2311.16086

2. Y. Demidovich, Y. Panichkin, M. Zhukovskii, "Reconstruction of graph colourings".
   https://arxiv.org/abs/2308.01671

3. Y. Demidovich, G. Malinovsky, I. Sokolov, P. Richtárik, "A Guide Through the Zoo of Biased SGD", NeurIPS 2023.
   https://arxiv.org/abs/2305.16296

4. Y. Demidovich, A. Skorkin, M. Zhukovskii, "Cycle saturation in random graphs", SIAM Journal on Discrete Mathematics, 37(3) (2023).
   https://epubs.siam.org/doi/10.1137/21M1456479

5. Y. Demidovich, M. Zhukovskii, "Tight asymptotics of clique-chromatic numbers of dense random graphs", Journal of Graph Theory (2023).
   https://doi.org/10.1002/jgt.22927

6. Y.A. Demidovich, "New lower bound for the minimal number of edges of simple uniform hypergraph without the property B_k", Discrete Mathematics and Applications 32 (3), 155–176 (2022).
   De Gruyter Link

7. Yu.A. Demidovich, "On some generalizations of property B-problem of an n-uniform hypergraph", Journal of Mathematical Sciences, 262, 457—475 (2022).
   Springer Link
   Arxiv version: https://arxiv.org/abs/1903.11708

8. Y. Demidovich, M. Zhukovskii, "Cycle saturation in random graphs", Extended Abstracts EuroComb 2021, Birkhauser, Cham, 811–816.
   Springer Link

9. Y.A. Demidovich, D.A. Shabanov, "On the Chromatic Number of a Random 3-Uniform Hypergraph". In: Shiryaev A.N., Samouylov K.E., Kozyrev D.V. (eds) Recent Developments in Stochastic Methods and Applications. ICSM-5 2020. Springer Proceedings in Mathematics & Statistics, vol 371. Springer, Cham. (2021).
   Springer Link

10. Yu.A. Demidovich, M.E. Zhukovskii, “Chromatic Numbers of Distance Graphs without Short Odd Cycles in Rational Spaces”, Math. Notes, 109:5 (2021), 727–734.
Springer Link

11. N. Bogachev, D. Baranchuk, Y. Demidovich, A. Kolpakov, L. Prokhorenkova-Ostroumova, “Graph-Based Nearest Neighbor Search in Hyperbolic Spaces”, ICLR’2022.
OpenReview Link

12. Y. Demidovich, D. Shabanov, “On the Chromatic Numbers of Random Hypergraphs”, Doklady Mathematics, 102, 380—383 (2020).
doi.org/10.1134/S1064562420050312

13. Yu.A. Demidovich, “2-Colorings of Hypergraphs with Large Girth”, Math. Notes, 108:2 (2020), 188–200.
Springer Link

14. Yu.A. Demidovich, “Distance Graphs with Large Chromatic Number and without Cliques of Given Size in the Rational Space”, Math. Notes, 106:1 (2019), 38–51.
Springer Link

15. Yu.A. Demidovich, “Lower Bound for the Chromatic Number of a Rational Space with Metric ℓ_u and with One Forbidden Distance”, Math. Notes, 102:4 (2017), 492–507.
Springer Link

16. Yu.A. Demidovich, A.M. Raigorodskii, “2-Colorings of Uniform Hypergraphs”, Math. Notes, 100:4 (2016), 629–632.
Springer Link