

# Dmitrii Avdiukhin

## Curriculum Vitae

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📁 [dyukha.github.io](https://github.com/dyukha)

### Research interests

I am broadly interested in theoretical foundations of machine learning.

- Continuous optimization: non-convex, distributed, constrained.
- Limitations and capabilities of LLMs.
- LLMs and reasoning.
- Clustering and hierarchical clustering.
- Approximation algorithms.
- Learning theory.

*Previous areas:* Submodular optimization, syntax and static analysis, model generation and model checking, balanced graph partitioning.

### Academic Appointments

2023–current **McCormick Postdoctoral Fellow**, *Northwestern University*, Evanston, IL.  
Mentor: Konstantin Makarychev (<https://konstantin.makarychev.net>)

### Education

2017–2023 **Ph.D.**, *Indiana University*, Bloomington, IN.  
Advisor: Grigory Yaroslavtsev (<http://grigory.us>). Dissertation title: “New directions in distributed and constrained non-Convex optimization”

2008–2013 **Specialist (5 years) Degree**, *Saint Petersburg State University*, GPA 4.9/5.0.  
Advisor: Iakov Kirilenko ([https://researchgate.net/profile/Iakov\\_Kirilenko](https://researchgate.net/profile/Iakov_Kirilenko)).  
Diploma with distinction. Thesis title: “Translation definition language for information system reengineering tools”.

### Experience

Summer 2022 **Research Intern**, *Amazon*.  
Demonstration selection for few-shot learning for small language models.  
Mentor: Ashish Khetan (<https://scholar.google.com/citations?user=AaaUqDAAAAAJ>)

Summer 2020 **Research Intern**, *Amazon*.  
Federated Learning under weak assumptions.  
Mentor: Shiva Kasiviswanathan (<http://shivakasiviswanathan.com>)

Summer 2019 **Research Intern**, *Amazon*, New York.  
Improving accuracy and performance of graph convolutional networks.  
Mentor: Zohar Karnin (<https://sites.google.com/site/zoharkarnin>)

Summer 2018 **Software Engineer**, *Pro Unlimited @ Facebook*, Menlo Park.  
Implementing balanced graph partitioning algorithm.  
Mentor: Sergey Pupyrev (<https://spupyrev.github.io>)

- 2016-2017 **Researcher**, *ITMO University*, Saint Petersburg.  
Model generation from execution traces
- 2013-2016 **Software Engineer**, *JetBrains*, Saint Petersburg.  
SQL dialect support
- 2012-2013 **Software Engineer**, *Lanit Tercom*, Saint Petersburg.  
Participating in project of migration a system from SQL Server to Oracle

## Publications

Authors are listed in alphabetical order unless marked with ★

- NeurIPS 2024 **Dmitrii Avdiukhin**, Vaggos Chatziafratis, Orr Fischer, Grigory Yaroslavtsev. "Embedding Dimension of Contrastive Learning and  $k$ -Nearest Neighbors", 38<sup>th</sup> Annual Conference on Neural Information Processing Systems
- ICLR 2024 Noga Alon, **Dmitrii Avdiukhin**, Dor Elboim, Orr Fischer, Grigory Yaroslavtsev. "Optimal Sample Complexity of Contrastive Learning", 12<sup>th</sup> International Conference on Learning Representations. **Spotlight presentation, 5% acceptance rate**
- AAAI 2024 **D. Avdiukhin**, Vaggos Chatziafratis, Konstantin Makarychev, Grigory Yaroslavtsev. "Approximation Scheme for Weighted Metric Clustering via Sherali-Adams", 38<sup>th</sup> Annual AAAI Conference on Artificial Intelligence. **Oral presentation**
- IJCAI 2023 **D. Avdiukhin** and G. Yaroslavtsev. "HOUDINI: Escaping from Moderately Constrained Saddles", 32<sup>nd</sup> International Joint Conference on Artificial Intelligence.
- AAAI 2023 **D. Avdiukhin**, S. Das, O. Fischer, F. Mirza, D. Vainstein and G. Yaroslavtsev. "Tree Learning: Optimal Algorithms and Sample Complexity", 37<sup>th</sup> AAAI Conference on Artificial Intelligence.
- OPT 2022 **D. Avdiukhin** and G. Yaroslavtsev. "HOUDINI: Escaping from Moderately Constrained Saddles", 14<sup>th</sup> OPT Workshop on Optimization for Machine Learning.
- OPT 2022 **D. Avdiukhin**, V. Braverman, N. Ivkin, and S. U. Stich. "Bidirectional Adaptive Communication for Heterogeneous Distributed Learning", 14<sup>th</sup> OPT Workshop on Optimization for Machine Learning.
- NeurIPS 2021 **D. Avdiukhin** and G. Yaroslavtsev. "Escaping Saddle Points with Compressed SGD", 35<sup>th</sup> Conference on Neural Information Processing Systems
- ICML 2021 **D. Avdiukhin** and S. Kasiviswanathan. "Federated Learning under Arbitrary Communication Patterns", 38<sup>th</sup> International Conference on Machine Learning
- AAAI 2021 ★ S. Naumov, **D. Avdiukhin**, and G. Yaroslavtsev. "Objective-Based Hierarchical Clustering of Deep Embedding Vectors", 35<sup>th</sup> AAAI Conference on Artificial Intelligence
- OPT 2020 **D. Avdiukhin**, and G. Yaroslavtsev. "Escaping Saddle Points with Compressed SGD", 12<sup>th</sup> OPT Workshop on Optimization for Machine Learning.
- AISTATS 2020 ★ G. Yaroslavtsev, S. Zhou, and **D. Avdiukhin**. "'Bring Your Own Greedy'+Max: Near-Optimal 1/2-Approximations for Submodular Knapsack", 23<sup>rd</sup> International Conference on Artificial Intelligence and Statistics. <https://arxiv.org/pdf/1910.05646.pdf>

- OPT 2019 **D. Avdiukhin**, C. Jin and G. Yaroslavtsev. "Escaping Saddle Points with Inequality Constraints via Noisy Sticky Projected Gradient Descent", 11<sup>th</sup> OPT Workshop on Optimization for Machine Learning, **Oral + poster**. [https://opt-ml.org/papers/2019/paper\\_30.pdf](https://opt-ml.org/papers/2019/paper_30.pdf)
- VLDB 2019 **D. Avdiukhin**, S. Pupyrev and G. Yaroslavtsev. "Multi-Dimensional Balanced Graph Partitioning via Projected Gradient Descent", 45<sup>th</sup> International Conference on Very Large Data Bases, Research Track. <https://arxiv.org/pdf/1902.03522.pdf>
- KDD 2019 **D. Avdiukhin**, S. Mitrovic, G. Yaroslavtsev and S. Zhou "Adversarially Robust Submodular Maximization under Knapsack Constraints". **Oral presentation**, 9.2% acceptance rate. <https://arxiv.org/pdf/1905.02367.pdf>
- INDIN 2017 **D. Avdiukhin**, D. Chivilikhin, G. Korneev, V. Ulyantsev and A. Shalyto. "Plant trace generation for formal plant model inference: methods and case study", 15<sup>th</sup> IEEE International Conference on Industrial Informatics
- PSI 2015 E. Verbitskaia, S. Grigorev and **D. Avdiukhin**. "Relaxed Parsing of Regular Approximations of String-Embedded Languages", 10<sup>th</sup> International Andrei Ershov Memorial Conference on Perspectives of System Informatics

## Organizer

- December 2024 **Junior Theorists Workshop 2024**, Northwestern University, IL. <https://theory.cs.northwestern.edu/junior-theorists-workshop-2024/>
- November 2023 **Junior Theorists Workshop 2023**, Northwestern University, IL. <https://theory.cs.northwestern.edu/quarterly-theory-workshop-fall-2023-junior-theorists-workshop>

## Conference/Workshop Talks and Posters

- NeurIPS 2024 "Embedding Dimension of Contrastive Learning and  $k$ -Nearest Neighbors"
- ICLR 2024 "Optimal Sample Complexity of Contrastive Learning"
- ITA 2023 "First-Order Methods in Distributed Optimization"
- OPT 2022 "HOUDINI: Escaping from Moderately Constrained Saddles" (Poster)
- OPT 2022 "Bidirectional Adaptive Communication for Heterogeneous Distributed Learning" (Poster)
- NeurIPS 2021 "Escaping Saddle Points with Compressed SGD" (Poster)
- VLDB 2019 "Multi-Dimensional Balanced Graph Partitioning via Projected Gradient Descent"
- KDD 2019 "Adversarially Robust Submodular Maximization under Knapsack Constraints"

## Other Talks

- November 2023 **Junior Theorists Workshop 2023**. "Optimal Sample Complexity of Contrastive Learning"
- June 2023 **SIAM OP 2023**. "Escaping Saddle Points with Compressed SGD"
- Feb 2023 **Google Algorithms Seminar**. "Tree Learning: Optimal Algorithms and Sample Complexity"

- Dec 2021 **Saint Petersburg State University, Russia.** “Escaping from Saddle Points with Compressed SGD”
- Dec 2019 **Yandex, Moscow, Russia.** “Multi-Dimensional Balanced Graph Partitioning via Projected Gradient Descent”

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## Honors

- 2019 Nominated for Microsoft Research Fellowship by the Indiana University Computer Science Department (1 out of 2 per department)
- 2019 Nominated for Google PhD Fellowship Program by the Indiana University Computer Science Department

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## Teaching Experience

- Winter 2025 **“Theory of Gradient-Based Optimization in ML” (graduate).** Northwestern University, COMP\_SCI 496. Instructor.
- Spring 2025, Fall 2024, Spring 2024, Winter 2024 **“Design & Analysis of Algorithms” (undergraduate).** Northwestern University, COMP\_SCI 336. Instructor.
- Fall 2023 **“Advanced Algorithm Design through the Lens of Competitive Programming” (undergraduate & graduate).** Northwestern University, COMP\_SCI 396/496. Instructor.
- Spring 2023 **“Introduction to Algorithm Design and Analysis” (undergraduate).** Indiana University, Bloomington, CSCI-B403. Associate Instructor.
- Fall 2022 **“Math & logic for cognitive science” (graduate).** Indiana University, Bloomington, CSCI-B590. Associate Instructor.
- Spring 2022 **“Math & logic for cognitive science” (graduate).** Indiana University, Bloomington, CSCI-B590. Associate Instructor.
- Spring 2020 **“Applied Algorithms” (graduate).** Indiana University, Bloomington, CSCI-B505. Head Associate Instructor.
- Spring 2019 **“Data Structures” (Honors, undergraduate).** Indiana University, Bloomington, CSCI-H343. Associate Instructor.

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## Competitive programming

- ACM ICPC Latest result: 19th place on world semi-final, 2014 (<https://neerc.ifmo.ru/archive/2014/standings.html>)
- Codeforces Rating: 2232 (<https://codeforces.com/profile/dyukha>)
- Topcoder Rating: 1784 (<https://topcoder.com/members/dyukha>)

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## Technical Skills

- ML Skills PyTorch, LLM fine-tuning, LLM reasoning techniques
- Languages Python, Kotlin, C#, Java, Python, C++, various SQL dialects. To lesser extent: Rust, Coq
- VCS Git, Mercurial, SVN