

RUMEN R DANGOVSKI

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GitHub: <https://github.com/rdangovs>; Homepage: <http://super-ms.mit.edu/rumen.html>.

RESEARCH FOCUS

I study meaningful pretext tasks, prescribed from human knowledge, for computer vision, natural language processing and science problems. I have worked on fundamental machine learning systems that generalize well across a variety of domains. In particular, I have tackled real world problems, such as text summarization of scientific articles, by developing methods inspired by fundamental science, such as novel recurrent neural networks that use rotations to remember and recall information better or efficient convolutional layers based on optimal connectivity patterns.

Keywords: physics-inspired, self-supervised learning, transfer learning, meta learning, AI accelerators.

EDUCATION

Massachusetts Institute of Technology

2019 – present

PhD Candidate: Electrical Engineering and Computer Science.

Minor: Management.

Master of Science: completed in June 2020. [link to thesis](#).

Teaching Assistant: 6.867 (Machine Learning) in Fall 2020.

Notable coursework: Inference and Information, Automatic Speech Recognition, Optimization for Machine Learning, Bayesian Modelling, Meta Learning.

Reference: Professor Marin Soljačić.

Massachusetts Institute of Technology

2014 – 2018

Bachelor of Science: Mathematics, Physics.

Minor: Economics.

Notable coursework: Theory of Computation, Machine Learning, Quantum Computation, Discrete Applied Mathematics, Complex Analysis, Game Theory, Commutative Algebra, Representation Theory.

Reference: Professor Marin Soljačić.

NOTABLE EXPERIENCE

Lightelligence inc.

AI Research Scientist

June 2018 – February 2019
Boston, MA, USA.

- First employee at the start-up: assisted building the Algorithms team from scratch;
- Developed and supported the algorithm for the first optical AI accelerator chip ([press](#));
- Built high-performing kernels for optical deep learning ops using the Eigen library;
- Reference: Doctor Yichen Shen, CEO of Lightelligence.

CERN, CMS (The European Organization for Nuclear Research)

Summer Data Analyst

June – August 2016
Geneva, Switzerland

- Identified a bias problem in Monte Carlo simulations and improved efficiency;
- Developed tools for generation of histograms in ROOT to analyze detector's data to assist the analysis of the 750GeV diphoton excess;
- Reference: Doctor Chris Seez, Imperial College London.

PUBLICATIONS

1. **Rumen Dangovski**, Li Jing, Charlotte Loh, Seungwook Han, Akash Srivastava, Brian Cheung, Pulkit Agrawal, Marin Soljačić. Equivariant Contrastive Learning *ICLR 2022*. [doi](#).
2. **Rumen Dangovski**, Michelle Shen, Dawson Byrd, Li Jing, Preslav Nakov and Marin Soljačić. 2020. We Can Explain Your Research in Layman's Terms: Towards Automating Science Journalism at Scale. *AAAI 2021*. [doi](#).
3. Matthew Khoury, **Rumen Dangovski**, Longwu Ou, Preslav Nakov, Yichen Shen and Li Jing. 2020. Vector-Vector-Matrix Architecture: A Novel Hardware-Aware Framework for Low-Latency Inference in NLP Applications. *EMNLP 2020*. [doi](#).

4. **Rumen Dangovski**, Nicholas Rivera, Marin Soljačić and Ido Kaminer. 2019. Shaping Long-lived Electron Wavepackets for Customizable Optical Spectra. *Optica*, 6:1089–1097. [doi](#).
5. **Rumen Dangovski**, Li Jing, Preslav Nakov, Mico Tatalović and Marin Soljačić. 2019. Rotational Unit of Memory: A Novel Representation Unit for RNNs with Scalable Applications. *Transaction of the Association of Computational Linguistics*, 7:121–138. [doi](#). [MIT Technology Review](#). [Other people presenting our work](#).
6. Ivan Ivanov, Li Jing and **Rumen Dangovski**. 2018. Improving the Performance of Unitary Recurrent Neural Networks and Their Application in Real-life Tasks. *Proceedings of the 19th International Conference on Computer Systems and Technologies CompSysTech '18*. 6-11. [doi](#).
7. **Rumen Dangovski** and Chavdar Lalov. 2017. Self-avoiding Walks of Lattice Strips. *Serdica Mathematical Journal*, 43:187–210. [doi](#). Cited in [book](#).
8. **Rumen Dangovski**, Vesselin Drensky and Şehmus Fındık. 2017. Weitzenböck Derivations of Free Metabelian Associative Algebras. *Journal of Algebra and Its Applications*, 16:1750041. [doi](#).
9. **Rumen Dangovski**, Vesselin Drensky and Şehmus Fındık. 2013. Weitzenböck Derivations of Free Metabelian Lie Algebras. *Linear Algebra and its Applications*, 439:3279–3296. [doi](#).
10. **Rumen Dangovski**. 2012. On Self-avoiding Walks on Certain Grids and the Connective Constant. *Serdica Mathematical Journal*, 38:615–632. [doi](#). Cited in [book](#).
11. **Rumen Dangovski** and Kalina Petrova. 2012. Self-Avoiding Walks in the Plane. *Union of Bulgarian Mathematicians*, 41:152–157. [doi](#).

PREPRINTS

1. Yung-Sung Chuang, **Rumen Dangovski**, Hongyin Luo, Yang Zhang, Shiyu Chang, Marin Soljacic, Shang-Wen Li, Scott Yih, Yoon Kim, James R. Glass. DiffCSE: Difference-based Contrastive Learning for Sentence Embeddings. Under review at NAACL-HLT 2022.
2. Charlotte Loh, Thomas Christensen, **Rumen Dangovski**, Samuel Kim, Marin Soljačić. 2021. Surrogate-and Invariance-boosted Contrastive Learning for Data-scarce Applications in Science. Under review at Nature Communications.
3. Li Jing, Lay Jain, **Rumen Dangovski**, Marin Soljačić. 2020. Manifold Transfer Networks for Lens Distortion Rectification. In preparation.
4. Ileana Rugina, **Rumen Dangovski**, Li Jing, Preslav Nakov and Marin Soljačić. 2020. Data-Informed Global Sparseness in Attention Mechanisms for Deep Neural Networks. [arXiv:2012.02030](#).
5. Allan Costa, **Rumen Dangovski**, Samuel Kim, Pawan Goyal, Marin Soljačić and Joseph Jacobson. 2020. Interpretable Neuroevolutionary Models for Learning Non-Differentiable Functions and Programs. *arXiv preprint* [arXiv:2007.10784](#).
6. Evan Vogelbaum, **Rumen Dangovski**, Li Jing and Marin Soljačić. 2020. Contextualizing Enhances Gradient Based Meta Learning. *arXiv preprint* [arXiv:2007.10143](#).
7. Guillem Ramírez, **Rumen Dangovski**, Preslav Nakov and Marin Soljačić. 2020. On a Novel Application of Wasserstein-Procrustes for Unsupervised Cross-Lingual Learning. *arXiv preprint* [arXiv:2007.09456](#).
8. Li Jing, **Rumen Dangovski** and Marin Soljačić. 2018. WaveletNet: Logarithmic Scale Efficient Convolutional Neural Networks for Edge Devices. *arXiv preprint* [arXiv:1811.11644](#).
9. **Rumen Dangovski**. 2015. On the Maximal Containments of Lower Central Series Ideals. *arXiv preprint* [arXiv:1509.08030](#).

PATENTS

1. Yichen Shen, Li Jing, **Rumen Dangovski**, Peng Xie, Huaiyu Meng, Matthew Khoury, Cheng-Kuan Lu, Ronald Gagnon, Maurice Steinman, Jianhua Wu and Arash Hosseinzadeh. 2019. Optoelectronic Computing Systems. Application 16/431,167.
2. Yichen Shen, Li Jing, **Rumen Dangovski**, Peng Xie, Matthew Khoury and Cheng-Kuan Lu. 2018. Optical Neural Network Computing. Application 62/744,706.
3. Yichen Shen, Li Jing, **Rumen Dangovski** and Peng Xie. 2018. Optical Neural Network Computing. Application 62/680,944.

CONFERENCES

1. The 2020 Conference on Empirical Methods in Natural Language Processing. November 2020. Contributed presentation. [link](#).
2. 2019 Annual Conference of the North American Chapter of the Association for Computational Linguistics. June 2019. Minneapolis, MN, USA. Contributed poster. [link](#).
3. Electron, Ion, and Photon Beam Technology and Nanofabrication. June 2018. San Juan, Puerto Rico. Invited talk. [link](#).
4. CLEO Laser Science to Photonic Applications. May 2018. San Jose, CA, USA. Contributed talk. [link](#).
5. International Conference on Learning Representations. April 2018. Vancouver, Canada. Contributed workshop poster. [link](#).
6. Groups and Rings – Theory and Applications. July 2016. Sofia, Bulgaria. Invited talk. [link](#).

SERVICE

Paper reviewing: ICML 2022; ICLR 2022; NeurIPS 2021; Physical Review Applied; IJCAI 2021 NLP. [link](#); NAACL-HLT 2021 NLP Applications. [link](#); Computer Speech and Language. [link](#); NeurIPS 2020. NLP. [link](#); EMNLP 2020 Demonstrations. [link](#); Natural Language Engineering. [link](#); SIGIR 2020 NLP Applications. [link](#); ACL 2020 NLP Applications. [link](#).

TALKS

1. MIT Spoken Language Systems Group. May 2019. Rotational Unit of Memory: A Novel Representation Unit for RNNs with Scalable Applications. Invited talk.
2. MIT Experimental Physics Lab I. May 2017. Optical Trapping. Measuring the Boltzmann Constant. Final Public Oral Presentations. [link](#).
3. Emil Horozov's Mathematics Seminar at Sofia University. July 2014. On the Maximal Containments of Lower Central Series. Invited talk.

MENTORING

1. Boris Velasevic (MIT 2023): working on equivariant neural networks.
2. Jialan Wang (MIT 2022): working on contrastive learning with Transformers.
3. Adriano Hernandez (MIT 2022): working on modularity of neural networks.
4. Abnihav Goel (MIT 2025): working on combining manifold learning with self-supervised learning.
5. Tung Tran (MIT 2024): working on robustness of self-supervised learning.
6. Julia Balla (MIT 2021): working on neural symbolic regression for social sciences.
7. Rouba Houssami (RSI 2021): manifold learning for scientific discovery.
8. Christine Yang (RSI 2021): exploring time-invariant contrastive representation learning.
9. Anugrah Chemparathy (MIT 2024): understanding conservation laws in physical systems through contrastive learning.
10. Owen Dugan (MIT 2025): ML models for physics. 2021 Davidson Fellow and 2021 US Presidential Scholar.
11. Isaac Liao (MIT 2023): recursive meta-learning and Transformers.
12. Lay Jain (MIT 2021): neural cellular automata.
13. Pawan Goyal (MIT 2020): differentiable learning of programs. D.E. Shaw Nexus Fellowship.
14. Guillem Ramírez (MIT Exchange Student): aligning word embeddings across languages.
15. Evan Vogelbaum (MIT 2023): physics-inspired meta-learning.
16. Renbin Liu (MIT 2021): improving attention models for NLP.
17. Michelle Shen (MIT 2022): NLP applications for automating science journalism.
18. Dawson Byrd (Exeter 2019, MIT 2024): transfer learning for NLP. Top 5 oral presentations at RSI 2019.

19. Chavdar Lalov (Stanford 2023): enumerative combinatorics and algebra. Third Place at EUCYS 2017. Third Place in Mathematics at Intel ISEF 2018. Top 10 oral presentations at RSI 2018.

PRESS

Work covered in [MIT Technology Review](#), [MIT News](#), [Eureka Alert](#), [Science Blog](#), etc.

[Additional press coverage.](#)

NOTABLE AWARDS

MEMSI Best Pitch Awards

First place

January 2022

Virtual

- Awarded by the MIT Entrepreneurship and Maker Skills Integrator judges for identifying and proposing a solution to a data-collection problem faced by the Hong Kong International Airport.

John Atanasoff Awards

Debut category

October 2019

Bulgaria, Sofia

- Awarded by the President of Bulgaria for contributions to the field of electrical engineering and computer science.

Intel International Engineering and Science Fair

Second place in category Mathematics

May 2014

Los Angeles, CA, USA

- Project developed at RSI 2013.

Research Science Institute

Top 5 scholars (out of 80) for outstanding written work

June – August 2013

Cambridge, MA, USA

- Worked on abstract algebra.

PROFICIENCY

Coding

Python, SLURM, C/C++, Mathematica, TensorFlow, PyTorch, JAX, L^AT_EX

Leadership

MIT [Bulgarian](#) and [Korean Karate](#) Clubs President
[MLxMIT](#) Representative
[MIT AI Physics](#) Representative