Bruno Gavranović

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Working Experience

Symbolica AI

PRINCIPAL SCIENTIST

- Pivoted the R&D programme of the company to Categorical Deep Learning, leading to \$31M funding
- Transformed the theoretical categorical framework into concrete research projects
- Built and led a research team, defining and executing a technical roadmap

Huawei

RESEARCH INTERN

· Worked on theory and C++ implementation of a reverse-mode automatic differentiation framework

Strongly Typed

BACKEND HASKELL DEVELOPER

- · Contributed to the internals of a Haskell codebase for a fleet-management system for restaurant delivery
- Worked with lenses, monad transformers, an effect system, type-level API and template haskell

Selected publications _____

Position: Categorical Deep Learning is an Algebraic Theory of All ArchitecturesConfeB. GAVRANOVIĆ, P. LESSARD, A. DUDZIK, T. VON GLEHN, J. ARAÚJO, P. VELIČKOVIĆ4• Accepted to the International Conference on Machine Learning, 2025.5	e <mark>rence Paper</mark> July 2025.
Categorical Foundations of Gradient-Based Learning Confe	erence Paper
G.S.H. Cruttwell, B. Gavranović, N. Ghani, P. Wilson, and F. Zanasi	March 2022.
Accepted to the conference European Symposium of Programming, 2022	
Learning Functors Using Gradient Descent Confe	erence paper
B. Gavranović	July 2019.
Accepted to the conference Applied Category Theory, 2019.	
Category Theory in Machine Learning	Preprint
D. Shiebler, B. Gavranović, and P. Wilson	July. 2021.
Accepted as a talk at the conference Applied Category Theory, 2021.	
Space-time tradeoffs of lenses and optics via higher category theory	Preprint
B. Gavranović	Sep. 2022.

Education _

PhD, Applied Category Theory

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES, UNIVERSITY OF STRATHCLYDE

- Thesis Fundamental Components of Deep Learning: A Category-Theoretic Approach supervised by Prof. Neil Ghani
- · Developed a novel, end-to-end and uniform framework for neural networks based on rigorous mathematical foundations
- Viva date: 21st of September 2023. Degree obtained: 19th of June 2024.

MSc, Computer Science

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

- Master thesis Compositional Deep Learning supervised by assoc. prof. Jan Šnajder
- Received Special Award of the Rector of the University of Zagreb
- Received Stanko Turk award for distinguished master thesis in Computer Science

BSc, Computer Science

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

Bachelor thesis Application of Deep Learning for Sentiment Analysis supervised by assoc. prof. Jan Šnajder

London, UK March. 2024. - Dec 2024.

Edinburgh, Scotland Aug. 2021. - Nov 2021.

Zagreb, Croatia Sep. 2018. - March 2019.

Glasgow, UK

2019. - 2024.

Zagreb, Croatia 2016. - 2019.

Zagreb, Croatia

2013. - 2016.

M. Cap	ucci, B. Gavranov	ić, A. Malik, F. F	los, J. Weinbe	RGER		
• Acce	epted to the conf	erence Mathe	matical Found	dations of Prog	ramming Sen	nantic
Grap	h Convolution	al Neural N	etworks as	Parametric	CoKleisli m	orph
B. Gave	anović, M. Villan	I				

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• 1 ECTS point worth of academic lectures taught by university professors **Other publications Towards foundations of categorical cybernetics** Conference paper M. CAPUCCI, B. GAVRANOVIĆ, J. HEDGES, F. FJELDGREN RISCHEL July 2021. • Accepted to the conference Applied Category Theory, 2021. **Compositional Game Theory, Compositionally** Conference Paper R. ATKEY, B. GAVRANOVIĆ, N. GHANI, C. KUPKE, J. LEDENT AND F. NORDVALL FORSBERG. • Accepted to the conference Applied Category Theory, 2020. **Fibre Optics** Preprint D. BRAITHWAITE, M. CAPUCCI, B. GAVRANOVIĆ, J. HEDGES, E. FJELDGREN RISCHEL Dec. 2021. **Actegories for the Working Amthematician** M. CAPUCCI, B. GAVRANOVIĆ March 2021. On a fibrational construction for optics, lenses, and Dialectica categories Conference Paper M C. December 2024. ^S hisms Preprint

BEST Spring Course (Board of European Students of Technology)

• Developed an efficient, general PyTorch-like framework for backpropagation in Python

• Reimplemented large parts of foundational category theory formally in Agda

• Including natural transformations, monoidal structure, dependent actions, indexed structure, lenses, ...

· Implemented dynamic computational graphs, higher order derivatives, tensor differentiation and more

MAIN ORGANIZER

OPEN SOURCE PROJECT

• Organized an international 10-day seminar on technology

Helped bring category theory to 1000+ participants

Formalisation of category theory in Agda

Applied Category Theory - Adjoint School

 Studied mathematical foundation of autopoiesis Wrote an nCafe blog post on Behavioral Mereology

Framework for automatic differentiation

PART OF THE TEAM LED BY DAVID SPIVAK

- Coordinated a team of 12 people (PR, FR, HR, Logistics, Design, Web)

Proiects

Categories for AI

ONLINE LECTURE SERIES

OPEN SOURCE PROJECT

October 2022. - May 2023. Organised an introductory lecture series to category theory with collaborators from Google DeepMind

2019 - Present

Oxford, UK

July 2019.

Zagreb, Croatia

Mar. 2017. - Jan. 2018.

Zagreb, Croatia

Preprint

Dec. 2022.

Online

Talks, Awards, Reviewing and Teaching

TALKS

NYC Category Theory Seminar Categorical Deep Learning: An Algebraic Theory of Architectures, Oct 2024.	Online
OxML Categorical Deep Learning: An Algebraic Theory of Architectures, July 2024.	Oxford, UK
Dartmouth LISP Lab What is Applied Category Theory?, March 2024.	Online
CitAl Category Theory \cap Deep Learning: Where are we, and what are the new horizons?, Feb 2024.	London, UK
FER Zagreb What is Category Theory and what is its role in the Future of Deep Learning?, Jan 2024.	Zagreb, Croatia
MSP Group Category Theory \cap Deep Learning: Where are we, and what are the new horizons?, Oct 2023.	Online
Online Machine Learning Seminar Fundamental Components of Deep Learning, Sep 2023.	Online
IQCapital What is Applied Category Theory?, Feb 2023.	Online
Topos Institute Space-time tradeoffs of lenses and optics via higher category theory, Jun 2022.	Berkeley, CA
MSP Group Can we compose Dependent Lenses as Optics?, Jun 2022.	Online
Intercats Optics vs. Lenses, Operationally, Apr 2022.	Online
MSP Group Operational view on Optics, Feb 2022.	Online
UnderstandingDL Learning Functors using Gradient Descent, July 2021.	Online
Lab for AI Verification Neural Networks through the lens of Category Theory, Mar 2021.	Online
MSP Group Generalised open learners, Feb 2021.	Online
Institute for Categorical Cybernetics Generalised open learners, Dec 2020.	Online
MSP Group Towards Compositional Structures in Neural Networks, Feb 2020.	Online
Petnica Summer School on Machine Learning Generative Adversarial Networks, 2017, 2018.	Petnica, Serbia

Awards

Recipient, Helium Grant (1000\$), 2019.	
Winner, National award "Oscar of Knowledge", 2013.	Zagreb, Croatia
1 st place, National Astronomy Competition, 2012.	Rovinj, Croatia
Honorable mention, 6 th International Olympiad on Astronomy and Astrophysics, 2012.	Rio de Janeiro, Brazil

REVIEWING EXPERIENCE

NeurIPS 2024 Logic in Computer Science 2020 Applied Category Theory 2021, 2022, 2023 Compositionality 2022 Journal of Financial Technology 2022

LAB DEMONSTRATOR

Computer Systems and Organization - CS106, CIS Department, University of Strathclyde
Functional Thinking - CS260, CIS Department, University of Strathclyde
Functional Programming - CS316, CIS Department, University of Strathclyde
Theory of Computation - CS411, CIS Department, University of Strathclyde
Machine Learning for Data Analytics - CS985, CIS Department, University of Strathclyde
Computer Forensics - Faculty of Electrical Engineering and Computing, University of Zagreb

Knowledge & Abilities _

TECHNICAL SKILLS

- Programming: Haskell, Agda, Python, Java, Idris, SQL, C, Metamath
- Other: linux, git, vim, emacs, zsh, PyTorch, TensorFlow

LANGUAGES

• English (C1.1), Spanish (B1), Croatian (Native)