

Bruno Gavranović

AUGUST, 2022

Glasgow, Scotland, United Kingdom

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PhD student applying category theory to supervised learning, unsupervised learning, and game theory.

Publications

Categorical Foundations of Gradient-Based Learning

Conference Paper

G.S.H. CRUTTWELL, B. GAVRANOVIĆ, N. GHANI, P. WILSON, AND F. ZANASI

March 2022.

- Programming Languages and Systems. ESOP 2022. Lecture Notes in Computer Science, vol 13240. Springer, Cham.

Towards foundations of categorical cybernetics

Conference paper

M. CAPUCCI, B. GAVRANOVIĆ, J. HEDGES, F. FJELDGREN RISCHER

July 2021.

- Accepted in Proceedings of 'Applied Category Theory', 2021.

Compositional Game Theory, Compositionally

Conference Paper

R. ATKEY, B. GAVRANOVIĆ, N. GHANI, C. KUPKE, J. LEDENT AND F. NORDVALL FORSBERG.

July 2020.

- Accepted in Proceedings of 'Applied Category Theory', 2020.

Learning Functors Using Gradient Descent

Conference paper

B. GAVRANOVIĆ

July 2019.

- Accepted in Proceedings of 'Applied Category Theory', 2019.

Category Theory in Machine Learning

Preprint

D. SHIEBLER, B. GAVRANOVIĆ, AND P. WILSON

July. 2021.

- Accepted as a talk at 'Applied Category Theory', 2021

Fibre Optics

Preprint

D. BRAITHWAITE, M. CAPUCCI, B. GAVRANOVIĆ, J. HEDGES, E. FJELDGREN RISCHER

Dec. 2021.

Actegories for the Working Amthematician

Preprint

M. CAPUCCI, B. GAVRANOVIĆ

March 2021.

Education

PhD, Applied Category Theory

Glasgow, UK

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES, UNIVERSITY OF STRATHCLYDE

2019. - present

- Supervisor: Neil Ghani
- Working on compositional frameworks on the intersection of supervised learning, unsupervised learning, and game theory

Master studies, Computer Science

Zagreb, Croatia

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

2016. - 2019.

- Supervisor: assoc. prof. dr. sc. Jan Šnajder
- Master thesis - *Compositional Deep Learning*
- Master thesis was accepted into the ACT2019 conference and awarded the following:
 - Special Award of the Rector of the University of Zagreb
 - Stanko Turk award for distinguished master thesis in Computer Science

Master studies, Artificial Intelligence

Madrid, Spain

ETS INGENIEROS INFORMÁTICOS, UNIVERSIDAD POLITÉCNICA DE MADRID

Sept. 2016 - Feb. 2017

- Semester abroad as a part of student exchange

Undergraduate studies, Computer Science

Zagreb, Croatia

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

2013. - 2016.

- Supervisor: assoc. prof. dr. sc. Jan Šnajder
- Bachelor thesis: *Application of Deep Learning for Sentiment Analysis*
- Diploma Seminar - TensorFlow implementation of the *Differentiable Neural Computer*

Working Experience

Huawei

RESEARCH INTERN

Edinburgh, Scotland

Aug. 2021. - Nov 2021.

- Spent three months as a part of the Programming Languages group led by Dan Ghica
- Worked on theory and implementation of a reverse-mode automatic differentiation framework

Strongly Typed Ltd.

BACKEND HASKELL DEVELOPER

Zagreb, Croatia

Sep. 2018. - March 2019.

- 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

Projects

Framework for automatic differentiation

OPEN SOURCE PROJECT

Zagreb, Croatia

Mar. 2017. - Jan. 2018.

- Developed an efficient, general PyTorch-like framework for backpropagation in Python
- Implemented dynamic computational graphs, higher order derivatives, tensor differentiation and more

Reimplemented a dozen of state of the art deep learning papers and frameworks

HIGHLIGHTS INCLUDE

Zagreb, Croatia

Feb. 2017. - Present

- **Backprop as Functor:** Haskell implementation of a category-theoretic formulation of neural networks
- **Differentiable Neural Computer:** DeepMind's 2016 Nature paper, neural network architecture capable of learning algorithms
- **Generative Adversarial Networks:** DCGAN, Wasserstein GAN, CycleGAN and others
- **Decoupled Neural Interfaces:** a novel approach to distributed training of networks

BEST Spring Course (Board of European Students of Technology)

MAIN ORGANIZER

Zagreb, Croatia

2015.

- Organized an international 10-day seminar on technology
- Coordinated a team of 12 people (PR, FR, HR, Logistics, Design, Web)
- 1 ECTS point worth of academic lectures taught by university professors

Misc. Academic Experience

Applied Category Theory - Adjoint School

PART OF THE TEAM LED BY DAVID SPIVAK

Oxford, UK

July 2019.

- Studied mathematical foundation of autopoiesis
- Culminated in a nCafe blog post on Behavioral Mereology

Petnica Summer School of Machine Learning

INVITED TALK, MENTORING

Petnica, Serbia

2017., 2018.

- Held a lecture and workshop on Generative Adversarial Networks
- Mentored several teams in implementing various neural network architectures

Lab Demonstrator

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES, UNIVERSITY OF STRATHCLYDE

Glasgow, UK

Oct. 2019. - present

- CS106 - Computer Systems and Organization
- CS260 - Functional Thinking
- CS316 - Functional Programming
- CS411 - Theory of Computation
- CS985 - Machine Learning for Data Analytics

FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

Oct. 2017. - Feb. 2018.

- Computer Forensics

Refereeing

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES, UNIVERSITY OF STRATHCLYDE

- Logic in Computer Science: 2020
- Applied Category Theory: 2021, 2022
- Compositionality, 2022
- Journal of Financial Technology, 2022

Additional education, awards & recognition

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

Knowledge & Abilities

TECHNICAL SKILLS

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

LANGUAGES

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