

Guillaume Wang

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RESEARCH INTERESTS

- Machine Learning Theory: generalization guarantees, implicit bias of models and of learning algorithms
- Convex and Nonconvex Optimization

EDUCATION

- 2019 - 2021 **M.Sc. in Computer Science**
ETH Zurich, Switzerland
Overall GPA: **5.80 (max: 6, min: 1)** via 114 credits
- 2016 - 2020 **Cycle Ingénieur polytechnicien**
3rd year track: Computer Systems Design
École polytechnique, France
Overall GPA: **3.87 out of 4** via 166 credits
- 2014 - 2016 Classe Préparatoire aux Grandes Écoles **MPSI/MP*** (Math, Physics)
Collège Stanislas, Paris, France

ACADEMIC RESEARCH

Apr. 2021 -
Present

RKBS and “In-Principle” Inductive Bias of Overparametrized Models

Internship at Statistical Machine Learning group, ETH Zurich, under the supervision of **Prof. Fanny Yang**

In the first months of this ongoing internship I explored two directions. Firstly, I attempted to adapt the efficient learning algorithms for RKHS models to the Banach case. This is impossible in most cases due to the nonlinearity of the duality map. In the process I partly clarified competing definitions of RKBS.

Secondly, prompted by the unintuitive case of the RKBS \mathcal{F}_1 capturing two-layer neural networks trained with ℓ^2 weight decay, I defined the “in-principle” inductive bias of parametric models. I calculated it for a number of deep linear network architectures and showed that it is non-convex for deep ReLU networks.

I expect that, combined with the implicit bias of learning algorithms, knowledge of the in-principle inductive bias of neural networks will lead to generalization guarantees. This framework would strictly extend known results for the kernel (“lazy”) regime, for the mean-field regime, for weight-alignment phenomena, and for linear models.

Sep. 2020 -
Mar. 2021

Entropy Numbers of Nonlinear Systems

Master's Thesis Project at Chair for Mathematical Information Science, ETH Zurich, under the supervision of **Prof. Helmut Bölcskei**

I extended common proof techniques for upper-bounding covering numbers – equivalently, metric entropy or entropy numbers – of function spaces, to spaces of nonlinear systems. This extension proceeds either via general parametric models such as Volterra or Wiener series, or by viewing nonlinear systems as mappings between signals.

In the process, I showed how to leverage Banach operator approximation theory for general metric entropy estimates, by interpreting the entropy number of any set as the entropy number of an operator. I showed that symmetric tensor functions are dense in the space of permutation-invariant multivariate functions. Relatedly, Volterra series are the elements of the Reproducing Kernel Banach Space (RKBS) for the polynomial kernel. Finally, extending the Nyquist-Shannon sampling theorem, I characterized all functions that can be used for shift-invariant reconstruction from a multivariate band-limited function's samples.

Adviser: Dr. Erwin Riegler

<https://bit.ly/3kGe56L>

Summer
2019

Optimizing Commuter Welfare with Subsidies in Multimodal Transportation

Internship at School of Civil and Environmental Engineering, Cornell University, under the supervision of **Prof. Samitha Samaranyake**

I studied how public transit agencies could collaborate with ride-hailing companies, e.g Uber or Lyft, to improve commuter welfare. The public transit agency's budget would be split into costs for operating the public bus network, and subsidies designed to incentivize the ride-hailing company's collaboration. I modeled the situation as a three-step game: the public transit agency chooses a subsidy scheme, then the ride-hailing company chooses its fares, then each commuter chooses a (possibly multimodal) itinerary. Several behaviour models for the commuters and the ride-hailing company were considered. Even for small road networks, this three-step game is difficult to solve analytically. I studied the case of networks with one or two roads, and presented a framework for the general case.

Adviser: Dr. Raga Gopalakrishnan

Report: <https://bit.ly/360jW1E>

Slides: <https://bit.ly/3hUu0g4>

TALKS

- Entropy Numbers of Nonlinear Systems, **Master's Thesis**.
ETH Zurich, Switzerland, March 2021.
<https://bit.ly/3zk05Sp>
- “Streaming PCA & Subspace Tracking: The Missing Data Case” (Balzano, Chi, and Lu, 2018), **Seminar**.
ETH/USZ Seminar Database Systems, Switzerland, May 2020.
<https://bit.ly/3hTV8eS>
- “What Can ResNet Learn Efficiently, Going Beyond Kernels?” (Allen-Zhu and Li, 2019), **Seminar**.
ETH Zurich, Switzerland, May 2020.
<https://bit.ly/3iBfsAU>

SELECTED COURSES

Applied Mathematics	MAP557 Operations Research	Prof. Stéphane Gaubert	A
	MAP564 Social & Communication Networks	Prof. Laurent Massoulié	A
	MAP432 Modelling Random Events	Prof. Thierry Bodineau	A
ML Theory	Guarantees for Machine Learning	Prof. Fanny Yang	6
	Probabilistic Artificial Intelligence	Prof. Andreas Krause	6
	Statistical Learning Theory	Prof. Joachim Buhmann	6
	Neural Network Theory	Prof. Helmut Bölcskei	6
Computer Science	Algorithms Lab	Prof. Angelika Steger	5.75
	Concepts of Object-Oriented Programming	Prof. Peter Müller	5.75
	INF559 Computer Architectures & Operating Systems	Prof. Francesco Zappa Nardelli	A
	INF421 Algorithm Design & Analysis	Prof. Benjamin Doerr	A

ACADEMIC PROJECTS

Fall 2021	Axiomatic Approach to Journal and Article Impact Metrics Course Project, Department of Humanities, Social and Political Sciences, ETH Zurich The PageRank method plays a central role not only for journal-level, but also for article-level metrics, despite article citation graphs being DAGs. https://bit.ly/3kMc1KF Course: Mathematics for Politics and Law, Dr. Philip Grech
Spring 2020	Character-level Sequence Representation for Classification of Tweets with Misspellings Course Project, Department of Computer Science, ETH Zurich A language model based on character-level embeddings that classifies tweets with competitive accuracy without any pre-processing, despite misspellings and abbreviations. Course: Computational Intelligence Lab, Prof. Thomas Hofmann
Fall 2019	Automated Certifier for Neural Network Robustness against Adversarial Attacks Course Project at Department of Computer Science, ETH Zurich Scalable automated certification of robustness against adversarial attacks, for ReLU-activated fully connected and convolutional neural networks. Based on DeepZ with a learned zonotope transformer. https://bit.ly/2UC1GGd Course: Reliable and Interpretable Artificial Intelligence, Prof. Martin Vechev
Spring 2019	Mini-C compiler Course Project, Department of Computer Science, École polytechnique Writing a compiler from a subset of the C language to x86-64 assembly, in OCaml. Course: INF564 Compilation, Prof. Jean-Christophe Filliâtre
Spring 2018	Distributed Join Processing on Social Network Data Programming Project (PI), Department of Computer Science, École polytechnique Processing join queries in a distributed fashion with MPI, in C++. https://bit.ly/3zjysuz Course: INF442 Massive Data Processing, Prof. Claudia D'Ambrosio

Fall 2017 | **Rush Hour Solver**
Programming Project (PI), Department of Computer Science, École polytechnique
Efficient solver for the puzzle game Rush Hour in Java.
Course: INF421 Design and Analysis of Algorithms, Prof. Benjamin Doerr

PROGRAMMING SKILLS

Programming Languages Python (pytorch, pandas, scikit-learn), Java, C, C++, Caml
javascript (Node.js, React.js), GraphQL, Django, PHP (Symfony)

LANGUAGE PROFICIENCY

French Native
Chinese Native
English Fluent (C1)
TOEFL iBT: 107 out of 120 - November 2018
Reading: 28, Listening: 28, Speaking: 24, Writing: 27
German Conversational (B2-C1)
Russian Intermediary (B1)

HOBBIES

Student life at ETH

- Member of MoEB (Masters ohne ETH Bachelor)
Student association for Master students without an ETH bachelor.
- Started and administrated a Discord server for ETH Computer Science Master students.
<https://bit.ly/3rpsuW6>

Student life at Polytechnique

- Board member (treasurer) of Binet Réseau (computer network student association)
- Board member (treasurer) of X-Chine (Chinese student association)
- Member of Binet BD (comic book student association)
- Member of Album Promo (yearbook)
- Sigma development project
Reinitiated the “Sigma” project, a multi-year development project to replace the old student website, “Frankiz”. Took part in full-stack web development and infrastructure design. Sigma is a group- and event-based social network, written in Node.js, React.js, and using GraphQL.
<https://sigma.binets.fr>

REFERENCES

Prof. Fanny Yang Assistant Professor
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Prof. Helmut Bölcskei Professor
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