

# Abhimanyu Pallavi Sudhir

Mathematics undergraduate interested in AI research. Familiar and reasonably experienced with the basic dimensions of neural network architectures, and looking to explore the theoretical aspects of machine learning in greater detail.

## Research

- **Specialized neural network architectures for finance · 2020-present** – In-progress work on encoder-decoder models for feature extraction from financial time series.
- **Agent-based economic simulation · 2020-present** – In-progress work on the reformulation of economic concepts in the language of agent-based simulation and reinforcement learning.
- **Fractional calculus · 2018-19** · [\[arXiv 1\]](#)[\[arXiv 2\]](#) – Pure maths project on fractional calculus; proposed defining a “principal value” of the Grünwald-Letnikov derivative.
- **Generalized determinants · 2013-14, 2019** · [\[Journal 1\]](#)[\[Journal 2\]](#)[\[arXiv\]](#) – Proposed a determinant for non-square matrices and researched its relationship with existing literature. (*publication list at end of document*)

## Machine learning and programming projects

### Contribution to Lean · 2018-present

Lean is a formal proof verification system developed by Microsoft Research.

- Wrote the ultraproduct and hyperreal libraries for the Lean math library, authoring over 1500 lines of code [\[Github 1\]](#)[\[Github 2\]](#)
- Formalized solutions to a first-year Imperial math exam in Lean [\[announcement\]](#)
- Currently writing a model theory and theoretical computer science library.

### Machine Learning projects · 2020-present

- *This Latin character does not exist · work in progress* – a transfer learning approach to create new (undecipherable) glyphs in the style of an alphabetical script (e.g. Latin/Indic).
- *This Chinese character does not exist · 2020* · [\[Colab\]](#)[\[Github\]](#) – I trained a GANN to generate new (i.e. undecipherable, fake) Chinese characters by learning the distribution of Chinese characters from a sample of 80,000 distinct Chinese characters with one example each.
- *Neural networks are a poor source of entropy · 2020* [\[Colab\]](#) – an attempt (via RNNs) to demonstrate that neural networks, like human brains, are poor sources of entropy.
- *A deeper dive into CNNs · 2020* [\[Colab\]](#) – experimental tests of widely-claimed properties of convolutional neural networks, such as isotropy and locality.

### Miscellaneous programming

- Continuous Bayesian Inference (2019) [\[RShiny\]](#)
- Sudoku solver (2018) [\[Github\]](#)

## Pet projects

### Personal blog · 2016-present

- I run a blog on topics including statistics, information theory, machine learning and pure mathematics. Sample articles:
  - Sigma fields as Venn diagrams [\[link\]](#)
  - Machine learning as function approximation [\[link\]](#)
  - Introduction to Bayesian inference [\[link\]](#)
  - Lossless compression, invertible change of variables and entropy [\[link\]](#)

## Volunteer work

- *Reviewer for Advances in Applied Clifford Algebras (Springer) · 2020-present*
- *Co-founder, moderator of PhysicsOverflow · 2014-18* [[Website link](#)]/[[Wikipedia page](#)]

## Formal qualifications

### Education

- *Mathematics MSci · Imperial College London · 2018-22* – First-class honors + Dean’s list (top 10% of class) in year 1, year 2.
- *IB Diploma · 2016-18* – 44/45 points; GPA: 3.93/4.00

### Internships and experience

- *Schroders Asset Management · Spring Insight · 2020*
- *Jane Street · Spring Insight (SPIN) · 2020* [event cancelled due to COVID-19]
- *Jane Street · Insight day · 2018*

### Supervised reading projects

- *Undergraduate Research Opportunities Program (2019)* – Studied Lie theory and topology under Professor Richard Thomas at Imperial College, and wrote a 10-pg report. [[report](#)]

### Courses

- *Machine Learning and Applied Statistics (2019)*
  - 3-week summer course at Imperial Business school, worth 7.5 ECTS points.
  - Syllabus: classical data mining, neural networks, time series analysis
  - Coursework: analysis of genome data using dimensionality reduction and neural networks; fitted and analyzed test statistics for an ARIMA model to stock price data
  - Overall score: 97.5%
- *Tensorflow for AI Professional Certificate (deeplearning.ai, 2019)* – score: 93.3% [[certificate](#)]
- *Securities Education Certificate (2019)* – score: Distinction; introduction to various asset classes
- *Fundamentals of Finance (2019)* – syllabus: basics of investment banking and capital structures, risk management (portfolio optimization, efficient frontiers, volatility), returns models (CAPM, Fama-French), Greeks

## Big lists

### Publication list

#### *Machine learning and Agent theory*

- Abhimanyu Pallavi Sudhir (2020), “Specialized Neural Network architectures for financial time-series”, Draft in Progress.
- Abhimanyu Pallavi Sudhir (2020), “On endogenous business cycles in agent-based economic models”, Draft in Progress.
- Abhimanyu Pallavi Sudhir (2020), “A general agent-based model of classical economics”, Draft in Progress.

#### *Pure mathematics*

- Abhimanyu Pallavi Sudhir (2019), “Infinitesimal translations and a multivariate Grünwald-Letnikov calculus”, [arxiv.org/abs/1904.02710](https://arxiv.org/abs/1904.02710)

- Abhimanyu Pallavi Sudhir (2018), “The generalized Cauchy derivative as a principal value of the Grünwald-Letnikov fractional derivative for divergent expansions,” [arxiv.org/abs/1809.08051](https://arxiv.org/abs/1809.08051)
- Abhimanyu Pallavi Sudhir (2019), “Generalisations of the determinant to interdimensional transformations: a review,” [arxiv.org/abs/1904.08097](https://arxiv.org/abs/1904.08097)
- Abhimanyu Pallavi Sudhir (2014), “On the Determinant-like function and the Vector Determinant,” *Advances in Applied Clifford Algebras* (24-3: 805-807), [link.springer.com/article/10.1007/s00006-014-0455-3](https://link.springer.com/article/10.1007/s00006-014-0455-3)
- Abhimanyu Pallavi Sudhir (2014), “On the Properties of the Determinant-like function,” (presented at International Conferences on Mathematical Sciences, Chennai, July 17-19, 2014).
- Abhimanyu Pallavi Sudhir (2013), “Defining the Determinant-like function for  $m$  by  $n$  matrices using the exterior algebra,” *Advances in Applied Clifford Algebras* (23-4: 787-792), [link.springer.com/article/10.1007/s00006-013-0416-2](https://link.springer.com/article/10.1007/s00006-013-0416-2)
- Abhimanyu Pallavi Sudhir (2012), “The Representation of Matrices in unit vector notation,” *Journal of Mathematics Research* (4-4: 86-91), [dx.doi.org/10.5539/jmr.v4n4p86](https://dx.doi.org/10.5539/jmr.v4n4p86)

#### Miscellaneous

- Abhimanyu Pallavi Sudhir and Rahel Knoepfel (2015), “PhysicsOverflow: A postgraduate-level physics Q&A site and open peer review system,” *Asia-Pacific Physics Newsletter* (4-1: 53-55), [dx.doi.org/10.1142/S2251158X15000193](https://dx.doi.org/10.1142/S2251158X15000193)

#### Talks and conferences

- *Local normal forms of analytical maps near fixed points* – Group report and presentation (module) 2020
- *Lie theory: the topology of groups* – Warwick-Imperial Autumn Meeting (WIMP) 2020 · Imperial Undergraduate Colloquium 2019 · Imperial 3-minute thesis competition 2019
- *Ultraproducts and hyperreal numbers* – Individual presentation project (module) 2019
- *Fractional calculus* – IMA Tomorrow’s Mathematicians Today (IMA TMT) 2019 · Imperial Undergraduate Colloquium 2018
- *Lectures on special relativity* – lectures to my high-school physics class 2017-18
- *Generalized determinants* – Intel ISEF 2015 · International Conference on Mathematical Sciences 2014

#### Awards

- ICBS Machine Learning Summer course (2019) – departmental full scholarship
- Conferences and science fairs
  - IMA TMT, London (2019) – among 4 shortlisted for GCHQ prize
  - Intel ISEF, Pittsburgh (2015) – AMS Karl Menger Award
  - International Conference on Mathematical Sciences 2014 – Best Paper Award
- Problem-solving and olympiads
  - Imperial Mathematics Competition (2019) – nationwide finalist
  - IIT Math Olympiad (2017) – sixth place nationally in India
  - Regional Mathematical Olympiad (2016) – Merit

#### Programming Languages

- *General* – Python, Matlab, PHP, C++, Javascript; standard libraries thereof
- *Data and ML* – R, Tensorflow, Keras, Pytorch, SQL, Excel
- *Functional programming* – Lean
- *Miscellaneous* – RegEx, markup languages (HTML, CSS, LaTeX)