

# Sankalp Gambhir

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I am a senior undergraduate student at IIT Bombay, graduating in May 2022, looking for a summer internship researching automated reasoning and program analysis. I will be beginning my PhD in Computer Science in Fall 2022.

My research interests revolve around automata theory, formal methods, and program analysis. I have 3 years of experience researching temporal logics and verification of probabilistic and concurrent systems, and a strong background in abstract math and formal methods in CS.

## education

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|           | Year | Program  | CPI/% | Institute                                     |
|-----------|------|--|-------|---|
| (ongoing) | 2022 | B.Tech. Engineering Physics,<br>Minor in Computer Science,<br>Minor in Mathematics | 9.20  | Indian Institute of Technology, Bombay (IITB) |
|           | 2018 | Intermediate/+2  | 96.4% | Central Board of Secondary Education, India   |

## research projects

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### Non-Markovian Inverse Reinforcement Learning

2022, Under Review

Mohammad Afzal, *Sankalp Gambhir*, Ashutosh Gupta, Krishna Shankaranarayanan, Ashutosh Trivedi, Alvaro Velasquez

- ✂ Formulated novel learning formalism for Non-Markovian reward function inference.
- ✂ Adapted LTL learning techniques to Inverse Reinforcement Learning (IRL) to utilize logical specifications as reward functions.
- ✂ Demonstrated capabilities of the technique to learn previously unexplored Non-Markovian properties in reward functions for an agent exploring grid worlds.

### Quantitatively Learning LTL Specification

2019-2021

Mohammad Afzal, *Sankalp Gambhir*, Ashutosh Gupta, Krishna Shankaranarayanan

Preprint: [arXiv:2110.13616](https://arxiv.org/abs/2110.13616) | Tool: <https://github.com/sankalpgambhir/quantlearn>

- ✂ Developed a system to rank and learn LTL formulae for a set of input traces with high resilience to noise and low input size requirement compared to state-of-the-art systems presented in literature.
- ✂ Studied structure of  $\omega$ -regular languages to improve algorithmic efficiency for inference.

### Information Theoretic Bounds on NISQ Learning Systems

2021-Ongoing

Advisor: Prof. Sai Vinjanampathy, Department of Physics, IIT Bombay

*Bachelor's Thesis* | [working copy](#)

- ✂ Proposed error bounds on Variational Quantum Algorithms (VQAs) arising from information-theoretic channel limits in classical control systems.
- ✂ Established an uncertainty bound on VQA optimization for problem-specific ansatzes.
- ✂ Studying extension to generalisation error bounds in Quantum Support Vector Machines.

## key projects

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### Ardio - Model for realtime audio processing on low power embedded systems

Fall 2020

Advisor: Prof. Pradeep Sarin, Department of Physics, IIT Bombay

Course Project, <https://github.com/sankalpgambhir/ardio>

- ✂ Worked in a team of two to develop an optimized Fourier Transform algorithm capable of working on low power devices such as an Arduino whilst retaining reasonable accuracy.
- ✂ Demonstrated frequency finding on live audio samples in near real-time on an Arduino Uno with less than 2KB RAM.

### Petris - An FPGA based Tetris clone

Spring 2020

Advisor: Prof. Pradeep Sarin, Department of Physics, IIT Bombay

Course Project, <https://github.com/sankalpgambhir/petris>

- ✂ Worked in a team of two to design and simulate the game of Tetris on an FPGA simulator. Used Verilog to make a state machine and created a C++ wrapper using SDL and OpenGL to handle display and I/O.
- ✂ Developed a VGA simulator using SDL2 to write the serial 'electronic' VGA output from the FPGA simulations into a low-level frame buffer.
- ✂ Developed an interface to pass keyboard presses on the computer to the FPGA via simulated electronic connections to allow for real-time input.

### Logarithmic Order Long Binary Multiplication on TTL circuits

Spring 2019

Advisor: Prof. Mahesh B. Patil, Department of Electrical Engineering, IIT Bombay

Course Project

- ✂ Led a team of three to devise a shift-and-add cascade for efficient digital multiplication on TTL circuits.
- ✂ Utilised asynchronous modules to achieve logarithmic time performance and achieved a scalable plug and play design to extend to larger systems.

## teaching experience

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- ✂ Awarded *Excellence in CSE Teaching Assistantship Award* for 'CS228M' by the CSE Department. Fall 2021
- ✂ Led a team of 10 Teaching Assistants for 'CS228M - Logic in Computer Science (Minor)' to a class of 130 students, organising tutorials and course evaluations, under Prof. Krishna Shankaranarayanan. Fall 2021
- ✂ Teaching Assistant for 'CS228 - Logic in Computer Science' to a class of 147 students, under Prof. Krishna Shankaranarayanan and Prof. Ashutosh Gupta. Spring 2021
- ✂ Held basic English and computer classes for university employees, as part of the Computer Literacy Program – NSS, IIT Bombay. Spring 2019
- ✂ Held Physics classes for the JEE for underprivileged children; prepared study material and tests for the same, as a part of the Aarohan Winter Internship Program – NSS, IIT Delhi. Winter 2018

## seminars held

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### Eigenfunctions of Dirichlet Laplacians and Nodal Domains over Graphs

Fall 2019

Department of Mathematics, IIT Bombay

Advisor: Prof. Gopala K Srinivasan, Department of Mathematics, IIT Bombay

- ✂ Discussed spectral features of the Laplacian operator and the distribution of nodes relative to the spectrum, via variational principles and via optimisation of Rayleigh quotients over  $H^2$  space.
- ✂ Presented new insights on the multidimensional extension of Sturm's Oscillation Theorem and its application to discretized domains using graph Laplacians.

## technical skills

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|-------------|---|
| Languages   | English (native), Hindi (native)  |
| Programming | C++, C, Python, Haskell, Bash/POSIX tools, Lustre/SCADE/Heptagon, Verilog |
| Packages    | LaTeX, Z3, LLVM, Mathematica, AutoCAD, Solidworks                         |

## key courses

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|                  |  |
|------------------|--|
| Computer Science | Analysis of Concurrent Programs <sup>‡</sup> *, Embedded Systems <sup>‡</sup> *, Implementation of Functional Programming Languages <sup>‡</sup> *, Operating Systems <sup>‡</sup> , Complexity Theory <sup>*</sup> , Computational Ring Theory and Algebras <sup>*</sup> , Automated Reasoning <sup>*</sup> , Concepts Tools and Algorithms for Model Checking <sup>*</sup> , Logic for Computer Science, Computer Networks |
| Mathematics      | Combinatorics <sup>‡</sup> *, Differential Geometry <sup>*</sup> , Topics in Hyperplane Arrangements (Coxeter Theory) <sup>*</sup> , Semigroup Theory <sup>*</sup> , Topics in Algebra 2 (Representation and Category Theory) <sup>*</sup> , Complex Analysis <sup>*</sup> , Ordinary Differential Equations <sup>*</sup> , Partial Differential Equations, Linear Algebra   |
| Physics          | Quantum Information and Computing <sup>*</sup> , Condensed Matter Physics, Statistical Physics, Quantum Mechanics 1 & 2, Photonics, Electromagnetism, Special Theory of Relativity, Classical Mechanics  |
| Others           | Analog Electronics, Analog Electronics Lab, Digital Circuits, Digital Electronics Lab, Microprocessor Lab, Data Analysis and Interpretation  |

<sup>‡</sup> To be completed by April 2022      <sup>\*</sup> Graduate level course

## academic achievements

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|------|--|
| 2018 | Ranked in the 99.98 <sup>th</sup> percentile in JEE Main 2018 amongst over 1 million candidates. |
| 2018 | Ranked in the 99.7 <sup>th</sup> percentile in JEE Advanced 2018 amongst 200,000 candidates.     |
| 2018 | Awarded <i>National Top 1%</i> certification in National Standard Examination in Physics.        |
| 2018 | Awarded <i>National Top 1%</i> certification in National Standard Examination in Chemistry.      |
| 2016 | Qualified for KVPY Fellowship from the Department of Science and Technology, India.              |

## extracurricular involvement

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### Social Involvement

- ✂ Recorded audiobooks in Hindi for the visually-impaired as part of Voice of Purpose – NSS, IIT Bombay. Fall 2018

### Fine Arts

- ✂ Had four pieces of digital art on display at Vision 2019 – Design weekend of IIT Bombay.
- ✂ Had two pieces of digital art on display at Vision 2020 – Design weekend of IIT Bombay.

## references

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Prof. Ashutosh Gupta  
IIT Bombay  
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Prof. Krishna Shankaranarayanan  
IIT Bombay  
krishnas@cse.iitb.ac.in

Prof. Sai Vinjanampathy  
IIT Bombay  
sai@phy.iitb.ac.in