Sankalp Gambhir

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I am an undergraduate student at IIT Bombay looking for a doctorate in Computer Science . 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

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

research projects

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 | 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.
- Studying topological structure of ω−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

- Established error bounds on Variational Quantum Algorithms (VQAs) arising from information-theoretic channel limits in classical control systems.
- Studying behaviour of error bounds with changes in circuit parameters and problem-specific ansatz choices.
- Studying extension to generalisation error bounds in Quantum Support Vector Machines.

teaching experience

- 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

key projects

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.

seminars held

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

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

Computer Science	Analysis of Concurrent Programs ‡*, Embedded Systems ‡*, Implementation of Functional Programming Languages ‡*, Operating Systems ‡, Complexity Theory *, Computational Ring Theory and Algebras *, Automated Reasoning *, Concepts Tools and Algorithms for Model Checking *, Logic for Computer Science, Computer Networks
Mathematics	Combinatorics ‡*, Differential Geometry*, Topics in Hyperplane Arrangements (Coxeter Theory) *, Semigroup Theory *, Topics in Algebra 2 (Representation and Category Theory)*, Complex Analysis*, Ordinary Differential Equations*, Partial Differential Equations, Linear Algebra
Physics	Quantum Information and Computing *, 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

‡ To be completed by April 2022 * Graduate level course

academic achievements

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

extracurricular involvement

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

Prof. Ashutosh Gupta
IIT Bombay
akg@cse.iitb.ac.in

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

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