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1. Relevant Experience

a) Category Theory

I have familiarity with basic category theory concepts (kleisli categories, functors, currying, monads, and their usage...) from “Category Theory for Programmers by Bartosz Milewski”. Also, I’m comfortable with OCaml and Coq and know a little bit of Haskell and Lisp.

b) Quantum Mechanics

I have a strong background and interest in Quantum Mechanics especially the foundational issues (“the Measurement Problem”), various competing interpretations of QM (“GRW”/ “Bohmian”/ “Everettian”), Quantum Computing, and Black-hole Information paradox.

c) Computational Complexity

I have studied the Theory of Computation, Logic, Complexity Theory and I’m aware of the major tools and techniques in the area (“reduction”, “algebraic circuit complexity”, “relation between complexity classes” etc.)

d) Financial Modelling

My interest in (elementary) game theory and probability and randomized procedures has led me to join a Quantitative Hedge fund for my summer internship as a Quant. But I wasn't aware of the use of Category theory in this direction, so I'll be excited to learn.

2. Education

I'm still pursuing my undergrad in Computer Science(expected 2020).

3. Order of project preference

1. Simplifying quantum circuits using the ZX-calculus
2. Complexity classes, computation, and Turing categories
3. Partial evaluations, the bar construction, and second-order stochastic dominance
4. Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces
5. Toward a mathematical foundation for autopoiesis
6. Traversal optics and profunctors

4. To what extent can you commit to coming to Oxford

I'm highly likely to be able to come to Oxford(I have holidays during that period.)

Statement of Purpose

My interest in this school is due to the following reasons:

1. Foundational issues in Quantum Mechanics

I have a strong interest in the apparent contradictions in foundations of physics(like “the Measurement Problem in QM”, “Black Hole Information Paradox”, “Time Asymmetry”).

For the first issue, I believe, addressing the problem from a philosophical point of view could be helpful(since a huge issue is deciding what the words actually mean and avoiding categorical mistakes(of the kind that were made in the last century)). I think here adopting the style of Bob Coecke’s(and others) could be helpful or at least revealing of any contradictions in logic.

For the second one, it could be possible that the only resolution is through the discovery of a theory of Quantum Gravity, and one direction of research is the hypothesis that nature is a Quantum Error Correction Code(ECC). Again philosophical and diagrammatic analysis could turn out to be useful in figuring out the ECC.

2. Quantum Computing(and acheiving it in practice)

I’m also interested in various aspects of Quantum Computing(from algorithms to interfaces to applications). By the time Quantum computers will become mainstream(that is large circuits which are able to do things like Shor factorization), which might be a long time from now, would require smarter ways for manipulating gates used in quantum circuits. And here ZX calculus could be of help. I looked into Miriam Backens’s Categorical QM course and found it really exciting. Hence by doing this project, I would like to learn this amazing set of ideas.

3. A (Universal) Theory of Networks

I really got drawn into ACT after hearing to John Baez's talk about how many sciences(physics: Feynman diagrams, ecology & biology: use a language of blocks of various shapes and sizes etc...) make use of diagrams (graphs/networks) and formulate rules which are only applicable to that field. By using the language of categories we can standardize them. Thus anyhow
CT is a nice tool to have for anyone working in the sciences.

Bhavishya Desai

PRE-FINAL YEAR UNDERGRADUATE · COMPUTER SCIENCE AND ENGINEERING

Indian Institute of Technology Kanpur

☎ (+91) 9413015982 | ✉ bhavishyagopesh@gmail.com | 🏠 <https://bhavishyagopesh.github.io/> | 📱 bhavishyagopesh | 🌐

bhavishya-desai-aa4439130

Education

Indian Institute of Technology Kanpur

BACHELOR OF TECHNOLOGY, MAJOR IN COMPUTER SCIENCE AND ENGINEERING

Kanpur, India

2016 - 2020

Honors & Awards

- 2018 **Quant Role summer internship offered at Jane Street and Quadeye,** Mumbai, India
- 2014 **Aditya Birla Group Scholarship Nominee,** India
- 2016 **All India Rank 57,** Joint Entrance Exam Mains, 1.5 million candidates India
- 2016 **All India Rank 169,** Joint Entrance Exam Advanced, 150,000 candidates India
- 2016 **Merit Certificate Awardee, Overall 96.8%,** Grade 12 national examination India
- 2015 **KVPY Scholarship Awardee AIR 71,** Indian Institute of Science and Government of India Bangalore, India
- 2014 **NTSE Scholarship Awardee,** Government of India India

Work Experience

National University of Singapore

RESEARCH FELLOW, UNDER PROF. KULDEEP MEEL

Singapore, Singapore

May. 2018 - Jul. 2018

- **Effect of sparse-XORs and randomization** to be submitted in proceedings of **TACAS-2019**
- Worked to refute the claim that sparser XORs could replace pairwise-independent hash functions in approximate counters
- Developed an algorithm which improved the proposed one using dependent hash functions and proved it's correctness.
- Provided a mathematical argument for ineffectiveness of sparse-XORs
- Conducted experiments on 36k node super computing facility.

Google Summer Of Code with Python Software Foundation

PSF

MENTORS: JAMES LOPEMAN

May. 2017 - August. 2017

- Worked on grand performance suite of cpython (Most popular version of python).
- Suggested and implemented a C version of weakset
- Fixed the logging time benchmark and Working upon various possibilities to improve startup time of python.
- Wrote benchmarks for threading, multiprocessing, socket, zlib, smtplib, math module.

New York Office, IIT Kanpur

INFRASTRUCTURE INTERN, UNDER PROF. MANINDRA AGARWAL

Kanpur, India

May. 2017 - Apr. 2018

- Dev-ops for a three node kubernetes cluster managing a "polyglot" app.
- Deployed docker containers, wrote configuration files for nginx and automated cert generation (through kube-lego/kube cert manager)
- Setting up kafka (and zookeeper through statefulsets), prometheus, kibana-logstash, iframely for the cluster.
- Complete dev-ops for another django app which used redis, elasticsearch and unicorn.

Projects

Infrastructure for JEE-ADVANCED 2018

JoSAA FOR JEE-ADVANCED PROF. SATYADEV NANDAKUMAR

IIT Kanpur

December. 2017 - Apr. 2018

- Dev-Ops for JoSAA website including GCloud and SQL set up.
- Wrote algorithms and scripts for generating marks, ranks and center allocation.
- Created Network of redundant data buckets and VMs in case of failure.

Trading strategies with Auquan/Optiver

CAPSTONE PROJECT, MENTOR CHANDANI JAIN

Jan. 2018 - April. 2018

- Worked on multiple trading strategies and algorithms and tested them on test data.
- Worked with various statistics concepts Monte Carlo methods, Pair-Trading, Hedging etc.
- Used python, numpy, pandas, scipy.

Geolang: A language for geometry

UNDERGRADUATE PROJECT, PROF. AMEY KARKARE

IIT Kanpur

August. 2017 - December. 2017

- Implementation of DSL from scratch for handling geometric entities
- Takes in Natural Language from user and map it to DSL
- Interpreter present at <https://github.com/bhavishyagopesh/Geolang>

Extracurricular Activity

WRITING SERIES OF SURVEY RELATED TO TOPICS IN QUANTUM COMPUTATION AND COMPUTATIONAL COMPLEXITY

- Expository article on Quantum Random walks [<https://github.com/bhavishyagopesh/Random-Walks/blob/master/proposal.pdf>]

RANKED AMONG TOP 200 IN MICROSOFT Q# COMPETITION ON CODEFORCES

Jul. 2018

- Solved 12/15 problems based on Quantum Algorithms in Q#.

Secretary PROGRAMMING CLUB AND INFORMATION SECURITY GROUP, IIT KANPUR

Apr. 2017 - Apr. 2018

- Helped spreading FOSS, wrote articles and startup-guides, and built the infrastructure for club's website[pclub.in].

Microsoft MICROSOFT CODE-FUN-DO

Aug. 2017 - Present

- Made a Poker app in Android.

Skills

Programming C/C++, Golang, Python, Shell, OCaml, Haskell, Scala, Matlab, R

Tools git, vim, latex, build-tools(make), databases(SQL/Sqlite), gdb, Docker, Kubernetes, Nginx, tensorflow

Platform ArchLinux, Ubuntu, CentOS, MacOS

Miscellaneous

- Contributed to open source projects like SymPy, Mozilla/balrog, hyper-h2, GNU-MailMan,coala.
- Presently Volunteering for managing a polyglot application(with a diverse technological stack and based on 12 factor app principles) for IITK-NYO office.