

Pavan Dayal

OBJECTIVE

I am an artist but I also happen to like playing with computers. I want to work with high performance computing to solve problems and make real impact in the world. My creativity and wide skill set have enabled me to produce unique solutions in the fields I've worked in: from mission control UI for rockets to data science tools for Quantum Computing research. I want to apply my knowledge of mathematics and physics to new challenges and more than anything I want to grow.

RELEVANT EXPERIENCE

Zoox AI Verification Engineer

APR 2021 - SEP 2022

Our team used software simulation to test the effectiveness of the autonomous vehicles and calculate metrics for the probability of crashes for these cars using technologies such as high dimensional bayesian optimization for efficient identification of potential hazards and problems with the AI. I hand produced visualization frameworks for data analysis and identifying sources of error. I created tools to automatically produce diagrams to replace text descriptions increasing the productivity of the team by a factor of 10. I also created automation tools for the systematic generation of new simulation scenarios to thoroughly cover cases not previously captured which reduced the amount of error-prone manual work from the time scale of weeks to mere seconds.

Liquid Rocketry Lab Mission Control Product Owner

MAR 2019 - APR 2021

I am the creator of and lead the development of the mission control for Liquid Rocketry Lab which involved 3 major components: a RESTful API backend and database which collects live sensor telemetry data, a Vue.js UI for visualizing this data and managing actions, and a C++ hardware and sensor simulator for testing the capabilities and functionality of the mission control. I brought on and managed new team members as the project grew.

Kemper Lab Undergraduate Researcher

MAR 2018 - DEC 2020

I integrated theoretical models utilizing the large computing resources at NERSC to simulate crystal lattices of high temperature superconductors like $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ and calculated phonon modes of these materials using pseudopotentials and interfacing with the FORTRAN library Quantum ESPRESSO. I also presented this research with my colleague and we have published our results on arxiv.

I used hybrid quantum computing while investigating optimization problems where I used the python libray Qiskit and IBM's Quantum Experience to compare results utilizing real quantum computers. I constructed methods for rebuilding the full density matrix for the resulting state of a circuit to be combined with classical optimization methods.

PUBLICATIONS

Catalogue of phonon modes in several cuprate high-temperature superconductors from density functional theory
N.J. Jabusch, P. Dayal, A.F. Kemper
 arXiv:2010.10553, (2020)



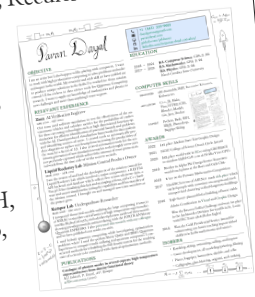
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EDUCATION

2018 - 2021 **B.S. Computer Science:** GPA: 3.94
 2017 - 2021 **B.S. Mathematics:** GPA: 3.94
B.S. Physics: GPA: 3.94
 North Carolina State University

COMPUTER SKILLS

BEGINNER x86 Assembly, PHP, Recursive Résumés, Kubernetes
ADVANCED C++, JS, Make, Vim, HTML/CSS, Blender, Matlab, Git, Java, Docker
EXPERT Python, Bash, SSH, L^AT_EX, Photoshop, Bagpipe Skiing



AWARDS

- 2022 1st place Alaskan State Fair for Graphic Design
- 2021 NCSU College of Science Dean's Circle Award
- 2020 5th place world wide in SC20 using GROMACS to simulate SARS-CoV-2 on 16 Nvidia V100 GPUs
- 2019 Brother in Alpha Phi Omega Service Fraternity: would teach piano at the Boys and Girls Club
- 2018 8/120 on the Putnam Mathematics Competition
- 2017 HackNC best use of ASP.Net: made sick.place which tracked people with norovirus on campus and used unsupervised clustering to find dangerous buildings
- 2016 Eagle Scout: planned/led rebuilding of horse stable
 Adobe Certification in Visual and Graphic Design
 Won the \$10,000 FedEx Challenge and won 1st place in the Archimedes Division for world's in St. Louis with FRC Team 4828 (Robo Eagles)
- 2014 Won the Gold Presidential Service Award for volunteering 300 hours teaching impoverished children in India mathematics and science.

HOBBIES

- Kayaking, skiing, swimming, sailing, and improv
- Game development, 3D modeling/printing, filming
- Piano, bagpipes, harmonica, ukulele, and cello
- Calligraphy, glass blowing, origami, and cooking

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$$\mathcal{L} = T - U = \frac{1}{2}m\dot{\phi}^2 + mgl \cos(\phi)$$

$$\hat{H} = -J \sum_{\langle j,k \rangle} \sigma_j \sigma_k \dots \uparrow \downarrow \uparrow \dots$$

CURRICULUM VITAE

Liquid Rocketry - Mission Control Product Owner (March 2019 - April 2021)

- >> I am the creator of and lead the development of the mission control for [Liquid Rocketry Lab](#) which was based on NASA's [OpenMCT](#). The project involves a RESTful API backend and database which collects live sensor telemetry data and a Vue.js UI for visualizing this data and managing actions. I also built a C++ hardware and sensor emulator for testing the capabilities and functionality of the mission control. I used knowledge from my industry experience to equip this project with automated testing and containerization. Also, I got to be an inspiration to the other members of my team and gain valuable experience in managing others and helping them grow while developing this product.

Assistant Professor - MA 792 - C, C++, and Python for Financial Math Majors (April 2020 and April 2021)

- >> After taking this graduate course freshman year of my undergrad, the professor reached out to me to be a guest lecturer for the Python section of this course. I instructed mathematics graduate students on the basics of Python. I also tied this in to their C knowledge with details on how Python works under the hood. Finally, I provided a brief glimpse at cool, advanced things such as doing automated trading, neural networks for image classifying, and quantum computing. The [final project](#) that I prepared for them was fitting an exponential model to live-scraped coronavirus data.
- >> (April 2021) Prof. Kaltofen reached out to me to guest teach the Python section of the course again, so I did. This time the [final project](#) I assigned was to scrape through Elon Musk's twitter using NLP for stock information. They generated statistics for these stocks and calculated the correlation between his tweets sentiment and the price of TSLA and DOGE.

Android Hacking Nomad (December 2020 - April 2021)

- >> I had the opportunity to become a volunteer at a HUMC hospital in New Jersey during the peak of the COVID-19 pandemic when help was needed most. I worked as a scribe on a COVID Intensive Care Unit where I would write down notes for the doctors and do paperwork while they were doing vital operations such as resuscitating patients undergoing cardiac arrest or during emergency debridement procedures. It was... intense.
- >> While finishing up my triple major senior year at NCSU during COVID-19 remotely on Zoom, I moved to Colorado and I cross compiled gcc and ssh onto my rooted Nokia android so I could attend my classes and do my programming homework from my phone while being out in the great Colorado nature. I took an Automata test while on a snowy mountain top; got a 100.
- >> I became a stained glass artist in a studio in Colorado Springs as well as an amateur residential electrician. I also expanded my dangerous hobby of playing the bagpipes while skiing to doing that while also on a Zoom call for Liquid Rocketry Lab.

Oracle Cloud Native Engineer Co-Op (January 2020 – August 2020)

- >> I made and maintained network tools for the Kubernetes cluster on the networking subteam. This included projects like the Outbound Proxy for securely allowing different Docker containers in the cluster to reach network endpoints and have working DNS.
- >> I viewed and resolved tickets to assist end-users using Jira. I developed tools and scripts utilizing GitLab and Jenkins for continuous integration and automated testing.
- >> Near the end of my co-op, I planned and developed a project for Cross Regional DNS to allow pods from different sites world-wide to communicate with each other.
- >> I lead the planning and organization of a service project for the co-op program which was to refurbish old hardware for low-income families. Before the event, COVID-19 hit and it had to be cancelled.

Mathematics and Physics Research (2020)

- >> In November 2020, I became a coauthor on a paper with my friend Noah Jabusch, who I have been working with in Kemper Lab since 2018. [This paper](#) is about the high-temperature superconductor crystal Bi2212 and using DFT (with [Quantum Espresso](#)) to calculate the force constants on the atoms and then use that to calculate the phonon modes of the crystal.
- >> In December 2020, as part of my final project for the graduate Lie Algebras Representation Theory class I was taking, I produced a [paper and gave a presentation](#) on how $\mathfrak{su}(2)$ and $SU(2)$ are derived and then an application of how they are used in [Quantum Computing](#) for the [QAOA](#) algorithm.
- >> For physics senior lab, I worked on doing topology optimization with 3D printers with my friend Sreeram. We [presented this project](#) at the end of the semester in November.

Kemper Lab Undergraduate Researcher (March 2018 – December 2020)

- >> I integrated theoretical models using the super computers at NERSC to simulate crystal lattices of high temperature superconductors like $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ and calculated phonon modes of these materials using pseudopotentials and interfacing with the FORTRAN library Quantum ESPRESSO.
- >> I presented this research with my colleague and we published our results on arxiv.
- >> I created hybrid quantum computing models for optimization problems where I used the python library Qiskit and IBM's Quantum Experience to compare results of real quantum computers. I constructed methods for rebuilding the full density matrix for the state of a blackbox circuit that could be implemented on a real machine for calculating thermodynamic quantities such as von Neumann entropy and used this to minimize expectations for parameterized circuits with a hybrid computing model.

Lunch Time Python Presentation at ASIC North (September 2019)

- >> I gave a talk at ASIC North the previous year about why Python is a good scripting language. During this talk, I compared the language's capabilities for hacking and scripting when compared to Perl and how it can be used to interface with C. As a bonus in the last 5 min, I showed how quickly you can train a convolutional neural net with Tensorflow with MNIST in just a few lines of Python and I used that to recognize a digit someone wrote.

Hacking Jenkins - CSC 316 - Data Structs (May 2019)

- >> I was given permission to exploit the Jenkins automatic grading system for my Data Structures class and ended up getting root on the server. This gave me experience with detecting vulnerabilities and also with reporting and documenting them to Dr. Jennings which started a back and forth relationship of attacking the server then updating its security. In the end, I managed to get access to every single student's code as well as all of the teaching staff's tests.

Christmas in the Dorms (December 2018)

- >> I made a door decoration using an arduino one night that would play 8 bit Christmas music while also controlling some lights. This, along with other IOT projects, have provided entertainment, but also allowed me to teach other friends basic electronics and get them interested. I also attached a sensor to my door so that when anyone would walk by it would automatically play a random song.

Bagpipe Skiing (November 2018)

- >> It's a grand old story that I love to tell.
- >> If you google my name and go to images, you will see a picture of me preparing to ski down a double black diamond while wearing a suit and playing the bagpipes.
- >> <https://google.com/search?q=pavan+dayal&tbm=isch>
- >> The journey began at freshman year orientation when my buddy turned best friend decided to enroll in the bagpipes class at NCSU. After the semester started, he asked me to join the class as well. Over the next couple of semesters as underclassmen, we and the others in the class became close. We all slowly learned to play the beautiful, majestic instrument with years of trial and failure.
- >> At the same time, I started learning how to ski. At first I really sucked. I remember seeing a guy wearing a suit while going down all the hard slopes and I thought to myself "damn, I'm never going to be that good." On my second ski trip, I was magically much better. I formed the resolution in my head: one day, I would one-up that suit guy.
- >> Another year passed. I was ready to go skiing at the slopes. I saw the bagpipe in the trunk of the car. I knew exactly what I had to do. The time had come for me to prove to the world that I can do anything I set my heart to. I went straight for the hardest slope, no poles, full suit, and invented ski bagpiping; I didn't even warm up.

Book Judging AI - PY 599 - Applied AI (November 2018)

- >> I collaborated on making a combined RNN and CNN model as a final project for an AI class in order to judge books by their covers. The idea was to see if there was a correlation between the cover of a book and the rating it had. During this project, I also developed bot tools to scrape goodreads.com using Python and Selenium and got some very real experience in data collection and became very familiar with Keras and Tensorflow.

Little Big History of the CPU Poem (April 2018)

- >> For a final project for an honors seminar at NCSU, I wrote this poem late one night. It is a complete history of the CPU starting with the big bang and it encompasses my beliefs about the nature of the universe. One day this will be a published childrens book complete with doodles.

Freshman Year Make-A-Thon Robot (January 2018)

>> We made a raspberry pi robot using selfie sticks and fidget spinners in an attempt to help save energy and recycle garbage. The idea was that this robot could be used to physically flick off light switches in dorms. Also a statement of how ridiculous the rules are for dorms because they wouldn't let me put Arduino's inside the light switch wiring and that the only way I could achieve what I wanted would be to build a physical robot to turn the light off for me.

Maple Web Interface (2016 - 2017)

>> In high school, I developed a mobile friendly interface to Maplesoft Maple by running it (as a Windows application through WINE) on an external server. I have maintained and updated this project throughout the years and still use it regularly when I'm tutoring online. It's basically my own private wolfram alpha and it still works better than most calculator apps and websites. The thing I value most from this experience is discovering that programming is a way to solve problems and make life easier, and I have benefited greatly by putting the time in when I was young.

Linux Origin Story (2011)

>> I had a weak netbook in middle school with an Atom Processor that was unbearably slow running Windows Vista, so I had no choice but to try Ubuntu. This was the beginnings of my journey into linux, where now I can't live without having a terminal on my phone and I have made my own linux OS from scratch.

>> I believe in perseverance and I enjoy working with devices with less than sufficient hardware capabilities and seeing discovering optimizations to squeeze out extra performance (ex. arduino music). Solving problems despite limitations are what have made me strong.

TI BASIC Prankster (2010)

>> Some of the first programs I wrote in elementary school were trolls and pranks that I would quickly copy to a friends calculator to run. My favorite of these was a 4 liner I still love showing people today:

```
>> label 0; input "", A; disp A+1; goto 0;
```

>> The result of this program is it would add 1 to anything the user typed so doing 2+2 on the TI-83 would yield the answer 5.

REFERENCES

Cynthia Elder

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