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Jonathan Koch
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OVERVIEW

Languages: *Python, C & C++, DJ (Diminished Java), C#, Java, RISC-V, Julia, Lua, JavaScript, Rust, Perl, R, CUDA, OpenCL, oneDNN*
Competencies: *ROS, Actor-Critic, Tensor Libraries & Math, Docker, Kubernetes, REST, Linux, Networking, 2D & 3D Physics and Simulation Engines, LLM finetuning, Prompt Engineering, Language Processing, Semantic Models, G-Flow Nets, Generative Models, Self-supervised learning, Compiler, SAFE*
Research Background: *Robotics & AI; Object Manipulation, Audio & Image Processing, Perception Modeling, Reinforcement Learning, Model Predictive Control, Reward tuning, heuristic-based control, Variational Auto Encoders, Representations of data in LLMs for Cognitive Reasoning*
Interests: *Predictive Models, Perception, NLP, Multi-Agent Learning & AI, Underactuated Robots, Self-Supervised Learning in Robotics, Computational Thinking, Cognitive Science, Generative Models, Data Science, MIT Open Courseware, Acoustic Guitar, Piano, BJJ*

EDUCATION

Bachelor of Science in Computer Science, Concentration in Robotics and AI   **Engineering GPA:**
University of South Florida College of Engineering | Tampa, FL | Fall 2020 - Spring 2024   *3.7/4.0*

EXPERIENCE

Data Science Data Engineering Co/Op
CAE USA https://cae.com/
November 2023 – Present
Tampa FL
- Prototyped a Generative Agents Architecture built on LLMs capable of reasoning and explainable action steering.
- Incorporated contrastive learning into text classification improving the classification accuracy from 93% to 99%.
- Created training tools for preventing overfitting by augmenting training data such that it allows for structured data generation, but forces learned semantical representations without the need of human supervision.

Software Engineering Co/Op
CAE USA https://cae.com/
May 2022 - November 2023
Tampa FL
- Developed Windows and Linux lab nodes of in parallel computer clusters for simulation and hardware.
- Added 4 untested base repository trees into a Continuous Integration pipeline and dozens of repositories into SonarQube.
- Worked alongside embedded developers to map sensor data from touchscreen hardware to screen positions from device.

Research Scientist
Robot Perception and Action Laboratory, *University of South Florida,* https://rpal.cse.usf.edu/
Fall 2021 – Present
Tampa FL
- Research in robotic <u>object manipulation</u> through supervised and reinforcement learning; constructed and pretrained a transformer network for encoding spatial information for perception, explored methods for improving learned policies.
- Utilization of graph neural networks and transformers for learning relationships between states and actions.
- Probabilistically modeled dynamics for policy optimization via contrastive divergence in latent space conditioning based on actions, leveraging historical state-action pairs to enhance predictive accuracy and representation quality.
- Heuristic approaches based on predictive models; utilized self-supervised techniques to learn a predictive physics-based model of our robot enabling heuristic algorithms for effective object manipulation and grasping without RL.

Senior Coding Coach and Instructor
theCoderSchool Tampa *https://github.com/theCoderSchoolTampa/CoderSchoolAI*
Fall 2021 – Summer 2023
Tampa FL
- Spearheaded initiative for effectively delivering Agent AI concepts in a simpler and more digestible interface for kids.
- Developed an educational library built on-top of Python designed to remove complexity of Agent AI and Neural Network training; *"pip install CoderSchoolAI"* enables you to train a Neural Network for Image Classification in 7 lines of code.
- 15+ projects at theCoderSchool have integrated the library for use in games, scripts, lessons, and AI Camp.

Vice Chair; AI Group, VEX Robotics
USF IEEE Student Chapter
Fall 2020 – Spring 2024
Tampa FL
- Organize and oversee Professional Development events/forums, plan our Spring/Fall Picnics and Banquets, introduce new students and act as the main POC for all USF students interested in joining IEEE's Technical Clubs and Teams.
- Founded AI Group; leadership in AI projects, including Auton-Drone and Just Dance Robots, and AI Workshops.
- Founded programming team for VEX with currently 20 active members, raised $10k towards scholarship endowment.

PROJECTS

IEEE VEX Robotics Software Stack
October 2021 - Present

https://github.com/USF-IEEE/ (*The code is distributed amongst various repositories*)   (*Competition Video*) https://www.instagram.com/reel/CdJ00oyvc0V/

- Enables full autonomous capability and task implementation, distributed computation via usage of multiple computers enabling perception, SLAM, and planning while enabling low latency control and reaction.
- Modeled the dynamics of the environment and the variance in the resulting next state. Utilized latent representations for behavior cloning and reinforcement learning, enabling advanced perception systems for edge devices (Jetson Nano).

Teach-A-Bull (AI Tutor)
November 2023 - Present

https://github.com/USF-IEEE/AITutor-Backend/blob/main/README.md   *(Read the Paper)*

- Made high-quality, personalized, and cheap education available to all students, regardless of socioeconomic status.
- Proposed iterative prompting techniques to generate progressively more complex data structures (Chapters, Lessons, Presentations, Homework, Evaluation, Schedule); *LLMs as Actors in Text-Based Environments* (LLMaAiT-BE).
- Measured high (*cosine*) similarity between generated content and Expert data for educational content and materials.
- 10x decrease in the cost of SAT/ACT prep (73$ per session vs. $7.30 per content generation session in API requests).

MicrogradPlus
November 2023

https://github.com/Johnnykoch02/MicroGradPlus

- Simple computational graph / auto-differentiation API implemented with only NumPy as a weekend hobby project.
- Inspired by Andrej Karpathy's Micrograd which implements scalar auto-diff, MicroGradPlus approaches the task similarly by utilizing vector-based differentiation for mathematical operations including *sum*, *mean*, *sigmoid*, and *matmul*.
- Achieves perfect (100%) accuracy on all vector gradient tests when compared to PyTorch, 94% accuracy on MNIST.

CoderSchoolAI (pip install CoderSchoolAI)
May 2023 – August 2023

https://github.com/theCoderSchoolTampa/CoderSchoolAI/blob/master/README.md   (*Demo*) https://youtu.be/_cpspql8Chw?si=IlI8mxfdjF8rDdph

- Neural Network API, AI tools, and Reinforcement *learning* library built on-top of PyTorch; beginner-friendly docs.
- MDP implementation in 10 lines of code, created simple API for training many-to-many DNN function approximators, various data and tensor utilities for optimized data manipulation, implementation of PPO, DQN, and DDPG algorithms.
- Used in my robotics research in *RPAL*. Continuously developing and expanding capabilities. Find it on PyPi.

Micromouse E-puck Robot
May 2023

https://github.com/theCoderSchoolTampa/CoderSchoolAI/blob/master/README.md   (*Demo*) https://www.youtube.com/watch?v=hjf3wgnN1mo

- Implementation of a E-puck robot in Webots used to solve the Micromouse competition via SLAM and pathfinding.
- The robot starts in a corner and has 10 minutes to map the maze. My implementation utilizes various heuristics to encourage exploration of the map and decides which cells to visit by naively estimating their novelty and utility.

Robbie the Danci-Bull Robot (HackaBull Entry)
March 2023

https://github.com/Johnnykoch02/USF-HackaBull-2023   (*Dancing!*) https://youtu.be/zSz2d7ekwHU

- Our mission was to develop a Simulated Robot that can dance to any song you provide as input.
- Pretrained the policy network of our robot on hundreds of Just Dance videos using MediaPipe to estimate joint position.
- Our policy implements a convolutional neural network which receives audio data and current joint angles as observations, and outputs a discretized probability distribution corresponding to a dθ in each of the seventeen joints on the robot.

AI Chess
August 2022 - Present

https://github.com/Johnnykoch02/ChessEngine   (*Video Detailing Project*) https://www.screencast.com/t/f4BB4gmnze

- theCoderSchool Project with an advanced Python Student, who had the desire to learn about Game Development
- Inspired by AlphaZero, developed a self-play pipeline guided by neural networks and Monte-Carlo tree search.
- Utilizes the CoderSchoolAI Markov implementation templates allowing me to research and experiment algorithm design.

Virtual Assistant
August 2022 – Present

https://github.com/Johnnykoch02/VirtualAssistant/blob/main/README.md

- Converts spoken Natural Language prompts into a sequence of tasks which execute sequentially to solve the problem.
- Keyword Detection via Audio Sequence Modeling, avoiding 1000's of Speech-To-Text Charges from Google ♥
- Developed my understanding for using LLMs in problem solving, deepened my curiosity for using LLMs as Actors.

I take pride in my work, I strive for perfection, and I love being curious.