Adithya Ramesh

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SUMMARY

I am interested in deep reinforcement learning (deep RL), in particular, it's application to autonomous systems and robotics. I have applied deep RL to problems such as multi-agent co-operation and autonomous navigation. I have a strong multidisciplinary engineering and science background.

EDUCATION

- **Dual Degree (B.Tech, M.Tech), Indian Institute of Technology (IIT), Madras**   Chennai, India
  Major in Engineering Design ; Minor in Systems Engineering ; CGPA: 8.30   *Aug 2011 - Jun 2016*

PROFESSIONAL EXPERIENCE

- **Honeywell Aerospace**   Bengaluru, India
  R &D Engineer/Scientist II, Advanced Technologies Group   *Jun 2018 - Mar 2021*

  - Deep Reinforcement Learning

  ○ Studied important publications and followed latest trends in the area.

  ○ **Multi Agent Co-operation using Deep Reinforcement Learning**

    * Designed, developed deep RL based multi agent systems that can co-operate and execute a given task by learning how to communicate, in simulation. Business use case targeted was air traffic management.

    * The representative problem considered involves a 2D environment where two agents with partial but complementary information about a target must communicate, navigate to reach it simultaneously. One agent has a 360° depth sensor and the other has a 360° color sensor. The agents can communicate using discrete symbols and can move in discrete directions.

    * Trained using MADDPG algorithm. Successful in $\sim 99\%$ environment configurations used in training. On unseen environment configurations, successful in $\sim 50\%$.

  ○ **Autonomous Navigation for UAVs using Deep Reinforcement Learning**

    * Designed, developed a deep RL based autonomous navigation system for unmanned aerial vehicles (UAVs), in simulation. The task is to navigate to a goal position in the shortest path, without colliding with obstacles, in an unknown environment.

    * Deep RL agent uses it's own position, the goal position and a 360° depth sensor as inputs and outputs which direction to move. A standard flight controller then controls the UAV to move a fixed distance in that direction and the process repeats.

    * Trained using Double DQN algorithm. Successful in $\sim 92\%$ environment configurations used in training. On unseen environment configurations, successful in $\sim 72\%$.

  ○ Developed the required simulations from scratch using Python. Procedurally generated random environment configurations for training and testing. Briefly worked with Airsim, an open source simulator for drones based on Unreal Engine.

  ○ Implemented the required deep RL algorithms from scratch using Pytorch - MADDPG, Double DQN and other algorithms used in intermediate experiments such as DDPG, A2C, ACKTR, DQN, Recurrent DQN.

  ○ Performed systematic research involving several stages of experimentation in order to achieve final results. Experimented with different agent inputs, agent outputs, reward functions, network architectures, algorithm specific hyperparameters and algorithms themselves. Analyzed learnt agent behaviours.

  ○ Experimented with different methods to speed up training such as parallelizing experience collection across multiple workers, natural gradient descent based on kronecker factored approximate curvature (KFAC), precomputing and storing observations offline by discretizing environment.

  - Point Cloud Segmentation

  ○ Designed, developed a deep neural network containing PointCNN layers to segment point clouds. Based on the paper "PointCNN: Convolution on $\mathcal{X}$-Transformed Points".

  ○ Trained on 1600 point clouds containing 3 classes. Average accuracy of $\sim 99\%$ on test dataset containing 400 point clouds. Developed mainly to be used as a preprocessing layer for depth agent in multi agent RL experiments.

- LSTM based Speaker Verification

- ○ Designed, developed, tested, deployed a LSTM based text-independent speaker verification model to authenticate users in a speech based building automation system.
- ○ Based on the paper "Generalized End-to-End Loss for Speaker Verification".
- ○ Trained on ~ 2000 hours of audio from 6000 speakers. EER (error rate) of $\sim 8.2\%$ on test dataset containing 1250 speakers.
- ○ Drove collaboration with Microsoft Research, India in development of light-weight recurrent neural networks for deployment on resource constrained edge devices.

- **Predible Health**   Bengaluru, India
  Deep Learning Engineer   *Sep 2017 - May 2018*

  - CNNs for biomedical images

  - ○ Developed CNNs to classify lung nodules in chest CT scans as benign or malignant. Achieved sensitivity of $\sim 90\%$, specificity of $\sim 81\%$ after performing 5-fold cross-validation on a dataset of $\sim 40k$ images.
  - ○ Experimented with CNNs to segment liver, tumour and background in abdominal CT scans.
  - ○ Involved in preprocessing of multiparametric prostate MRI scans.

- **Self Employed**   Chennai, India
  Machine Learning Enthusiast   *Jun 2016 - Sep 2017*

  - Deep Learning and Reinforcement Learning

  - ○ Learnt fundamentals of deep learning by studying Stanford University's course, CS231n : CNNs for Visual Recognition. Learnt fundamentals of reinforcement learning by studying David Silver's course.
  - ○ Worked on representative problems in image classification (CIFAR-10), tabular RL (Grid World, Random Walk) and deep RL (Open AI Gym environments such as CartPole, Breakout etc) to gain an in-depth understanding of concepts.
  - ○ Partially developed own C++ library to train deep neural networks. Later switched to Pytorch.
  - ○ As a side project, conducted a robotics and hobby electronics course for high school students.

- **Airwood Pvt Ltd**   Chennai, India
  Intern   *Dec 2014 - May 2015*

  - Flight Controller for UAVs

  - ○ Worked towards developing a flight controller for quadrotors. Worked on state estimation algorithms to estimate quadrotor's state from noisy IMU data and PID based control algorithms to fly it.
  - ○ Owned all aspects of development - hardware and software. Extensively performed flight tests.

PROJECTS

- Mixed State Entanglement in Quantized Chaotic Systems (Master's Thesis)

Advisors : Prof. Arul Lakshminarayan, Department of Physics, IIT Madras
         Prof. Sandipan Bandyopadhyay, Department of Engineering Design, IIT Madras

- The study of mixed state entanglement in quantized chaotic systems forms an important and unexplored problem and could have an important role to play in how quantum chaos may affect quantum computing.

- We studied the entanglement of the quantum coupled standard map under time evolution for initial states that are mixed, for different interaction strengths between the standard maps and different dimensions of the surrounding environment.

- We found that for a given interaction strength, as we increase the environment dimension, the tendency to get entangled reduces and there exists a critical environment dimension, in most cases beyond which the state remains separable at all times. Such a phenomenon is potentially a problem in situations where entanglement is desirable.

- **Chaotic Dynamics in Robotic Manipulation** (Course Project)
  - Studied chaotic dynamics in robotic manipulation that can occur for certain values of controller gains and model mismatch.
  - Simulated a parallel manipulator - a planar 5-bar, to track a periodic trajectory. Calculated Lyapunov exponents and plotted phase space plots to identify chaotic dynamics.

- **Mechatronics**

  Built several projects combining hardware and software, mainly as a hobby.
  - **Ground Robot** : Developed different variants of a four-wheeled ground robot - line follower, remote controlled (RF transmitter, receiver based & WiFi based), simple collision avoider.
  - **Automatic Transmission for a Bicycle** : Experimentally developed an automatic transmission system for a geared bicycle that determines the optimal gear during operation and automatically switches to it.
  - **Home Automation** : Experimented with WiFi based control of home appliances.
  - **Dimmer circuit for incandescent light bulbs** : Developed an Arduino based dimmer circuit to control intensity of incandescent light bulbs.

SKILLS

- **Operating Systems** - Linux, Windows
- **Programming Languages** - Python, C, C++
- **Deep Learning Frameworks** - Pytorch
- **Scientific Computing** - Numpy, Mathematica, Matlab
- **Version Control** - Git
- **Container Technologies** - Docker
- **Microcontrollers** - Arduino, NodeMCU
- **CAD** - Autodesk Inventor

AWARDS AND SCHOLASTIC ACHIEVEMENTS

- Awarded the NTSE scholarship by NCERT, Government of India in 2007.
- Awarded the KVPY fellowship by Department of Science and Technology, Government of India in 2011.
- Secured All India Rank 2264 in IIT Joint Entrance Examination (IIT-JEE) 2011 (out of 0.5 million candidates).
- Secured All India Rank 642, Tamil Nadu State Rank 20 in All India Engineering Entrance Examination (AIEEE) 2011 (out of 1 million candidates).
- Featured in the top 300 in the National Standard Examination in Physics and subsequently participated in the Indian National Physics Olympiad in 2011.
- Cleared qualifying stages and participated in the Indian National Mathematics Olympiad and the Indian National Olympiad in Informatics in 2010.

RELEVANT COURSE WORK

- Deep Learning
- Reinforcement Learning
- Data Structures and Algorithms
- Mathematics - Calculus, Linear Algebra, Probability, Optimization, Numerical Methods etc
- Physics - Classical Mechanics, Quantum Mechanics, Electromagnetism etc
- Mechatronic System Design
- Kinematics and Dynamics of Machinery
- Analog and Digital Circuits
- Modern Control Theory
- Mechanics and Control of Robotic Manipulators
- Vehicle Dynamics

TEACHING

- Teaching Assistant for Electronics Laboratory course at Department of Engineering Design, IIT Madras during 2015-16.