Ramanan Sekar, Senior Machine Learning Engineer at Qualcomm

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Interests: Deep Learning and Robotics (Embodied AI)

Education

- **University of Pennsylvania** Philadelphia, PA
  Master of Science in Engineering in Robotics; GPA: 4.00 *Aug 2018-May 2020*
  Relevant Courses: Computer Vision and Computational Photography, Introduction to Robotics, Machine Perception, Machine Learning, Learning in Robotics, Integrated Intelligence with Robotics, Operating Systems, Master's Thesis

- **Anna University** Chennai, India
  Bachelor of Electrical Engineering; GPA: 3.9 (8.89/10.0 - top 1% of Graduating Class) *Aug 2014 - May 2018*
  Relevant Courses: Advanced Control Systems, System Identification and Adaptive Control, Object Oriented Programming, Applied Soft Computing, Computer Programming

Skills Summary

- **Languages**: Python, C++, C, MATLAB
- **Machine Learning Tools**: Tensorflow, PyTorch, Keras, Scikit-Learn, ONNX
- **Tools**: Linux, Git, Docker, OpenCV, NumPy, ROS, Matplotlib, Google Cloud Platform, MuJoCo, LaTeX

Experience

- **Qualcomm** Santa Clara, CA
  Senior Machine Learning Engineer, Qualcomm R&D *June 2020 - Present*
  - **Harware-Software Co-design for Autonomous Driving**:
    - Working in the ML Systems team in the Autonomous Driving R&D unit at Qualcomm Research on developing deep learning models for the driving stack and efficiently deploying them on Qualcomm's SnapDragon Ride platform, collaborating with cross-functional teams internally (compiler, hardware, AI research, customer engineering, AD research) and externally (Automotive customers, Google)
    - Leading effort on Transformer model optimization focused towards perception and motion prediction models. Innovated on architecture and attention design to result in BEV perception models that are 60 times faster than baseline models, and motion prediction models that are 5 times faster than baseline. Filed Invention Disclosures and Patent applications for this work
    - Leading the Neural Architecture Search R&D work in the BU. Work involves developing i: effective search spaces that trade-off efficiency vs complexity, ii: efficient search algorithms such as Reinforcement Learning, evolutionary search, etc., iii: fast evaluation procedures to develop deep models that have high task performances as well as efficient deployment on target hardware. This work has been used to optimize different components of the perception stack, including CNN based models, Transformer based models, Multi-task networks.
    - Worked on effective quantization and compression of internal models as well as external customer models for improving real-time performance. This involves using internally developed tools like AIMET to understand compressibility, or quantizability of models using post-training quantization or quantization-aware training methods.
    - Worked on developing tools to understand performance bottlenecks such as analysis of quantization errors of models through a layer-wise breakdown, analysis of profiling tools by enabling tracing bottlenecks all the way from the hardware execution to the source code, analysis of accuracy degradations when executing models on target devices using different error metrics
    - Key contributor in the development of a model zoo inside the Automotive BU, collaborating with internal and external stakeholders in curating a model list and taking them through model onboarding process to have optimized and fully functional set of models to benchmark results on.
    - Work has so far led to several invention disclosures and innovations internal to Qualcomm, with one invention currently being filed for patent by Qualcomm.
    - Mentored interns in the team on research projects that lead to several useful and impactful results. Mentored students externally in Universities through the Qualcomm Innovation Fellowship.

- **Qualcomm** Bridgewater, NJ
  Deep Learning Intern, Qualcomm R&D *May 2019 - August 2019*
  - **Denoising with Recurrent Neural Networks**:
    - Designed large, custom recurrent neural networks for optimally denoising signals at the Shannon decoding limit, by decoding signals on graphs
    - Implemented and refactored vectorized Tensorflow code and a modular,scalable codebase for high frequency design iterations. Produced a reproducible codebase by attacking non-determinism problems in GPU processing
    - Scaled performance to real-time, full scale models and achieved significant performance boosts with the developed method

- **GRASP Lab, University of Pennsylvania** — Philadelphia, PA
  Research Assistant *(Unpaid) - Prof. Kostas Daniilidis' Group* — *Nov. 2018 - Nov. 2020*
  - **Master's Thesis**: Worked on a self-supervised reinforcement learning agent to quickly solve new tasks at test time, without having access to them in training time, with a model-based approach on high-dimensional continuous control tasks, learning directly from pixels. This work was published in ICML 2020.
  - **Intrinsic Curiosity with Distribution-based Rewards**: Contributed to developing a C-VAE based perception module for future prediction. Used this module to give robots intrinsic motivation to explore environments, running on PPO. Integrated 3D simulations of the Baxter robot for testing. Published work in RSS 2019
  - **Unsupervised Few-Shot Classification with Meta-Learning**: Developed a novel meta-learning based few-shot unsupervised classification module with MAML, using a novel CNN + MLP architecture, in Tensorflow. Used Bayesian Optimization to tune hyperparameters. Achieved similar performance with 85% less labelled data
- **University of Pennsylvania** — Philadelphia, PA
  Teaching Assistant *- Machine Learning* — *Spring 2019, Fall 2019, Spring 2020*
  - **TA for CIS 520: Machine Learning, CIS 519: Applied Machine Learning**: Teaching Assistant for graduate level machine learning courses focusing on both theory and applications. In charge of designing homeworks, conducting office hours, grading and project feedbacks.
- **Indian Institute of Technology** — Madras, India
  Robotics Research Intern *(Unpaid)* — *Dec 2016 - April 2018*
  - **Kalman Filters for efficient Localization**: Developed a novel KF algorithm using correlations between measurements, proved superiority to original EKF, and validated on a Mobile Robot using SONARs. Achieved Faster and accurate convergence
  - **Sensor Fusion Algorithm**: Developed a new efficient sensor fusion algorithm using Maximum likelihood estimators and measurement noise correlations. Achieved an error reduction of 70% compared to existing methods
  - **SLAM**: Implemented 2D Feature based EKF-SLAM for AmigoBot, using SONAR ring and wheel encoders, and Particle Filter based 2D localization for mobile robots. Worked with ARIA C++ libraries to deploy on mobile robots like P3DX and Amigobot
- **Raman Research Institute** — Bengaluru, India
  Summer Research Fellow — *May 2017 - August 2017*
  - **Decoy-state Quantum Key Distribution**: Studied about the loss of security in practice of the original BB84 QKD protocol due to Photon Number Splitting Attacks in multi-photon signal states. Studied about Decoy State QKD as a solution to improve security, increase distance and rate of key distribution. Described mathematical background and state-of-the-art advances in Decoy State QKD in a comprehensive final report

Publications

- [**1**]: ***R. Sekar***, O. Rybkin, K. Daniilidis, P. Abbeel, D. Hafner, and D. Pathak. (2020) **Planning to explore via self-supervised world models**, International Conference on Machine Learning (ICML), 2020
- [**2**]: Beradette Bucher, Anton Arapin, ***Ramanan Sekar***, Feifei Duan, Marc Badger, Kostas Daniilidis, Oleh Rybkin (2019) **Perception-driven Curiosity with Bayesian Surprise**, Workshop on Combining Learning and Reasoning Towards Human-Level Robot Intelligence , RSS 2019
- [**3**]: ***Sekar R***, Sai Shankar N., Shiva Shankar B., Manivannan P.V. (2018) **Modified Extended Kalman Filter Using Correlations Between Measurement Parameters**, Advances in Intelligent Systems and Computing, Springer
- [**4**]: ***Sekar R***, Sai Shankar N., Shiva Shankar B., Manivannan P.V. (2017) **Use of measurement noise correlations for an improved SONAR model**, IEEE

Other Projects

- **Operating System**: Contributed to the building of a functioning, simple operating system with a working process scheduler and file system, in a team of 4. Specifically worked on the creation of the process scheduler
- **Real-time Object Detection**: Contributed to the deployment of a real-time object detection model on an embedded NVIDIA Jetson device, running on a Turtlebot. Worked on optimizing the trained model for real-time perf. on-device.
- **Qualcomm's Hackathon: Unsupervised Depth Estimation**: Integrated a real-time unsupervised monocular depth estimation system, coupled with an off-the-shelf object detection module, for vision based navigation guidance for visually impaired people, in Tensorflow
- **Multi-Robot Vision based Collaboration**: Designed an Aerial and Ground mobile robot collaboration with SIFT based aerial imagery stitching and object detection for ground robot motion planning with Probabilistic Roadmaps
- **3D Reconstructions with Structure from Motion**: Developed an SfM pipeline from two views with the 8 point RANSAC algorithm
- **Deep Fakes**: Developed a pipeline in Python for swapping faces between videos. Used DLib Library to detect faces and generate features. Used a KLT Tracker to track features in both source and target video, and used Delaunay Triangulation and Affine Transforms to swap faces with Seamless Blending

- **Hindsight Experience Replay for Manipulators:**: Controlled a simulated 2DOF manipulator with Deep Reinforcement Learning by learning its Inverse Kinematics with sparse rewards using Hindsight Experience Replay (HER) on top of DDPG in Tensorflow
- **Manipulator Motion Planning:**: Implemented Motion Planning on the 5DOF manipulator Lynx physical robot with PRMs and novel Potential Field Planners, after implementing Forward, Inverse and Velocity kinematics for the Lynx.
- **Sparse Optical Flow:**: Developed from scratch the KLT feature tracking for Optical Flow of sparse features in slow to medium paced videos, in Python.