# RESEARCH BACKGROUND
## Karthik Ragunath Ananda Kumar
a.karthikragunath@gmail.com | +19402798502

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## Introduction

I'm Karthik Ragunath Ananda Kumar, a Master's Thesis student in the Computer Science department at UT Dallas researching on perception and motion planning **deep reinforcement learning algorithms** based on **agent's camera POV RGB images, segmentation maps, depth maps and uncertainty probabilities of objects detected**.

Also, I am currently a **Machine Learning Intern** at **Samsung Research America (SRA) - NEON Lab (Mountain View, California)** working on **multimodal generative models.**

## Research Experiences

**(i) -** About my **academia research experience:**

As part of my on-going thesis research under the guidance of Prof. Feng Chen on Perception and Motion Planning components of Autonomous Driving Systems in the Pattern Discovery and Machine Learning **(PDML)** Laboratory at UTD, I am experimenting with **Deep Reinforcement Learning Algorithms**, namely, **Proximal Policy Optimization (PPO)** and **Soft Actor-Critic algorithms (SAC)** powered by **Agent's Camera-POV image features** and also on **Uncertainty-Aware Object Detection**, **Semantic Scene Segmentation, Scene Depth Mapping and Vehicle Localization** components. The **Uncertainty-Aware Object Detection** is particularly designed to compute Out-of-Distribution (OOD) probabilities of the objects identified by the object detection component in order to augment the motion planning deep reinforcement learning algorithm along with other input features such as agent's POV RGB images, segmentation maps and depth maps.

The deep reinforcement learning algorithms were trained on CARLA Autonomous Driving Simulator Engine. The simulator is wrapped as a custom gym environment so that data streamed from the simulator engine can be accessed in real time (with synchronization) when used for training with Deep RL algorithms with the objective to plan the motion path of the agent (vehicle).

**(ii) -** About my **industry research experience:**

**(1) -** I am currently **(from August 2022 to Present)** researching at **Samsung Research America (SRA) - NEON Lab (Mountain View, California)** as ML Research Intern where I am working on **multimodal generative models** particularly on body motion and facial action generation with lip syncing and on voice cloning. This research involves working on the following:

> ### 1.1 - MVAEs, CVAEs and GANs:
> For the body motion and facial action generation, I am primarily working with **Motion Variational Auto-Encoders (MVAEs)** to generate realistic human movement videos in a planned/conditioned manner.

**1.2 - Few-Shot Learning, Temporal Convolutions and Space-Time Attention Transformer Architectures:**

I am also researching unsupervised body motion and facial action recognition models on short video scale (multi-frame scale). This research involves experimenting with:
(i) Multi-staged unsupervised classification models
(ii) Few-Short Learning based approaches **- Prototypical Networks and Model-Agnostic Meta-Learning**.
(iii) Temporal Convolution based approaches
(iv) Space-Time Attention Transformer based approaches.

**1.3 - Zero-Shot Text to Speech Synthesizers:**

Recently started working on a voice cloning project to build the capability to synthesize new voices with very small training data. For this research, I am currently experimenting with Zero-Shot Text to Speech Synthesizers like VALL-E.

**(2) -** During my Summer 2022 research internship **(June 2022 to Aug 2022)** at **Ancestry.com (Utah)**, I worked extensively in the areas of:

**2.1 - Entity and Relationship Extraction models** (at multi-paged text document scale):

This research primarily involved working on ensembling deep learning models from multiple SOTA research papers to solve the problems of:
(i) capturing long range entity relation dependencies
(ii) subject entity overlap,
(iii) entity pair overlap problems
(iv) coreference resolution in extracting entity relationships, etc.

**2.2 - Summary Generation:**

This research involved building interpretable knowledge graphs from the entity relationships extracted in previous step (2.1)

**(3) -** I also previously worked as a ML Engineer (NLP) at **Mad Street Den** where I worked on building **neural network powered Information-Retrieval systems**. This research involved:

**3.1** - Building affinity models
**3.2** - Designing boosting functions for query search
**3.3** - Building semantic filtering queries
**3.4** - Prototyping Learning To Rank (LTR) to be used for ranking documents in search database
**3.5** - Designing BERT language models to create search embeddings in order to improve search accuracy.
**3.6** - Designing Auto-Suggestion algorithms.