

Improve Machine Learning-IoT Infrastructure

Project Website

<https://xuzheng863.github.io/>

Project Description

Content of research:

The content of this research is to improve IoT-Machine Learning bridge. Machine learning on device data now would require human to collect the data from, preprocess the data and run the algorithms manually. This process takes time and would hinder further automation of Machine Learning-IoT connection.

In order to reduce human actions needed in this process and improve training efficiency, two challenges needed to be overcome. The first is creating a scheduler for IoT server and Machine Learning Server. Because two servers will be executing computationally expensive operations, the scheduler needs to preemptively estimate the workload, identify dependencies between multiple machine learning processes and schedule the computation and interaction between servers. The second is the need to preprocess data. Because of the variety of dataset and their dependencies, for example, multiple sensors capturing the same phenomena, the datasets need to be synchronized, batched and preprocessed for the machine learning algorithm to achieve maximum effect. Thus, once given a basic set of rules, the servers need to preprocess the data accordingly before feeding it to a machine learning algorithm.

This research will focus on: 1. Creating a scheduler for Machine Learning and IoT server to achieve low server load and high training efficiency and 2. Setting basic set of rules for data preprocessing in order to synchronize the data for better training results. To narrow down the research direction, this research will focus on a ML IoT combo of extracting cooking related information to evaluate cooking process and replicate cooking process with robots.

Mentor:

Professor Howie Choset

Significance:

If research completes, the server setup will minimize human involvement in the process of Machine Learning on IoT to near automation. The result can serve as basic structure for future project on Machine Learning on IoT to use and improve. The specific examples tested on this setup can be used to monitor cooking patterns of chef and train machine learning models on the dataset in order to evaluate cooking process and replicate process with robotics. The entire system can be used to for educational purposes in culinary art.

Project Goals

75% completion:

The scheduler will schedule tasks based on only dataset size and time, machine learning server would probably have low load or queued tasks. Preprocessing will synchronize the datasets and send as input to machine learning algorithms.

100% completion:

The scheduler will schedule tasks based on the estimated time cost of a task and ensure machine learning server is fully utilized with queued tasks as few as possible. Preprocessing can slice the video or audio feedback according to content and synchronize the dataset.

125% completion:

The scheduler can learn from previous schedules and adapt to data input style to better utilize machine learning server. Preprocessing happens with minimal human input instructions. Possibly test with other machine learning algorithms and dataset to prove overall robustness.

Milestones

First technical Milestone for Fall 2018

The first step would be get familiarized with current IoT and Machine Learning server setup: learn basic functionalities, experiment full chain of process from data collection to getting output from machine learning server. This part is expected to be done by the end of November. If there is still time left in Fall 2018, I shall start on the design of a scheduler that would meet 75% completion.

Bi-weekly Milestones for 15-400

In the first two week till Feb 1st, I will focus on creating a scheduler on a local pc to test its effectiveness. The following two weeks I will integrate the scheduler into the IoT and Machine Learning server. By March 1st the parameters in the scheduler will be tuned to fit the behavior of both servers. Afterwards I shall start with the data preprocessing experiment and have a moderate understanding of the limit of preprocessing by March 22nd. By April 5th I shall come up with a basic setup that can synchronize and batch the datasets. If everything is according to plan at this point, I will work on slicing the datasets in the next month.

Literature Search

I have read one scientific publication, *Internet of Things (IoT): A vision, architectural elements, and future directions*, which gave me a basic idea of how the research will shape up. Other than scientific publication, I have gone through tutorials of Amazon AWS and S3 services that will serve as IoT server base. I have not done much research on the machine learning server side and is currently researching on possible choices such as a GPU accelerated machine learning server, or for this research, a local rig that can pull information from the Amazon service for better manipulation offline.

Resources needed

I have been granted permission to equipment in the bio-robotics lab in CMU, and I can request for purchase of equipment if the need emerges. Because Amazon has SQL service integrated I do not need SQL on my personal computer for now.