# System Identification of Rover Dynamics

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## Introduction

Our sponsor is the Robotic Space Exploration (RoSE) VIP team. The RoSE team formulate robotic methods in autonomy, mobility, manipulation, and life detection for space exploration and science applications. We were tasked to assist one of the PhD researcher with the machine learning program he was building for RoSE. The particular aspect of the rover dynamics being worked on is the system identification. When solving simple dynamical system problems, we look to theory for the correct equations to explain what is occuring. However in complicated and obscure scenarios such as the varying terrain and environments that a rover would encounter there needs to be a more adaptive approach to determine what system is being experienced by the rover and how to adjust to it. The question now is, can we optimize machine learning in such a way to make those determinations for us?

## What Does this Machine Learning Program Do?

The Active Learning program uses the dynamical systems actuated pendulum, double pendulum, lorenz, pendulum, and two tank system for the behavior of the system. It then uses the models ensemble , bayesian neural network, and gaussian process. By using these models it can model the behavior of each dynamical system. This program is important part research for RoSE because it allows for predicting an active learning of multiple dynamical systems. It provides the metrics like the amount of time it took to run. It is actively learning through each iterations by selecting data points that are expected to be the most beneficial for improving each models performance.

## Why Restructure the Program?

The original Active Learning for dynamical systems was made to train and compare machine learning models for dynamical systems. This Active Learning program worked and did as expected however there were some issues with it. The program itself was not made to be user friendly and was originally designed for one specific user which is the PhD researcher. However this brings up several issues when trying to expand this to a larger audience. The original program had hardcoded file paths which was only specific to a single individual making it difficult for other users to be able to use this program for training and comparison. The program was also structured in a way where it was difficult to add more dynamical systems into the comparison. Restructuring the program allowed for easier readability making it easier to add more dynamical systems and use similar instances of models that were already added into the program.

## Methodology

- Github repository
- Koa/Mana supercluster
- Visual Studio
- Python
- Shell

## Result

The current program is now user friendly allowing for anyone who sees the repository on Github is able to use the program to see the comparison of each model as it is more flexible, accessible, and scalable. The current design also allows the user to add more dynamical systems and models with easier use by removing hard coded file path. It is now more flexible due to having a more modular design. The design is also more centralized making the data more consistent throughout the whole system. A simplified initialization script also allows for a more straightforward configuration

## Takeaways

- Machine Learning
  - Understanding the fundamentals of machine learning and artificial learning
- Dynamical Systems
  - Having a more in depth understanding of the mathematics behind dynamical systems
- Client Communication
  - Learning how to effectively communicate with clients to ensure positive expectations and outcomes
- Data Efficiency
  - Learning how to effectively use data resources
- Supercluster Usage
  - Better understanding of superclusters and how to use the, specifically the Koa/Mana supercluster