Proposal

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committee

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Agenda

- Background
- Related work
- Approach of this study

High-dimensional Spaces Motion Planning for Robotic Arm in Dynamic Environment

- Robotic Lab in Pace: 2 Kinova Gen3 arms

Franka Panda

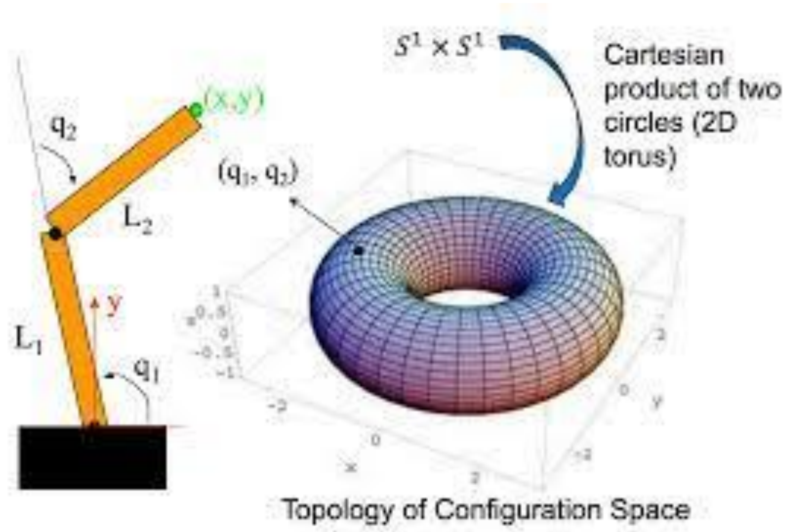
Kinova Gen3

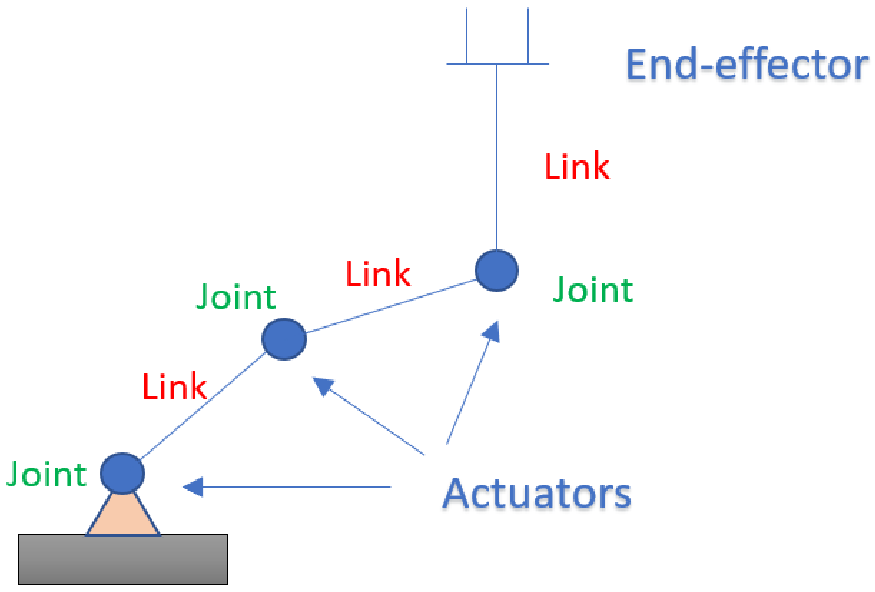
UR10e

KUKA LBR IIWA 7 R800

Basic Concepts

- Link, Joint and End-effector
- Configuration, Configuration Space (C-Space)
- Degrees of Freedom (DOF)





Piano Mover's Problem

Classical Problem Formulation

The aim of motion planning: find the collision-free path $\sigma\colon [0, T] \longrightarrow \mathcal{C}_{free}$

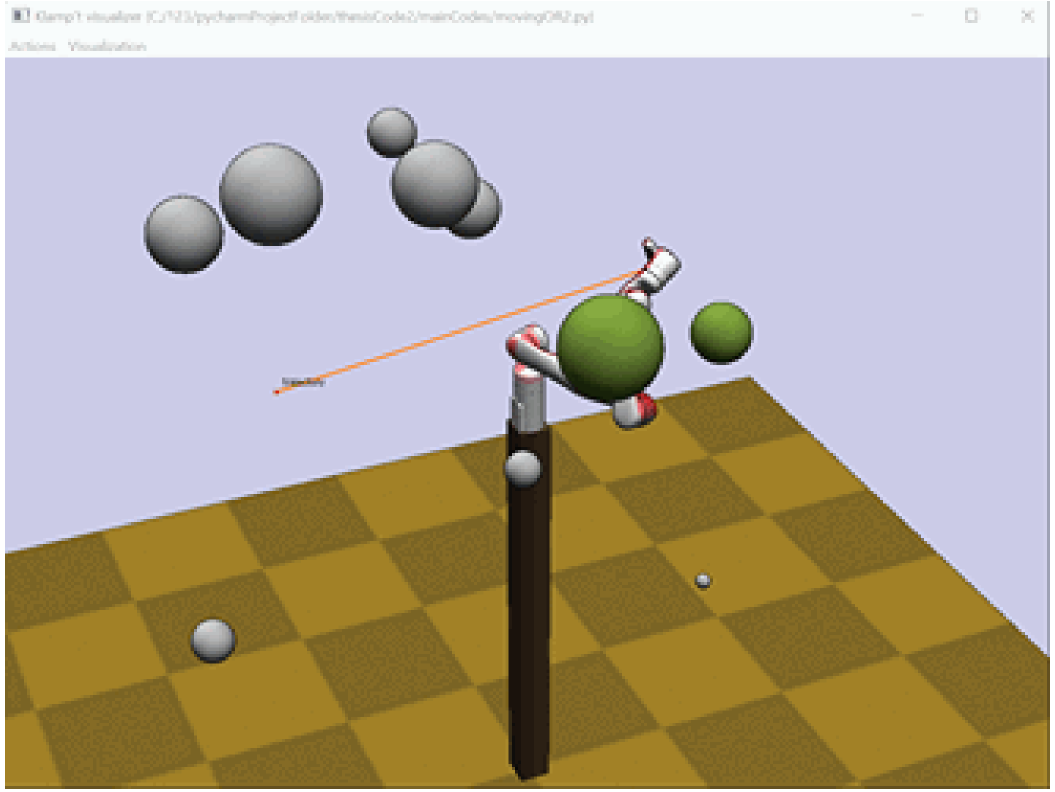
such that $\sigma(0) = q_{init}$ and $\sigma(T) = q_{goal}$.

Problem

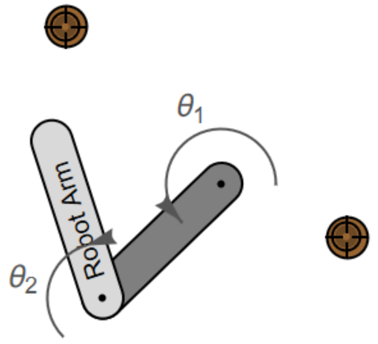
- Static VS Dynamic environments
- Velocity info is important

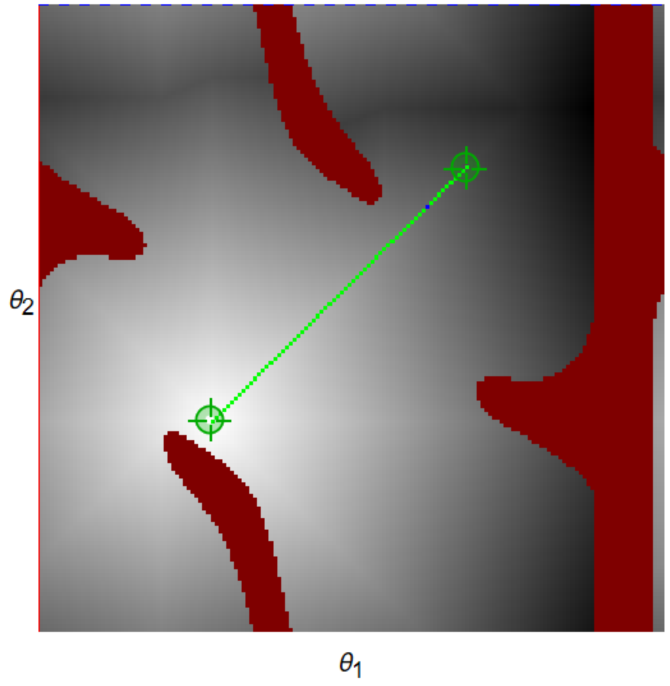
Most manipulators are predetermined motion trajectories, non-reactive

plan their motion or path on the fly



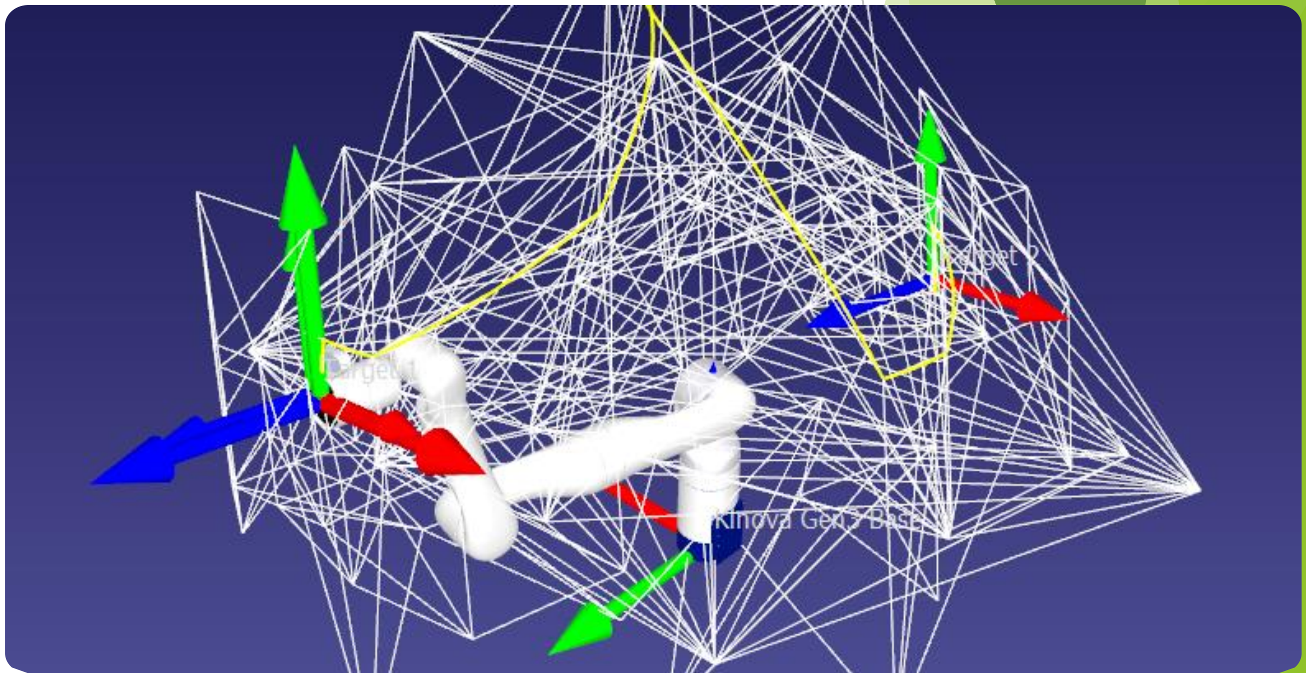
Related Work





- Grid-based
- Sampling-based
- Machine Learning based

Limitation: low DOF, static



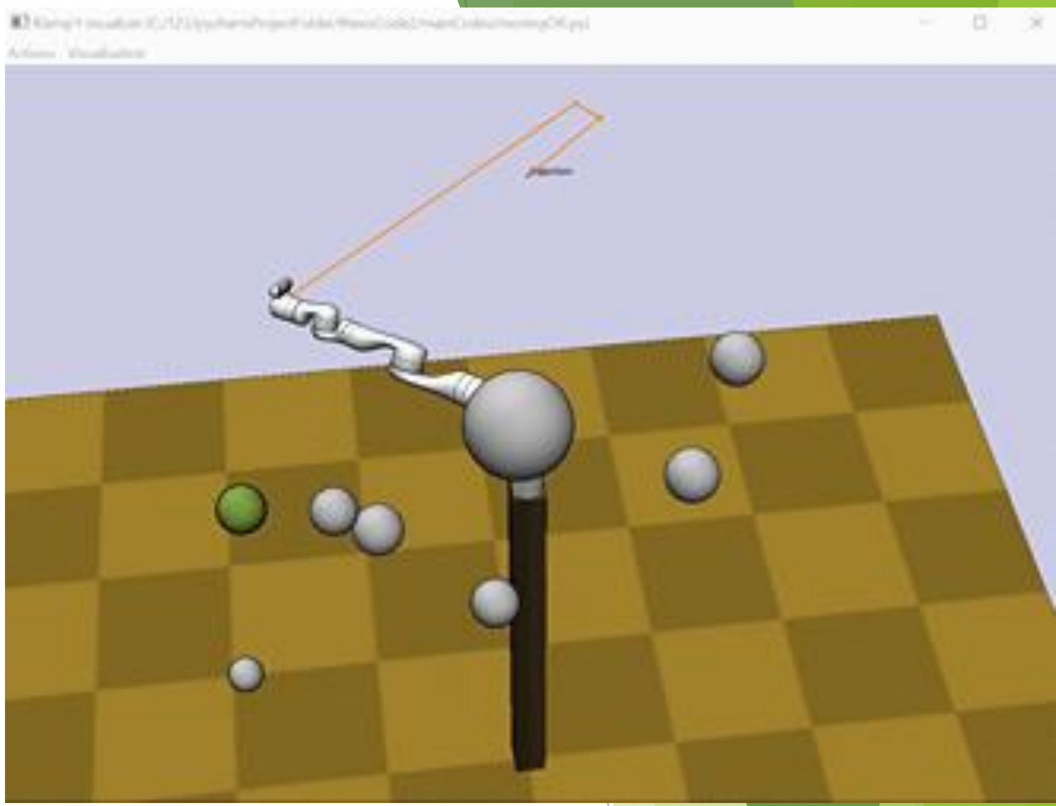
Limitation: velocity

Approach of This Study

Why Supervised learning :

- Require fast reaction
- Successful rate

Supervised learning



Supervised learning is to learn the mapping function from input to output:

$$Y=f(X)$$

Input:

1. Current and previous Configurations
2. Current and previous Obstacles Info
3. Goal Configuration
4. Constant

→

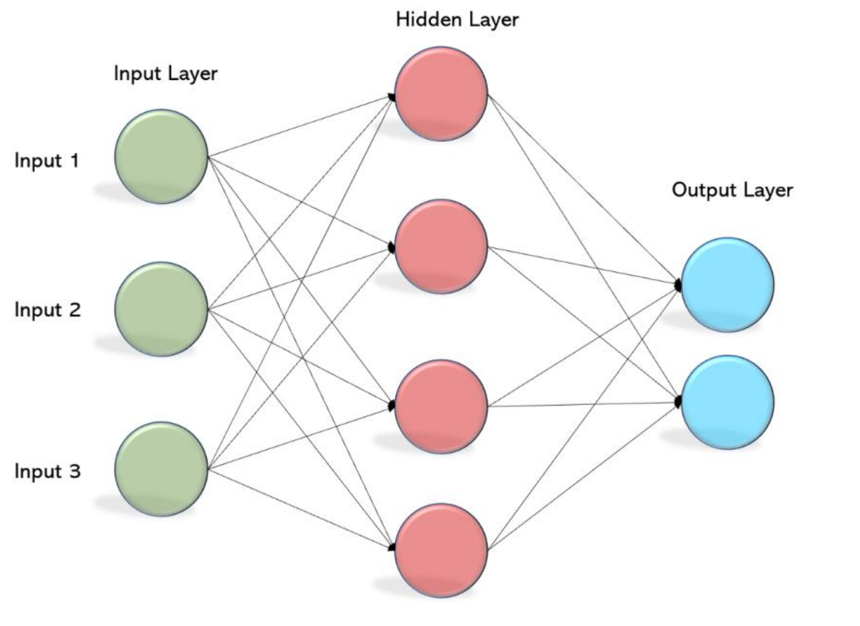
1. Denavit-Hartenberg(DH) Parameters
2. Moment of Inertia

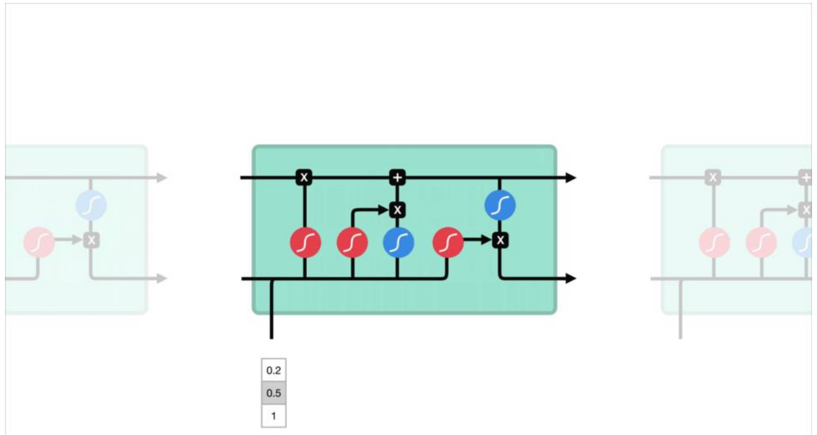
Output:

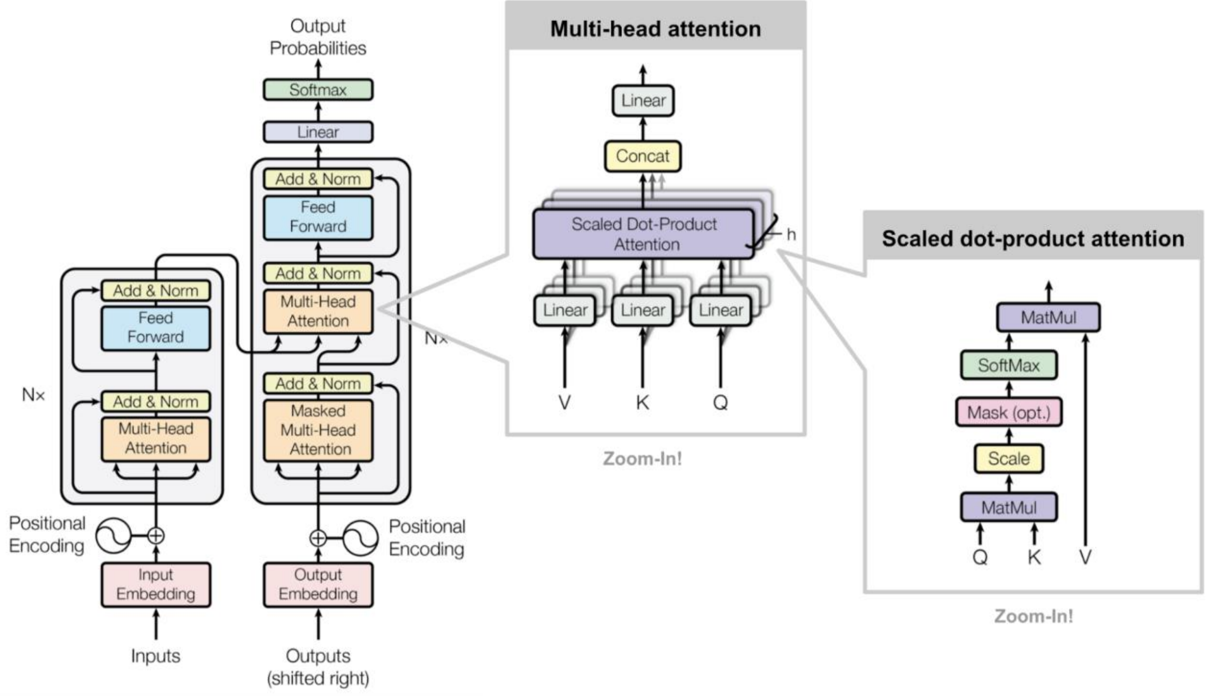
Next Configuration

Deep learning structure

- MLP-based
- LSTM-based
- Transformer-based







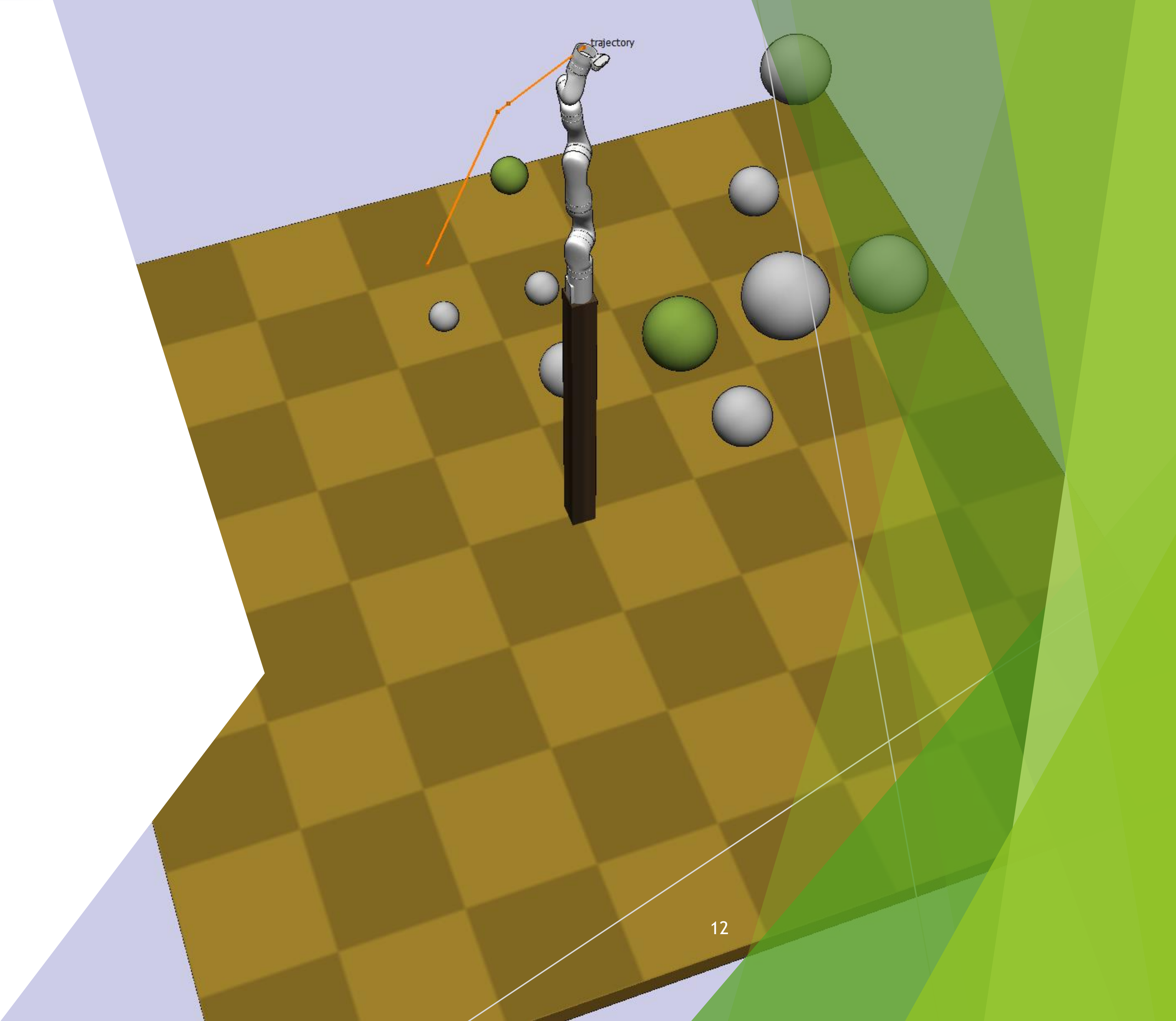
Data Acquisition

Why? -> better performance

How to generate training data?

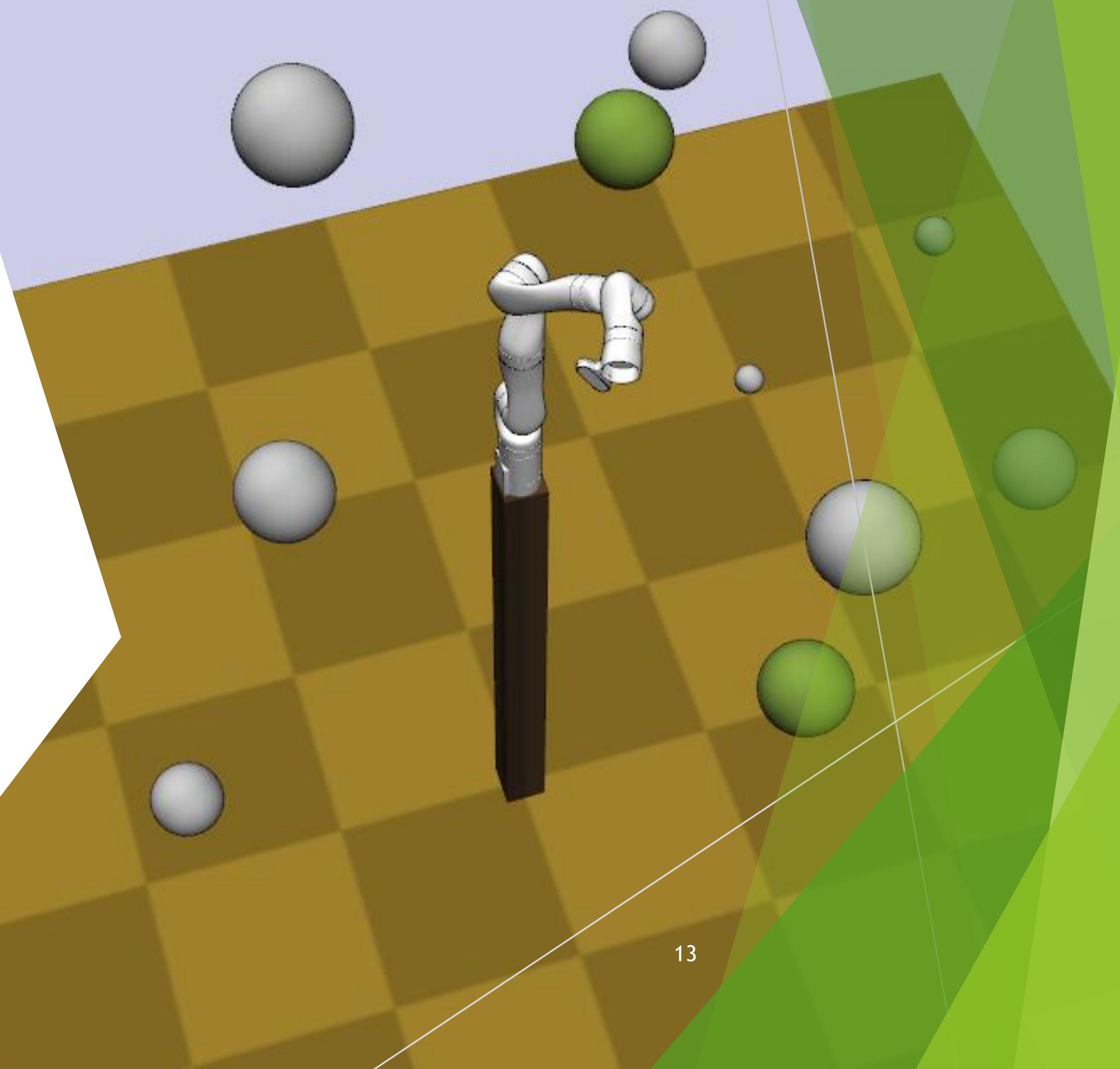
- Static

RRT* algorithm:
asymptotically optimal



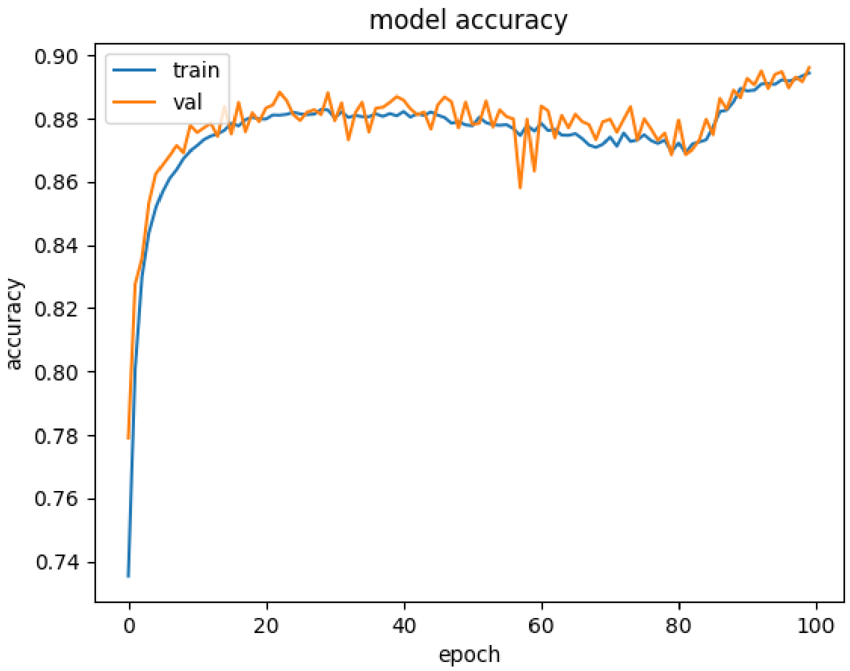
Detail of Generating Data

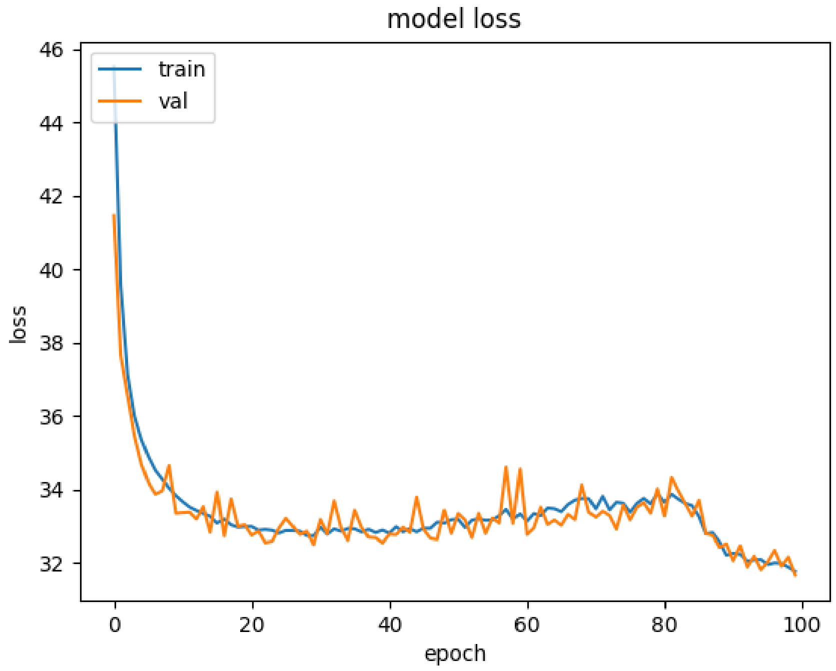
- Generate environments store as .xml.
- 100 different environments each with different obstacles
- Each has 3000 paths(trajectories) with different start and goal configurations
- Total of 300,000 data paths
- Save paths data as .configs



Training parameters for DNN

- backpropagation algorithm
- loss='mae' or 'mse' , optimizer='adam'
- batch_size=500-5000 ,epochs=300-3000





Evaluation

SUCCESS RATE

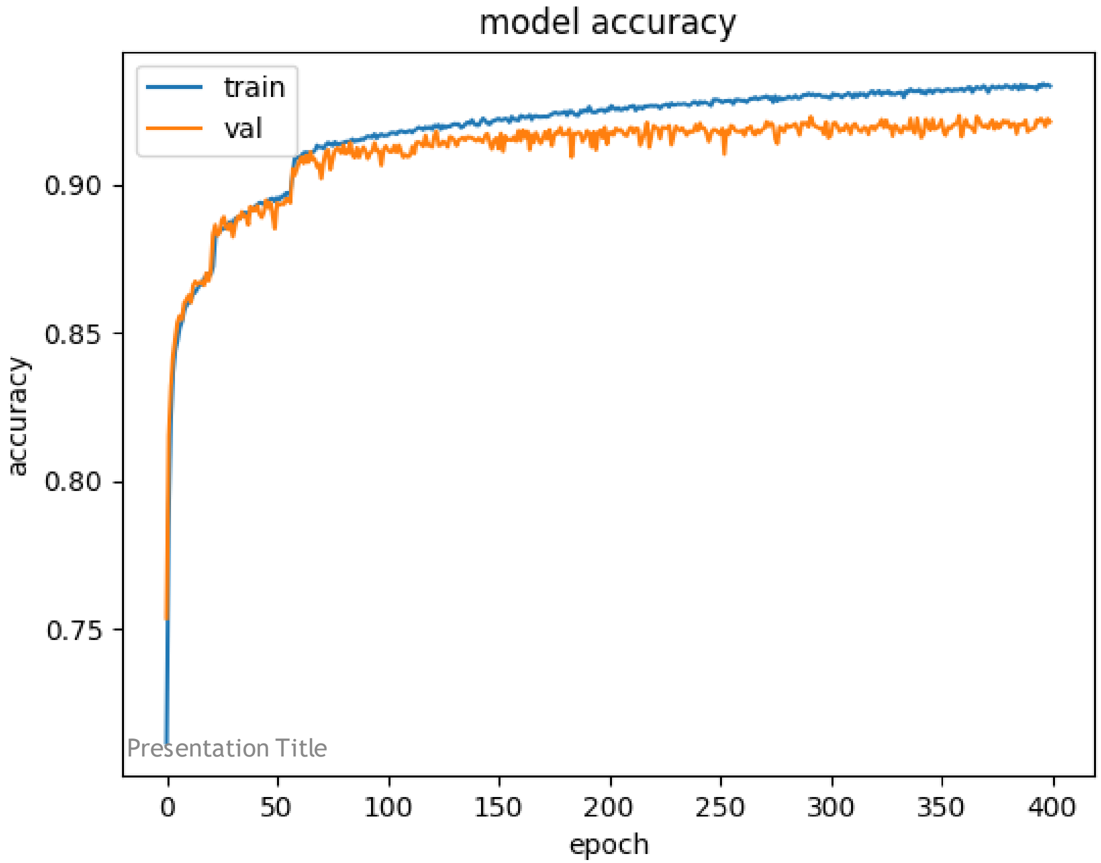
PLANNING TIME

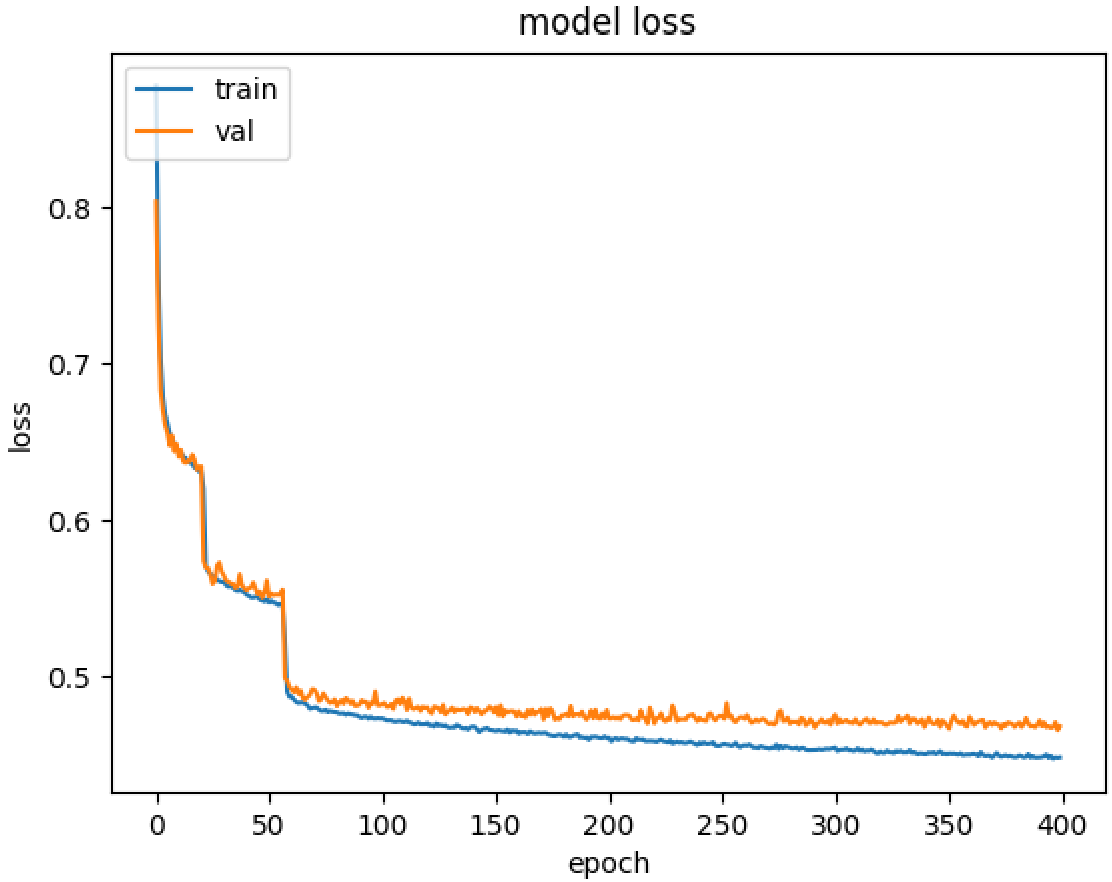
Software and Packages

- Klampt – Simulation, data generation
- Tensorflow – Deep learning

Result

Train my MPL-based DNN:
-about 92% accuracy for predicting the next configuration
-2% better if we take the Constants as input





Thank you

Thanks to Nishark Singhal for implementing the simulation environment

Reference

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