# Deep Reinforcement Learning on Arm Manipulation

Team: A1-06

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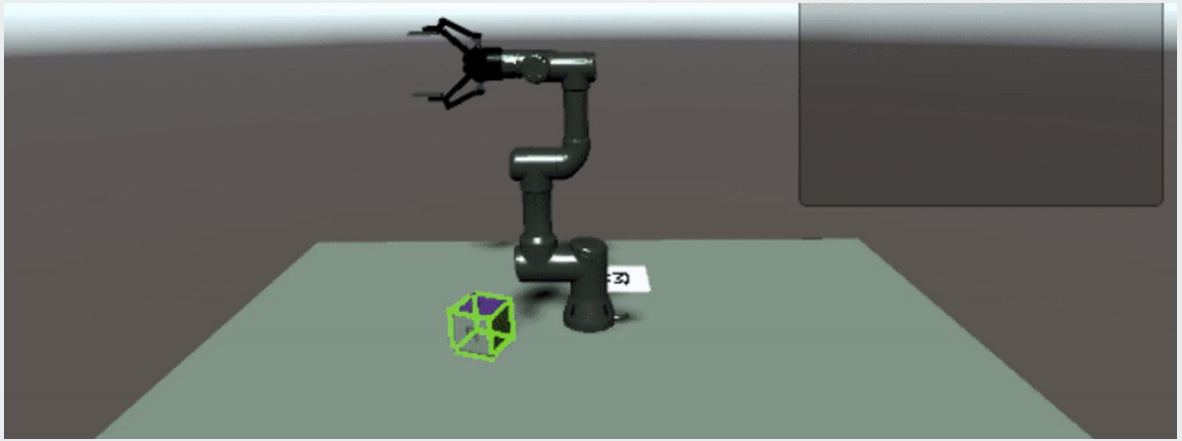


# Product Mission

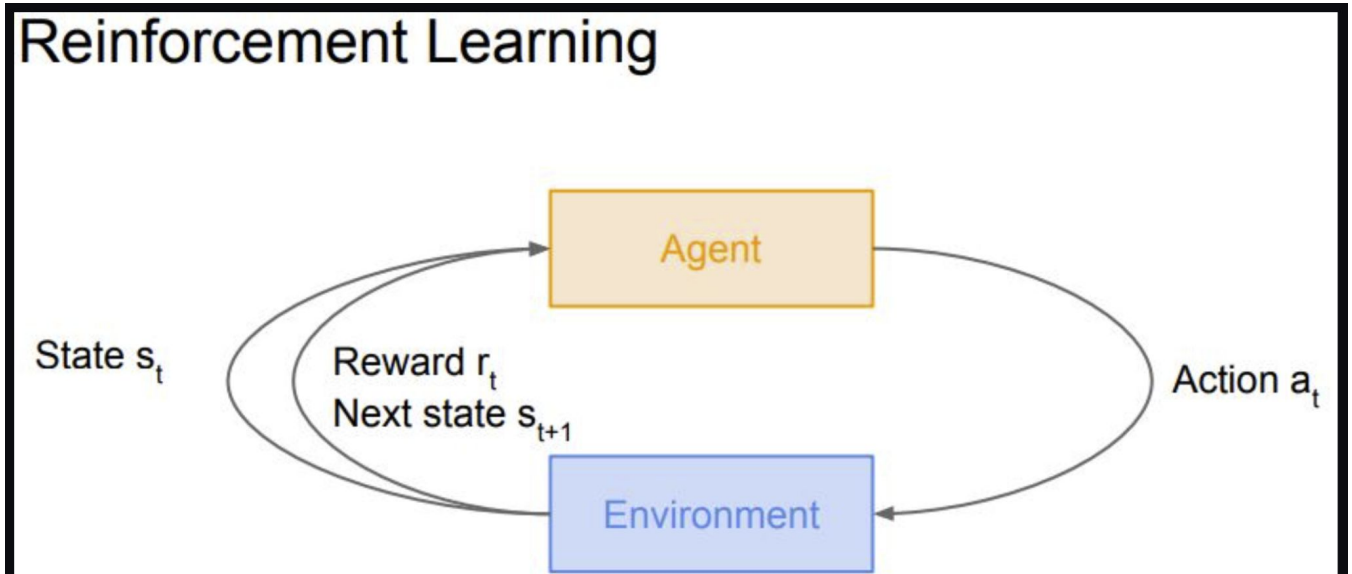
We hope to use robotic arm to pick up the small objects and move it to somewhere else.

The current target of this project is to create a DQN agent and define reward functions to teach a robotic arm to carry out two primary objectives:

1. Training any part of the robot arm touch the object of interest.
2. Training only the gripper base of the robot arm touch the object.

# Model of RL

Reinforcement learning is about positive and negative rewards (punishment) and learning to choose the actions which yield the best cumulative reward. To find these actions, it's useful to first think about the most valuable states in environment. The goal is to move from state S (Start) to state G (Goal). The final solution can be tuned by altering the reward values.

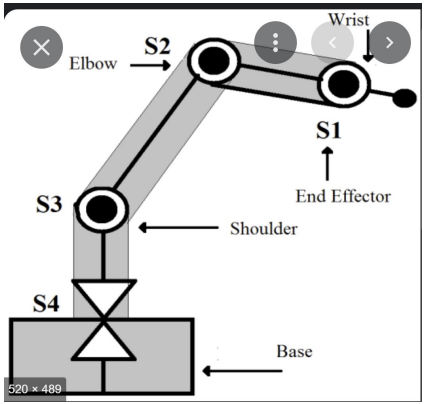


# Task of project

The robotic arm in this project has 3 DOF(Degree of Freedom): base, joint 1 and joint 2. The code has the LOCKBASE condition where we can select to use 2 or 3 DOF. For each DOF we have two actions: increase or decrease.

For instance, suppose the agent receives the state: joint 1, even. It means that the agent must send the action: increase joint 1 in x value.

| State Angle | Action | Description |
|---|---|---|
| EVEN | increase | Increase the joint angle value |
| ODD | decrease | Decrease the joint angle value |



# Parameters used to optimize the model

| Hyperparameters | Value | Reason |
|---|---|---|
| Velocity Control | false | The position control worked very well |
| LOCKBASE | true | Using DOF = 2 |
| EPS_DECAY | 1000 | Original value worked fine |
| INPUT_WIDTH | 64 | 512 was causing memory issues. Changed to 64 |
| INPUT_HEIGHT | 64 | 512 was causing memory issues. Changed to 64 |
| BATCH_SIZE | 16 | Changed from 8 to 16 to improve feature quality |
| LSTM_SIZE | 32 | Original value |
| REWARD_WIN | 10.0f | Value defined for win |
| REWARD_LOSS | -10.02f | Value defined for loss |
| LEARNING_RATE | 0.01f | Suggested value |
| REPLAY_MEMORY | 10000 | Original value |

# Our user

autonomous cars, robots, humans, customer support chat bots, go players

Any user who want to use robotic arm to pick up small object and move to somewhere else.

It is helpful for disable people to use robotic arm.

It can help people to pick up something in a small range.

# Literature Review

**DQN-TAMER: Human-in-the-Loop Reinforcement Learning with Intractable Feedback**

Riku Arakawa, Sosuke Kobayashi, Yuya Unno, Yuta Tsuboi, Shin-ichi Maeda

X. Xue, Z. Li, D. Zhang and Y. Yan, "**A Deep Reinforcement Learning Method for Mobile Robot Collision Avoidance based on Double DQN**," 2019 IEEE 28th International Symposium on Industrial Electronics (ISIE), 2019, pp. 2131-2136, doi: 10.1109/ISIE.2019.8781522.

# User Story

Improve the accuracy of using robotic arm to pick up something, then move state A to state B.

# MVP

We can get  target accuracy over 80%.

We can use arm move object from A to B.

# Technologies and tools

Ubuntu

Python

C++

Robot Operating System (ROS)  Gazebo

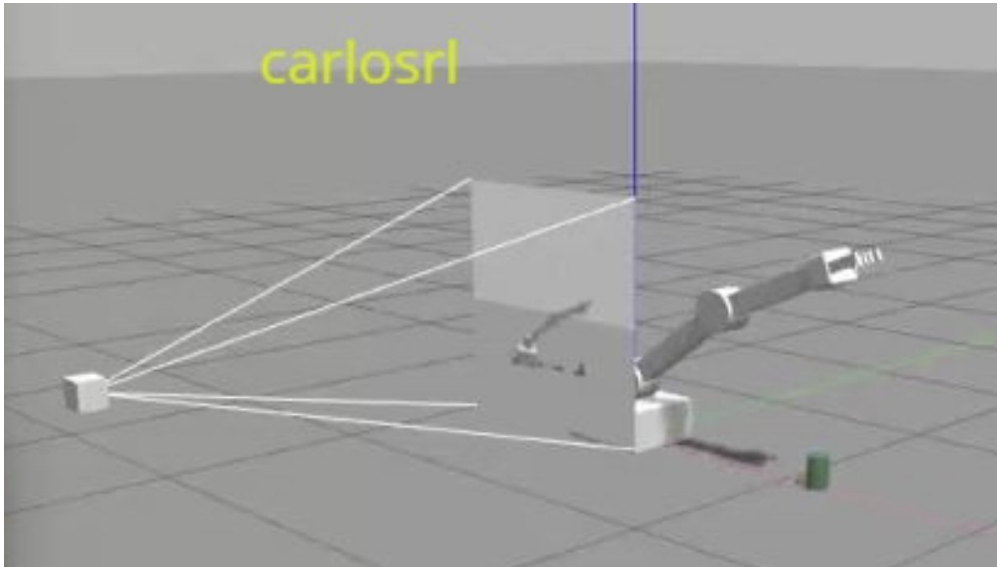
ROSMoveIt:  a powerful motion planning framework which has many features to control a robotic arm.

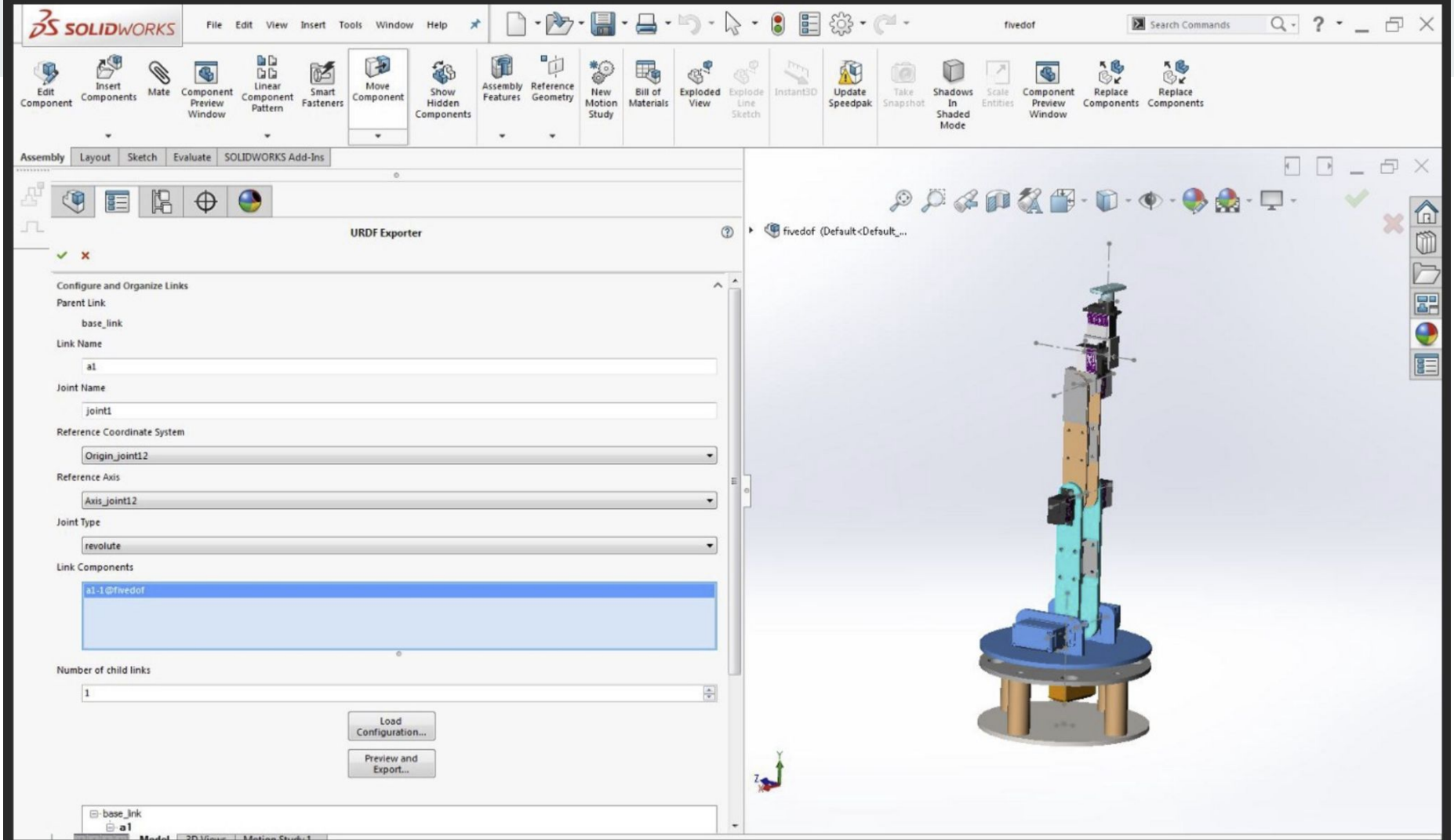
Unified Robotic Description Format (URDF)

CAD neutral format (such as STL)

# Setup of develop environment

The environment has a robotic arm, a tube in the ground and a camera that register the arm motion.

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Assembly Features
Reference Geometry
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Explode Line Sketch
Instant3D
Update Speedpak
Take Snapshot
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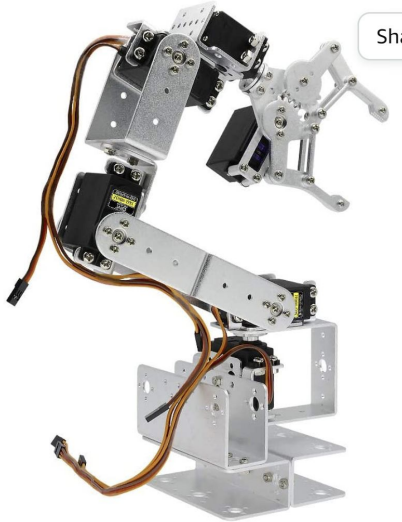

# Next Sprint Goals

Setup environment for the robotic arm training

Get baseline for the training

Try to think about the optimized parameters, review more research paper.

My teammate will talk about how to use actuator and mcu to make a simple robotic arm.

# Thank you!