RL and Autonomous Driving: Week 8

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Problem Statement

- Collision Prevention with CAT Vehicle in Gazebo
  - Reinforcement learning to train CAT Vehicle in Gazebo to detect and avoid potential collisions
  - Train the vehicle on a variety of situations such as collision detection and pedestrian avoidance
  - Use a meta-cognitive radio to relay information to nearby vehicles

Gazebo: Poorly Optimized

- Can’t reset Gazebo world due to massive slowdown.
    - Took out OpenAI ROS code since it relies on resetting simulation.
    - Moved everything to a single class.
- Need to restart Gazebo for each episode.
    - Episode: A training instance of the car
    - Timestep: An instance where the car decides what to do.

RL Framework: Pausing

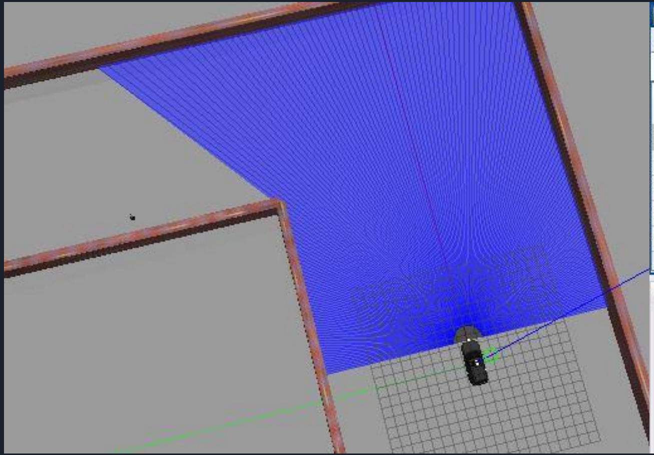
- Need to spawn Gazebo world at the start of each episode.
  - Requires pauses in between each episode so ROS doesn’t throw errors.
  - Requires a pause after spawning Gazebo world so topics have time to spawn.
    - Problem was subscribers tried to subscribe to topics that did not exist yet.

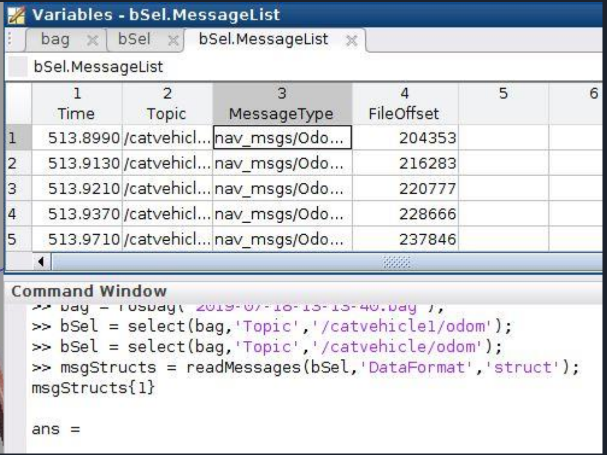
Training NN

- Trained Neural Network over the weekend.
  - Takes ~25 hours to train.
- Problems encountered:
  - Killing and restarting ROS too fast causes errors.
    - Need to pause after killing ROS.
  - Subscribers trying to subscribe before Gazebo world fully loaded. Trying to subscribe to topics that did not exist.
    - Need to pause after loading Gazebo world.

Gazebo ROS Collision World

- Created three usable worlds for RL algorithm testing (wall, human collision, curved turn human collision)
- No physicality to actor
- Record topic data to bag file accessible readable from matlab





Variables - bSel.MessageList

bSel.MessageList

	1 Time	2 Topic	3 MessageType	4 FileOffset	5	6
1	513.8990	/catvehicl...	nav_msgs/Odo...	204353		
2	513.9130	/catvehicl...	nav_msgs/Odo...	216283		
3	513.9210	/catvehicl...	nav_msgs/Odo...	220777		
4	513.9370	/catvehicl...	nav_msgs/Odo...	228666		
5	513.9710	/catvehicl...	nav_msgs/Odo...	237846		

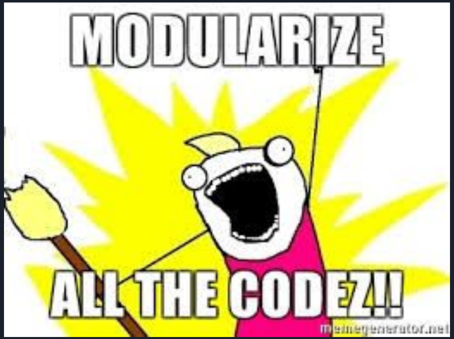
Command Window

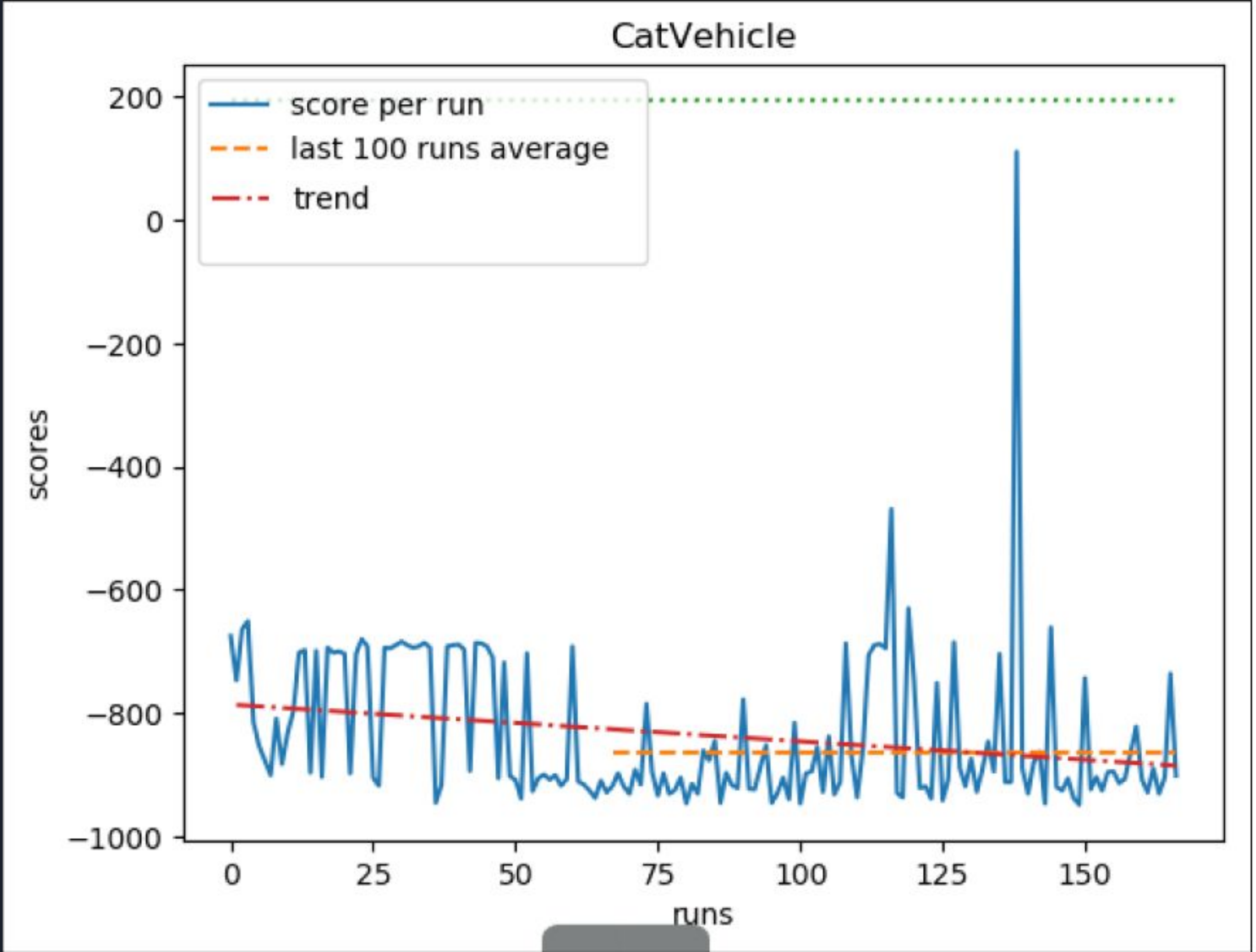
```
>> bag = rosbag('2019-07-18-13-13-40.bag');
>> bSel = select(bag,'Topic','/catvehicle1/odom');
>> bSel = select(bag,'Topic','/catvehicle/odom');
>> msgStructs = readMessages(bSel,'DataFormat','struct');
msgStructs{1}

ans =
```

Algorithm Improvement

- Modularize the reinforcement learning algorithm
- Save all the data of the trained model to a training file: model structure, weights values, optimizer's configuration.
- Load the training file into a new model to test the autonomous vehicle.

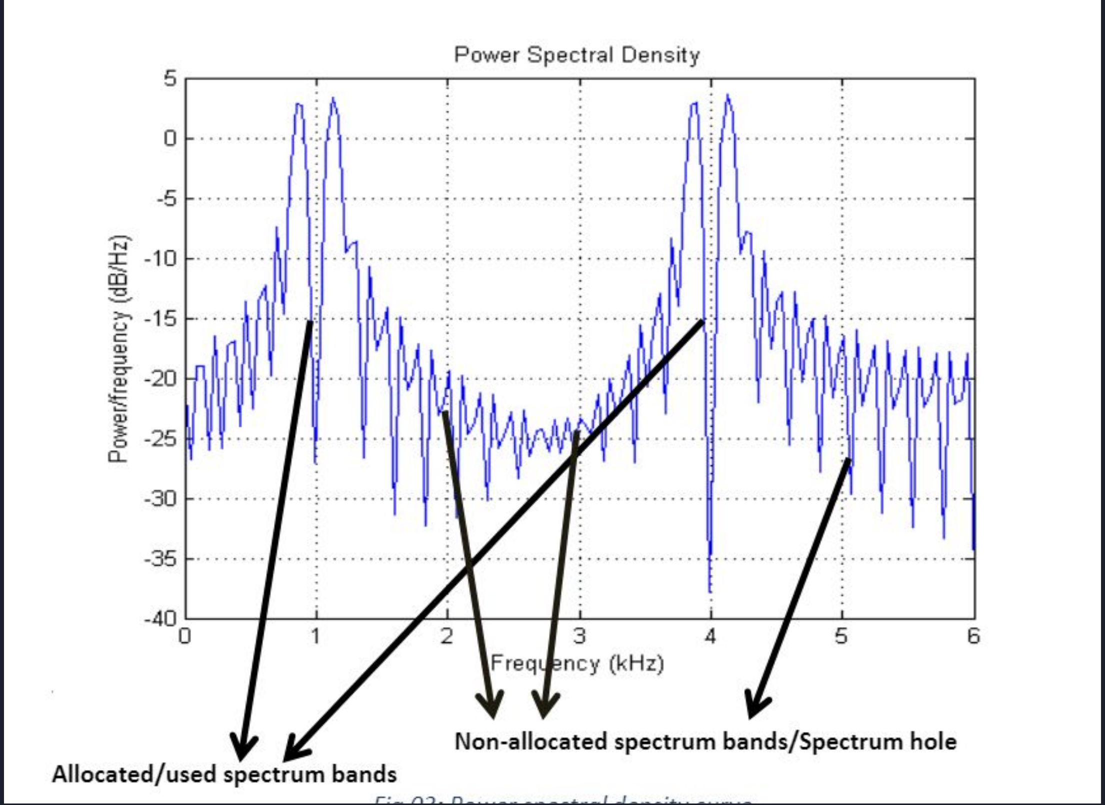



CatVehicle
score per run
last 100 runs average
trend
200
0
−200
−400
−600
−800
−1000
scores
0
25
50
75
100
125
150
runs

Lit Review: Simulation of CR Environment

- J. Hossain, S. Kawsar: Simulation of a Cognitive Radio System By Using MATLAB
  - Simulation defined from beginning to end with 5 different channels
  - Code provided
  - Challenges
    - Paper uses a different modulation scheme (Amplitude instead of PSK)
    - Paper uses Energy Detection for their CR and to determine Interference
      - Signal needs to be an actual passband wave in order to do this

- PSD Graph of 5 Channels
- If channel is active: dip/ “Hole”
    - If not, flat
- Ideal Single State Simulation:
    - Environment randomly assigns users to 4 bands, leaves one open
    - Agent uses info about PSD to select a band
    - + Reward if correct , - Reward if wrong
    - Environment gets reset



Future Goals

- Focus on demo
- Reduce training time needed for neural network
- Modify training world
  - Give car more space to maneuver
  - Make reward path more dense.
- Finish Environment and Begin work with Agents
  - First a Q-Learning Agent, followed by UCB