

Testing Learning Capabilities of Intelligent Collaborative Robots

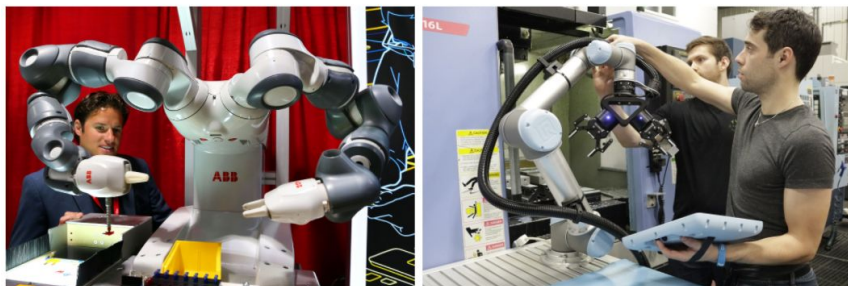
Mohit Kumar Ahuja

PhD Student

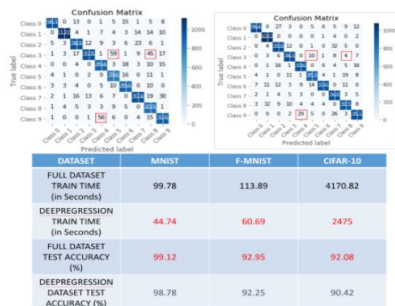
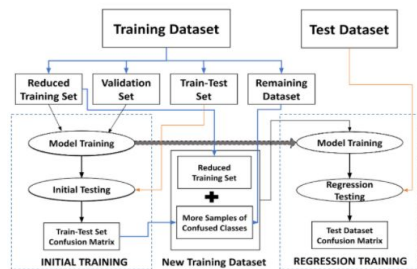
Simula Research Laboratory

In this presentation, I will explain what we do with collaborative robots at Simula.

What are Collaborative Robots?



DeepRegression: Regression Training of Deep Learning Systems using Reduced Dataset



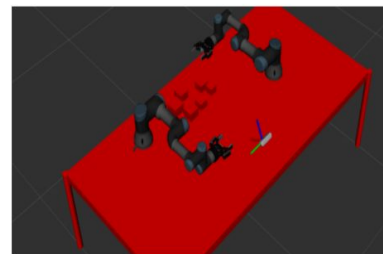
Why is testing required for AI-driven robots

Need for Testing Learning Capabilities of Cobots.

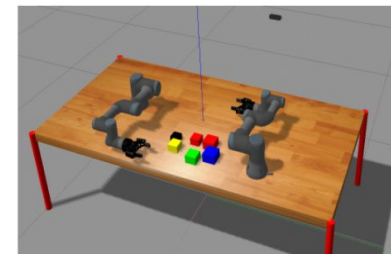
- Are Cobots 100% accurate/reliable to solve AI-driven vision tasks?
- Is it safe to deploy AI-Driven robots in collaboration with humans?
- Are there strong testing techniques available to test the learned abilities of robots/cobots?



Metamorphic Testing of Robots (Metero)



Visualization in RVIZ

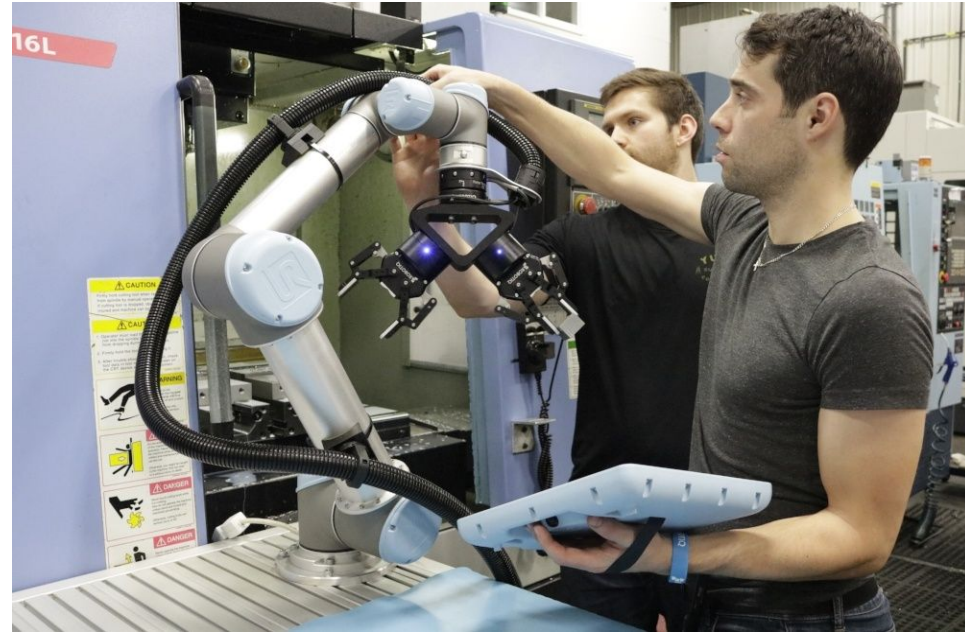


Simulation in Gazebo

For years, robots used to work in cages



What are Collaborative Robots?



Humans can work with these robots safely.



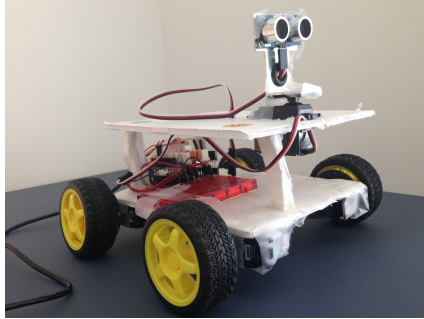
simula

But other than their safety aspect, these robots does not have any level of intelligence



How can we make these collaborative robots intelligent?

Ultrasonic
Sensor



RADAR
(Radio Detection
and Ranging)

1. Not accurate
2. Can be fooled easily
3. Low resolution

They can't see anything~!

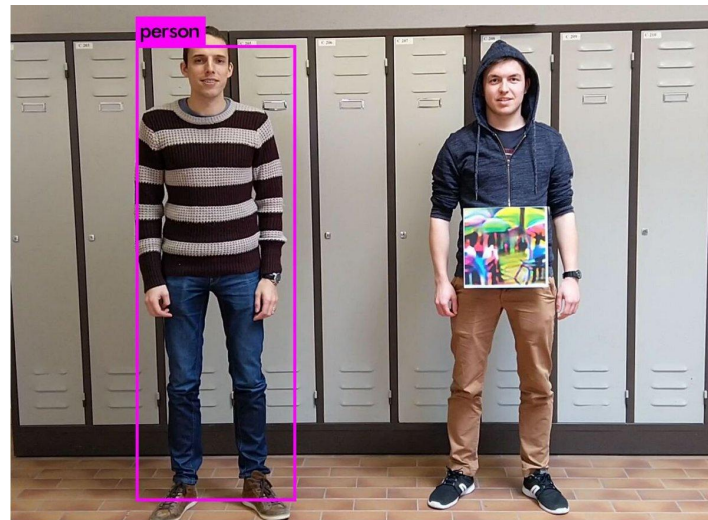
LiDAR
(Light Detection
and Ranging)

1. Expensive
2. Heavy
3. Fails with changing environment

Camera



These robots can learn from the environment using AI. But Can we Trust AI?



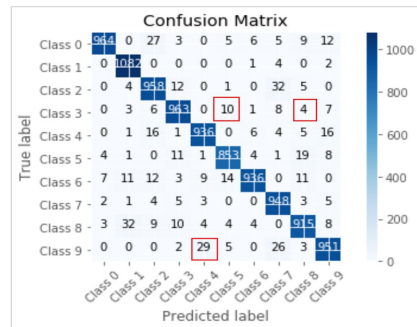
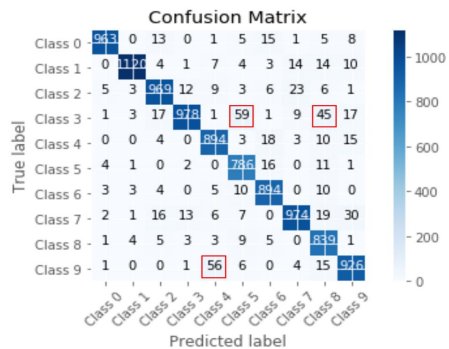
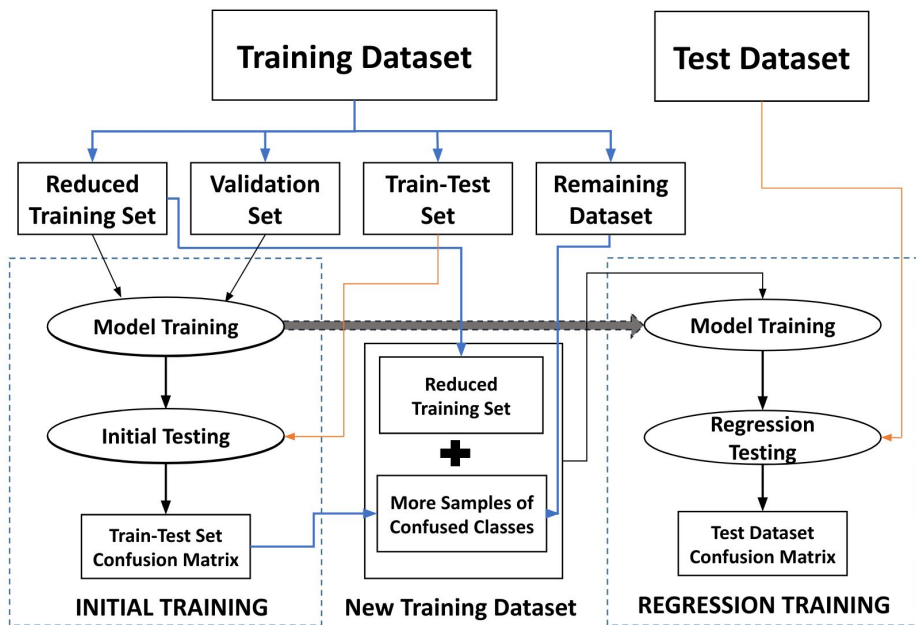
By just changing the illuminance of an image, or by wearing a patched T-shirt, even State-of-the-art DNN's can show disastrous results.

A. Nguyen, J. Yosinski, and J. Clune, "Deep neural networks are easily fooled: High confidence predictions for unrecognizable images".

Testing is required for AI-driven collaborative robots due to these two reasons.

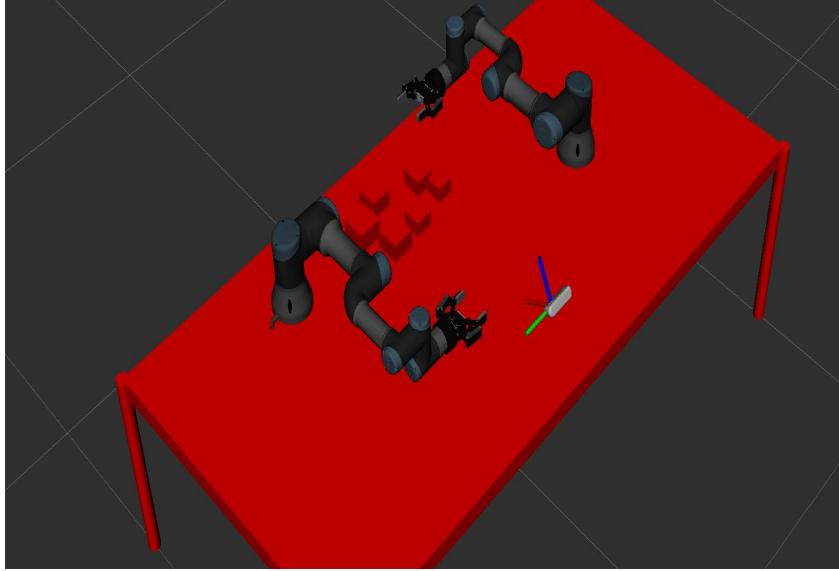
1. Cobots are not 100% accurate/reliable to solve AI-driven vision tasks.
2. It is important to create trust before deploying AI-Driven robots in collaboration with humans.

DeepRegression: Regression Training of Deep Learning Systems using Reduced Dataset

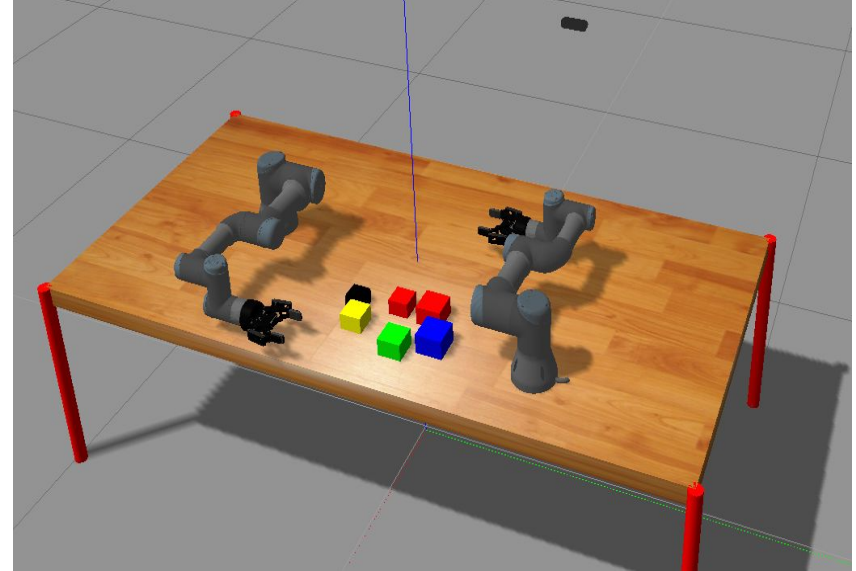


DATASET	MNIST	F-MNIST	CIFAR-10
FULL DATASET TRAIN TIME (in Seconds)	99.78	113.89	4170.82
DEEPREGRESSION TRAIN TIME (in Seconds)	44.74	60.69	2475
FULL DATASET TEST ACCURACY (%)	99.12	92.95	92.08
DEEPREGRESSION DATASET TEST ACCURACY (%)	98.78	92.25	90.42

Metamorphic testing of collaborative robots to identify corner case scenarios



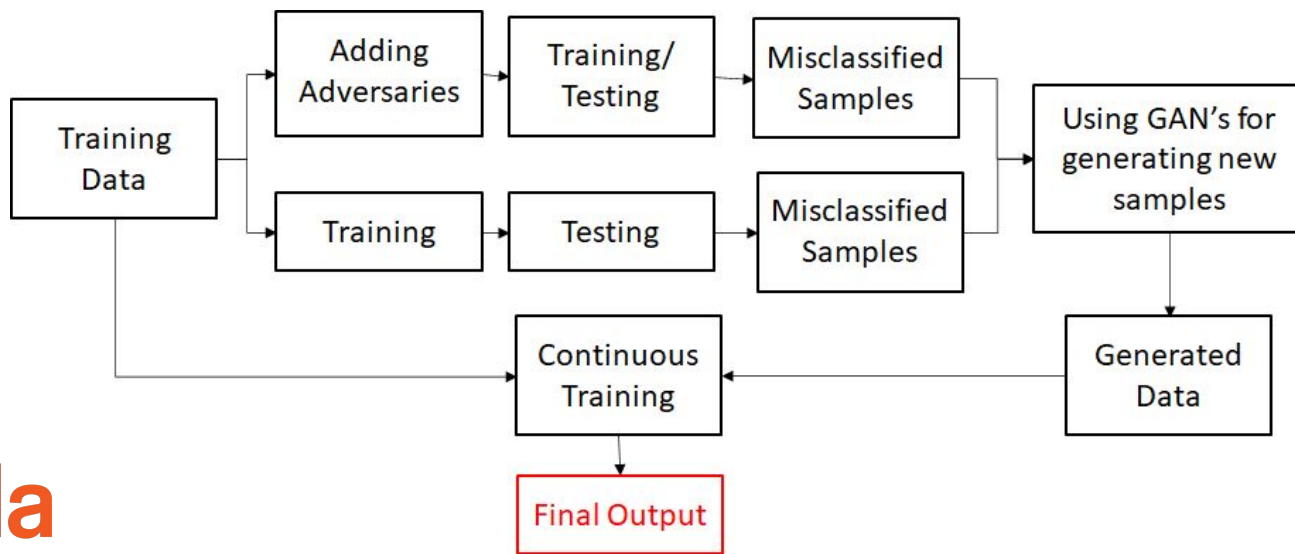
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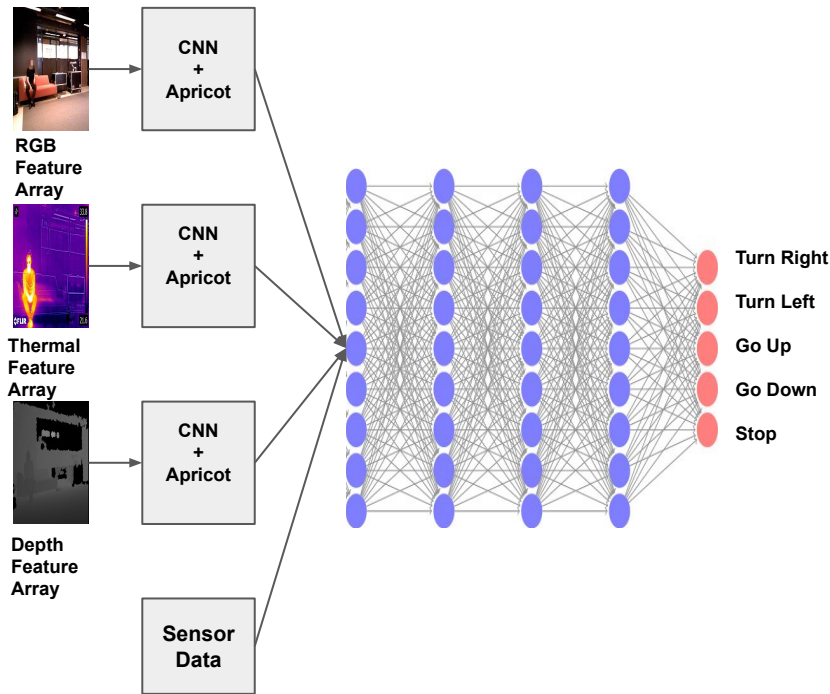
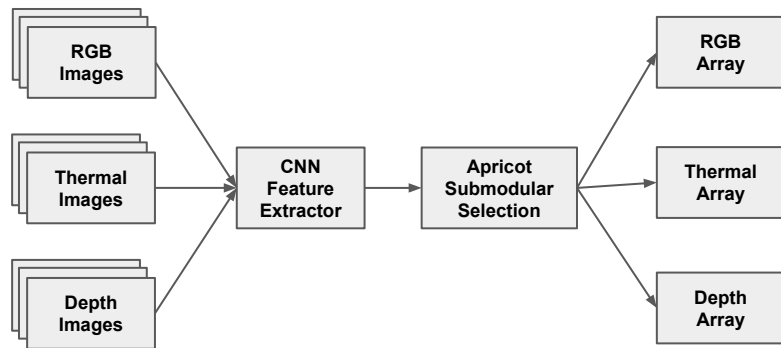
Simulation in Gazebo

Improvised training of cobot with limited training data

1. Extract all samples which are misclassified while usual training and adversarial training.
2. Use GAN's to generate looklike samples for misclassified samples.
3. Continue training using original and generated samples.
4. Apply the same to robotic dataset and deploy it in real-time.

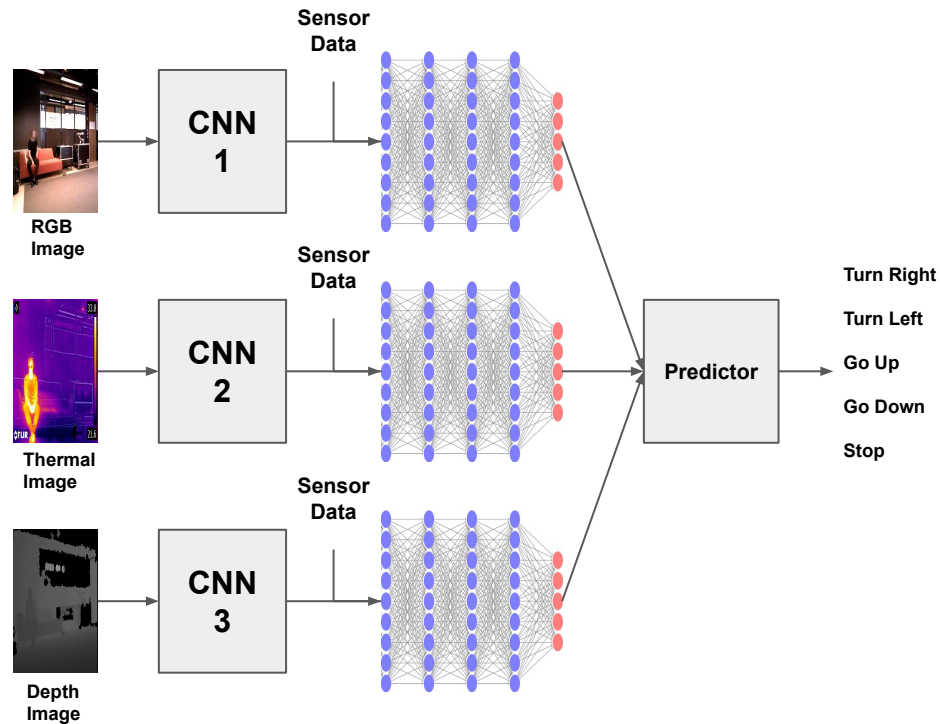
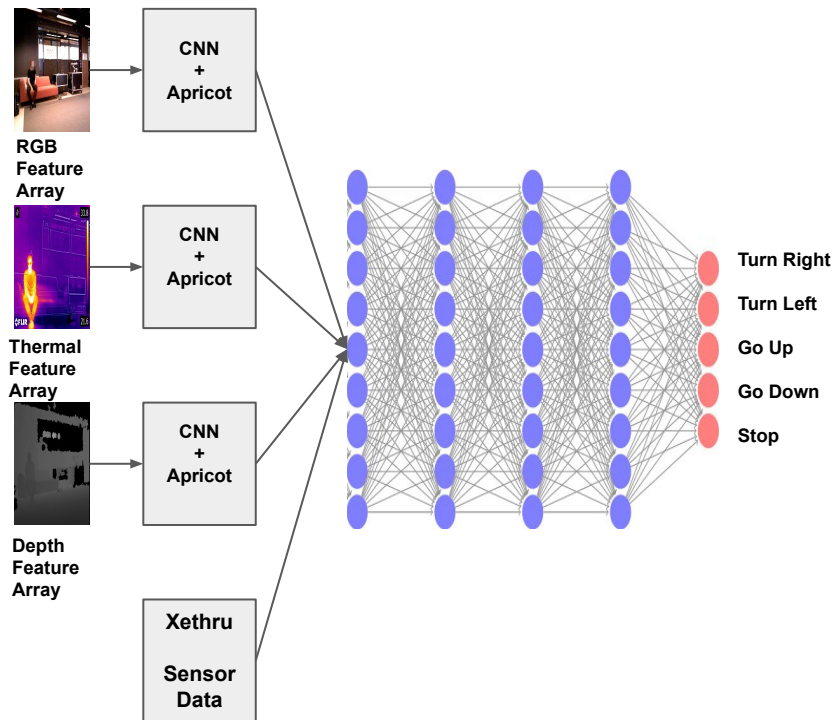


Using multi-modeling techniques for huge datasets leading to safer robot trajectories



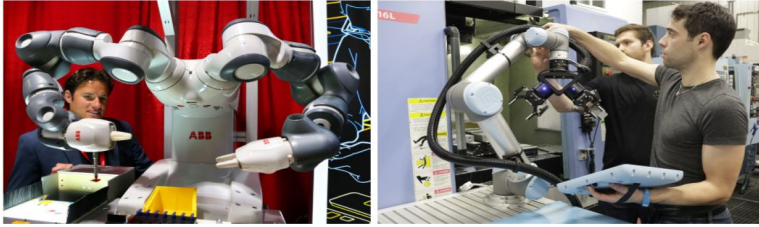
Schreiber, Jacob, Jeffrey Bilmes, and William Stafford Noble. "Apricot: Submodular selection for data summarization in Python." *Journal of Machine Learning Research* 21.161 (2020): 1-6.

Implement two different techniques and compared the results



To Conclude, we at Simula are trying to train and test the learning capabilities of industrial collaborative robots.

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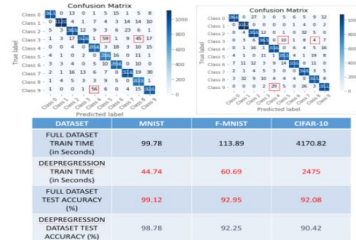
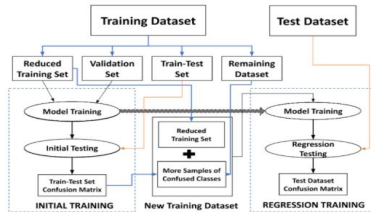
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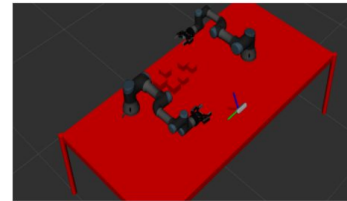
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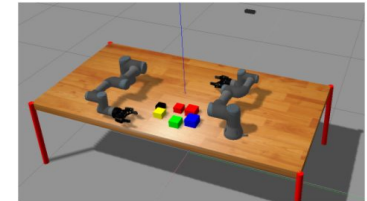
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