ADS-AI

Training RL Agents Remotely

Reinforcement learning agents can take a long time to train. In this datalab we will learn how to train reinforcement learning agents remotely on the ADSAI servers. This will allow us to send the training job to the cloud and continue working on other tasks while the agent trains. We will also learn how to run multiple training jobs in parallel with different hyperparameters to find the best performing agent.

We will use the ClearML platform to manage the remote training jobs. We will also use the Weights and Biases platform to track the experiments and log the results.

Remote Training Jobs: Pendulum Control with RL

First lets start with a simple example to get familiar with the process. We will use the Stable Baselines 3 library to train a reinforcement learning agent to control the pendulum environment.

Use the following code to train the agent locally first:

```
from stable_baselines3 import PPO
import gym
import time

env = gym.make('Pendulum-v1',g=9.81)

model = PPO('MlpPolicy', env, verbose=1)

model.learn(total_timesteps=10000, progress_bar=True)
```

This time we leave out the test code since we will be running the agent remotely, after testing it locally. We need to test the agent locally first to make sure it is working correctly before we send it to the cloud to train. This will save us time.

Add Weights and Biases for Experiment Tracking (Optional)

Set your API key using os environment variables:

```
import os

os.environ['WANDB_API_KEY'] = 'INSERT_API_KEY_HERE'
```

Initialize the wandb project and add the wandb callback to the model:

```
import wandb
from wandb.integration.sb3 import WandbCallback

# initialize wandb project
run = wandb.init(project="sb3_pendulum_demo",sync_tensorboard=True)

# add tensorboard logging to the model
model = PPO('MlpPolicy', env, verbose=1, tensorboard_log=f"runs/{run.id}")

# create wandb callback
wandb_callback = WandbCallback(model_save_freq=10000,
                               model_save_path=f"models/{run.id}",
                               verbose=2,
                               )

# add wandb callback to the model training
model.learn(total_timesteps=timesteps, callback=wandb_callback, progress_bar=True, tb_log_name=f"runs/
```

Save the model incrementally

Since these models can take a long time to train, it is a good idea to save the model periodically so that you can resume training later if needed. We can also use the saved models to test the agent in the environment and visualize the progress.

Simply include the learn function in a for loop and save the model after each iteration:

```
# variable for how often to save the model
time_steps = 100000
for i in range(10):
    # add the reset_num_timesteps=False argument to the learn function to prevent the model from reseti
    # add the tb_log_name argument to the learn function to log the tensorboard data to the correct fol
    model.learn(total_timesteps=timesteps, callback=wandb_callback, progress_bar=True, reset_num_timest
    # save the model to the models folder with the run id and the current timestep
    model.save(f"models/{run.id}/{timesteps*(i+1)}")
```

Add command line arguments to the training script for the hyperparameters

This will allow you to easily change the hyperparameters without having to edit the training script. It will also allow you to run multiple training jobs with different hyperparameters in parallel, by simply cloning job in the ClearML dashboard and changing the hyperparameters through the UI.

Define the arguments:

```
import argparse

parser = argparse.ArgumentParser()
parser.add_argument("--learning_rate", type=float, default=0.0003)
parser.add_argument("--batch_size", type=int, default=64)
parser.add_argument("--n_steps", type=int, default=2048)
parser.add_argument("--n_epochs", type=int, default=10)

args = parser.parse_args()
```

Add the arguments to the model:

```
model = PPO('MlpPolicy', env, verbose=1,
            learning_rate=args.learning_rate,
            batch_size=args.batch_size,
            n_steps=args.n_steps,
            n_epochs=args.n_epochs,
            tensorboard_log=f"runs/{run.id}",)
```

To run the training script with the command line arguments, use the following command in the terminal:

```
python train_pendulum.py --learning_rate 0.0001 --batch_size 64 --n_steps 2048 --n_epochs 10
```

You will need to replace train_pendulum.py with the name of your training script, and replace the hyperparameters with the ones you want to use.

If this runs successfully, you are ready to start training the agent remotely.

Remote Training with ClearML

Installation and Setup

If you haven't already, install the ClearML package and initialize the configuration file If you are using remote JupyterLab, you will have already done this and can skip to running the training job. Run the following commands in the terminal (make sure you are in the correct virtual environment):

```
pip install clearml
```

```
clearml-init
```

Copy these credentials when prompted:

```
api {
    web_server: http://194.171.191.227:8080
    api_server: http://194.171.191.227:8008
    files_server: http://194.171.191.227:8081
    # Students
    credentials {
        "access_key" = "UJODYOFVELU1XCB7OFM2FKU7XCY48K"
        "secret_key"  = "OKCS8xT-vngmYWgpIMYsu_GbS2fLgMmMp1MbzqyLZdWZtA-FGxlUJ5KGISFGPMdcDDk"
    }
}
```

Leave all other settings as default.

Note: You need to be connected to the VPN to queue jobs and access the dashboard.

Github

ClearML uses git to clone your training script and any other files you need to run the job. Make sure you have the latest version of your training script committed to your github repository.

If you have permission errors related to cloning your github repository when running remote jobs a simple fix is to create a public repository on github and push only the files you need to run the job to the public repository.

Running Remote Training Jobs

Add the following code to the top of your training script after the imports:

```
from clearml import Task

# Replace Pendulum-v1/YourName with your own project name (Folder/YourName, e.g. 2022-Y2B-RoboSuite/Mi
task = Task.init(project_name='Pendulum-v1/YourName', # NB: Replace YourName with your own name
                 task_name='Experiment1')

#copy these lines exactly as they are
#setting the base docker image
task.set_base_docker('deanis/2023y2b-rl:latest')
#setting the task to run remotely on the default queue
task.execute_remotely(queue_name="default")
```

If you also want to save the model and upload it to clearml for later download add the following code to your training script (the saved model file will appear in the artifacts tab):

```
model.save("model_name")
task.upload_artifact("model", artifact_object="model_name.zip")
```

The above code does the following:

- Initializes the task in the ClearML platform using the project name and task name you specify. This will create a new task in the ClearML dashboard.
- Sets the base docker image to use for the training job. This is the docker image that will be used to run the training job. A docker image is a virtual machine that contains all the libraries and dependencies needed to run the training job. One has been created for you and is available on dockerhub. Just use the provided code to load the docker image.
- Sets the task to run remotely on the default queue. This will send the training job to the cloud to run on the default queue. You can also specify a specific queue to run the job on. For

example, if you want to run the job on the GPU queue, you would use `task.execute_remotely(queue_name="gpu")`. You can see what queues are available in the ClearML dashboard.

How to Run the Training Job

To run the training job, simply run the training script in the terminal with the desired hyperparameter arguments. For example:

```
python train.py --learning_rate 0.0001 --batch_size 64 --n_steps 2048 --n_epochs 10
```

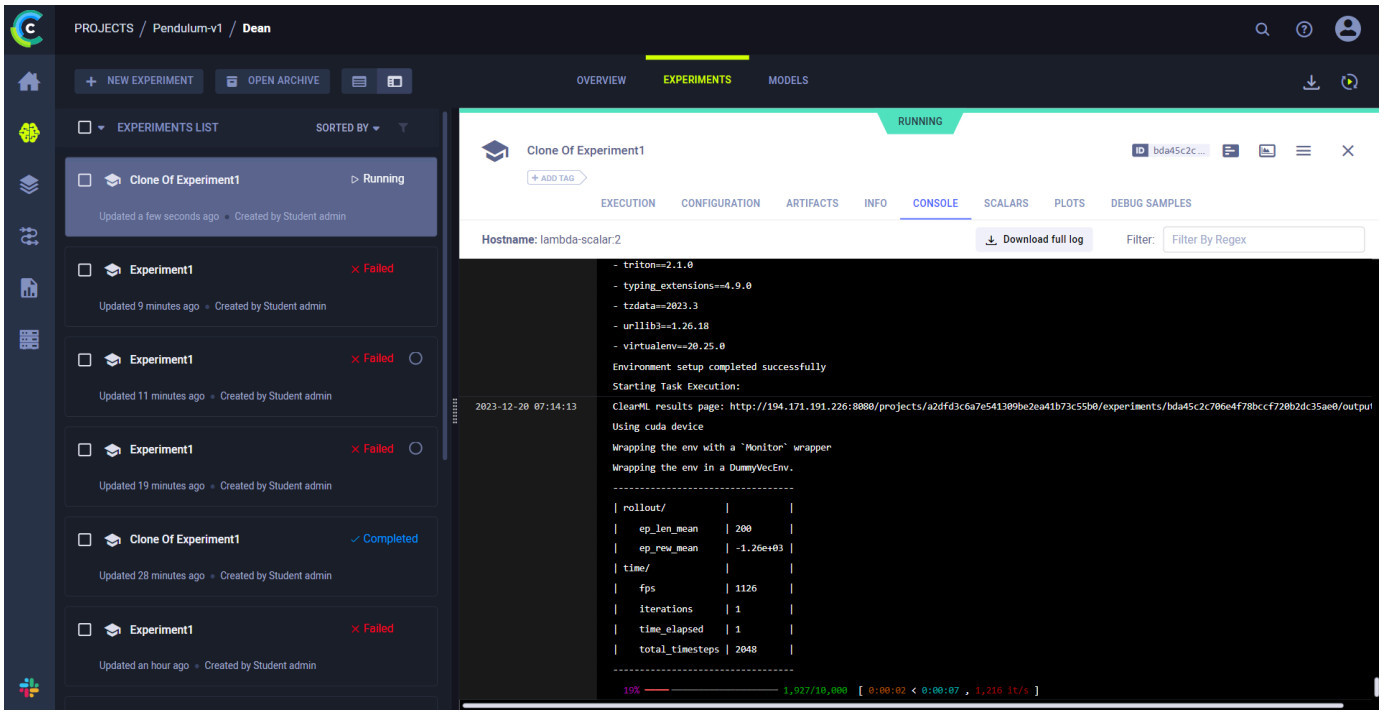
- Note: Replace train.py with the name of your training script, and replace the hyperparameters with the ones you want to use.

How do I know if it is working?

Go to the ClearML dashboard. Navigate to the project you created and click on the task you just created. You should see the task running in the dashboard. You can click on the task to see the logs and other information about the task. The console tab will show you the output from the training script.

Your login credentials *THE SAME AS YOUR CODER CREDENTIALS.*

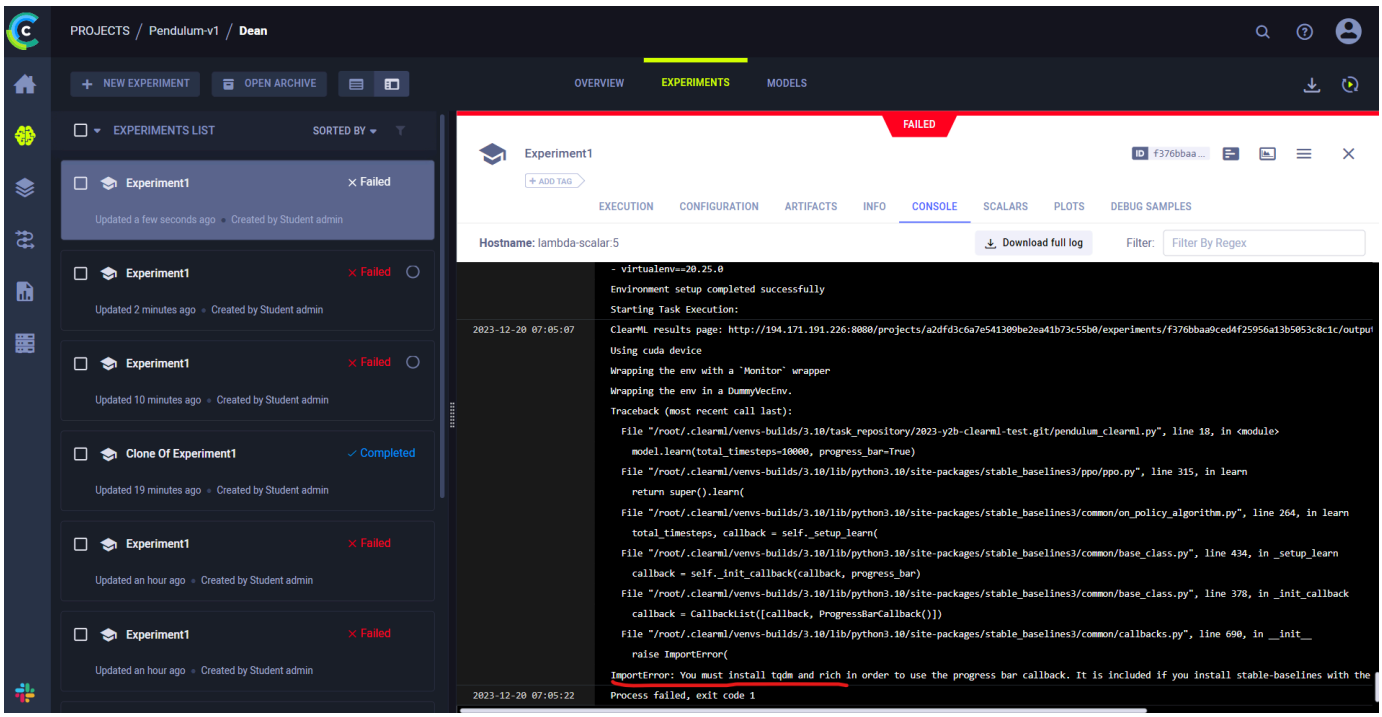
If it is working correctly, you should see the following output in the console tab:



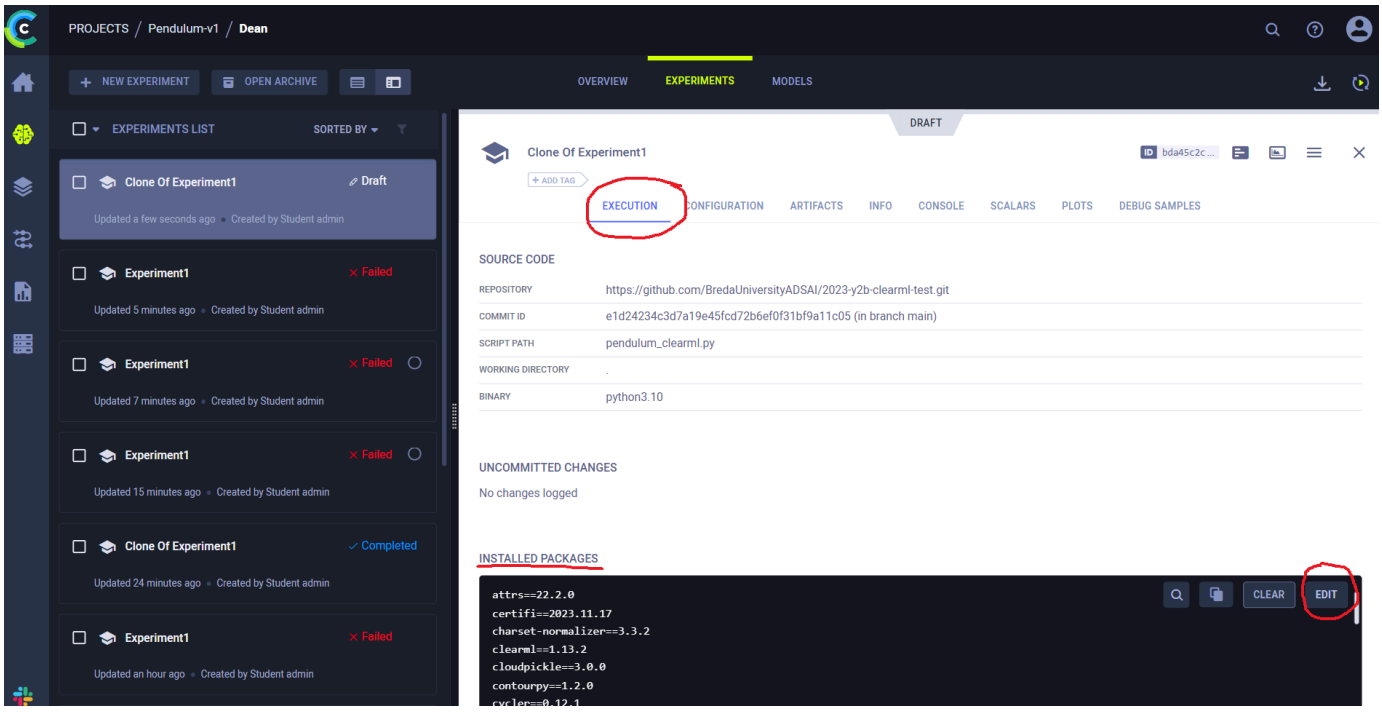
If there are errors, you will see them in the console tab, and you can use the error message to debug the issue. If you are having trouble debugging the issue.

There are missing dependencies in the docker image! What do I do?

If you get an error saying there are missing dependencies in the docker image like in the screenshot below:



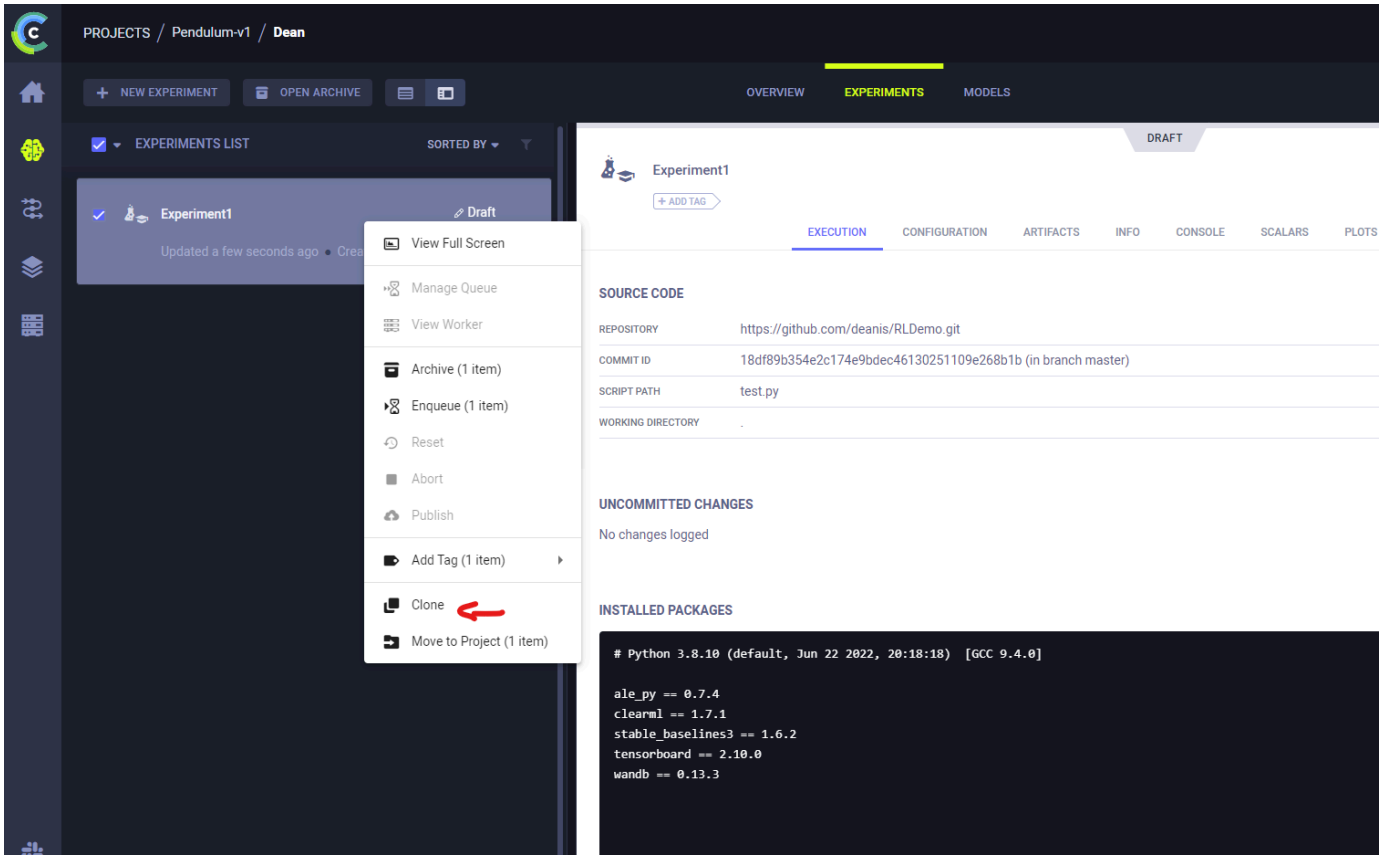
You can simply clone the experiment and add the missing dependencies to the list of installed packages in the execution tab. For example, if you get an error saying the package `tqdm` is missing, you can add `tqdm` to the list of installed packages and rerun the job.



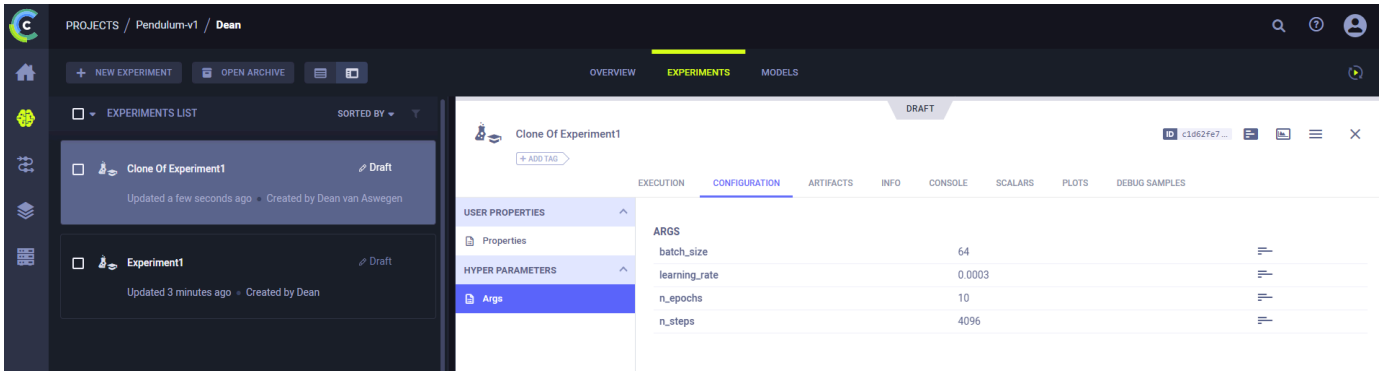
Cloning Jobs and Changing Hyperparameters

You can clone jobs in the ClearML dashboard to run multiple training jobs with different hyperparameters in parallel. Simply click the clone button on the job you want to clone and change the hyperparameters in the UI. You can also just rerun the job with different hyperparameters in your terminal.

- Clone job:



- Select cloned job and change hyperparameters on the configuration tab:

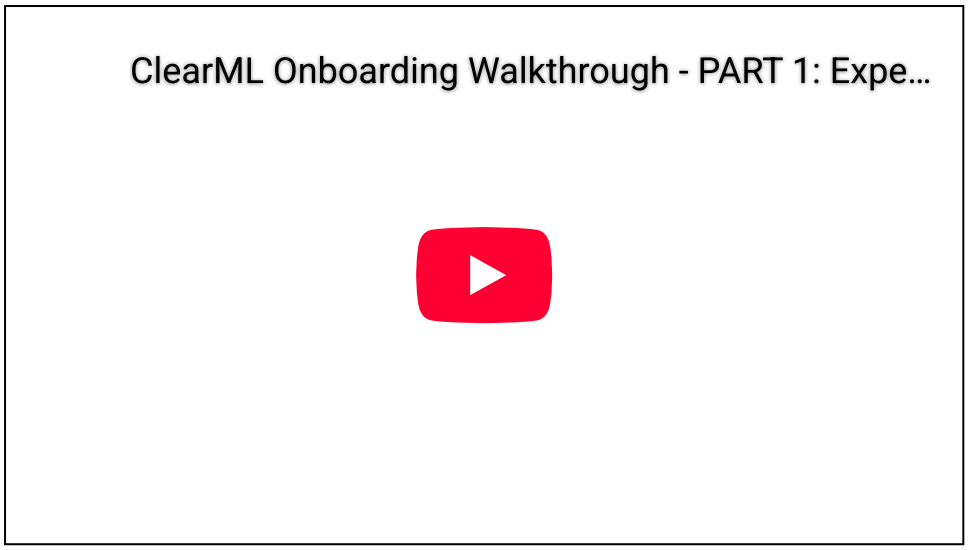


To start running the jobs right click on the cloned job and select `enqueue`.

ClearML Tutorials and Documentation (Optional)

If you want more information about ClearML, you can check out the tutorials and documentation here:

- ClearML Docs



<iframe width="480" height="270"src="https://www.youtube.com/embed/PDQQxKeuK0A" title="ClearML Onboarding Walkthrough - PART 2: Remote Task Execution and Automations" frameborder="0" allow="accelerometer; autoplay; clipboard-write; encrypted-media; gyroscope; picture-in-picture; web-share" allowfullscreen></iframe>

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