MushroomRL Benchmark Documentation

Release 1.1.0

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Benchmarks Results:

CHAPTER 1

Reinforcement Learning python library

MushroomRL Benchmark is a benchmarking tool for the Mushroom RL library. The focus of this benchmarking tool is to benchmark the results of deep reinforcement learning algorithms, in particular Deep Actor-Critic. The idea behind MushroomRL Benchmarking is to have a complete platform to run batch comparisons of Deep RL algorithms implemented in MushroomRL under a set of standard benchmark tasks.

With MushroomRL Benchmarking you can:

- Run the benchmarks in a local machine, both sequentially and in parallel fashion
- Run experiments on a SLURM-based cluster.

CHAPTER 2

Download and installation

MushroomRL Benchmark can be downloaded from the GitHub repository. Installation can be done running

```
cd mushroom-rl-benchmark
pip install -e .[all]
```

To compile the documentation:

```
cd mushroom-rl-benchmark/docs
make html
```

or to compile the pdf version:

```
cd mushroom-rl-benchmark/docs
make latexpdf
```

CHAPTER 3

Benchmarks

3.1 Policy Search Benchmarks

We provide the benchmarks for the Policy Gradient algorithms:

- **REINFORCE**
- **GPOMDP**
- **eNAC**

We provide the benchmarks for the following Black-Box optimization algorithms:

- **RWR**
- **REPS**
- **PGPE**
- **ConstrainedREPS**

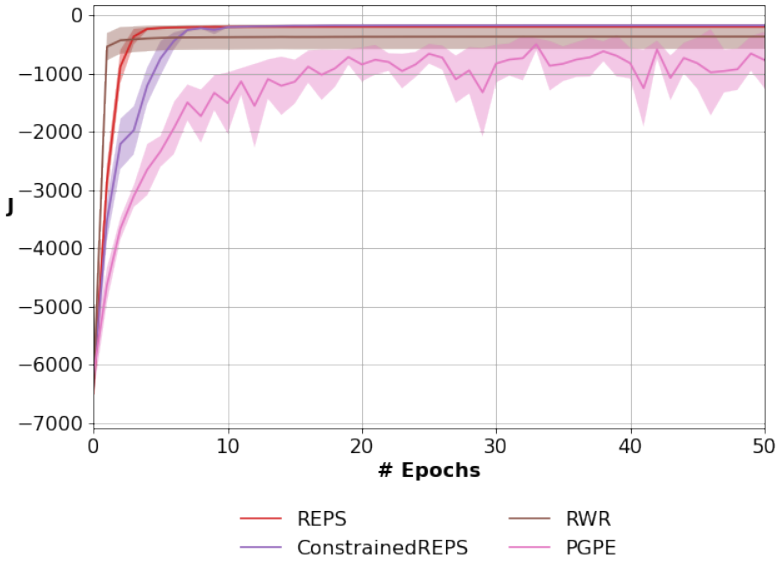
We consider the following environments in the benchmark

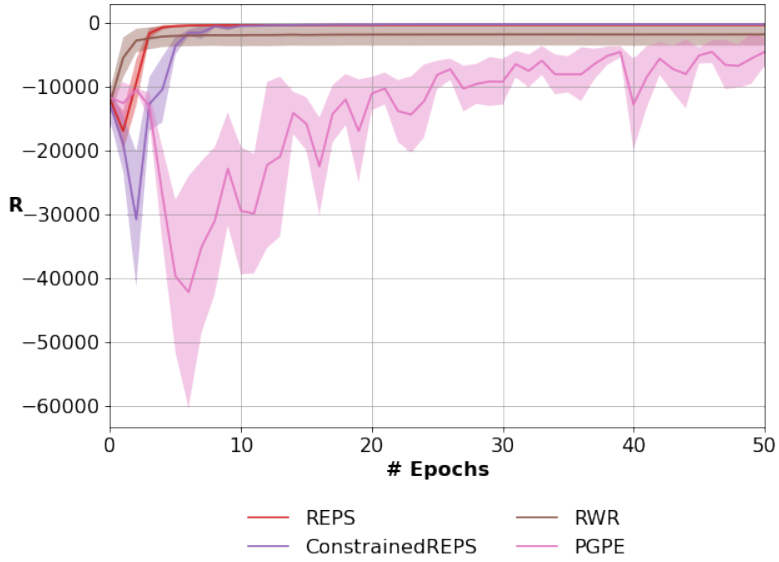
3.1.1 Classic Control Environments Benchmarks

Segway

Run Parameters	
n_runs	25
n_epochs	50
n_episodes	100
n_episodes_test	10

```
ConstrainedREPS:
  eps: 0.5
  kappa: 0.1
  n_episodes_per_fit: 25
PGPE:
  alpha: 0.3
  n_episodes_per_fit: 25
REPS:
  eps: 0.5
  n_episodes_per_fit: 25
RWR:
  beta: 0.01
  n_episodes_per_fit: 25
```

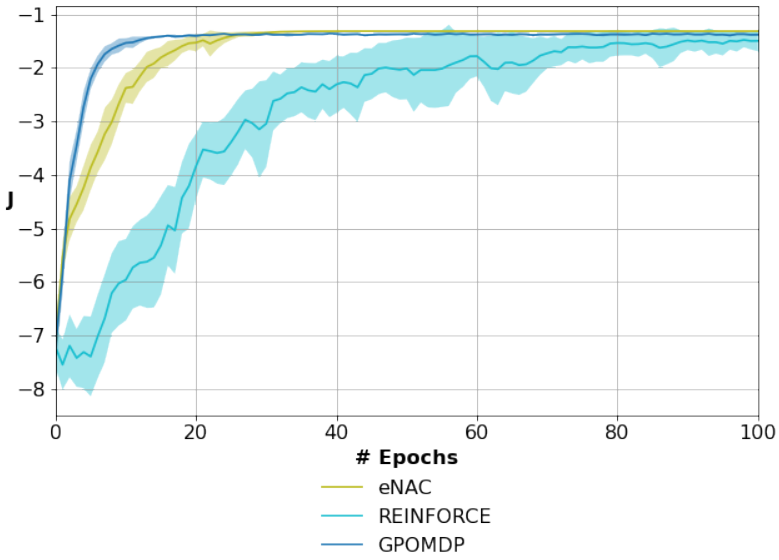


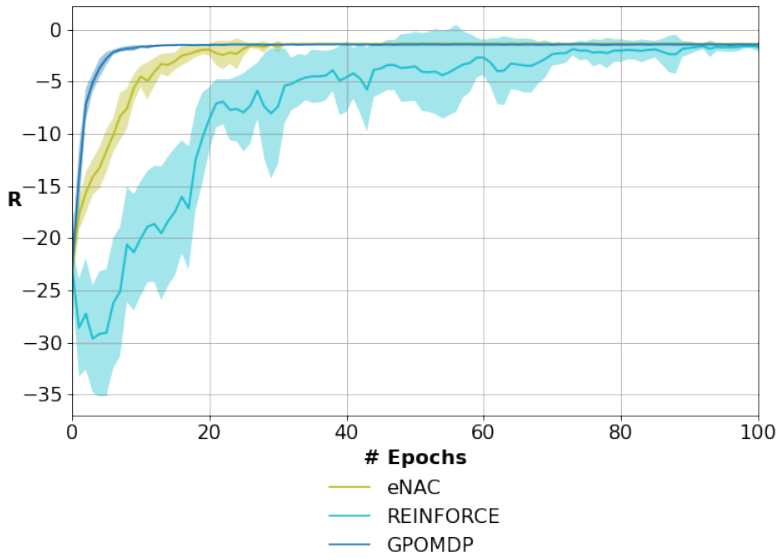


LQR

Run Parameters	
n_runs	25
n_epochs	100
n_episodes	100
n_episodes_test	10

```
GPOMDP:
  alpha: 0.01
  n_episodes_per_fit: 25
REINFORCE:
  alpha: 0.01
  n_episodes_per_fit: 25
eNAC:
  alpha: 0.01
  n_episodes_per_fit: 25
```





3.2 Actor-Critic Benchmarks

We provide the benchmarks for the following Deep Actor-Critic algorithms:

- **StochasticAC**
- **COPDAC_Q**

We provide the benchmarks for the following Deep Actor-Critic algorithms:

- **A2C**
- **PPO**
- **TRPO**
- **SAC**
- **DDPG**
- **TD3**

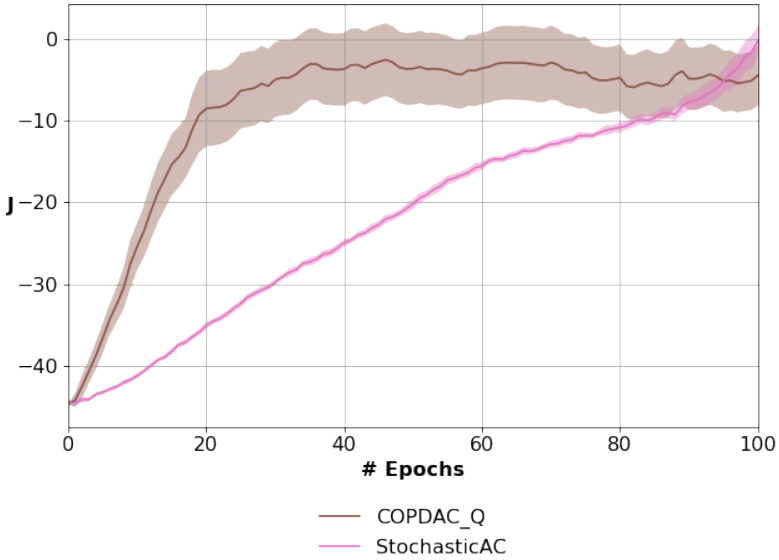
We consider the following environments in the benchmark

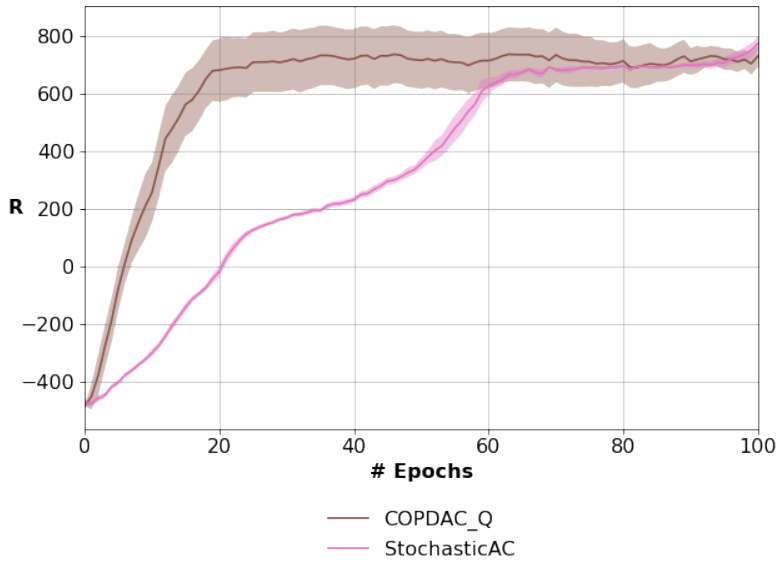
3.2.1 Classic Control Environments Benchmarks

Run Parameters	
n_runs	25
n_epochs	100
n_episodes	10
n_episodes_test	5

InvertedPendulum

```yaml
COPDAC_Q:
  alpha_omega: 0.5
  alpha_theta: 0.005
  alpha_v: 0.5
  n_tiles: 11
  n_tilings: 10
  std_eval: 0.001
  std_exp: 0.1
StochasticAC:
  alpha_theta: 0.001
  alpha_v: 0.1
  lambda_par: 0.9
  n_tiles: 11
  n_tilings: 10
  std_0: 1.0
```





3.2.2 Gym Control Environments Benchmarks

Run Parameters	
n_runs	25
n_epochs	10
n_steps	30000
n_episodes_test	10

Pendulum-v0

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: null
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 64
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 128
  max_replay_size: 1000000
  n_features:
  - 64
  - 64
```

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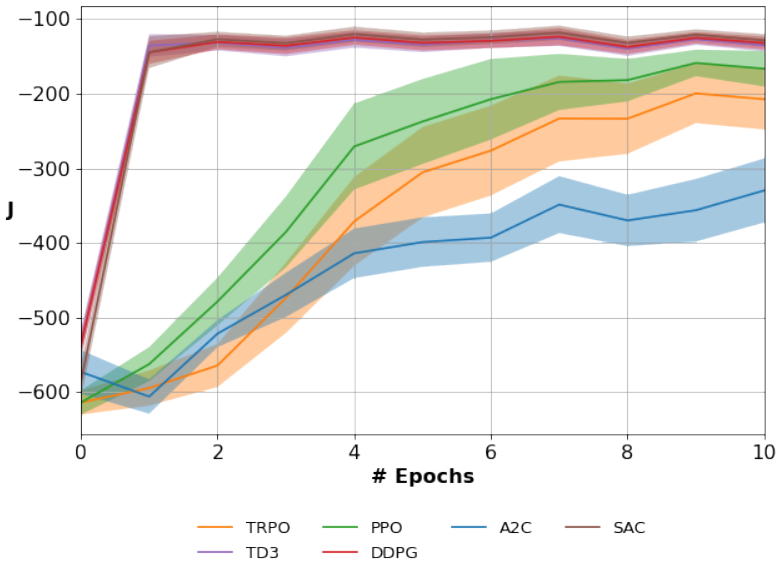
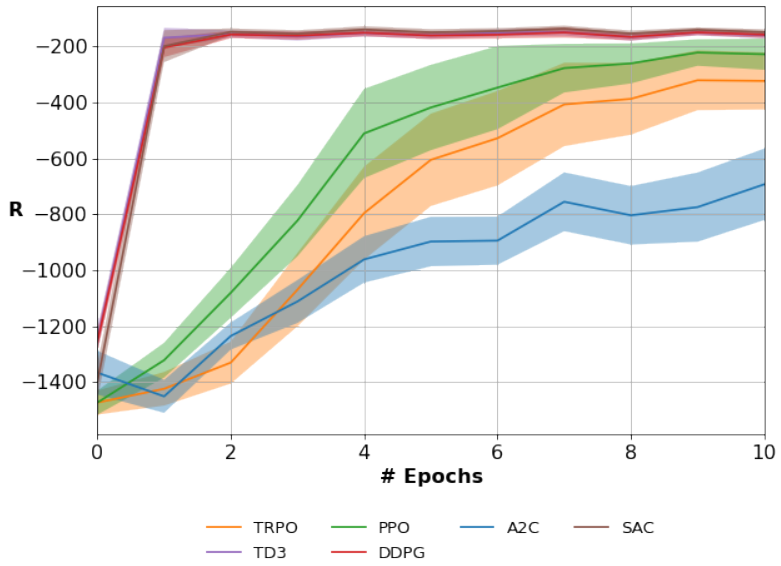
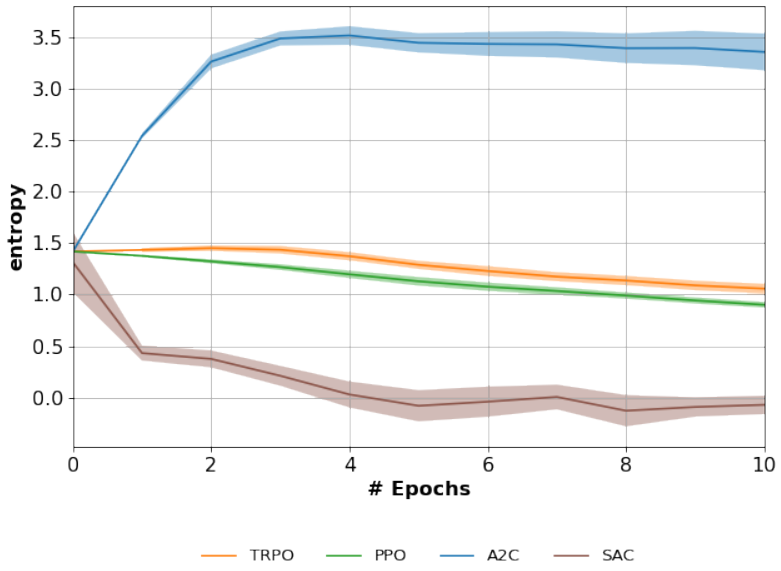
```
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 64
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 128
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 64
  preprocessors: null
  target_entropy: null
  tau: 0.001
  warmup_transitions: 128
TD3:
  actor_lr: 0.0001
  actor_network: TD3ActorNetwork
  batch_size: 64
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 128
  max_replay_size: 1000000
  n_features:
  - 64
  - 64
  tau: 0.001
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
```


−100
−200
−300
−400
−500
−600
J
0
2
4
6
8
10
Epochs
TRPO
PPO
A2C
SAC
TD3
DDPG


−200
−400
−600
−800
−1000
−1200
−1400
R
0
2
4
6
8
10
Epochs
TRPO
PPO
A2C
SAC
TD3
DDPG



LunarLanderContinuous-v2

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: StandardizationPreprocessor
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 64
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 128
  max_replay_size: 1000000
  n_features:
  - 64
  - 64
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
```

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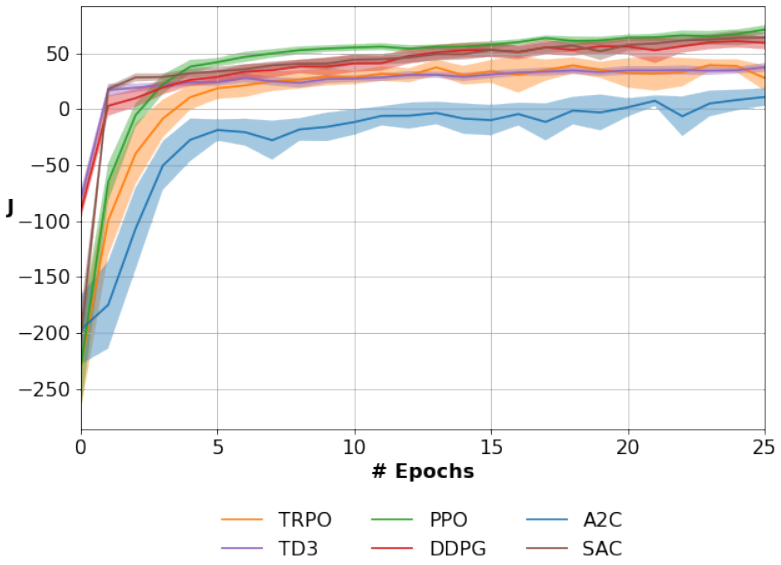
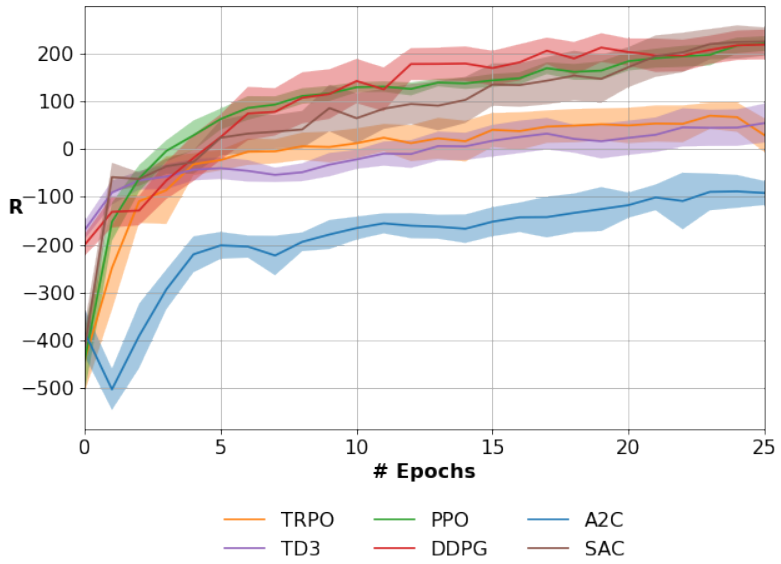
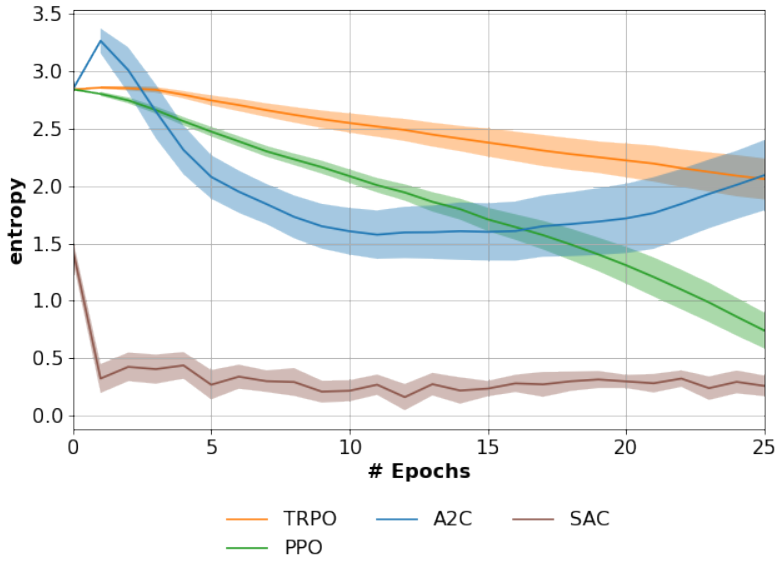
```
  n_steps_per_fit: 3000
  preprocessors: StandardizationPreprocessor
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 64
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 128
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 64
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 128
TD3:
  actor_lr: 0.0001
  actor_network: TD3ActorNetwork
  batch_size: 64
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 128
  max_replay_size: 1000000
  n_features:
  - 64
  - 64
  tau: 0.001
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.03
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: StandardizationPreprocessor
```


J
50
0
−50
−100
−150
−200
−250
0
5
10
15
20
25
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
200
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
25
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



3.2.3 Mujoco Environments Benchmarks

Run Parameters	
n_runs	25
n_epochs	50
n_steps	30000
n_episodes_test	10

Hopper-v3

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: StandardizationPreprocessor
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
```

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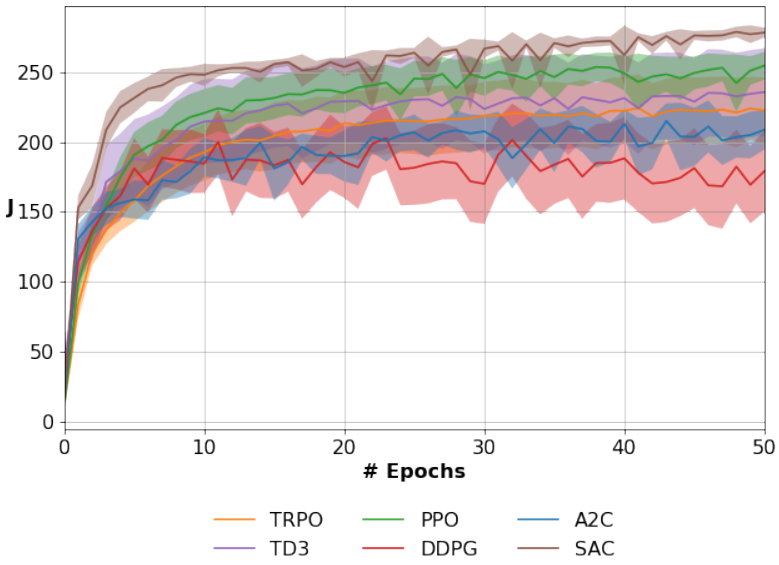
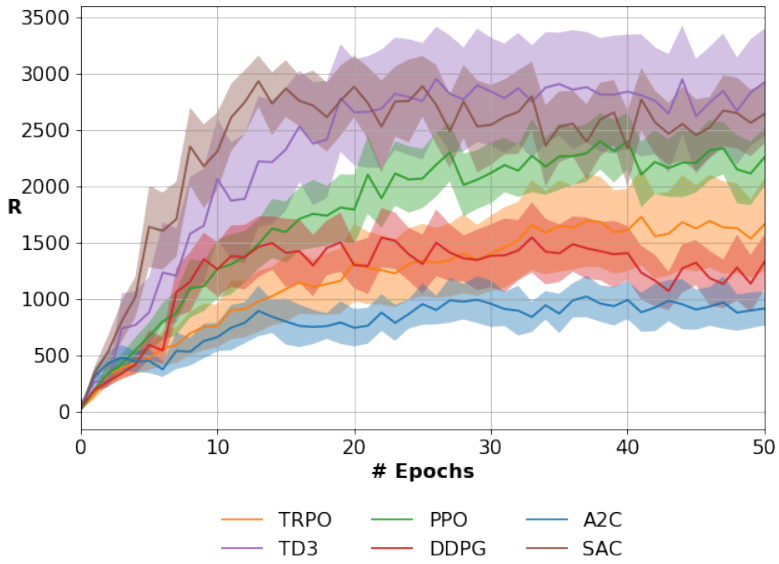
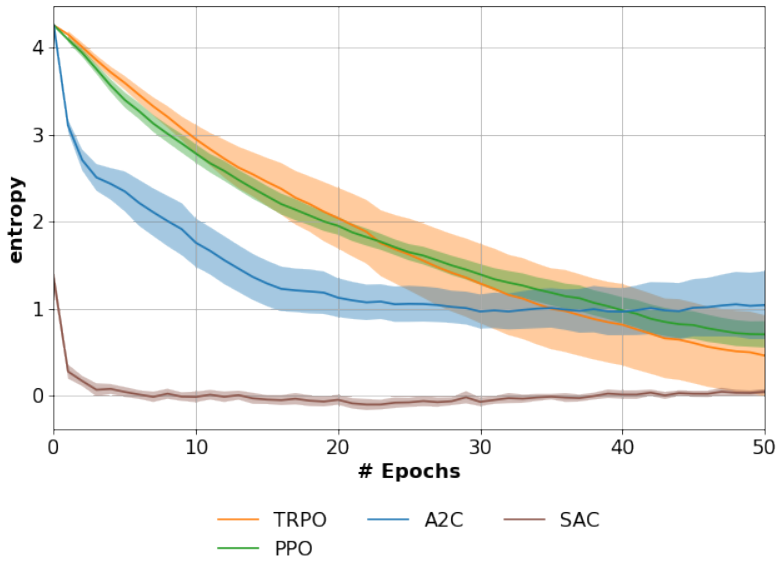
```
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 32
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 10
  n_features: 32
  n_steps_per_fit: 2000
  preprocessors: StandardizationPreprocessor
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 1000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.001
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 1000
  preprocessors: StandardizationPreprocessor
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



Walker2d-v3

```yaml
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: StandardizationPreprocessor
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 32
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 10
  n_features: 32
```

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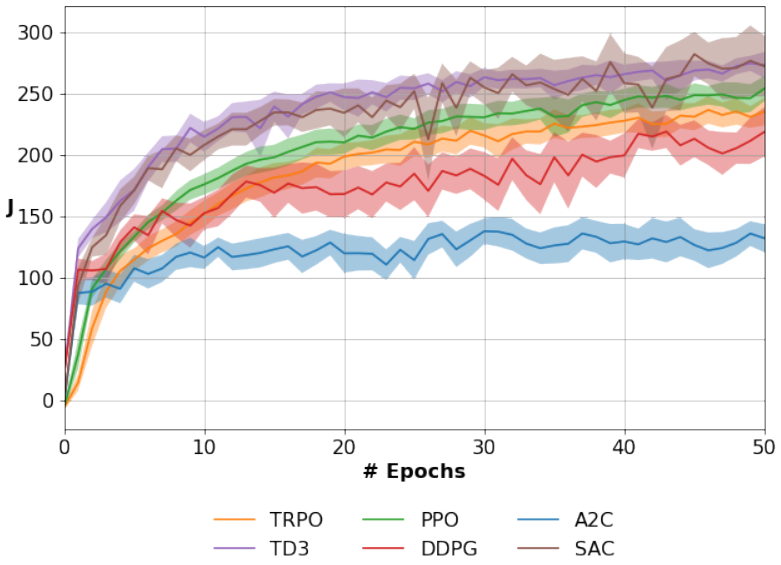
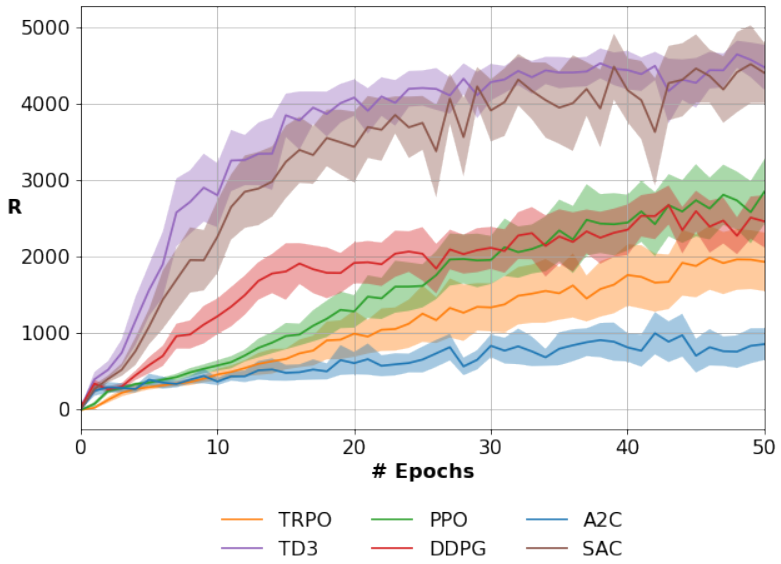
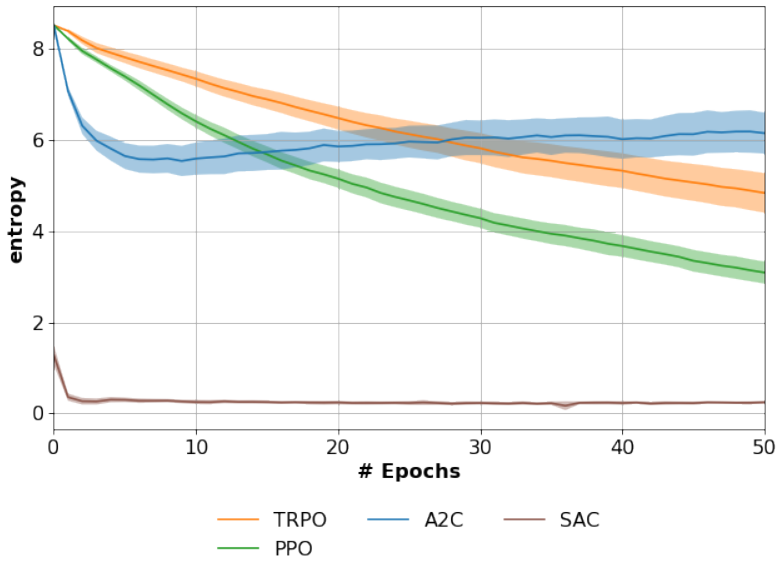
```
  n_steps_per_fit: 2000
  preprocessors: StandardizationPreprocessor
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 1000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.001
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 1000
  preprocessors: StandardizationPreprocessor
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



HalfCheetah-v3

```yaml
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: StandardizationPreprocessor
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 32
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 10
  n_features: 32
```

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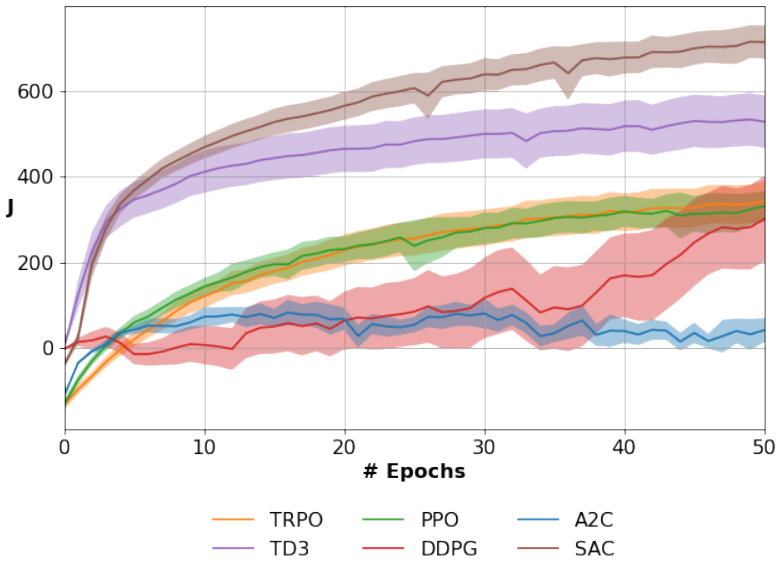
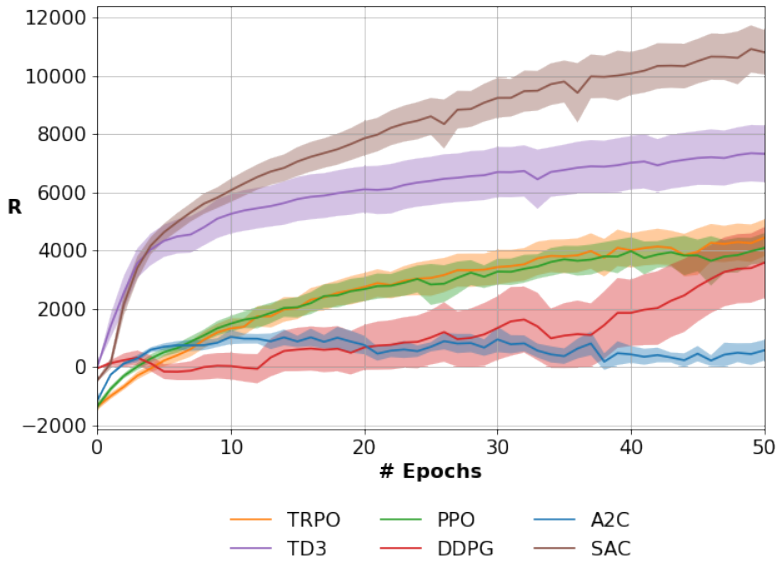
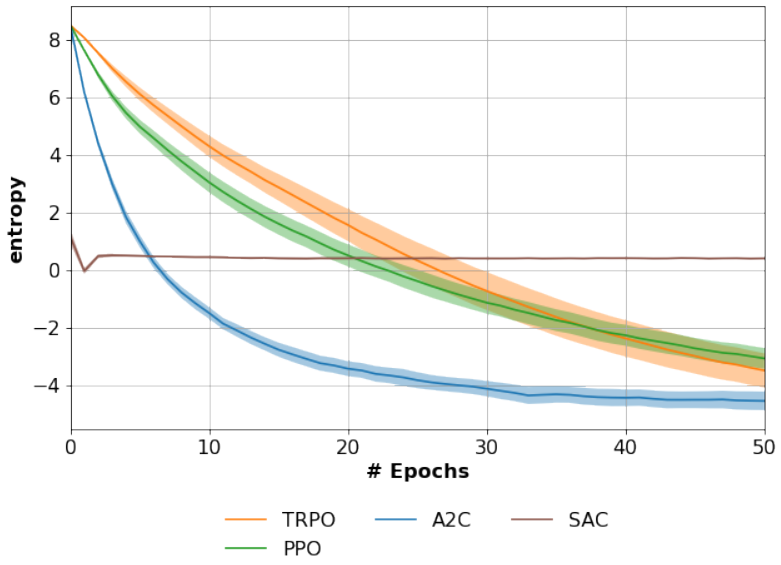
```
  n_steps_per_fit: 2000
  preprocessors: StandardizationPreprocessor
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 10000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005

TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.001
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 1000
  preprocessors: StandardizationPreprocessor
```


600
400
200
0
J
0
10
20
30
40
50
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


12000
10000
8000
6000
4000
2000
0
−2000
R
0
10
20
30
40
50
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



Ant-v3

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: StandardizationPreprocessor
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 32
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 10
  n_features: 32
```

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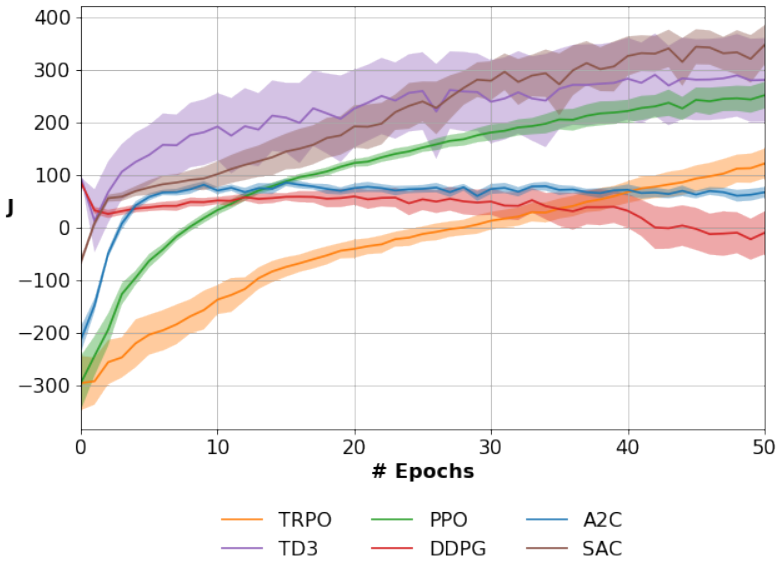
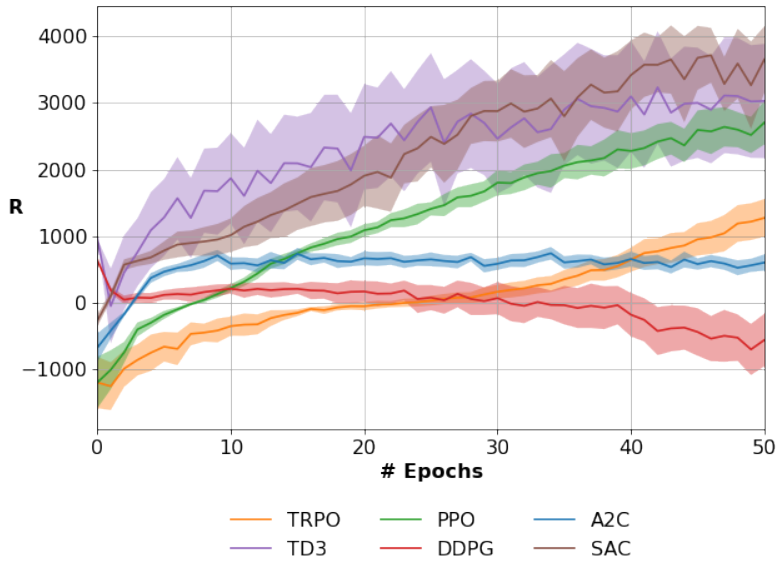
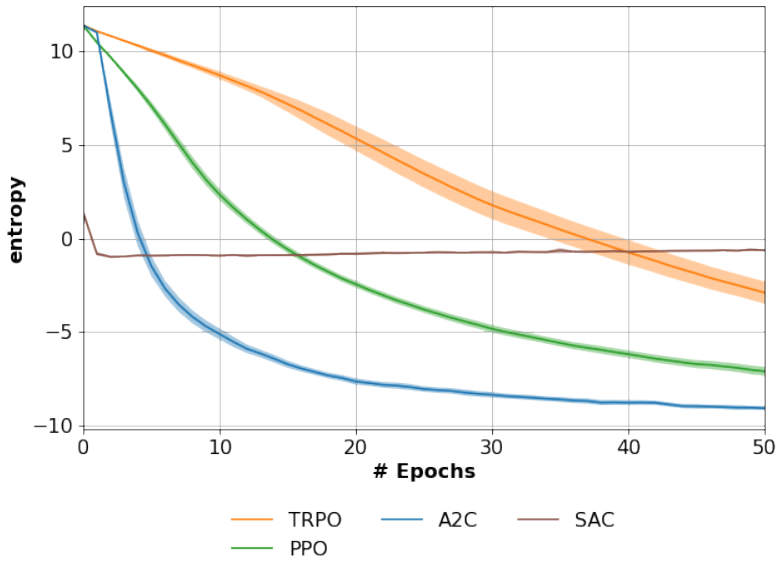
```
  n_steps_per_fit: 2000
  preprocessors: StandardizationPreprocessor
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 10000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.001
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 1000
  preprocessors: StandardizationPreprocessor
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



3.2.4 Bullet Environments Benchmarks

Run Parameters	
n_runs	25
n_epochs	50
n_steps	30000
n_episodes_test	10

HopperBulletEnv-v0

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: null
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
```

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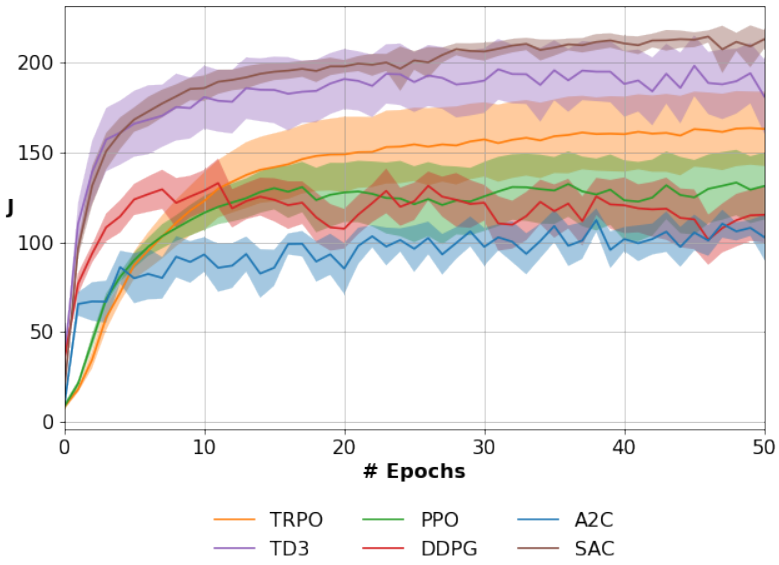
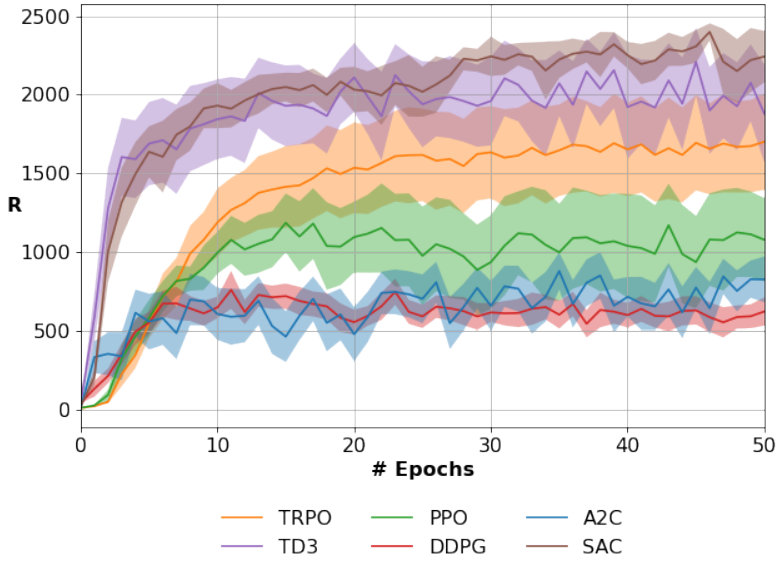
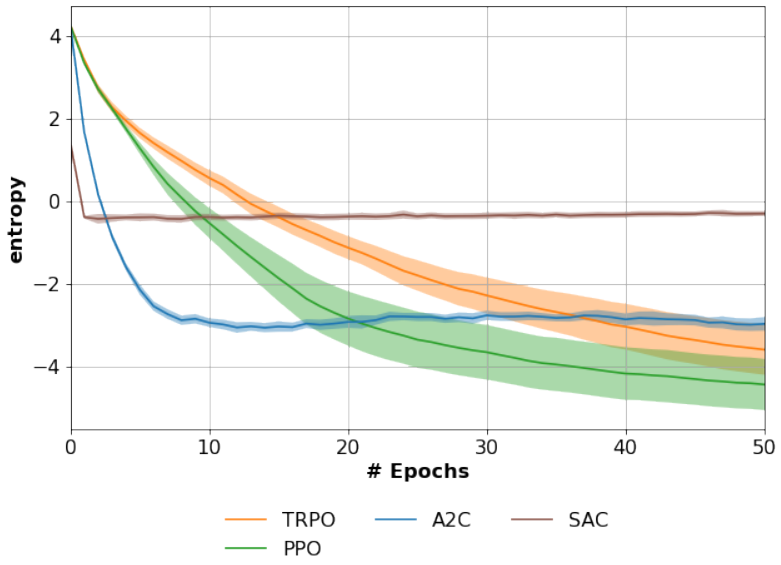
```
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 1000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005

TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.003
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



Walker2DBulletEnv-v0

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: null
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
```

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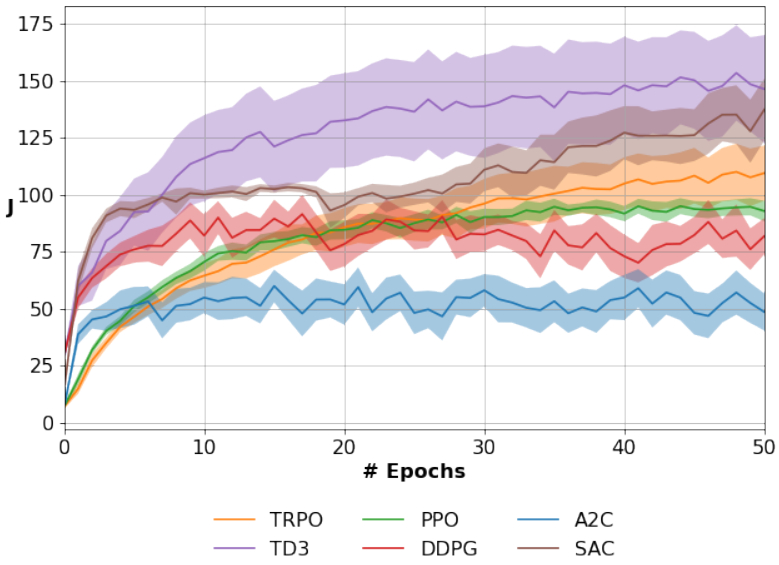
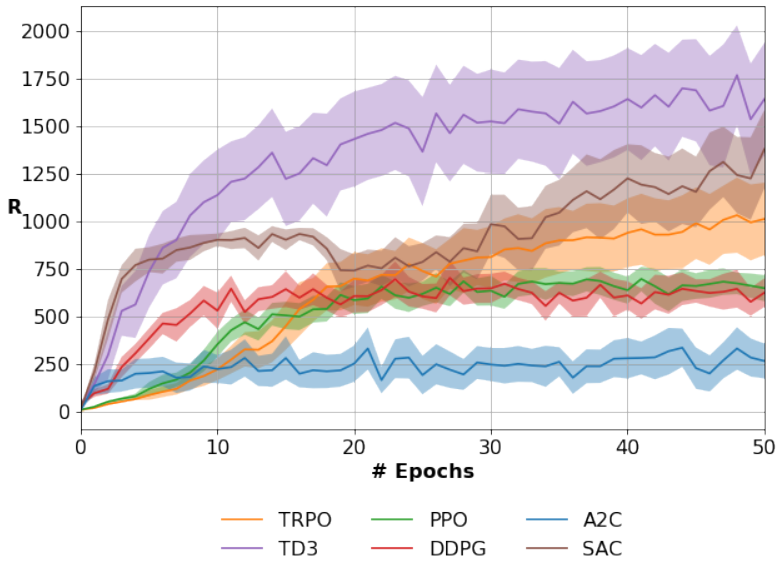
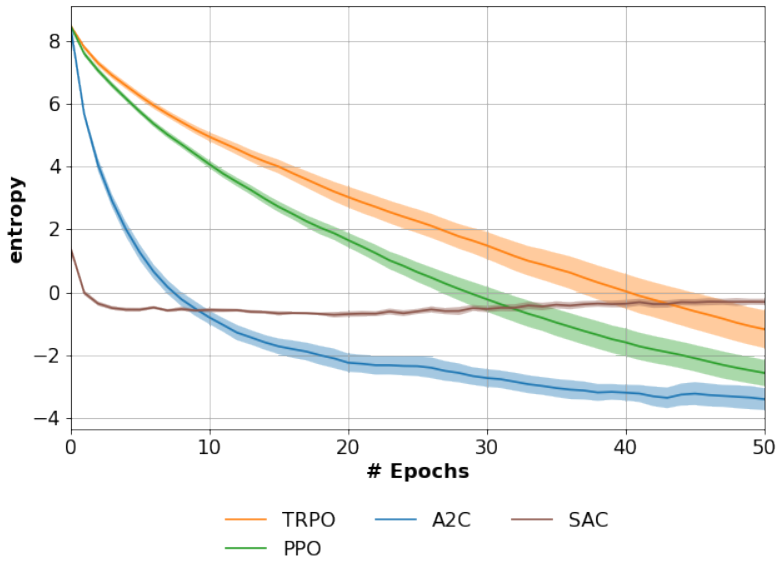
```
  n_steps_per_fit: 3000
  preprocessors: null
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 1000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.003
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



HalfCheetahBulletEnv-v0

```yaml
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: null
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
```

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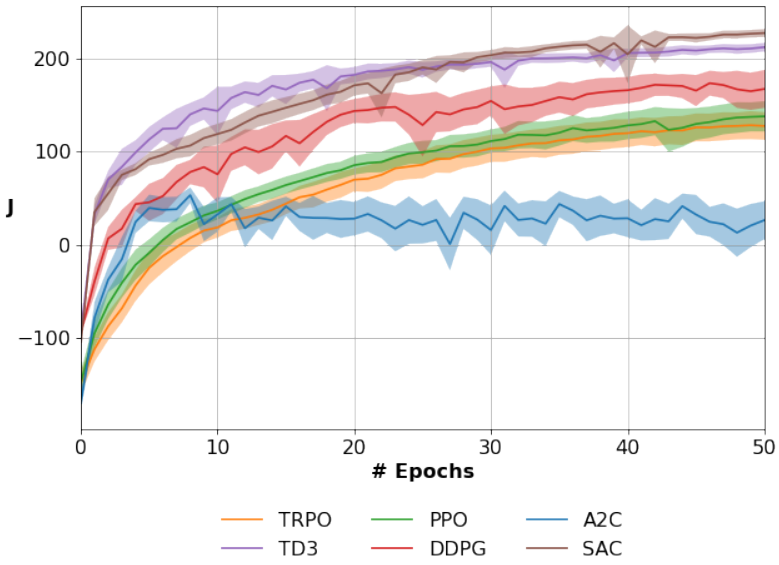
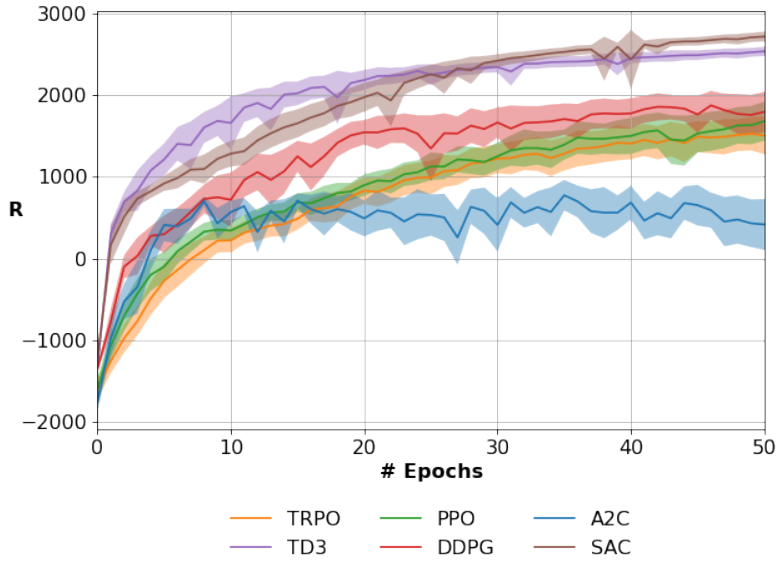
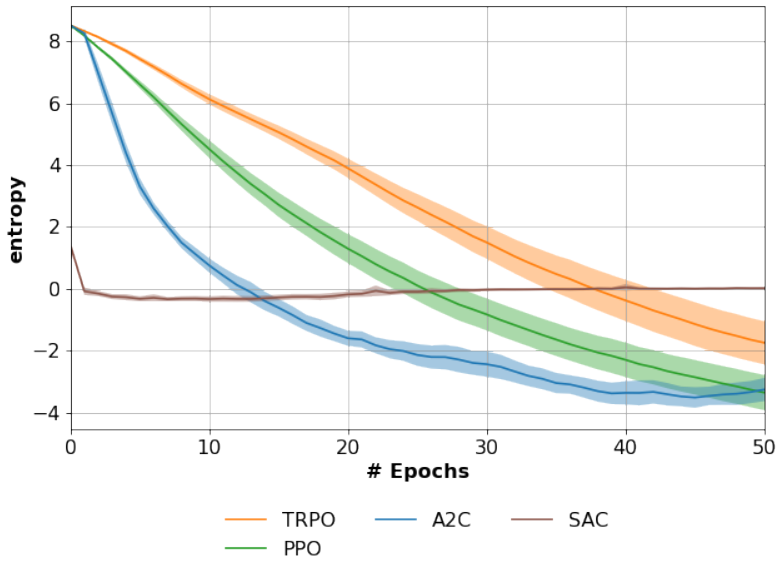
```
  n_steps_per_fit: 3000
  preprocessors: null
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 10000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005
TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.003
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
```


200
100
0
−100
J
0
10
20
30
40
50
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


3000
2000
1000
0
−1000
−2000
R
0
10
20
30
40
50
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



AntBulletEnv-v0

```
A2C:
  actor_lr: 0.0007
  batch_size: 64
  critic_lr: 0.0007
  critic_network: A2CNetwork
  ent_coeff: 0.01
  eps_actor: 0.003
  eps_critic: 1.0e-05
  max_grad_norm: 0.5
  n_features: 64
  preprocessors: null
DDPG:
  actor_lr: 0.0001
  actor_network: DDPGActorNetwork
  batch_size: 128
  critic_lr: 0.001
  critic_network: DDPGCriticNetwork
  initial_replay_size: 5000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.001
PPO:
  actor_lr: 0.0003
  batch_size: 64
  critic_fit_params: null
  critic_lr: 0.0003
  critic_network: TRPONetwork
  eps: 0.2
  lam: 0.95
  n_epochs_policy: 4
  n_features: 32
```

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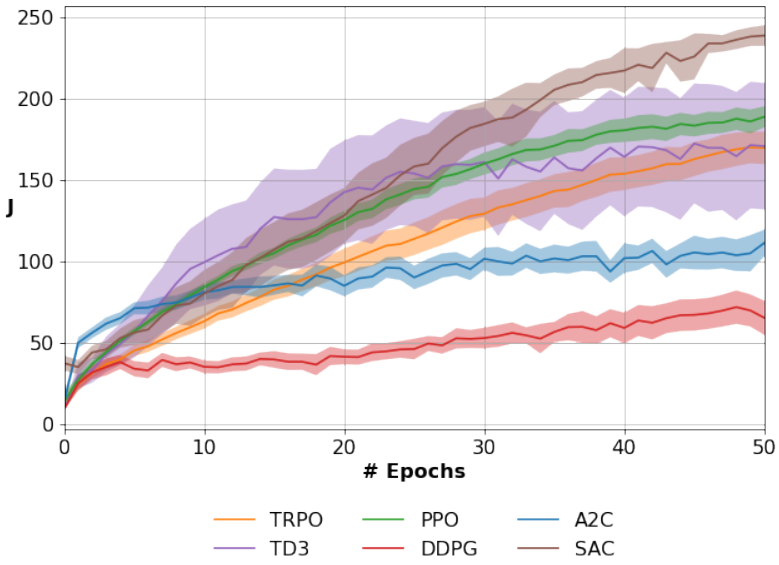
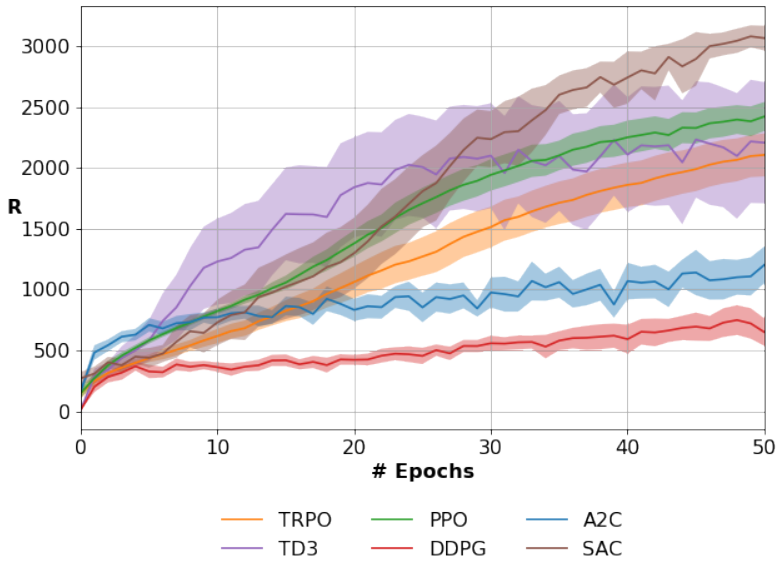
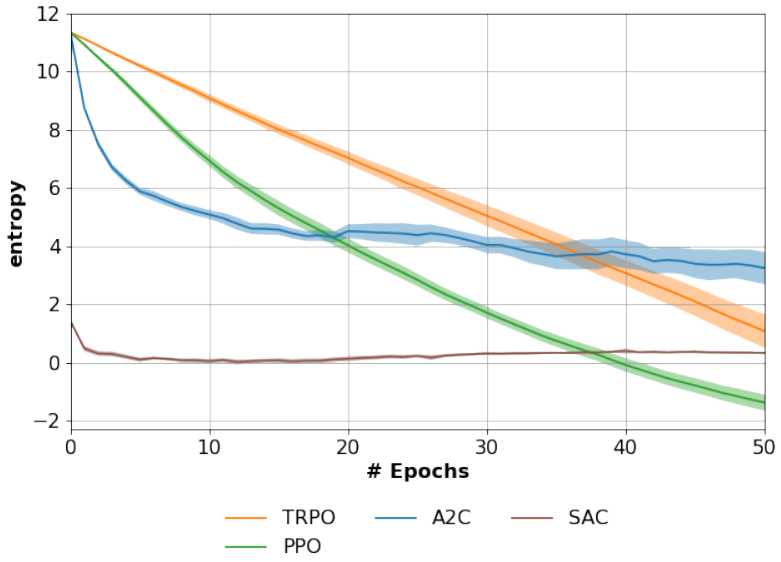
```
  n_steps_per_fit: 3000
  preprocessors: null
SAC:
  actor_lr: 0.0001
  actor_network: SACActorNetwork
  batch_size: 256
  critic_lr: 0.0003
  critic_network: SACCriticNetwork
  initial_replay_size: 5000
  lr_alpha: 0.0003
  max_replay_size: 500000
  n_features: 256
  preprocessors: null
  target_entropy: null
  tau: 0.005
  warmup_transitions: 10000
TD3:
  actor_lr: 0.001
  actor_network: TD3ActorNetwork
  batch_size: 100
  critic_lr: 0.001
  critic_network: TD3CriticNetwork
  initial_replay_size: 10000
  max_replay_size: 1000000
  n_features:
  - 400
  - 300
  tau: 0.005

TRPO:
  batch_size: 64
  cg_damping: 0.01
  cg_residual_tol: 1.0e-10
  critic_fit_params: null
  critic_lr: 0.003
  critic_network: TRPONetwork
  ent_coeff: 0.0
  lam: 0.95
  max_kl: 0.01
  n_epochs_cg: 100
  n_epochs_line_search: 10
  n_features: 32
  n_steps_per_fit: 3000
  preprocessors: null
```


J
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC


R
Epochs
TRPO
PPO
A2C
TD3
DDPG
SAC



3.3 Value-Based Benchmarks

We provide the benchmarks for the following Finite Temporal-Difference algorithms:

- **SARSA**
- **QLearning**
- **SpeedyQLearning**
- **WeightedQLearning**
- **DoubleQLearning**
- **SARSALambda**
- **QLambda**

We provide the benchmarks for the following Continuous state Temporal-Difference algorithms:

- **SARSALambdaContinuous**
- **TrueOnlineSARSALambda**

We provide the benchmarks for the following DQN algorithms:

- **DQN**
- **PrioritiziedDQN**
- **DoubleDQN**
- **AveragedDQN**
- **DuelingDQN**
- **MaxminDQN**
- **CategoricalDQN**
- **NoisyDQN**

We consider the following environments in the benchmark

3.3.1 Finite State Environment Benchmark

Run Parameters	
n_runs	25
n_epochs	100
n_steps	100
n_steps_test	1000

GridWorld

```
DoubleQLearning:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  learning_rate: ExponentialParameter
QLambda:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  lambda_coeff: 0.9
  learning_rate: ExponentialParameter
  trace: replacing
QLearning:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  learning_rate: ExponentialParameter
SARSA:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  learning_rate: ExponentialParameter
SARSALambda:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  lambda_coeff: 0.9
  learning_rate: ExponentialParameter
  trace: replacing
SpeedyQLearning:
  decay_eps: 0.5
  decay_lr: 0.8
  epsilon: ExponentialParameter
  epsilon_test: 0.0
  learning_rate: ExponentialParameter
WeightedQLearning:
  decay_eps: 0.5
```

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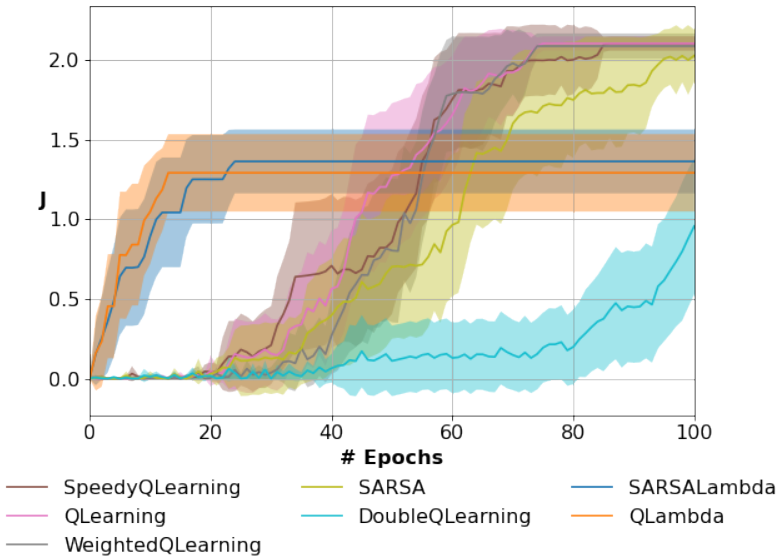
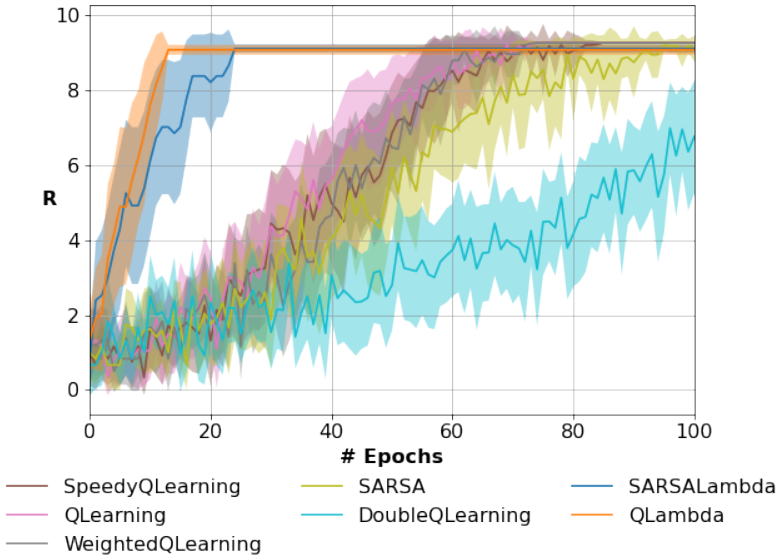
```
decay_lr: 0.8
epsilon: ExponentialParameter
epsilon_test: 0.0
learning_rate: ExponentialParameter
precision: 1000
sampling: true
```



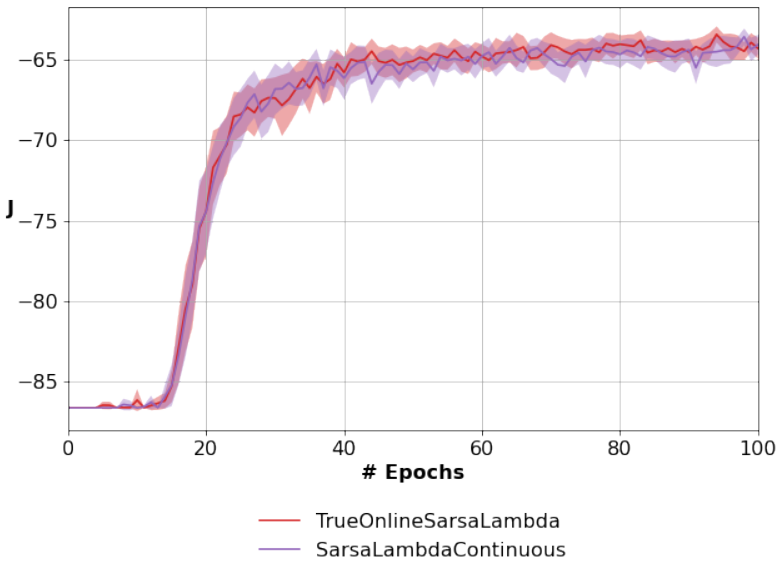


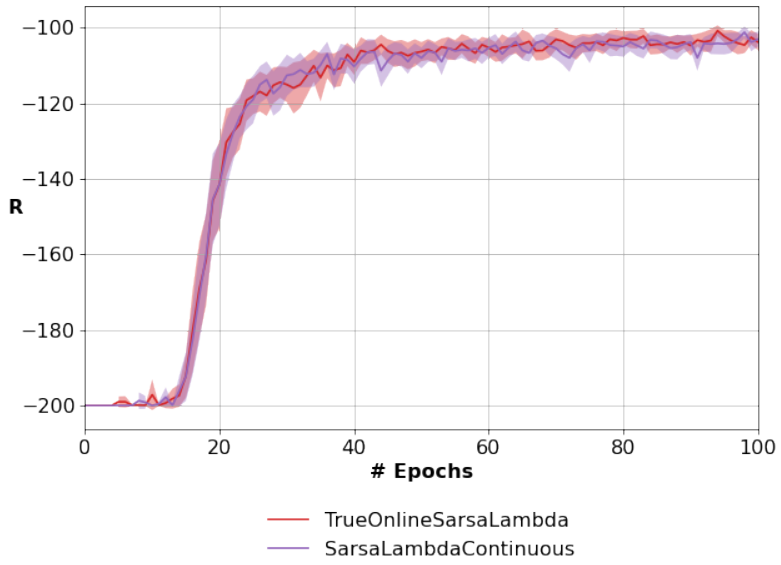
3.3.2 Gym Environments Benchmarks

Run Parameters	
n_runs	25
n_epochs	100
n_steps	1000
n_episodes_test	10

MountainCar-v0

```
SarsaLambdaContinuous:
  alpha: 0.1
  epsilon: 0
  epsilon_test: 0.0
  lambda_coeff: 0.9
  n_tiles: 10
  n_tilings: 10
TrueOnlineSarsaLambda:
  alpha: 0.1
  epsilon: 0
  epsilon_test: 0.0
  lambda_coeff: 0.9
  n_tiles: 10
  n_tilings: 10
```





3.3.3 Atari Environment Benchmark

Run Parameters	
n_runs	5
n_epochs	200
n_steps	250000
n_episodes_test	125000

BreakoutDeterministic-v4

```
AveragedDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_approximators: 10
  n_steps_per_fit: 4
  network: DQNNetwork
  target_update_frequency: 2500
CategoricalDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_atoms: 51
  n_features: 512
  n_steps_per_fit: 4
  network: DQNFeatureNetwork
  target_update_frequency: 2500
  v_max: 10
  v_min: -10
DQN:
```

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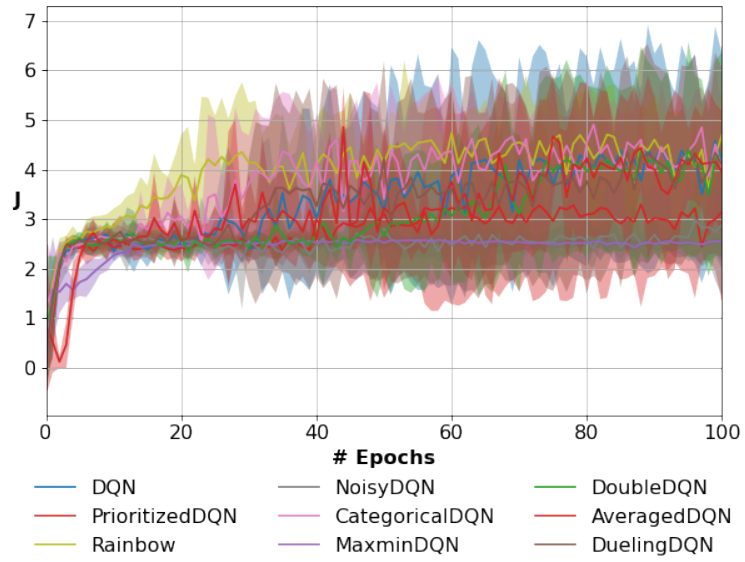
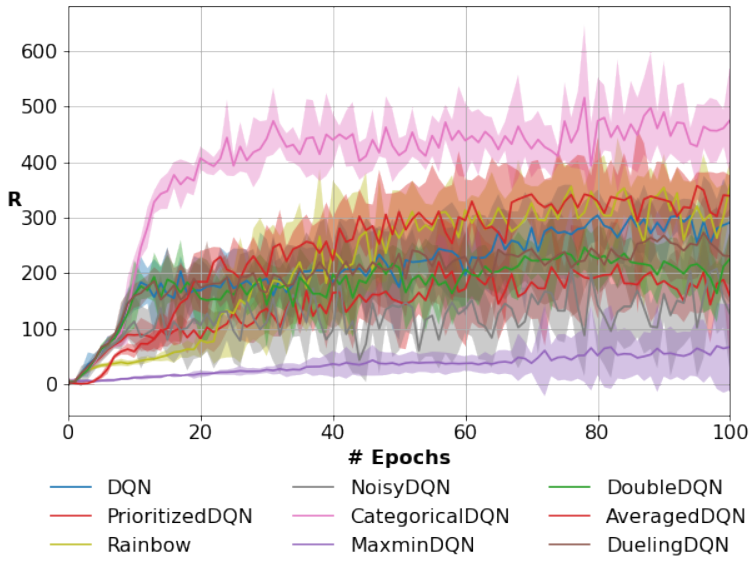
```
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_steps_per_fit: 4
  network: DQNNetwork
  target_update_frequency: 2500
DoubleDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_steps_per_fit: 4
  network: DQNNetwork
  target_update_frequency: 2500
DuelingDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_features: 512
  n_steps_per_fit: 4
  network: DQNFeatureNetwork
  target_update_frequency: 2500
MaxminDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_approximators: 3
  n_steps_per_fit: 4
  network: DQNNetwork
  target_update_frequency: 2500
NoisyDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_features: 512
  n_steps_per_fit: 4
  network: DQNFeatureNetwork
  target_update_frequency: 2500
PrioritizedDQN:
  batch_size: 32
  initial_replay_size: 50000
  lr: 0.0001
  max_replay_size: 1000000
  n_steps_per_fit: 4
  network: DQNNetwork
  target_update_frequency: 2500
```





3.4 Core functionality

3.4.1 Suite

class BenchmarkSuite

log_dir=None, *log_id=None*, *use_timestamp=True*, *parallel=None*, *slurm=None* Bases: `object`

Class to orchestrate the execution of multiple experiments.

__init__

log_dir=None, *log_id=None*, *use_timestamp=True*, *parallel=None*, *slurm=None* Constructor.

Parameters

- **log_dir** (*str*) – path to the log directory (Default: ./logs or /work/scratch/$USER)

- **log_id** (*str*) – log id (Default: benchmark[_YYYY-mm-dd-HH-MM-SS])
- **use_timestamp** (*bool*) – select if a timestamp should be appended to the log id
- **parallel** (*dict, None*) – parameters that are passed to the run_parallel method of the experiment
- **slurm** (*dict, None*) – parameters that are passed to the run_slurm method of the experiment

add_experiments
environment_name, *environment_builder_params*, *agent_names_list*, *agent_builders_params*, ***run_params* Add a set of experiments for the same environment to the suite.

Parameters

- **environment_name** (*str*) – name of the environment for the experiment (E.g. Gym.Pendulum-v0);
- **environment_builder_params** (*dict*) – parameters for the environment builder;
- **agent_names_list** (*list*) – list of names of the agents for the experiments;
- **agent_builders_params** (*list*) – list of dictionaries containing the parameters for the agent builder;
- **run_params** – Parameters that are passed to the run method of the experiment.

add_experiments_sweeps
environment_name, *environment_builder_params*, *agent_names_list*, *agent_builders_params*, *sweeps_list*, ***run_params* Add a set of experiments sweeps for the same environment to the suite.

Parameters

- **environment_name** (*str*) – name of the environment for the experiment (E.g. Gym.Pendulum-v0);
- **environment_builder_params** (*dict*) – parameters for the environment builder;
- **agent_names_list** (*list*) – list of names of the agents for the experiments;
- **agent_builders_params** (*list*) – list of dictionaries containing the parameters for the agent builder;
- **sweeps_list** (*list*) – list of dictionaries containing the parameter sweep to be executed;
- **run_params** – Parameters that are passed to the run method of the experiment.

add_environment
environment_name, *environment_builder_params*, ***run_params* Add an environment to the benchmarking suite.

Parameters

- **environment_name** (*str*) – name of the environment for the experiment (E.g. Gym.Pendulum-v0);
- **environment_builder_params** (*dict*) – parameters for the environment builder;
- **run_params** – Parameters that are passed to the run method of the experiment.

add_agent
environment_name, *agent_name*, *agent_params* Add an agent to the benchmarking suite.

Parameters

- **environment_name** (*str*) – name of the environment for the experiment (E.g. Gym.Pendulum-v0);
- **agent_name** (*str*) – name of the agent for the experiments;
- **agent_params** (*list*) – dictionary containing the parameters for the agent builder.

add_sweep
environment_name, *agent_name*, *agent_params*, *sweep_dict* Add an agent sweep to the benchmarking suite.

Parameters

- **environment_name** (*str*) – name of the environment for the experiment (E.g. Gym.Pendulum-v0);
- **agent_name** (*str*) – name of the agent for the experiments;
- **agent_params** (*list*) – dictionary containing the parameters for the agent builder;
- **sweep_dict** (*dict*) – dictionary with the sweep configurations.

run
exec_type='sequential' Run all experiments in the suite.

print_experiments
Print the experiments in the suite.

save_parameters
Save the experiment parameters in yaml files inside the parameters folder

save_plots
***plot_params* Save the result plots to the log directory.

Parameters ****plot_params** – parameters to be passed to the suite visualizer.

show_plots
***plot_params* Display the result plots.

Parameters ****plot_params** – parameters to be passed to the suite visualizer.

3.4.2 Experiment

class BenchmarkExperiment
agent_builder, *env_builder*, *logger* Bases: `object`

Class to create and run an experiment using MushroomRL

__init__
agent_builder, *env_builder*, *logger* Constructor.

Parameters

- **agent_builder** (`AgentBuilder`) – instance of a specific agent builder;
- **env_builder** (`EnvironmentBuilder`) – instance of an environment builder;
- **logger** (`BenchmarkLogger`) – instance of a benchmark logger.

run
exec_type='sequential', ***run_params* Execute the experiment.

Parameters

- **exec_type** (*str, 'sequential'*) – type of executing the experiment [sequential|parallel|slurm];
- ****run_params** – parameters for the selected execution type.

run_sequential
n_runs, *n_runs_completed=0*, *save_plot=True*, ***run_params* Execute the experiment sequential.

Parameters

- **n_runs** (*int*) – number of total runs of the experiment;
- **n_runs_completed** (*int, 0*) – number of completed runs of the experiment;
- **save_plot** (*bool, True*) – select if a plot of the experiment should be saved to the log directory;
- ****run_params** – parameters for executing a benchmark run.

run_parallel
n_runs, *n_runs_completed=0*, *threading=False*, *save_plot=True*, *max_concurrent_runs=None*, ***run_params* Execute the experiment in parallel threads.

Parameters

- **n_runs** (*int*) – number of total runs of the experiment;
- **n_runs_completed** (*int, 0*) – number of completed runs of the experiment;
- **threading** (*bool, False*) – select to use threads instead of processes;
- **save_plot** (*bool, True*) – select if a plot of the experiment should be saved to the log directory;
- **max_concurrent_runs** (*int, -1*) – maximum number of concurrent runs. By default it uses the number of cores;
- ****run_params** – parameters for executing a benchmark run.

run_slurm
n_runs, *n_runs_completed=0*, *aggregation_job=True*, *aggregate_hours=3*, *aggregate_minutes=0*, *aggregate_seconds=0*, *only_print=False*, ***run_params* Execute the experiment with SLURM.

Parameters

- **n_runs** (*int*) – number of total runs of the experiment;
- **n_runs_completed** (*int, 0*) – number of completed runs of the experiment;
- **aggregation_job** (*bool, True*) – select if an aggregation job should be scheduled;
- **aggregate_hours** (*int, 3*) – maximum number of hours for the aggregation job;
- **aggregate_minutes** (*int, 0*) – maximum number of minutes for the aggregation job;
- **aggregate_seconds** (*int, 0*) – maximum number of seconds for the aggregation job;
- **only_print** (*bool, False*) – if True, don't launch the benchmarks, only print the submitted commands to the terminal;
- ****run_params** – parameters for executing a benchmark run.

reset
Reset the internal state of the experiment.

resume
logger Resume an experiment from disk

start_timer
Start the timer.

stop_timer
Stop the timer.

save_builders
Save agent and environment builder to the log directory.

extend_and_save_J
J Extend J with another datapoint and save the current state to the log directory.

extend_and_save_R
R Extend R with another datapoint and save the current state to the log directory.

extend_and_save_V
V Extend V with another datapoint and save the current state to the log directory.

extend_and_save_entropy
entropy Extend entropy with another datapoint and save the current state to the log directory.

set_and_save_config
***settings* Save the experiment configuration to the log directory.

set_and_save_stats
***info* Save the run statistics to the log directory.

save_plot
Save the result plot to the log directory.

show_plot
Display the result plot.

3.4.3 Logger

class BenchmarkLogger
log_dir=None, *log_id=None*, *use_timestamp=True* Bases: `mushroom_rl.core.logger.console_logger.ConsoleLogger`

Class to handle all interactions with the log directory.

__init__
log_dir=None, *log_id=None*, *use_timestamp=True* Constructor.

Parameters

- **log_dir** (*str, None*) – path to the log directory, if not specified defaults to ./logs or to /work/scratch/$USER if the second directory exists;
- **log_id** (*str, None*) – log id, if not specified defaults to: benchmark[_YY-mm-ddTHH:MM:SS.zzz]);
- **use_timestamp** (*bool, True*) – select if a timestamp should be appended to the log id.

set_log_dir
log_dir Set the directory for logging.

Parameters **log_dir** (*str*) – path of the directory.

get_log_dir

Returns The path of the logging directory.

set_log_id
log_id, *use_timestamp=True* Set the id of the logged folder.

Parameters

- **log_id** (*str*) – id of the logged folder;
- **use_timestamp** (*bool, True*) – whether to use the timestamp or not.

get_log_id

Returns The id of the logged folder.

get_path
filename='' Get the path of the given file. If no filename is given, it returns the path of the logging folder.

Parameters **filename** (*str, ''*) – the name of the file.

Returns The complete path of the logged file.

get_params_path
filename='' Get the path of the parameters of the given file. If no filename is given, it returns the path of the parameters folder.

Parameters **filename** (*str, ''*) – the name of the file.

Returns The complete path of the logged file.

get_figure_path
filename='', *subfolder=None* Get the path of the figures of the given file. If no filename is given, it returns the path of the figures folder.

Parameters

- **filename** (*str, ''*) – the name of the file;
- **subfolder** (*None*) – the name of a subfolder to add.

Returns The complete path of the logged file.

save_J
J Save the log of the cumulative discounted reward.

load_J

Returns The log of the cumulative discounted reward.

save_R
R Save the log of the cumulative reward.

load_R

Returns The log of the cumulative reward.

save_V
V Save the log of the value function.

load_V

Returns The log of the value function.

save_entropy
entropy Save the log of the entropy function.

load_entropy

Returns The log of the entropy function.

exists_policy_entropy

Returns True if the log of the entropy exists, False otherwise.

exists_value_function

Returns True if the log of the value function exists, False otherwise.

save_best_agent
agent Save the best agent in the respective path.

Parameters **agent** (*object*) – the agent to save.

save_last_agent
agent Save the last agent in the respective path.

Parameters **agent** (*object*) – the agent to save.

exists_best_agent

Returns True if the entropy file exists, False otherwise.

load_best_agent

Returns The best agent.

load_last_agent

Returns The last agent.

save_environment_builder
env_builder Save the environment builder using the respective path.

Parameters **env_builder** (*str*) – the environment builder to save.

load_environment_builder

Returns The environment builder.

save_agent_builder
agent_builder Save the agent builder using the respective path.

Parameters **agent_builder** (*str*) – the agent builder to save.

load_agent_builder

Returns The agent builder.

save_config
config Save the config file using the respective path.

Parameters **config** (*str*) – the config file to save.

load_config

Returns The config file.

exists_stats

Returns True if the entropy file exists, False otherwise.

save_stats
stats Save the statistic file using the respective path.

Parameters **stats** (*str*) – the statistics file to save.

load_stats

Returns The statistics file.

save_params

env, *params* Save the parameters file.

Parameters

- **env** (*str*) – the environment used;
- **params** (*str*) – the parameters file to save.

save_figure

figure, *figname*, *subfolder=None*, *as_pdf=False*, *transparent=True* Save the figure file using the respective path.

Parameters

- **figure** (*object*) – the figure to save;
- **figname** (*str*) – the name of the figure;
- **subfolder** (*str, None*) – optional subfolder where to save the figure;
- **as_pdf** (*bool, False*) – whether to save the figure in PDF or not;
- **transparent** (*bool, True*) – whether the figure should be transparent or not.

classmethod from_path

path Method to create a BenchmarkLogger from a path.

3.4.4 Visualizer

class BenchmarkVisualizer

logger, *data=None*, *has_entropy=None*, *has_value=None*, *id=1* Bases: object

Class to handle all visualizations of the experiment.

plot_counter = 0

__init__

logger, *data=None*, *has_entropy=None*, *has_value=None*, *id=1* Constructor.

Parameters

- **logger** (BenchmarkLogger) – logger to be used;
- **data** (*dict, None*) – dictionary with data points for visualization;
- **has_entropy** (*bool, None*) – select if entropy is available for the algorithm.

is_data_persisted

Check if data was passed as dictionary or should be read from log directory.

get_J

Get J from dictionary or log directory.

get_R

Get R from dictionary or log directory.

get_V

Get V from dictionary or log directory.

get_entropy

Get entropy from dictionary or log directory.

get_report
Create report plot with matplotlib.

save_report
file_name='report_plot' Method to save an image of a report of the training metrics from a performend experiment.

show_report
Method to show a report of the training metrics from a performend experiment.

show_agent
episodes=5, *mdp_render=False* Method to run and visualize the best builders in the environment.

classmethod from_path
path Method to create a BenchmarkVisualizer from a path.

class BenchmarkSuiteVisualizer
logger, *is_sweep*, *color_cycle=None*, *y_limit=None*, *legend=None* Bases: `object`

Class to handle visualization of a benchmark suite.

plot_counter = 0

__init__
logger, *is_sweep*, *color_cycle=None*, *y_limit=None*, *legend=None* Constructor.

Parameters

- **logger** (`BenchmarkLogger`) – logger to be used;
- **is_sweep** (*bool*) – whether the benchmark is a parameter sweep.
- **color_cycle** (*dict, None*) – dictionary with colors to be used for each algorithm;
- **y_limit** (*dict, None*) – dictionary with environment specific plot limits.
- **legend** (*dict, None*) – dictionary with environment specific legend parameters.

get_report
env, *data_type*, *selected_alg=None* Create report plot with matplotlib.

get_boxplot
env, *metric_type*, *data_type*, *selected_alg=None* Create boxplot with matplotlib for a given metric.

Parameters

- **env** (*str*) – The environment name;
- **metric_type** (*str*) – The metric to compute.

Returns A figure with the desired boxplot of the given metric.

save_reports
as_pdf=True, *transparent=True*, *alg_sweep=False* Method to save an image of a report of the training metrics from a performed experiment.

Parameters

- **as_pdf** (*bool, True*) – whether to save the reports as pdf files or png;
- **transparent** (*bool, True*) – If true, the figure background is transparent and not white;
- **alg_sweep** (*bool, False*) – If true, thw method will generate a separate figure for each algorithm sweep.

save_boxplots
as_pdf=True, *transparent=True*, *alg_sweep=False* Method to save an image of a report of the training metrics from a performed experiment.

Parameters

- **as_pdf** (*bool, True*) – whether to save the reports as pdf files or png;
- **transparent** (*bool, True*) – If true, the figure background is transparent and not white;
- **alg_sweep** (*bool, False*) – If true, thw method will generate a separate figure for each algorithm sweep.

show_reports
boxplots=True, *alg_sweep=False* Method to show a report of the training metrics from a performend experiment.

Parameters **alg_sweep** (*bool, False*) – If true, thw method will generate a separate figure for each algorithm sweep.

3.5 Builders

class EnvironmentBuilder
env_name, *env_params* Bases: object

Class to spawn instances of a MushroomRL environment

__init__
env_name, *env_params* Constructor

Parameters

- **env_name** – name of the environment to build;
- **env_params** – required parameters to build the specified environment.

build
Build and return an environment

static set_eval_mode
env, *eval* Make changes to the environment for evaluation mode.

Parameters

- **env** (*Environment*) – the environment to change;
- **eval** (*bool*) – flag for activating evaluation mode.

copy
Create a deepcopy of the environment_builder and return it

class AgentBuilder
n_steps_per_fit=None, *n_episodes_per_fit=None*, *compute_policy_entropy=True*, *compute_entropy_with_states=False*, *compute_value_function=True*, *preprocessors=None* Bases: object

Base class to spawn instances of a MushroomRL agent

__init__
n_steps_per_fit=None, *n_episodes_per_fit=None*, *compute_policy_entropy=True*, *compute_entropy_with_states=False*, *compute_value_function=True*, *preprocessors=None* Initialize AgentBuilder

get_fit_params
Get n_steps_per_fit and n_episodes_per_fit for the specific AgentBuilder

set_preprocessors
preprocessors Set preprocessor for the specific AgentBuilder

Parameters **preprocessors** – list of preprocessor classes.

get_preprocessors
Get preprocessors for the specific AgentBuilder

copy
Create a deepcopy of the AgentBuilder and return it

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

set_eval_mode
agent, *eval* Set the eval mode for the agent. This function can be overwritten by any agent builder to setup specific evaluation mode for the agent.

Parameters

- **agent** (*Agent*) – the considered agent;
- **eval** (*bool*) – whether to set eval mode (true) or learn mode.

classmethod default
get_default_dict=False, ***kwargs* Create a default initialization for the specific AgentBuilder and return it

3.5.1 Policy Search Builders

Policy Gradient

class PolicyGradientBuilder
n_episodes_per_fit, *optimizer*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Policy Gradient Methods. The current builder uses a state dependant gaussian with diagonal standard deviation and linear mean.

__init__
n_episodes_per_fit, *optimizer*, ***kwargs* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
n_episodes_per_fit=25, *alpha=0.01*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

class REINFORCEBuilder
n_episodes_per_fit, *optimizer*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.policy_search.policy_gradient.PolicyGradientBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.policy_gradient.reinforce.REINFORCE

class GPOMDPBuilder
n_episodes_per_fit, *optimizer*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.policy_search.policy_gradient.PolicyGradientBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.policy_gradient.gpomdp.GPOMDP

class eNACBuilder
n_episodes_per_fit, *optimizer*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.policy_search.policy_gradient.PolicyGradientBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.policy_gradient.enac.eNAC

Black-Box optimization

class BBOBuilder
n_episodes_per_fit, ***kwargs* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Black Box optimization methods. The current builder uses a simple deterministic linear policy and gaussian Diagonal distribution.

__init__
n_episodes_per_fit, ***kwargs* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
n_episodes_per_fit=25, *alpha=0.01*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

class PGPEBuilder
n_episodes_per_fit, *optimizer* Bases: *mushroom_rl_benchmark.builders.policy_search.black_box_optimization.BBOBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.black_box_optimization.pgpe.PGPE

__init__
n_episodes_per_fit, *optimizer* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

classmethod default
n_episodes_per_fit=25, *alpha=0.3*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class RWRBuilder
n_episodes_per_fit, *beta* Bases: *mushroom_rl_benchmark.builders.policy_search.black_box_optimization.BBOBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.black_box_optimization.rwr.RWR

__init__
n_episodes_per_fit, *beta* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

classmethod default
n_episodes_per_fit=25, *beta=0.01*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class REPSBuilder
n_episodes_per_fit, *eps* Bases: *mushroom_rl_benchmark.builders.policy_search.black_box_optimization.BBOBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.black_box_optimization.reps.REPS

__init__
n_episodes_per_fit, *eps* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

classmethod default
n_episodes_per_fit=25, *eps=0.05*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class ConstrainedREPSBuilder
n_episodes_per_fit, *eps*, *kappa* Bases: *mushroom_rl_benchmark.builders.policy_search.black_box_optimization.BBOBuilder*

alg_class
alias of mushroom_rl.algorithms.policy_search.black_box_optimization.constrained_reps.ConstrainedREPS

__init__
n_episodes_per_fit, *eps*, *kappa* Constructor.

Parameters

- **optimizer** (*Optimizer*) – optimizer to be used by the policy gradient algorithm;
- ****kwargs** – others algorithms parameters.

classmethod default
n_episodes_per_fit=25, *eps=0.05*, *kappa=0.01*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

3.5.2 Value Based Builders

Temporal Difference

class TDFiniteBuilder
learning_rate, *epsilon*, *epsilon_test*, ***alg_params* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for a generic TD algorithm (for finite states).

__init__
learning_rate, *epsilon*, *epsilon_test*, ***alg_params* Constructor.

Parameters

- **epsilon** (*Parameter*) – exploration coefficient for learning;
- **epsilon_test** (*Parameter*) – exploration coefficient for test.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

set_eval_mode
agent, *eval* Set the eval mode for the agent. This function can be overwritten by any agent builder to setup specific evaluation mode for the agent.

Parameters

- **agent** (*Agent*) – the considered agent;
- **eval** (*bool*) – whether to set eval mode (true) or learn mode.

classmethod default
learning_rate=0.9, *epsilon=0.1*, *decay_lr=0.0*, *decay_eps=0.0*, *epsilon_test=0.0*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class QLearningBuilder
learning_rate, *epsilon*, *epsilon_test* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

alg_class
alias of mushroom_rl.algorithms.value.td.q_learning.QLearning

__init__
learning_rate, *epsilon*, *epsilon_test* Constructor.

Parameters

- **epsilon** (*Parameter*) – exploration coefficient for learning;
- **epsilon_test** (*Parameter*) – exploration coefficient for test.

class SARSABuilder
learning_rate, *epsilon*, *epsilon_test* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

alg_class
alias of mushroom_rl.algorithms.value.td.sarsa.SARSA

__init__
learning_rate, *epsilon*, *epsilon_test* Constructor.

Parameters

- **epsilon** (*Parameter*) – exploration coefficient for learning;
- **epsilon_test** (*Parameter*) – exploration coefficient for test.

class SpeedyQLearningBuilder
learning_rate, *epsilon*, *epsilon_test* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

alg_class
alias of mushroom_rl.algorithms.value.td.speedy_q_learning.SpeedyQLearning

__init__
learning_rate, *epsilon*, *epsilon_test* Constructor.

Parameters

- **epsilon** (*Parameter*) – exploration coefficient for learning;
- **epsilon_test** (*Parameter*) – exploration coefficient for test.

class DoubleQLearningBuilder

learning_rate, *epsilon*, *epsilon_test* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

alg_class

alias of mushroom_rl.algorithms.value.td.double_q_learning.DoubleQLearning

__init__

learning_rate, *epsilon*, *epsilon_test* Constructor.

Parameters

- **epsilon** (*Parameter*) – exploration coefficient for learning;
- **epsilon_test** (*Parameter*) – exploration coefficient for test.

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

class WeightedQLearningBuilder

learning_rate, *epsilon*, *epsilon_test*, *sampling*, *precision* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

alg_class

alias of mushroom_rl.algorithms.value.td.weighted_q_learning.WeightedQLearning

__init__

learning_rate, *epsilon*, *epsilon_test*, *sampling*, *precision* Constructor.

Parameters

- **sampling** (*bool, True*) – use the approximated version to speed up the computation;
- **precision** (*int, 1000*) – number of samples to use in the approximated version.

classmethod default

learning_rate=0.9, *epsilon=0.1*, *decay_lr=0.0*, *decay_eps=0.0*, *epsilon_test=0.0*, *sampling=True*, *precision=1000*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class TDTraceBuilder

learning_rate, *epsilon*, *epsilon_test*, *lambda_coeff*, *trace* Bases: *mushroom_rl_benchmark.builders.value.td.td_finite.TDFiniteBuilder*

Builder for TD algorithms with eligibility traces and finite states.

__init__

learning_rate, *epsilon*, *epsilon_test*, *lambda_coeff*, *trace* Constructor.

lambda_coeff ([float, Parameter]): eligibility trace coefficient; trace (str): type of eligibility trace to use.

classmethod default
learning_rate=0.9, *epsilon=0.1*, *decay_lr=0.0*, *decay_eps=0.0*, *epsilon_test=0.0*, *lambda_coeff=0.9*, *trace='replacing'*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class SARSALambdaBuilder
learning_rate, *epsilon*, *epsilon_test*, *lambda_coeff*, *trace* Bases: *mushroom_rl_benchmark.builders.value.td.td_trace.TDTraceBuilder*

alg_class
alias of `mushroom_rl.algorithms.value.td.sarsa_lambda.SARSALambda`

class QLambdaBuilder
learning_rate, *epsilon*, *epsilon_test*, *lambda_coeff*, *trace* Bases: *mushroom_rl_benchmark.builders.value.td.td_trace.TDTraceBuilder*

alg_class
alias of `mushroom_rl.algorithms.value.td.q_lambda.QLambda`

class SarsaLambdaContinuousBuilder
policy, *approximator*, *learning_rate*, *lambda_coeff*, *epsilon*, *epsilon_test*, *n_tilings*, *n_tiles* Bases: `mushroom_rl_benchmark.builders.value.td.td_continuous.TDContinuousBuilder`

AgentBuilder for Sarsa(Lambda) Continuous. Using tiles as function approximator.

__init__
policy, *approximator*, *learning_rate*, *lambda_coeff*, *epsilon*, *epsilon_test*, *n_tilings*, *n_tiles* Constructor.

Parameters **approximator** (*class*) – Q-function approximator.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
alpha=0.1, *lambda_coeff=0.9*, *epsilon=0.0*, *decay_eps=0.0*, *epsilon_test=0.0*, *n_tilings=10*, *n_tiles=10*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class TrueOnlineSarsaLambdaBuilder
policy, *learning_rate*, *lambda_coeff*, *epsilon*, *epsilon_test*, *n_tilings*, *n_tiles* Bases: `mushroom_rl_benchmark.builders.value.td.td_continuous.TDContinuousBuilder`

AgentBuilder for True Online Sarsa(Lambda) Continuous. Using tiles as function approximator.

__init__
policy, *learning_rate*, *lambda_coeff*, *epsilon*, *epsilon_test*, *n_tilings*, *n_tiles* Constructor.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
alpha=0.1, *lambda_coeff=0.9*, *epsilon=0.0*, *decay_eps=0.0*, *epsilon_test=0.0*, *n_tilings=10*, *n_tiles=10*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

DQN

class DQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Deep Q-Network (DQN).

__init__
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Constructor.

Parameters

- **policy** (*Policy*) – policy class;
- **approximator** (*dict*) – Q-function approximator;
- **approximator_params** (*dict*) – parameters of the Q-function approximator;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 1*) – number of steps per fit.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

set_eval_mode
agent, *eval* Set the eval mode for the agent. This function can be overwritten by any agent builder to setup specific evaluation mode for the agent.

Parameters

- **agent** (*Agent*) – the considered agent;
- **eval** (*bool*) – whether to set eval mode (true) or learn mode.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_steps_per_fit=1*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class DoubleDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

class AveragedDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_steps_per_fit=1*, *n_approximators=10*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class PrioritizedDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_steps_per_fit=1*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class DuelingDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNFeatureNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_features=512*, *n_steps_per_fit=1*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class MaxminDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_steps_per_fit=1*, *n_approximators=3*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class NoisyDQNBuilder
policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default
lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNFeatureNetwork'>*,

initial_replay_size=50000, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_features=512*, *n_steps_per_fit=1*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class CategoricalDQNBuilder

policy, *approximator*, *approximator_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.value.dqn.dqn.DQNBuilder*

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default

lr=0.0001, *network=<class 'mushroom_rl_benchmark.builders.network.dqn_network.DQNFeatureNetwork'>*, *initial_replay_size=50000*, *max_replay_size=1000000*, *batch_size=32*, *target_update_frequency=2500*, *n_features=512*, *n_steps_per_fit=1*, *v_min=-10*, *v_max=10*, *n_atoms=51*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

3.5.3 Actor Critic Builders

Classic AC

class StochasticACBuilder

std_0, *alpha_theta*, *alpha_v*, *lambda_par*, *n_tilings*, *n_tiles*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

Builder for the stochastic actor critic algorithm. Using linear approximator with tiles for mean, standard deviation and value function approximator. The value function approximator also uses a bias term.

__init__

std_0, *alpha_theta*, *alpha_v*, *lambda_par*, *n_tilings*, *n_tiles*, ***kwargs* Constructor.

Parameters

- **std_0** (*float*) – initial standard deviation;
- **alpha_theta** (*Parameter*) – Learning rate for the policy;
- **alpha_v** (*Parameter*) – Learning rate for the value function;
- **n_tilings** (*int*) – number of tilings to be used as approximator;
- **n_tiles** (*int*) – number of tiles for each state space dimension.

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

classmethod default

std_0=1.0, *alpha_theta=0.001*, *alpha_v=0.1*, *lambda_par=0.9*, *n_tilings=10*, *n_tiles=11*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;

- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

class COPDAC_QBuilder

std_exp, *std_eval*, *alpha_theta*, *alpha_omega*, *alpha_v*, *n_tilings*, *n_tiles*, ***kwargs* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

Builder for the COPDAQ_Q actor critic algorithm. Using linear approximator with tiles for the mean and value function approximator.

__init__

std_exp, *std_eval*, *alpha_theta*, *alpha_omega*, *alpha_v*, *n_tilings*, *n_tiles*, ***kwargs* Constructor.

Parameters

- **std_exp** (*float*) – exploration standard deviation;
- **std_eval** (*float*) – evaluation standard deviation;
- **alpha_theta** (*Parameter*) – Learning rate for the policy;
- **alpha_omega** (*Parameter*) – Learning rate for the
- **alpha_v** (*Parameter*) – Learning rate for the value function;
- **n_tilings** (*int*) – number of tilings to be used as approximator;
- **n_tiles** (*int*) – number of tiles for each state space dimension.

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

set_eval_mode

agent, *eval* Set the eval mode for the agent. This function can be overwritten by any agent builder to setup specific evaluation mode for the agent.

Parameters

- **agent** (*Agent*) – the considered agent;
- **eval** (*bool*) – whether to set eval mode (true) or learn mode.

classmethod default

std_exp=0.1, *std_eval=0.001*, *alpha_theta=0.005*, *alpha_omega=0.5*, *alpha_v=0.5*, *n_tilings=10*, *n_tiles=11*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

Deep AC

class A2CBuilder

policy_params, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=5*, *preprocessors=None* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Advantage Actor Critic algorithm (A2C)

__init__
policy_params, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=5*, *preprocessors=None* Constructor.

Parameters

- **policy_params** (*dict*) – parameters for the policy;
- **actor_optimizer** (*dict*) – parameters for the actor optimizer;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 5*) – number of steps per fit;
- **preprocessors** (*list, None*) – list of preprocessors.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default
actor_lr=0.0007, *critic_lr=0.0007*, *eps_actor=0.003*, *eps_critic=1e-05*, *batch_size=64*, *max_grad_norm=0.5*, *ent_coeff=0.01*, *critic_network=<class 'mushroom_rl_benchmark.builders.network.a2c_network.A2CNetwork'>*, *n_features=64*, *preprocessors=None*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class DDPGBuilder
policy_class, *policy_params*, *actor_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=1*
Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Deep Deterministic Policy Gradient algorithm (DDPG)

__init__
policy_class, *policy_params*, *actor_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=1* Constructor.

Parameters

- **policy_class** (*Policy*) – policy class;
- **policy_params** (*dict*) – parameters for the policy;
- **actor_params** (*dict*) – parameters for the actor;
- **actor_optimizer** (*dict*) – parameters for the actor optimizer;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 1*) – number of steps per fit.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default
actor_lr=0.0001, actor_network=<class 'mushroom_rl_benchmark.builders.network.ddpg_network.DDPGActorNetwork'>, critic_lr=0.001, critic_network=<class 'mushroom_rl_benchmark.builders.network.ddpg_network.DDPGCriticNetwork'>, initial_replay_size=500, max_replay_size=50000, batch_size=64, n_features=[80, 80], tau=0.001, use_cuda=False, get_default_dict=False Create a default initialization for the specific AgentBuilder and return it

class PPOBuilder
policy_params, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=3000*, *preprocessors=None*
Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Proximal Policy Optimization algorithm (PPO)

__init__
policy_params, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=3000*, *preprocessors=None* Constructor.

Parameters

- **policy_params** (*dict*) – parameters for the policy;
- **actor_optimizer** (*dict*) – parameters for the actor optimizer;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 3000*) – number of steps per fit;
- **preprocessors** (*list, None*) – list of preprocessors.

build
mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q
agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default
eps=0.2, *ent_coeff=0.0*, *n_epochs_policy=4*, *actor_lr=0.0003*, *critic_lr=0.0003*, *critic_fit_params=None*, *critic_network=<class 'mushroom_rl_benchmark.builders.network.trpo_network.TRPONetwork'>*, *lam=0.95*, *batch_size=64*, *n_features=32*, *n_steps_per_fit=3000*, *std_0=1.0*, *preprocessors=None*,

use_cuda=False, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class SACBuilder

actor_mu_params, *actor_sigma_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_q_samples=100*, *n_steps_per_fit=1*, *preprocessors=None* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder Soft Actor-Critic algorithm (SAC)

__init__

actor_mu_params, *actor_sigma_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_q_samples=100*, *n_steps_per_fit=1*, *preprocessors=None* Constructor.

Parameters

- **actor_mu_params** (*dict*) – parameters for actor mu;
- **actor_sigma_params** (*dict*) – parameters for actor sigma;
- **actor_optimizer** (*dict*) – parameters for the actor optimizer;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_q_samples** (*int, 100*) – number of samples to compute value function;
- **n_steps_per_fit** (*int, 1*) – number of steps per fit;
- **preprocessors** (*list, None*) – list of preprocessors.

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default

actor_lr=0.0003, *actor_network=<class 'mushroom_rl_benchmark.builders.network.sac_network.SACActorNetwork'>*, *critic_lr=0.0003*, *critic_network=<class 'mushroom_rl_benchmark.builders.network.sac_network.SACCriticNetwork'>*, *initial_replay_size=64*, *max_replay_size=50000*, *n_features=64*, *warmup_transitions=100*, *batch_size=64*, *tau=0.005*, *lr_alpha=0.003*, *preprocessors=None*, *target_entropy=None*, *use_cuda=False*, *get_default_dict=False* Create a default initialization for the specific AgentBuilder and return it

class TD3Builder

policy_class, *policy_params*, *actor_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=1* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Twin Delayed DDPG algorithm (TD3)

__init__

policy_class, *policy_params*, *actor_params*, *actor_optimizer*, *critic_params*, *alg_params*, *n_steps_per_fit=1* Constructor.

Parameters

- **policy_class** (*Policy*) – policy class;
- **policy_params** (*dict*) – parameters for the policy;
- **actor_params** (*dict*) – parameters for the actor;
- **actor_optimizer** (*dict*) – parameters for the actor optimizer;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 1*) – number of steps per fit.

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default

actor_lr=0.0001, actor_network=<class 'mushroom_rl_benchmark.builders.network.td3_network.TD3ActorNetwork'>, critic_lr=0.001, critic_network=<class 'mushroom_rl_benchmark.builders.network.td3_network.TD3CriticNetwork'>, initial_replay_size=500, max_replay_size=50000, batch_size=64, n_features=[80, 80], tau=0.001, use_cuda=False, get_default_dict=False Create a default initialization for the specific AgentBuilder and return it

class TRPOBuilder

policy_params, *critic_params*, *alg_params*, *n_steps_per_fit=3000*, *preprocessors=None* Bases: *mushroom_rl_benchmark.builders.agent_builder.AgentBuilder*

AgentBuilder for Trust Region Policy optimization algorithm (TRPO)

__init__

policy_params, *critic_params*, *alg_params*, *n_steps_per_fit=3000*, *preprocessors=None* Constructor.

Parameters

- **policy_params** (*dict*) – parameters for the policy;
- **critic_params** (*dict*) – parameters for the critic;
- **alg_params** (*dict*) – parameters for the algorithm;
- **n_steps_per_fit** (*int, 3000*) – number of steps per fit;
- **preprocessors** (*list, None*) – list of preprocessors.

build

mdp_info Build and return the AgentBuilder

Parameters **mdp_info** (*MDPInfo*) – information about the environment.

compute_Q

agent, *states* Compute the Q Value for an AgentBuilder

Parameters

- **agent** (*Agent*) – the considered agent;
- **states** (*np.ndarray*) – the set of states over which we need to compute the Q function.

classmethod default
critic_lr=0.0003, *critic_network=<class 'mushroom_rl_benchmark.builders.network.trpo_network.TRPONetwork'>*, *max_kl=0.01*, *ent_coeff=0.0*, *lam=0.95*, *batch_size=64*, *n_features=32*, *critic_fit_params=None*, *n_steps_per_fit=3000*, *n_epochs_line_search=10*, *n_epochs_cg=100*, *cg_damping=0.01*, *cg_residual_tol=1e-10*, *std_0=1.0*, *preprocessors=None*, *use_cuda=False*, *get_default_dict=False*
Create a default initialization for the specific AgentBuilder and return it

3.6 Networks

class A2CNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state, ***kwargs* Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

---

class DDPGCriticNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state, *action* Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

---

class DDPGActorNetwork
input_shape, *output_shape*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

---

class SACCriticNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state, *action* Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

---

class SACActorNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

---

class TD3CriticNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state, *action* Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks

while the latter silently ignores them.

class TD3ActorNetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

class TRPONetwork
input_shape, *output_shape*, *n_features*, ***kwargs* Bases: `torch.nn.modules.module.Module`

__init__
input_shape, *output_shape*, *n_features*, ***kwargs* Initializes internal Module state, shared by both nn.Module and ScriptModule.

forward
state, ***kwargs* Defines the computation performed at every call.

Should be overridden by all subclasses.

Note: Although the recipe for forward pass needs to be defined within this function, one should call the `Module` instance afterwards instead of this since the former takes care of running the registered hooks while the latter silently ignores them.

3.7 Experiment

exec_run
agent_builder, *env_builder*, *n_epochs*, *n_steps=None*, *n_episodes=None*, *n_steps_test=None*, *n_episodes_test=None*, *seed=None*, *save_agent=False*, *quiet=True*, ***kwargs* Function that handles the execution of an experiment run.

Parameters

- **agent_builder** (`AgentBuilder`) – agent builder to spawn an agent;
- **env_builder** (`EnvironmentBuilder`) – environment builder to spawn an environment;
- **n_epochs** (*int*) – number of epochs;
- **n_steps** (*int, None*) – number of steps per epoch;
- **n_episodes** (*int, None*) – number of episodes per epoch;
- **n_steps_test** (*int, None*) – number of steps for testing;

- **n_episodes_test** (*int, None*) – number of episodes for testing;
- **seed** (*int, None*) – the seed;
- **save_agent** (*bool, False*) – select if the agent should be logged or not;
- **quiet** (*bool, True*) – select if run should print execution information.

compute_metrics
core, *eval_params*, *agent_builder*, *env_builder* Function to compute the metrics.

Parameters

- **eval_params** (*dict*) – parameters for running the evaluation;
- **agent_builder** (AgentBuilder) – the agent builder;
- **env_builder** (EnvironmentBuilder) – environment builder to spawn an environment;

print_metrics
logger, *epoch*, *J*, *R*, *V*, *E* Function that pretty prints the metrics on the standard output.

Parameters

- **logger** (*Logger*) – MushroomRL logger object;
- **epoch** (*int*) – the current epoch;
- **J** (*float*) – the current value of J;
- **R** (*float*) – the current value of R;
- **V** (*float*) – the current value of V;
- **E** (*float*) – the current value of E (Set None if not defined).

3.7.1 Slurm utilities

aggregate_results
res_dir, *res_id*, *console_log_dir=None* Function to aggregate the benchmark results from running in SLURM mode.

Parameters

- **res_dir** (*str*) – path to the result directory;
- **res_id** (*str*) – log id of the result directory;
- **console_log_dir** (*str,None*) – path to be used to log console.

make_arguments
***params* Create a script argument string from dictionary

read_arguments_run
arg_string=None Parse the arguments for the run script.

Parameters **arg_string** (*str, None*) – pass the argument string.

read_arguments_aggregate
arg_string=None Parse the arguments for the aggregate script.

Parameters **arg_string** (*str, None*) – pass the argument string.

create_slurm_script
slurm_path, *slurm_script_name='slurm.sh'*, ***slurm_params* Function to create a slurm script in a specific directory

Parameters

- **slurm_path** (*str*) – path to locate the slurm script;
- **slurm_script_name** (*str, slurm.sh*) – name of the slurm script;
- ****slurm_params** – parameters for generating the slurm file content.

Returns The path to the slurm script.

generate_slurm
exp_name, *exp_dir_slurm*, *python_file*, *gres=None*, *project_name=None*, *n_exp=1*, *max_concurrent_runs=None*, *memory=2000*, *hours=24*, *minutes=0*, *seconds=0* Function to generate the slurm file content.

Parameters

- **exp_name** (*str*) – name of the experiment;
- **exp_dir_slurm** (*str*) – directory where the slurm log files are located;
- **python_file** (*str*) – path to the python file that should be executed;
- **gres** (*str, None*) – request cluster resources. E.g. to add a GPU in the IAS cluster specify gres='gpu:rtx2080:1';
- **project_name** (*str, None*) – name of the slurm project;
- **n_exp** (*int, 1*) – number of experiments in the slurm array;
- **max_concurrent_runs** (*int, None*) – maximum number of runs that should be executed in parallel on the SLURM cluster;
- **memory** (*int, 2000*) – memory limit in mega bytes (MB) for the slurm jobs;
- **hours** (*int, 24*) – maximum number of execution hours for the slurm jobs;
- **minutes** (*int, 0*) – maximum number of execution minutes for the slurm jobs;
- **seconds** (*int, 0*) – maximum number of execution seconds for the slurm jobs.

Returns The slurm script as string.

to_duration
hours, *minutes*, *seconds*

3.8 Utils

get_init_states
dataset Get the initial states of a MushroomRL dataset

Parameters **dataset** (*Dataset*) – a MushroomRL dataset.

extract_arguments
args, *method* Extract the arguments from a dictionary that fit to a methods parameters.

Parameters

- **args** (*dict*) – dictionary of arguments;
- **method** (*function*) – method for which the arguments should be extracted.

object_to_primitive
obj Converts an object into a string using the class name

Parameters **obj** – the object to convert.

Returns A string representing the object.

dictionary_to_primitive
data Function that converts a dictionary by transforming any objects inside into strings

Parameters **data** (*dict*) – the dictionary to convert.

Returns The converted dictionary.

get_mean_and_confidence
data Compute the mean and 95% confidence interval

Parameters **data** (*np.ndarray*) – Array of experiment data of shape (n_runs, n_epochs).

Returns The mean of the dataset at each epoch along with the confidence interval.

plot_mean_conf
data, *ax*, *color='blue'*, *line='-'*, *facecolor=None*, *alpha=0.4*, *label=None* Method to plot mean and confidence interval for data on pyplot axes.

build_sweep_list
algs, *sweep_conf*, *base_name='c_'* Build the sweep list, from a compact dictionary specification, for every considered algorithm.

Parameters

- **algs** (*list*) – list of algorithms to be considered;
- **sweep_conf** (*dict*) – dictionary with a compact sweep configuration for every algorithm;
- **base_name** (*str, 'c_'*) – base name for the sweep configuiration.

Returns The sweep list to be used with the suite.

build_sweep_dict
base_name='c_', ***kwargs* Build the sweep dictionary, from a set of variable specifications.

Parameters

- **base_name** (*str, 'c_'*) – base name for the sweep configuiration;
- ****kwargs** – the parameter specifications for the sweep.

Returns The sweep dictionary, where the key is the sweep name and the value is a dictionary with the sweep parameters.

generate_sweep
base_name='c_', ***kwargs* Generator that returns tuples with sweep name and parameters

Parameters

- **base_name** (*str, 'c_'*) – base name for the sweep configuiration;
- ****kwargs** – the parameter specifications for the sweep.

generate_sweep_params
***kwargs* Generator that returns sweep parameters

Parameters ****kwargs** – the parameter specifications for the sweep.

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