Deep Reinforcement Learning Recommenders using RayOnSpark

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Agenda

- Why Reinforcement Learning Recommenders?
- What is Analytics Zoo and RayOnSpark?
- How to build reinforcement learning recommenders using RayOnSpark
- Summary

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- **Why Reinforcement Learning Recommenders?**
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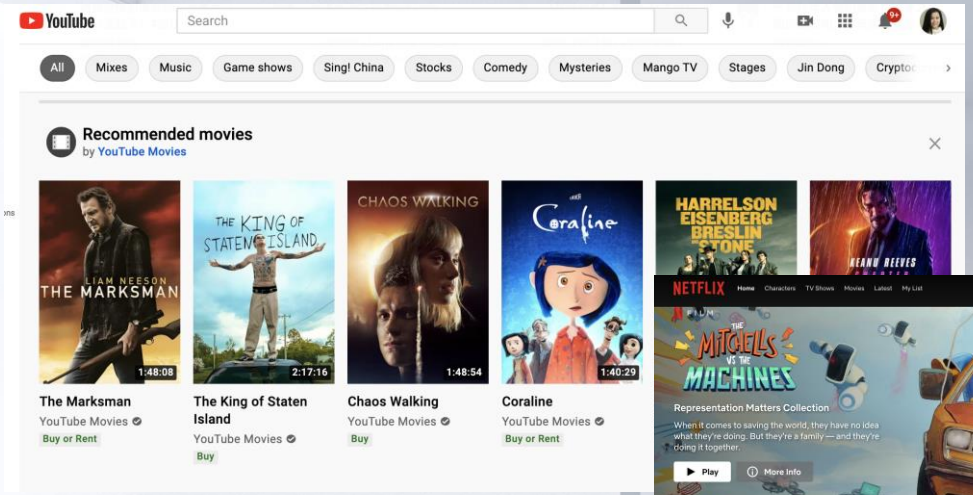
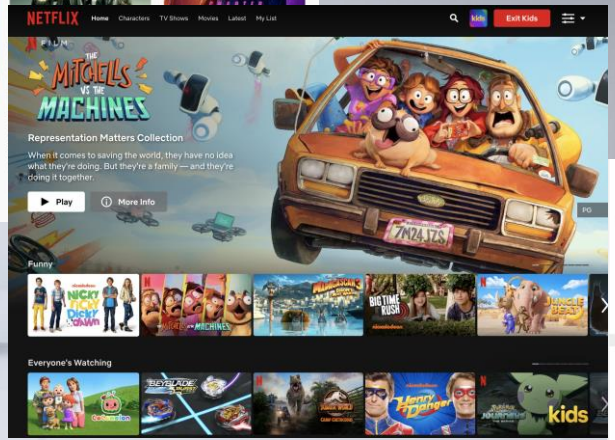
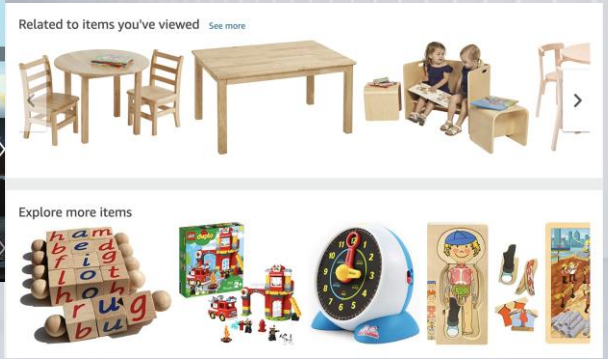
Recommendations everywhere







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Recommenders everywhere

Users

Items

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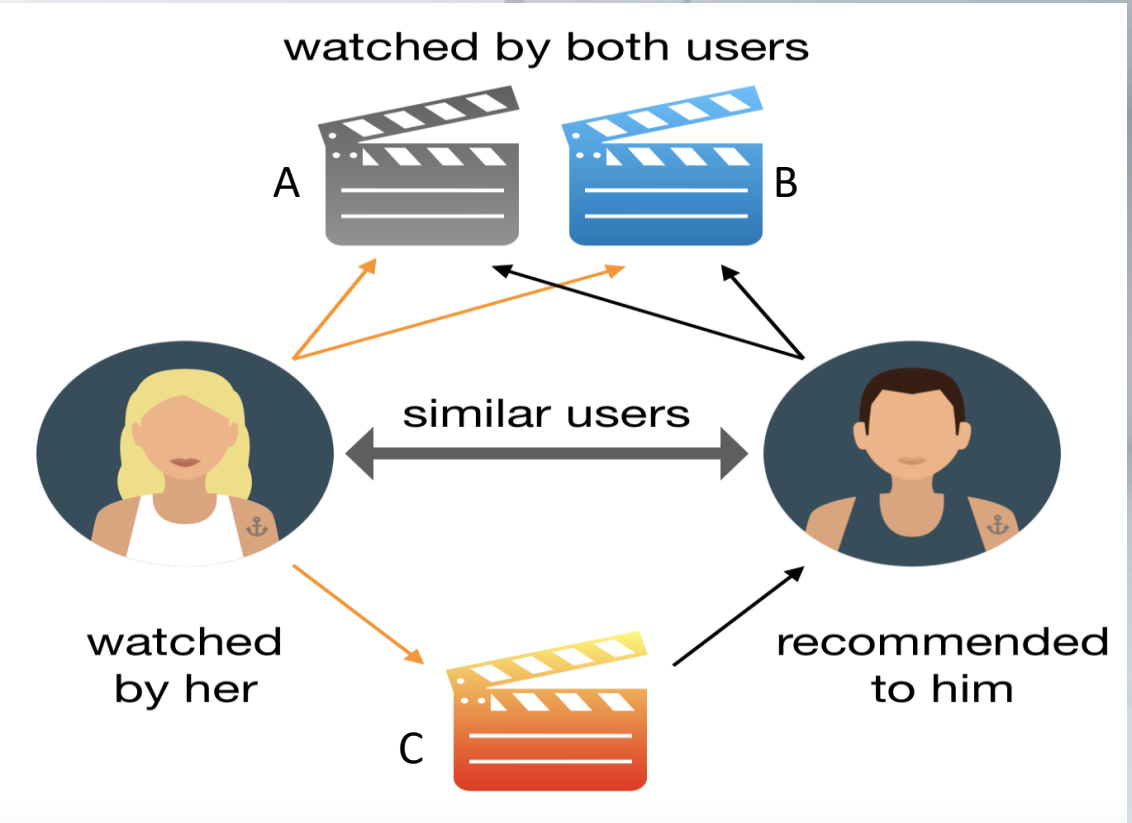
Traditional recommenders challenges



- **Static procedure**
- **Focus on immediate feedback**

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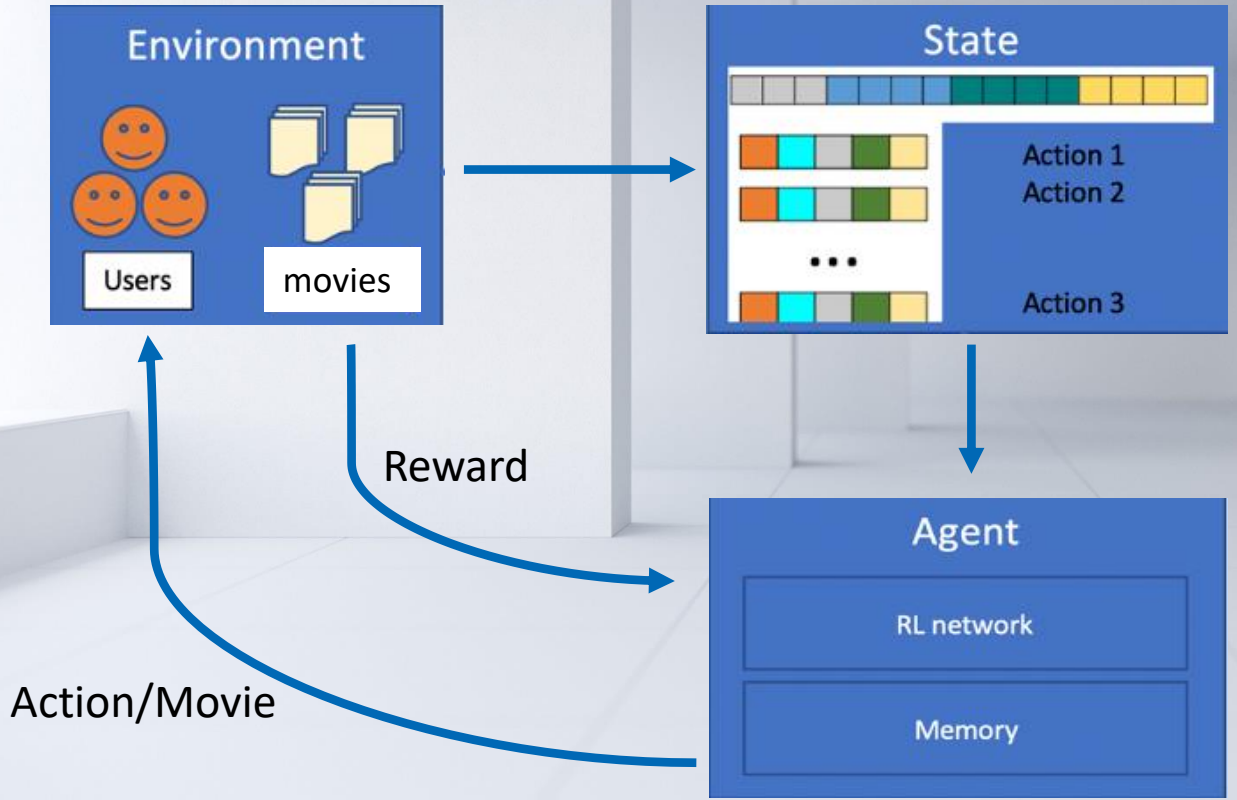
Reinforcement learning recommenders



- Sequential decision process
- Focus on both immediate and long-term rewards

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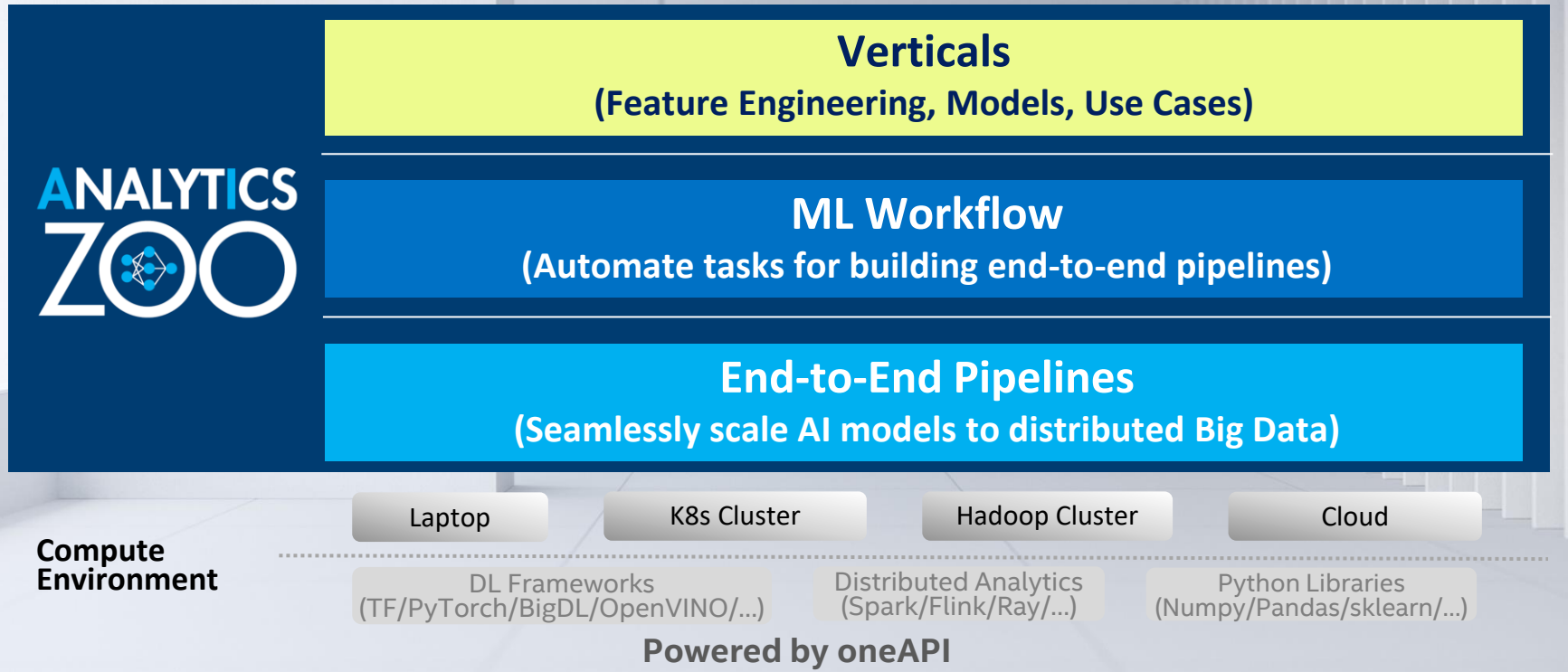
Analytics Zoo: Software Platform for Big Data AI



https://github.com/intel-analytics/analytics-zoo

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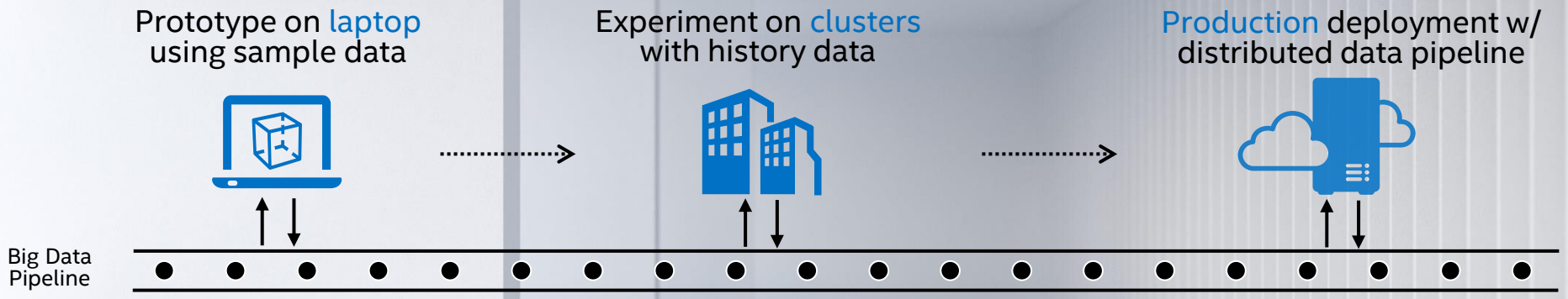
End-to-End Big Data Analytics and AI

Seamless Scaling from Laptop to Distributed Big Data



- Easily prototype end-to-end pipelines that apply AI models to big data
- "Zero" code change from laptop to distributed cluster
- Seamlessly deployed on production Hadoop/K8s clusters
- Automate the process of applying machine learning to big data

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Analytics Zoo: Open Source Platform for Big Data AI

Scaling End-to-End AI to Distributed Big Data

PPML	Privacy Preserving Data Analytics & ML on SGX
Zouwu	Scalable time series analysis pipeline w/ AutoML
RayOnSpark	Run Ray programs directly on Big Data platform
Cluster Serving	Distributed real-time model serving on Flink
Orca	Seamlessly scale out TF & PyTorch on Spark & Ray

Laptop | K8s Cluster | Hadoop Cluster | Cloud

DL Frameworks (TF/PyTorch/BigDL/OpenVINO/...) | Distributed Analytics (Spark/Flink/Ray/...) | Python Libraries (Numpy/Pandas/sklearn/...)

Powered by oneAPI

https://github.com/intel-analytics/analytics-zoo

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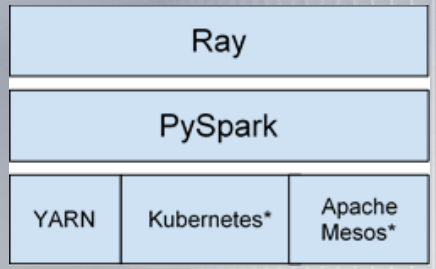
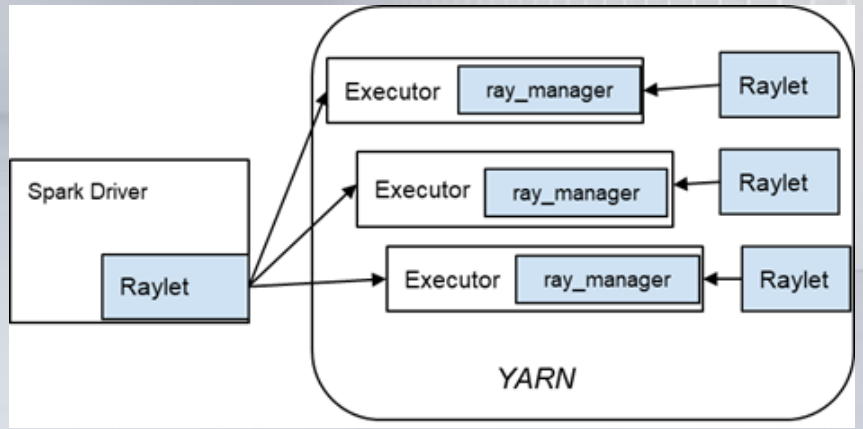
RayOnSpark

Run Ray Programs Directly on Big Data Platform

- RAY : **distributed framework for emerging AI applications**
- **RayOnSpark**
  - Directly run Ray programs on Big Data cluster
  - Integrate Ray programs into Spark data pipeline





https://medium.com/riselab/rayonspark-running-emerging-ai-applications-on-big-data-clusters-with-ray-and-analytics-zoo-923e0136ed6a

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RayOnSpark

Run Ray Programs Directly on Big Data Platform

```
from zoo.orca import init_orca_context, stop_orca_context
init_orca_context(cluster_mode="yarn", cores=4, memory="10g",
                  num_nodes=2, init_ray_on_spark=True)

#Ray code
@ray.remote
class TestRay():
    def hostname(self):
        import socket
        return socket.gethostname()

actors = [TestRay.remote() for i in range(0, 100)]
print([ray.get(actor.hostname.remote()) for actor in actors])

stop_orca_context()
```

https://medium.com/riselab/rayonspark-running-emerging-ai-applications-on-big-data-clusters-with-ray-and-analytics-zoo-923e0136ed6a

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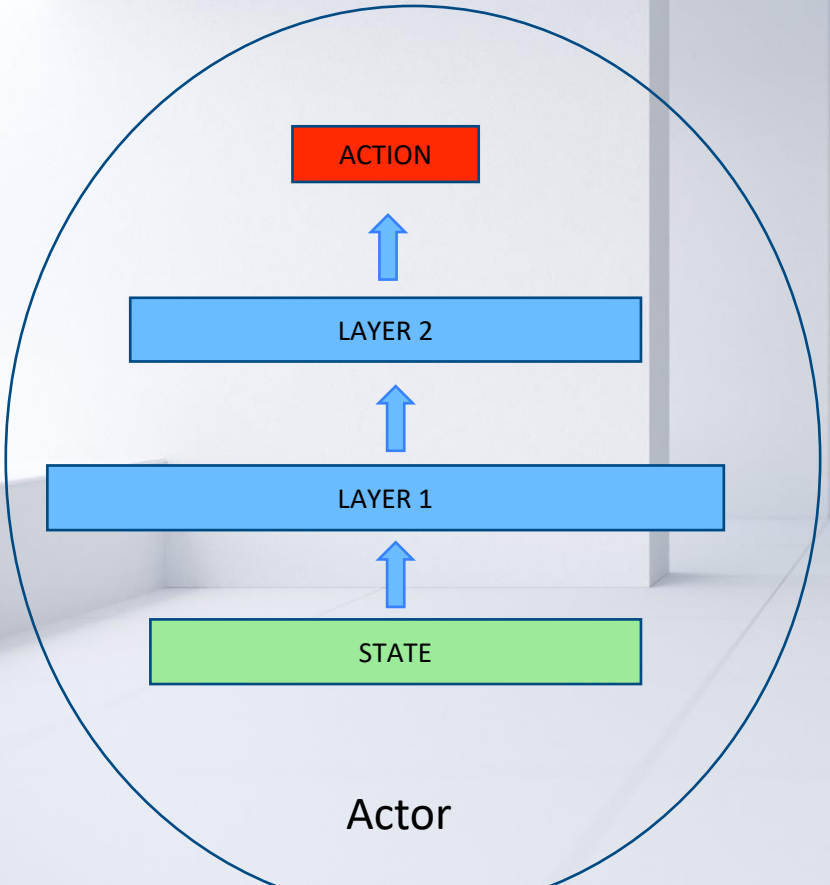
Build MovieEnv

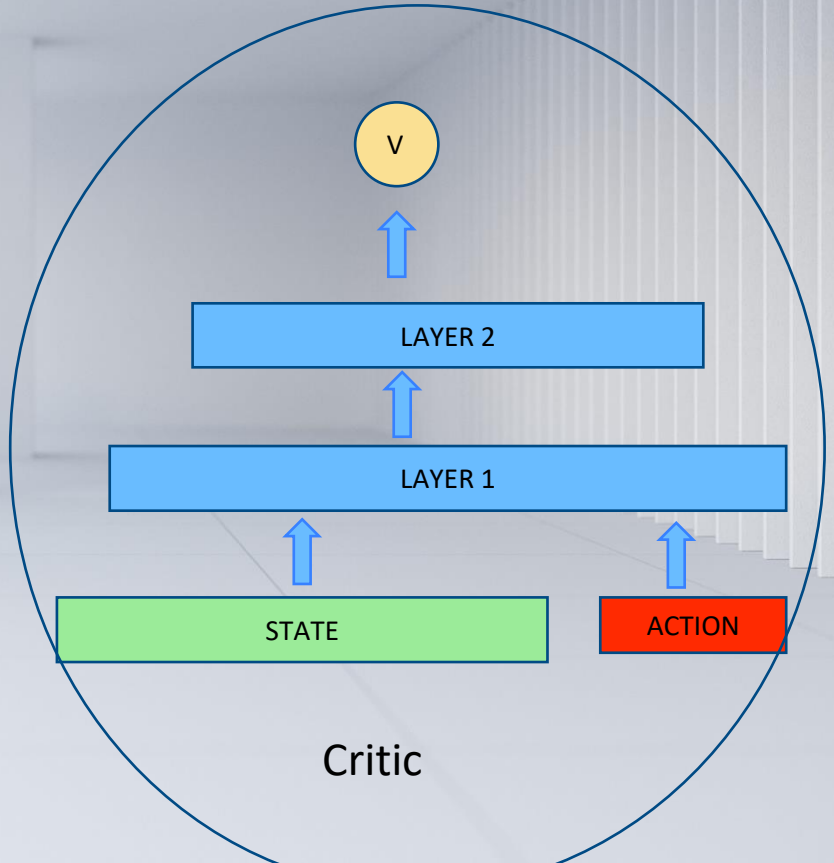
- Environment: MovieEnv(gym.Env)
- Agent: recommender
- Observation/States:
  - User embeddings, movie history embeddings
- Action: movie recommended
- Reward: rate + diversity
- Episode: user session

  20 steps

```
class MovieEnv(Env):
    def __init__(self, config):

    def step(self, action):
        ...
        return obs, reward, done, self.info

    def _get_reward(self, action):

        similarity = spatial.distance.cosine(m_action, m_vecs) if mid in
self.movies.keys()  else 0
        reward = rate + (1-similarity)
```

A2C


ACTION
LAYER 2
LAYER 1
STATE
Actor


V
LAYER 2
LAYER 1
STATE
ACTION
Critic

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Trainer with RayOnSpark

```
import ray.rllib.agents.a3c.a2c as a2c

init_orca_context(cores=8, memory="10g",
                  num_nodes=2, init_ray_on_spark=True)

env_conf= EnvConfig()
trainer_conf = a2c.A2C_DEFAULT_CONFIG.copy()
trainer_conf["env_config"] = env_conf._values
trainer_conf["env"] = MovieEnv
trainer = a2c.A2CTrainer(config=trainer_conf)
for i in range(1, 1000):
    result = trainer.train()
    if i % 50 == 0:
        checkpoint = trainer.save()

stop_orca_context()
```

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Recommend items

```
trainer.restore(path_to_checkpoint)
for i in range(100):
    obs = env.reset()
    while not done:
        action = trainer.compute_action(obs)
        obs, reward, done, info = env.step(action)
        episode_reward += reward

        print("episode_reward", episode_reward)
```

https://medium.com/riselab/rayonspark-running-emerging-ai-applications-on-big-data-clusters-with-ray-and-analytics-zoo-923e0136ed6a

Analytics Zoo API in blue

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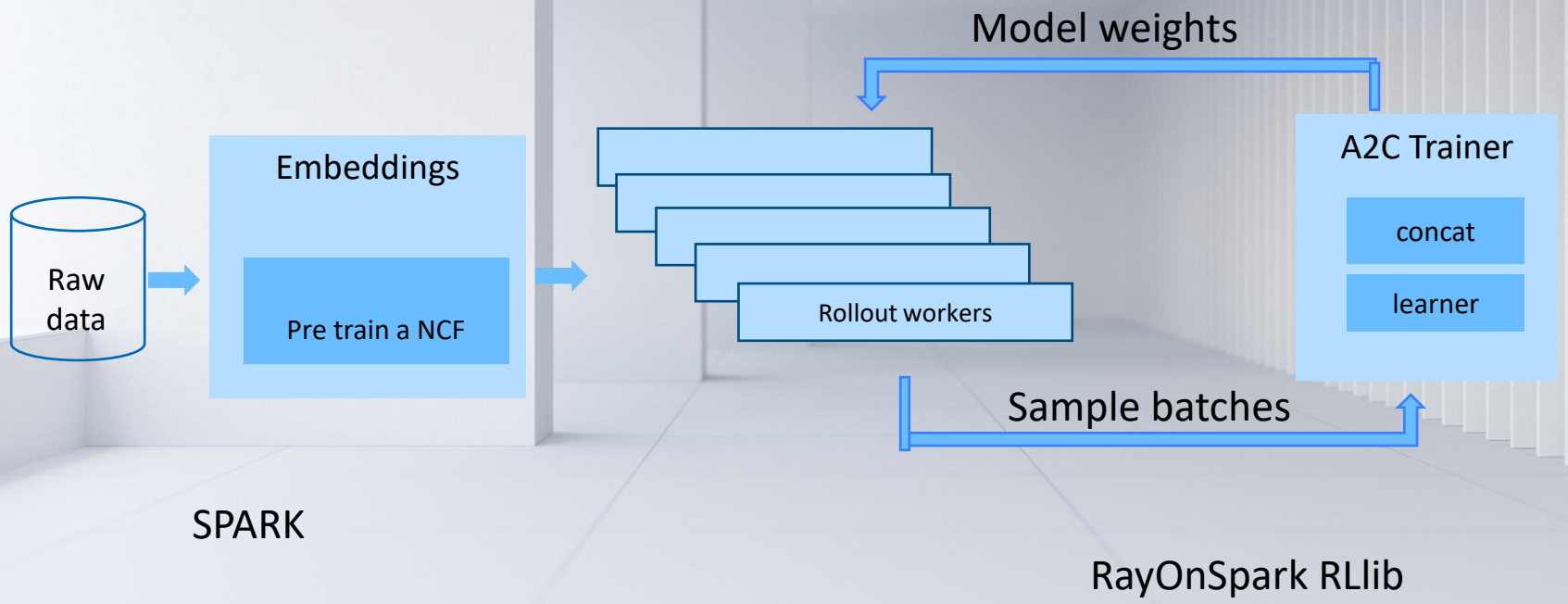
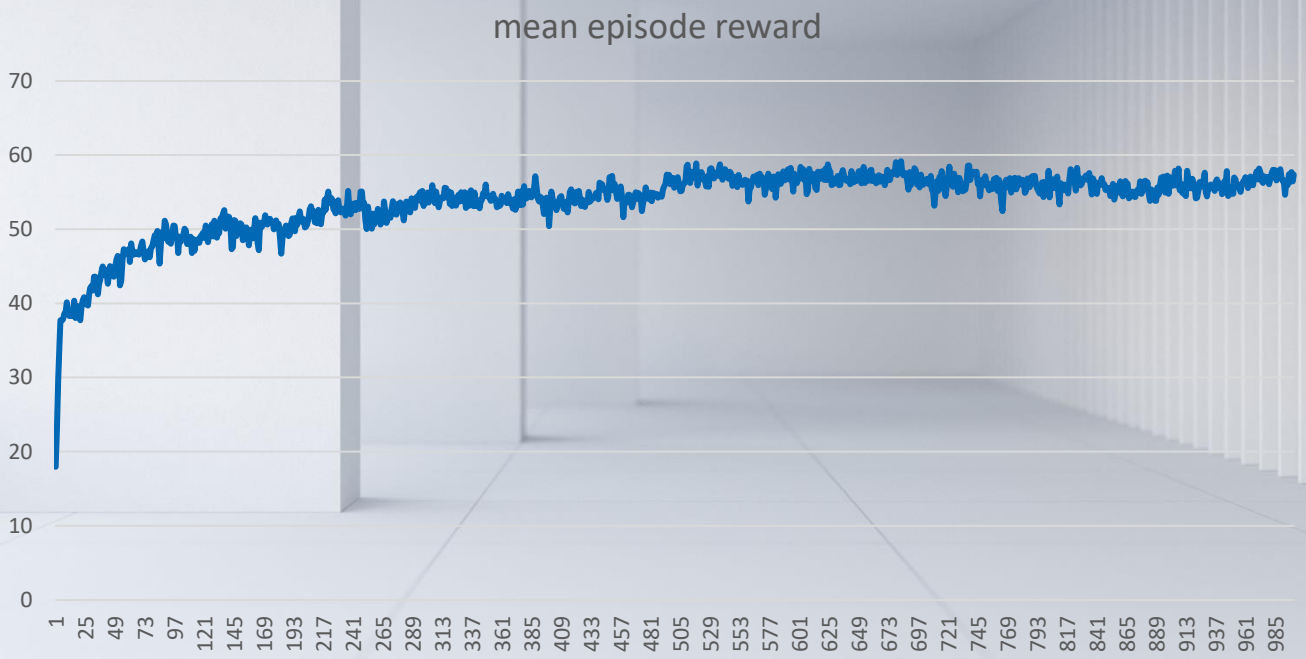
Training with RayOnSpark



Initial Results



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Summary

Built RL recommenders using RayOnSpark

- RL Recommenders capture dynamic nature of user-item interaction and focus on both immediate and long term reward
- Could maintain recommendation accuracy and diversity by adding similarity in reward
- Train different model components separately substantially reduces training time

Open Source Website

- Project repo: https://github.com/intel-analytics/analytics-zoo
- Use cases: https://analytics-zoo.readthedocs.io/en/latest/doc/Application/powered-by.html

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Thank You

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