Database Gyms

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Database Gyms: an integrated environment providing a unified API of pluggable components to obtain high-quality training data for autonomous DBMSs
HOLD UP

What happened to Peloton and NoisePage?
Self-Driving Databases @ CMU

INTRODUCTION >

Action Planning (Monte Carlo Tree Search)

Behavior Models

[SIGMOD 18]

[SIGMOD 21]

(Monte Carlo Tree Search)
Self-Driving Capabilities
What components are needed for self-driving?

- Workload forecasting
- Behavior modeling
- Action planning

How have recent papers focused on these problems?
ML = \boxed{\text{Models}} + \boxed{\text{Training Data}}

If you do know what model you want,
  • 1 month, 1k LOC

If you do not know what model you want,
  • Foundation models
  • Automated model design (e.g., AutoML)
Modern ML’s Implications

Training data is what matters today

With systems knowledge, generate training data that is
  • Better (higher quality)
  • Faster (less time taken)

Leave the ML to the ML people
TRAINING DATA

How do we collect training data?
Obtaining Training Data

Choice #1: Do it live!
- Performance degradations in production

Choice #2: Simulator (via a gym)
- Approximates the behavior of an entity when it would otherwise be too costly, time-consuming, or dangerous to experiment on the real system
- Packaged into toolkits for developing and evaluating different models and algorithms
Building a DBMS simulator is difficult

Key idea: Use the DBMS to simulate itself

- Requires solving systems and ML problems hand-in-hand
- We call this integrated solution the Database Gym
DATABASE GYM

Architecture
Using the DBMS as a Simulator
**Synthesizer**

Manages and manipulates the inputs to the database gym

- **Snapshot**: backups (e.g., pg_dump)
- **Workload**: timeseries of SQL queries

**Goal: what-if scenarios without replaying the workload**

- Example: “create a snapshot with 2x the data and increase the queries in the workload by 5x”
Given the workload and snapshot, coordinate workload execution to produce training data

- Observability
- Execution

Workload replay tools

- pgreplay supports speed factor for replay
Choice #1: Foreign Data Wrappers
• Save on storage

Choice #2: RAMDISK
• Save on disk access time

Choice #3: Query Progress Estimation
• Save on query execution time
Suggests a list of promising actions

Extensible Rule-based Action Generation

- Inspired by query optimizers (Exodus, Starburst)
- Example rule: “columns that occur together in a WHERE clause”
Pick the best action out of a list of candidate actions

By building on the OpenAI Gym, this component is free!

- Leverage what already exists in the ML community
- Various RL libraries integrate easily with gyms
Stop spending our time on ML problems, focus on database problems

Database Gym: systems for machine learning for systems
Hit Me Up

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