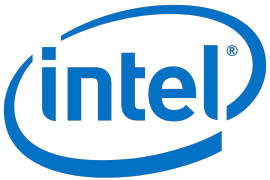
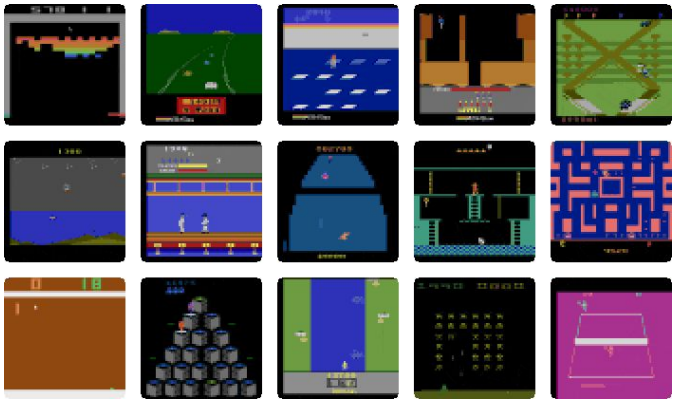
Megaverse: Simulating Embodied Agents at One Million Experiences per Second

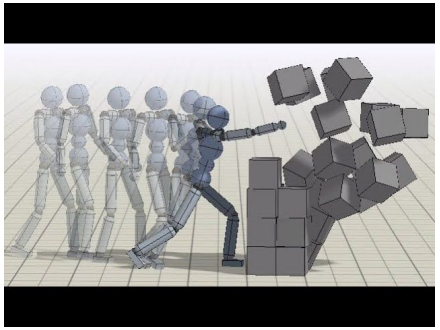
Aleksei Petrenko Erik Wijmans Brennan Shacklett Vladlen Koltun

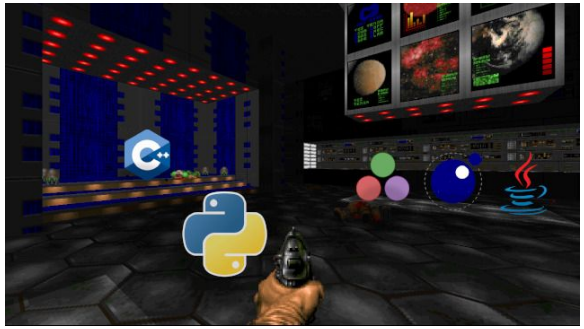
ICML 2021



Artificial intelligence & simulation







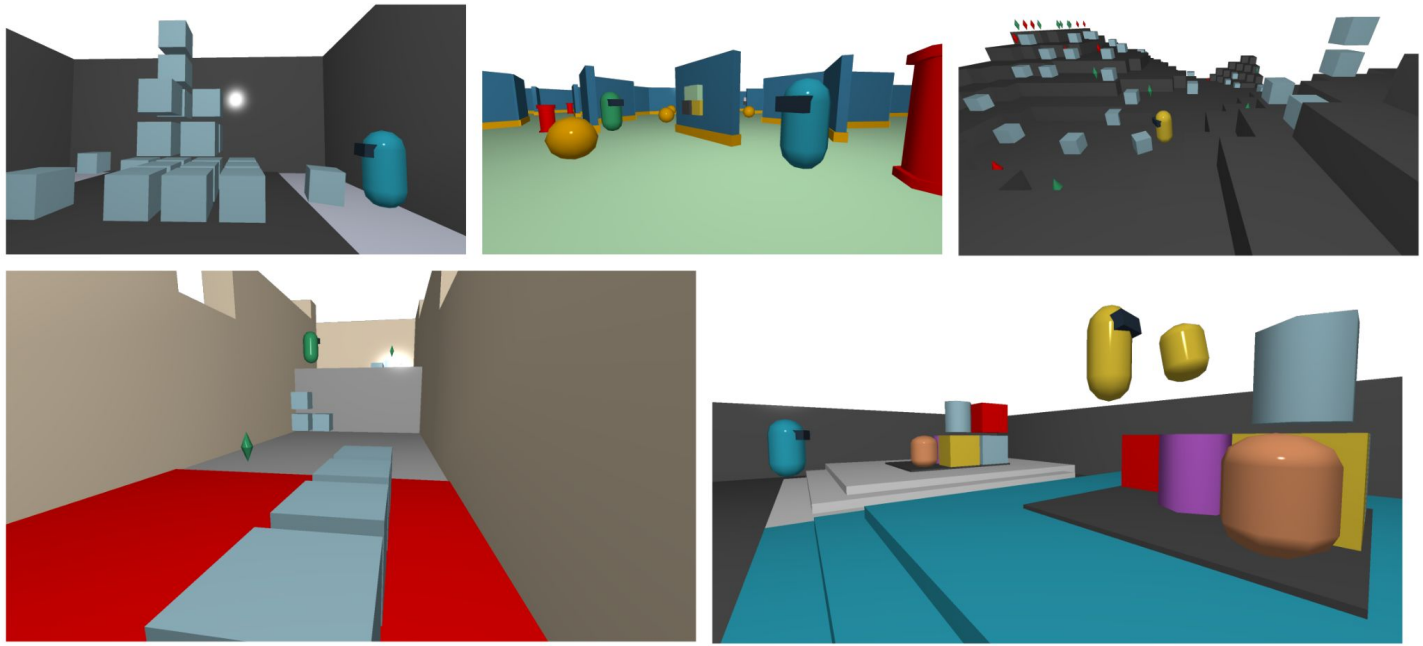
Disadvantages of existing RL platforms

- Based on existing video game engines
  - Atari, VizDoom (Doom), DMLab (Quake III), Unity, StarCraft II

Video games:	Embodied AI & RL research:
● High resolution, single viewpoint ● Rendering in real time for human perception ● Not designed for parallel execution ● No resource sharing between game instances	● Low resolution, many agents ● Rendering much faster than realtime

Megaverse - a dedicated platform for AI research

Optimized simulation engine designed from first principles

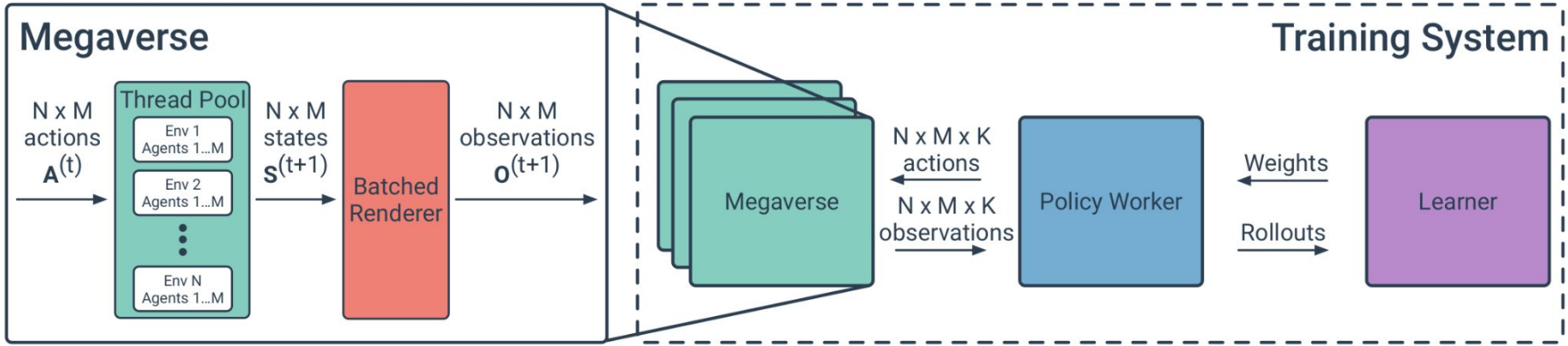


Megaverse performance

Environment	Simulation throughput	Training throughput, APPO [1]
12xCPU, 1xRTX3090		
Atari (84x84 grayscale)	19000 FPS (16x slower)	15000 FPS
DMLab (96x72 RGB)	6100 FPS (53x slower)	4600 FPS
Megaverse (128x72 RGB)	**327000 FPS**	**42700 FPS**
48xCPU, 8xRTX2080Ti		
Atari (84x84 grayscale)	53000 FPS (21x slower)	34000 FPS
DMLab (96x72 RGB)	15800 FPS (72x slower)	9800 FPS
Megaverse (128x72 RGB)	**1148000 FPS**	**134000 FPS**

[1] “Sample Factory: Egocentric 3D Control from Pixels at 100000 FPS with Asynchronous Reinforcement Learning”, Petrenko et. al (2020)

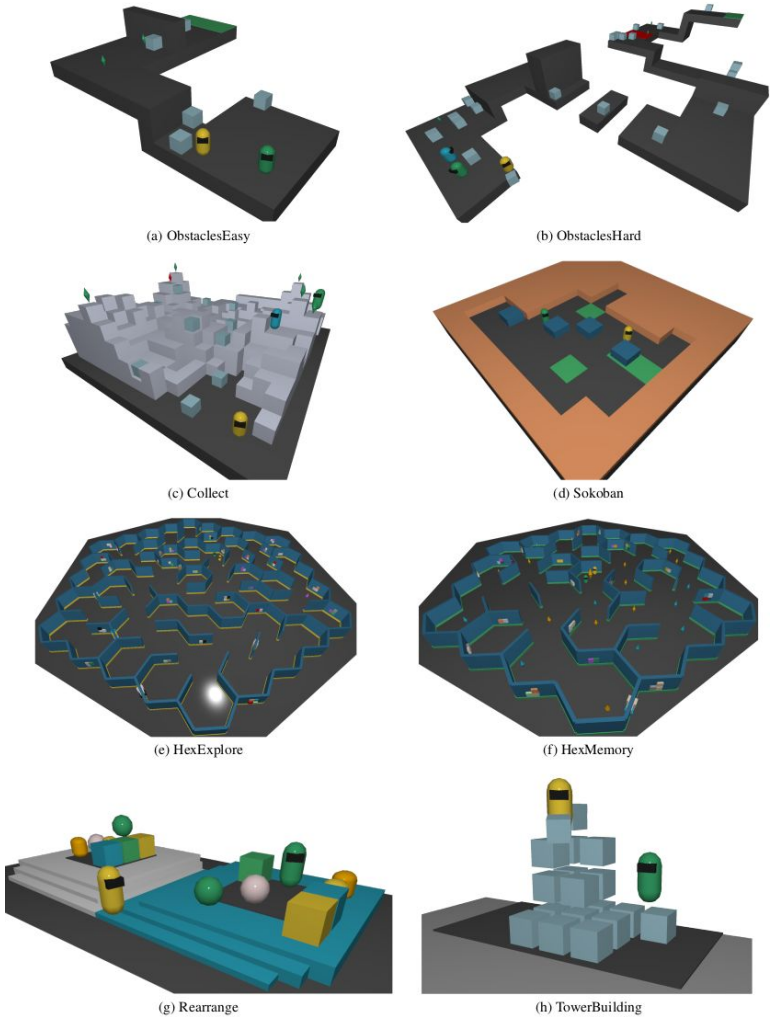
Parallel architecture & batched rendering



"Large Batch Simulation for Deep Reinforcement Learning", Shacklett et. al (2021)

Megaverse-8 benchmark

- Tasks:
  - “Collect” - navigation, episodic exploration
  - “HexExplore” - exploration
  - “HexMemory” - exploration, memory
  - “TowerBuilding” - object manipulation
  - “Sokoban” - long-term planning
  - “Rearrange” - rearrangement, object manipulation
  - “ObstaclesEasy” & “ObstaclesHard” - exploration, tool use, skill composition



Megaverse as a platform

Project website: https://www.megaverse.info

Source code: https://github.com/alex-petrenko/megaverse