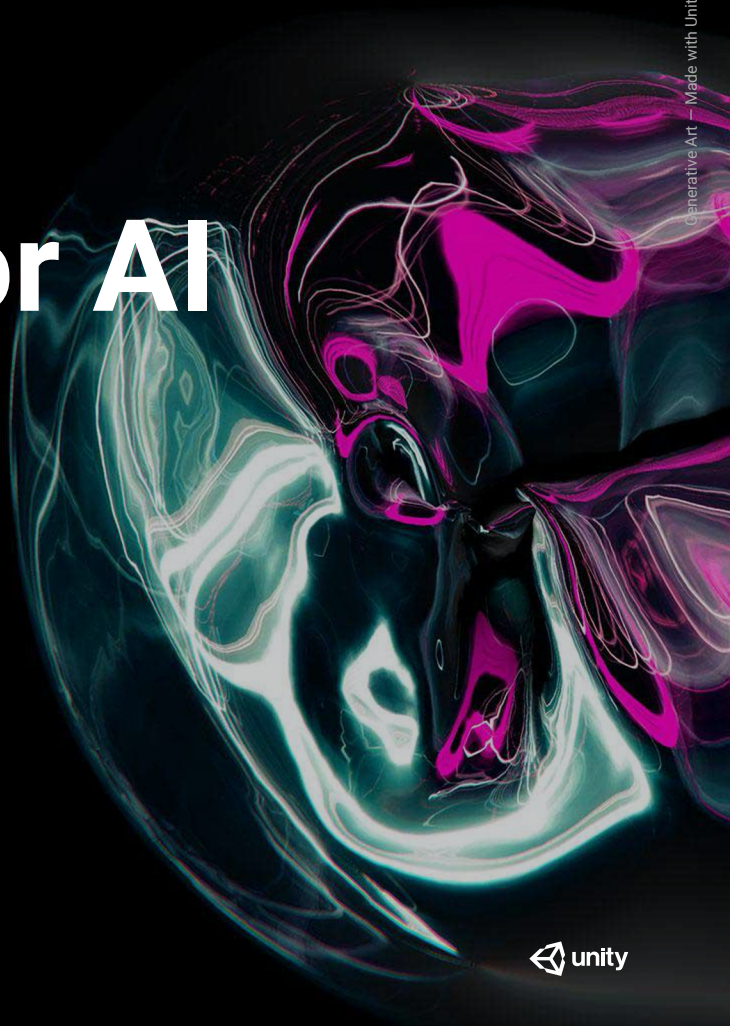
Simulation
The New Reality for AI

Danny Lange
VP of AI
Unity Technologies

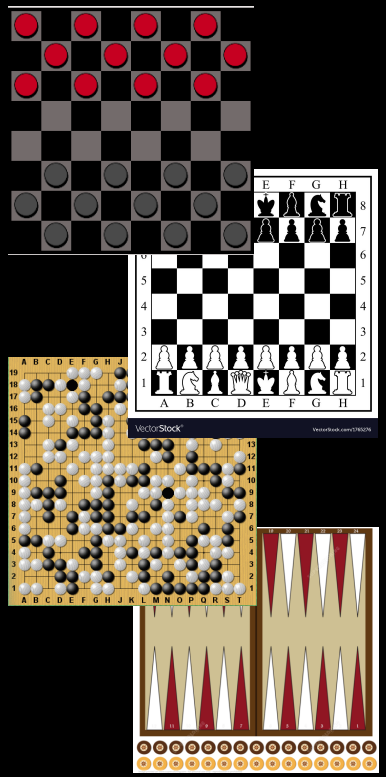


About Unity Technologies

- Real-time 3D Platform
- Games, AR/VR, film, automotive, robotics
- 60% of top 1,000 games made with Unity
- Installed on over 4 billion unique devices
- 2 billion monthly active players
- 3,000 employees with HQ in San Francisco

Games have been used to drive AI research for a long time

Board and Trivia Games in AI



- *1950:* Claude Shannon publishes “Programming a Computer for Playing Chess”
- *1989:* Chinook, a Checkers program reaching expert-level abilities, is developed at the University of Alberta
- *1997:* IBM Deep Blue defeats champion Garry Kasparov in Chess
- *2011:* IBM Watson defeated Ken Jennings and Brad Rutter in Jeopardy! using NLP, info retrieval and automated reasoning
- *2016:* DeepMind’s AlphaGo defeats champion Lee Sedol in Go

Board and Trivia Games in AI

- Atari 2600 Games - DeepMind, OpenAI
- Doom - VizDoom from Poznan University
- Quake 3 - DeepMind
- Minecraft - Microsoft Project Malmo
- Starcraft 2 - DeepMind / Blizzard
- Dota 2 - Open AI Five

Demis Hassabis - CEO of DeepMind

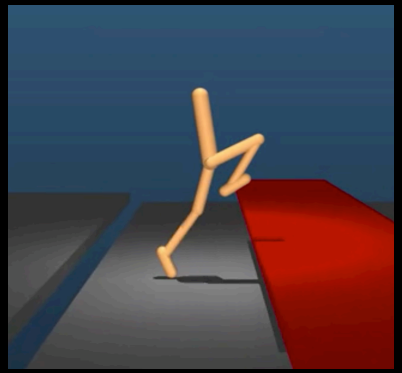
“As a former video game designer myself, I couldn’t be more excited to be collaborating with Unity, creating virtual environments for developing and testing the kind of smart, flexible algorithms we need to tackle real-world problems.”

So what is it with video games that link them to AI?

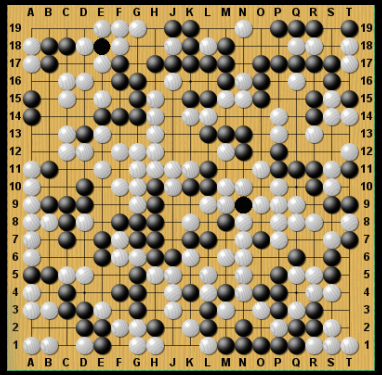
The Four Dimensions to AI

Visual

Physical



Cognitive

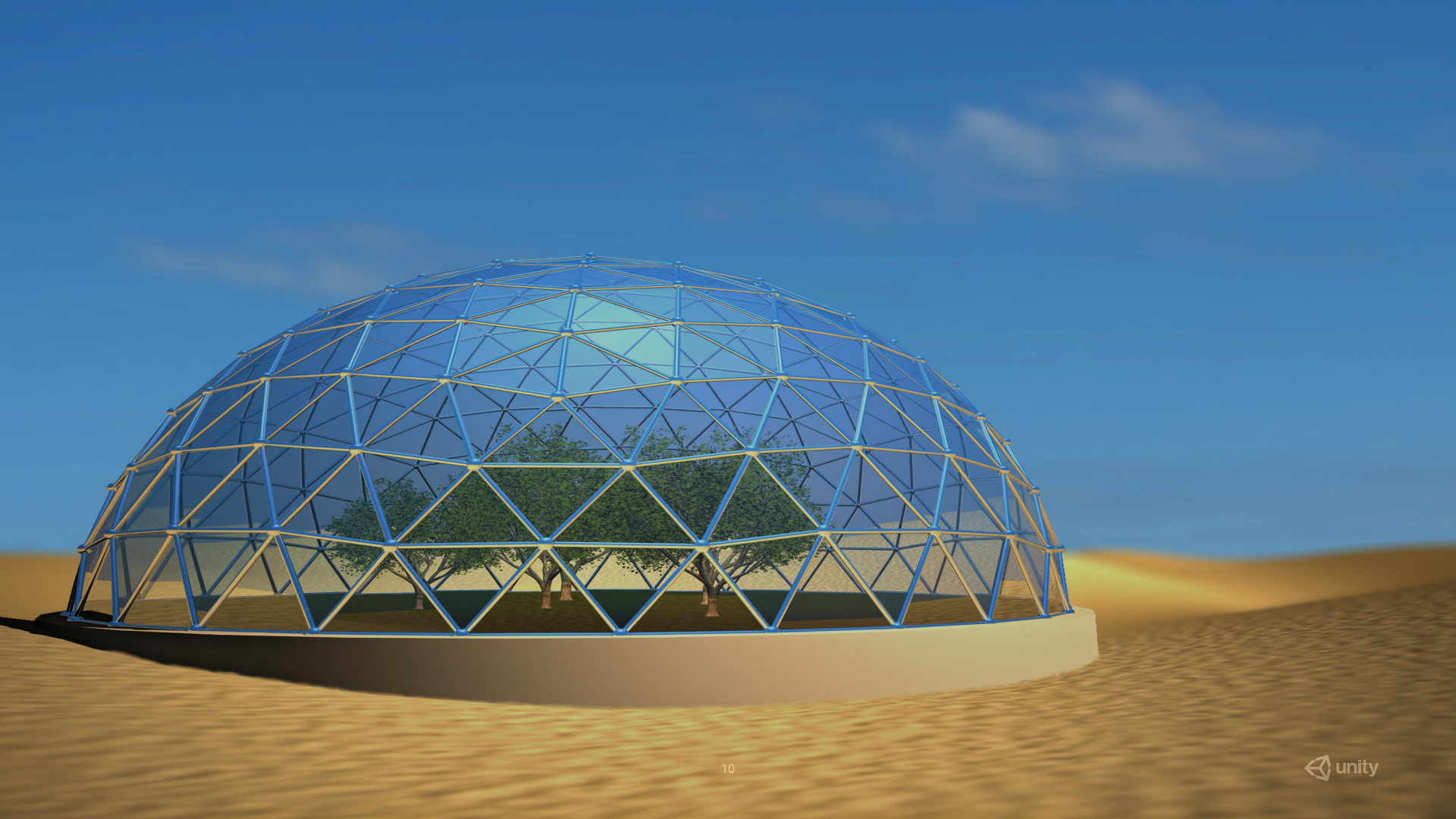


Social

Real-time 3D Engine

- Spatial environment
- Graphical rendering system
- Multi-sensory
- Physics engine

Controlled, self-sufficient ecosystem that replicates the real world



Unity Simulation

Let’s talk simulation

…for training Autonomous Systems

unity

Sense, Understand, and Interact

Perception

- Sensors: RGB, Lidar, Radar…
- Supervised Learning
- Object Labelling
- Semantic Segmentation
- Domain Randomization

Behavior

- Observation | Action | Reward
- Unsupervised Learning
- Reinforcement Learning
- Imitation Learning

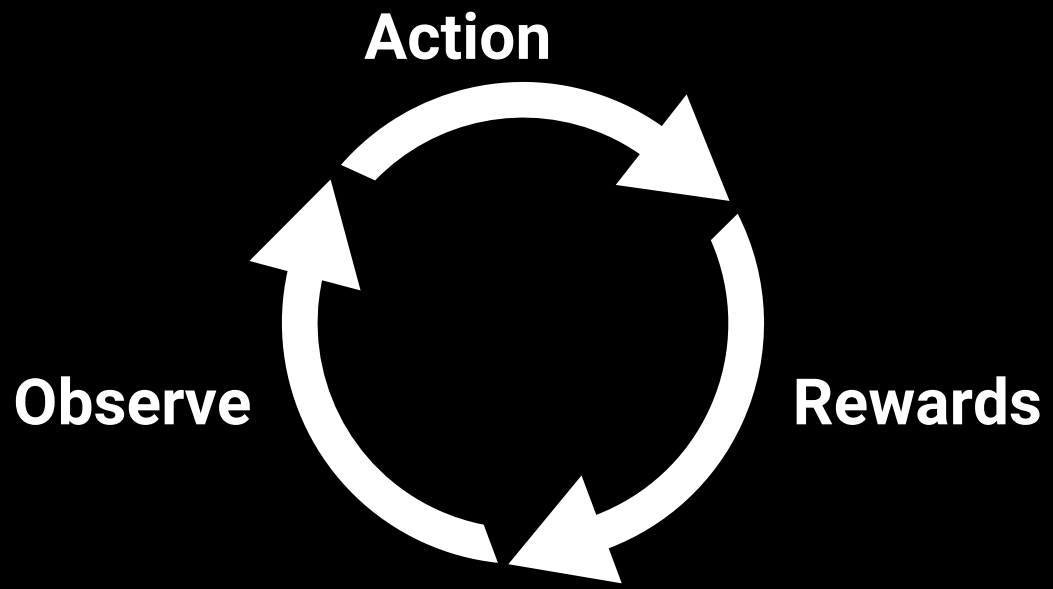
Perception


Depth Camera
Semantic Camera
Main Camera
2D Ground Truth


LGSVL Simulator
NO PARKING
PARKING RESTRICTED
24 HRS A DAY
TOWED AWAY
Press to pause

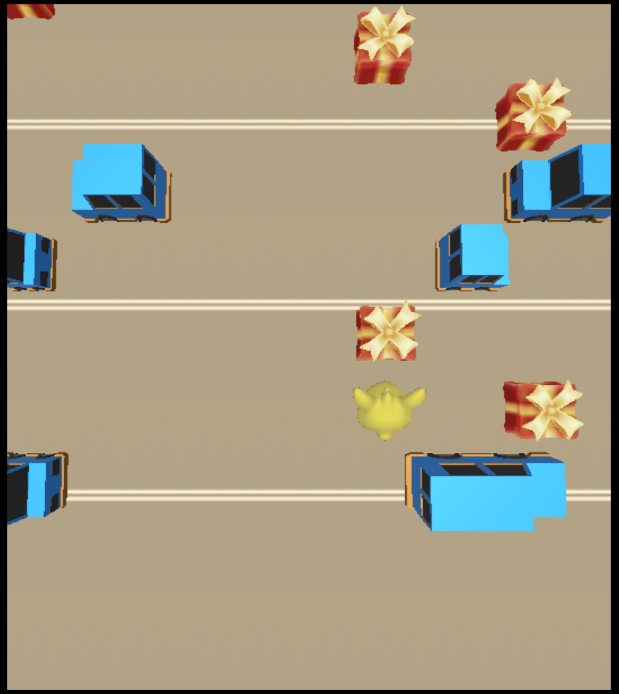
Behavior

Nature’s Learning Method: Reinforcement



Explore → Exploit

Chicken Crossing the Road: Tabula Rasa



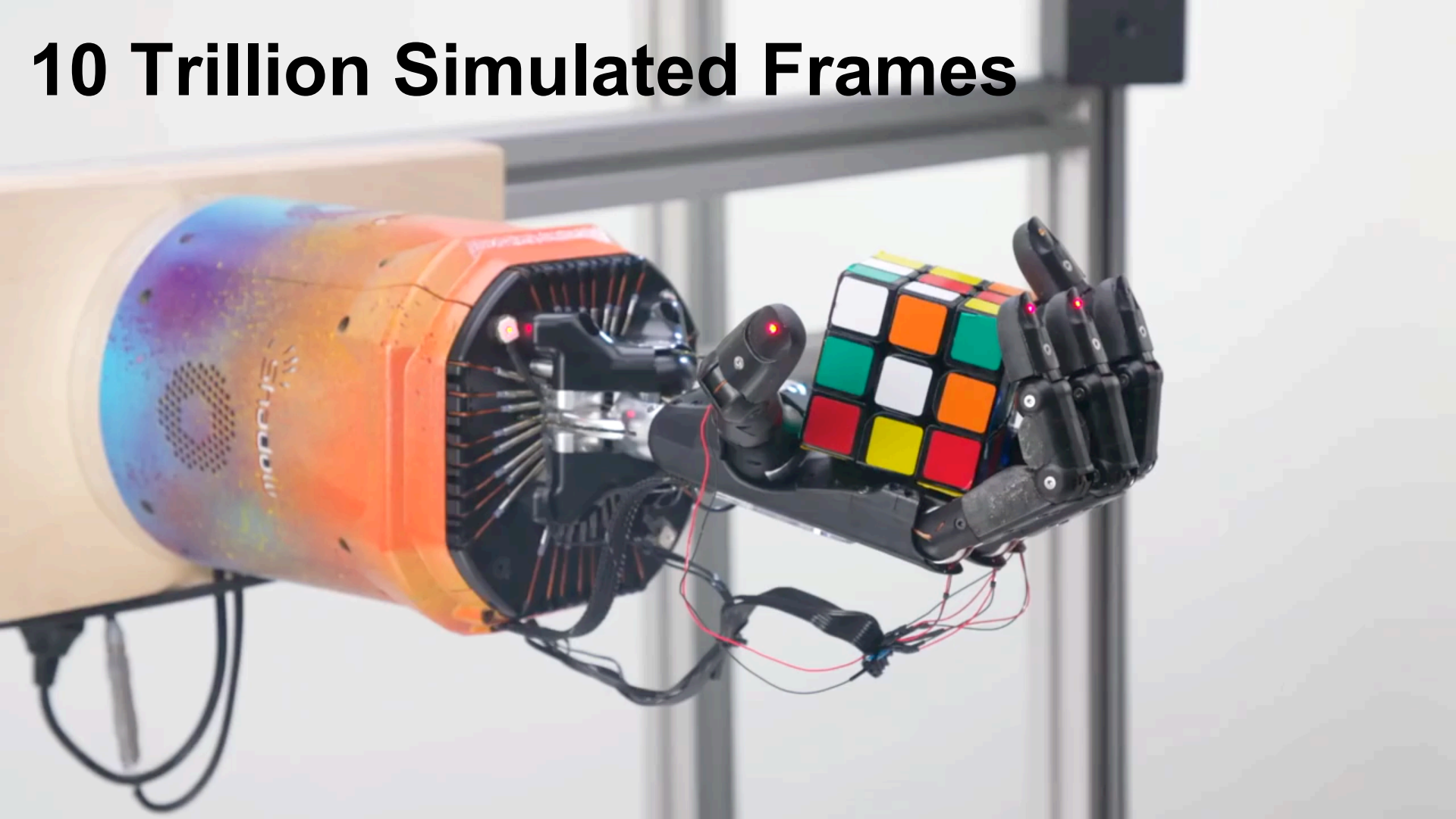
- Observe: Pixels in frame
- Actions: ➡ ⬅ ⬆⬇
- Rewards signal
  - Negative for being hit
  - Positive for gift pickup


Source: Peter Pastor

Synthetic Data: A Look at the Numbers

- 30 Frames per Second (FPS)
- ImageNet (20 Million) in seven days
- One year of your life in 1 Billion frames
- Autonomous systems often operate at 10Hz
- Planck Time: 5.39×10^{-44} sec

10 Trillion Simulated Frames



Let’s talk scale

Beating Evolution

- Accelerated time: Increased framerate
- Massive parallelism: Large-scale deployment
- Single “brain”: Blending species and individual
- Stepping back in time: Checkpointing
- Lower frequency: Drop the fill frames

Publications

Cognitive Robotics: Making Robots Sense, Understand, and Interact
Danny Lange. *Computer 52(12):39-44, December 2019*

Unity: A General Platform for Intelligent Agents
Arthur Juliani et al. *https://arxiv.org/abs/1809.02627*

Obstacle Tower: A Generalization Challenge in Vision, Control, and Planning
Arthur Juliani et al. *https://arxiv.org/abs/1902.0137*

Where to Learn More

ML-Agents

https://www.github.com/Unity-Technologies/ml-agents

Unity Simulation

https://unity.com/products/simulation


Thank You
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