

# MACHINE LEARNING

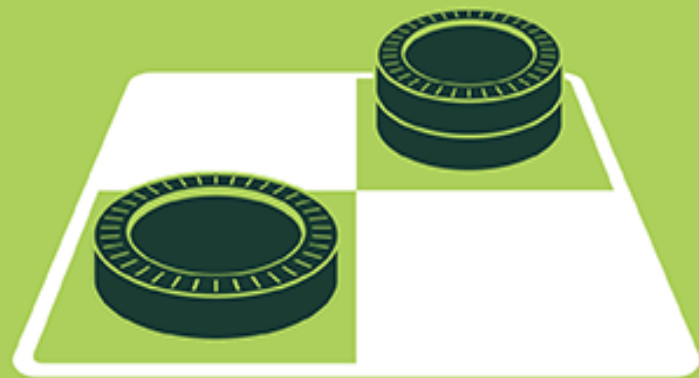
## Games and Beyond

Calvin Lin, NVIDIA



# ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



## MACHINE LEARNING

Machine learning begins to flourish.



## DEEP LEARNING

Deep learning breakthroughs drive AI boom.



# THE MACHINE LEARNING ERA IS HERE

And it is transforming every industry...  
including Game Development

# OVERVIEW

- NVIDIA Volta: An Architecture for Machine Learning
- NVIDIA GameWorks Materials & Textures
- Project Isaac & Holodeck



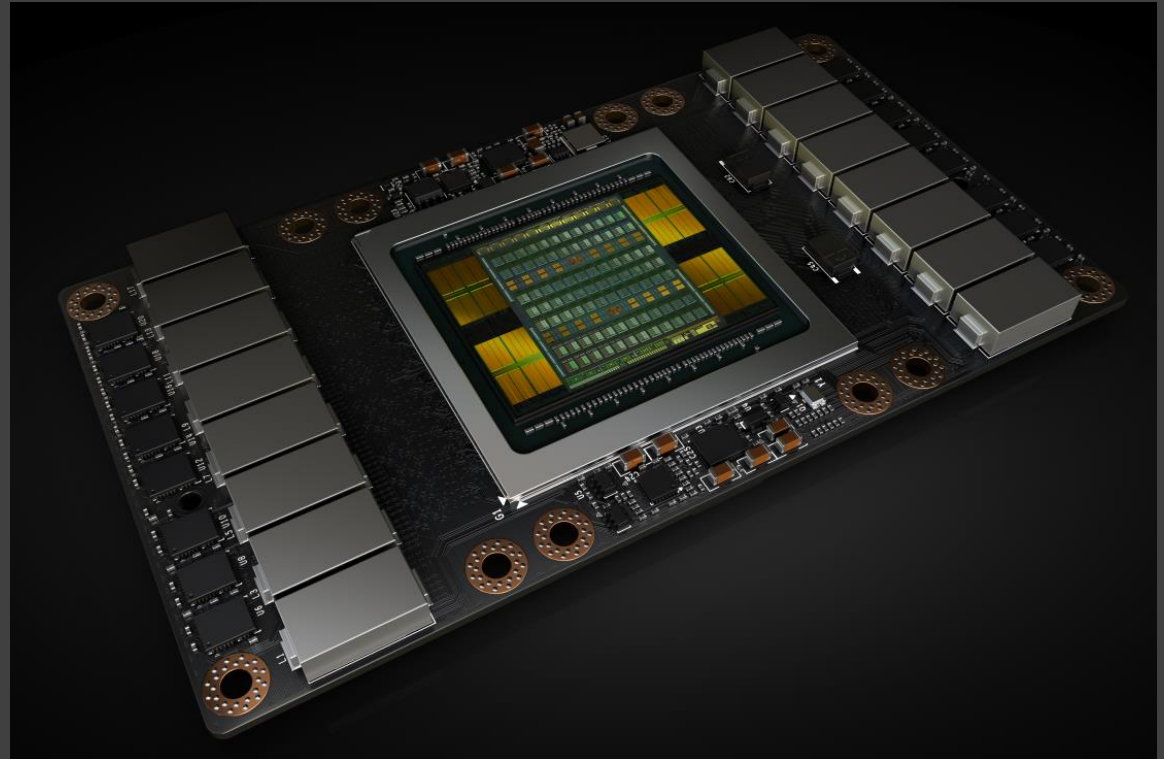


# NVIDIA VOLTA

## An Architecture for Machine Learning

# NVIDIA VOLTA GPU: KEY FEATURES

- Tensor Cores for deep learning
- 2<sup>nd</sup> generation NVIDIA NVLink
- HBM2 memory
- Cooperative groups
- Volta-optimized software



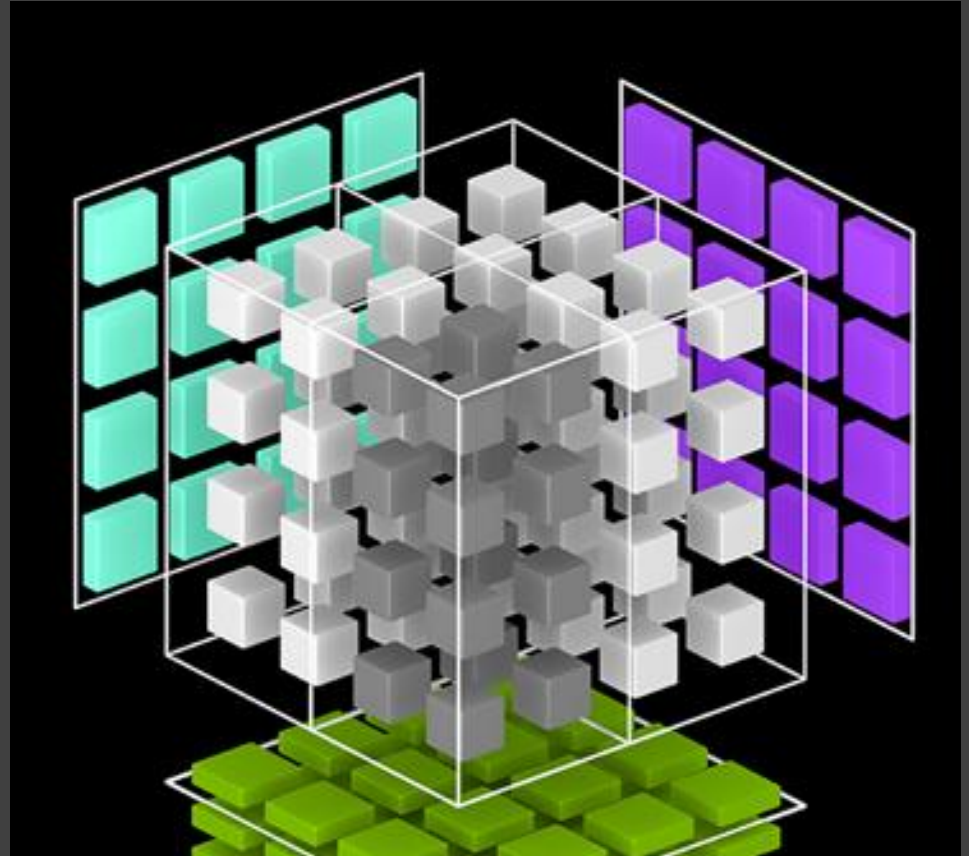
# TENSOR CORES

An Exponential Leap in Performance

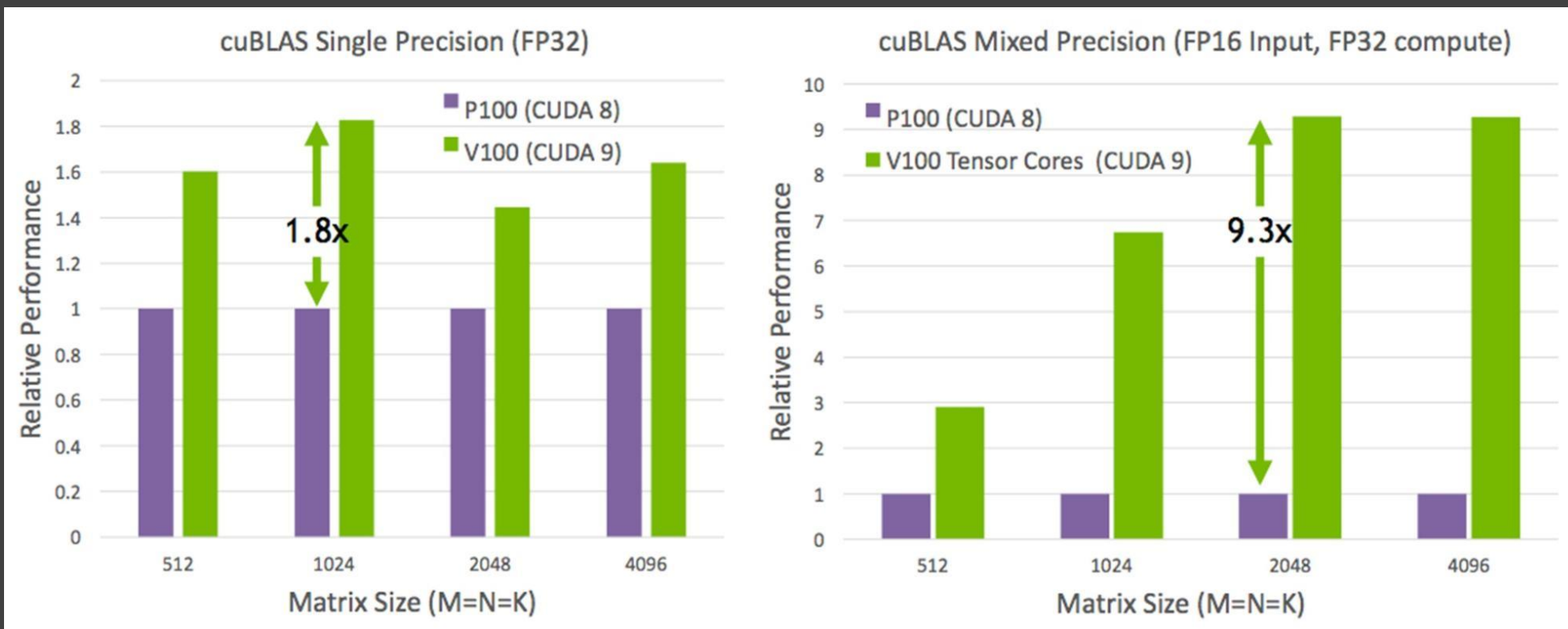
Equipped with **640** Tensor Cores

120T Tensor FLOPS

Over a 5X over NVIDIA Pascal™ architecture.



# TESLA V100 vs. TESLA P100





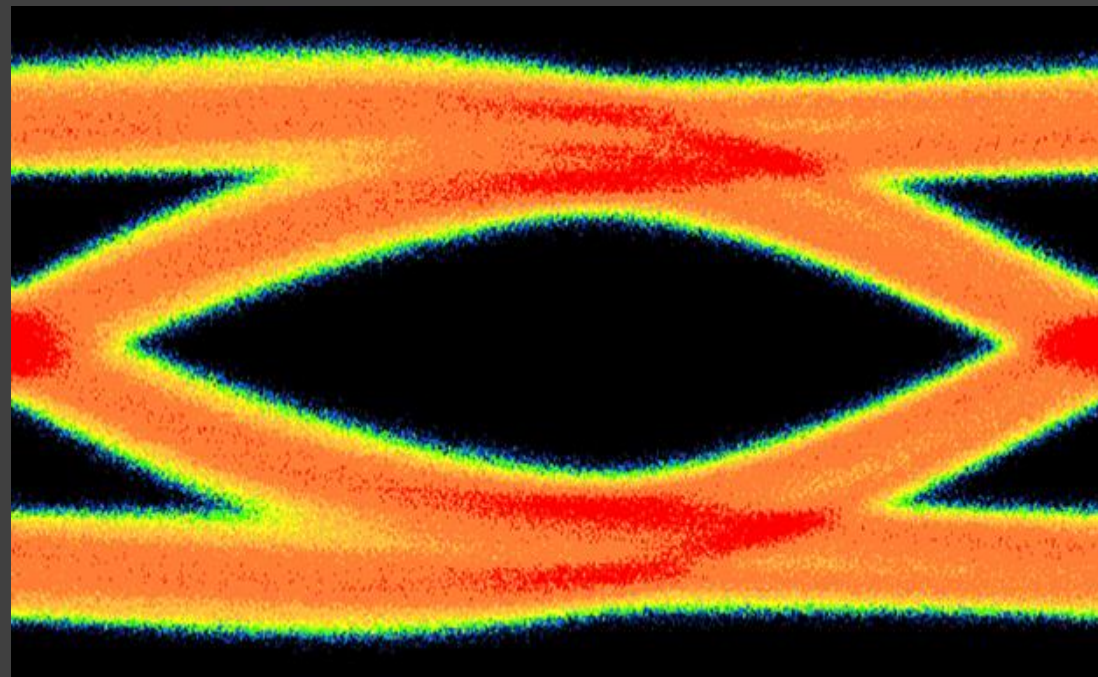
# 2<sup>ND</sup> GEN NVLINK

Scalability for Rapid Time-to-Solution

High-speed interconnect technology

2X throughput over previous gen

Enable large scale parallel computing

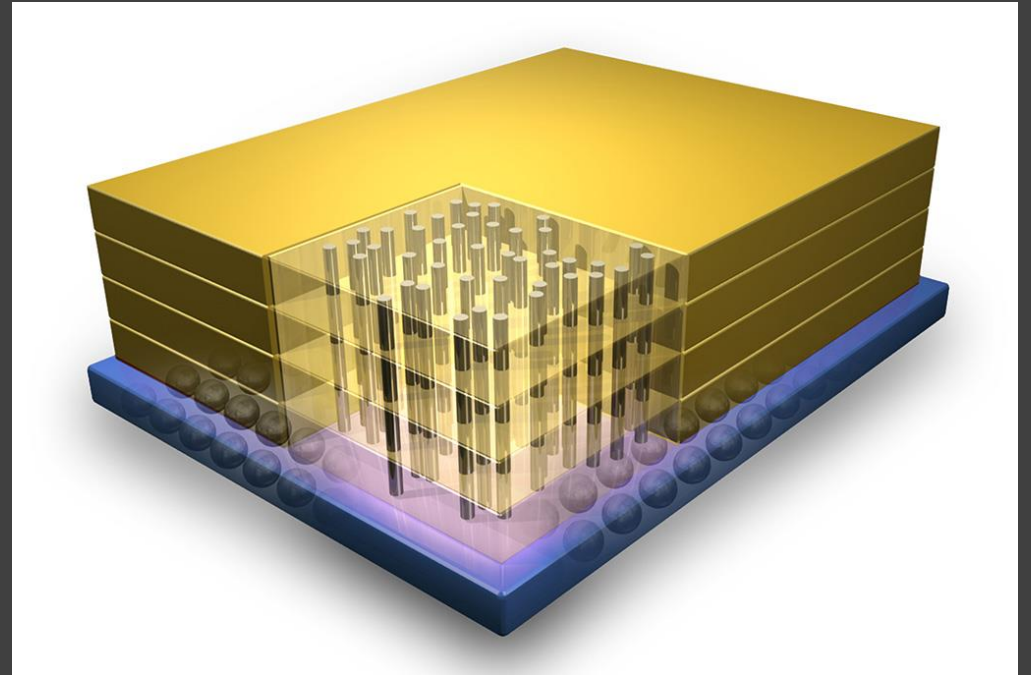


# HBM2 MEMORY

Faster, Higher Efficiency

16GB HBM2 memory

900 GB/sec peak bandwidth

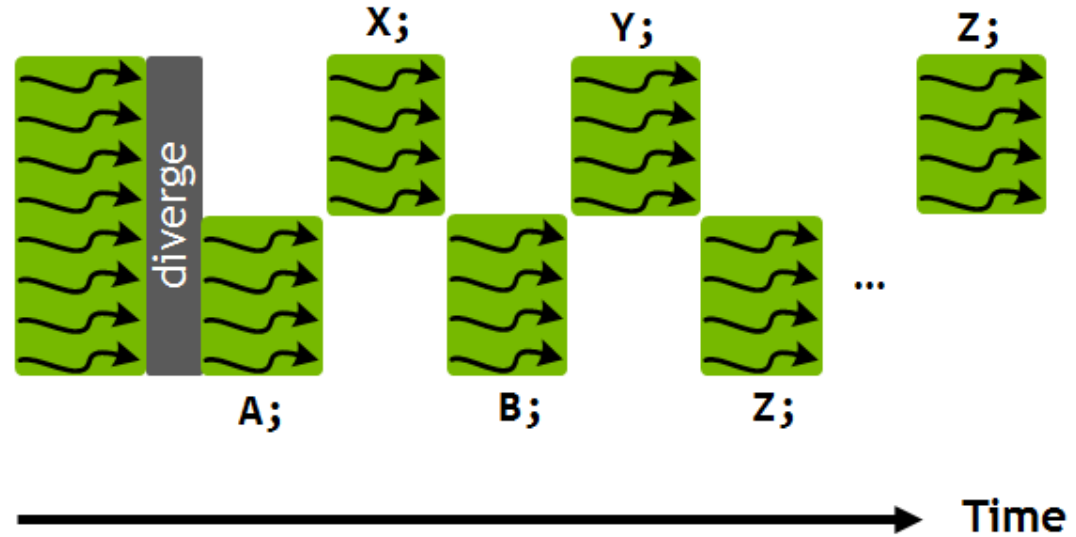


# COOPERATIVE GROUPS

New programming model in CUDA 9

Independent thread scheduling

New way for organizing groups of communicating threads



# VOLTA-OPTIMIZED SOFTWARE

GPU-Accelerated Frameworks and Applications

NVIDIA Deep Learning SDK libraries:

cuDNN, cuBLAS, NCCL, TensorRT







# NVIDIA GameWorks Materials & Textures

Game Content Creation by Machine Learning

# What is Machine Learning to Game Development?

## *Content Creation*

Better game assets with less effort

## *Game AI*

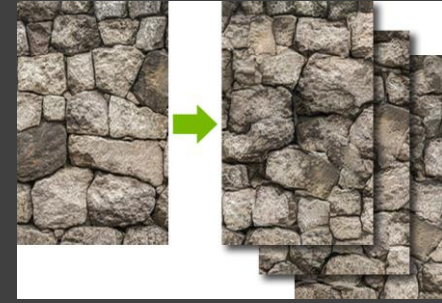
Bots are smarter and more fun

## *User Interface*

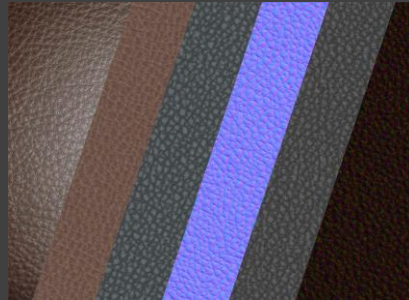
Innovative ways to interact



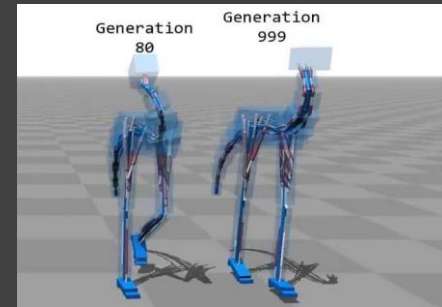
Super-Resolution



Texture Multiplier



Material from Photos



Physically Based Animation



Speech Synthesis



Human-like AI Player

# NVIDIA's Goal for Game Content Creation

Accelerate content creation

Remove the mundane/repetitive

Increase asset quality/realism

Promote creativity



## **GAMEWORKS RESEARCH**

300 world-class engineers at the intersection of art and science



## **GAMEWORKS LIBRARY**

Visual & physical simulation SDKs  
Technology, algorithms, engines, libraries



## **DEVELOPER TOOLS**

IDE-integrated and standalone  
Debuggers, profilers and utilities

# GameWorks: Materials & Textures

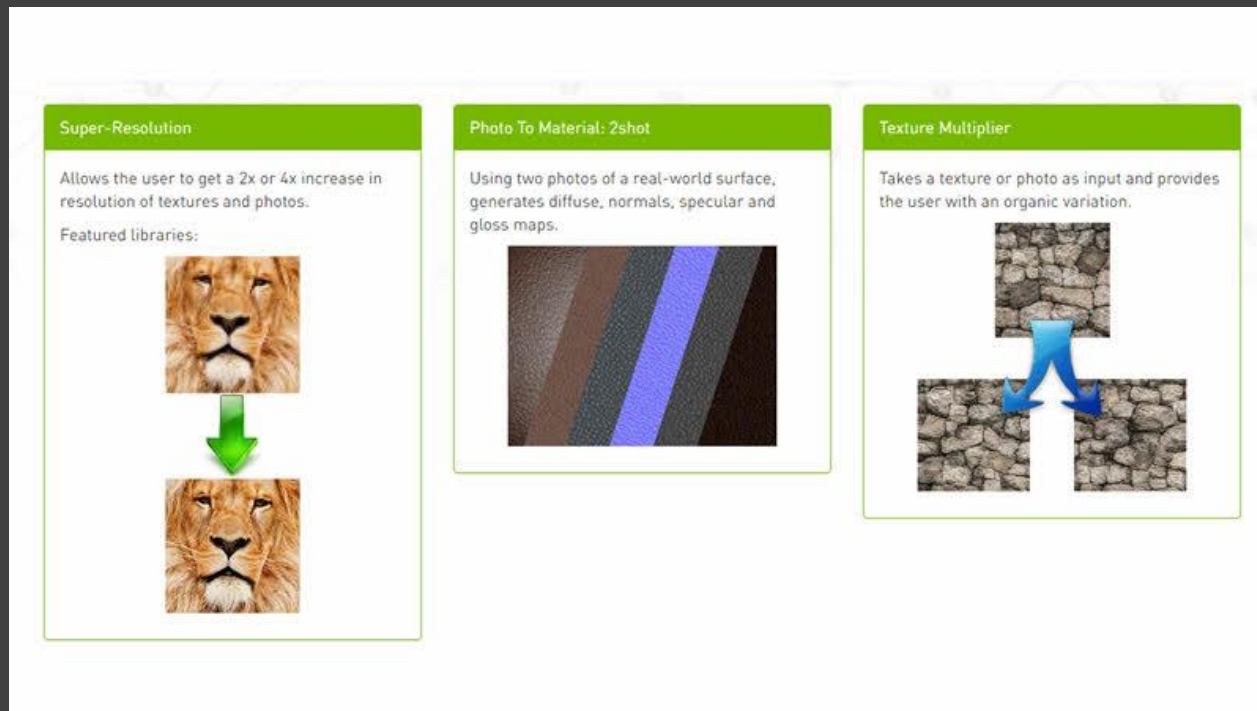
Set of tools targeting the game industry using machine learning

Tools in the initial release:

Photo To Material: 2shot

Super-resolution

Texture Multiplier



GameWorks Materials & Textures beta  
<https://gwmt.nvidia.com>



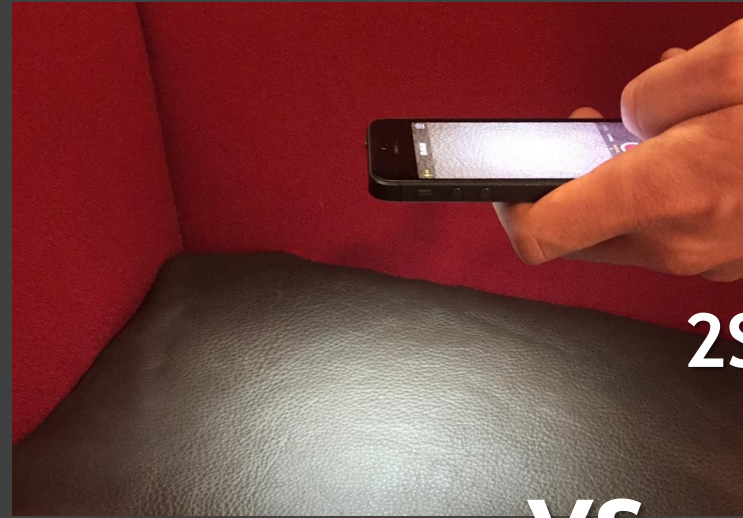
# Photo to Material: 2Shot

- Using CNN to generate PBR materials
- Two input photos:
  - Flash image (with flash)
  - Guide image (without flash)



# Photo to Material: 2Shot

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2Shot

VS.

Traditional

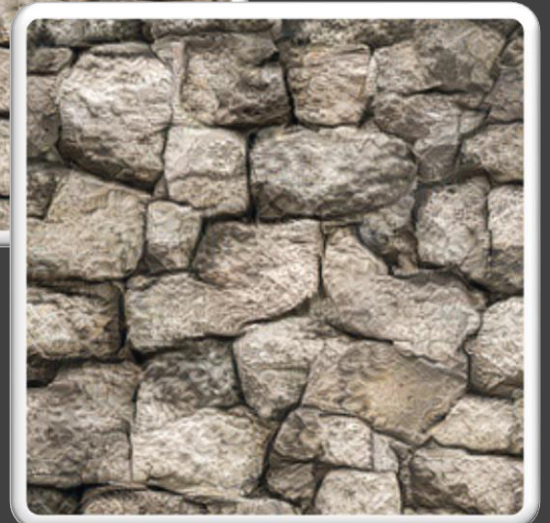




# Texture Multiplier

Example texture in, new  
textures out

Limitless images generated

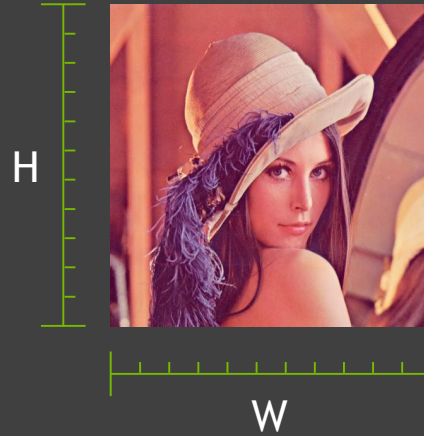


# Super-Resolution

Amplify the image by 2x or 4x  
using deep learning method

Far better quality than image  
filtering

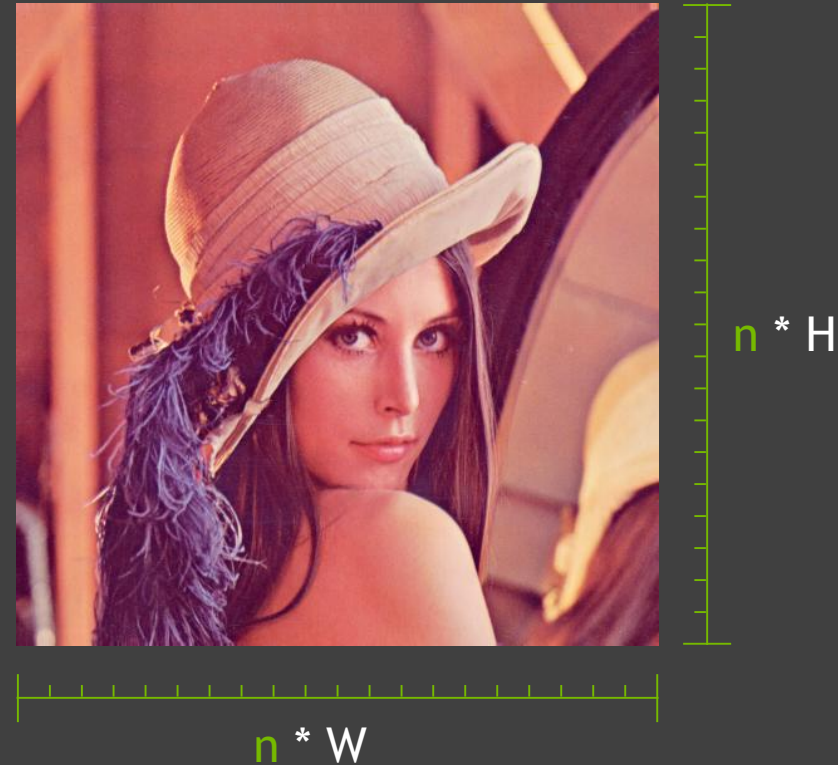
Given low-resolution image



Upscale

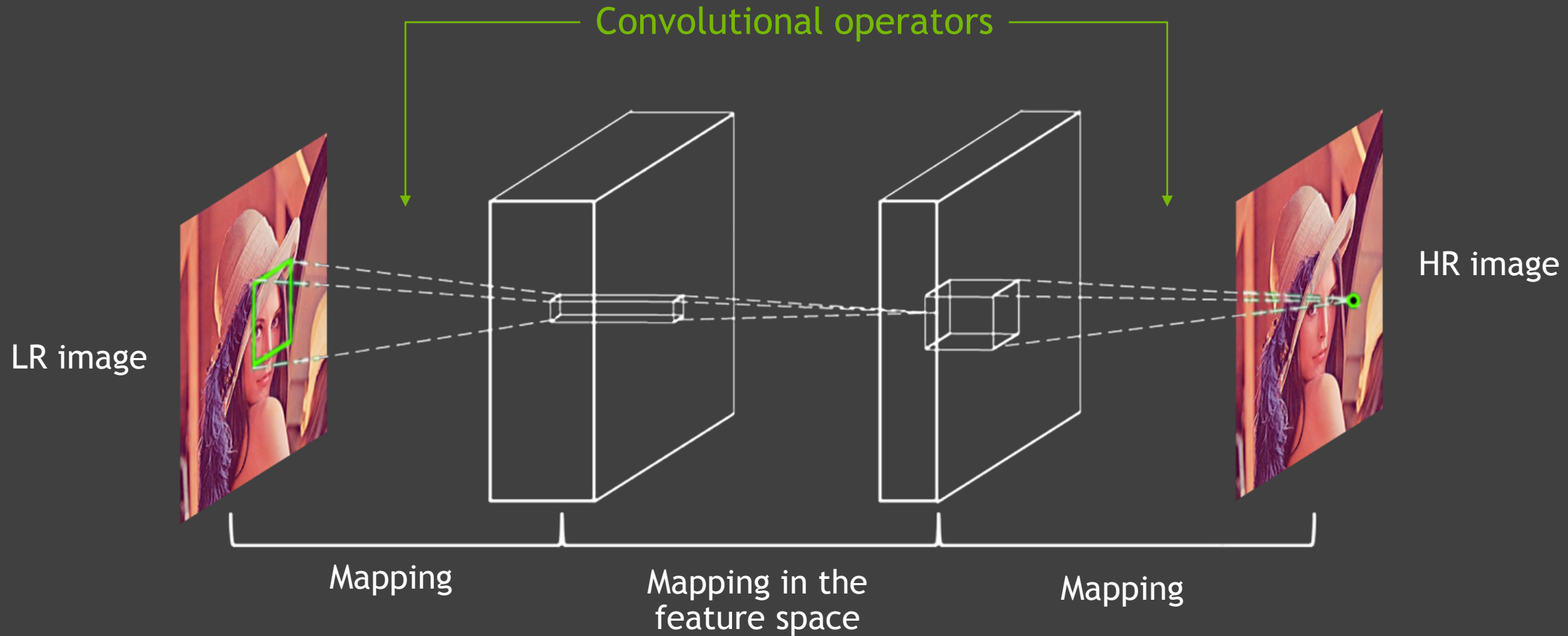


Constructed  
high-resolution image





# Super-Resolution Convolutional Auto-Encoder





<http://gwmt.nvidia.com>



# Project Isaac & Holodeck

## Machine Learning Beyond Games

# PROJECT ISAAC

Virtual Simulator for Robots

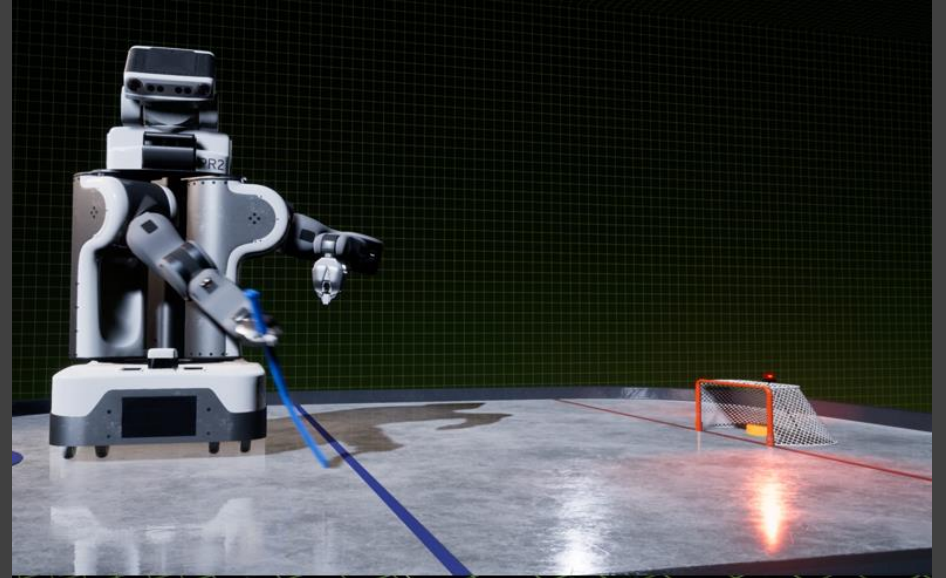




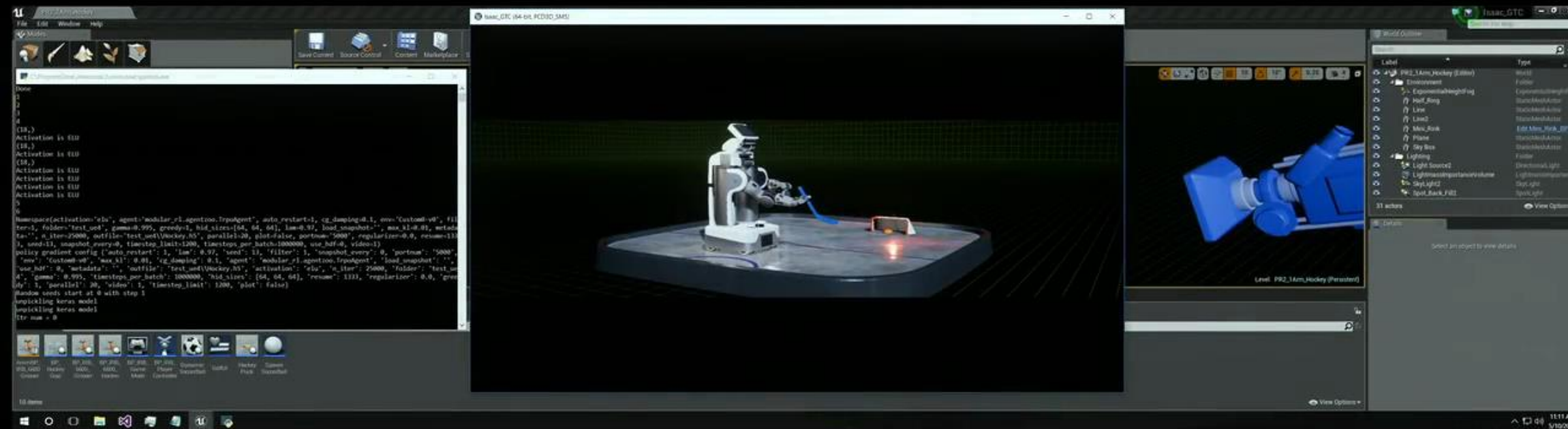
# Hockey Demo

Training: real world vs. virtual world

<https://www.nvidia.com/en-us/deep-learning-ai/industries/robotics/>



# **Real robot:** Power plug task



# ISAAC

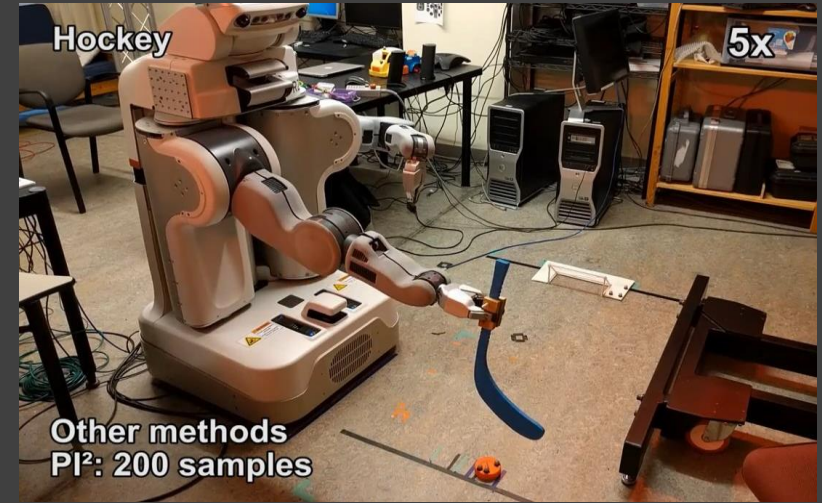
Training robots in the virtual world,  
downloading to the real world

The faster, safer, cheaper way to train robots

Faster - rapid domain adaptation

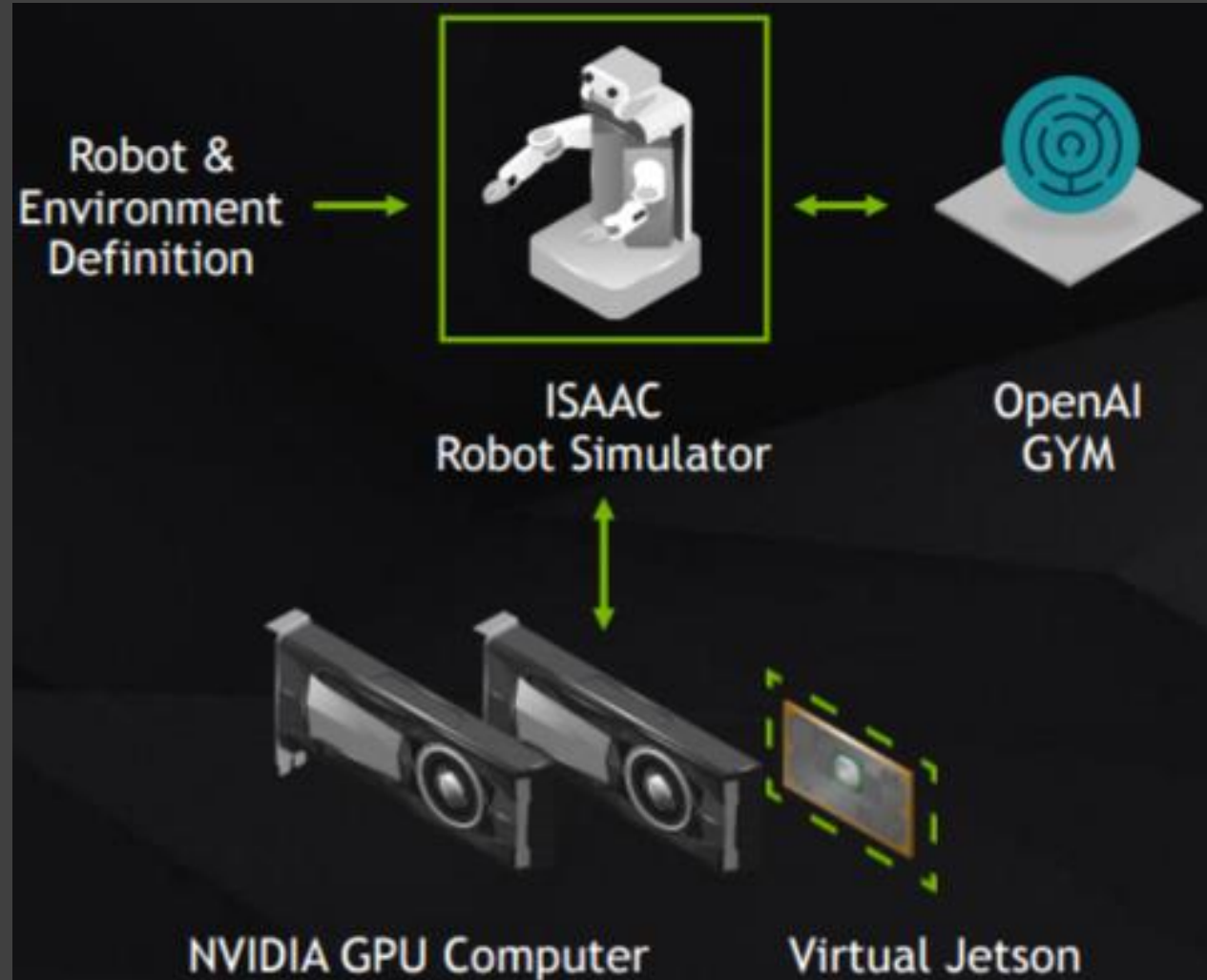
Safer - train scenarios difficult to do in  
real world

Cheaper - cost saving regression test and  
labelling



# The Robotic Simulator

1. The processor of NVIDIA Jetson TX
2. The software stack for perceive, localize, plan and take action
3. Isaac Lab - a real world simulator
4. A collection of reference platforms like drones and submersibles





# Isaac Lab

Training in the virtual world

## DNN / Compute platform

OpenAI Gym

Ease transition from training to inference

## Rendering

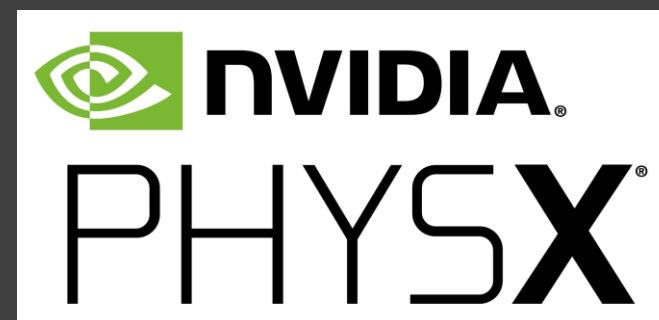
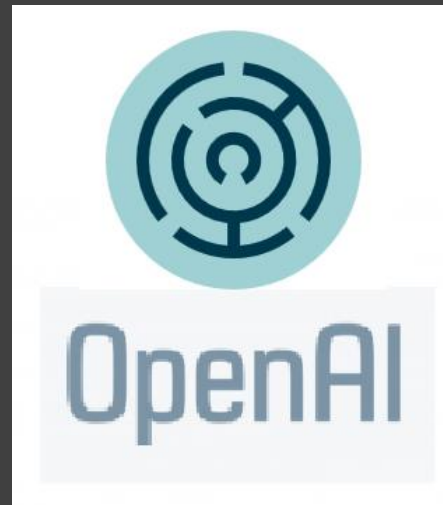
Customized UE4

Camera, lidar, radar sensing and segmentation

## Physical Simulation

PhysX

Hardware-accelerated simulation in the cloud



# Jetson Reference Platform

Downloading to the real world

Transfer training result to real world

Quick iteration on tuning final products

## Open-sourced robotic platforms

Various drones, submersibles, wheeled robots for developers to create & test prototypes

### NVIDIA® JETSON™ REFERENCE PLATFORMS



TEAL  
CONSUMER DRONE



LAB  
UGV



TOYOTA  
HUMAN SUPPORT ROBOT



LAB  
UAV



LAB  
USV



RACECAR/J  
RC CAR

# PROJECT HOLODECK



# Koenigsegg Regera Demo

Holodeck makes it easy to import render enormous models.

The Koenigsegg Regera supercar contains 50 million polygons.

<http://www.nvidia.com/object/nvidia-project-holodeck-notify-me.html>







# Holodeck

Photorealistic, Collaborative VR

Sight, sound and haptics

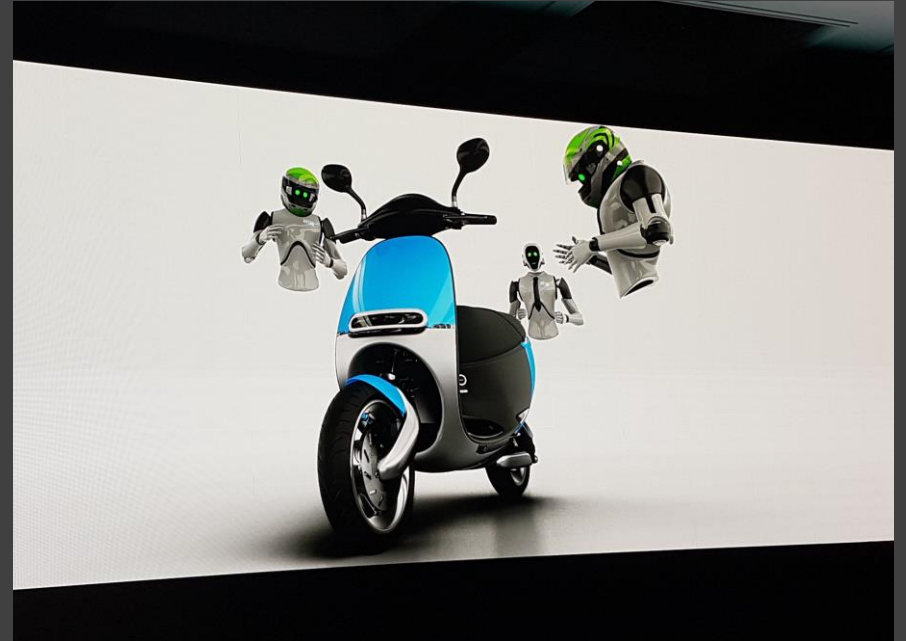
Headset & gloves

Models and physics

Built on UE4 and utilizing GameWorks, VRWorks  
and DesignWorks

Interaction and collaboration

Machine learning for posture recognition





# WRAP-UP: GAMES AND BEYOND

# THANK YOU!

