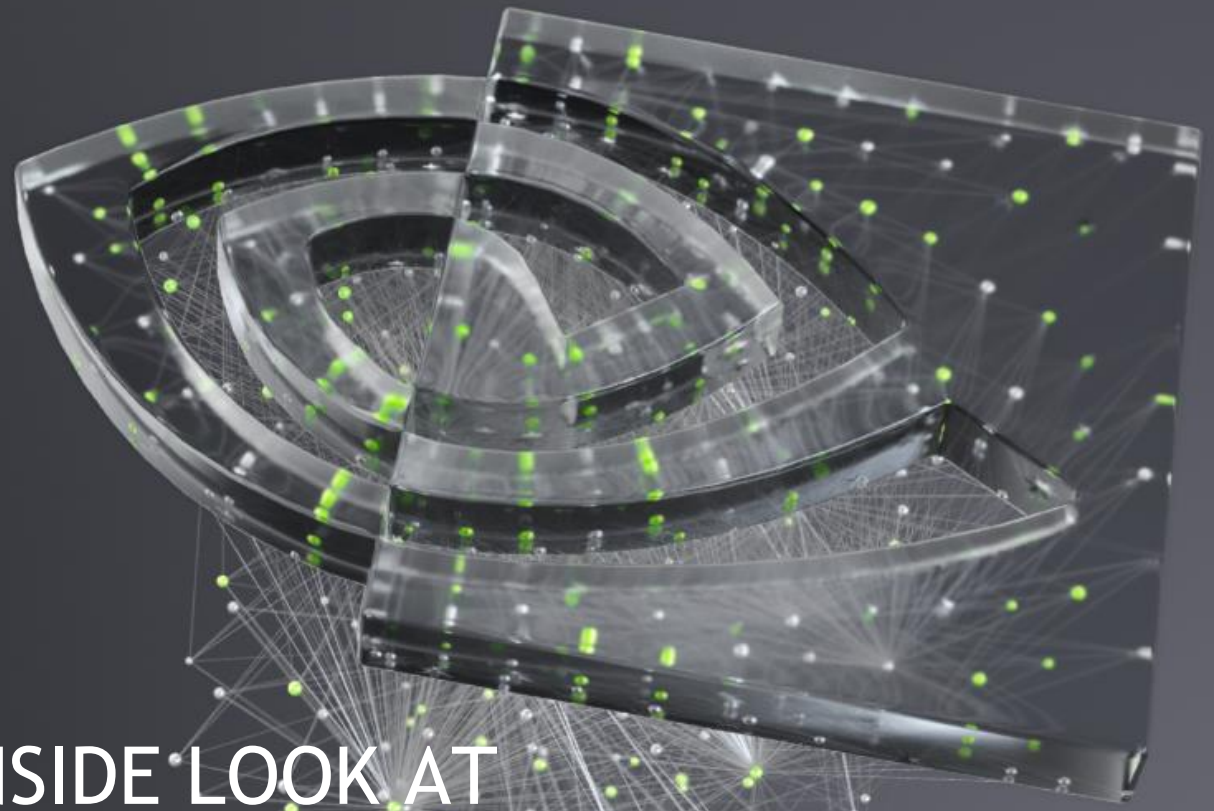
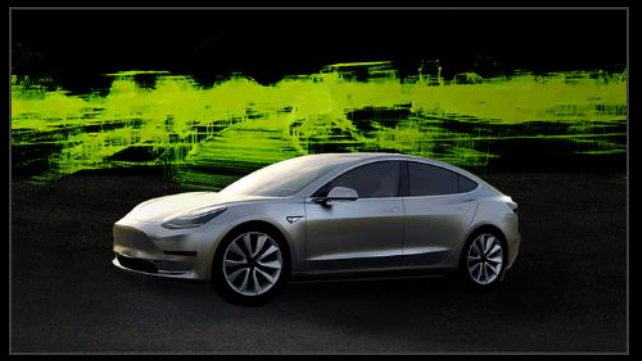


NVIDIA DRIVE LABS: AN INSIDE LOOK AT AUTONOMOUS VEHICLES SOFTWARE

Neda Cvijetic| Senior Manager, Autonomous Vehicles

April 1, 2020

$10T TRANSPORTATION INDUSTRY



1B Cars on the Road

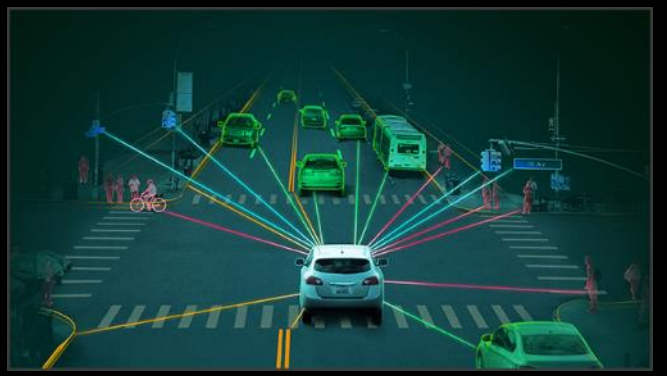
20M Rides per Day

300M Trucks — 1.2T Miles per Year

500K Buses in Operation

AI IS THE SOLUTION TO SELF-DRIVING

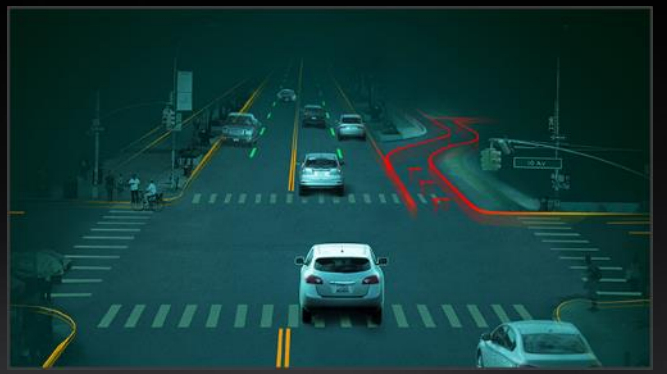
Perception



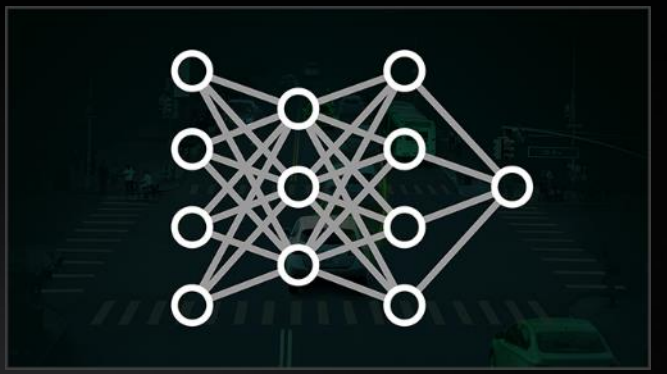
Reasoning

Driving

HD Map



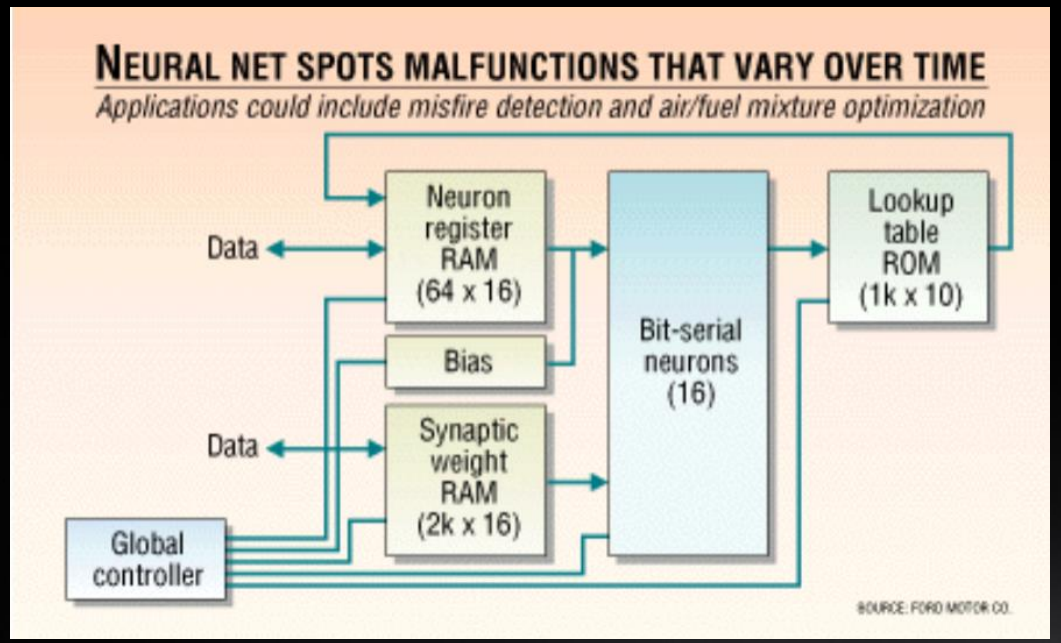
Mapping



AI Computing

NEURAL NETWORKS IN AUTOMOTIVE

Neural Networks are Not New in Automotive

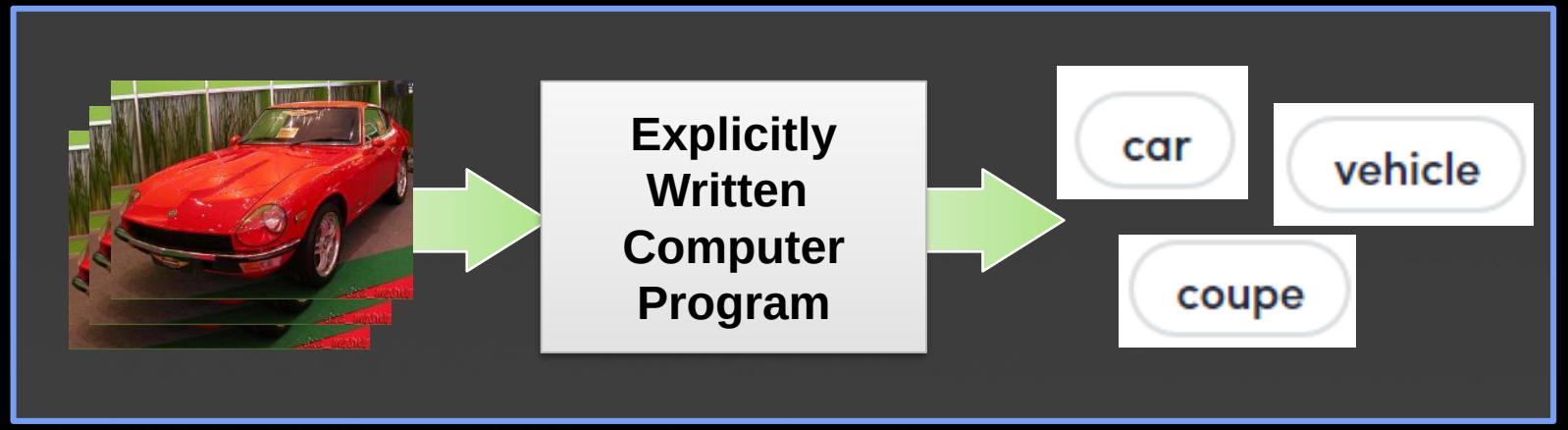


- From the early 1990s
- Applied to:
  - Misfire detection
  - Air/fuel mixture optimization
  - Dynamic suspension control
- Ford licensed neural network IP from JPL in 1998 for powertrain

https://www.eetimes.com/document.asp?doc_id=1138005

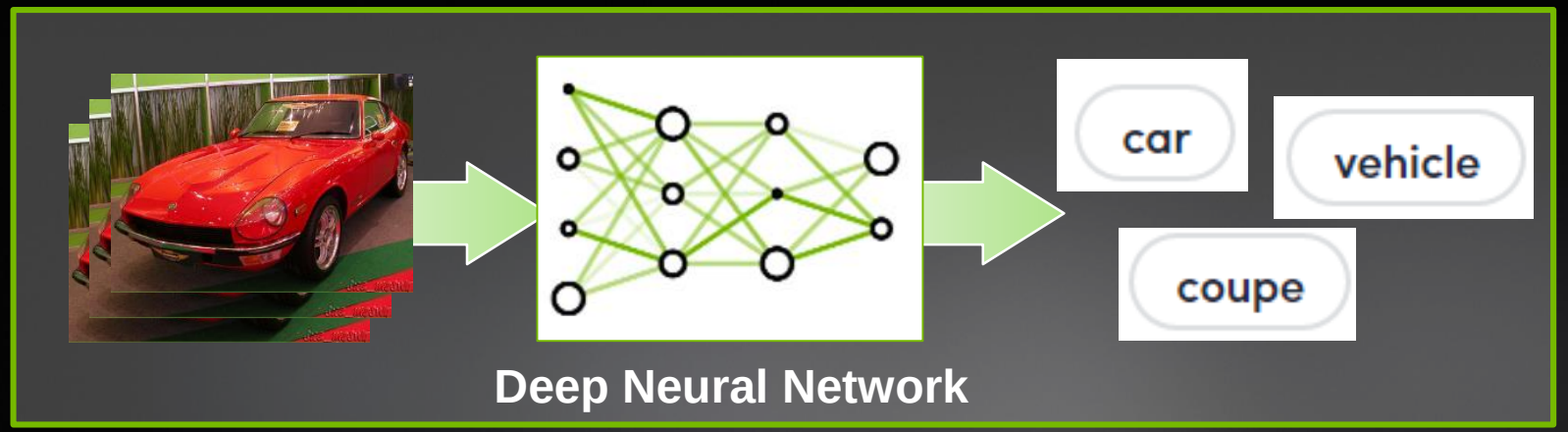
HOW DOES A DNN WORK?

Learning from Examples



Traditional Approach

- Time consuming
- Error prone
- Not scalable to new problems



Deep Learning Approach

- Learn from data
- Easily extended
- Speedup with GPUs

HOW A DEEP NEURAL NETWORK SEES

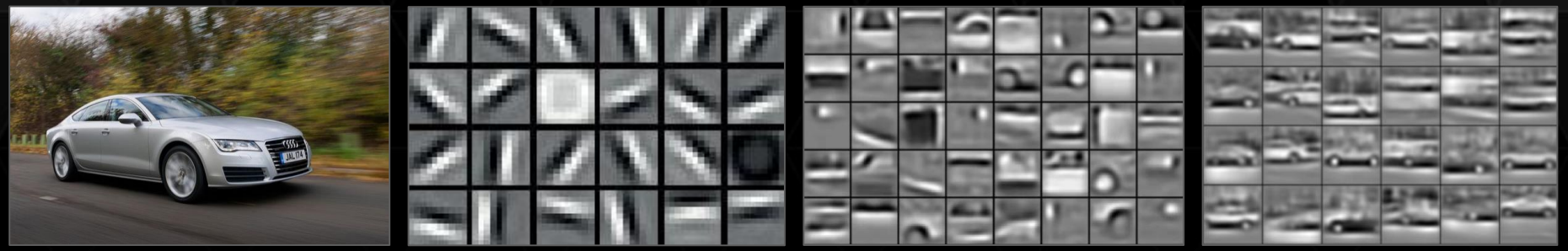


Image source: "Unsupervised Learning of Hierarchical Representations with Convolutional Deep Belief Networks" ICML 2009 & Comm. ACM 2011. Honglak Lee, Roger Grosse, Rajesh Ranganath, and Andrew Ng.

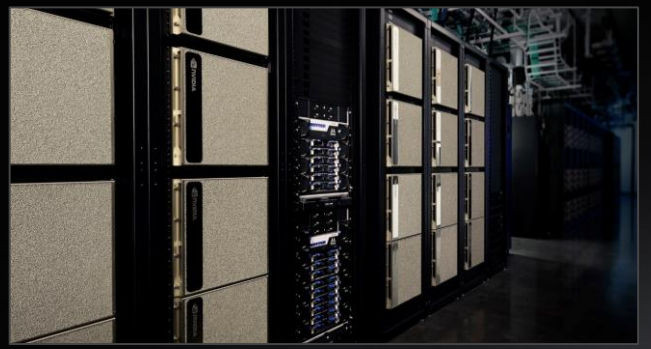
AV CHALLENGES & PAIN POINTS

50-Car Fleet Driving 6 Hours/Day Generates 1.6PB Each Day

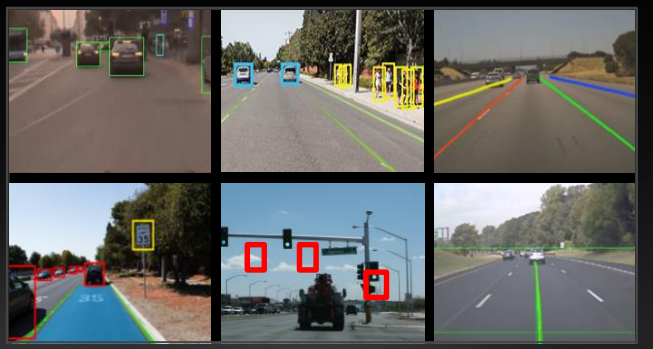
Ingestion
1.6PB/day needs to be transported,
encoded, and stored.

Curation
Billions of frames.
Find the 10% that are useful.

Labeling
Manage 1,000+ workers with 50+ projects.
Ensure quality every frame.



Training
20+ models. 100s Engineers,
Optimize models w/ 50+ parallel experiments.



Replay
Test against 1,000s hours of sensor data.
Repeat daily.

Simulation
Drive millions of miles.
Find the most critical scenarios to test.

BUILDING AI IS HARD

Every neural net needs to handle 1,000s of conditions and geolocations.


Vehicles


Pedestrians


Bicycles


Animals


Hazards


Day


Twilight


Night


Lamps


Backlit


Clear


Cloudy


Rain


Fog

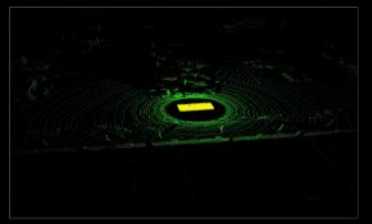

Snow


Perception


Free Space Perception


Distance Perception


Weather


LIDAR Perception


Camera-based Mapping


Camera Localization to HD Map

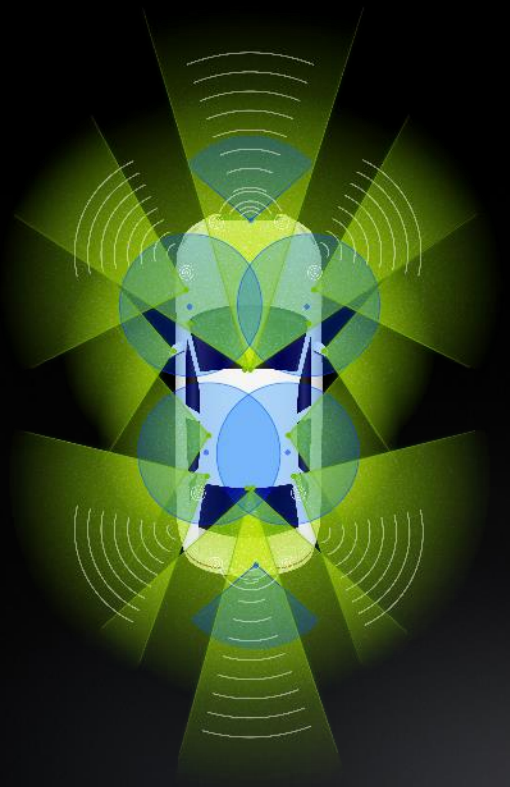

LIDAR Localization to HD Map


Path Perception

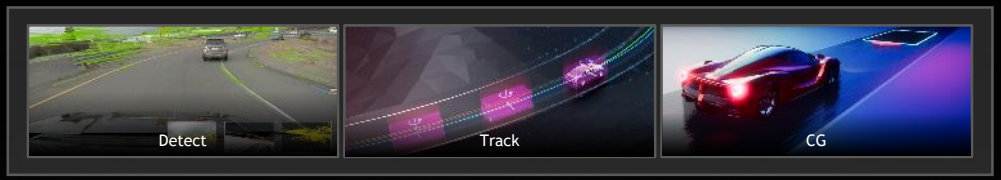

Scene Perception

FUTURE CAR IS SOFTWARE-DEFINED

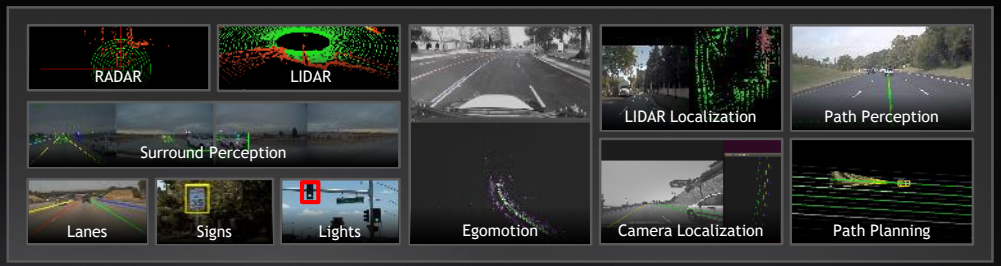
Powerful and Efficient AI, CV, AR, HPC | Rich Software Development Platform
Functional Safety | Open Platform



Assistive



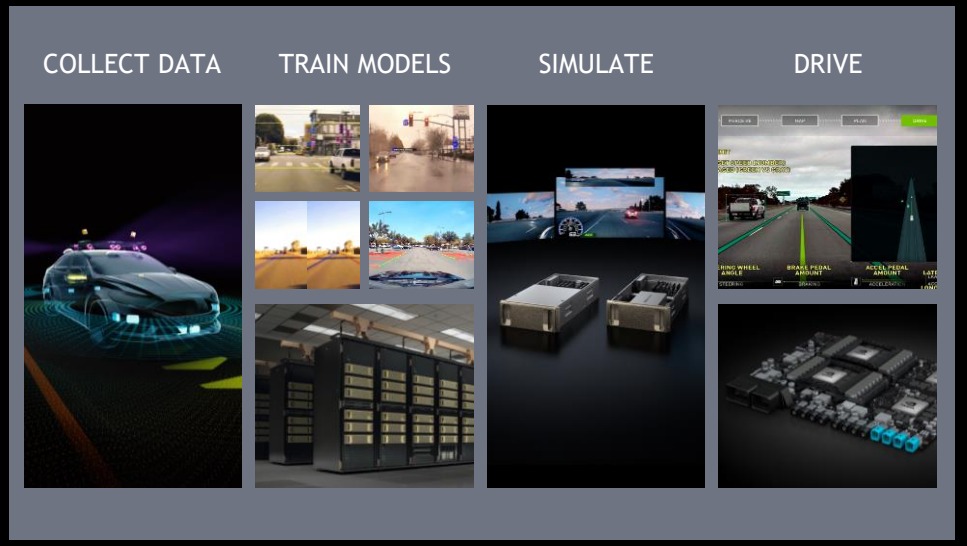
Augmented



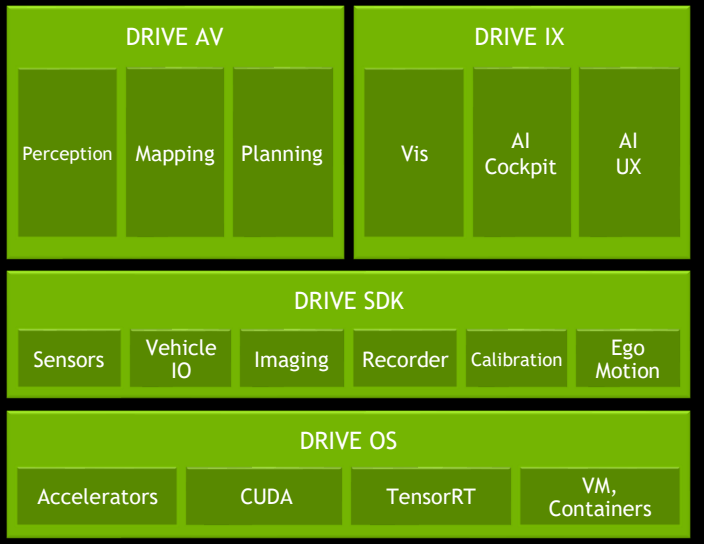
Autonomous

Safe

NVIDIA DRIVE — SOFTWARE-DEFINED AV PLATFORM



End-to-End Infrastructure



Open Software Platform

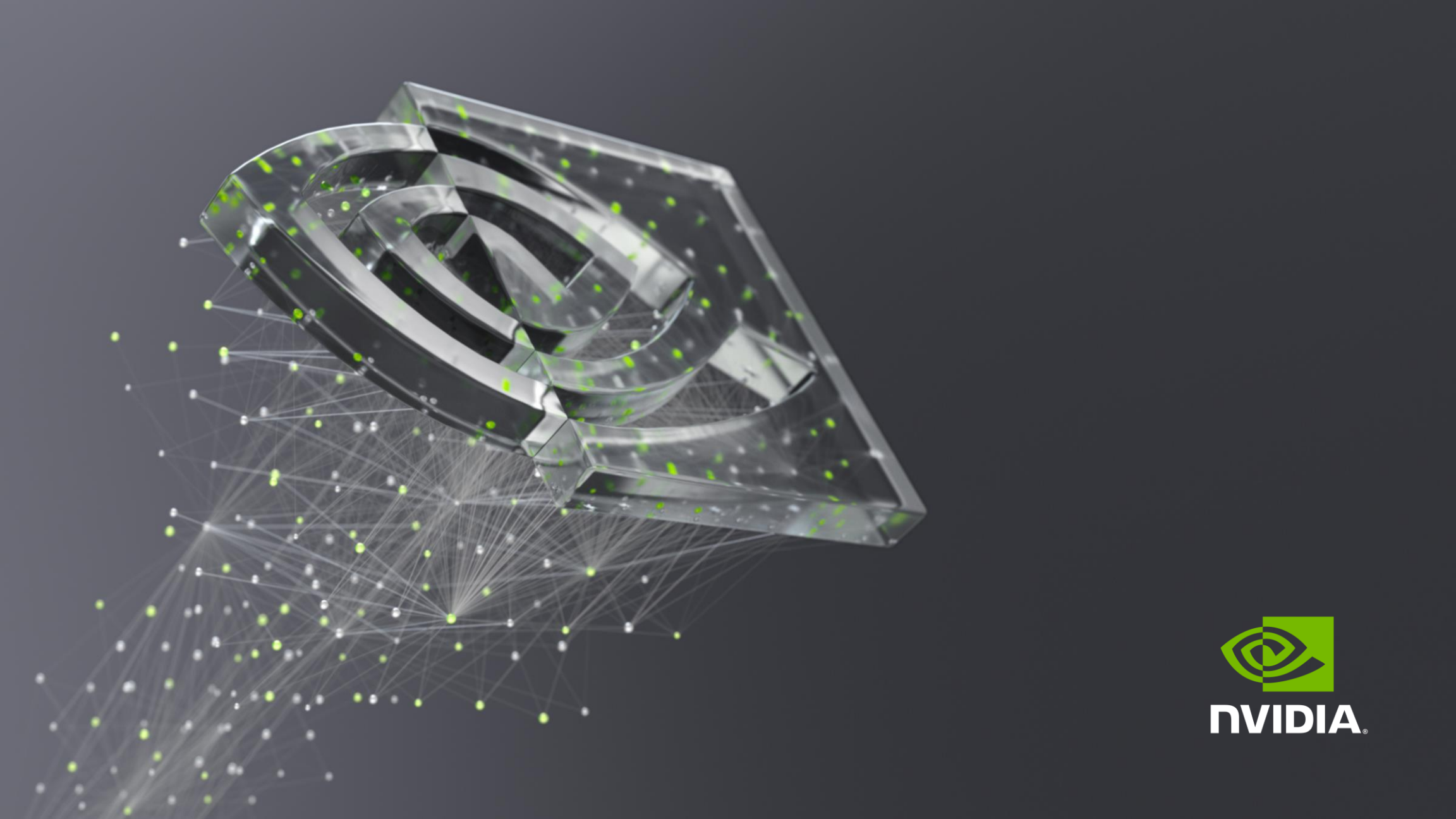
Pre-Trained Models

ADDITIONAL RESOURCES

NVIDIA Drive Labs website:
https://www.nvidia.com/en-us/self-driving-cars/drive-labs/

NVIDIA Drive Labs Youtube playlist:
https://www.youtube.com/watch?v=T7w-ZCVVUgM&list=PLZHnYvH1qtOYkElUMqYiHDMrGTPnqRhSr

NVIDIA AI Podcast episode:
https://soundcloud.com/theaipodcast/nvidias-neda-cvijetic-explains-the-science-behind-self-driving-cars-ep-108


NVIDIA