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*Autonomous Vehicles  
&  
Deep Learning*

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On behalf of Trevor Darrell and Tom West  
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*Redefining Mobility Summit, CCTA  
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# Deep Learning: A Buzzword

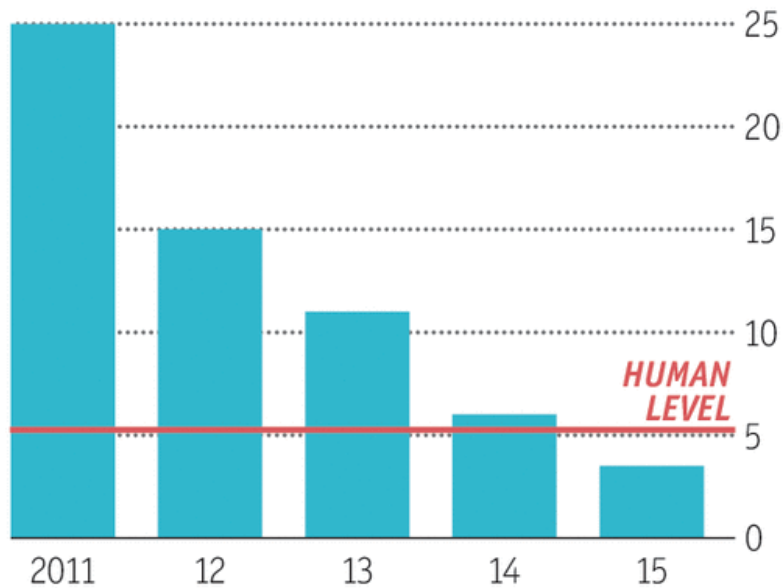
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- Alpha Go beating human chess champions
- Already broadly adopted at many high-tech companies
  - image processing, speech recognition, language translation, data analysis, etc.
- A cluster of start-ups
- A flurry of investments, notably by and in automotive industry
  - Toyota Research Institute \$1B on AI (11/2015)
  - Ford \$1B bet on Argo AI (02/2017)
  - Intel buys Mobileye \$15.3B (03/2017)

# Doing Better and Better With Deeper and Deeper Networks

## Ever cleverer

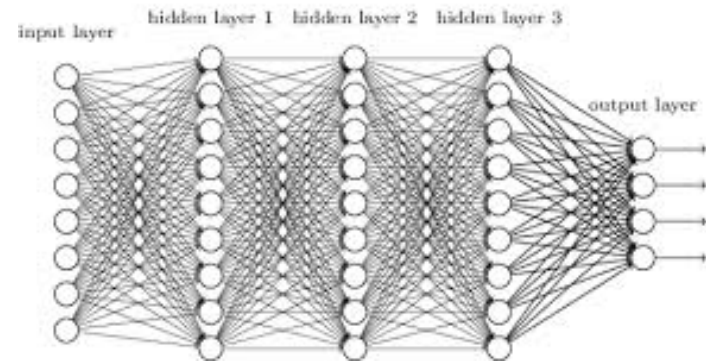
Error rates on ImageNet Visual Recognition Challenge, %



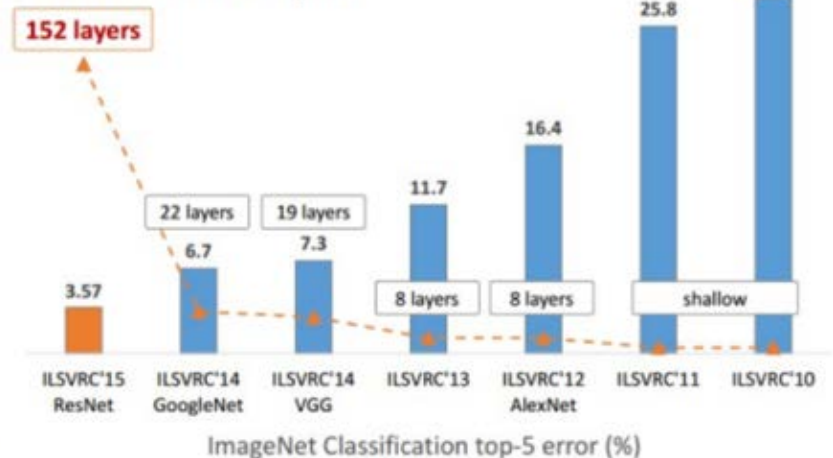
Sources: ImageNet; Stanford Vision Lab

Economist.com

Deep neural network



Revolution of Depth



Microsoft Research

# Cambrian Explosion in Computer Vision & AI

## *Driverless Car, Hod Lipson and Melba Kurman*

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- Life forms were simple and **blind** before the Cambrian explosion, 541 millions years ago.
- Over the next few million years, diversification accelerates and life-forms began to resemble organisms that make up the world we are familiar today.
- “**Visual system**” is the light-switch that turns on the rapid pace of evolution.
- Evolution is composed of long intervals of near-stasis punctuated by short periods of rapid change. (Steven Jay Gould, Harry Whittington, Niles Eldredge)
- Are we at the crossroads of this **punctuated equilibrium in machine intelligence**?

# Large-scale *Semantic Description*



Object Detection

...

Source:  
Trevor Darrell  
presentation

# Large-scale *Semantic Description*



Object Detection  
Semantic Segmentation  
Pose Estimation  
Attribute Classification  
Fine-Grained Recognition  
Action Recognition

...



# Hypothetically,

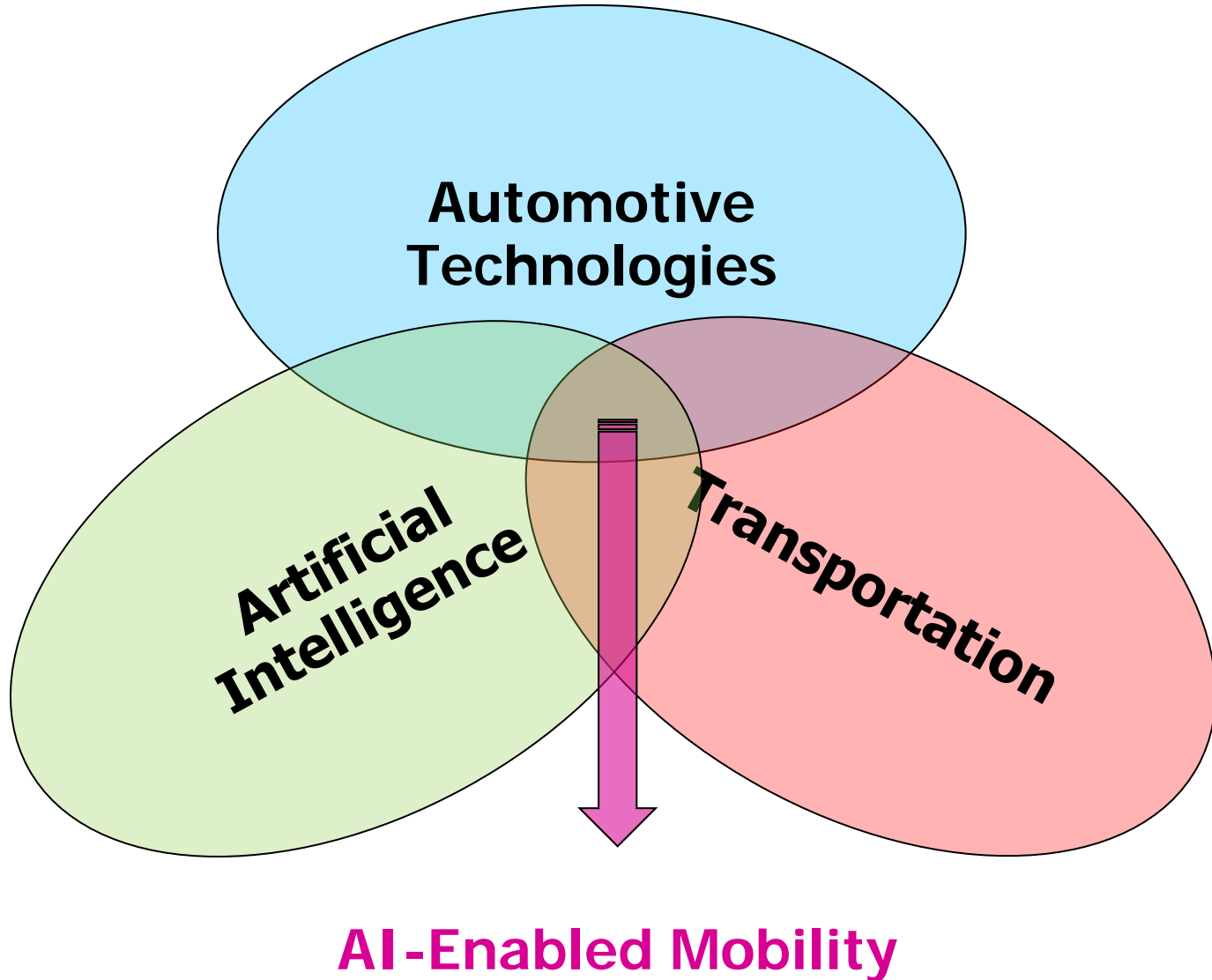
- **Recent Tesla Incident (May 2016, Florida)**
  - **Supposedly, the Tesla (camera + radar) sensor did not recognize the “side of truck” versus the background sky;**



- **Can a “deep learning” system recognize an object that does “not look the same” as a previously seen (trained) target?**

# When AI Meets Automobile

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# Berkeley Deep Drive

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- Headed by Prof. Trevor Darrell, EECS, UC Berkeley
- Current members include:
  - Automakers:
    - Audi/VW, Ford, GM, Honda, Hyundai, Toyota
  - System providers:
    - Bosch, Huawei, Panasonic, Sony,
  - Technology providers:
    - Google X, Mapillary, Nexar
    - Nvidia, NXP, Qualcomm, Samsung

# Berkeley Deep Drive

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## A Research Alliance

to Investigate State-of-the-Art Technologies  
in Computer Vision and Machine Learning  
for Automotive Applications

## Pushing the scientific forefronts of

- Computer Vision/Autonomous Perception
- Automated Driving Systems
- Robotics
- A.I./Machine Learning

# Future of AI/Deep Learning

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- **A progressive but accelerating enabler**
- **A worldwide community**
- **Deep Learning for image, speech, and language applications already widely deployed**
- **Bright Prospects for automated driving, medical imaging, robotics, etc.**
- **Probably still a way to go before truly intelligent machines rule the world.**

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Thank You

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