

# The Tale of Big Data, Machine Learning, and Artificial Intelligence

*VSLab*

清大電機

孫民

# Goal

**“big data being the source, machine learning being the technique, and AI being the outcome”**

by Prof. Hsuan-Tien Lin at IEEE BigData 2016

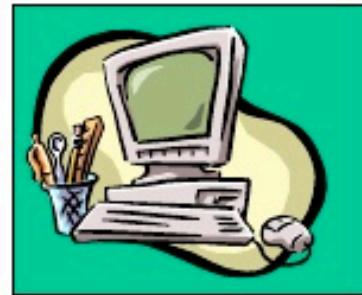
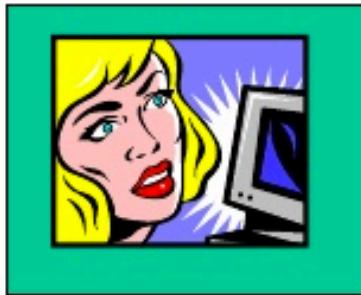
Many kinds of **source (data)** and **outcomes (AI tasks)** can be trained end-to-end using **Deep Learning (DL) – one kind of Machine Learning**

# Artificial Intelligence (AI)

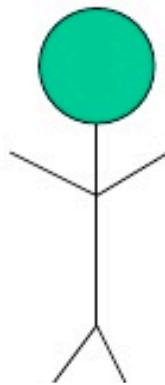
- Artificial intelligence (AI) is the **intelligence** exhibited by **machines or software**. It is also the name of the academic field which studies how to create **computers** and **computer software** that are capable of **intelligent** behavior

**What is intelligent?**

# Classical AI Tests: Turing Test



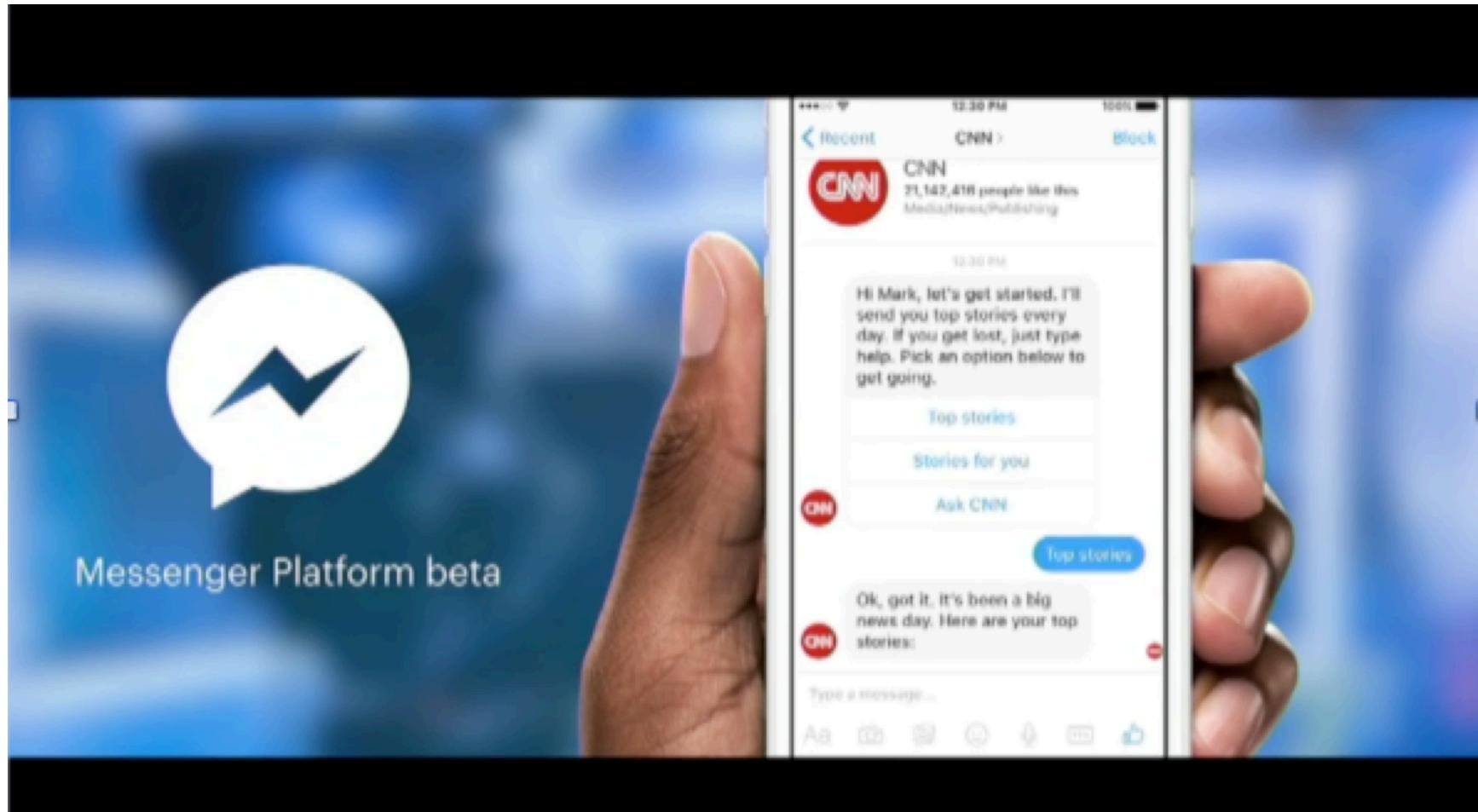
Judge



What color and in what style is your hair?

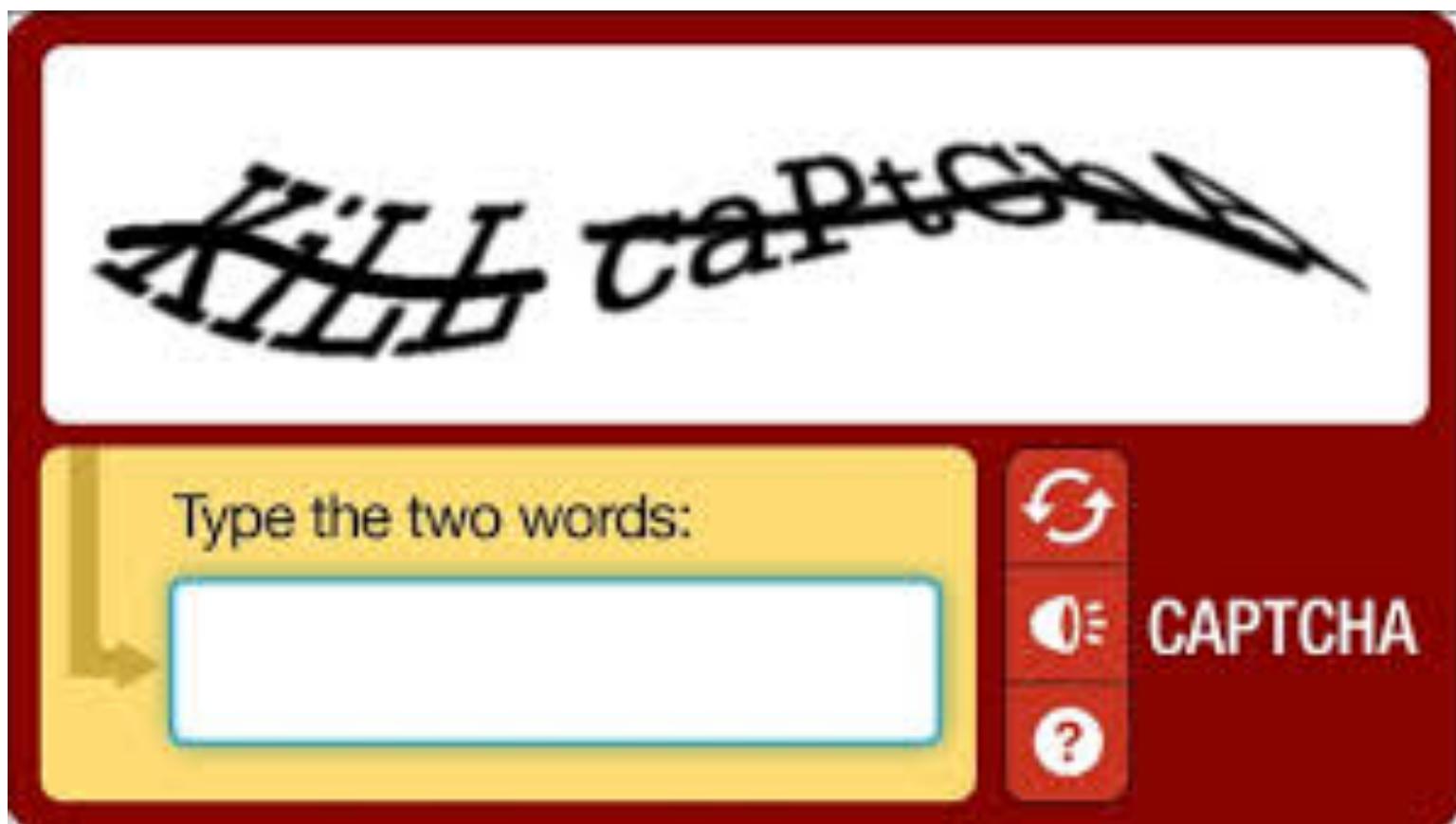
by Alan Turing in 1950

# Chatbot@F8



<https://developers.facebook.com/videos/f8-2016/keynote/>

# Classical AI Tests: CAPTCHA

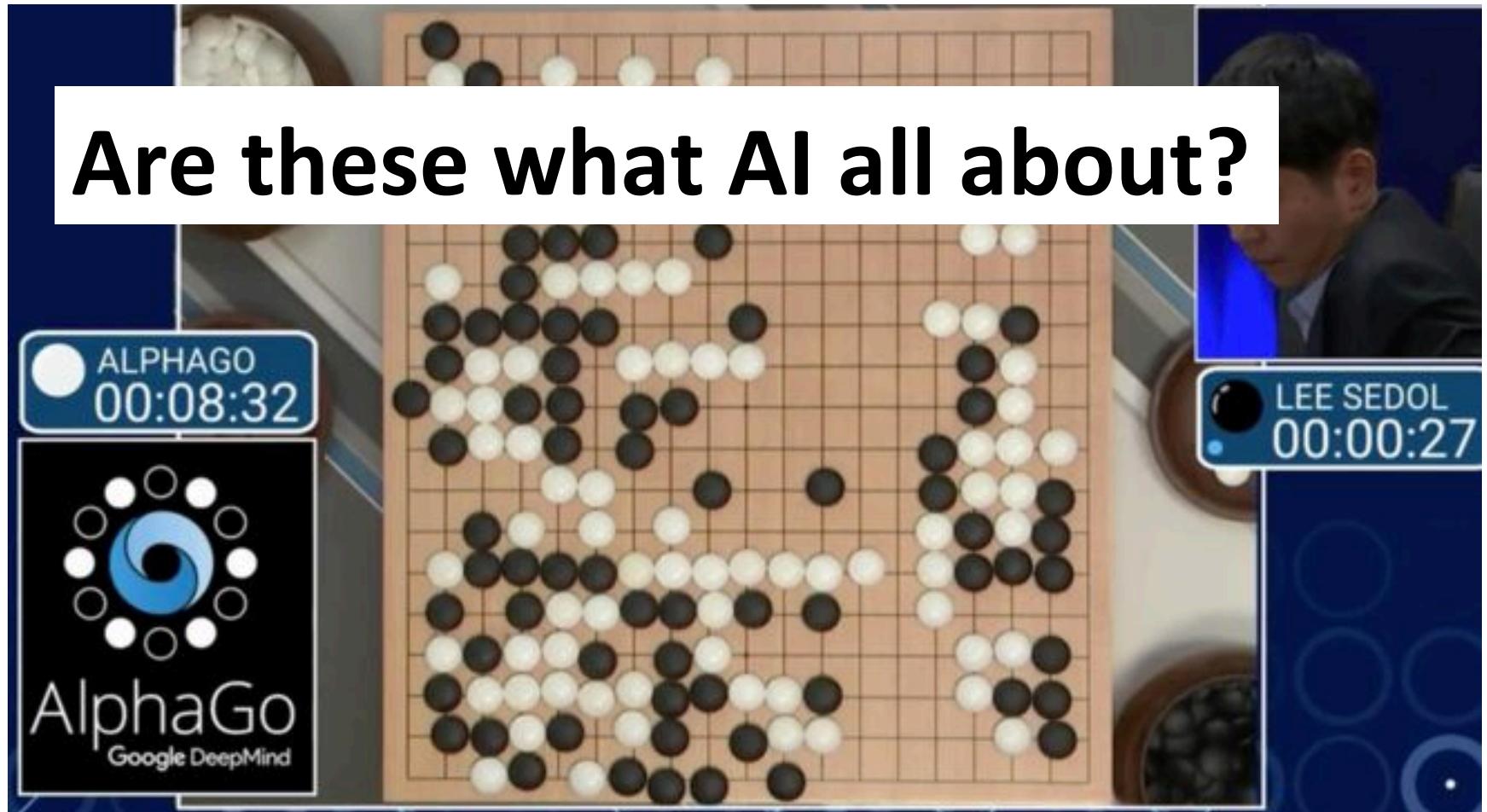


# Breaking CAPTCHA



by [vicarious.com](http://vicarious.com)

# AlphaGo



2016 by Google DeepMind

# Machine Intelligence LANDSCAPE

## Subfields of AI

2014

### CORE TECHNOLOGIES

ARTIFICIAL INTELLIGENCE	DEEP LEARNING	MACHINE LEARNING	NLP PLATFORMS	PREDICTIVE APIs	IMAGE RECOGNITION	SPEECH RECOGNITION				
IBM Watson Alimentary Cycorp Research Reactor	MetaMind ai-one facebook Google SKYMIIND	Vicarious facebook Google Baidu ersatz SignalSense	rapidsniper oxidata Littler Audeo ML GraphLab	context DATA.RPM Amplifire Audeo Sense GraphLab	cortollo idibon LUMINOSO Maluuba	wit.ai	AlchemyAPI Google ALGORITHMIA PredictionIO	MINDIPS bigML Indico Expect Labs	clarifai MADBTS DNNresearch DEXTERO VISENZE lockflow	GRIDSPACE popUP archive NUANCE

### RETHINKING ENTERPRISE

SALES	SECURITY / AUTHENTICATION	FRAUD DETECTION	HR / RECRUITING	MARKETING	PERSONAL ASSISTANT	INTELLIGENCE TOOLS				
Preact RelateIQ CLEARSKY Infer	AVISO NGDATA FRAME CYLANCE	CROSSMATCH SYNTHETIC CYLANCE BITSIGHT blonym	sift science ThreatMetrix Brighterion	SOCURE feedzai VERIFIN	TalentBin entelo predikt Connectifier gild hiQ connectiq	brightfunnel CommandIQ RADIUS Talk Apart	AIRPR people pattern Predictor	Siri Cortana tempo	Google now cleversense Rebinlabs	ADATO Quid Digital Reasoning

### RETHINKING INDUSTRIES

ADTECH	AGRICULTURE	EDUCATION	FINANCE	LEGAL	MANUFACTURING	MEDICAL
METAMARKETS distillery rocketfuel YieldMo ADBRAND	BLUEBIRD Terension cores imaging HOME LOGIC THE CLIMATE CORPORATION tule	declarative KNEWTON	coursera alphaSense Dataminr	Lex Machina brightleaf COUNSELYTICS JUDICATA Brevia	SIGHT MACHINE MICROSCAN IVISYS	Parzival ZEPHYR HEALTH GenoCloud Grand Rounds bing
kaggle AYASDI TACHYUS biota future	outbrain SAILTHRU newslet ARRIA OWIN Narrative Science SYNTHETIC Prismatic ai insite					

### RETHINKING HUMANS / HCI

AUGMENTED REALITY	GESTURAL COMPUTING	ROBOTICS	EMOTIONAL RECOGNITION	HARDWARE	DATA PREP	DATA COLLECTION
augmented intelligence APX blippar METRA layar	THALIMIUS SHUTTER iGySight GestureTek	omek LEAP 3Gear jibo anki	iRobot LEGO Mindstorms SoftBank Robotics emotient affectiva REMONDIS cogito	NVIDIA Qualcomm TRIMBLE rigetti	XILINX NEURONIAN	TRIFACTA tamr Alation

# MACHINE INTELLIGENCE 2.0

2015

## AGENTS

### PROFESSIONAL

Howdy! @clara  
KASIST® DigitalGenius  
OVERLAP.CC meekan  
fuse|machines PRIMER

### PERSONAL

facebook large  
assistant.ai @awesome

### OS INTERFACES

Siri VIV  
maluuba CogNEA Google Now

## AUTONOMOUS SYSTEMS

### AIR

3DR PROJECT LOON Google  
VERTICAL DroneDeploy  
AIRDOG SKYCATCH  
SKYDIO Airware

### GROUND

Google TESLA CRUISE  
MOBILEYE COMMA AdasWorks

### SEA

bluefin data BluHaptics

### INDUSTRIAL

KIVA Systems HARVEST AUTOMATION CLEARPATH  
AVIDBOTS ENERGID rethink robotics GREYORANGE OSARO

## ENTERPRISE

### SECURITY / FRAUD

Sentinel BITSIGHT feedzai AREA1  
drawbridge CYCLANCE Brightonter

### HR / RECRUITING

textio SpringRole entelo  
unifive

### SALES

Osense people pattern  
Preact Prism AVISO  
Vidora sentient  
 Gainsight

### MARKETING

LiftIgniter  
RADIUS brightfunnel  
 AIRPR

### CUSTOMER SUPPORT

CLARABRIDGE QUANTIFIND Wise.io  
ACTIONIQ FRAMED  
DigitalGenius

### INTERNAL INTEL

Alation Palantir sapho lucid  
Rainbird SKIPFLAG Agolgo  
Digital Reasoning Narrative Science

### MARKET INTEL

Quid DataFox bottlene PREMISE CB INSIGHTS

## PLATFORMS Artifical General Intelligence (AGI)

### RESEARCH / AGI

OpenAI Google DeepMind Numenta  
Cycorp SCALED INFERENCE GEOMETRIC INTELLIGENCE

### FULL STACK

context relevant   
 TERADEEP nervana SYSTEMS

### MACHINE LEARNING

Dato cortical.io AYASDI  
 Azure Machine Learning  
naralogics SKYTREE bigml blueyonder

### INDUSTRIAL IOT

ThingWorx IMUBIT Preferred Networks  
Alluvium PLANET OS

### AUDIO

Gridspace nexidia NUANCE Expect Labs  
popUP archive

### VISION

ORBITAL INSIGHT Descartes Labs cortica clarifai MetaMind

### DATA ENRICHMENT

diffbot TRIFACTA iDIBON WorkFusion CrowdFlower

## INDUSTRIES

### ADTECH

ROTHEREENT BEYONDVERBAL  
METAMARKETS rocketfuel affectiva

### AGRICULTURE

BLUE RIVER TerrAvion mavrX  
THE CLIMATE CORPORATION HONEYCOMB

### FOR GOOD

Conservation Metrics thorn

### RETAIL FINANCE

inVenture earnest MIRADOR  
Lendo LendUp

### LEGAL

Everlaw LEGAL ROBOT BEAGLE ROSS  
Lex Machina

### MATERIALS & MFG

zymergen GINKGO BIOWORKS CALCULARIO  
Eigen Innovations

### HEALTHCARE

deep genomics enlitic BUTTERFLY INC.  
Atomwise Recombine color METABIOTA GRAND ROUNDS Google Life Sciences IBM Watson Health

## INDUSTRIES (CONT'D)

### EDUCATION

KNEWTON turnitin UUDACITY  
KhanAcademy

### TRANSPORT & LOGISTICS

NAUTO PRETECKT

### INVESTMENT FINANCE

Bloomberg Quantopian iSENTRUM NEURENSIC alphasense

## TECH USER TOOLS

### DATA SCIENCE

DOMINO Sentenai yseop Outlier DataRobot

### MACHINE LEARNING

Cortana Analytics glowfi.sh Anodot SIGOPT  
(h [s]) HyperScience fuzzy.io SPARKBEYOND

### OPEN SOURCE

SKYLINE seldon Caffe theano Microsoft DPM TK spaCy  
DL4J SciKit CGT

## MACHINE INTELLIGENCE 3.0

# 2016

#### - ENTERPRISE INTELLIGENCE



## - ENTERPRISE FUNCTIONS



# AUTONOMOUS SYSTEMS



INDUSTRIES



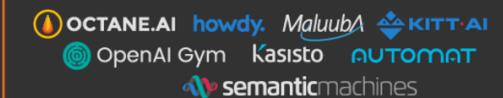
## INDUSTRIES CONT'D



[shivonzilis.com](http://shivonzilis.com) / MACHINEINTELLIGENCE · Bloomberg BETA

## TECHNOLOGY STACK

AGENT ENABLERS



DATA SCIENCE



# MACHINE LEARNING



NATURAL LANGUAGE



## DEVELOPMENT



## DATA CAPTURE



## OPEN SOURCE LIBRARIES



## HARDWARE

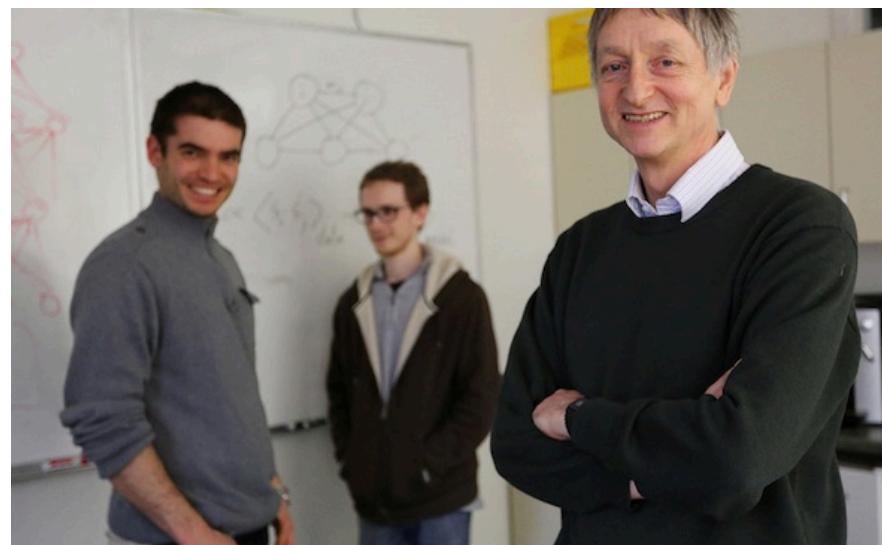
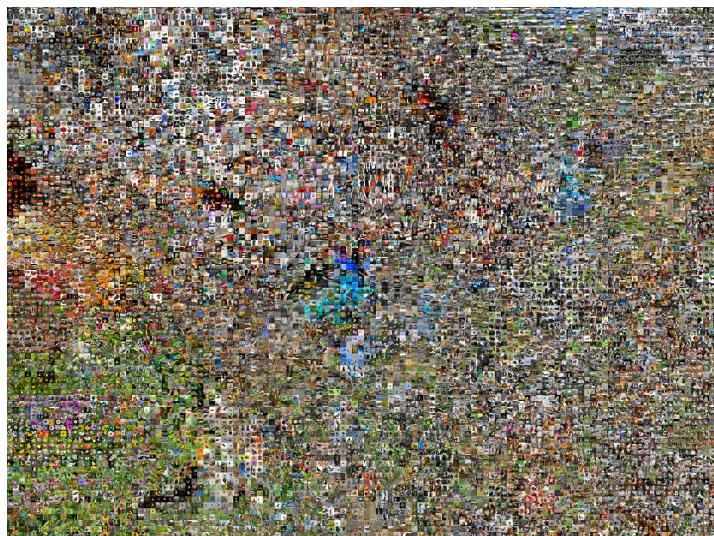
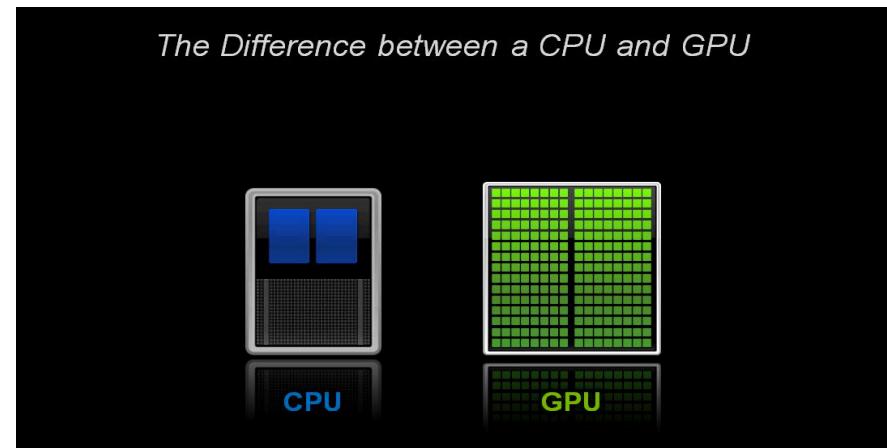


RESEARCH -



# Deep Learning (DL)

- Data
- GPU Computing
- Talents



# Data: ImageNet

- 開始於 2007 @ Princeton
- 初登場於 2009 @ CVPR
- 照片停止搜集於 2010
  - 總共類別 : 21841
  - 總共圖片 : 1千4百萬
- ILSVR Challenge 從2010到現今



Jia Deng

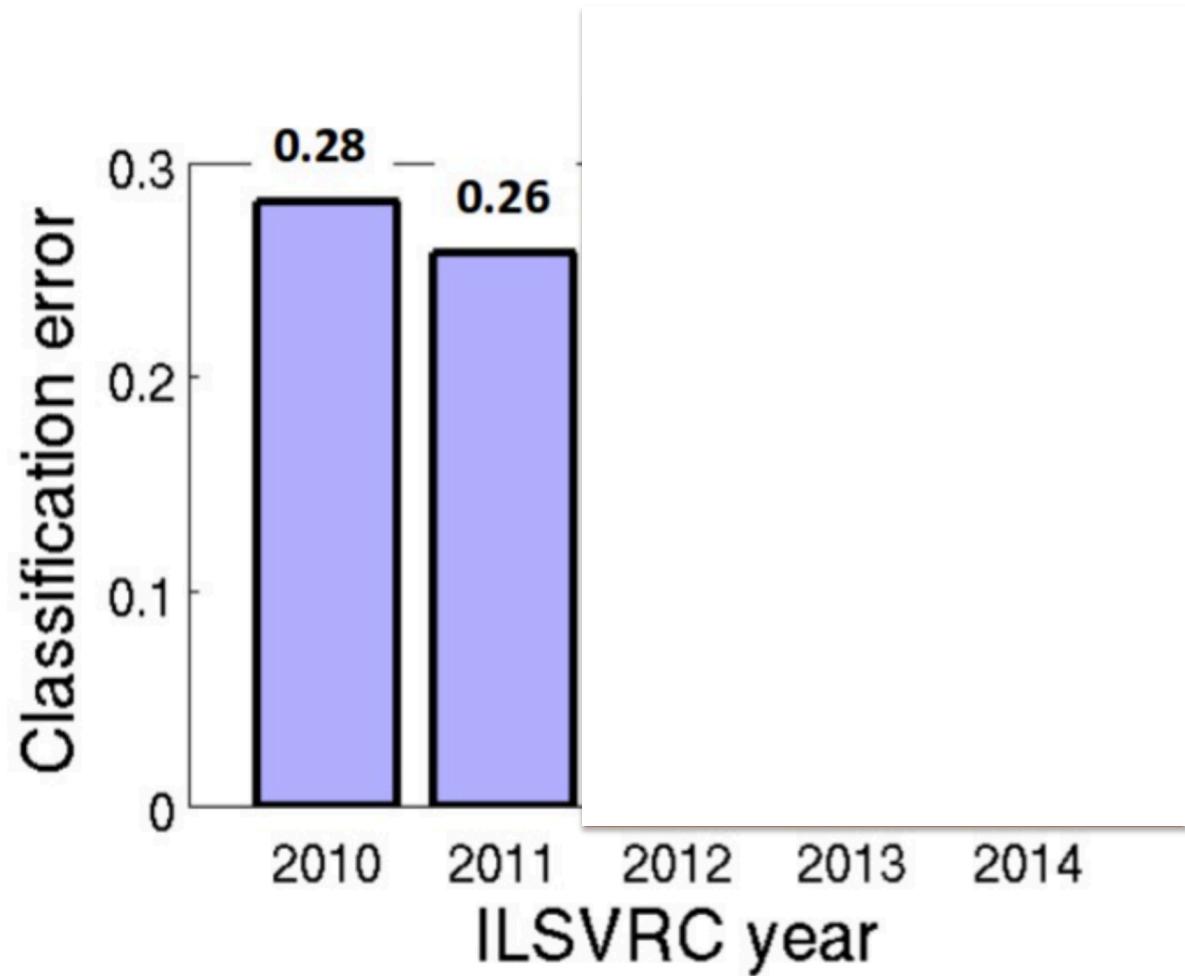


Fei-Fei Li

Info from <http://www.image-net.org/>

# 1K Image Classification

Label =  $f(\text{Image})$



Deep Learning

深度學習



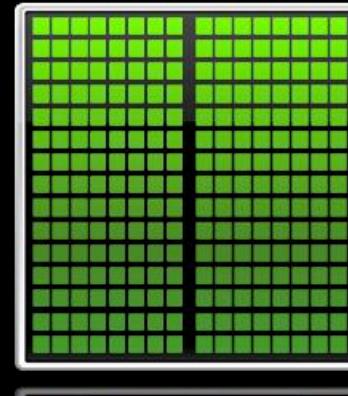
Figure from Olga Russakovsky ECCV'14 workshop

# GPU

*The Difference between a CPU and GPU*



CPU



GPU

Tesla P100 With Over 20 TFLOPS Of FP16

Read more: <http://wccftech.com/nvidia-pascal-gpu-gtc-2016/#ixzz456KT75Jf>

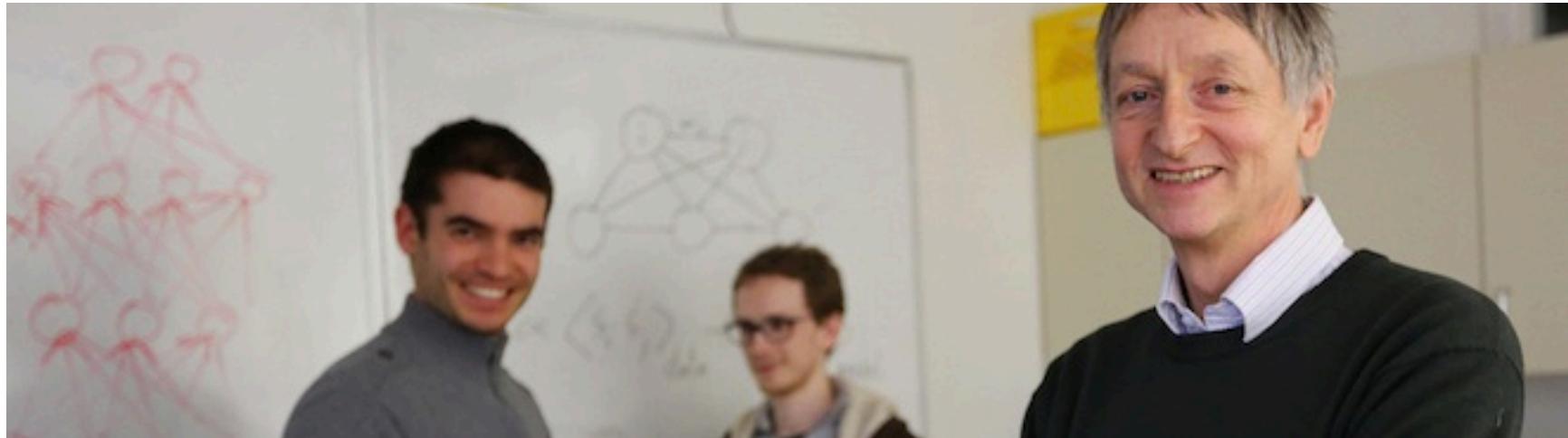
# Facebook Machine Learning Server



Big Sur: 8 NVIDIA M40

<https://techcrunch.com/gallery/a-look-inside-facebooks-data-center>

# Talents: DNNresearch acquired by Google



## A story in computer Vision in 2013!

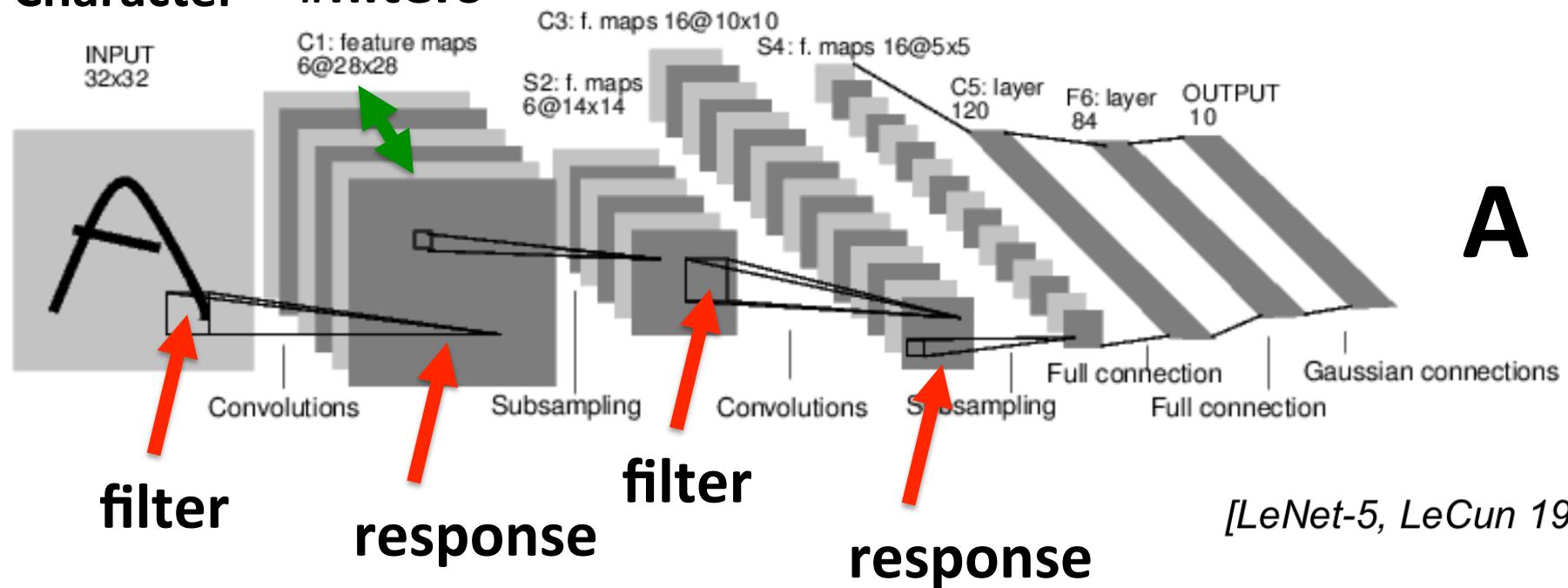


Geoffrey Hinton (right: Professor) Alex Krizhevsky (middle; PhD student), and Ilya Sutskever (left; Postdoc)

# Convolutional Neural Network (CNN)

Handwritten

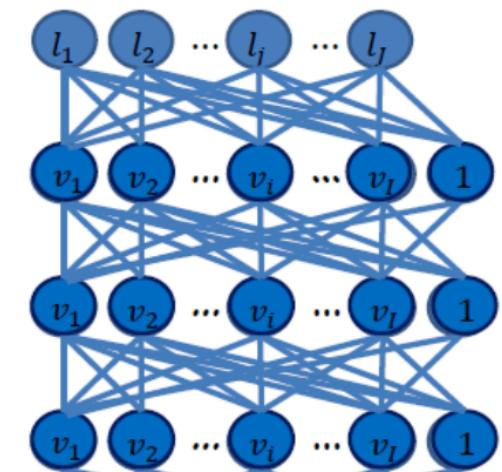
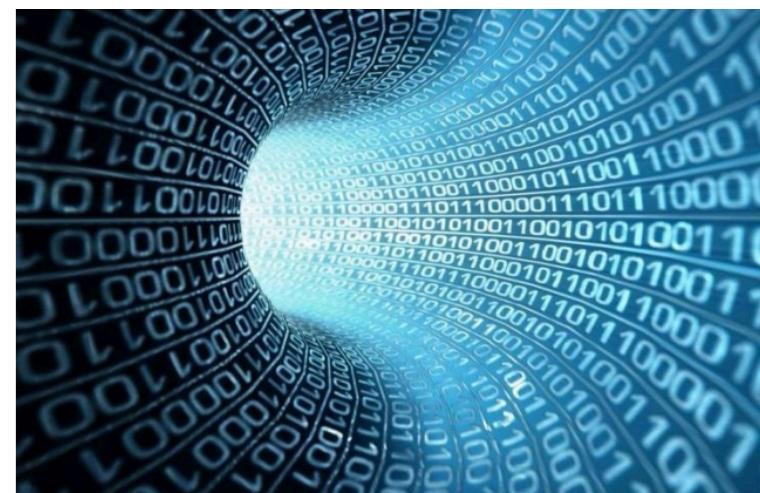
Character    #filters



Character =  $f(\text{Image})$

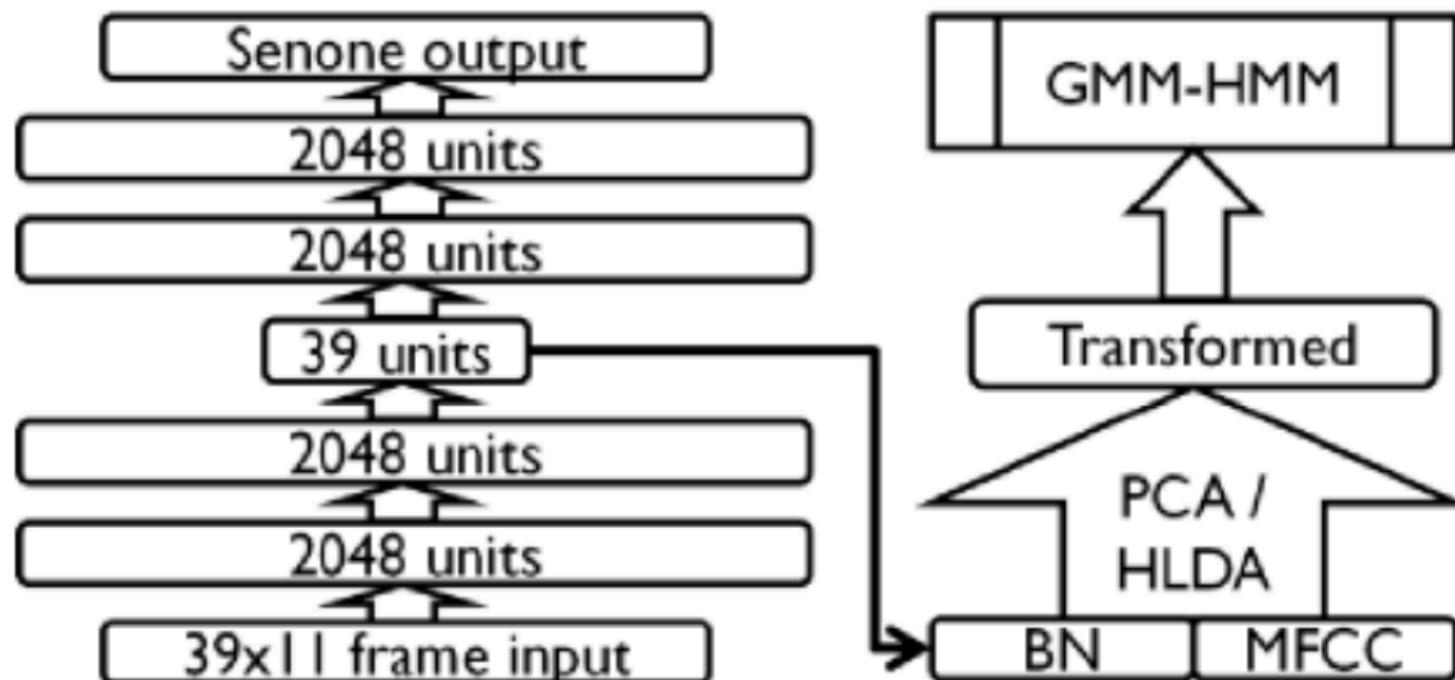
# Automatic Speech Recognition (ASR)

- DNN has become the-state-of-the-art for speech recognition since 2010
  - ✓ Large volume data available
  - ✓ Deep learning is changing everything. AM, LM...
  - ✓ ASR is going to practice. Siri, google, baidu, Tencent...



# DBN-HMM

Microsoft: 33% Recognition Error Reduction over discriminatively trained GMM-HMMs



F. Seide, Gang Li, Dong Yu, Conversational Speech Transcription Using Context-Dependent Deep Neural Networks, Interspeech 2011, Florence, Italy

# Natural Language Processing (NLP)

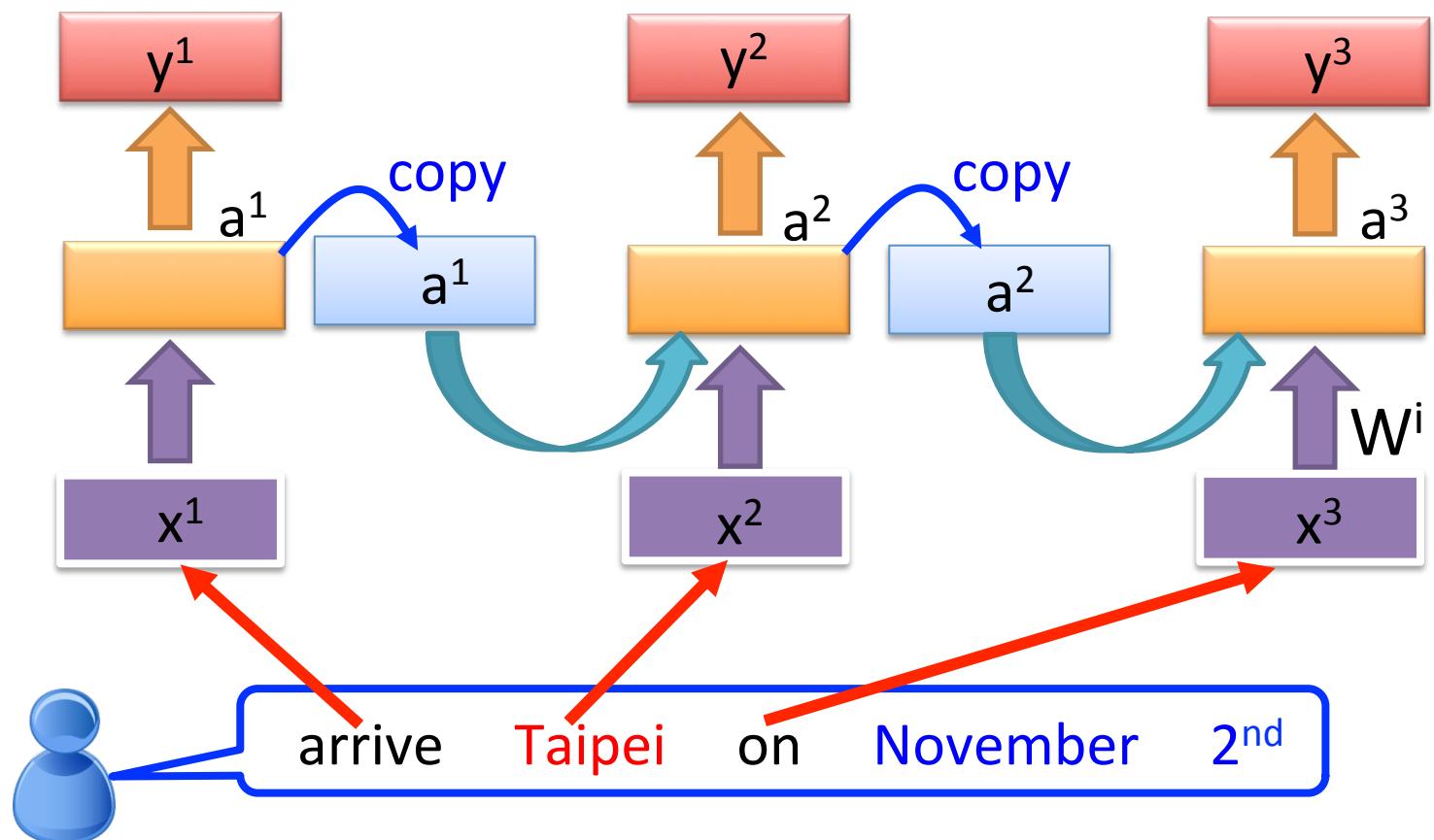
- “Deep Learning waves have lapped at the shores of computational linguistics for several years now, but 2015 seems like the year when the full force of the tsunami hit the major Natural Language Processing (NLP) conferences.” -Dr. Christopher D. Manning, Dec 2015

# Recurrent Neural Network

Probability of  
“arrive” in each slot

Probability of  
“Taipei” in each slot

Probability of  
“on” in each slot



# DL Fuses AI-subfields -> AGI

- Vision and Language



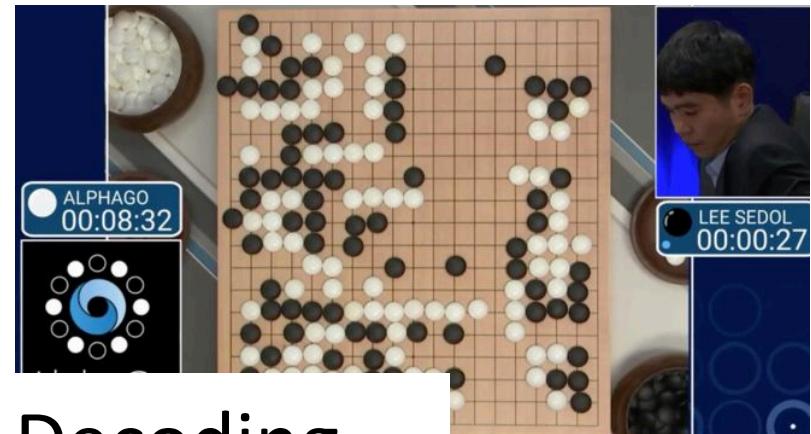
The man at bat readies to swing at the pitch while the umpire looks on.



<http://mscoco.org/>

- Vision and Control

Atari Breakout game & AlphaGo, DeepMind.



- Multiple Encoding and Decoding

# Image Captioning

Vision

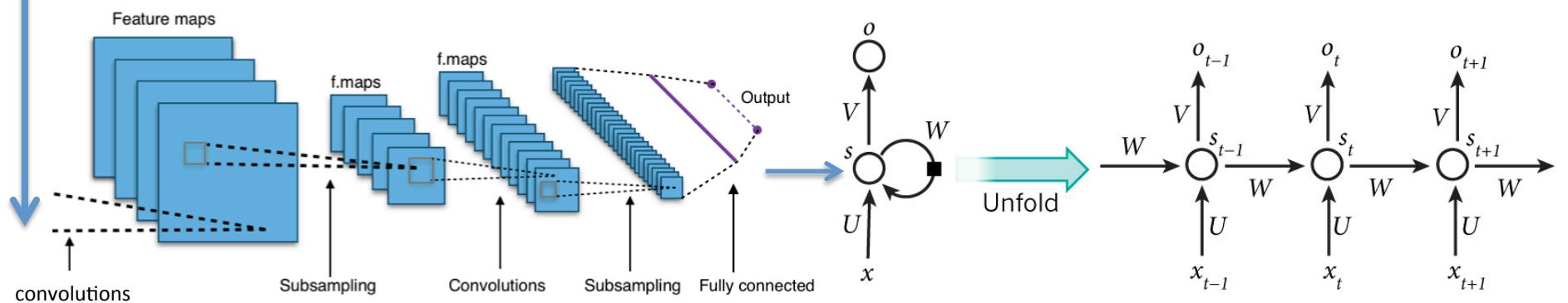
Language

**f(**



**) =**

The man at bat is  
ready to swing  
at the pitch



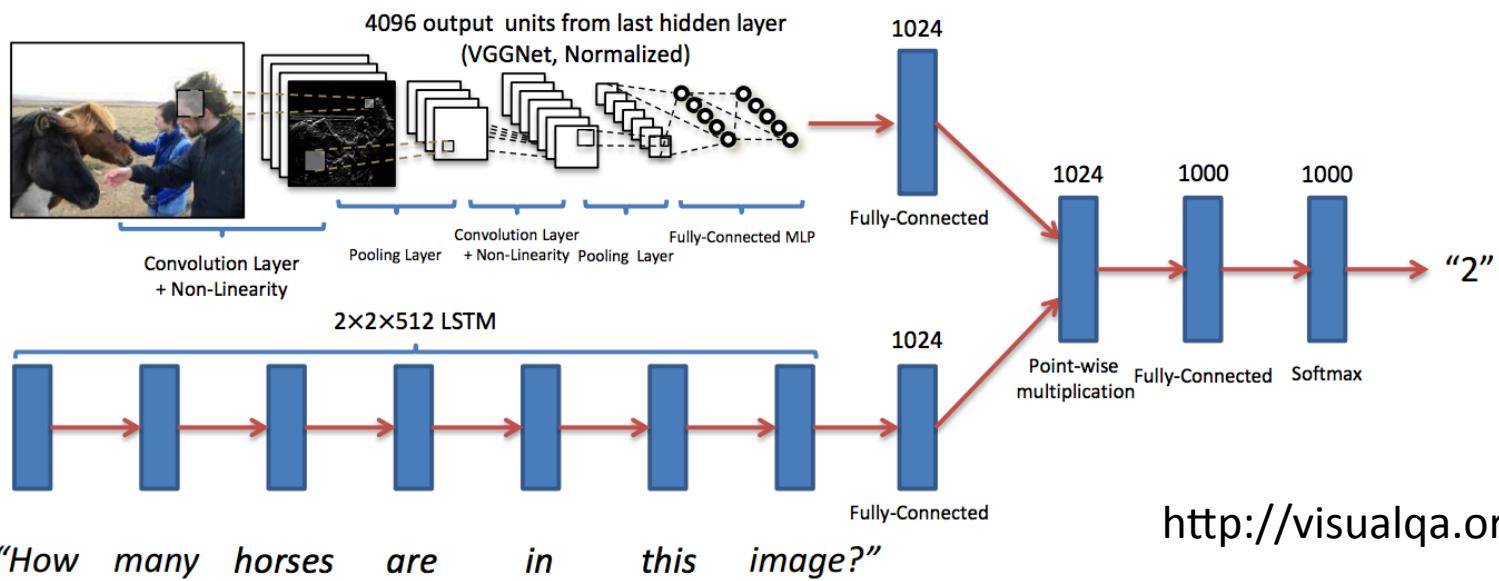
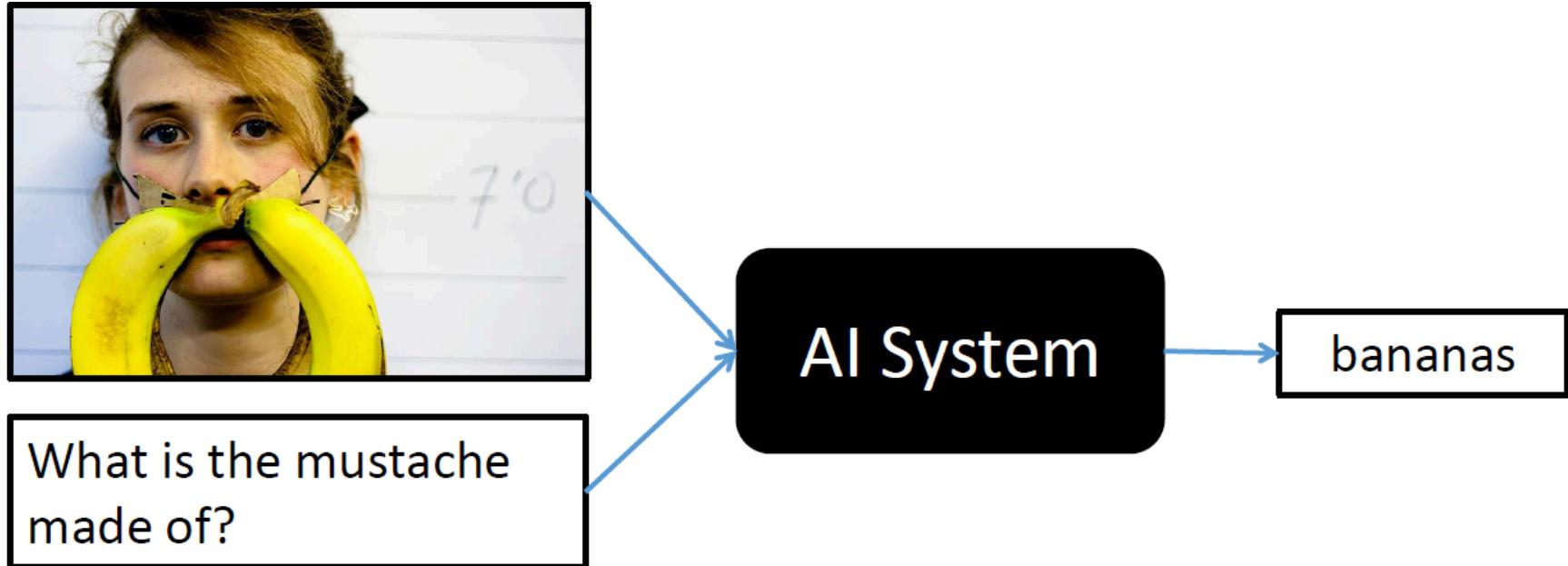
**Convolution Neuron Network (CNN)**

credit: wiki

**Recurrent Neuron Network (RNN)**

credit: Nature

# Image Question Answering



<http://visualqa.org/>

# Video Title Generation

ECCV 2016



**VSLab**

Microsoft  
**Research**  
微软亚洲研究院

科 技 部

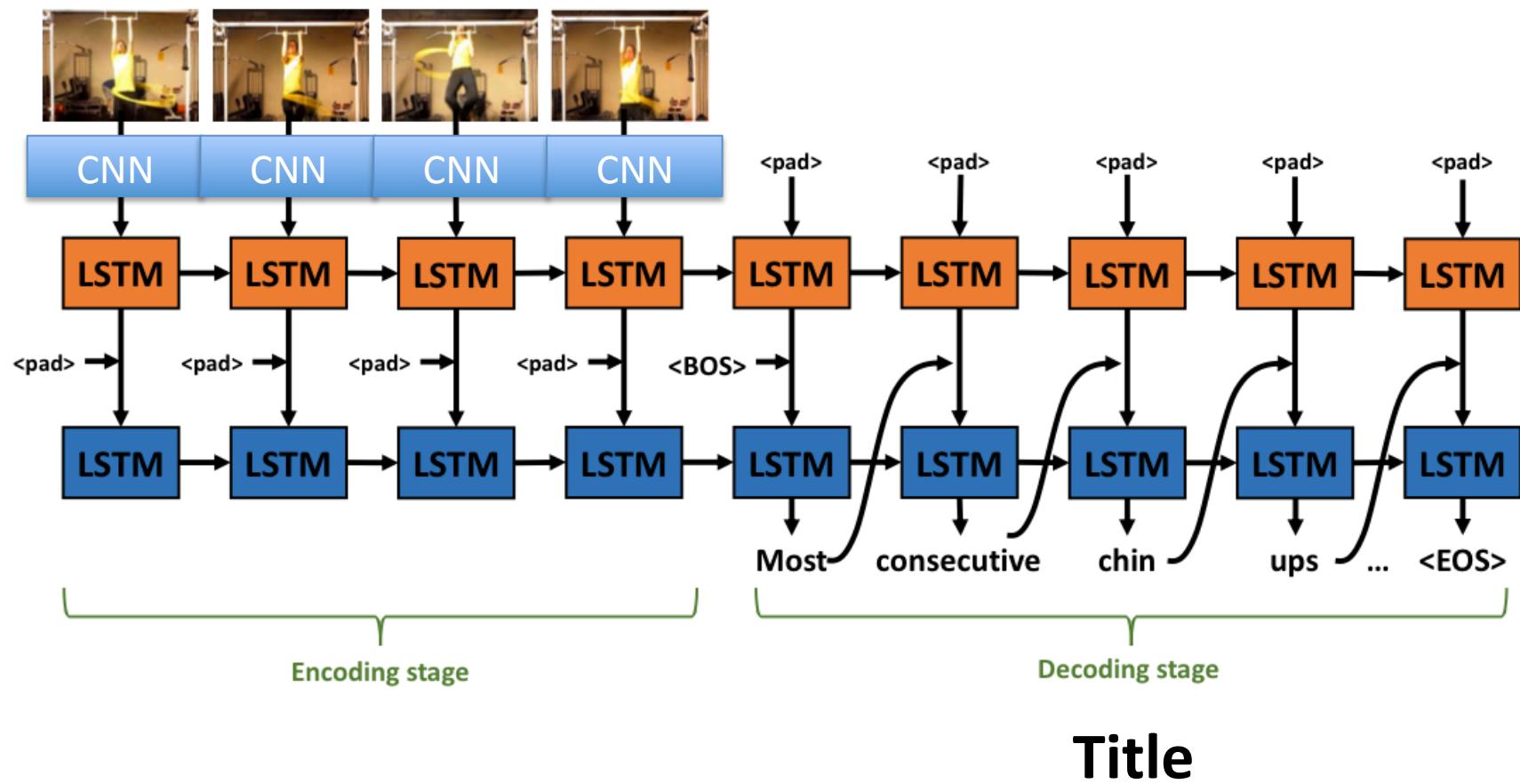
Ministry of Science and Technology

 **NOVATEK**

Zeng et al. ECCV 2016 from VSLab and Stanford AI Lab

# Big Video Data with Titles

- Pairs of  
Raw Video



# Viral Videos



Viral videos are our world.  
Whether you have them  
or you need them...

**We happen to cover both.**



100,074,680



likes

35,009,744



subscribers

34,955,730,86



views

Google for “viral video company”

# Large Video Repository



Wheel Pops off Truck During Burnout

Posted Date: N/A  
JV#: 936982



Dog Rummages Through Fridge

Posted Date: 06/23/16  
JV#: 936534



German Shepherd Splashes in Puddles with Joy

Posted Date: 07/13/16  
JV#: 937262



Father and Son Try to Make Toy Plane Fly

Posted Date: N/A  
JV#: 937212



Man Uses Vent to Cool Down

Posted Date: N/A  
JV#: 937140



Girl Juggles Balls with Limbs

Posted Date: 04/28/16  
JV#: 933528



Guy Falls into Truck Bed

Posted Date: N/A  
JV#: 937240



Dog Tries to Scare Away Deer

Posted Date: N/A  
JV#: 935626



Little Kid Launched off Blob

Posted Date: N/A  
JV#: 937037



Pole Breaks Mid-Pole Vault

Posted Date: 05/03/16  
JV#: 937052



Golfer Bounces Ball Off Rock into Hole

Posted Date: 10/12/15  
JV#: 936949-8



Golfer Whacks Golf Balls into Hole

Posted Date: 07/13/16  
JV#: 936949-7



Golfer Makes Behind the Back Shot

Posted Date: 11/02/15  
JV#: 936949-6



Golfer Sinks Two Balls at Once

Posted Date: 11/02/15  
JV#: 936949-5



Golfer Makes Bank Shot

Posted Date: 11/04/15  
JV#: 936949-4



Golfer Pops Ball out of Mouth and Hits It

Posted Date: 01/28/16  
JV#: 936949-3



Golfer Hits Ball after Friend Shoots it Out of Mouth

Posted Date: 03/23/16  
JV#: 936949-2



Golf Trickshot Behind the Back

Posted Date: N/A  
JV#: 936949-1

Currently 28740 videos and keep growing

# DL Fuses AI-subfields -> AGI

- Vision and Language



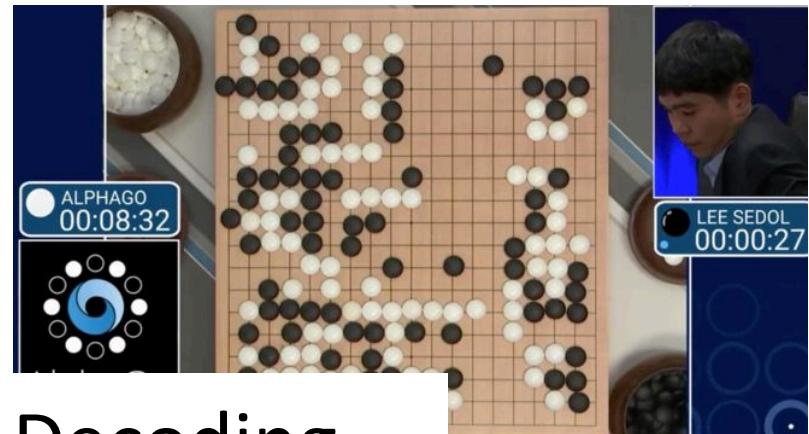
The man at bat readies to swing at the pitch while the umpire looks on.



<http://mscoco.org/>

- Vision and Control

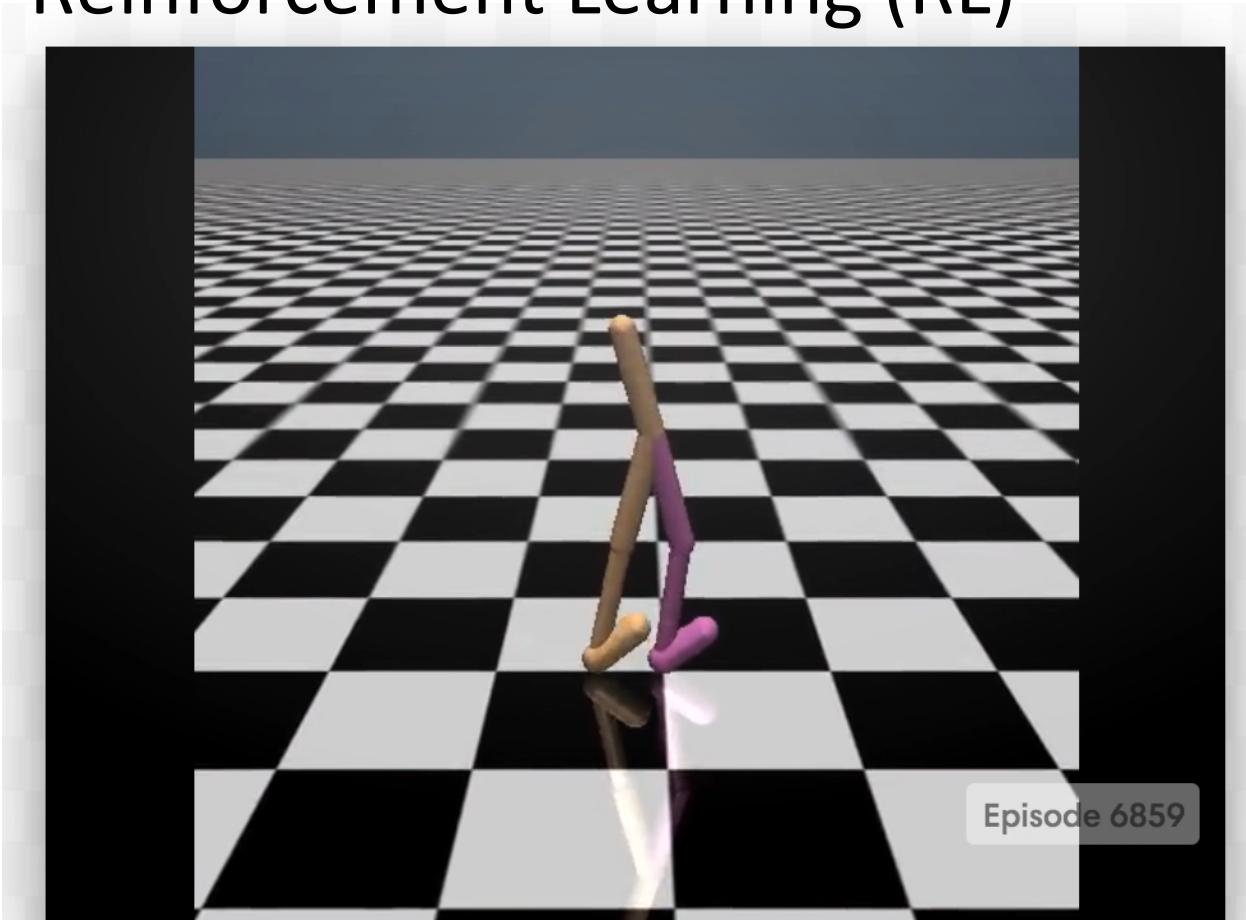
Atari Breakout game & AlphaGo, DeepMind.



- Multiple Encoding and Decoding

# Vision and Control

- Learning to play game with weak supervision:  
Reinforcement Learning (RL)



joschu's trpo-gae-v0 on Walker2d-v0

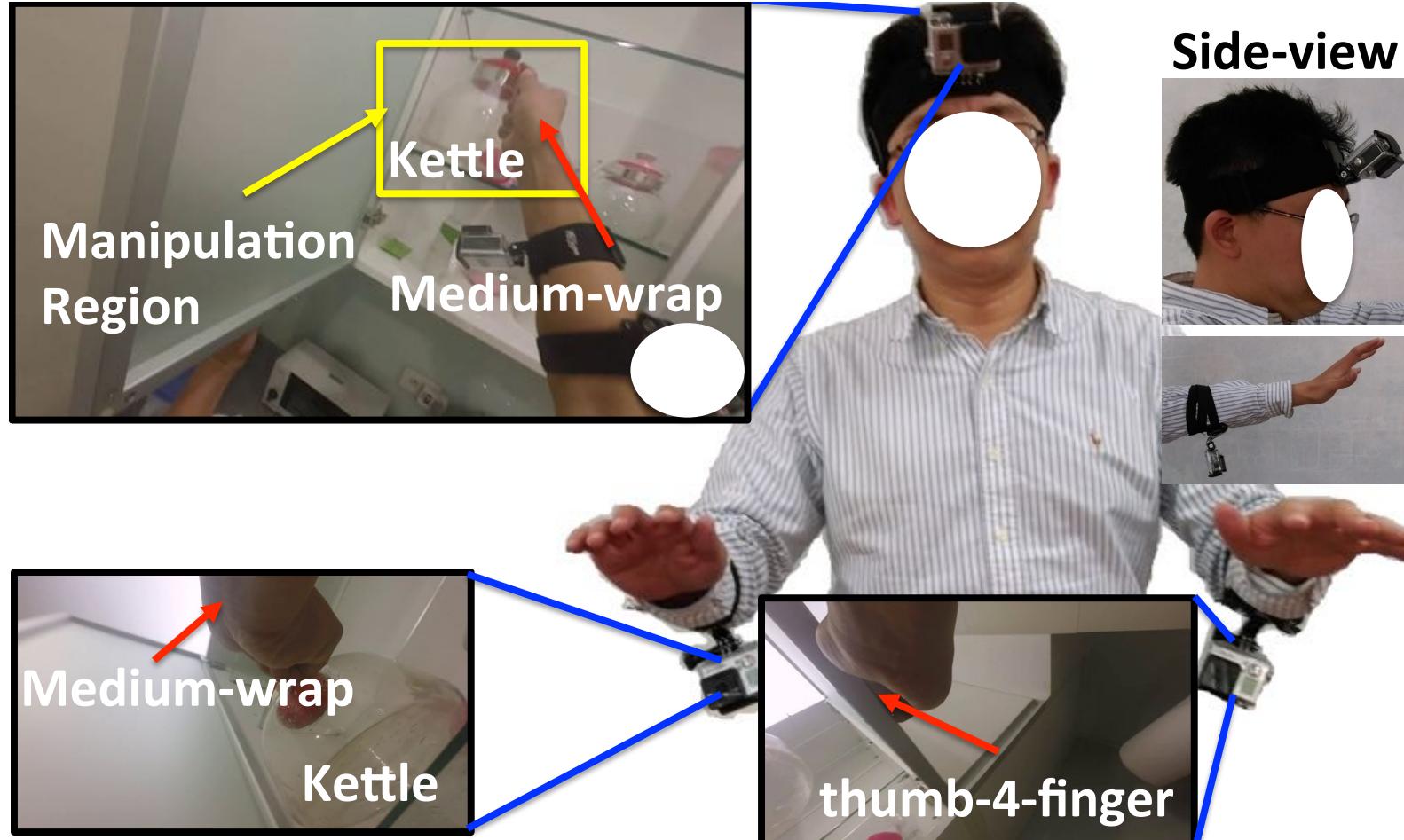
<https://gym.openai.com/>

# **Self-driving Car: Trigger Accident Warning**



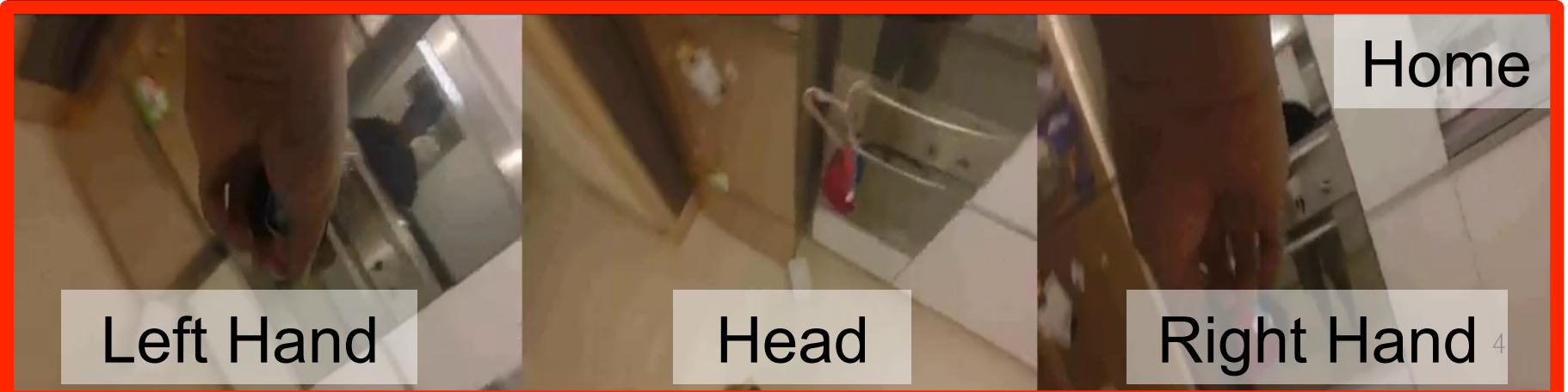
VSLab Under Submission

# Fusing Multiple Sensors



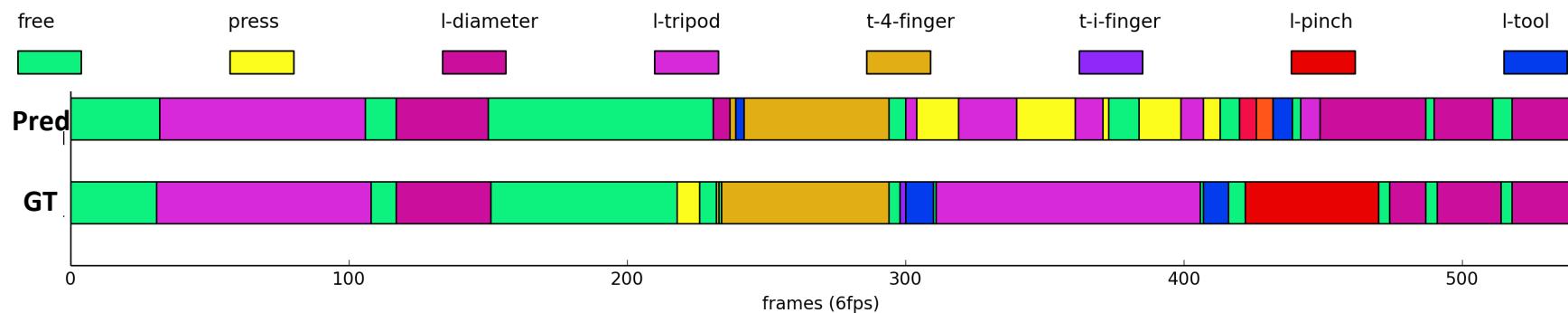
Chan et al. ECCV 2015 from VSLab



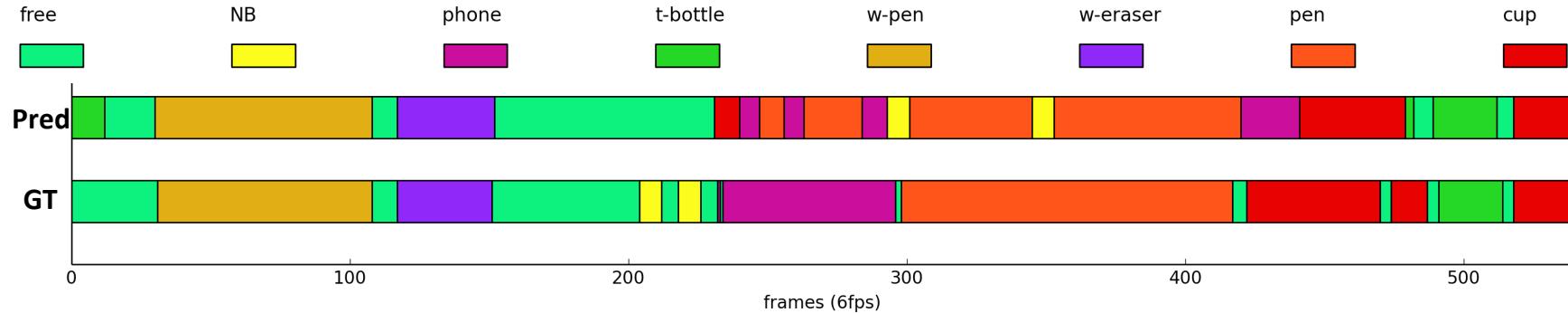


# Recognition from Wearable Cameras

## Gesture Recognition



## Object Category Recognition



# Real-time Wearable Demo



Fisheye camera

NVIDIA TK1

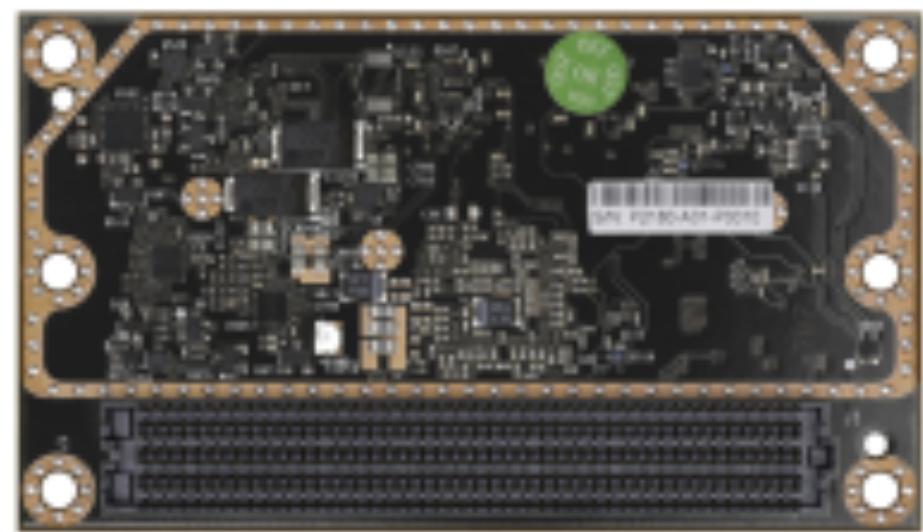
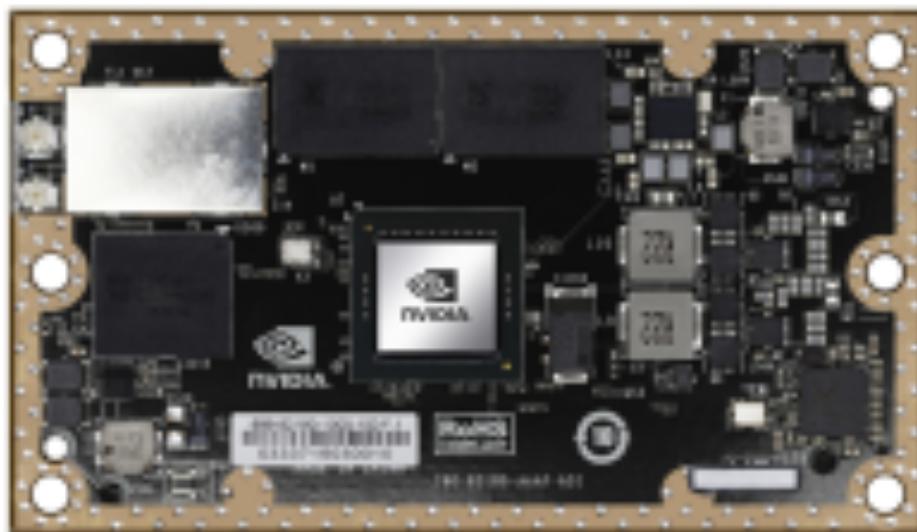
# Real-time Wearable Demo

cellphone, bottle, keyboard, mouse, free hand



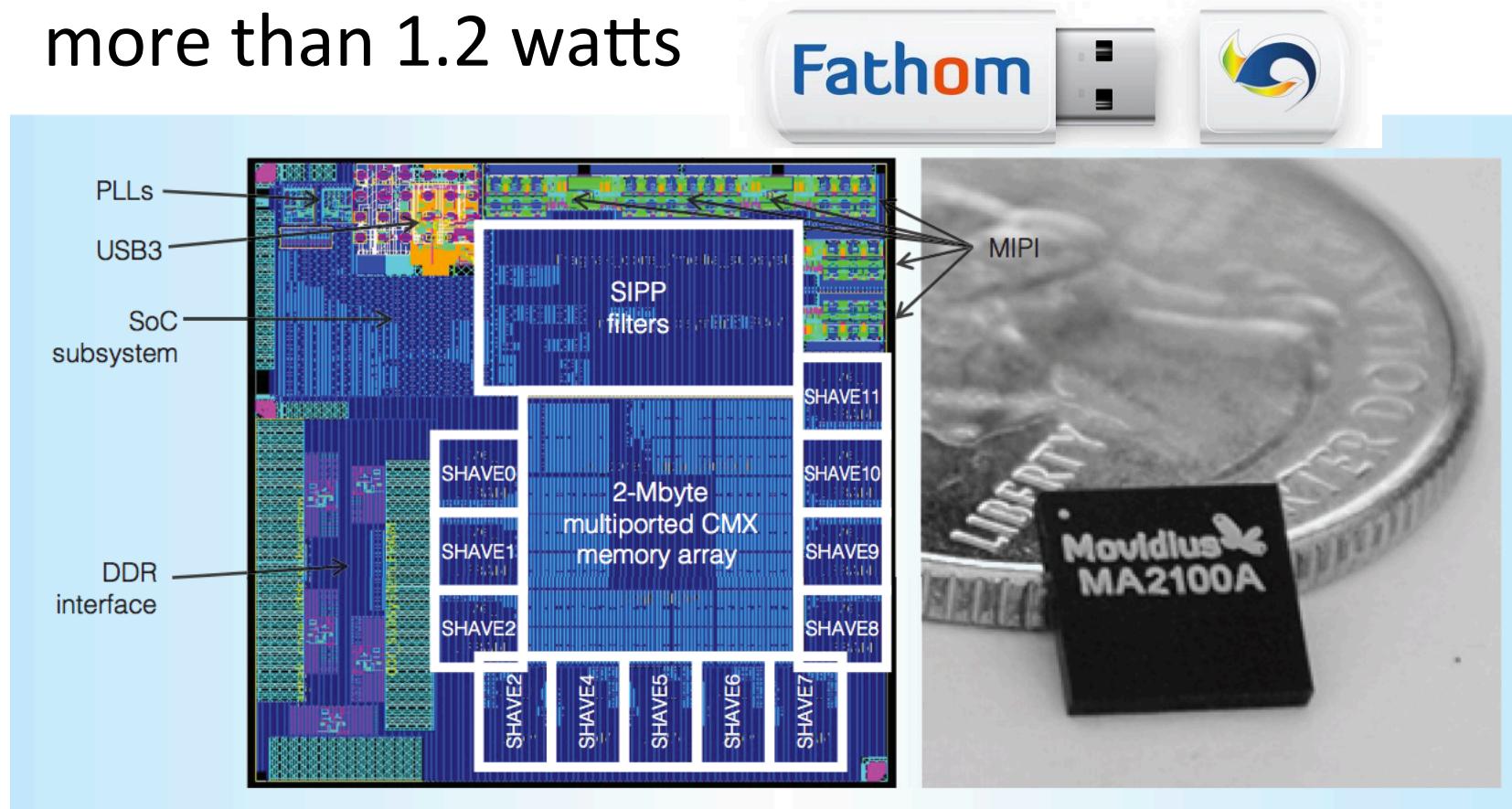
# NVIDIA TX1

- 1 TFLOP/s 256-core with NVIDIA Maxwell™ Architecture
- ~4GB GPU shared memory
- 8-15 watts



# Fathom USB Computer

- the Myriad 2 MA2450 VPU paired with 512MB of LPDDR3 RAM: 150 GFLOPS consuming no more than 1.2 watts



# Take-Home Message

- Encoding Source (data)
    - N-D observation
    - N
  - We get many tools to tackle Artificial General Intelligence
    - Deep learning
    - Reinforcement learning
    - N
  - Just Try!
  - Worse Thing: Do Nothing
  - If each module is differentiable/approximately differentiable -> End-to-End Learning

**Thanks!**