



# Introduction

**Prof. Seungchul Lee**  
**Industrial AI Lab.**

# Course Information For MECH527

- Course title: Advanced AI for ME (= Deep Learning)
- Instructor: Prof. Seungchul Lee
  - Office: 5-223
  - Email: [seunglee@postech.ac.kr](mailto:seunglee@postech.ac.kr)
- TAs: TBD
  - Will be announced later
  - Office: 5-427

# Introduction

- 2018 - present: POSTECH
  - Industrial AI Lab.
- 2013 - 2017: UNIST
  - iSystems Design Lab.
- 2010, Ph.D. from the University of Michigan, Ann Arbor
  - S. M. Wu Manufacturing Research Center
  - The Center of Intelligent Maintenance Systems (IMS)
- 2008, M.S. from the University of Michigan, Ann Arbor
- 2005, B.S. of Electrical Engineering from Seoul National University
- 2001, B.S. of Mechanical Engineering from Seoul National University



# Course Information For MECH527

- Deep learning
- Python in class and assignments
  - Used a lot
  - I highly recommend not to take this course for those who are not familiar with coding
  - Lots of coding problems in both homework and exam
- Grading
  - Two in-class exams (30% + 30%)
  - Many assignments (20%)
  - Project (10%)
  - Class participation (10%)

# Lecture Materials

- Some lecture materials are already available at
  - <http://iai.postech.ac.kr/index.php/machine-learning/>
  - Homework assignments (with an email notice)
- Updates will be made as semester goes

## Deep Learning

| Dates | Topics                                | with Python                 | Slides                 |
|-------|---------------------------------------|-----------------------------|------------------------|
|       | Artificial Neural Networks            | <a href="#">iNote#26py.</a> | <a href="#">pdf#21</a> |
|       | Autoencoder                           | <a href="#">iNote#27py.</a> | <a href="#">pdf#22</a> |
|       | Convolutional Neural Networks         | <a href="#">iNote#28py.</a> | <a href="#">pdf#23</a> |
|       | Recurrent Neural Networks             | <a href="#">iNote#29py.</a> | <a href="#">pdf#24</a> |
|       | Class Activation Map (CAM)            |                             |                        |
|       | Generative Adversarial Networks (GAN) | <a href="#">iNote#31py.</a> |                        |
|       | Advanced Autoencoders: CAE, DAE       |                             |                        |

# Communication Channels

- Communication will mainly be done through LMS and POSTECHx
  - Announcement
  - Group e-mail

The screenshot displays the POSTECH eClass LMS interface. The top navigation bar includes links for Home, eClass, Open 과정, 특강/세미나, 학습가이드, and an ENGLISH toggle. The left sidebar shows a user profile for 이승철 (00100925) and a list of navigation items: 학습목차, 학습일정관리, 강의실알림 (expanded), 과목관리 (expanded), 학습자료실, and 학습활동관리. The main content area is titled '2019년도 1학기 시스템및설계특론(고급기계인공지능) (MECH701G-01) 강의계획서'. It includes a course overview section with a magnifying glass icon and a '나가기' button. Below this is a table for '1. 수업정보' (Class Information) and a section for '2. 강의교수 정보' (Instructor Information) with a photo of the instructor, Lee Seung-cheol.

이승철 (00100925)  
📧 (0)

강의실 이동  
2019년도 1학기  
강의실선택

□ 학습목차  
□ 학습일정관리  
□ 강의실알림 +  
- 공지사항  
- 질의응답  
- 쪽지/메일  
- 일정표  
□ 과목관리 +  
- 과목정보  
- 강의계획서  
- 조교관리  
□ 학습자료실  
□ 학습활동관리 +

Home eClass Open 과정 특강/세미나 학습가이드 ENGLISH

나가기 →

과목명 시스템및설계특론(고급기계인공지능) [MECH701G-01]  
대표교수 : 이승철 ☎ 054-279-2181 ✉ seunglee@postech.ac.kr

2019년도 1학기 시스템및설계특론(고급기계인공지능) (MECH701G-01) 강의계획서

강의계획서 출력 수정

1. 수업정보

|      |   |      |    |    |   |
|------|---|------|----|----|---|
| 학수번호 | MECH701G                                | 분반명  | 01 | 학점 | 3 |
| 이수구분 | 전공선택                                    | 선수과목 |    |    |   |
| 강의시간 | 화 목(15:30~16:45)   제5공학관 강의실 [108/110호] |      |    |    |   |

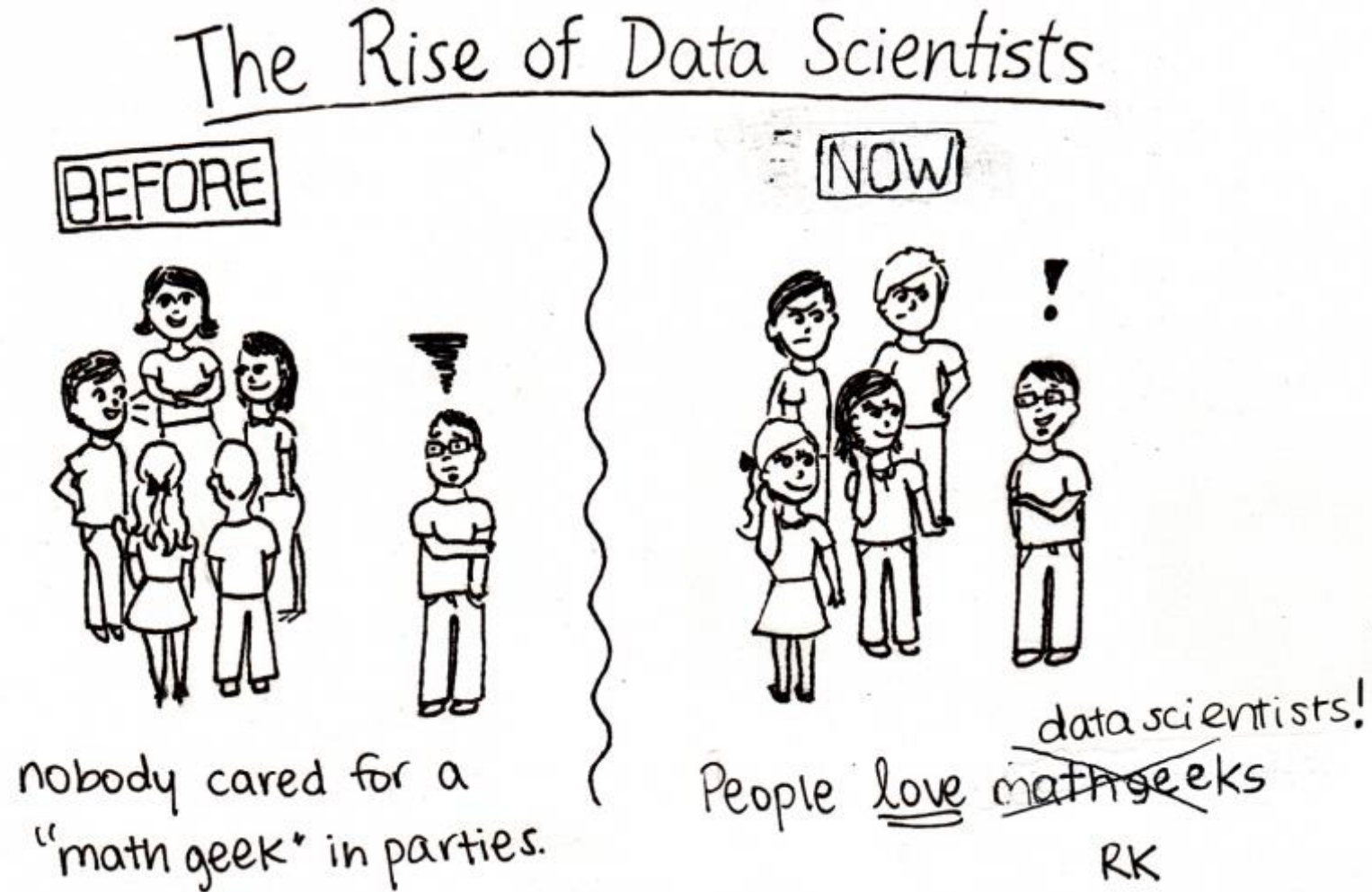
2. 강의교수 정보

|              |                        |          |                   |
|--------------|------------------------|----------|-------------------|
| 성명           | 이승철                    | 소속       | 기계공학과             |
| Email        | seunglee@postech.ac.kr | Homepage | iai.postech.ac.kr |
| 연구실          |                        | 직장번호     | 054-279-2181      |
| Office Hours |                        |          |                   |

# Prerequisites

- Proficiency in Python
  - All class assignments will be in Python. If you have a lot of programming experience but in a different language (e.g. C/C++/Matlab/Javascript) you will probably be fine.
  - If you are not familiar with Python, I recommend you not to take this course
- College Calculus, Linear Algebra, Optimization
  - You should be comfortable taking derivatives and understanding matrix vector operations and notation.
- Basic Probability and Statistics
  - You should know basics of probabilities, Gaussian distributions, mean, standard deviation, etc.
- Equivalent Knowledge of Machine Learning
  - We will be formulating cost functions, taking derivatives and performing optimization with gradient descent.

# The Rise of Data Scientists

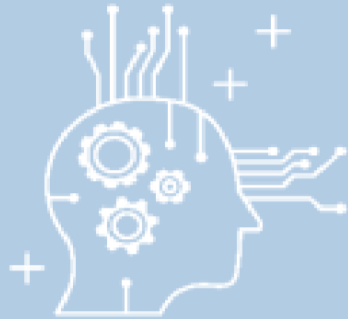




# What is Deep Learning?

## ARTIFICIAL INTELLIGENCE

Any technique that enables computers to mimic human behavior



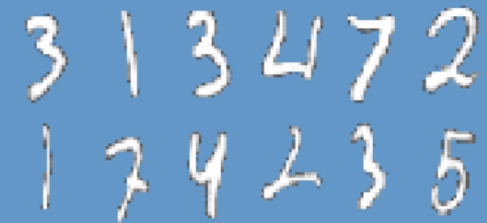
## MACHINE LEARNING

Ability to learn without explicitly being programmed



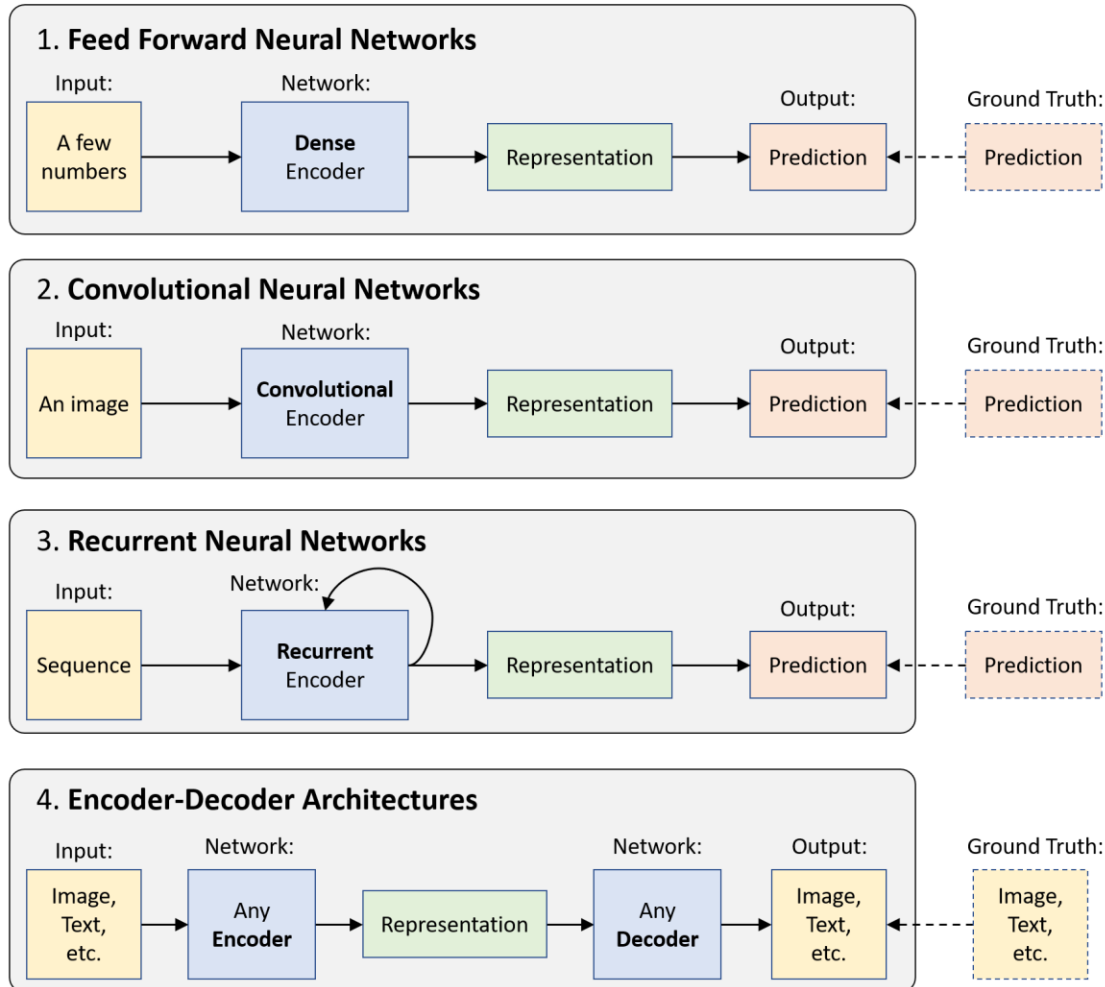
## DEEP LEARNING

Learn underlying features in data using neural networks

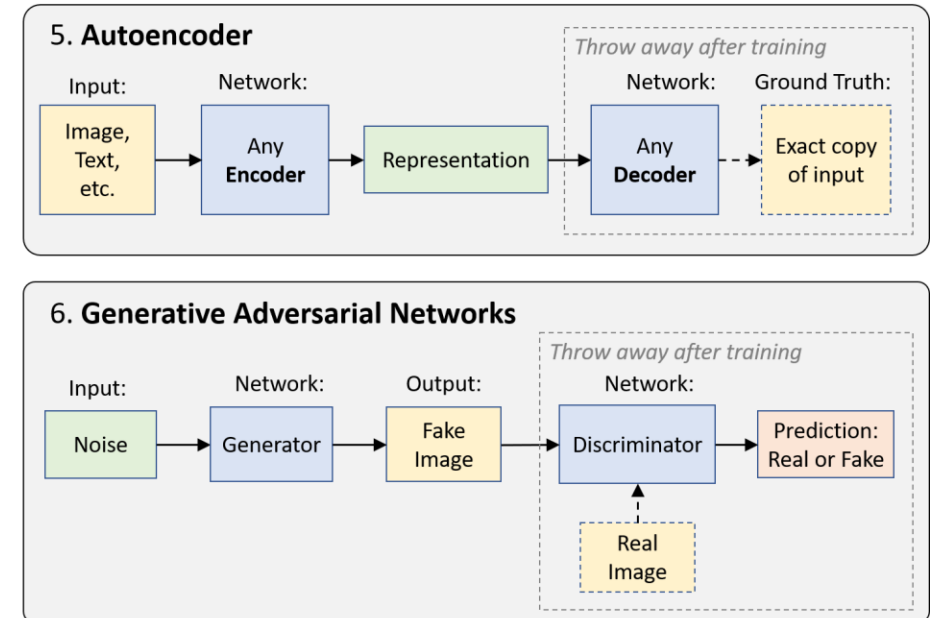


# Topics in Deep Learning

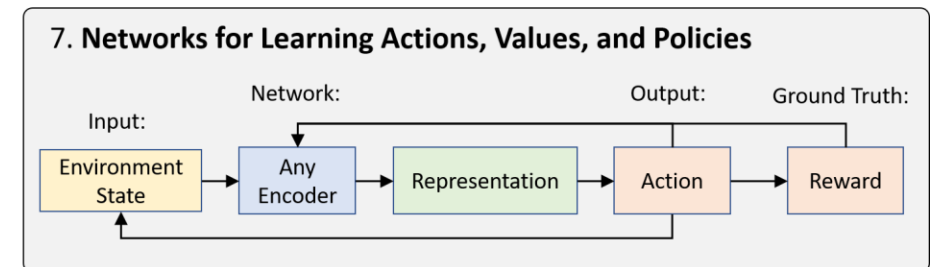
## Supervised Learning



## Unsupervised Learning

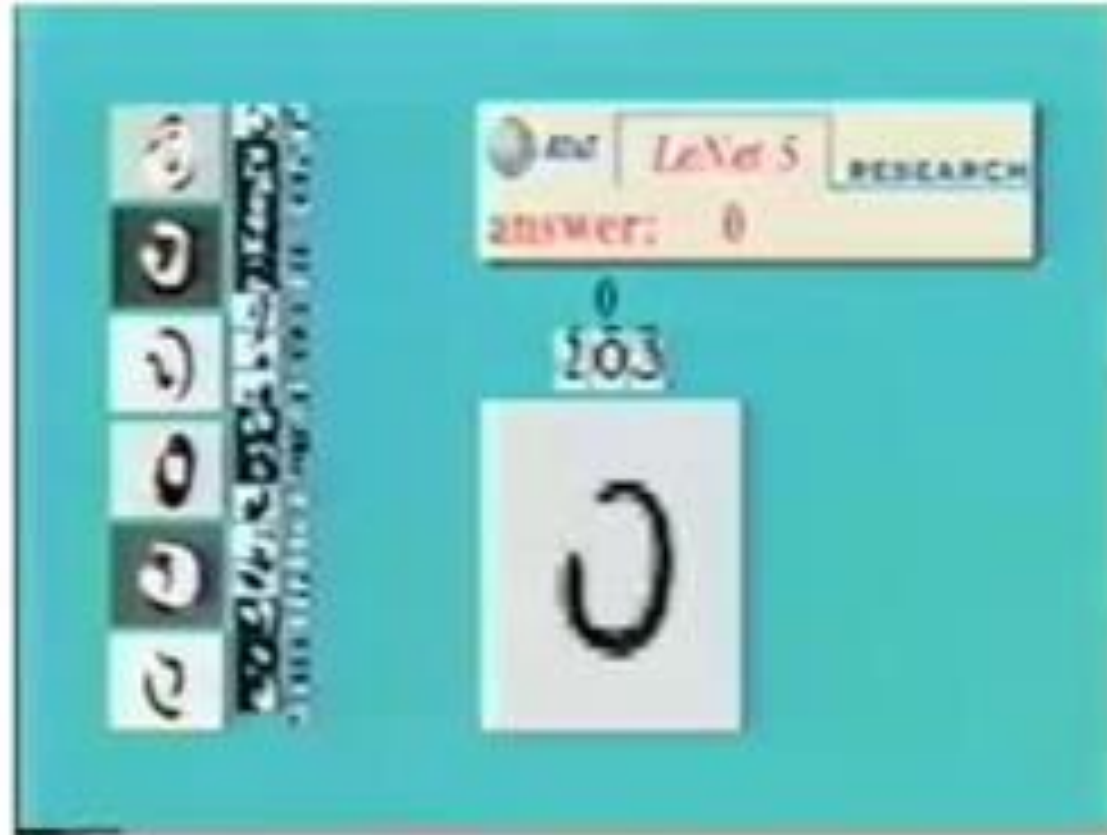


## Reinforcement Learning



# Handwritten Digit Classification

## Handwritten digit classification



(Courtesy of Yann LeCun)

Andrew Ng

# Convolutional Network Demo from 1993 by Yann LeCun



# Current Applications and Success

# Image Recognition



**mite**

**container ship**

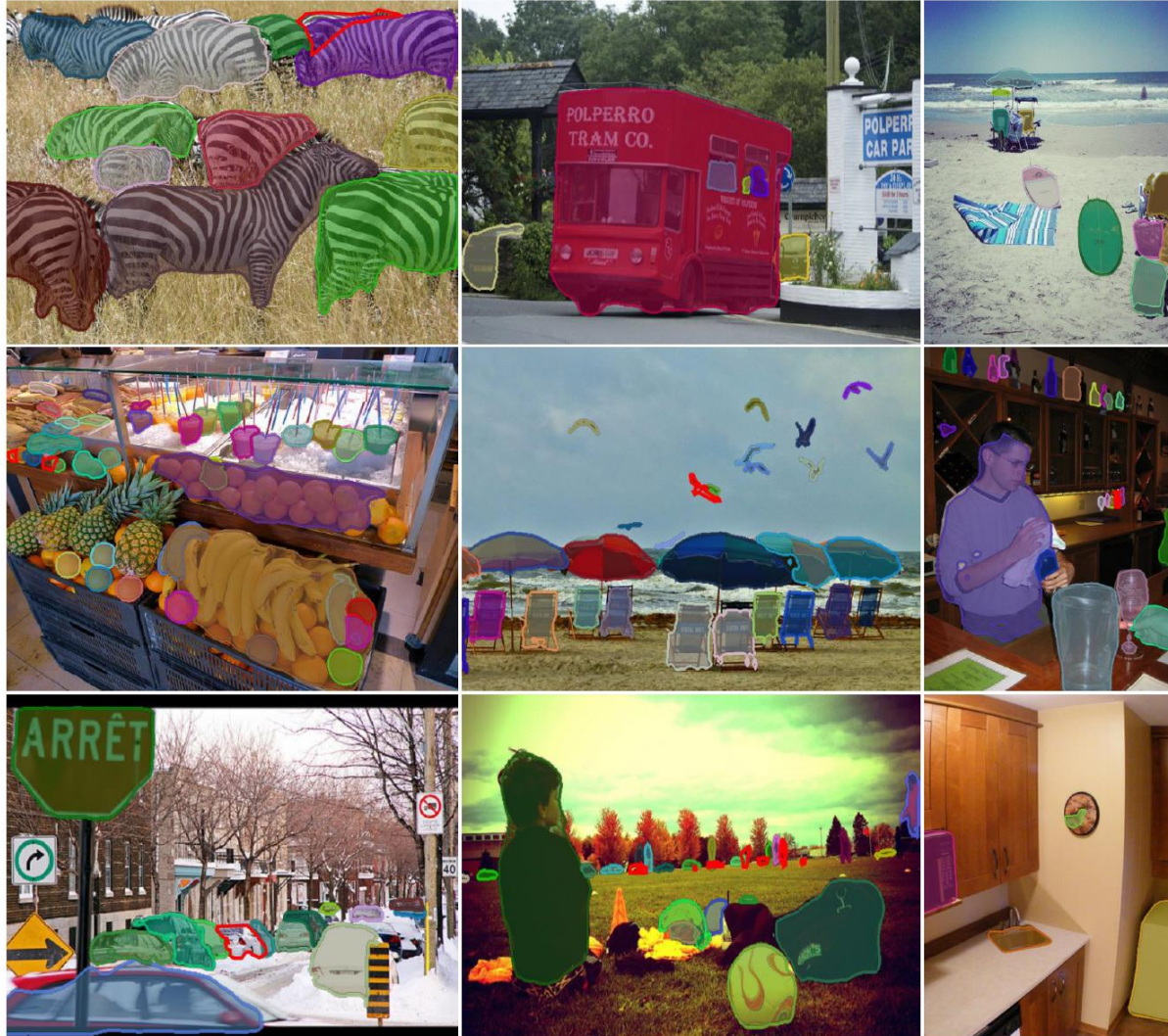
**motor scooter**

**leopard**

|  |             |                   |               |              |
|--|-------------|-------------------|---------------|--------------|
|  | mite        | container ship    | motor scooter | leopard      |
|  | black widow | lifeboat          | go-kart       | jaguar       |
|  | cockroach   | amphibian         | moped         | cheetah      |
|  | tick        | fireboat          | bumper car    | snow leopard |
|  | starfish    | drilling platform | golfcart      | Egyptian cat |

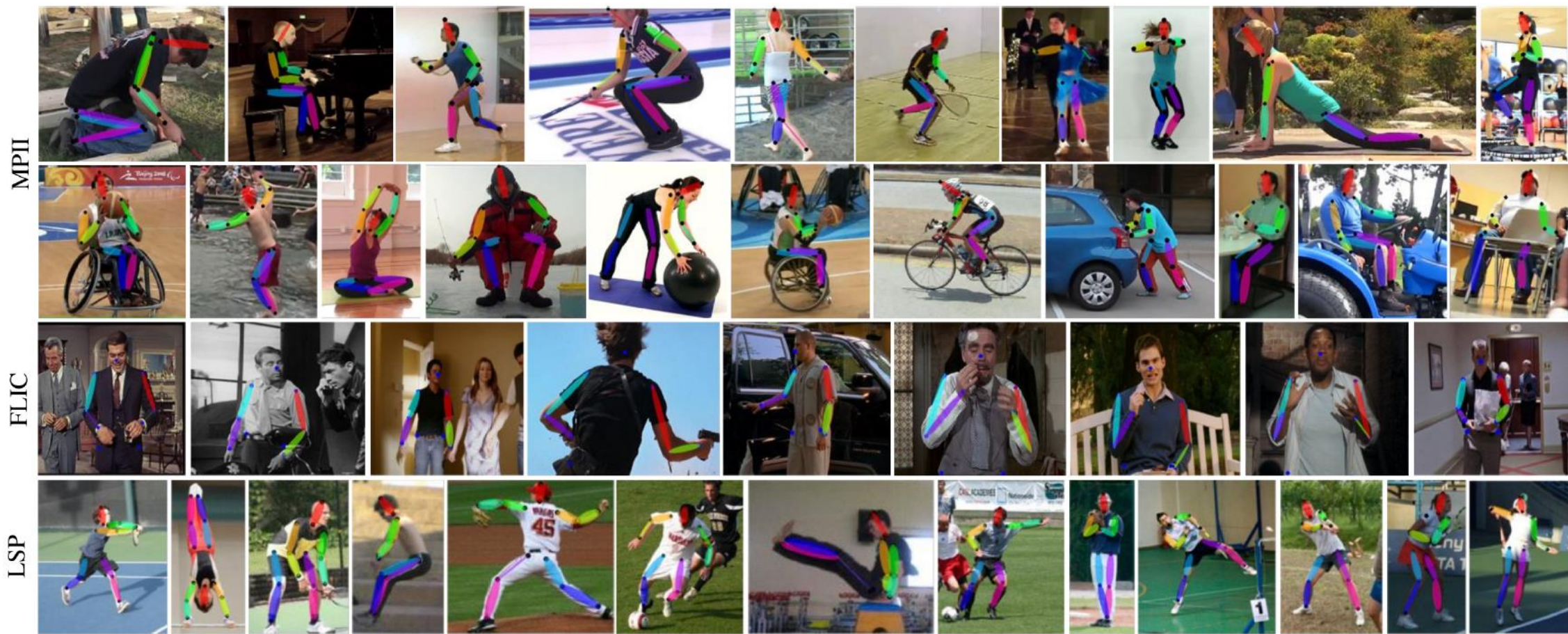


# Object Detection and Segmentation



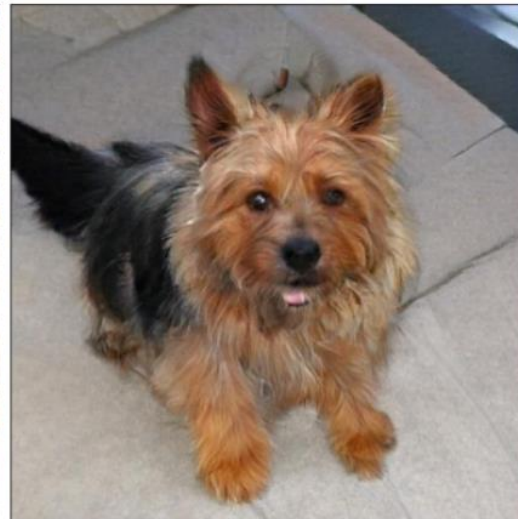


# Human Pose Estimation

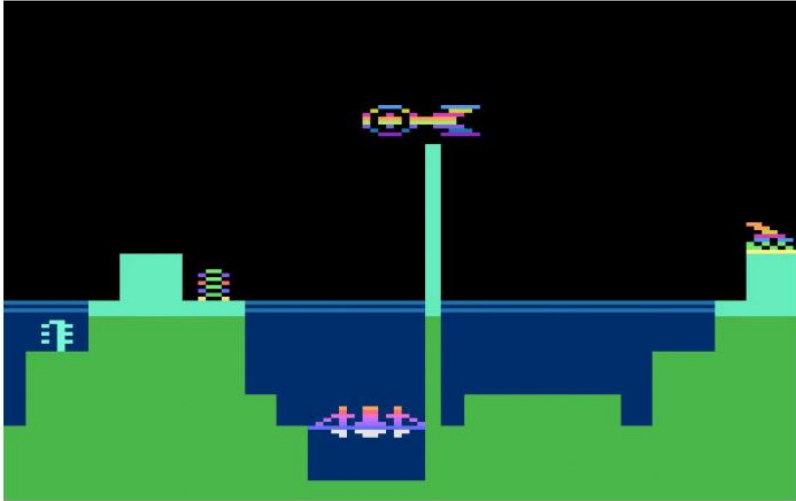




# Image Generation



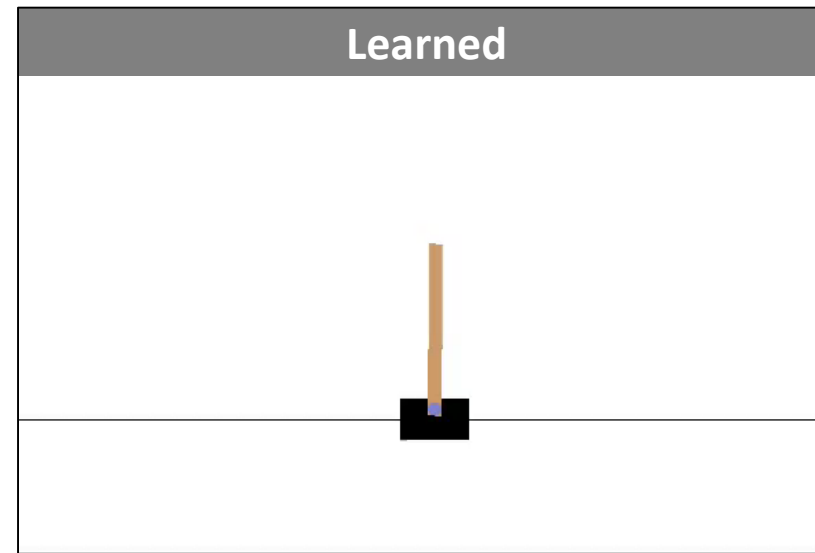
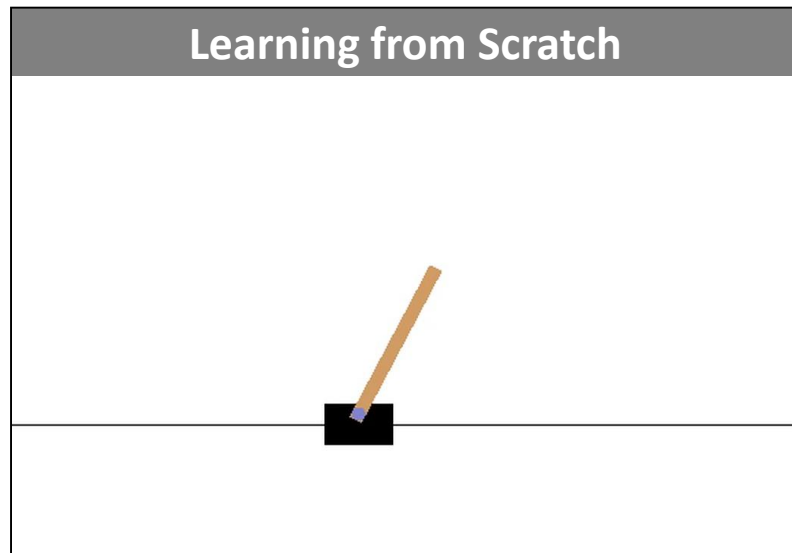
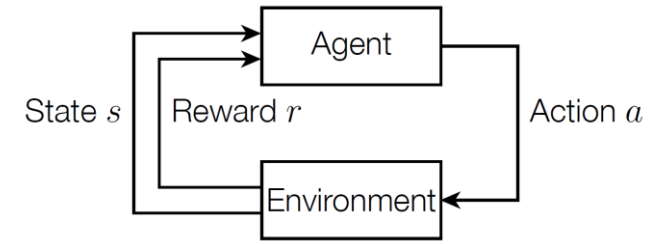
# Reinforcement Learning



# Reinforcement Learning

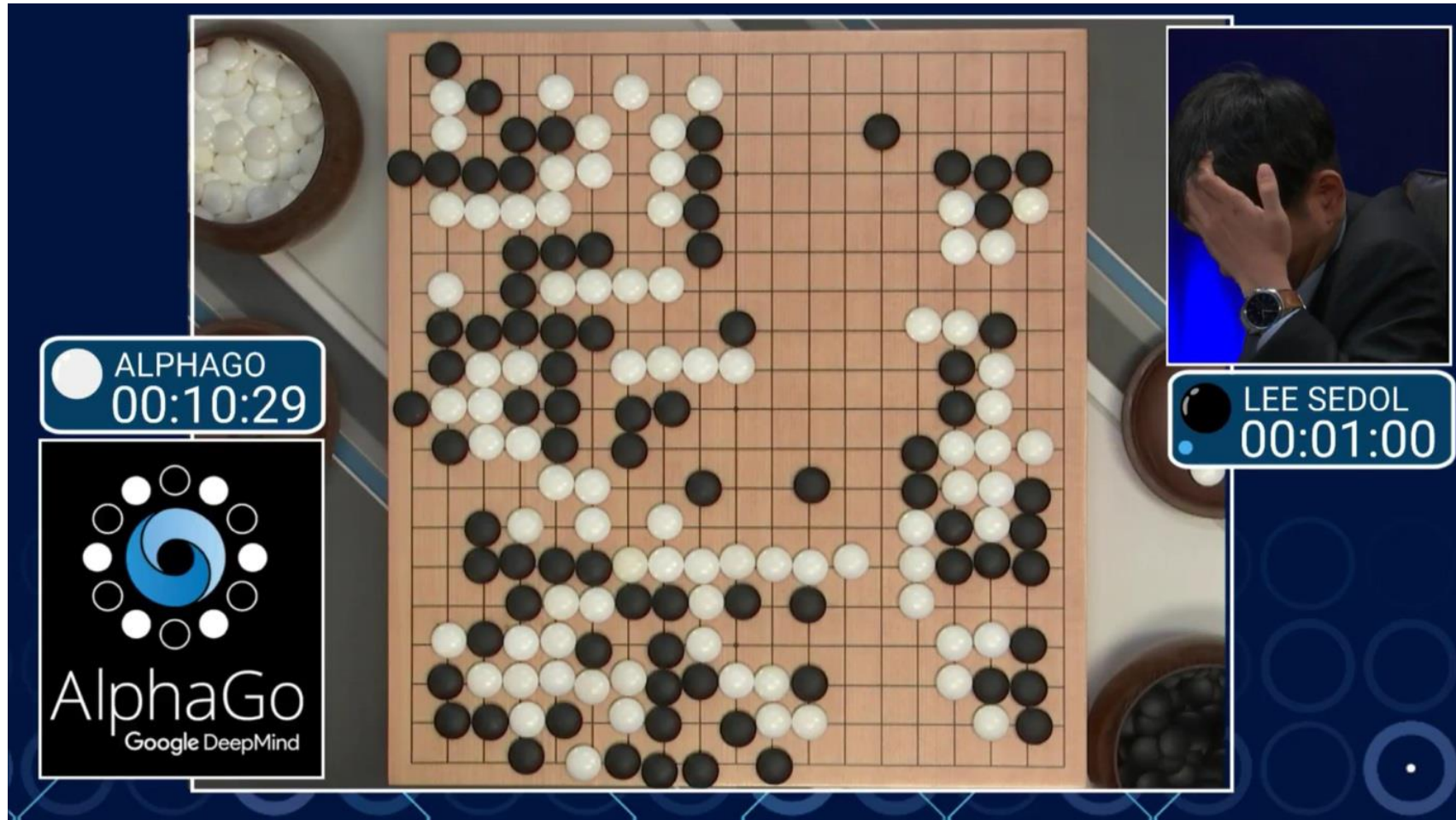
- **Software**-in-the-loop

## AlphaGo Zero





# Strategy Games



# Translation

영어



It was a quintessential Christmas scene: trees strung with lights, vendors serving candied fruit and waffles, the smell of mulled wine wafting through the cold December air.



한국어

번역하기

그것은 전형적인 크리스마스 풍경이었다. 나무로 장식된 과일들과 설탕을 공급하는 과일들이 있고, 12월 공기를 통한 와인 냄새를 맡은 mulled 와인 냄새를 맡았다.

# Auto-captioning

**A person riding a motorcycle on a dirt road.**



**Two dogs play in the grass.**



**A group of young people playing a game of frisbee.**



**Two hockey players are fighting over the puck.**



**A herd of elephants walking across a dry grass field.**



**A close up of a cat laying on a couch.**



## Question Answering

I: Jane went to the hallway.

I: Mary walked to the bathroom.

I: Sandra went to the garden.

I: Daniel went back to the garden.

I: Sandra took the milk there.

Q: Where is the milk?

A: garden

I: It started boring, but then it got interesting.

Q: What's the sentiment?

A: positive

# Why Does It Work Now?



# Five Decades of Research in ML Provided

- a taxonomy of ML concepts
  - classification, generative models, clustering, kernels, linear embeddings, etc.
- a sound statistical formalization
  - Bayesian estimation, PAC
- a clear picture of fundamental issues
  - bias/variance dilemma, VC dimension, generalization bounds, etc.
- a good understanding of optimization issues
- efficient large-scale algorithms
  - In both software and hardware

# The Success of Deep Learning Is Multi-factorial

- Five decades of research in machine learning
- CPUs/GPUs/storage developed for other purposes
- lots of data from “the internet”
- tools and culture of collaborative and reproducible science
- resources and efforts from large corporations

# Why Deep Learning ?

- Many applications require the automatic extraction of “refined” information from raw signal
  - e.g. image recognition, automatic speech processing, natural language processing, robotic control, geometry reconstruction



(ImageNet)

- Our brain is so good at interpreting visual information that the “semantic gap” is hard to assess intuitively.

# Why Deep Learning ?

- Extracting semantic automatically requires models of extreme complexity, which cannot be designed by hand.
- Techniques used in practice consist of
  - defining a parametric model, and
  - optimizing its parameters by “making it work” on training data.
- This is similar to biological systems for which the model (e.g. brain structure) is DNA-encoded, and parameters (e.g. synaptic weights) are tuned through experiences.
- Deep learning encompasses software technologies to scale-up to billions of model parameters and as many training examples.

# Implementing a Deep Network, TensorFlow

# Deep Learning Development Is Usually Done in A Framework:

- A fast, low-level, compiled backend to access computation devices, combined with a slow, high-level, interpreted language.

|                | Language(s)           | License       | Main backer        |
|----------------|-----------------------|---------------|--------------------|
| <b>PyTorch</b> | <b>Python</b>         | BSD           | Facebook           |
| Caffe2         | C++, Python           | Apache        | Facebook           |
| TensorFlow     | Python, C++           | Apache        | Google             |
| MXNet          | Python, C++, R, Scala | Apache        | Amazon             |
| CNTK           | Python, C++           | MIT           | Microsoft          |
| Torch          | Lua                   | BSD           | Facebook           |
| Theano         | Python                | BSD           | U. of Montreal     |
| Caffe          | C++                   | BSD 2 clauses | U. of CA, Berkeley |

- We will use the TensorFlow framework for our experiments.