인공지능 기술 동향과 R&D 전략

2017. 2. 28.

한동대학교 전산전자공학부 김 인 중

한동대학교
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목차

- 인공지능기술 발전 동향
  - 영상인식/생성
  - 자연어처리
  - 새로운 딥러닝 모델

- 인공지능 R&D 전략
  - 인공지능 R&D 문화 및 생태계
  - 인공지능 R&D 활성화 전략

인공지능, 머신러닝, 딥러닝

- 인공지능: 컴퓨터와 SW로 구현한 지능
  - 복잡한 문제, 변화하는 환경, 불확실한 상황에서의 판단
  - 학습, 인식, 추론, 예측, 지식의 획득 및 처리, 자연어처리 등

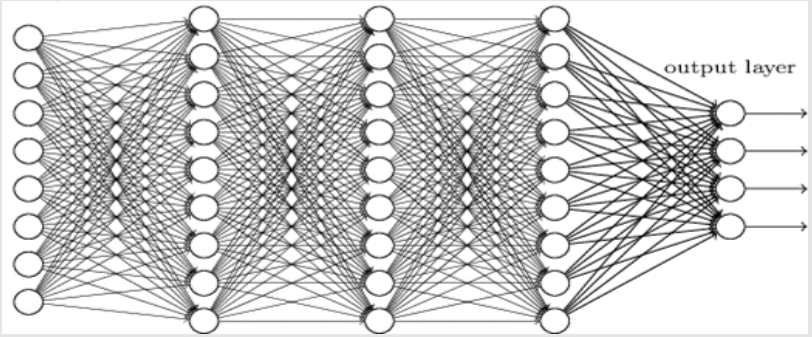
- 머신러닝: 업무 수행에 필요한 지식을 데이터로부터 스스로 습득하는 기술 (data-driven approach)

  cf. knowledge-based approach

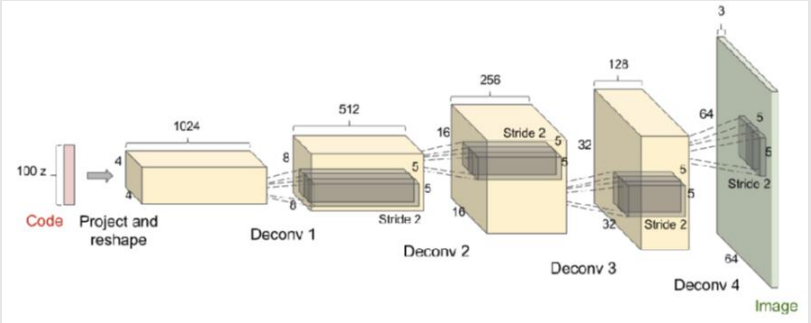
- 딥러닝: 심층신경망을 이용해 데이터로부터 고수준(High-level) 정보를 학습하는 머신러닝 기술
  - 기존 머신러닝 기술보다 탁월한 성능
  - 10여년 동안 지속되던 기술적 정체기를 돌파

주요 딥러닝 모델

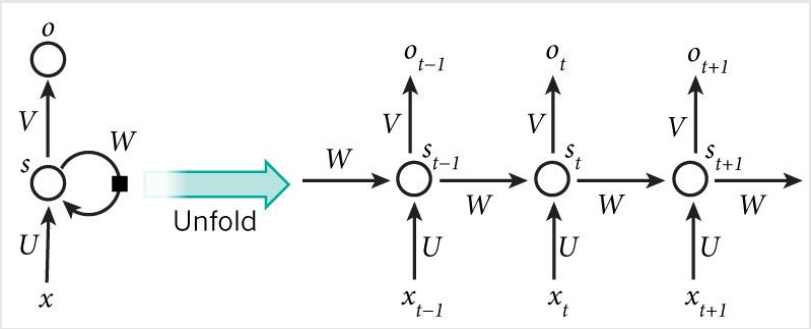
- 심층신경망
  - 일반적인 데이터 처리
  - MLP, SOM, RBF, …
  - RBM, DBN, DBM, …



- 컨볼루션 신경망 (CNN)
  - 영상처리 및 인식
  - Convolution + pooling



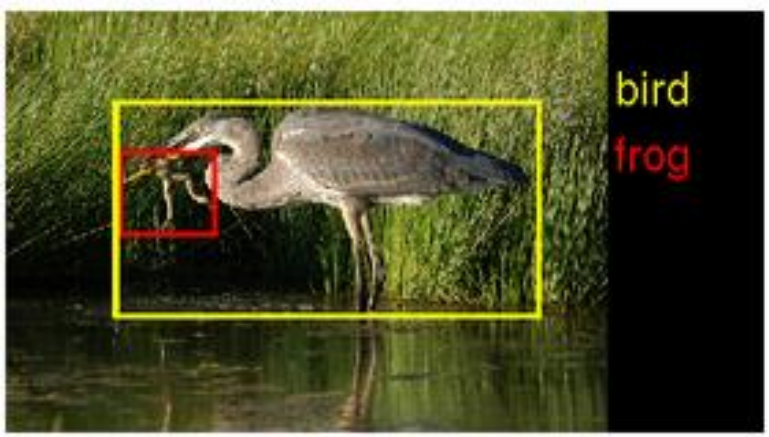
- 순환 신경망 (RNN)
  - 시계열 데이터 처리 및 인식
  - Recurrent connection (memory)

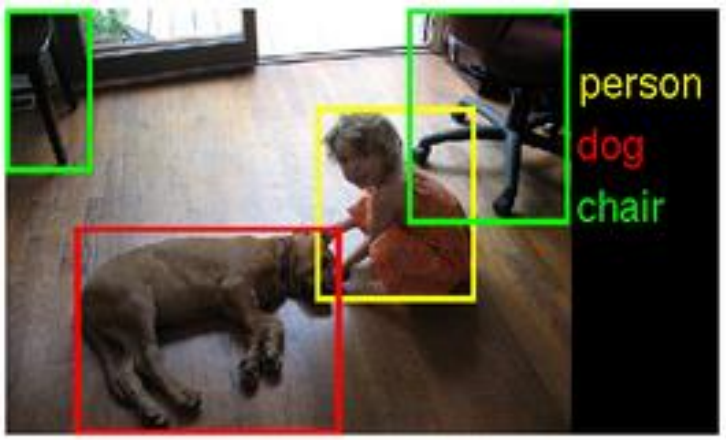


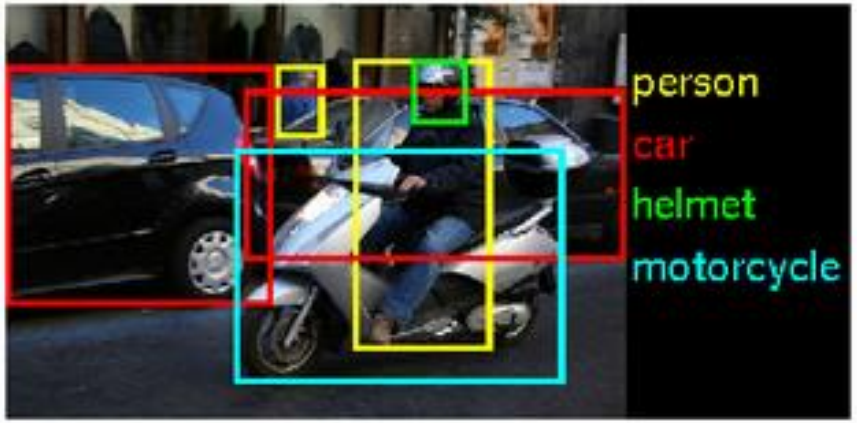
물체영상인식: ImageNet (ILSVRC)

- ImageNet Large Scale Visual Recognition Challenge (http://www.image-net.org)
  - 1000 object categories
  - Training set: 1,281,167 images
  - Validation set: 50,000 images
  - Test set: 100,000 images

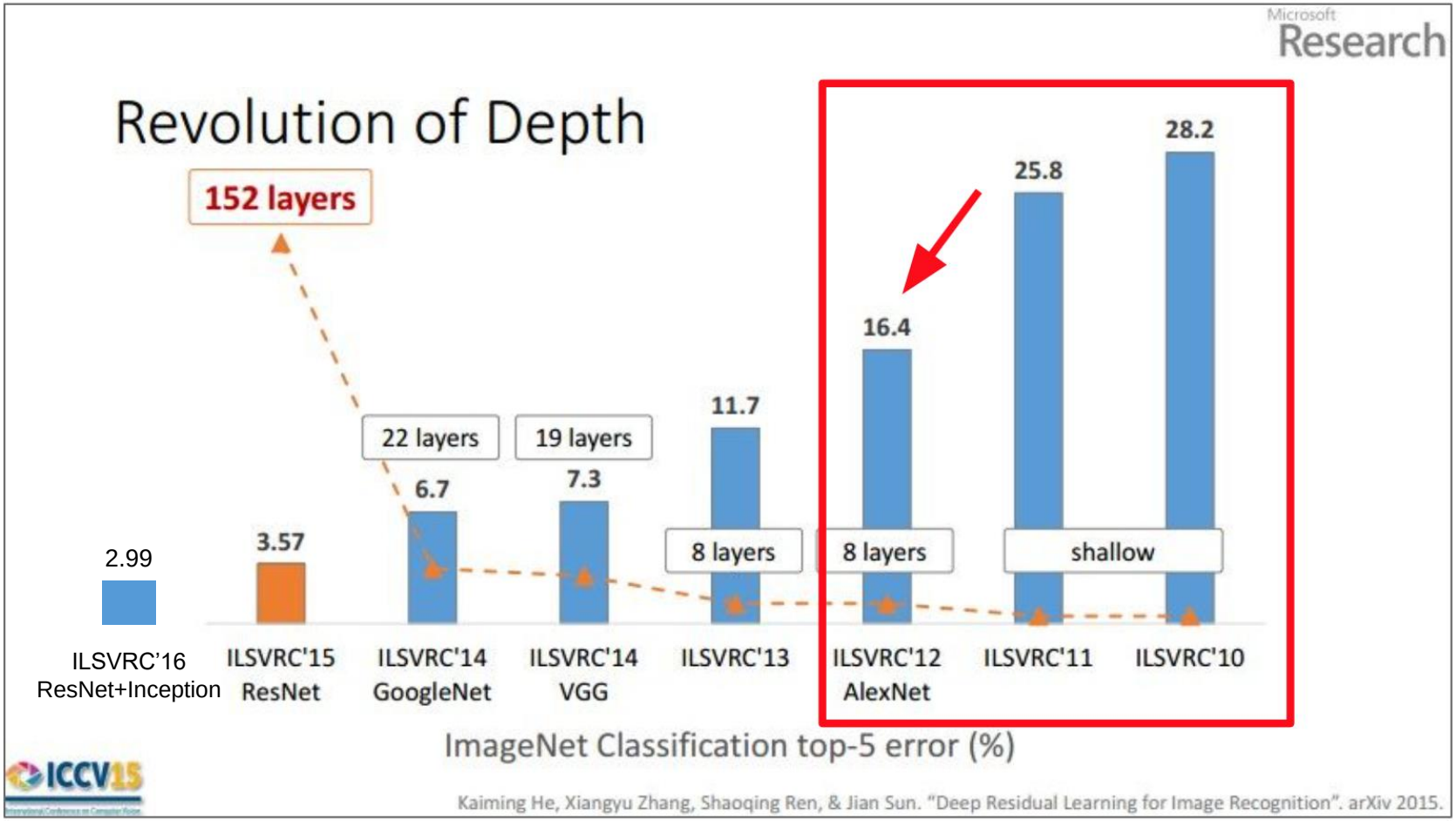
ILSVRC Image Samples







ILSVRC 결과



(slide from Kaiming He's recent presentation)

얼굴인식

- **딥러닝을 이용한 얼굴 인식 사례 (LFW 데이터)**

  - Taigman, et al, “DeepFace: Closing the Gap to Human-Level Performance in Face Verification”, 2014
    - 97.25% on LFW (Labeled Faces in the Wild)

  - Fan, et al, “Learning Deep Face Representation”, 2014
    - 97.30% on LFW

  - Sun, et al, “Deep Learning Face Representation from Predicting 10,000 Classes”, 2014
    - 99.15 on LFW

  - Shroff, et al, “FaceNet: A Unified Embedding for Face Recognition and Clustering”, 2015
    - 99.63% on LFW
    - 95.12% on YouTube Face DB

DeepFace [Taigman2014]

- Feature extraction by CNN
  - Train a CNN-based face recognizer
  - Represent the input face image by the output of (N-1)th layer

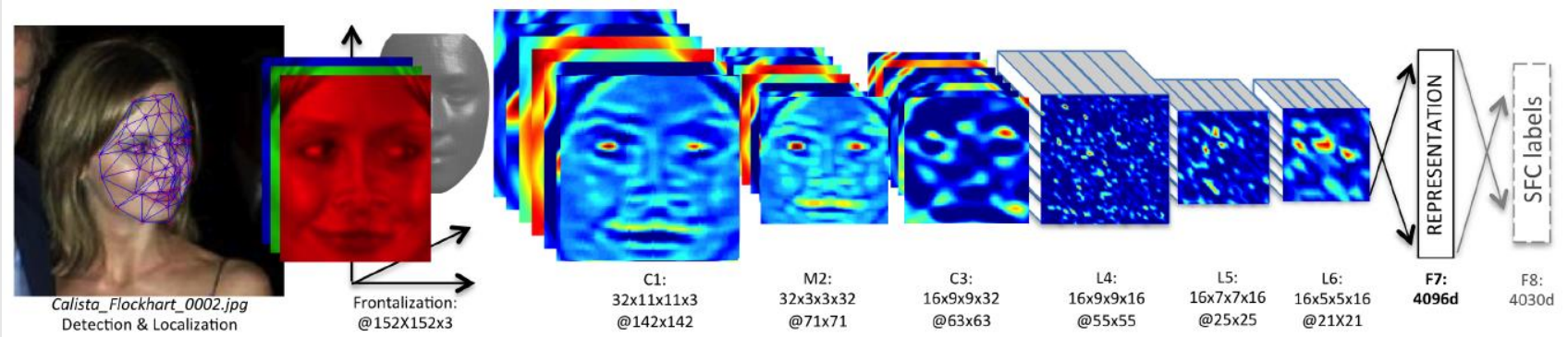


Figure 2. **Outline of the *DeepFace* architecture**. A front-end of a single convolution-pooling-convolution filtering on the rectified input, followed by three locally-connected layers and two fully-connected layers. Colors illustrate outputs for each layer. The net includes more than 120 million parameters, where more than 95% come from the local and fully connected layers.

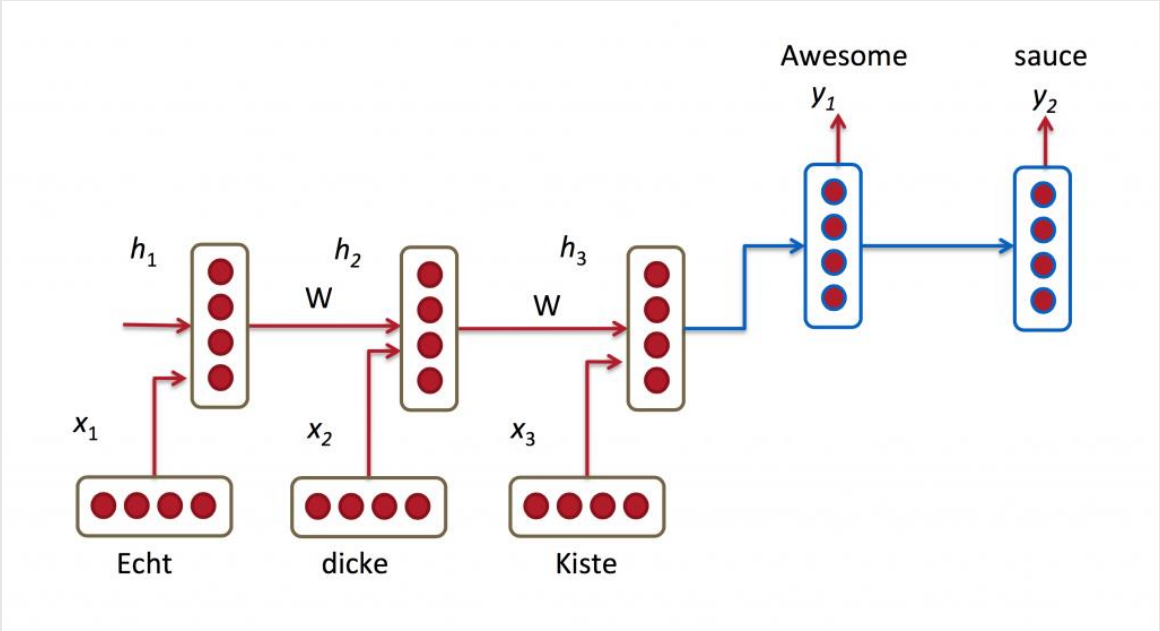
LFW 데이터에 대한 성능

Dahua-FaceImage[80]	0.9978 ± 0.0007	DeepID2+[55]	0.9947 ± 0.0012
AuthenMetric[65]	0.9977 ± 0.0009	ColorReco[76]	0.9940 ± 0.0022
Baidu[64]	0.9977 ± 0.0006	Faceall[71]	0.9940 ± 0.0010
THU CV-AI Lab[88]	0.9973 ± 0.0008	DeepID2[48]	0.9915 ± 0.0013
Samtech Facequest[84]	0.9971 ± 0.0018	MMDFR67	0.9902 ± 0.0019
Daream[78]	0.9968 ± 0.0009	Uni-Ubi[60]	0.9900 ± 0.0032
Easen Electron[81]	0.9968 ± 0.0009	XYZ Robot[87]	0.9895 ± 0.0020
Tencent-BestImage[63]	0.9965 ± 0.0025	JustMeTalk[72]	0.9887 ± 0.0016
FaceNet62	0.9963 ± 0.0009	GaussianFace[47]	0.9852 ± 0.0066
PingAn Tech[89]	0.9960 ± 0.0031	Asaphus[77]	0.9815 ± 0.0039
Facevisa[74]	0.9955 ± 0.0014	betaface.com[56]	0.9808 ± 0.0016
DeepID3[57]	0.9953 ± 0.0010	pose+shape+expression augmentation75	0.9807 ± 0.0060
Face++[40]	0.9950 ± 0.0036	DeepID46	0.9745 ± 0.0026
CW-DNA-1[70]	0.9950 ± 0.0022	DeepFace-ensemble41	0.9735 ± 0.0025

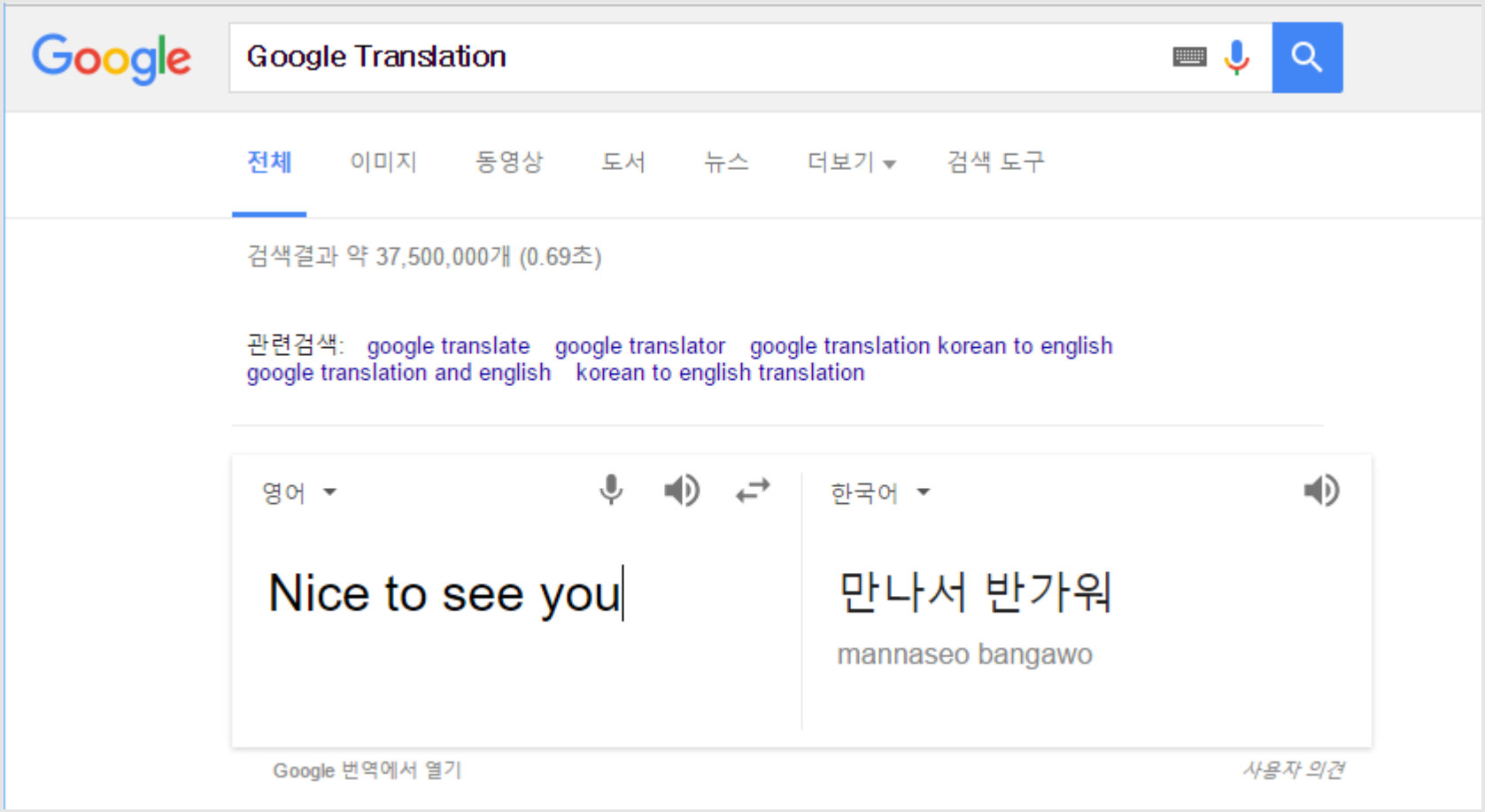
Source: http://vis-www.cs.umass.edu/lfw/results.html

신경망 기계 번역 (Neural Machine Translation)

- Encoder와 decoder로 구성
  - Encoder: 입력문장 -> 벡터
  - Decoder: 벡터 -> 출력문장 (다른 언어)

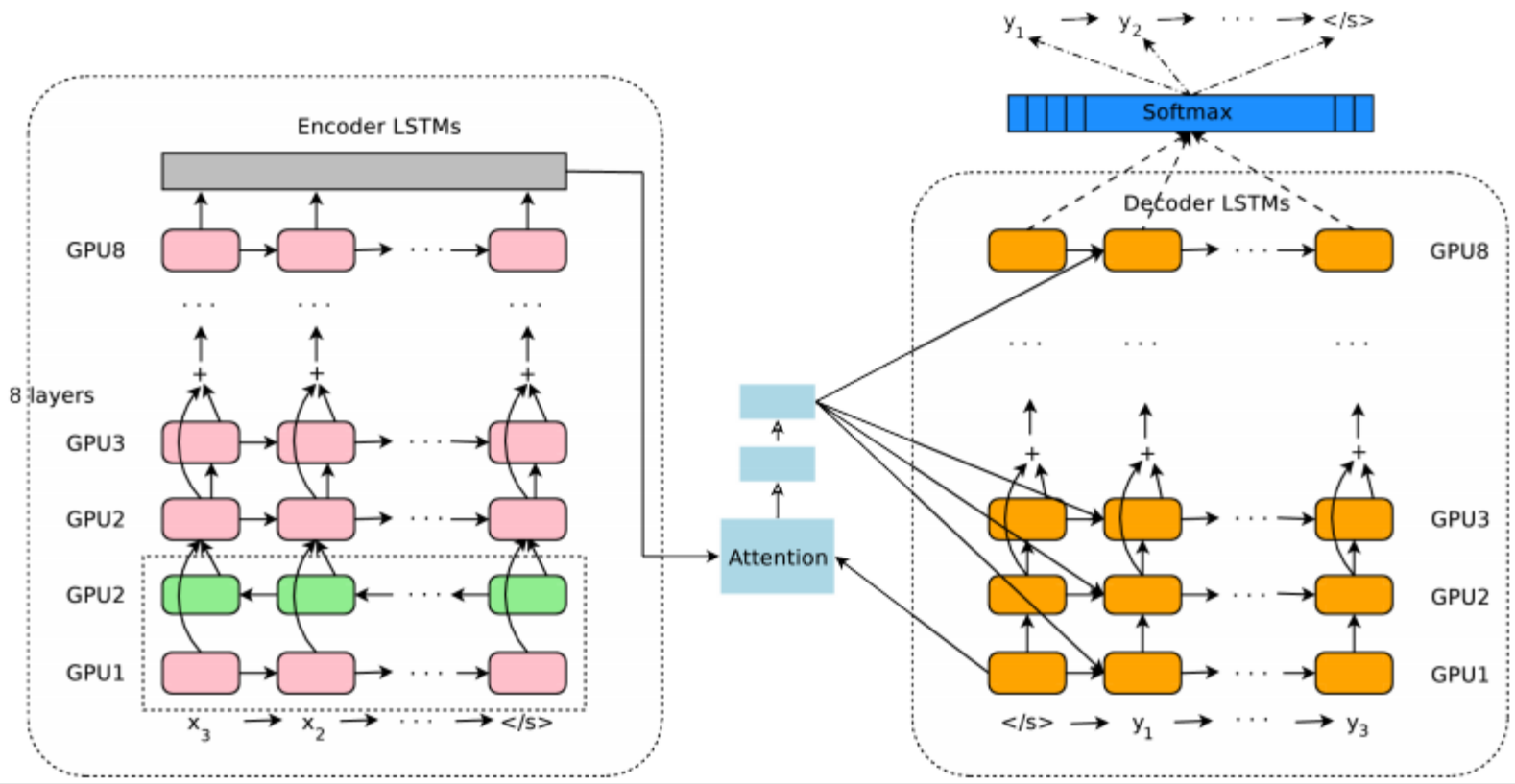


구글번역


Google
Google Translation
전체
이미지
동영상
도서
뉴스
더보기
검색 도구
검색결과 약 37,500,000개 (0.69초)
관련검색: google translate google translator google translation korean to english
google translation and english korean to english translation
영어
Nice to see you
한국어
만나서 반가워
mannaseo bangawo
Google 번역에서 열기
사용자 의견

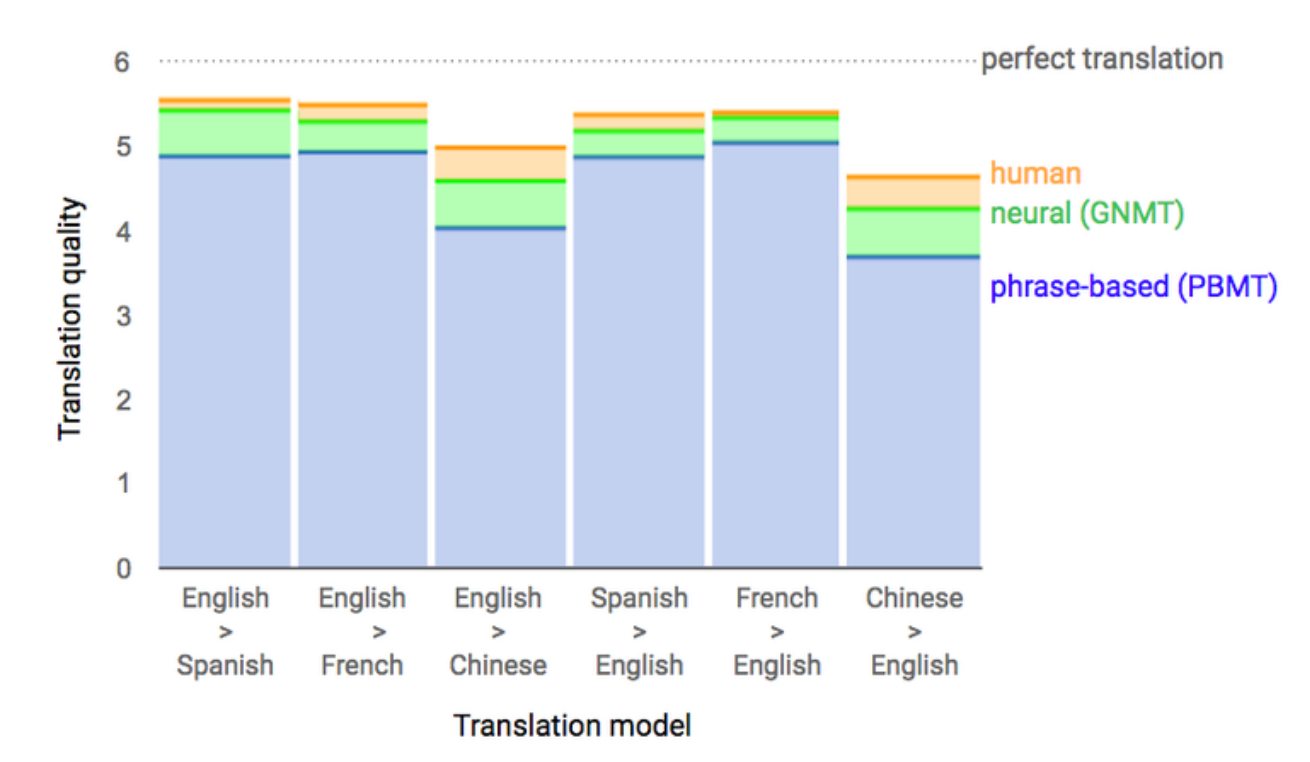
구글번역

- Google Neural Machine Translation (GNMT)
  - Word embedding + Deep Bidirectional LSTM + attention model



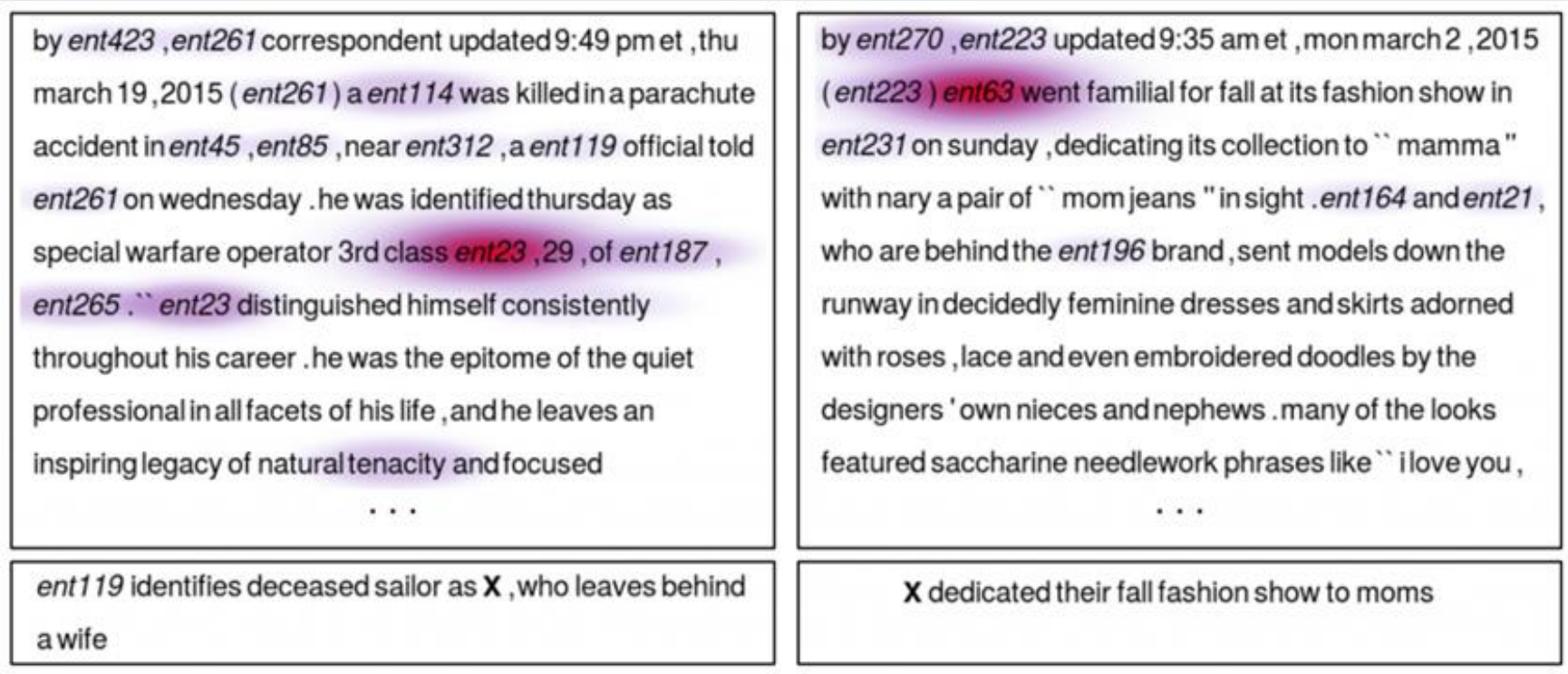
구글번역 성능

- Performance of Google Neural Machine Translation (GNMT)

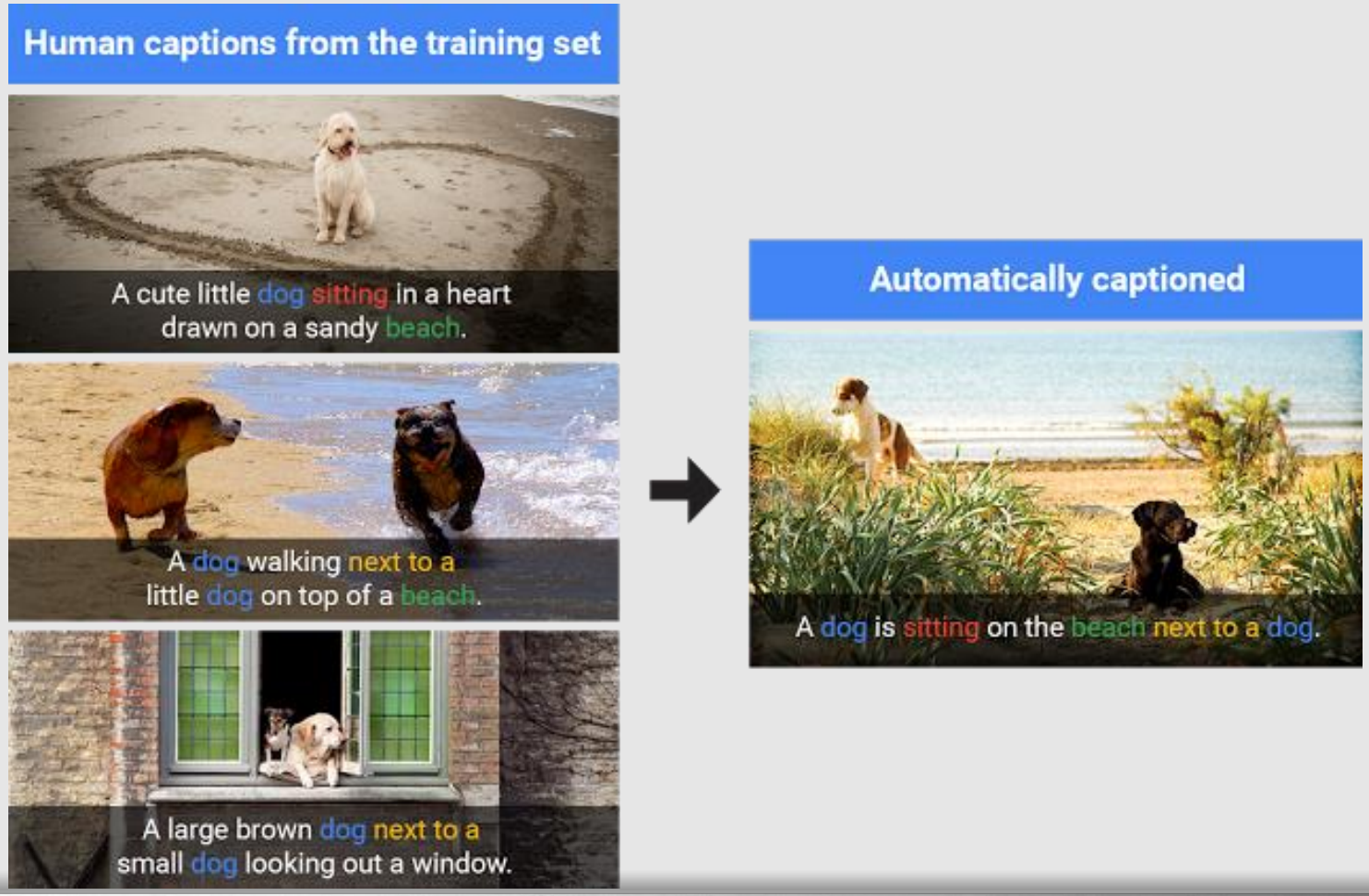


질의응답

- Hermann, et.al, “Teaching Machines to Read and Comprehend,” 2015.



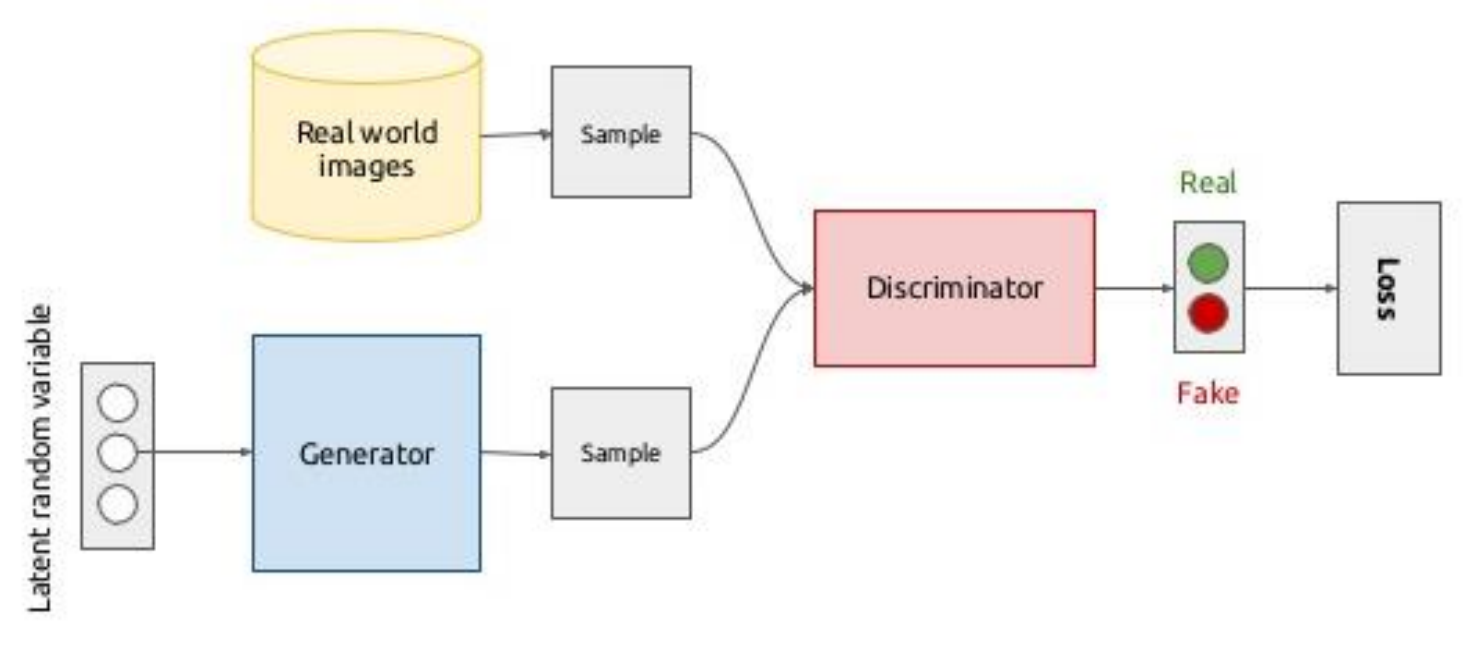
영상자막 자동생성


Human captions from the training set
A cute little dog sitting in a heart drawn on a sandy beach.
A dog walking next to a little dog on top of a beach.
A large brown dog next to a small dog looking out a window.
Automatically captioned
A dog is sitting on the beach next to a dog.

Generative Adversarial Networks (GANs)

- I. Goodfellow, et.al, “Generative Adversarial Nets,” 2014.

$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))]$$



Generative Adversarial Networks (GANs)

- I. Goodfellow, et.al, “Generative Adversarial Nets,” 2014.

Figure 3: Generated bedrooms after five epochs of training. There appears to be evidence of visual under-fitting via repeated noise textures across multiple samples such as the base boards of some of the beds.

Generative Adversarial Networks (GANs)

- Image-to-Image translation [Isola16]

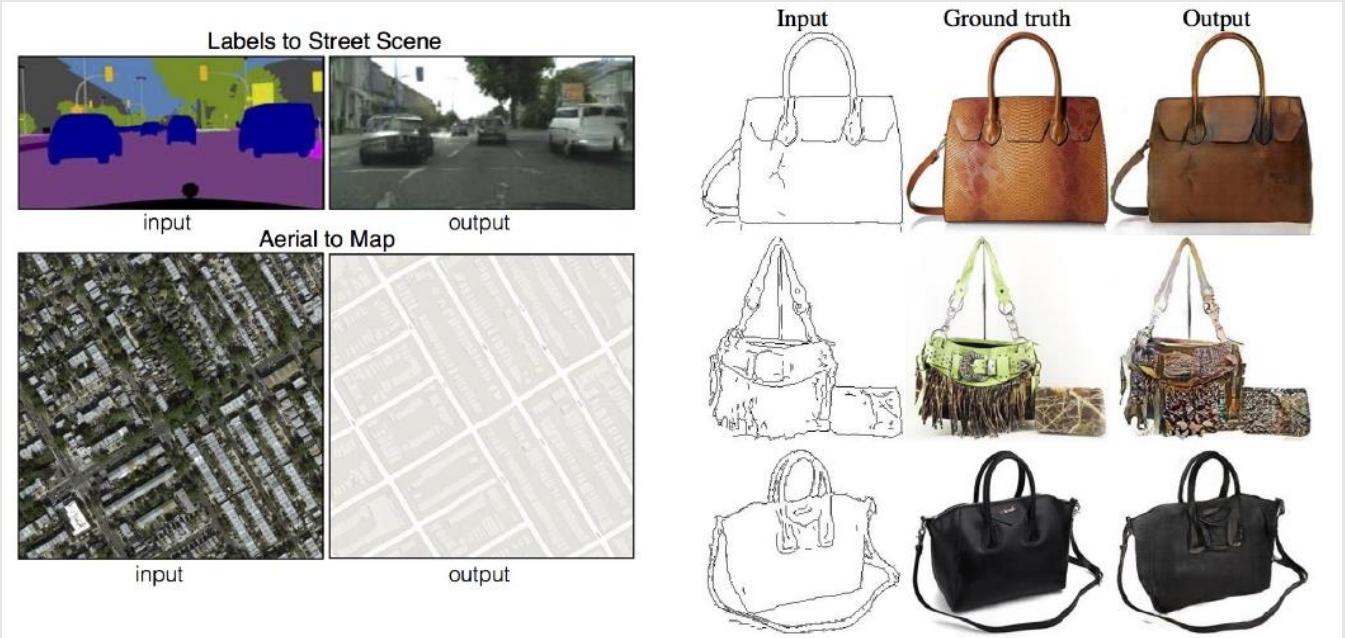
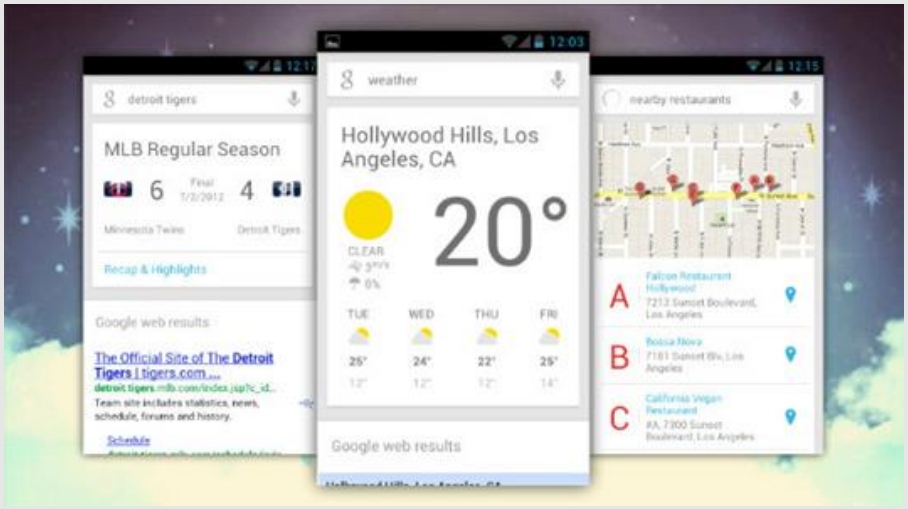


Figure 7: Isola *et al.* (2016) created a concept they called image to image translation, encompassing many kinds of transformations of an image: converting a satellite photo into a map, coverting a sketch into a photorealistic image, etc. Because many of these conversion processes have multiple correct outputs for each input, it is necessary to use generative modeling to train the model correctly. In particular, Isola *et al.* (2016) use a GAN. Image to image translation provides many examples of how a creative algorithm designer can find several unanticipated uses for generative models. In the future, presumably many more such creative uses will be found.

인공지능 비서


detroit tigers
MLB Regular Season
6
Final
4
Recap & Highlights
Google web results
The Official Site of The Detroit Tigers | tigers.com ...
weather
Hollywood Hills, Los Angeles, CA
20°
CLEAR
TUE
WED
THU
FRI
25°
24°
22°
25°
Google web results
nearby restaurants
A
B
C


Hi. I'm Cortana.
What Can I Help You?


Siri

인공지능 스피커

- 아마존 Echo (Alexa)

- 구글 홈

인공지능 의료 시스템

경향비즈

"인공지능 왓슨, 암진단 정확도 96%…전문의보다 높아"

주영재 기자 jyj@kyunghyang.com

입력 : 2016.03.29 16:24:52 | 수정 : 2016.03.29 16:30:58

Photo by Sean Gallup/Getty Images

인공지능이 전문의보다 더 높은 정확도로 암을 진단하는 시대가 도래했다. 인공지능 '알파고'의 학습 원리로 관심을 받고 있는 '딥러닝' 알고리즘도 의료 서비스에 적용되고 있다.

자율주행차

Skype Translator

- Speech recognition + machine translation + speech generation

새로운 딥러닝 모델

- Memory Networks [Weston15]
  - 명시적 메모리를 갖는 신경망

- Neural Turing machines [Graves14]

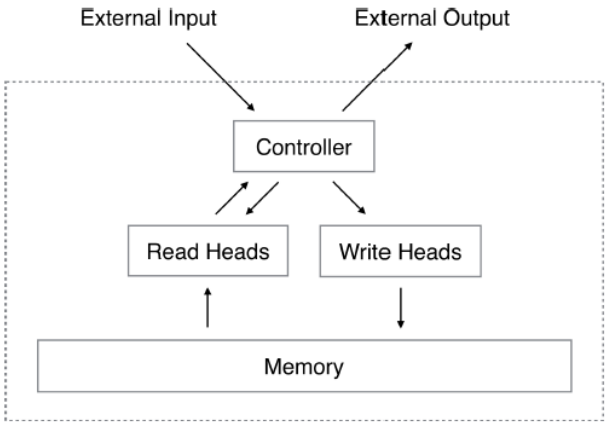


Figure 1: Neural Turing Machine Architecture. During each update cycle, the controller network receives inputs from an external environment and emits outputs in response. It also reads to and writes from a memory matrix via a set of parallel read and write heads. The dashed line indicates the division between the NTM circuit and the outside world.

새로운 딥러닝 모델

- PathNet: 다중 작업을 위한 하나의 거대 신경망 [Fernando17]

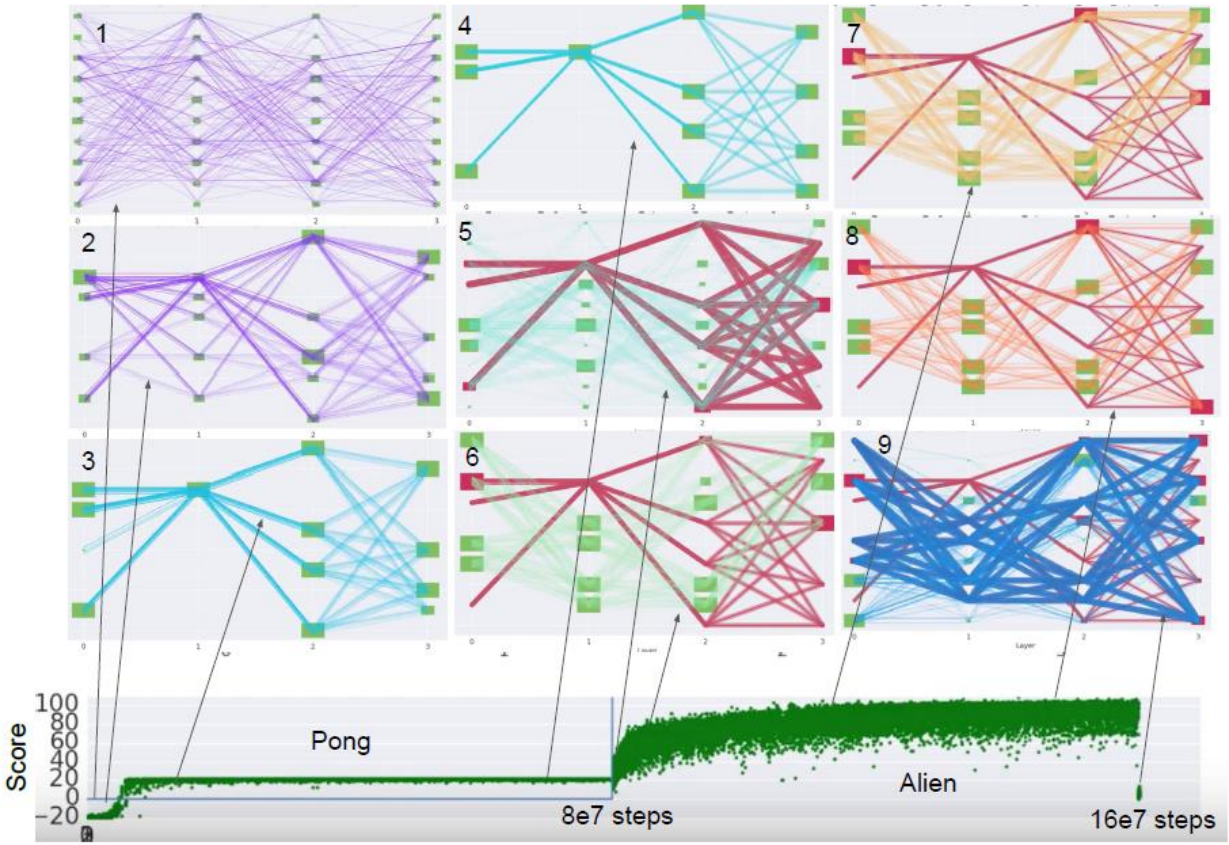


Figure 1: A population of randomly initialized pathways (purple lines in Box 1) are evolved whilst learning task A, Pong. At the end of training, the best pathway is fixed (dark red lines in Box 5) and a new population of paths are generated (light blue lines in Box 5) for task B. This population is then trained on Alien and the optimal pathway that is evolved on Alien is subsequently fixed at the end of training, shown as dark blue lines in Box 9.

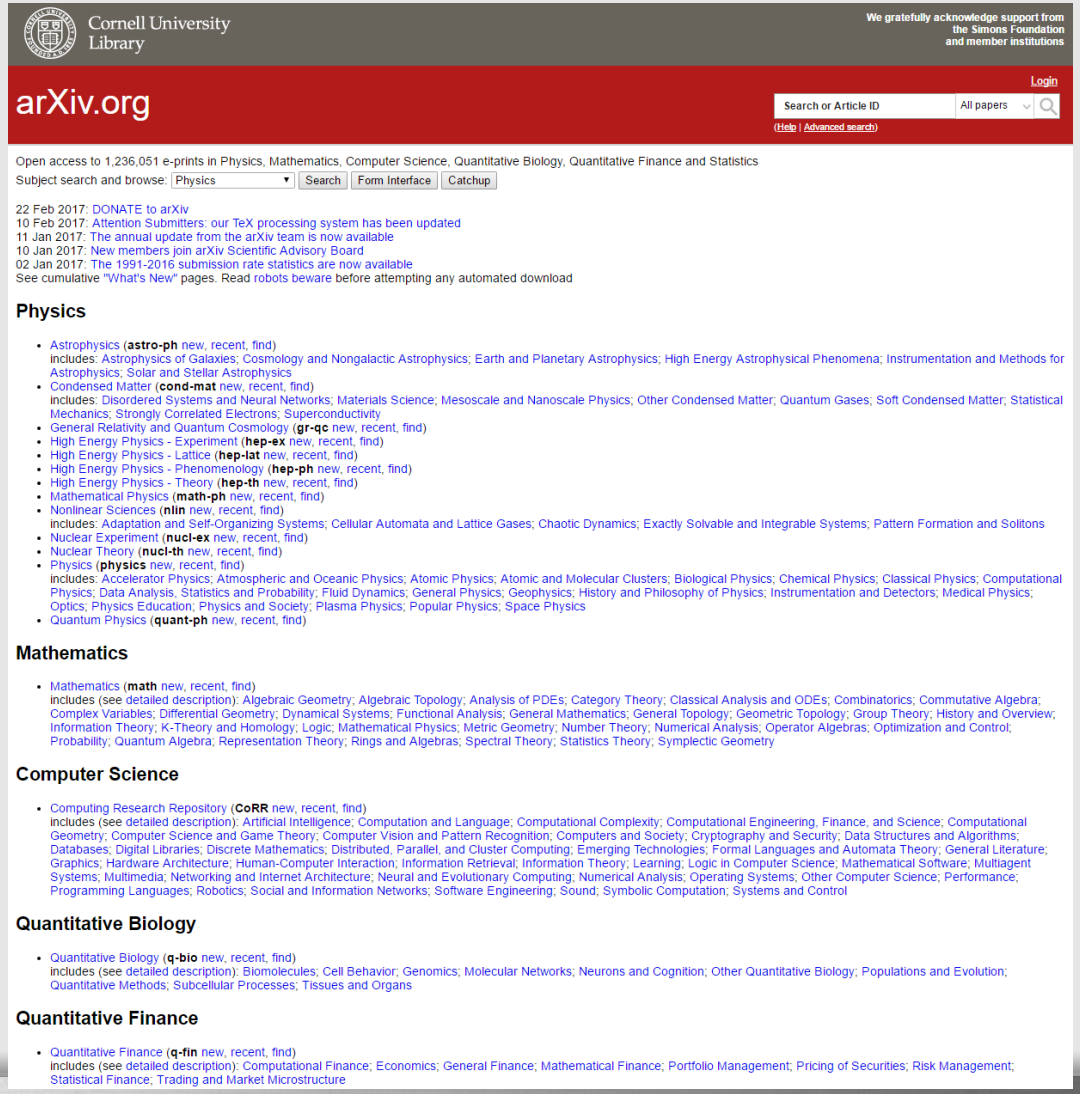
목차

선진국의 인공지능 R&D 문화

- Leading groups
  - Hinton, LeCun, Bengio, Ng, Schmidhuber, …
- 빠른 기술 공개
  - Conferences, arXiv
- 오픈소스

arXiv Open e-Print Library

- Repository of electronic-preprints
  - Submission rate >= 8,000 papers per month



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22 Feb 2017: DONATE to arXiv
10 Feb 2017: Attention Submitters: our TeX processing system has been updated
11 Jan 2017: The annual update from the arXiv team is now available
10 Jan 2017: New members join arXiv Scientific Advisory Board
02 Jan 2017: The 1991-2016 submission rate statistics are now available
See cumulative "What's New" pages. Read robots beware before attempting any automated download

Physics

- Astrophysics (**astro-ph** new, recent, find)
  includes: Astrophysics of Galaxies; Cosmology and Nongalactic Astrophysics; Earth and Planetary Astrophysics; High Energy Astrophysical Phenomena; Instrumentation and Methods for Astrophysics; Solar and Stellar Astrophysics
- Condensed Matter (**cond-mat** new, recent, find)
  includes: Disordered Systems and Neural Networks; Materials Science; Mesoscale and Nanoscale Physics; Other Condensed Matter; Quantum Gases; Soft Condensed Matter; Statistical Mechanics; Strongly Correlated Electrons; Superconductivity
- General Relativity and Quantum Cosmology (**gr-qc** new, recent, find)
- High Energy Physics - Experiment (**hep-ex** new, recent, find)
- High Energy Physics - Lattice (**hep-lat** new, recent, find)
- High Energy Physics - Phenomenology (**hep-ph** new, recent, find)
- High Energy Physics - Theory (**hep-th** new, recent, find)
- Mathematical Physics (**math-ph** new, recent, find)
- Nonlinear Sciences (**nlin** new, recent, find)
  includes: Adaptation and Self-Organizing Systems; Cellular Automata and Lattice Gases; Chaotic Dynamics; Exactly Solvable and Integrable Systems; Pattern Formation and Solitons
- Nuclear Experiment (**nucl-ex** new, recent, find)
- Nuclear Theory (**nucl-th** new, recent, find)
- Physics (**physics** new, recent, find)
  includes: Accelerator Physics; Atmospheric and Oceanic Physics; Atomic Physics; Atomic and Molecular Clusters; Biological Physics; Chemical Physics; Classical Physics; Computational Physics; Data Analysis, Statistics and Probability; Fluid Dynamics; General Physics; Geophysics; History and Philosophy of Physics; Instrumentation and Detectors; Medical Physics; Optics; Physics Education; Physics and Society; Plasma Physics; Popular Physics; Space Physics
- Quantum Physics (**quant-ph** new, recent, find)

Mathematics

- Mathematics (**math** new, recent, find)
  includes (see detailed description): Algebraic Geometry; Algebraic Topology; Analysis of PDEs; Category Theory; Classical Analysis and ODEs; Combinatorics; Commutative Algebra; Complex Variables; Differential Geometry; Dynamical Systems; Functional Analysis; General Mathematics; General Topology; Geometric Topology; Group Theory; History and Overview; Information Theory; K-Theory and Homology; Logic; Mathematical Physics; Metric Geometry; Number Theory; Numerical Analysis; Operator Algebras; Optimization and Control; Probability; Quantum Algebra; Representation Theory; Rings and Algebras; Spectral Theory; Statistics Theory; Symplectic Geometry

Computer Science

- Computing Research Repository (**CoRR** new, recent, find)
  includes (see detailed description): Artificial Intelligence; Computation and Language; Computational Complexity; Computational Engineering, Finance, and Science; Computational Geometry; Computer Science and Game Theory; Computer Vision and Pattern Recognition; Computers and Society; Cryptography and Security; Data Structures and Algorithms; Databases; Digital Libraries; Discrete Mathematics; Distributed, Parallel, and Cluster Computing; Emerging Technologies; Formal Languages and Automata Theory; General Literature; Graphics; Hardware Architecture; Human-Computer Interaction; Information Retrieval; Information Theory; Learning; Logic in Computer Science; Mathematical Software; Multiagent Systems; Multimedia; Networking and Internet Architecture; Neural and Evolutionary Computing; Numerical Analysis; Operating Systems; Other Computer Science; Performance; Programming Languages; Robotics; Social and Information Networks; Software Engineering; Sound; Symbolic Computation; Systems and Control

Quantitative Biology

- Quantitative Biology (**q-bio** new, recent, find)
  includes (see detailed description): Biomolecules; Cell Behavior; Genomics; Molecular Networks; Neurons and Cognition; Other Quantitative Biology; Populations and Evolution; Quantitative Methods; Subcellular Processes; Tissues and Organs

Quantitative Finance

- Quantitative Finance (**q-fin** new, recent, find)
  includes (see detailed description): Computational Finance; Economics; General Finance; Mathematical Finance; Portfolio Management; Pricing of Securities; Risk Management; Statistical Finance; Trading and Market Microstructure

주요 딥러닝 오픈소스

- Caffe (http://caffe.berkeleyvision.org)
  - BVLC (Berkeley Vision and Learning Center)
  - CNN, Vision, C++
- TensorFlow (http://www.tensorflow.org)
  - Google
  - CNN, RNN, Multi-GPU, Cloud, Tensor-board
- Torch (http://torch.ch)
  - NYU, Facebook, DeepMind, Twitter
  - Fast
- Theano (http://deeplearning.net/software/theano)
  - The Theano Development Team
  - Fast

선진국의 인공지능 생태계

- SW 기업 주도
  - Google, Amazon, Facebook, Baidu, Tesla, Microsoft, …
  - 연구진 + 데이터 + 컴퓨팅 인프라
- 대학 – 기업간 협력
  - Toronto Univ. NYU, Montreal Univ., Stanford, …
- 기술투자 선순환 고리 형성
  - 기술발전 → 서비스 창출/개선 → 수익증가 → 투자 → 기술발전

인공지능 R&D 활성화 전략

- 전문가 육성
  - 이론/알고리즘 전문가 vs. 응용 시스템 개발자
  - 신규 인재 배출 vs. 기존 인재 재교육
- 공공 데이터 구축/공개
  - 한국인 필체, 음성, 얼굴영상 등
  - 한-영 문장 별 말뭉치
- 컴퓨팅 인프라 지원
  - 벤처/연구실 GPU 서버 확보 지원
- 대학-기업 간 인적 교류 강화
  - 대학 교수의 산업체 활동 활성화

인공지능 R&D 활성화 전략

- 성능 평가 컨테스트
  - 데이터 구축, 컴퓨팅 인프라 지원과 연계

- 대학/연구소 평가 체계 개선
  - 학회논문 인정 (SCI보다 빠름)
  - 컨테스트 우수 결과 인정
  - 오픈소스 공헌 인정

- 중장기적 관점에서 개방적 R&D 문화 및 생태계 구축
  예) TensorFlow 공개

- 제도개선에 의한 기술 발전 수용
  예) 자율주행차, 의료진단 시스템