

Deep Learning Applications

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Outline

Introduction

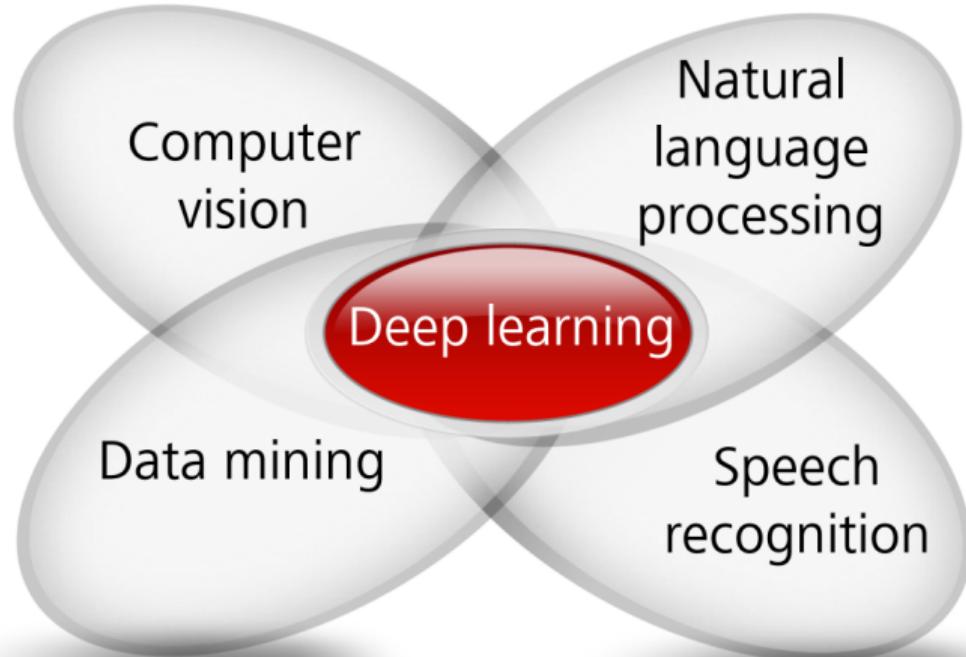
Computer Vision

Natural Language Processing (NLP)

Generative Adversarial Networks



Introduction



Computer Vision

- ▶ Image classification.
- ▶ Scene recognition.
- ▶ Face detection and recognition.
- ▶ Object detection and recognition.
- ▶ Semantic segmentation.
- ▶ Style transfer.
- ▶ Super-resolution.
- ▶ Optical Character Recognition (OCR).

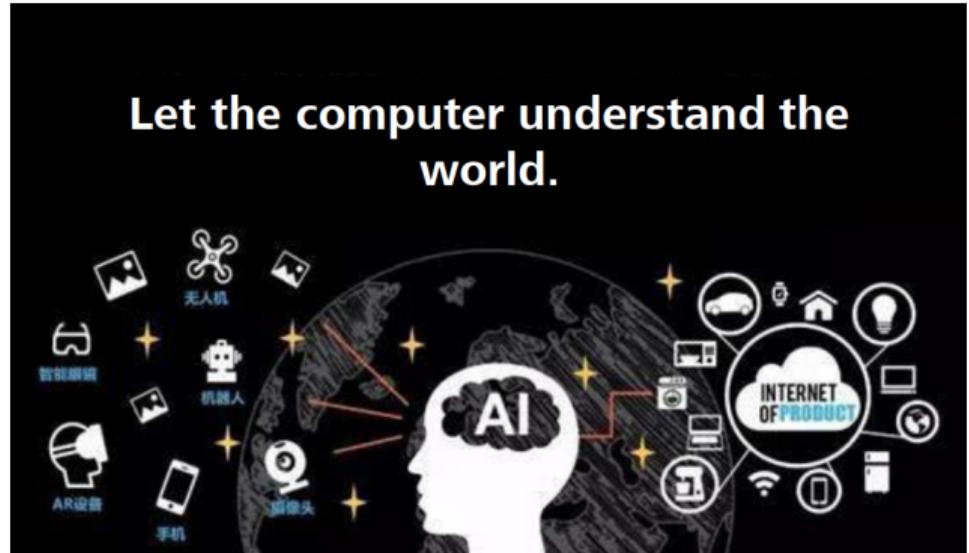


Image Classification

Maps images to different class sets, which can be used for:

- ▶ image retrieval, and;
- ▶ image archiving.



mite

container ship

motor scooter

leopard

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



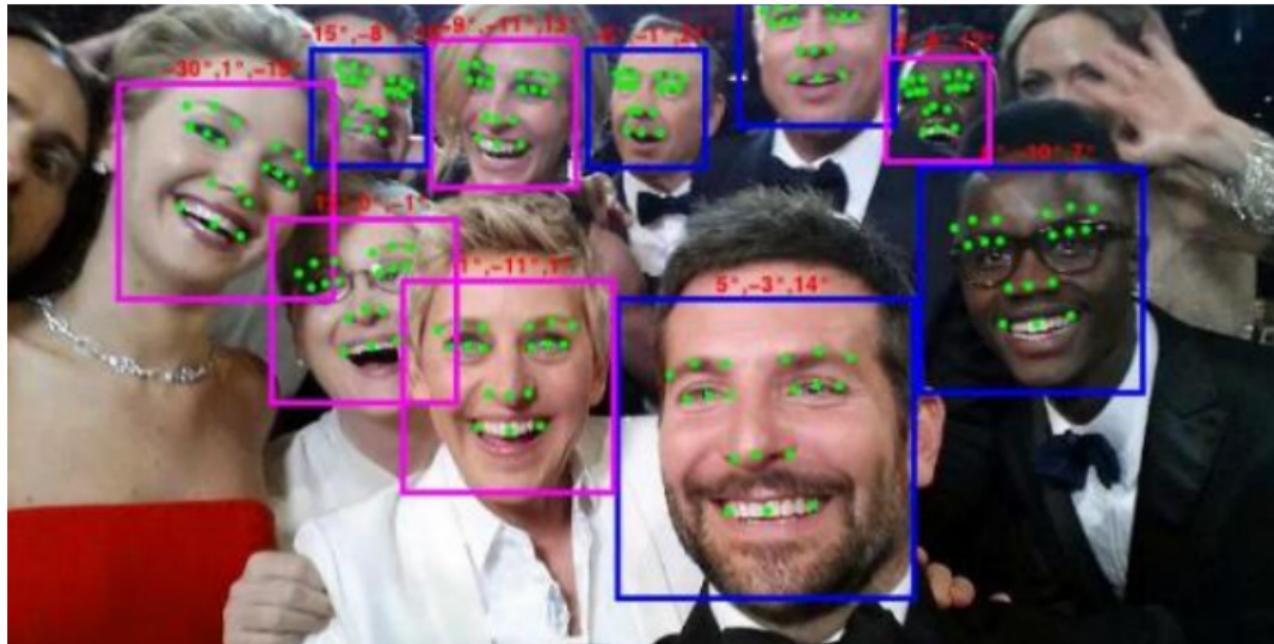
Scene Recognition

Classifies images based on scenes and environments, which can be used for situation awareness and intelligent 3A for photographing.



Face Detection

Discovers and locates faces and facial features in images, which can be used for face focusing, polishing up, and augmented reality.



Face recognition

Differentiates people, which can be used for identity authentication and privacy protection.



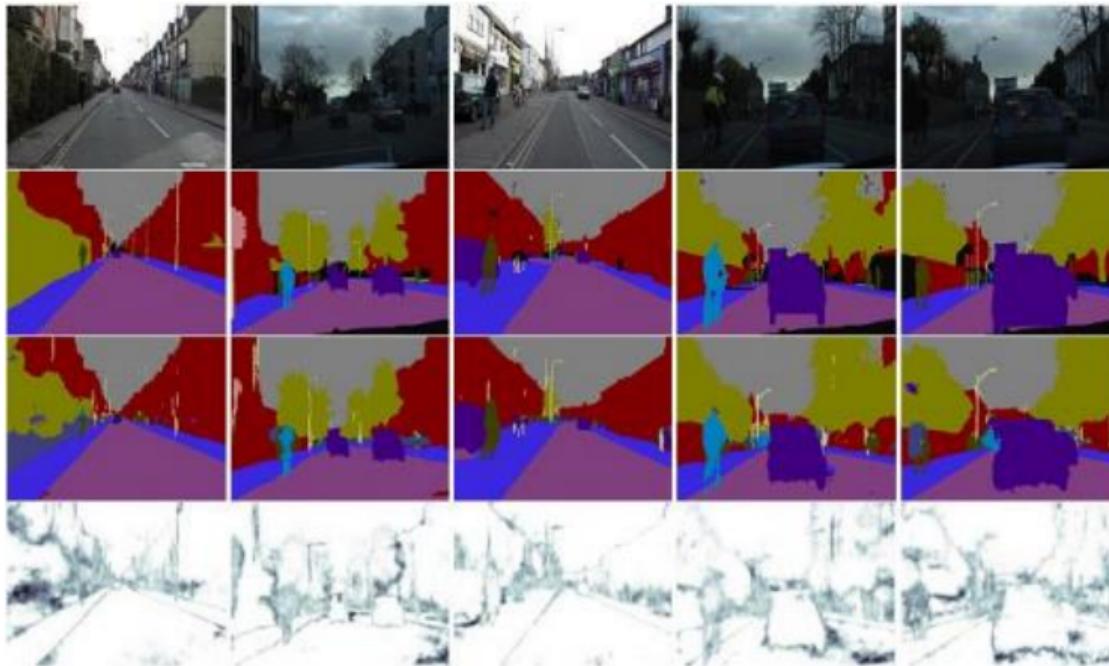
Object Detection and Recognition

Detects, locates, and identifies different objects in images, including digital, text, and pedestrian detection. This function can be used for OCR, unmanned driving, and intelligent image tailoring.



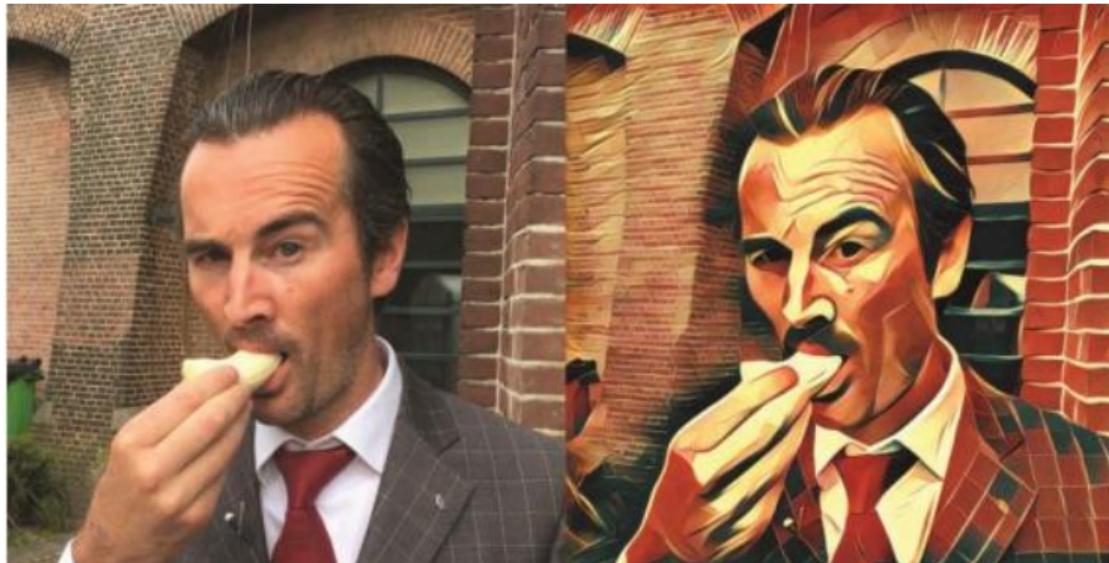
Semantic Segmentation

Predicts the label of each pixel in the image, including segmentation and recognition.
It can be used for unmanned driving, augmented reality, and situation awareness.



Style Transfer (Stylization)

Changes the image style while retaining the content of the image, which can be used for stylized image processing.



Super-resolution

Generates high-resolution images from low-resolution images, which can be used for image processing, security surveillance, and medical imaging.



| Ground Truth | Bicubic | Ours (ℓ_{pixel}) | SRCNN [11] | Ours (ℓ_{feat}) |
|--------------|----------------|-------------------------|----------------|------------------------|
| This image | 31.78 / 0.8577 | 31.47 / 0.8573 | 32.99 / 0.8784 | 29.24 / 0.7841 |
| Set5 mean | 28.43 / 0.8114 | 28.40 / 0.8205 | 30.48 / 0.8628 | 27.09 / 0.7680 |



| Ground Truth | Bicubic | Ours (ℓ_{pixel}) | SRCNN [11] | Ours (ℓ_{feat}) |
|--------------|----------------|-------------------------|----------------|------------------------|
| This Image | 21.69 / 0.5840 | 21.66 / 0.5881 | 22.53 / 0.6524 | 21.04 / 0.6116 |
| Set14 mean | 25.99 / 0.7301 | 25.75 / 0.6994 | 27.49 / 0.7503 | 24.99 / 0.6731 |
| BSD100 mean | 25.96 / 0.682 | 25.91 / 0.6680 | 26.90 / 0.7101 | 24.95 / 0.6317 |

OCR

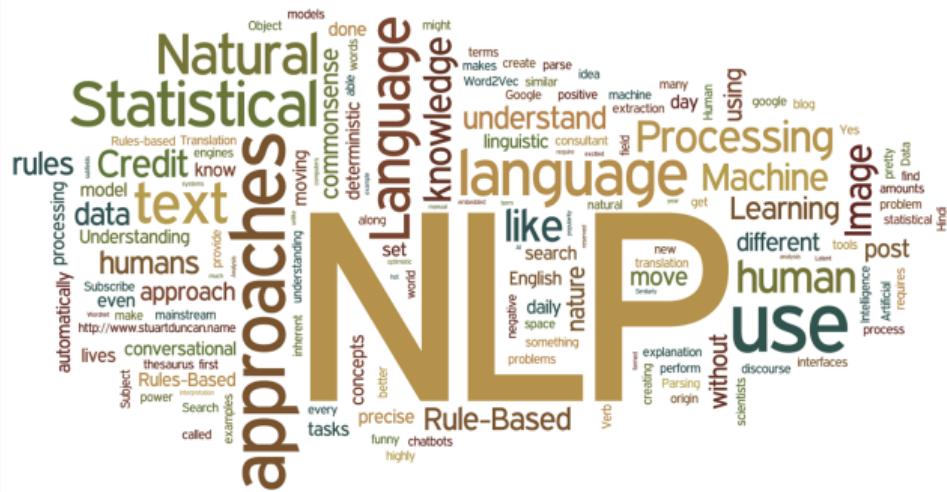
Identifies information such as numbers and texts in images to digitize images or paper documents, which can be used to automatically identify business cards or scan invoices.



Natural Language Processing (NLP)

Natural Language Processing

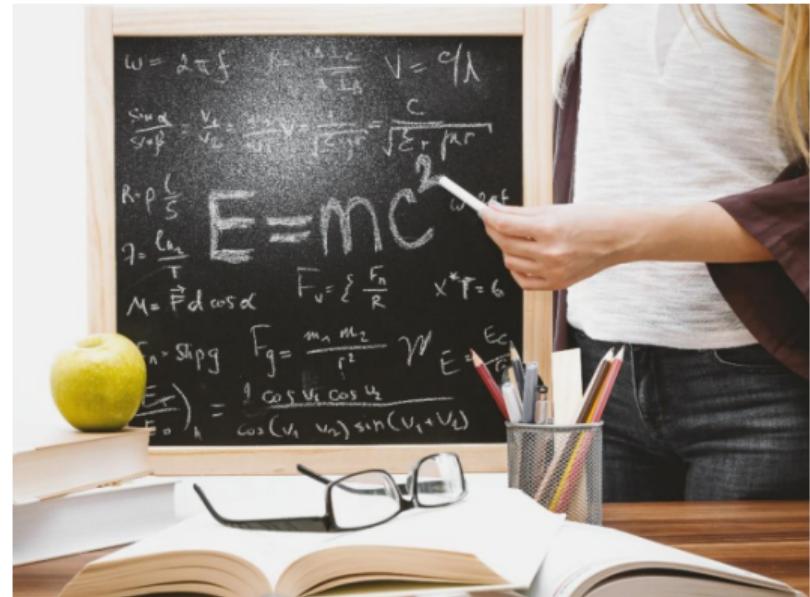
- ▶ Word segmentation.
- ▶ Knowledge exploration.
- ▶ Machine translation.
- ▶ Sentiment analysis.



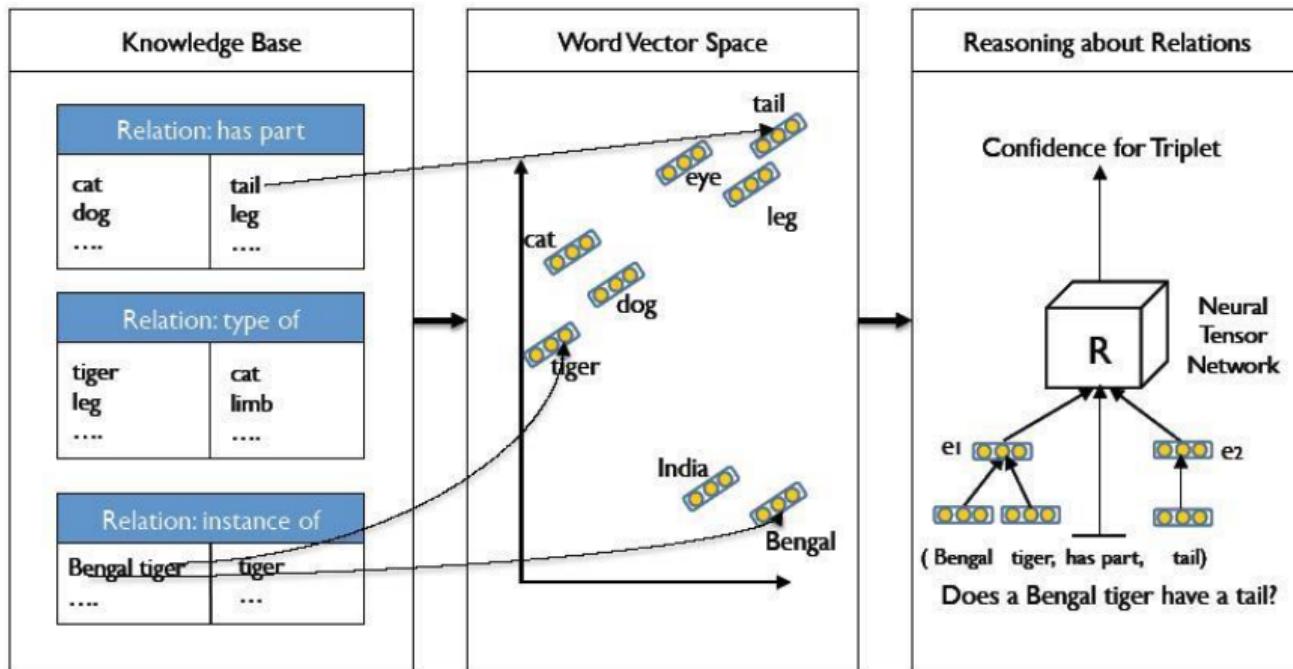
Knowledge Exploration

Two types of problems:

- ▶ New knowledge reasoning in the existing knowledge base
 - CYC, WordNet, FreeNet, etc.
 - Current studies use similar approaches.
 - Known entities are represented by word embeddings.
 - The entity relationship is modeled using tensor networks.
 - Backpropagation + SGD training.
- ▶ Mining structured knowledge from free text
 - Text mining
 - TF-IDF



New Knowledge Reasoning in the Existing Knowledge Base



Mining Structured Knowledge from Free Text (1)

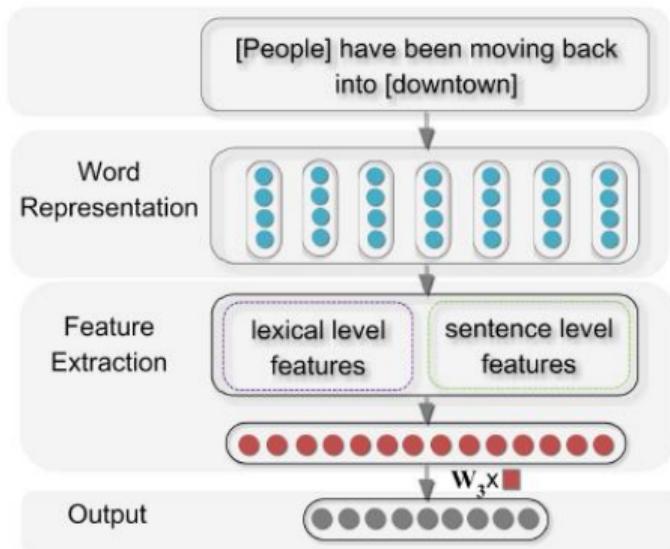


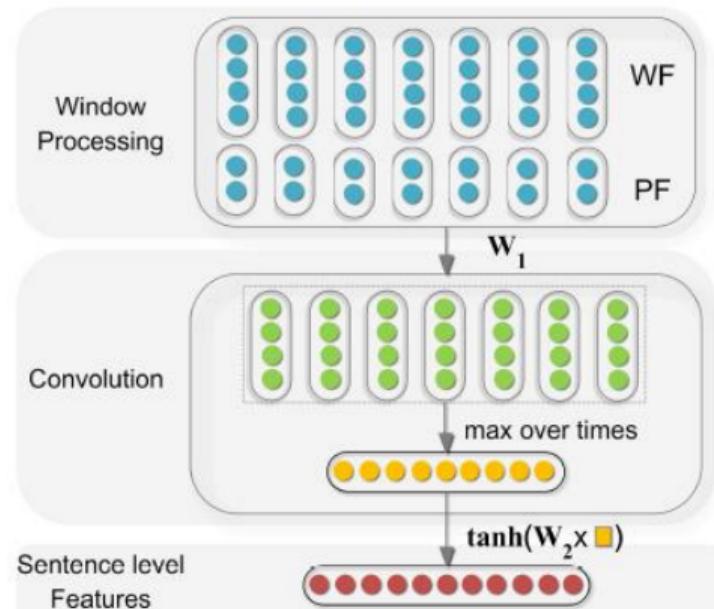
Figure: Overall structure

| Features | Remark |
|----------|---------------------------------|
| L1 | Noun 1 |
| L2 | Noun 2 |
| L3 | Left and right tokens of noun 1 |
| L4 | Left and right tokens of noun 2 |
| L5 | WordNet hypernyms of nouns |

Figure: Lexical feature

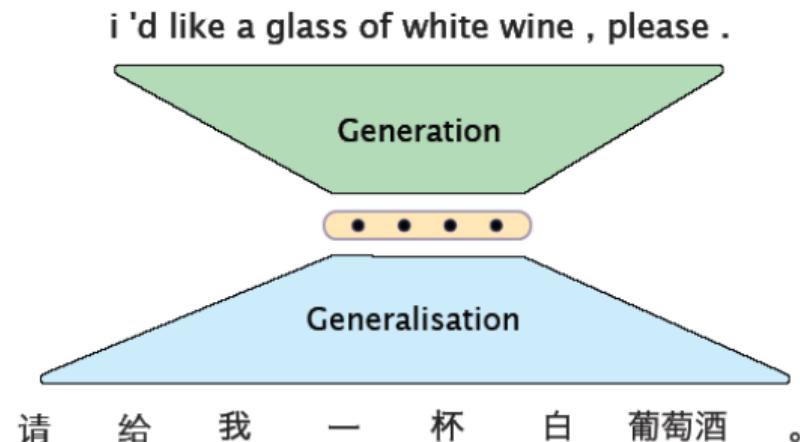
Mining Structured Knowledge from Free Text (2)

Sentence-level feature extraction: convolutional network.



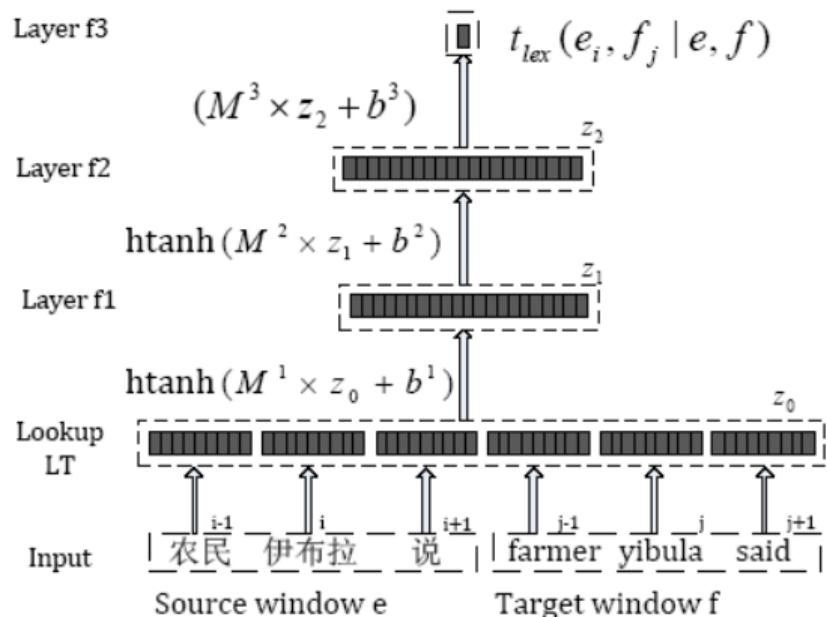
Machine Translation (Common Model)

- ▶ Decoder.
- ▶ Semantic vector.
- ▶ Encoder.



Machine Translation: Deep Learning Applied to Multiple Areas

- ▶ Word alignment
- ▶ Phrase alignment
- ▶ Phrase reordering
- ▶ Language model
- ▶ Translation model
- ▶ Conjunctive model
- ▶ Translation result reordering



Sentiment Analysis

Two core issues:

1. Sentence-level word embedding representation
2. How to encode emotional tendencies to word embedding at all levels

- Semi-supervised or supervised learning: The emotion tendency is encoded into the WE structure through the training process.

What is Sentiment Analysis?

A linguistic analysis technique that identifies opinion early in a piece of text.

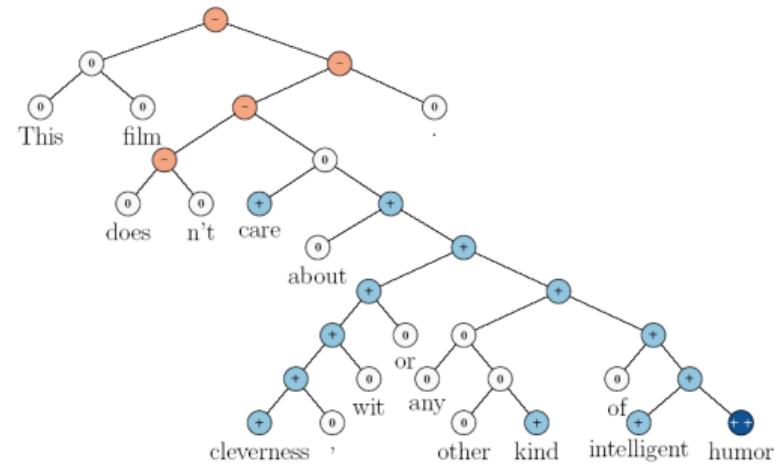
The movie is great.



The movie stars Mr. X



The movie is horrible.



Speech Recognition

Speech can have many roles in mobile apps



Accessibility



Medical
Conditions



Hands &
Eyes Free
Driving Apps
& Games



Learning &
Therapy



Travel Apps
with
Translation



Recommendation System

IMDb Find Movies, TV shows, Celebrities and more... All

Movies TV News Showtimes Community IMDbPro



Spider-Man (2002)  Top 500

(PG-13) 121 min - Action | Fantasy - 3 May 2002 (USA)

Your rating:  7.3 /10 Ratings: 7.3/10 from 322,552 users Metascore: 73/100 Reviews: 1,976 user | 276 critic | 37 from Metacritic.com

When bitten by a genetically modified spider, a nerdy, shy, and awkward high school student gains spider-like abilities that he eventually must use to fight evil as a superhero after tragedy befalls his family.

Director: Sam Raimi
Writers: Stan Lee (Marvel comic book), Steve Ditko (Marvel comic book), 1 more credit »
Stars: Tobey Maguire, Willem Dafoe, Kirsten Dunst | See full cast and crew

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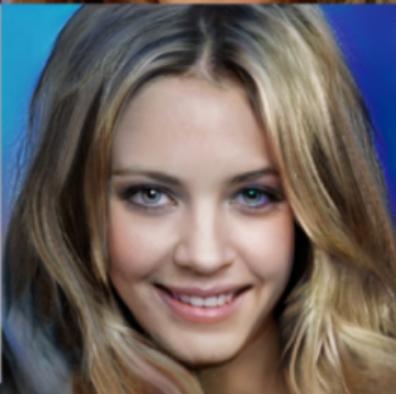
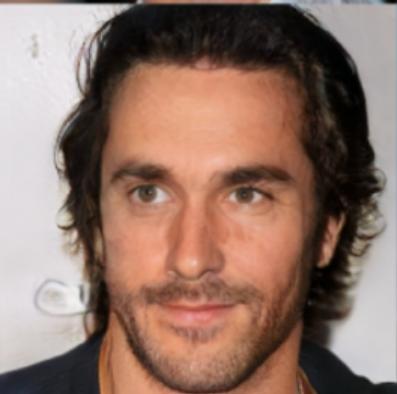
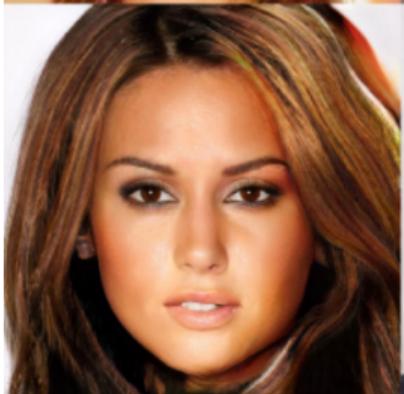
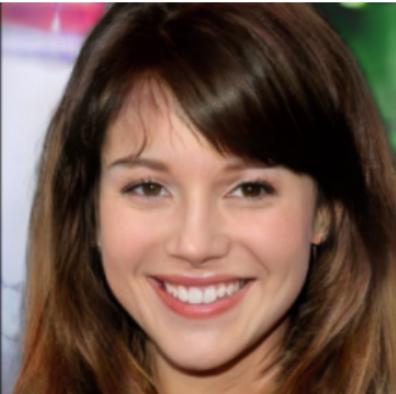
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Iron Man 3 (2013)
(PG-13) Action | Adventure | Sci-Fi  7.7/10

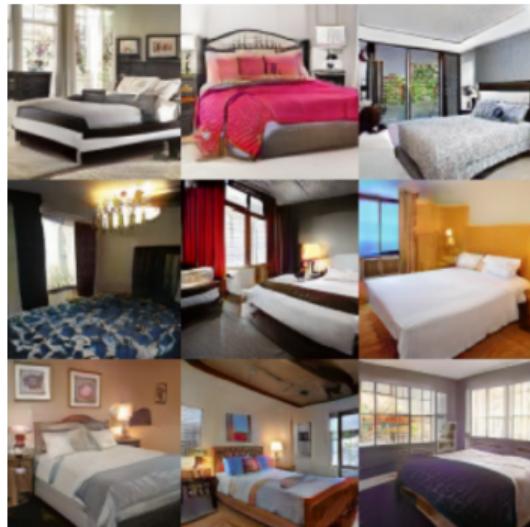
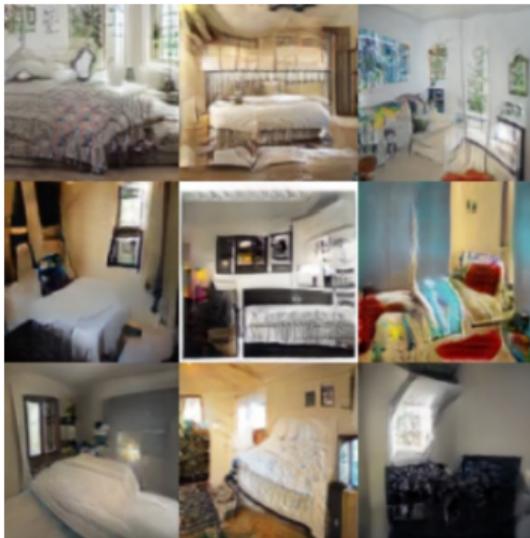
When Tony Stark's world is torn apart by a formidable terrorist called the Mandarin, he starts an odyssey of rebuilding and retribution.

Director: Shane Black
Stars: Robert Downey Jr., Gwyneth...













2014



2015



2016



2017



2018





Odena et al
2016

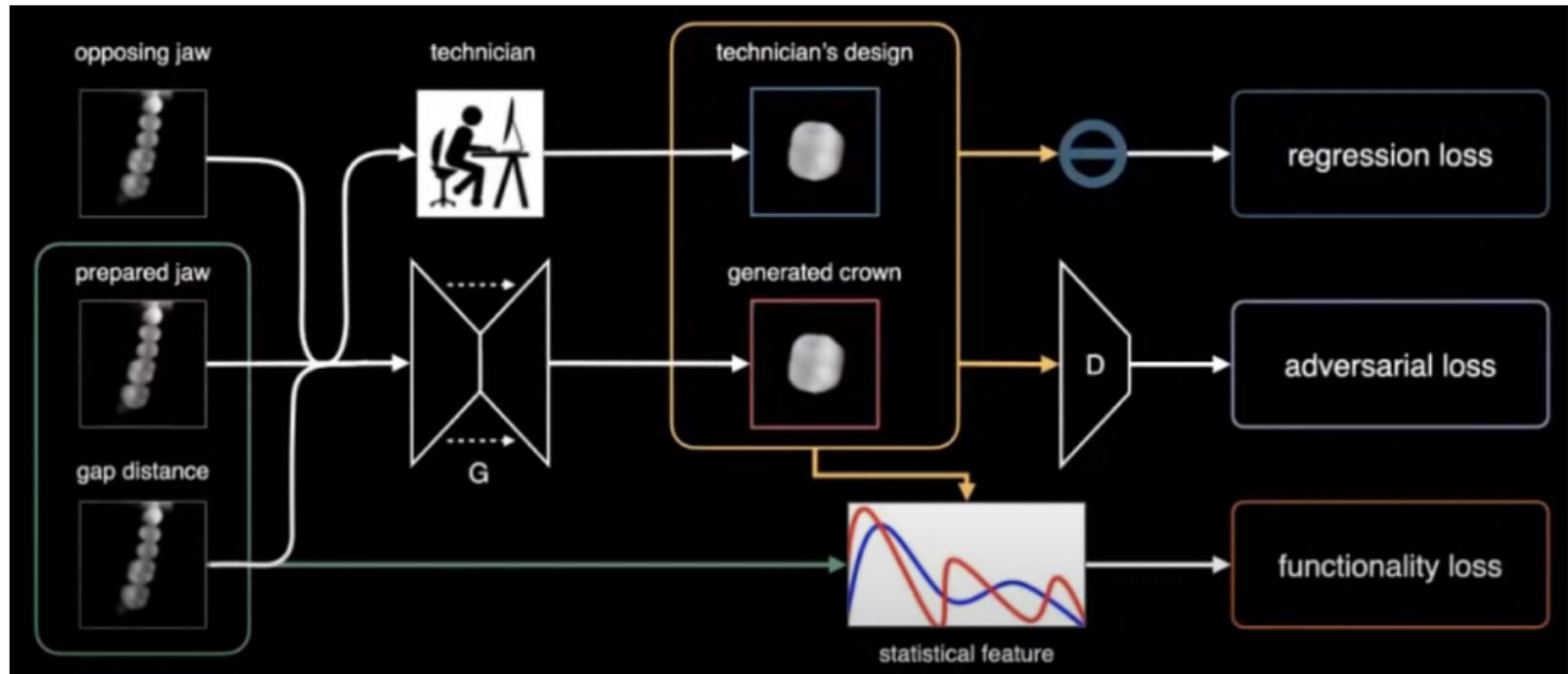


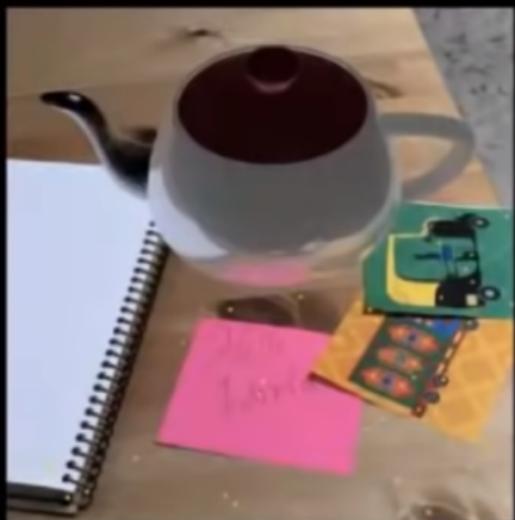
Miyato et al
2017



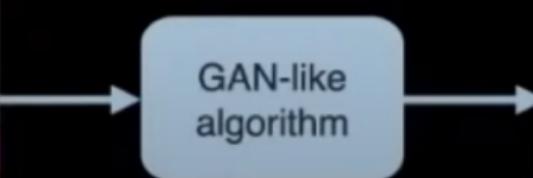
Zhang et al
2018







Incomplete Environment Map



Output Environment Map

Thank you!
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