機器學習、深度學習與醫療影像應用簡介

Healthcare Application with Images and AI

社團法人科技創意發明教育學會
許志宇
理事長
www.scie.org.tw

大綱

- 前言
- 機器學習之深度學習應用在(1:00)
  - 眼球影像
  - MRI去雜訊與清晰化
  - CT影像治療計畫
  - 肺臟影像Countouring
  - 其他
- 機器學習與深度學習介紹
- 交流時間(1:00)

TensorFlow

簡歷

許志宇
中興大學應用數學博士
社團法人科技創意發明教育學會 創會會長、理事長
朝陽科技大學資訊通訊系
副教授

德國雷根斯堡大學交換學者
碩士論文指導老師，題目: 發展雲端服務應用於統計計算
2011年德國紐倫堡國際發明展金牌獎
朝陽科技大學創意種子教師
朝陽科技大學創新創業教師
朝陽科技大學、新民高中、新民國中、華盛頓高中等校，創意發明社團指導老師。
發明專利共11項

Gastdozent aus Taiwan an OTH Regensburg

Web page 許老師在德國授課課程(April 2018):
Deep Learning for Image Classification and Segmentation

前言

人工智慧將會偷走我們的工作嗎?

前言

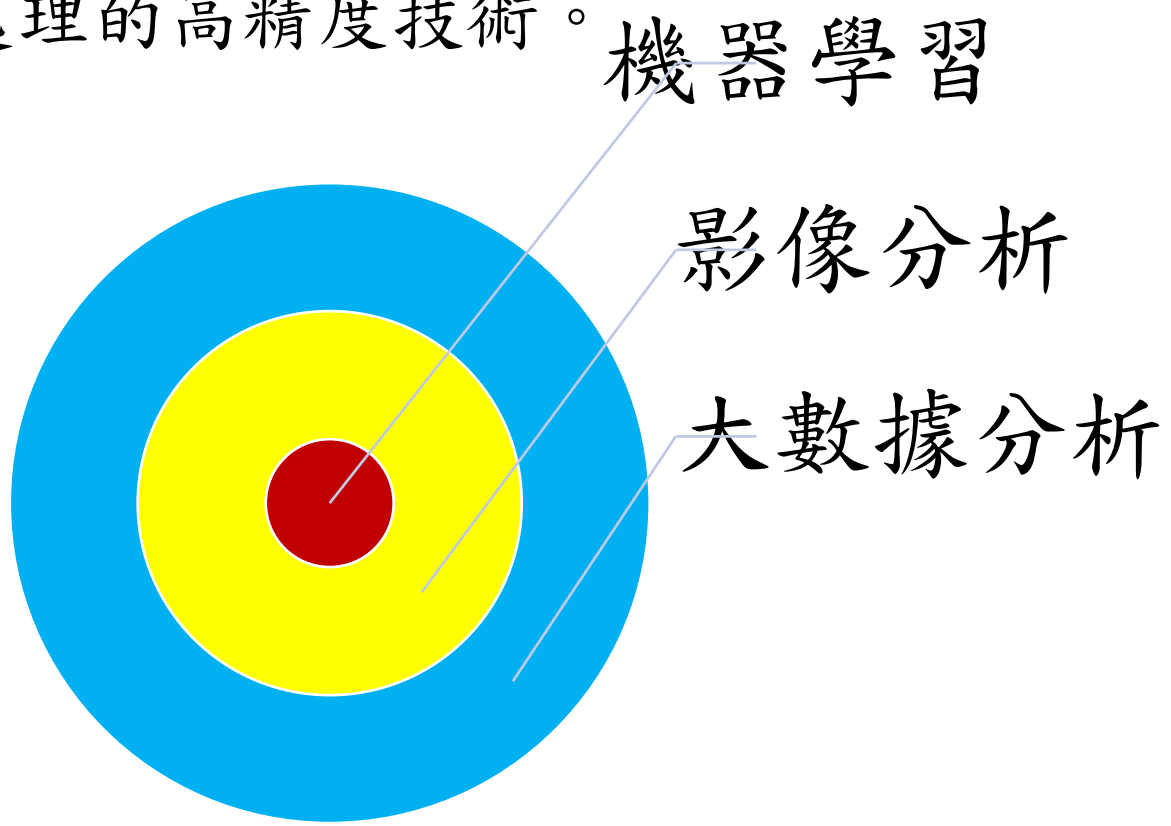
正確率？

前言

- 遊戲橘子數位科技股份有限公司
- 全職
- 台北市內湖區瑞湖街111號
- 工作簡介
- 公司網址： http://www.gamania.com/
- 工作類型： 全職
- 經驗需求： 3 年以上
- 職務分類： 資料科學家
- 薪資範圍： 依能力經驗面議
- 工作職稱： Data Scientist / 資料科學家
- 刊登日期： 2017-11-07 16:58:01
- 有效期限： 2017-12-31
- 工作內容描述
- 1. 建立 Data Pipeline，定義分析的範圍、指標以及方法論，調整設計數據模型
- 2. 將商業問題轉化為可分析的條件以及狀態
- 3. 帶領數據團隊挑戰實際商業活動的數據分析
- 4. 使用統計，數學,機器學習等方法分析商業活動產生的資料

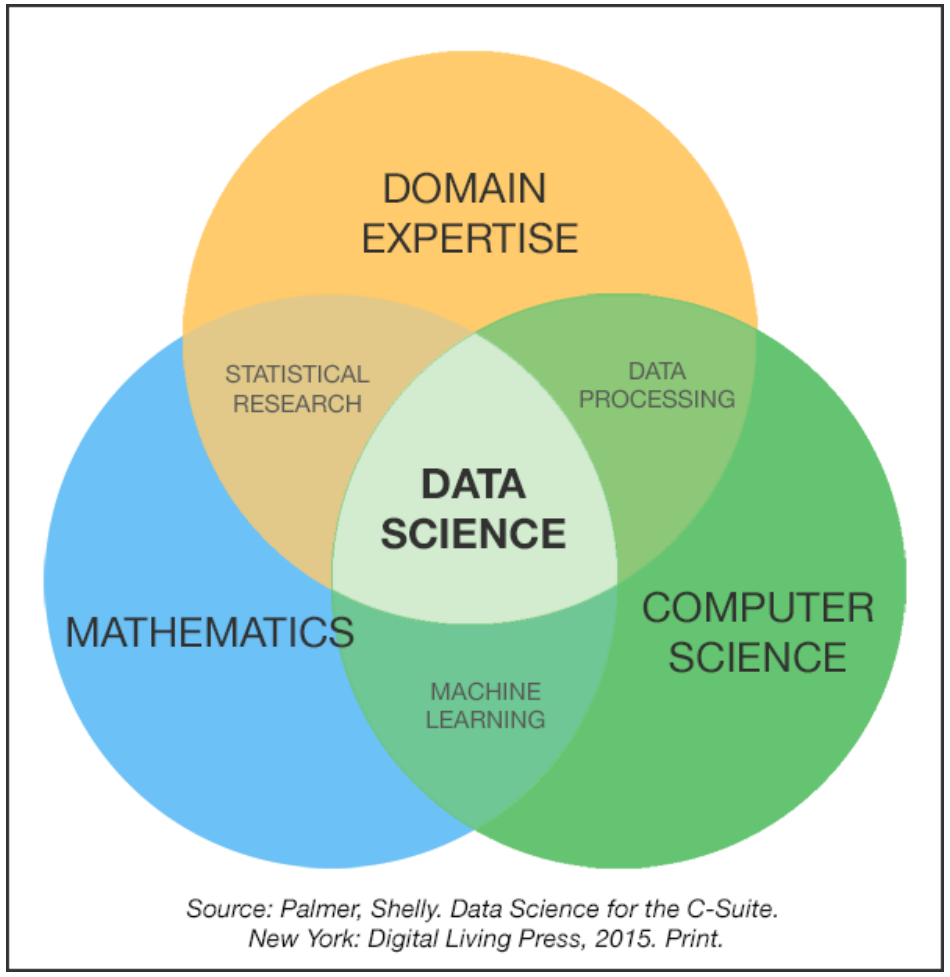
影像數據分析

- 影像數據分析是大數據分析的子集合。
- 機器學習是資料與影像處理的高精度技術。



前言

跨領域學習與團隊合作



Source: Palmer, Shelly. Data Science for the C-Suite. New York: Digital Living Press, 2015. Print.

前言

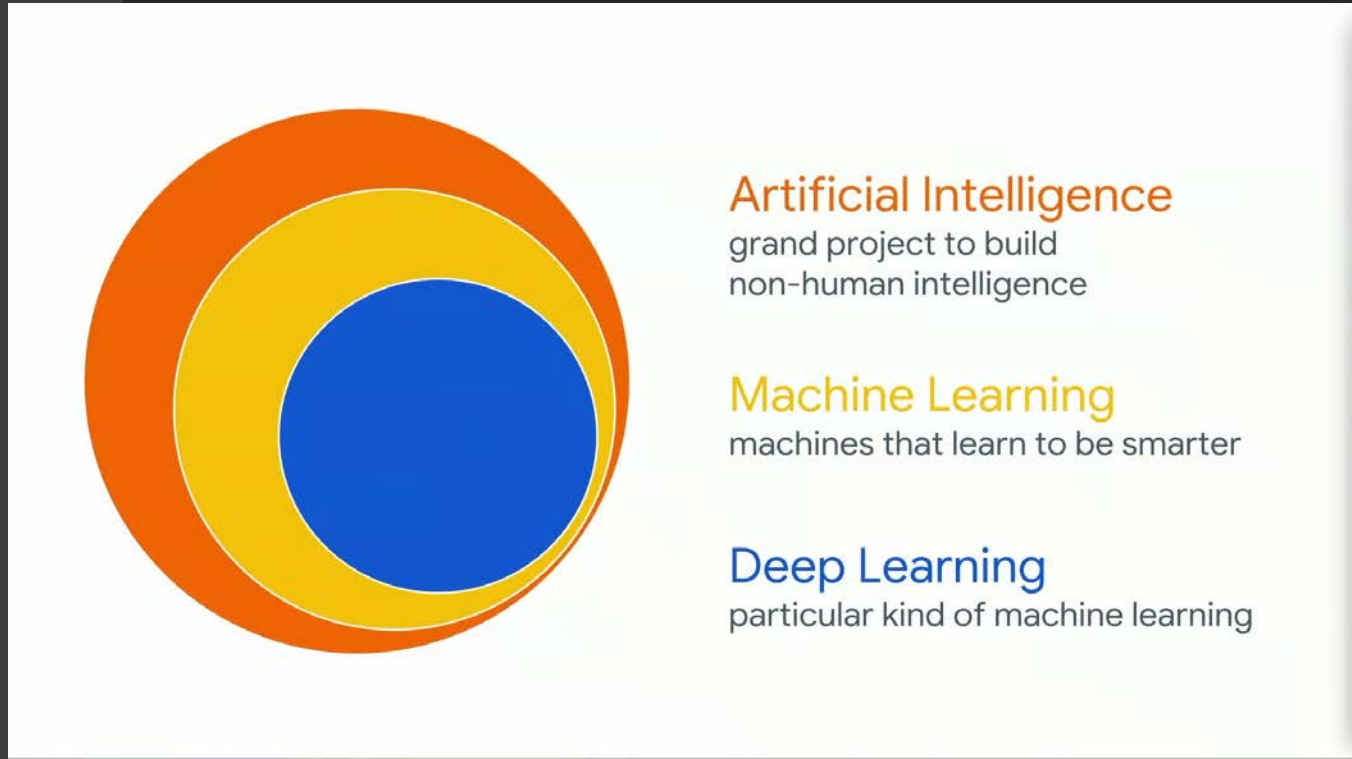
- Data science跨域
- 專業領域
- 數學和統計學statistics
- 計算機科學computer science
- 機器學習。machine learning.

資料來源

前言

- Bringing AI and Machine Learning innovations to Healthcare
- Artificial Intelligent
- Machine Learning
- Deep Learning

- https://youtu.be/JzB7yS9t1YE?t=42



What is

Big data

- Big data is data sets that are so voluminous and complex that traditional data-processing application software are inadequate to deal with them.
- Volume, variety, velocity, veracity (i.e., how much noise is in the data) and value.
- Big data tends to refer to the use of predictive analytics, user behavior analytics, or certain other advanced data analytics methods that extract value from data, and seldom to a particular size of data set.

What is

Artificial Intelligence

- Artificial Intelligence (AI) involves machines that can perform tasks that are characteristic of human intelligence.

What is

Machine learning

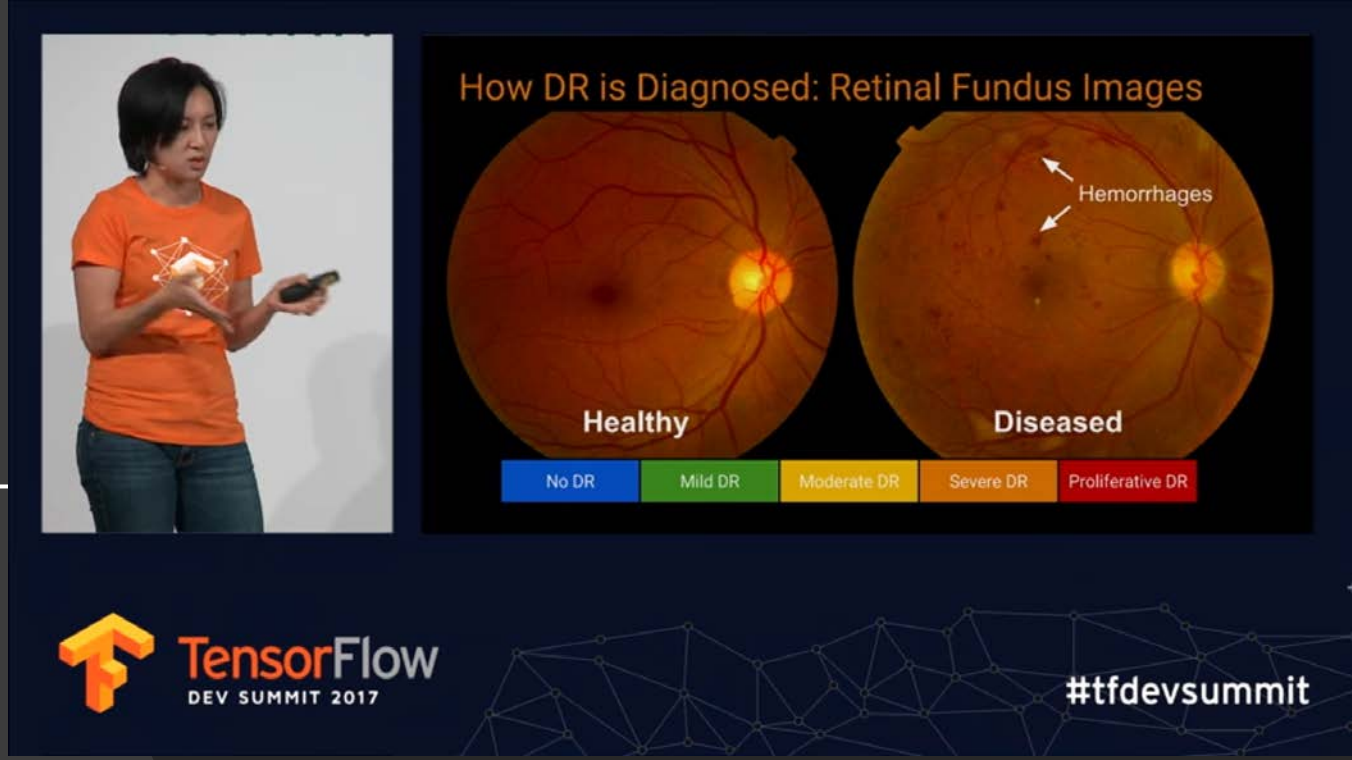
- Machine learning is simply a way of achieving AI.

What is

Deep learning

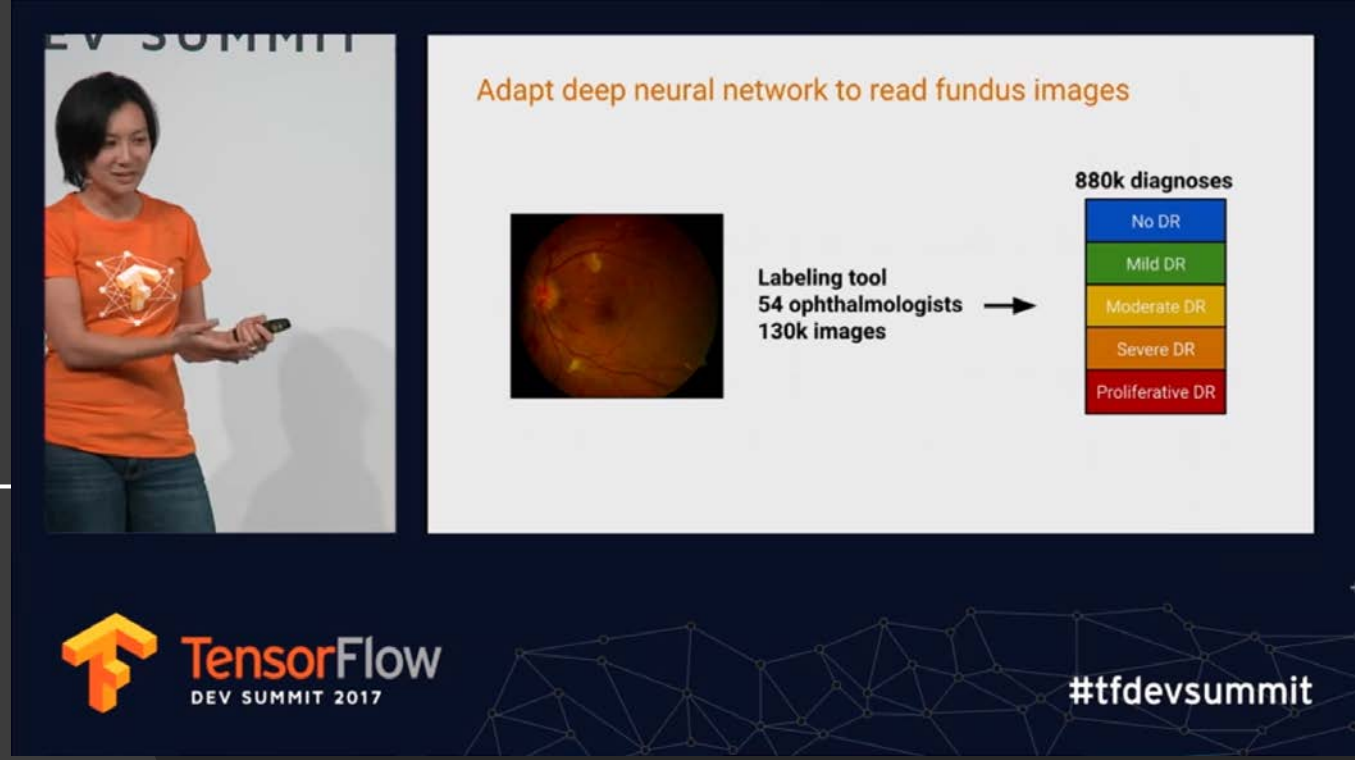
- Deep learning is one of many approaches to machine learning.

視網膜圖像



- diabetic retinopathy
- 糖尿病視網膜病變的疾病。
- 糖尿病的併發症。
- 患者都有可能因糖尿病视网膜病变（DR）而失明。
- 實例分析：TensorFlow 在醫療領域的應用 -視網膜圖像（2017年TensorFlow開發者大會）
- https://youtu.be/oOeZ7IgEN4o

視網膜圖像



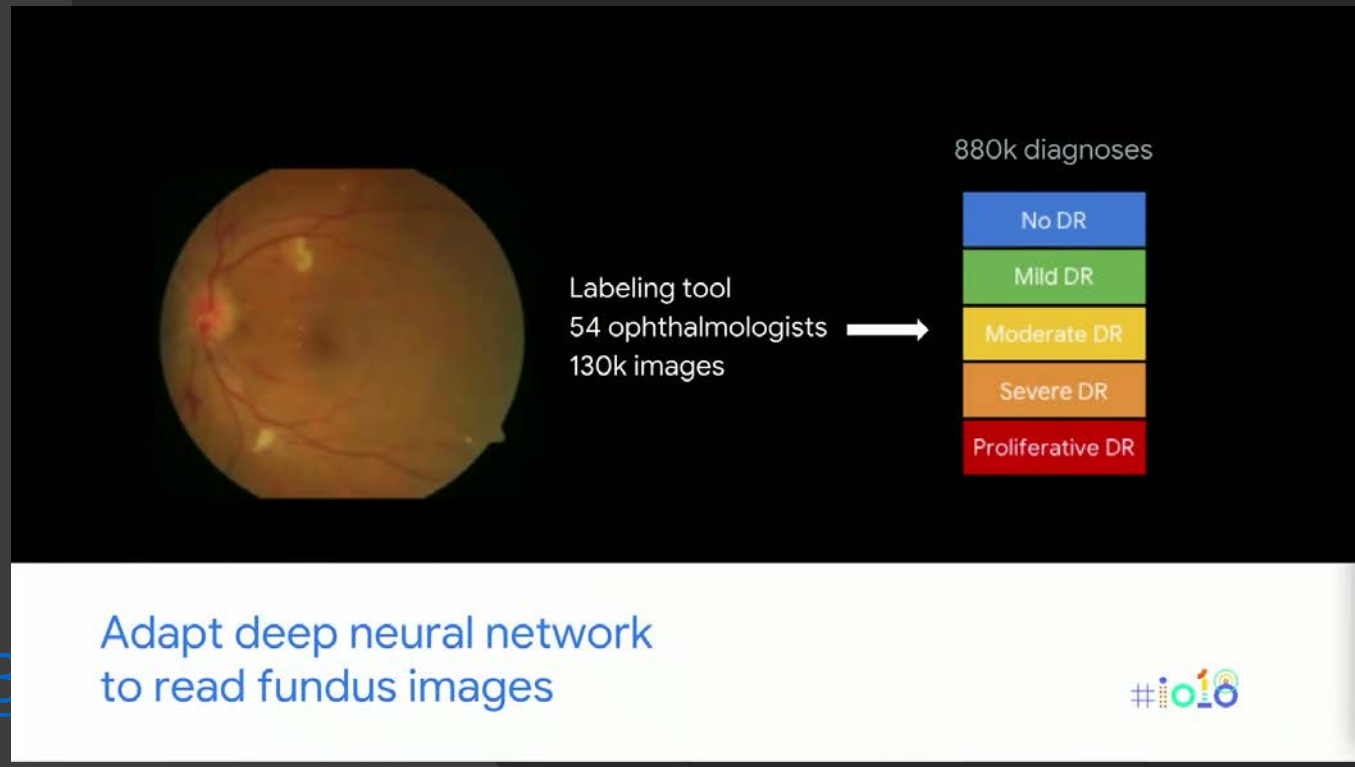
- 糖尿病性視網膜病變分類
- 54名眼科醫生幫忙做標記。
- 對這些圖片 進行了88萬次診斷。
- 因為有時候需要7次診斷才能得出一致的結論。
- 之後我們將資料進行整理，做好標記。

- https://youtu.be/oOeZ7IgEN4o

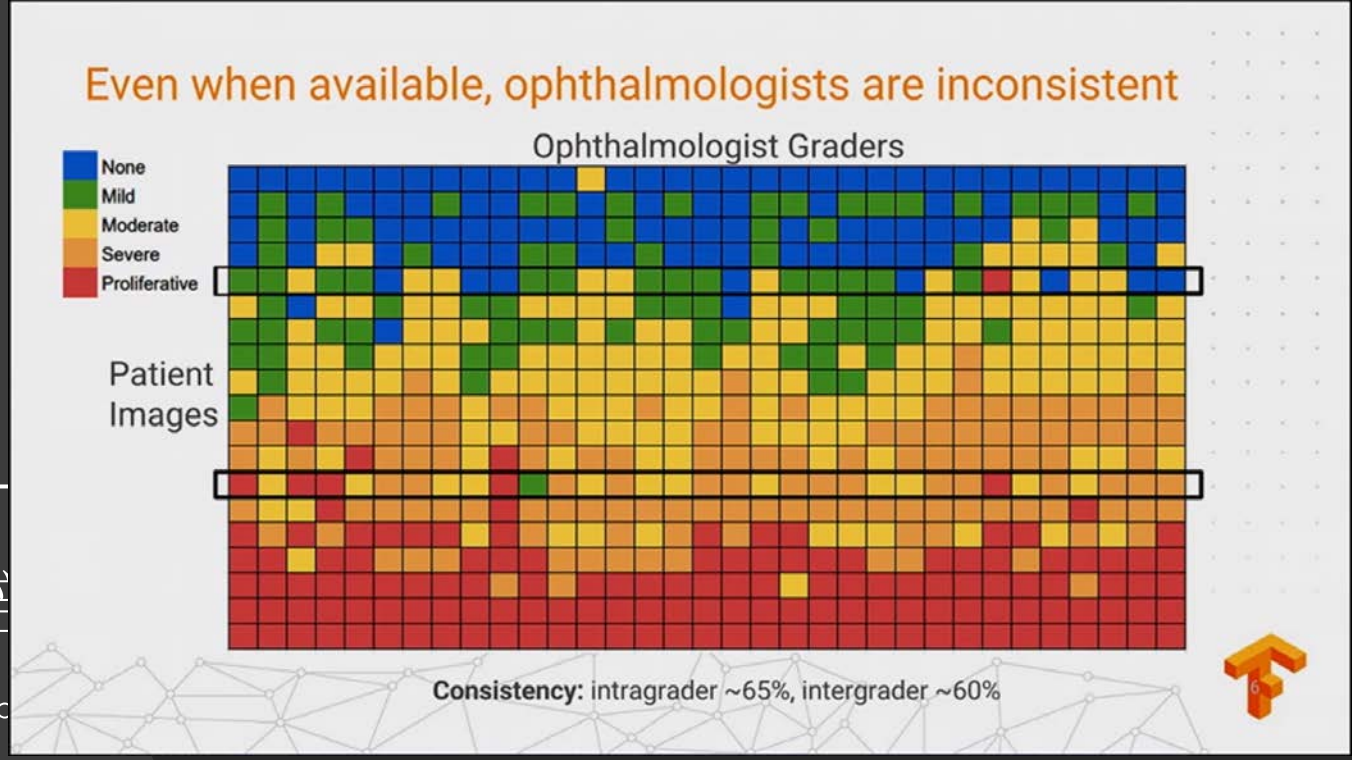
視網膜圖像

- Deep Learning
- Increase Innovation

- https://youtu.be/JzB7yS9t1YE?t=3

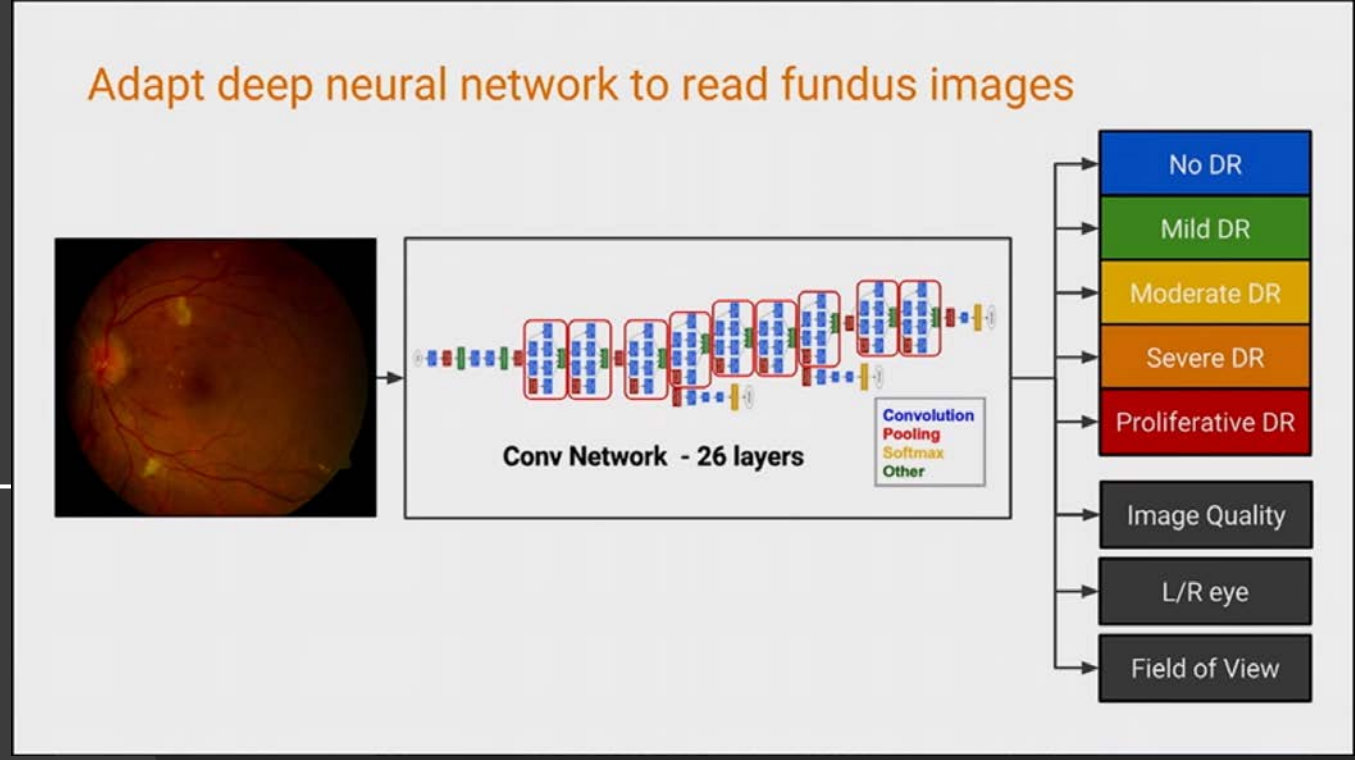


視網膜圖像



- 每一行代表的 是一個病人的眼
- 每一列代表的是一名眼科醫生。
- 這些都是美國委員會認證的眼科大夫，
- 看他們能不能準確判斷出病人處於疾病的哪個階段。
- 可以看到， 當患者沒生病的時候，大家的判斷都很一致。
- 同樣的，到最後階段，出現了增生病變，大家意見也很統一。

視網膜圖像



- 深度學習網路完成圖像識別任務。
- 訓練它識別5個等級的糖尿病視網膜病變。

- https://youtu.be/oOeZ7IgEN4o

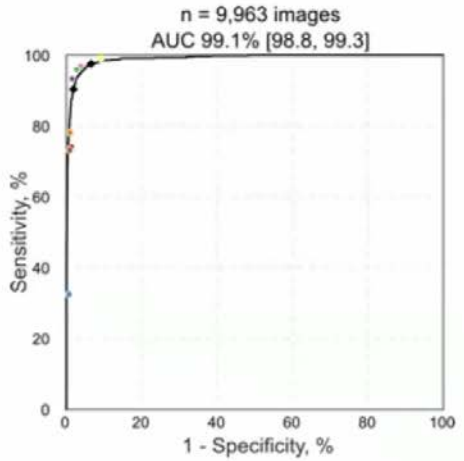
糖尿病性視網膜病變

- diabetic retinopathy
- 糖尿病性視網膜病變分類
- F-score=0.95
- AUC=99.1%

- https://youtu.be/JzB7yS9t1

JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep learning Algorithm for detection of Diabetic Retinopathy in Retinal Fundus Photographs



F-score

0.95	0.91
Algorithm	Ophthalmologist (median)

"The study by Gulshan and colleagues **truly represents the brave new world in medicine.**"

Dr. Andrew Beam, Dr. Isaac Kohane
Harvard Medical School

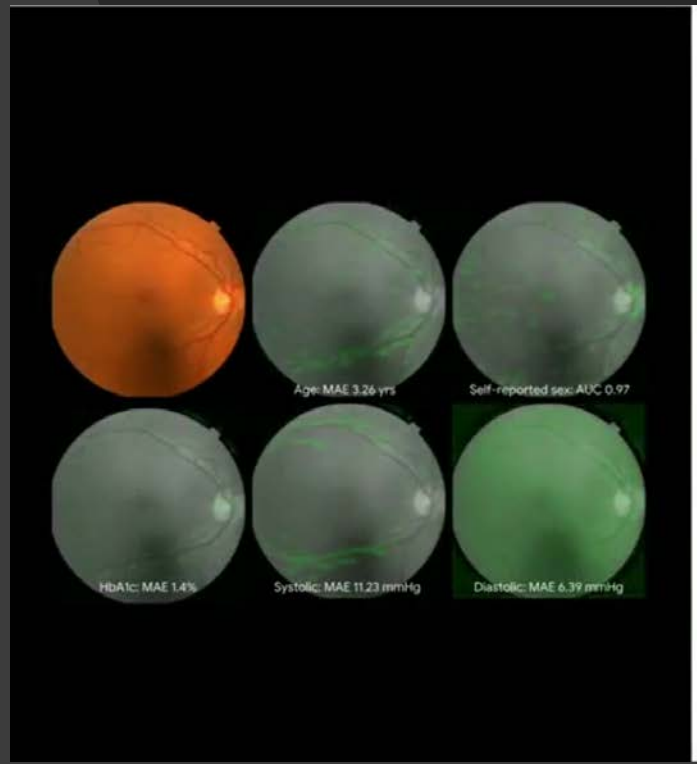
"Google just published this paper in JAMA (impact factor 37) [...] **It actually lives up to the hype.**"

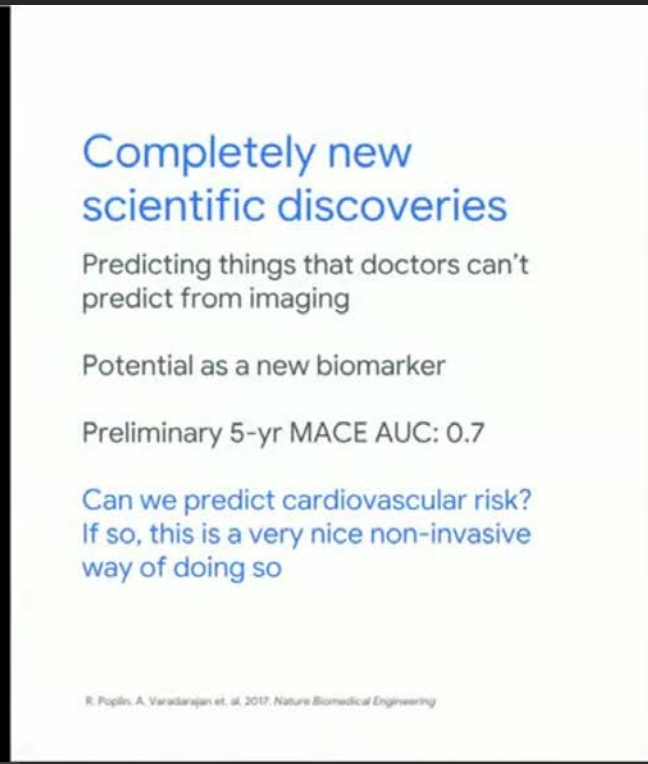
Dr. Luke Oakden-Rayner
University of Adelaide

視網膜圖像預測心臟病

- Deep Learning
- Cardiovascular risk
- predict your five-year risk of a cardiac
- event
- the AUC for this prediction is 0.7

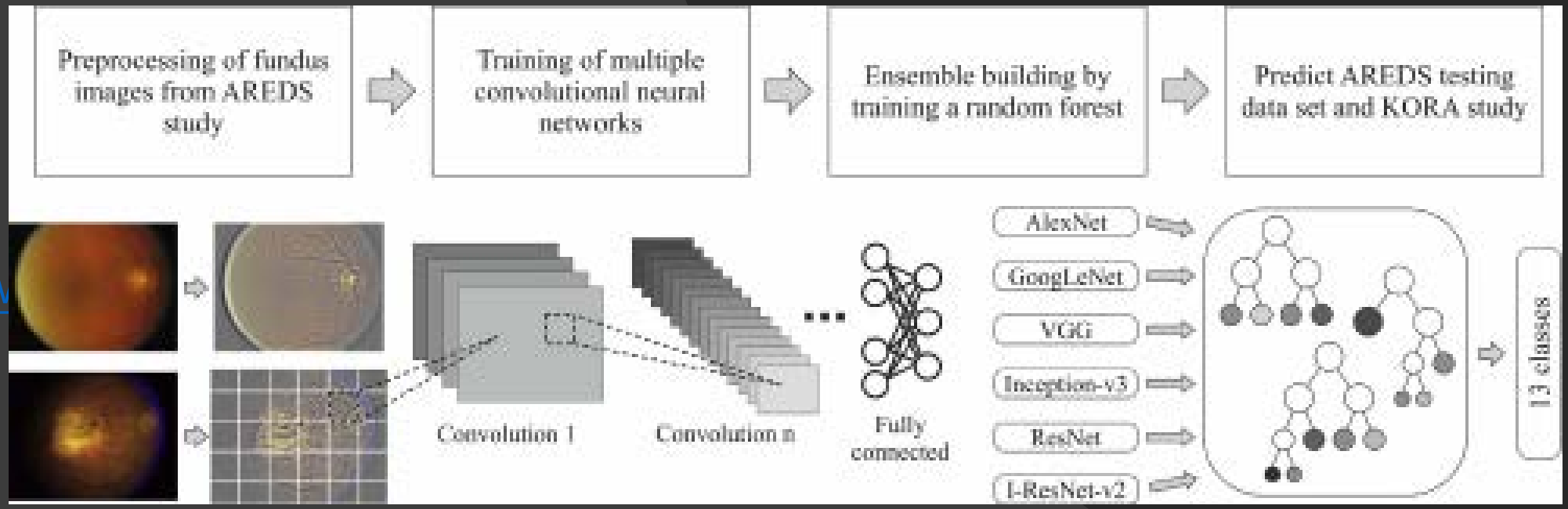
- https://youtu.be/JzB7yS9t1YE?t=890





Age-related macular degeneration
年齡相關性黃斑變性

- A Deep Learning Algorithm for Prediction of Age-Related Eye Disease Study Severity Scale for Age-Related Macular Degeneration from Color Fundus Photograp
- https://ww
6/fulltext



視網膜圖像

- 視網膜圖像 fundus images
- A Deep Learning Algorithm for Prediction of
- Age-Related Eye Disease Study Severity
- Scale for Age-Related Macular Degeneration from Color Fundus Photography

- https://www.aaojournal.org/article/S0161-6420(17)33064-6/fulltext

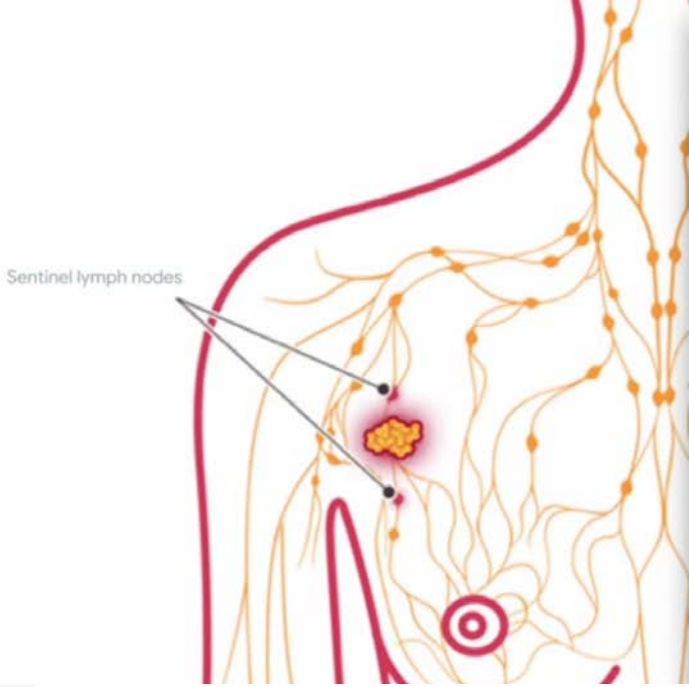
Breast cancer

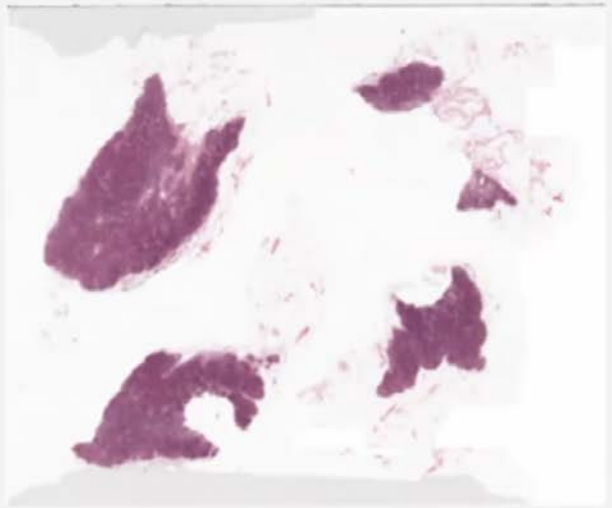
- Diagnosis and Detection
- of breast cancer
- Machine Learning
- 94%sensitvity
- 99%specificity
- Pathologist
- 40~79%sensitvity
- 96~100%specificity

- https://youtu.be/JzB7yS9t1YE?t=737

Application in diagnosis

Detecting Breast Cancer
Metastases in Lymph Nodes





Reading sentinel lymph node biopsies is a difficult task

~24% SLN biopsies had a change in nodal status with additional review[1]

Pathologist with unlimited time:
94% sensitivity, 99% specificity

Pathologists with time constraint:
40-79% sensitivity, 96-100% specificity[2]

1. Vestjens JHM.J, et al. Ann Oncol. 2012.
2. Bejnordi BE, et al. JAMA 2017

Clinic Validation

- 攝護腺癌Prostate cancer

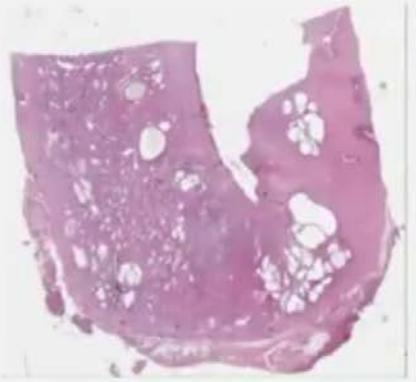
- https://youtu.be/JzB7yS9

What's next?

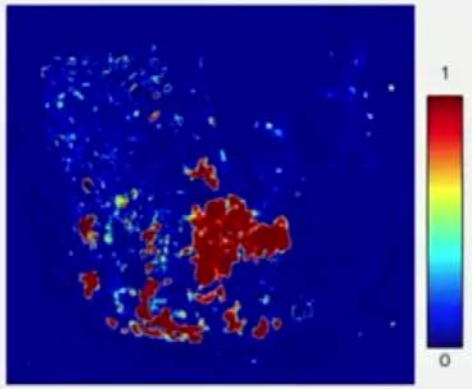
Clinical Validation: Reader accuracy, speed, confidence with algorithm assistance

Application to other tissue types

Example: Prostate cancer gleason grading performance **on par with pathologists**



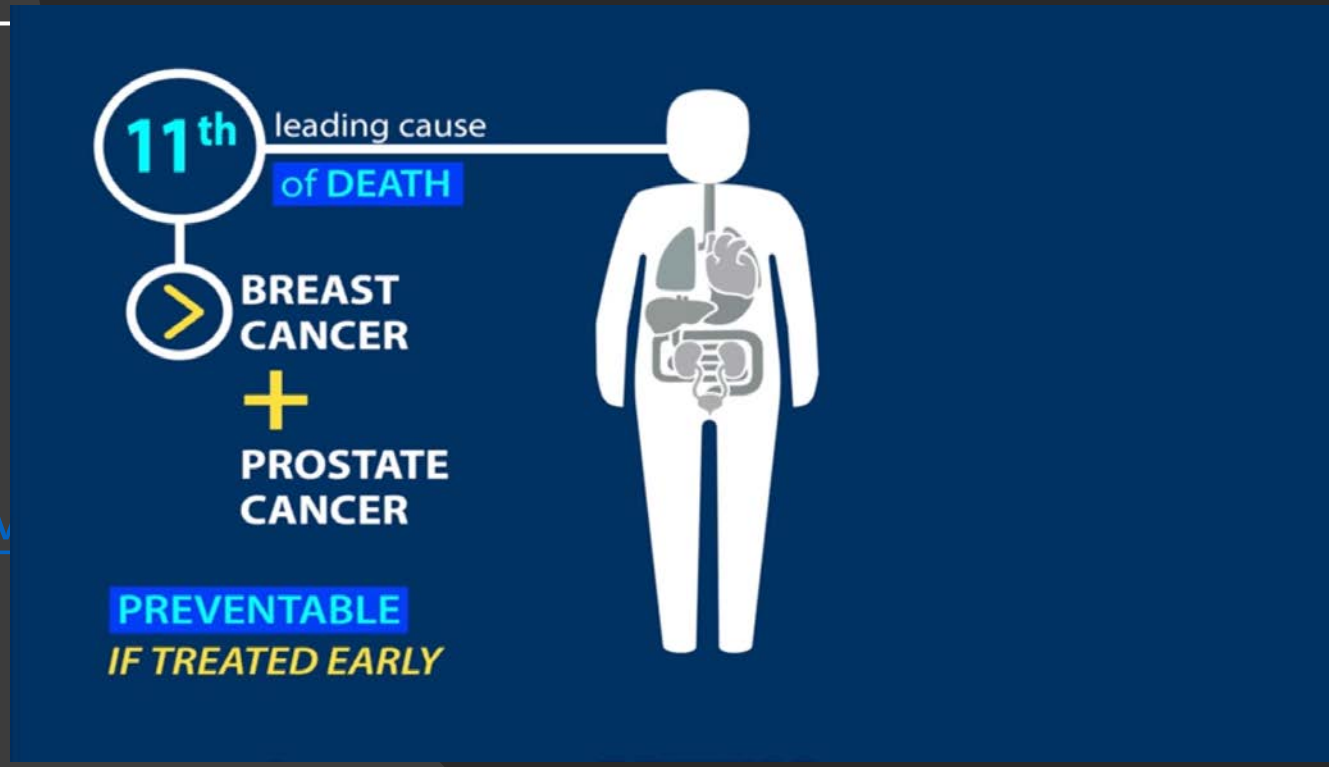
biopsy image



Medicine
Machine Learning

- Better Medicine
- Machine Learning

- https://www.youtube.com/watch?v



MRI影像應用

- 不足的採樣樣本中重建核磁共振成像（MRI）。
- Noise2Noise: Learning Image Restoration without Clean Data 研究報告全文：
- https://drive.google.com/file/d/114nV–mIF9ldbAYGtkjEwwpzG1tyvTX8/view
- https://buzzorange.com/techorange/2018/07/12/nvidia-ai-deep-learning-denoised-amazing/

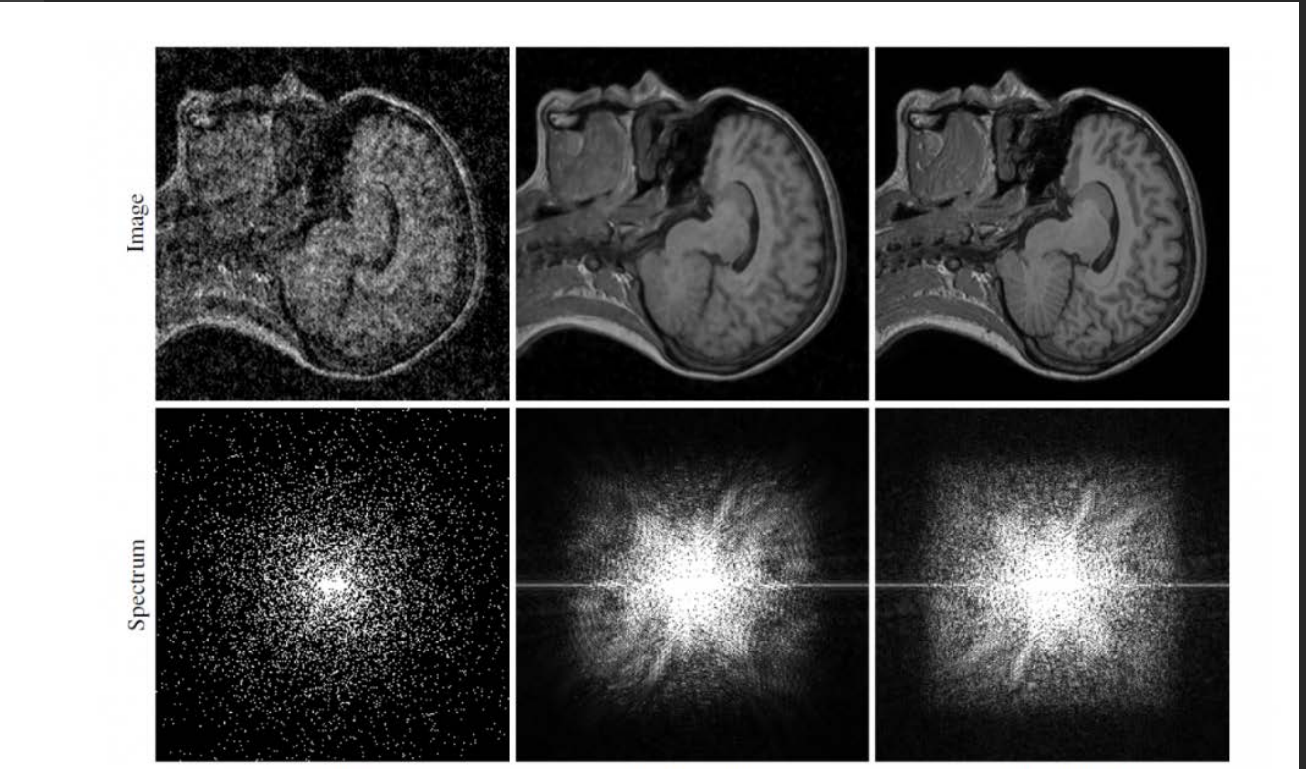


Figure 3. MRI reconstruction example. (a) Input image with only 10% of spectrum samples retained and scaled by $1/p$. (b) Reconstruction by a network trained with noisy target images similar to the input image. (c) Original, uncorrupted image.

MRI imaging

- imaging sampling time

- https://youtu.be/7vtpWbrVdDY 1:00:38

深度學習幫影像去雜訊

- NVIDIA Tesla P100 GPU，其採用 cuDNN 加速的 TensorFlow 深度學習框架，在 ImageNet 驗證集中對 50,000 個影像進行訓練
- 低解析CT 與 MRI的結合應用於ROI選取

- https://buzzorange.com/techorange/deep-learning-denoised-amazing/

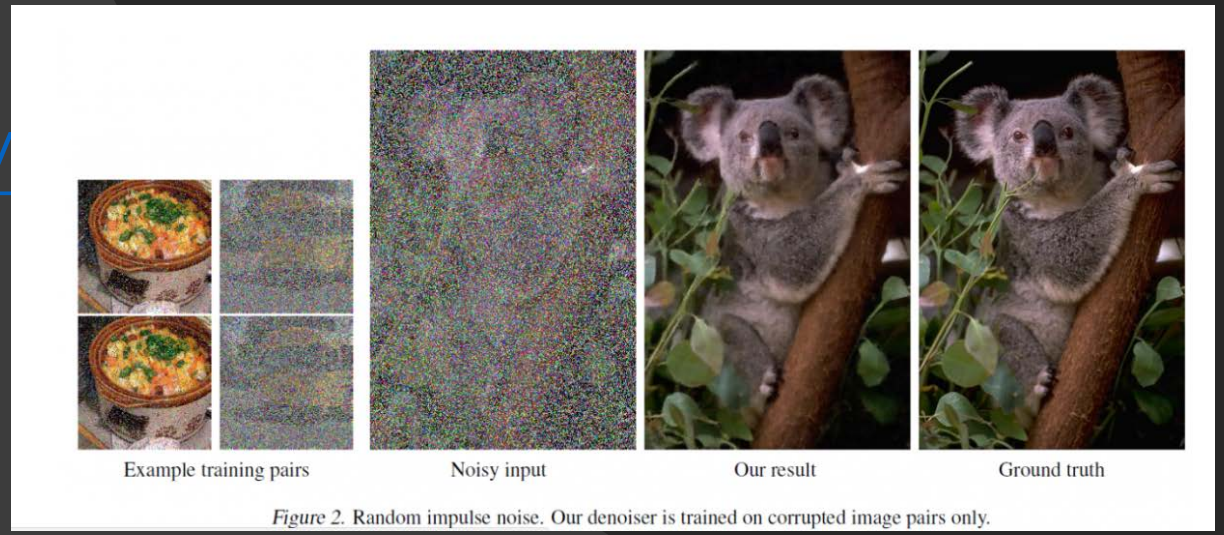


Figure 2. Random impulse noise. Our denoiser is trained on corrupted image pairs only.

Google

- 2 年前 Google 開發了一款能利用眼部圖像，來檢測糖尿病視網膜病變的神經網路；
- 今年2018其人工智慧團隊分享了能用相同技術預測病患心臟病發、或中風風險的深度學習模型，並在 2 月份已發表關於這項研究的論文。
- Google 的人工智慧模型更透過分析嵌入在「去識別化」（De-identification）健康紀錄上的資訊，
- 預測何時可能會再生病以及住院天數等醫療事件，將成為對病患健康產生重大影響的強大工具。
- https://youtu.be/ogfYd705cRs

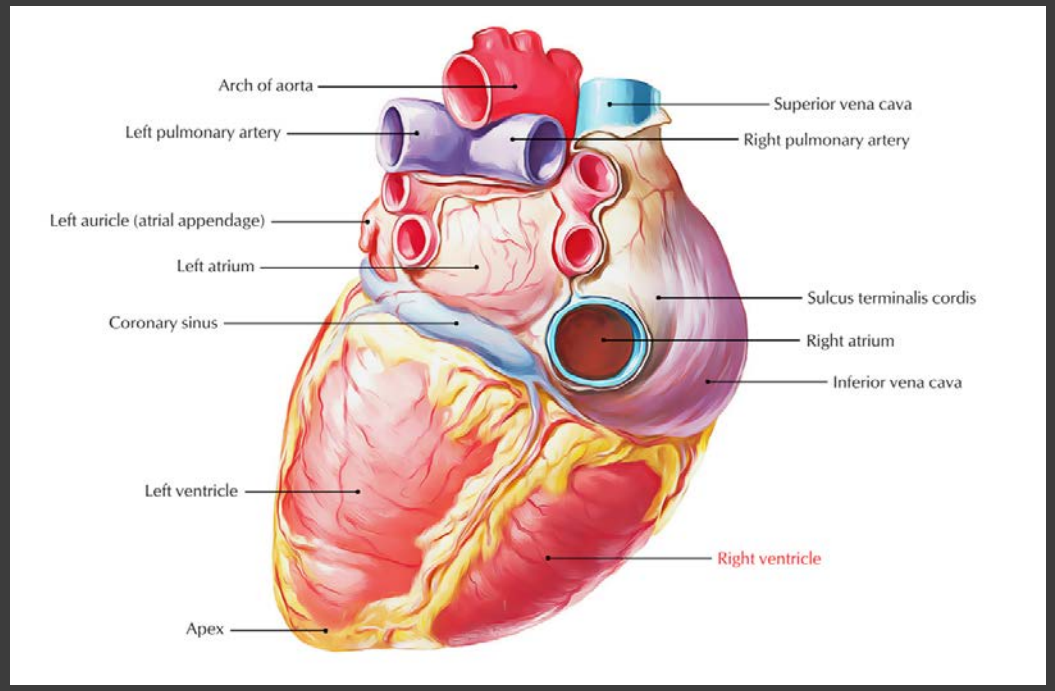
Deep Learning

- TensorFlow

- https://youtu.be/JzB7yS9

Deep learning based automatic contouring for Left Ventricle

- Deep Learning Contouring



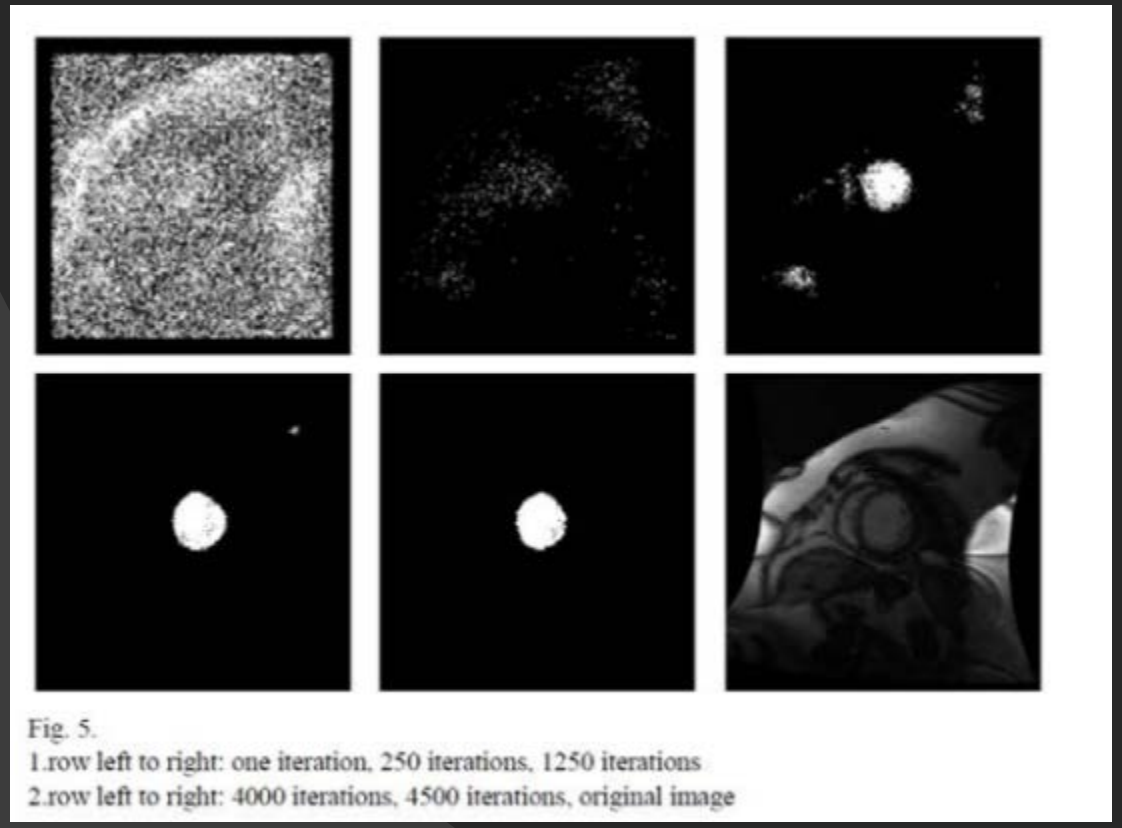


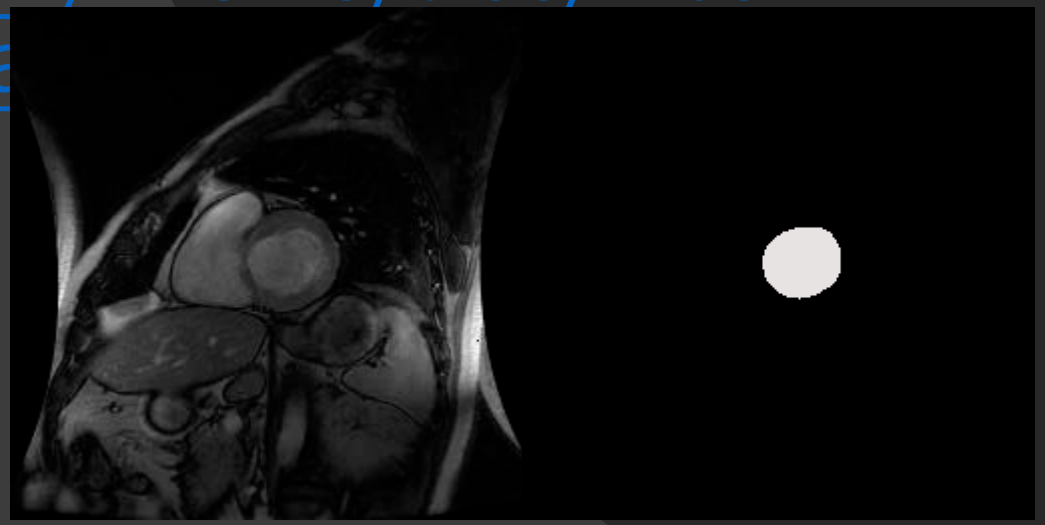
Fig. 5.
1.row left to right: one iteration, 250 iterations, 1250 iterations
2.row left to right: 4000 iterations, 4500 iterations, original image

Deep Learning Brain Lesion Segmentation

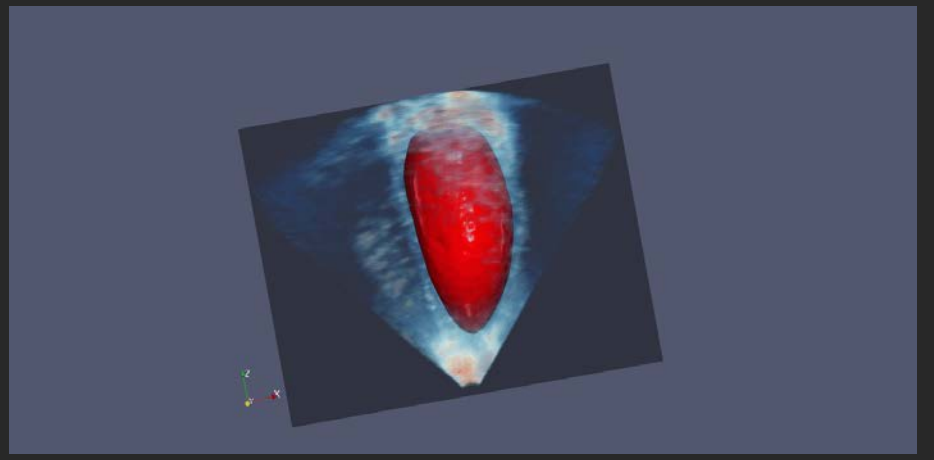
- Deep Learning for Brain Lesion Segmentation/technology
- Brain Lesion 腦腫瘤
- 3D convolutional networks for 3D voxel segmentation
- Class balance neighborhood pixel based segmentation
- https://youtu.be/6RVbKao5aMU

Deep learning based automatic contouring for Left Ventricle

- Using DIGITS to train a medical image segmentation network
- https://github.com/NVIDIA/DIGITS/tree/master/examples/medical-ima



3D 體積分割技術



- Project CLARA，一個雲端醫療診斷的項目。這個項目非常有趣，簡單來說，NVIDIA醫院提供基於雲端的醫療圖像識別超算，
- 深度學習及人工智慧為先進影像分析與量化，提供了令人雀躍不已的契機。近期一種稱為 V-Net 的演算法使用 3D 體積分割技術，可自動測量通過心臟的血流量。十五年前得用上一台耗資千萬美元、耗電 500 瓩的電腦才能運行這種演算法，而今日在幾顆 Tesla V100 GPU 上便可運行。
- https://blogs.nvidia.com.tw/2018/03/ai-healthcare-gtc/

放射線治療

- Deep-Learning Based Prediction of Achievable Dose for Personalizing Inverse Treatment Planning

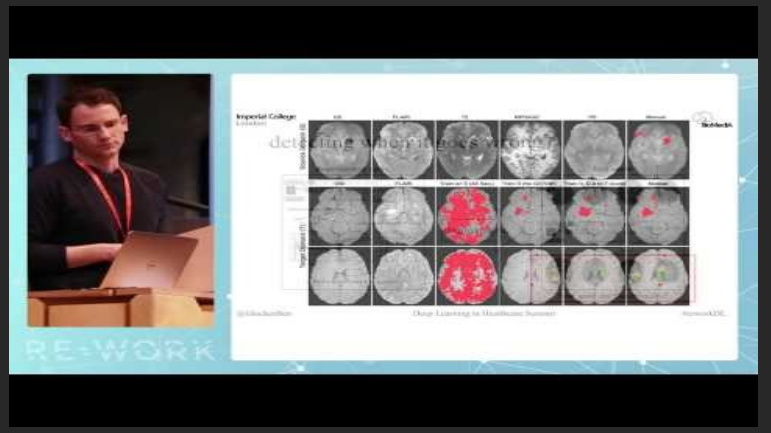
- A novel learning empowered approach is developed
- that predicts the 3D dose volume for a new patient based on the geometrical features of the contoured anatomical scan.

- https://www.redjournal.org/article/S0360-3016(16)32011-9/pdf

放射線治療

- A deep-learning based dose prediction model for VMAT/IMRT treatment is established.
- Our preliminary results based on a two-layer linear auto-encoder achieves more than %65 overlap volume between the actual and predicted iso-dose surfaces associated with V60%, V75%, and V90% dose volumes
- https://www.redjournal.org/article/S0360-3016(16)32011-9/pdf

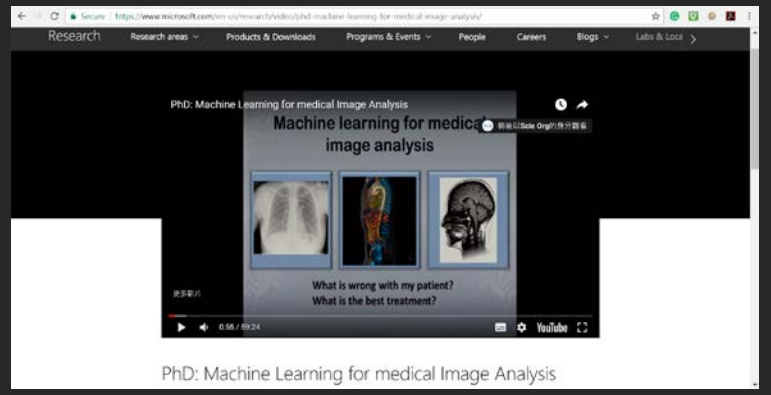
Machine Learning for medical Image Analysis



- Some successes and challenges coming from our group biomechanical image analysis group at Imperial College London
- these successes are mostly in medical imaging using deep learning

- https://youtu.be/2_Jv11VpOF4

Machine Learning for medical Image Analysis

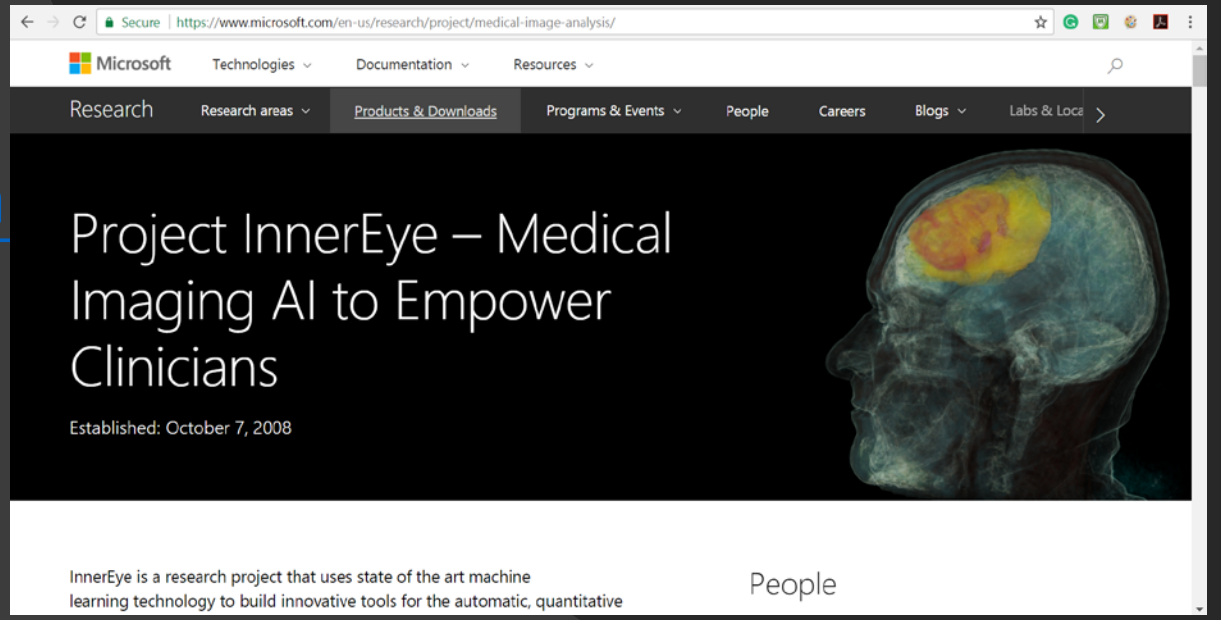


- Microsoft Project
- Analysis of medical images is essential in modern medicine. With the increasing amount of patient data, new challenges and opportunities arise for different phases of the clinical routine, such as diagnosis, treatment and monitoring.
- Neural Network and Decision tree
- The internal nodes and the leaf nodes and try to make sense of what features are used
- https://www.microsoft.com/en-us/research/video/phd-machine-learning-for-medical-image-analysis/

Machine Learning for medical Image Analysis

- Microsoft Project InnerEye
- Medical Imaging AI to Empower Clinicians

- https://www.microsoft.com/en-us/research/project/medical-image-a



Clinical evaluation of atlas and deep learning based automatic contouring for lung cancer

- Background and purpose:
- Contouring of organs at risk (OARs) is an important but time consuming part of radiotherapy treatment planning. The aim of this study was to investigate whether using institutional created software-generated contouring will save time if used as a starting point for manual OAR contour-ing for lung cancer patients.
- Material and methods: Twenty CT scans of stage I–III NSCLC patients were used to compare user adjusted contours after an atlas-based and deep learning contour, against manual delineation. The lungs, esophagus, spinal cord, heart and mediastinum were contoured for this study. The time to perform the manual tasks was recorded.

Clinical evaluation of atlas and deep learning based automatic contouring for lung cancer

- Results:
- With a median time of 20 min for manual contouring, the total median time saved was 7.8 min when using atlas-based contouring and 10 min for deep learning contouring. Both atlas based and deep learning adjustment times were significantly lower than manual contouring time for all OARs except for the left lung and esophagus of the atlas based contouring.

Clinical evaluation of atlas and deep learning based automatic contouring for lung cancer

- Conclusions: User adjustment of software generated contours is a viable strategy to reduce contouring time of OARs for lung radiotherapy while conforming to local clinical standards. In addition, deep learn-ing contouring shows promising results compared to existing solutions.
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MRI imaging

- Image registration
- medical imaging
- Some recent developments in in machine learning what has transformed the field of computer vision in the last 10 years
- Machine learning meets medical imaging: From signals to clinically useful information
- Motion artifact remove by machine learning
- https://youtu.be/7vtpWbrVdDY

Healthcare with NVIDIA’s

- AI and the Future Series, Episode 2
- Healthcare with NVIDIA’s Abdul Hamid Halabi

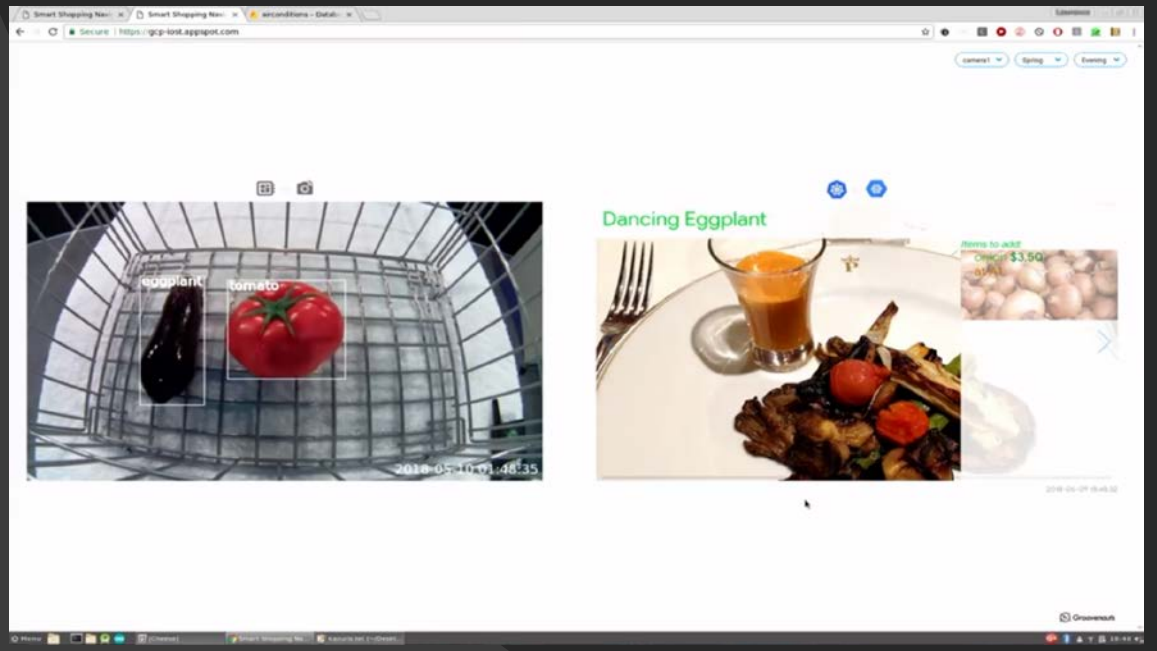
- https://www.nvidia.com/en-us/csr/
-
- https://youtu.be/ov2m9DY3qEc

Intro to machine learning

- Machine Learning
- Image Detection
- https://youtu.be/avxpkFUXIfA?t=871

Intro to machine learning

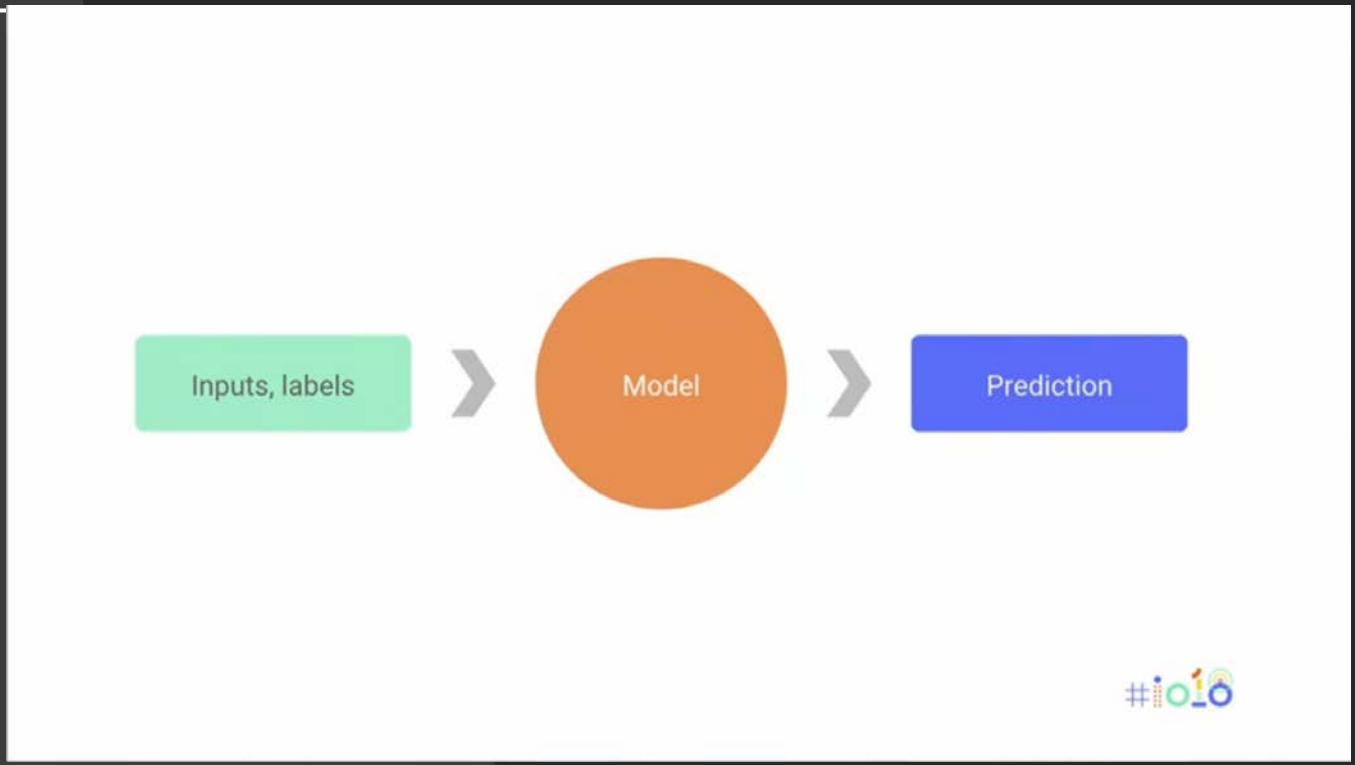
- Machine Learning+Image Detection
- Menu(菜單)
- https://youtu.be/avxpkFUXIfA?t=1123



Intro to machine learning

- Machine Learning
- Supervised Learnning

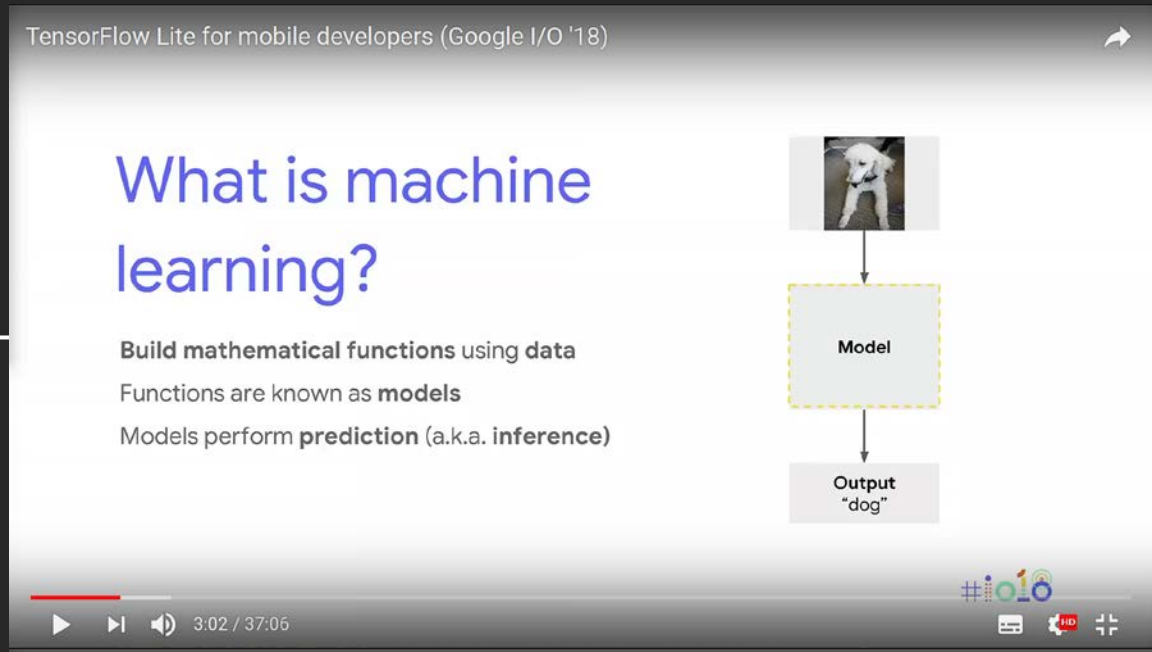
- Intro to machine learning on Google Cloud Platform
- https://youtu.be/gVz9jKE_9iU

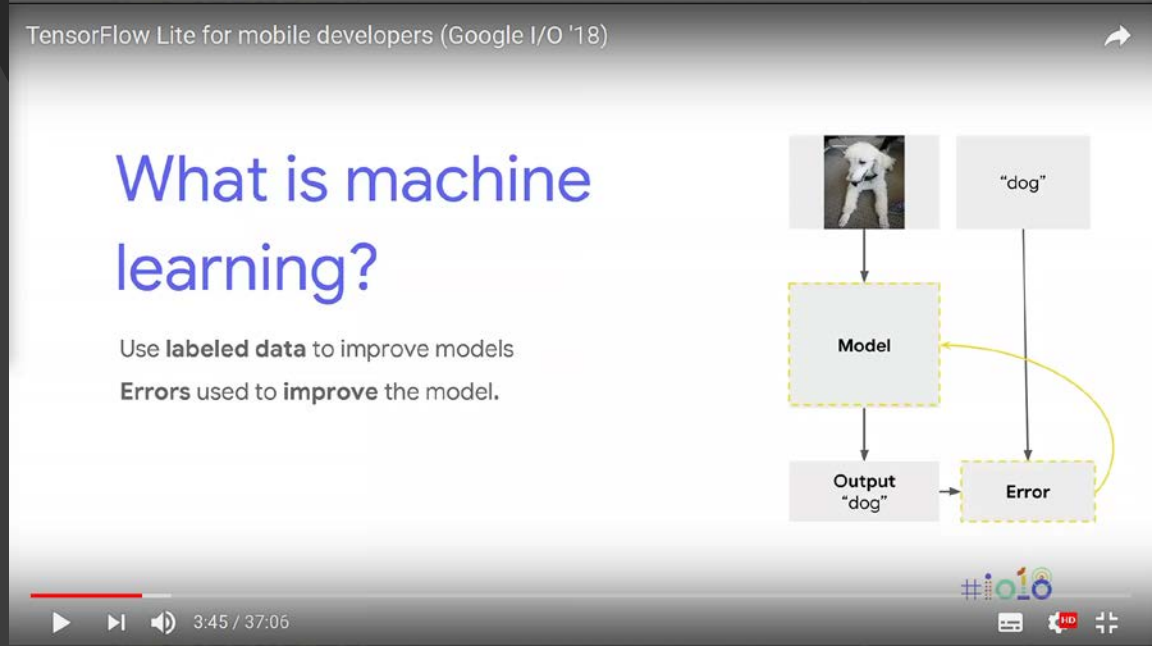


TensorFlow Lite

- Machine Learning

- https://youtu.be/ByJnpbDd-zc?t=182

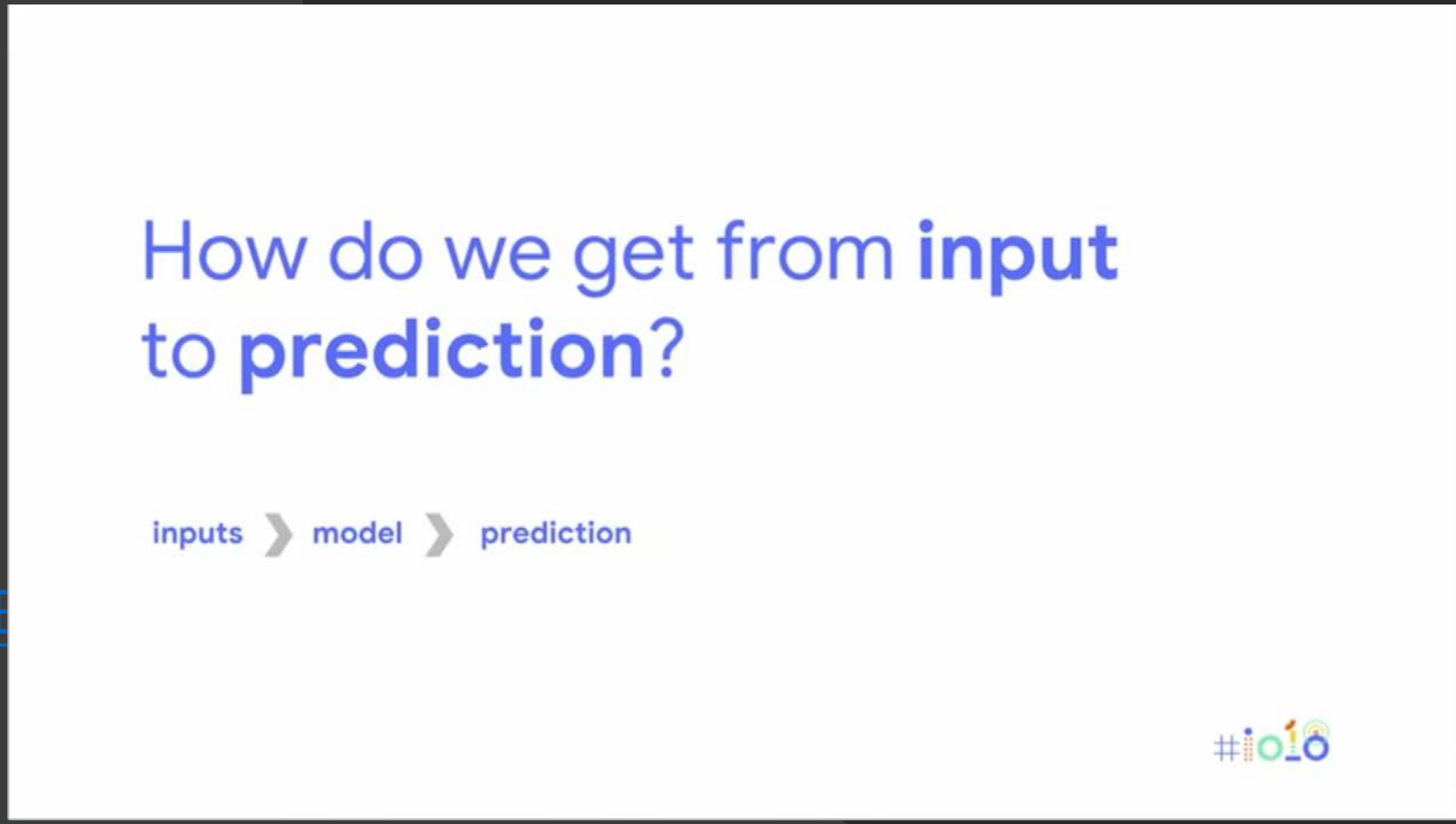




Intro to machine learning on Google Cloud Platform

- Prediction

- https://youtu.be/gVz9jKE



Deep Learning

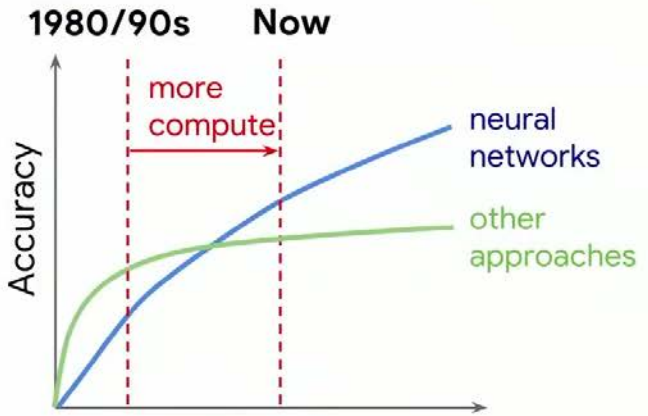
- Deep Learning

- https://youtu.be/JzB7yS

What is Deep Learning?

Modern Reincarnation of Artificial Neural Networks

Collection of simple trainable mathematical units, organized in layers, that work together to solve complicated tasks



What's New

Layered network architecture,
New training math,
Scale

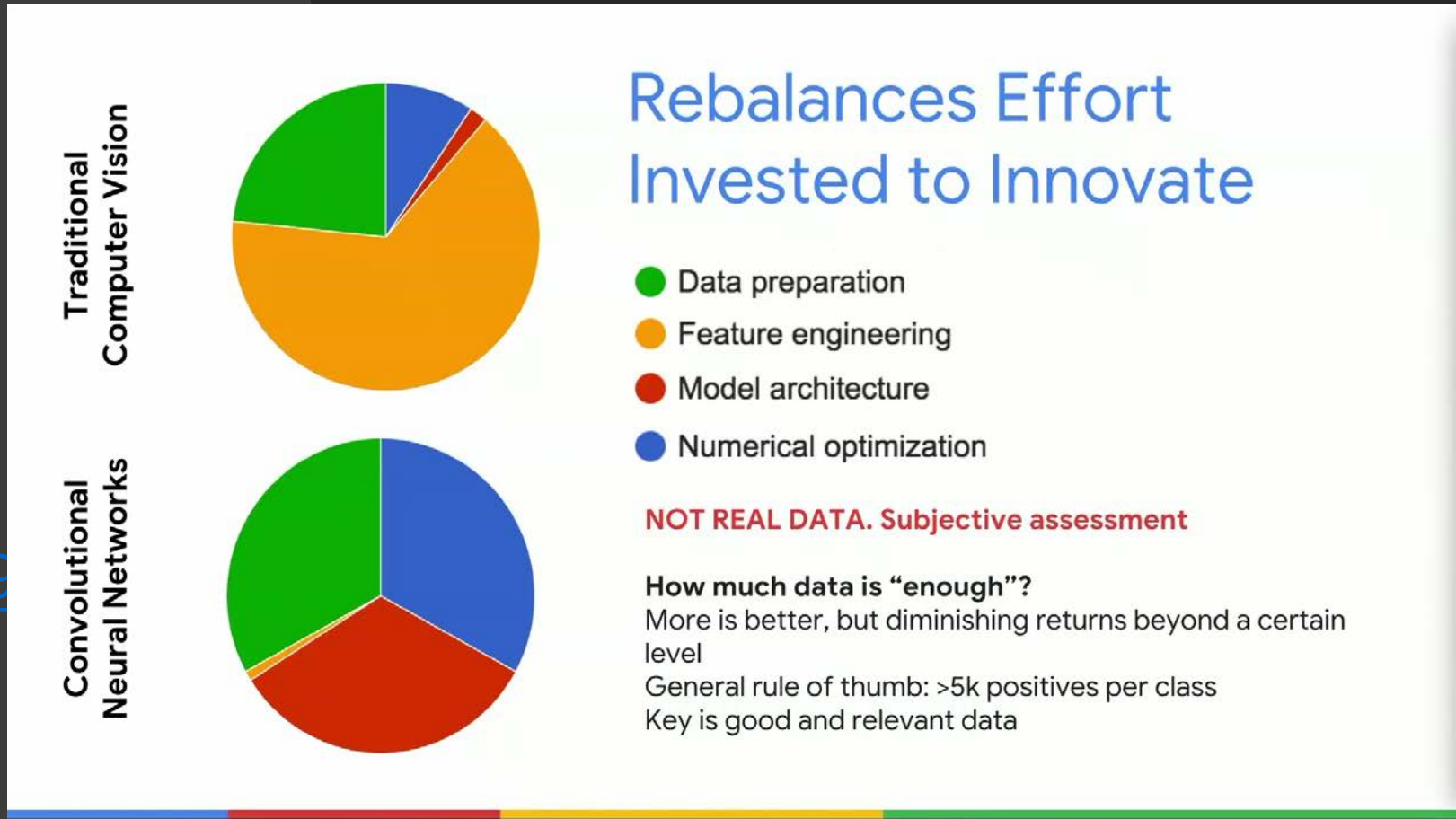
Key Benefit

Highly accurate
Learns features from raw data
No explicit feature engineering required

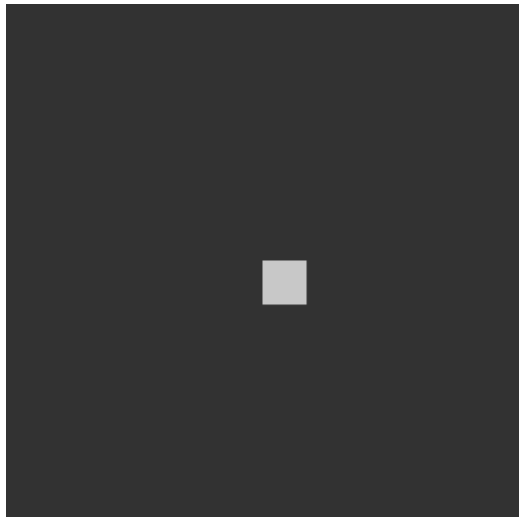
Deep Learning

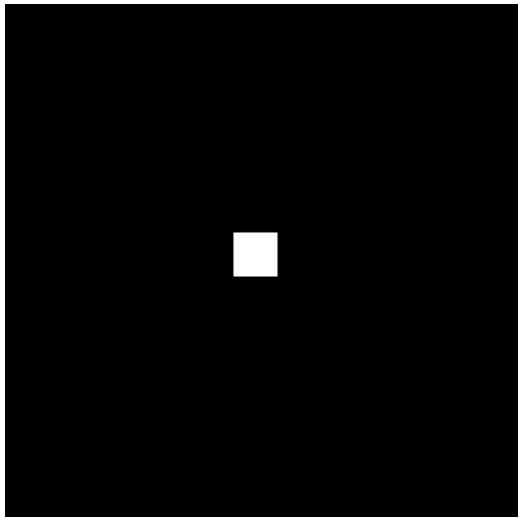
- Deep Learning
- Increase Innovation

- https://youtu.be/JzB7yS9

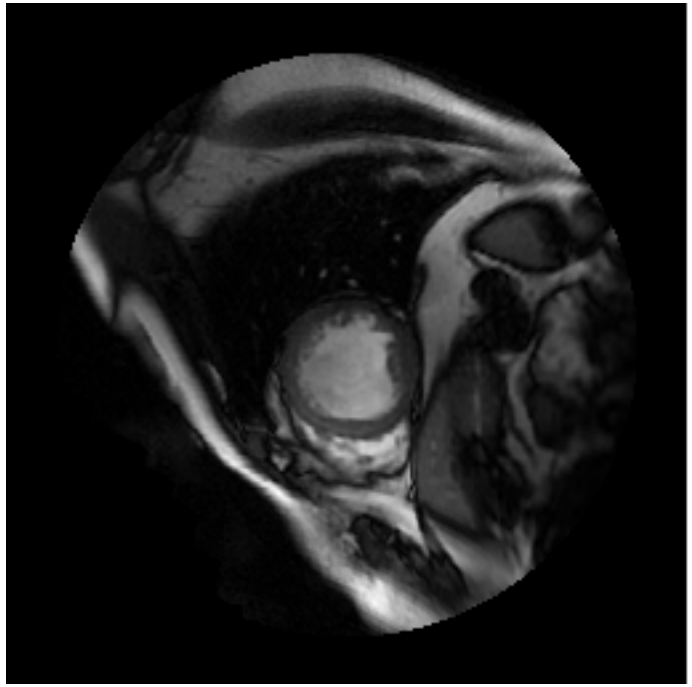


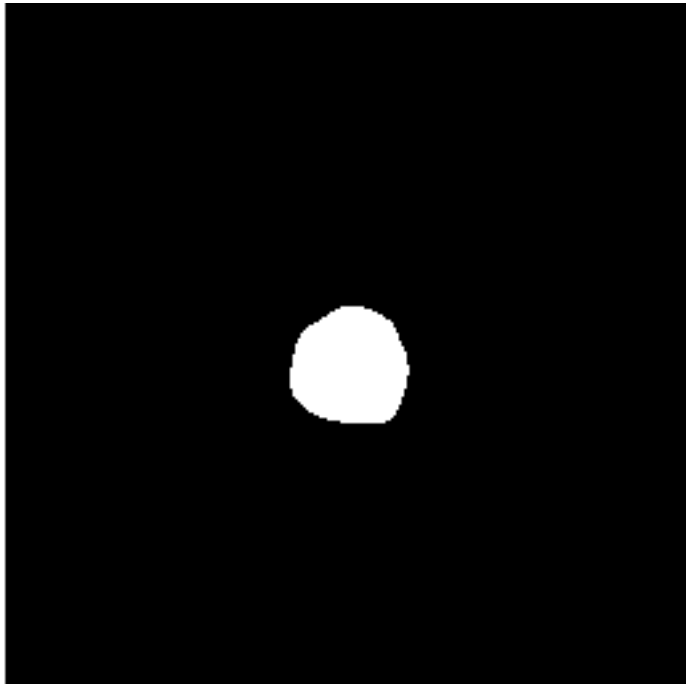
Synthetic Image Segmentation



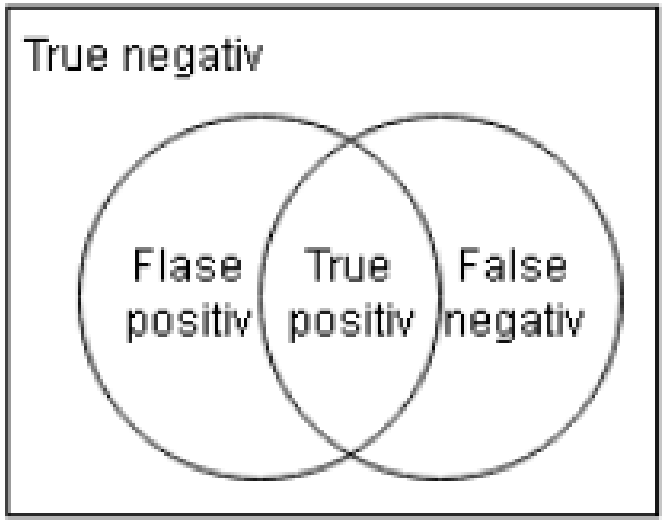


Medical Image Segmentation

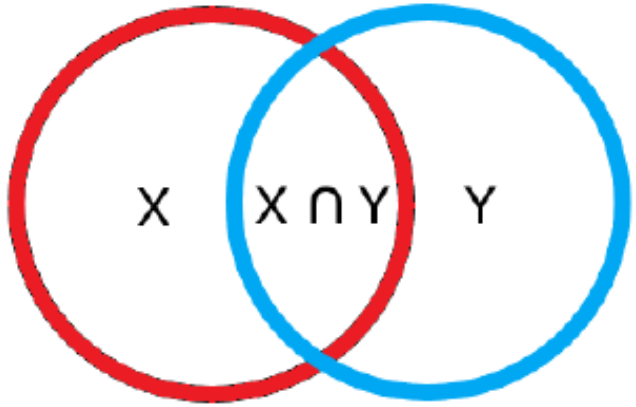




Medical Image Segmentation



$$DC = \frac{2TP}{2TP + FP + FN}$$



$$DSC = \frac{2|X \cap Y|}{|X| + |Y|}$$

Fig. 8. Explanation of Dice Coefficient

謝謝各位的聆聽