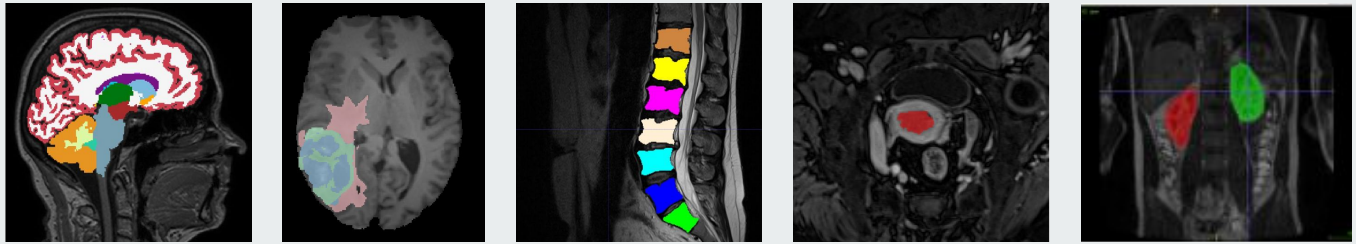
Artificial intelligence in image diagnostics: design methodologies for efficient use of data

Bergen Data Science Meetup, 19. november 2019

Sathiesh Kaliyugarsan

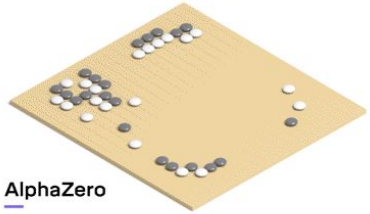


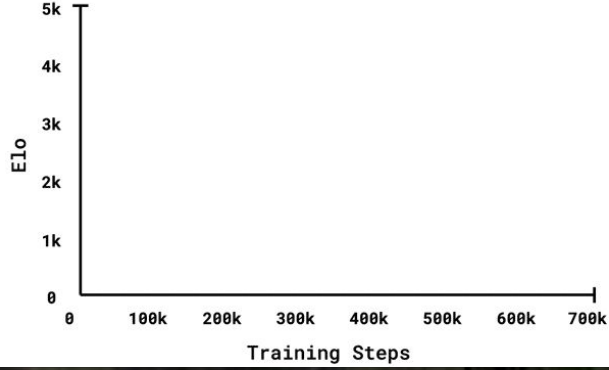
Sathiesh Kaliyugarasan

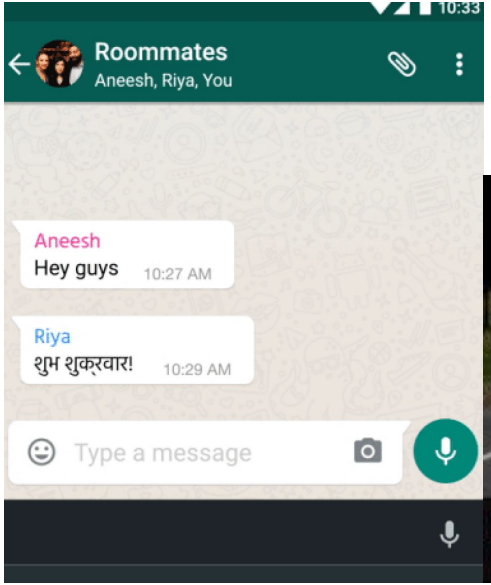
- Bergen, Norway
- BCs degree in Information Technology at HVL
- MSc degree in Software Engineering at HVL and UiB

- Data scientist at Bouvet
- Currently working as a researcher at MMIV, Haukeland University Hospital


PRODUCTION
DeepMind
StarCraft
DEMONSTRATION
8:58
REPLAY
2 AlphaStar
0 LiquidTLO
DeepMind
KAPWING


AlphaZero


5k
4k
3k
2k
1k
0
Elo
0
100k
200k
300k
400k
500k
600k
700k
Training Steps


10:33
Roommates
Aneesh, Riya, You
Aneesh
Hey guys
10:27 AM
Riya
शुभ शुक्रवार!
10:29 AM
Type a message


NVIDIA DRIVE Sim
Test & Validate in VR

More examples of deep learning applications

Speech recognition, speech analysis, speech synthesis, music synthesis, image and video synthesis, board games, computer games, super-resolution in computer games, animations, robotics, protein-folding, ...

Generic techniques!

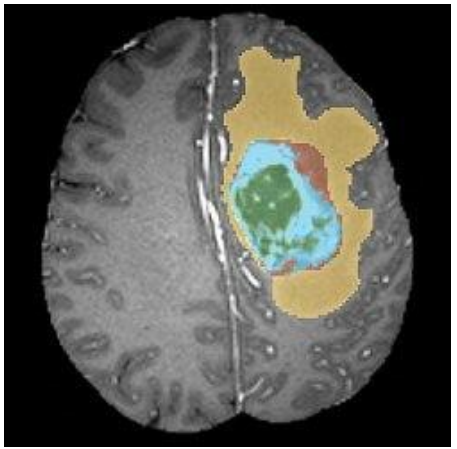
All development potentially useful in medicine

More examples of deep learning applications

Speech recognition, speech analysis, speech synthesis, music synthesis, image and video synthesis, board games, computer games, super-resolution in computer games, animations, robotics, protein-folding, ...

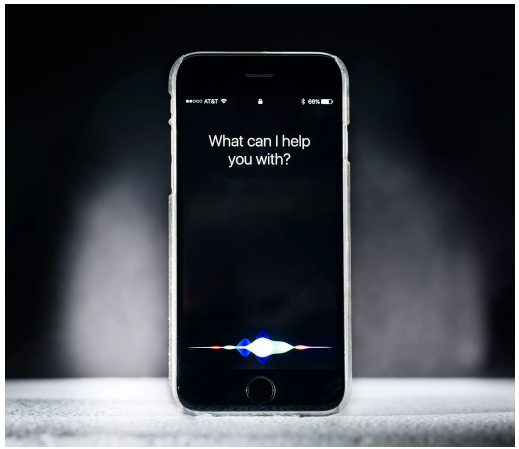
Generic techniques!

All development potentially useful in medicine



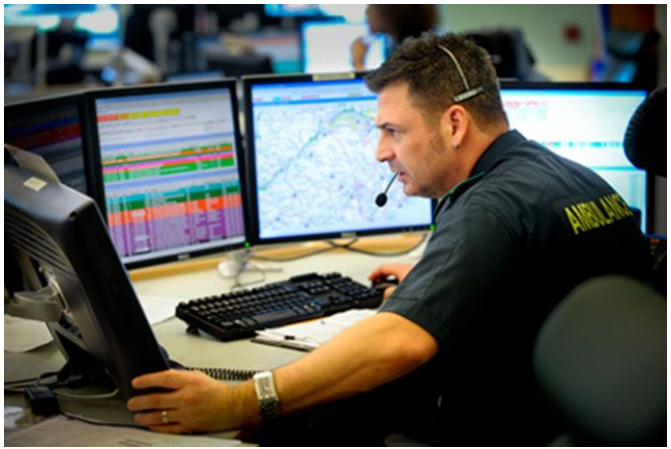
More examples of deep learning applications

Speech recognition, speech analysis, speech synthesis, music synthesis, image and video synthesis, board games, computer games, super-resolution in computer games, animations, robotics, protein-folding, ...



Generic techniques!

All development potentially useful in medicine



Emergency calls: sound classification

Skin cancer can't hide from deep-learning diagnostics

May 21, 2019 | Dave Pearson | Diagnostics

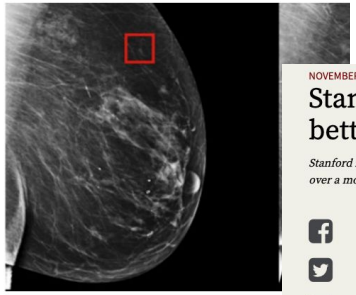
Can Detect Wrist Fractures

:he accuracy of wrist fracture diagnosis.

Deep Learning Model Can Predict B Five Years in Advance

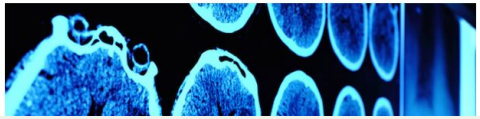
The system will help develop individual risk management plans.

By Jessica Miley
May 24th, 2019



Deep Learning Tool Identifies Disease Markers of Alzheimer's

A deep learning tool was able to rapidly detect markers of Alzheimer's disease in human brain tissue.



Deep learning improves detection of polyps during colonoscopy

November 07, 2018 | Matt O'Connor | Artificial Intelligence

NOVEMBER 15, 2017

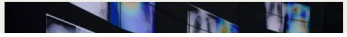
Stanford algorithm can diagnose pneumonia better than radiologists

Stanford researchers have developed a deep learning algorithm that evaluates chest X-rays for signs of disease. In just over a month of development, their algorithm outperformed expert radiologists at diagnosing pneumonia.

BY TAYLOR KUBOTA

Stanford researchers have developed an algorithm that offers diagnoses based off chest X-ray images. It can diagnose up to 14 types of medical conditions and is able to diagnose pneumonia better than expert radiologists working alone. A paper about the algorithm, called CheXNet, was published Nov. 14 on the open-access, scientific preprint website arXiv.

"Interpreting X-ray images to diagnose pathologies like



Deep learning predicts OCT measures of diabetic macular thickening

Exudates in the macula showing clinically significant macular edema (CSME) can be deceiving for the diagnosis of abnormal macular thickening. Left: Color fundus photo shows exudates indicating CSME, with associated CST <250 um. Right: CFP shows no CSME, but has associated CST >250 um. (Images courtesy of Jeffrey Willis, MD, PhD)

By Steve Lenier
May 21, 2019

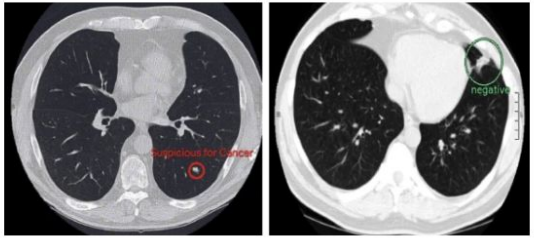
ıing detects ACL tears on MRI sir

Matt O'Connor | Artificial Intelligence

AI

Google's lung cancer detection AI outperforms 6 human radiologists

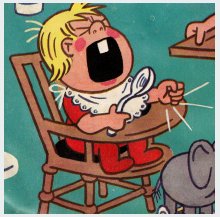
KHARI JOHNSON @KHARIJOHNSON MAY 20, 2019 8:00 AM



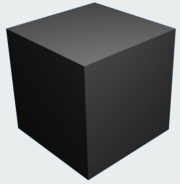
Challenges

for deep learning in medical image analysis

Data hungry!



Black box



DARPA

"Explainable AI"

Why did you do that?
Why not something else?
When do you not succeed?
When do you fail?
When can I trust you?
How can I correct an error?

Privacy

Data access

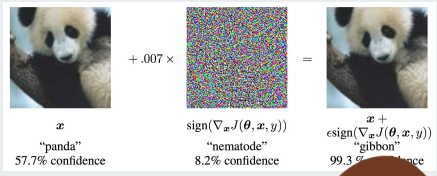
Data labeling

Law

Protecting data

De-anonymization-angrep

Adversarial examples



Fairness

Reproducibility

Lack of theory

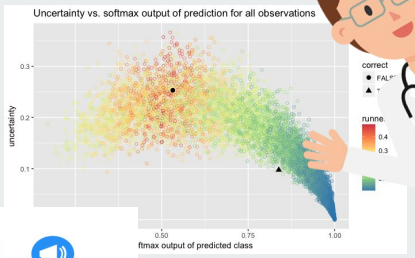
Models lack of understanding

Trust

Uncertainty

What makes one model better than another?

Clinical validation!

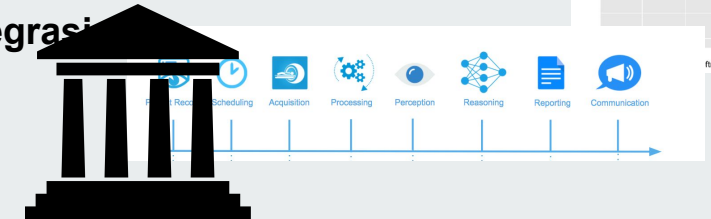


Education

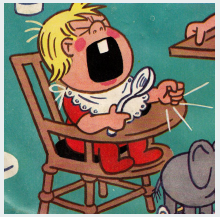
Software engineering best practices

...ployment, maintenance, ...g, hidden technical debt, ...

Workflow-integrasi



Data hungry!



Privacy

Data access

Law

Data labeling

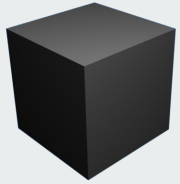
Protecting data

Fairness

Reproducibility

Lack of theory

Black box

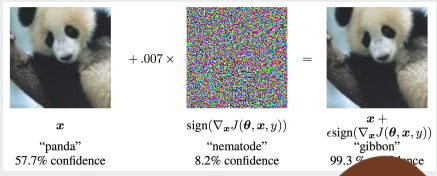


"Explainable AI"

Why did you do that?
Why not something else?
When do you not succeed?
When do you fail?
When can I trust you?
How can I correct an error?

De-anonymization-angrep

Adversarial examples

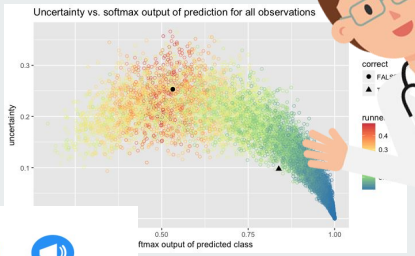


Models lack of understanding

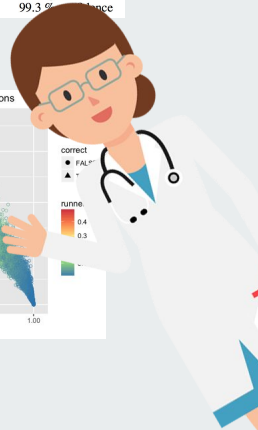
Trust

Clinical validation!

Uncertainty



Education

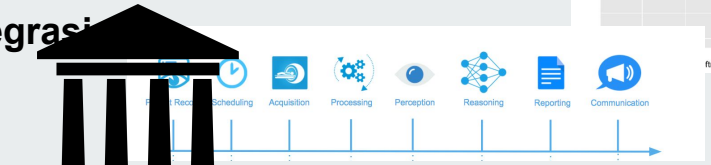


What makes one model better than another?

Software engineering best practices

...ployment, maintenance, ...g, hidden technical debt, ...

Workflow-integrasi



Data hungry methods

“Just label some data”

- *Someone who never had to label any data*

Using large freely available data repositories to design powerful ML models

OASIS
Open Access Series Of Imaging Studies

ADNI
Alzheimer's Disease Neuroimaging Initiative

PPMI
Parkinson's Progression Markers Initiative

IXI
Information eXtraction from Images

ABIDE
Autism Brain Imaging Data Exchange

ADHD-200
Attention Deficit Hyperactivity Disorder

AIBL
The Australian Imaging, Biomarkers and Lifestyle

ABCD
Adolescent Brain Cognitive Development

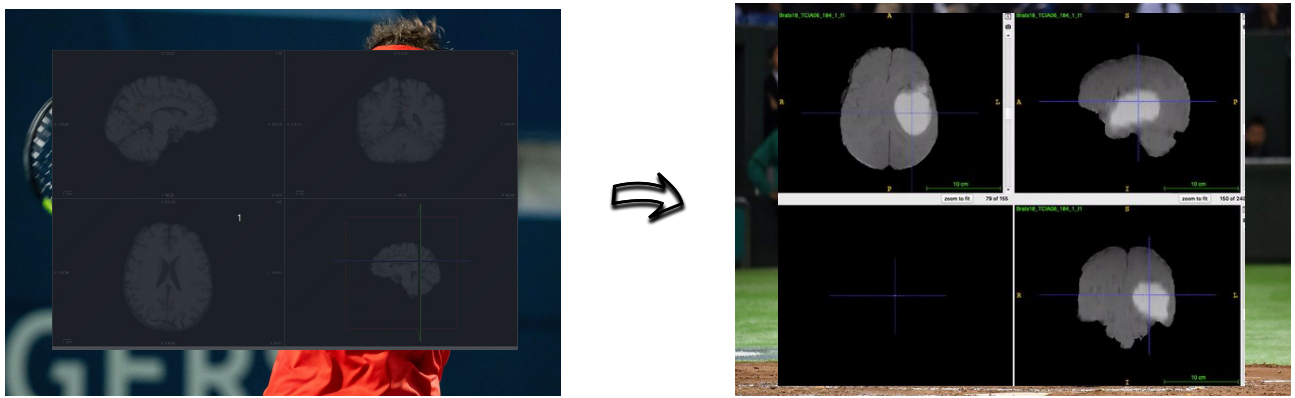
UK Biobank

~13.000

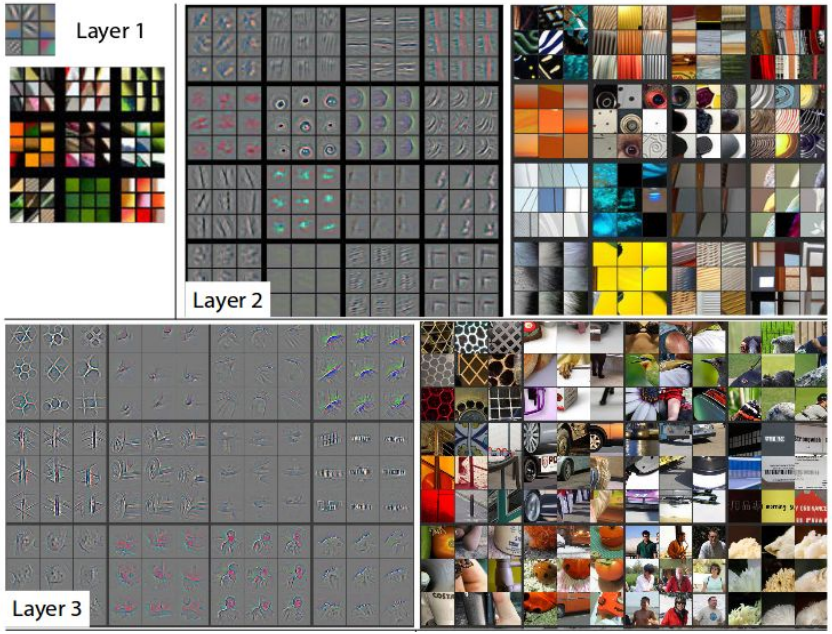
Transfer learning

What is transfer learning?

- It is the process of using the knowledge learned in one process in another task



Convolutional neural network

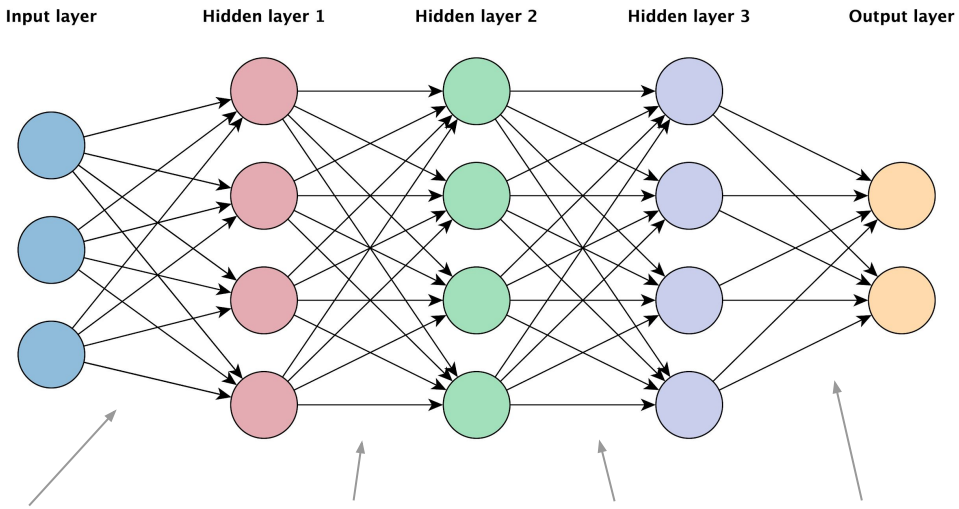


Source: *Visualizing and Understanding Convolutional Networks*

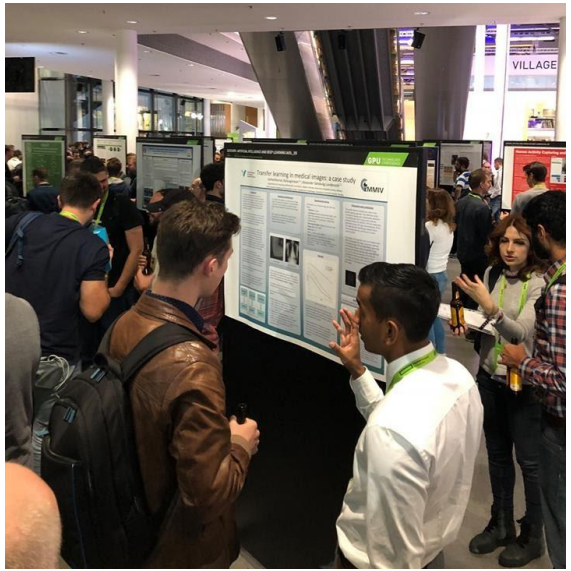
ImageNet

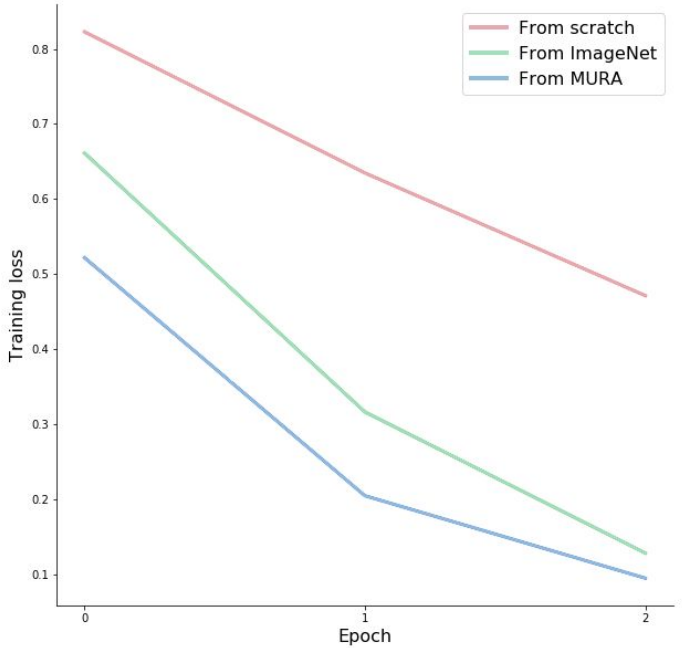
Source:https://patrykchrabaszcz.github.io/Imagenet32/

Deep neural network

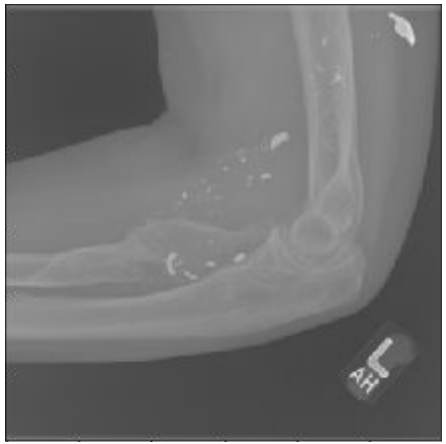


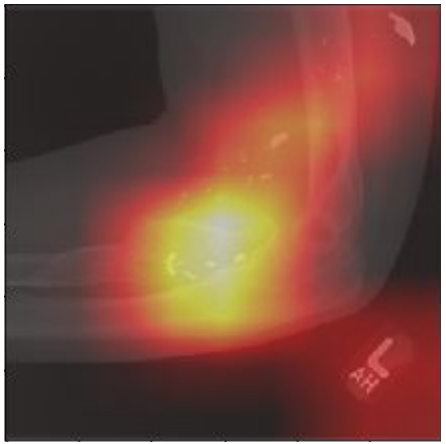
Previous studies I've done: transfer learning in 2D



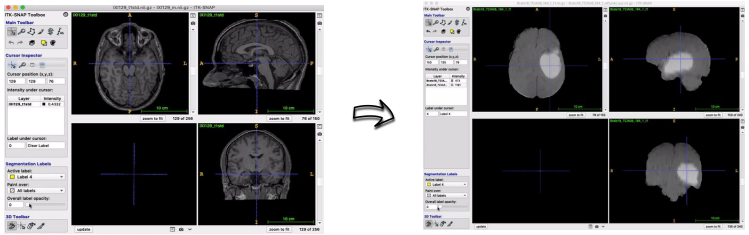


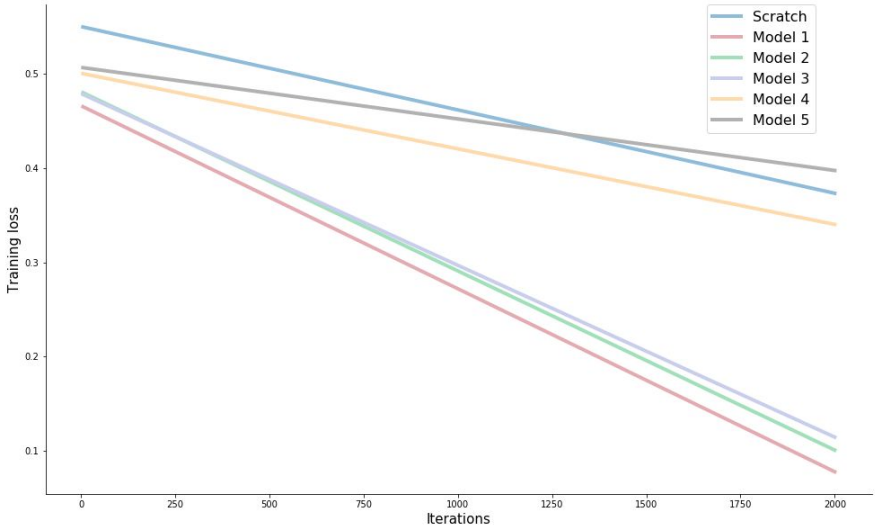
Previous studies I've done: class activation map





Previous studies I've done: transfer learning in 3D





Construct model based on “easily” available data

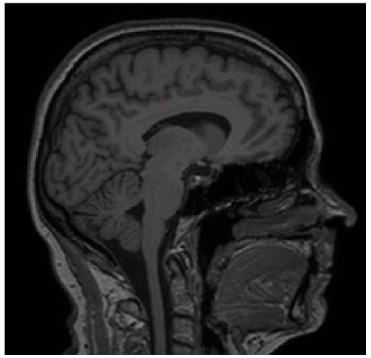
Brain Age versus Chronological Age

- **Structure of the brain is constantly changing throughout the lifetime**
- **Impossible for physicians to determine from brain image alone**
- **Three anatomical features associated with brain aging**

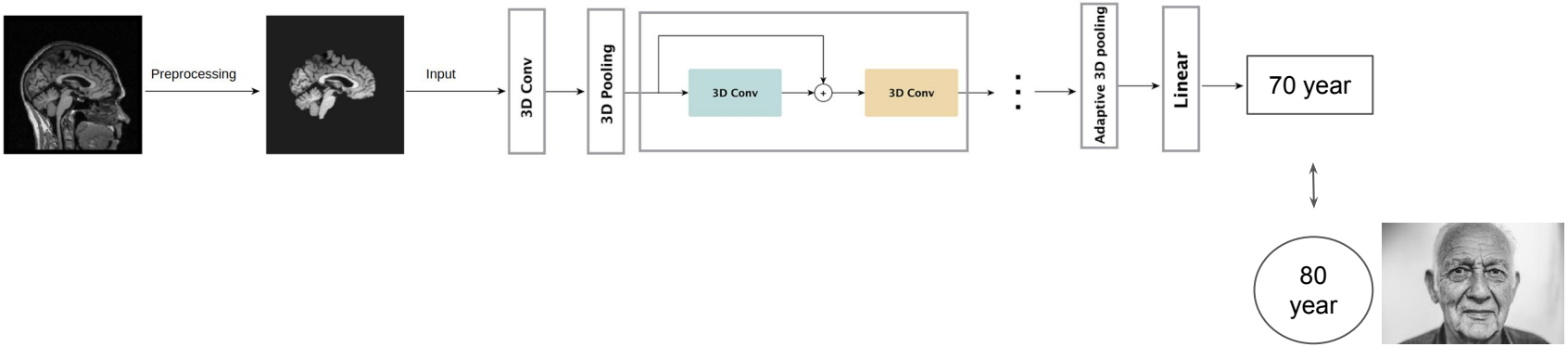
Source:https://patrykchrabaszcz.github.io/Imagenet32/

Related work

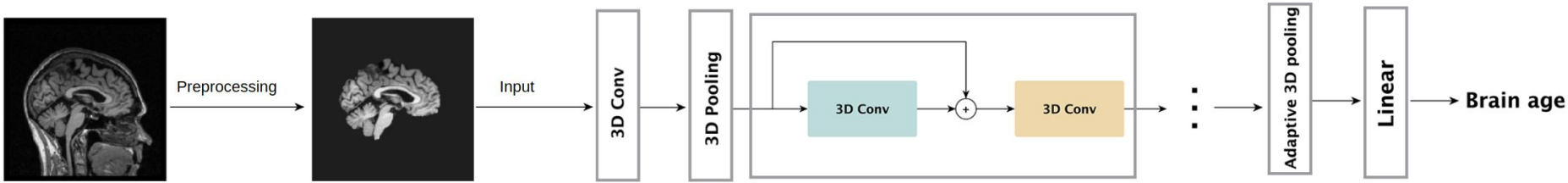
- ***Predicting brain age with deep learning from raw imaging data results in a reliable an heritable biomarker - James H. Cole .et al***



Pipeline

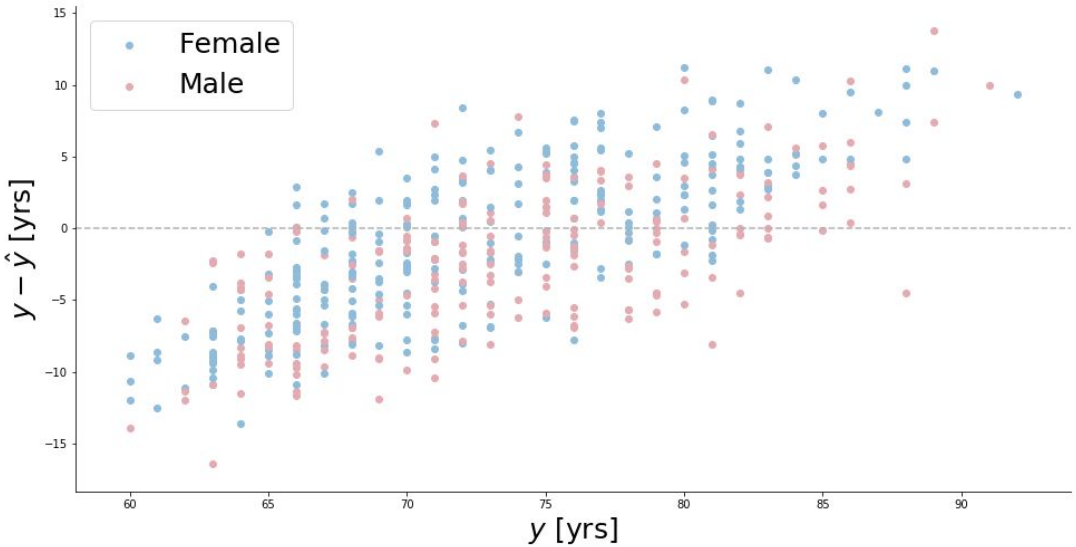

Preprocessing
Input
3D Conv
3D Pooling
3D Conv
3D Conv
Adaptive 3D pooling
Linear
70 year
80
year

Methods and Materials: Pipeline



- Prediction time per volume approx. 0.8 sec
- **Total time: 13.2 sec**

Results: Test set

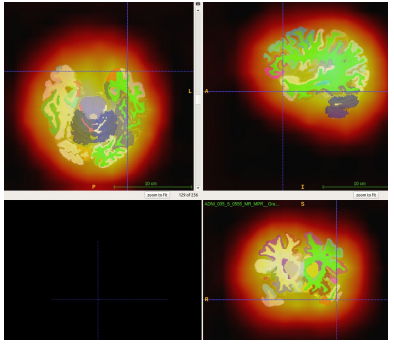


Residual plot of the accuracy obtained by our CNN model on the test set subjects (485 images), where y = age at scan, and ŷ = predicted age (“brain age”).

MAE: 4.46 (SD 4.82)

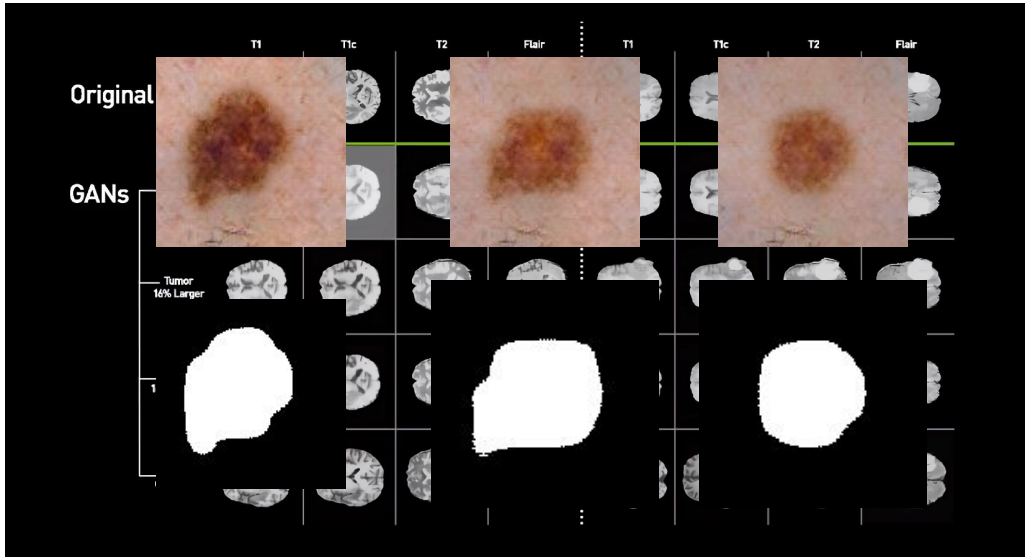
Ongoing work

- Fully convolutional network
- Grid search hyperparameters (RAdam, Mish, dropout, etc)
- Predict on patients with AD in the ADNI data set
- Add more training subjects from other datasets
- Apply techniques from explainable AI (e.g., regression activation map)

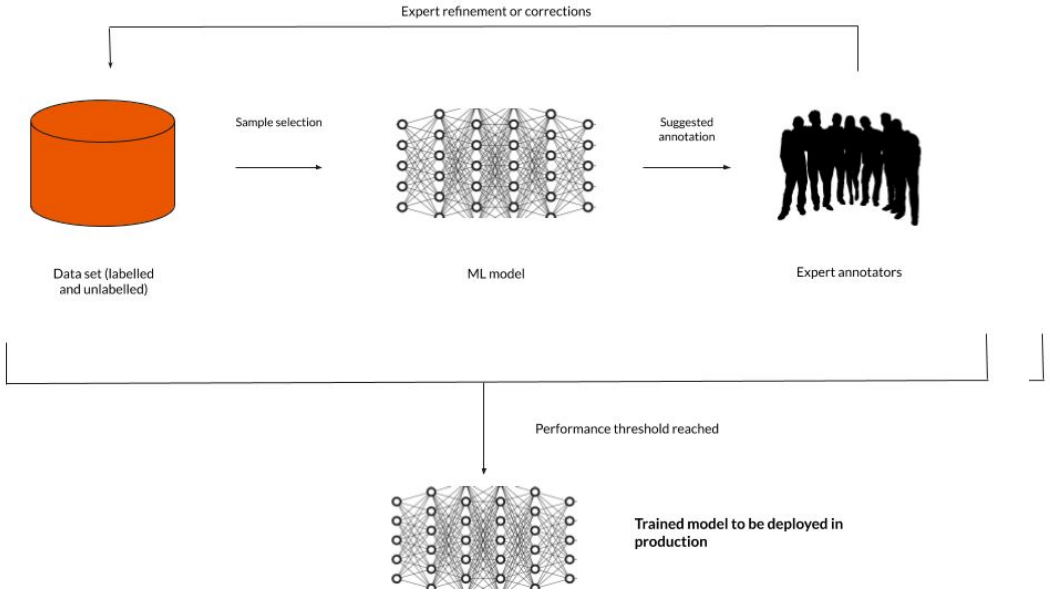


Other ongoing work in efficient use of data

GAN data augmentation



Active learning and “human-in-the-loop”



In order to develop such applications it is necessary with access to clinical expertise, interesting medical questions, data, and close contact with ICT activities at the hospital

Development of medical AI should take place with the health care system in the driver's seat

MMIV

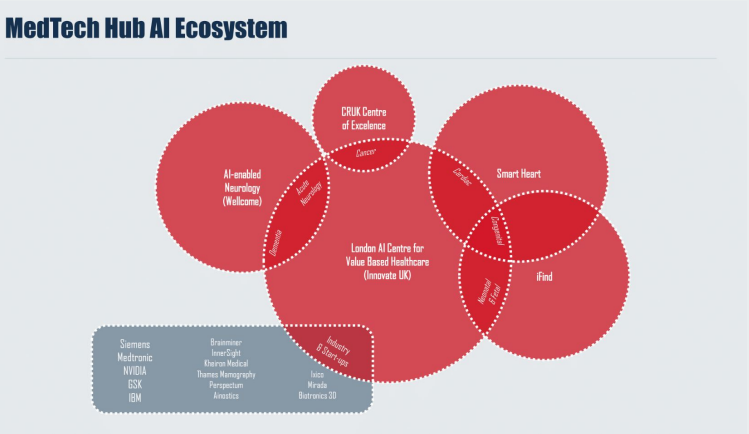
5 March 2019

Launch of the London Medical Imaging & Artificial Intelligence Centre for Value-Based Healthcare

Thursday 28 February saw the official opening event for the London Medical Imaging & Artificial Intelligence Centre for Value-Based Healthcare, established as part of the UK Government's Industrial Strategy Challenge Fund.

King's College London, NVIDIA Build Gold Standard for AI Infrastructure in the Clinic

NVIDIA and KCL will **co-locate researchers and engineers with clinicians** from major London hospitals



CMMIV

HELSE BERGEN

TROND MOHN STIFTELSE

UNIVERSITAS BERGENSIS

MMIV Conference 2019

https://mmiv.no/conference

December 9-11

Convergence of medical data science for improved patient care

Welcome to the second MMIV conference **on December 9th and 10th at Bikuben conference center**.

The main theme of the conference is **convergence of medical data science for improved patient care**. The four MMIV centre projects are presenting scientific sessions on machine learning, cancer imaging, neuro imaging, and visualization, along with invited talks on related topics.

The conference is open to everyone, and there is no admission fee. The conference will soon open for registration.

Click here to register

Featured Speakers

Dag Rune Olsen

Rector, University of Bergen

Bradley J, Erickson

Radiology Informatics, Mayo Clinic

Anders Persson

Director of the CMIV at Linköping University

Sebastien Ourselin

King's College London

Helga M. Brøgger

President, Norwegian Society of Radiology

Johanna Pijnenborg

Radboud University Medical Centre

Ofer Pasternak

Harvard Medical School

Thomas Schultz

University of Bonn

Thank you!