Medical Image Generation and Analysis using Bayesian Generative Models

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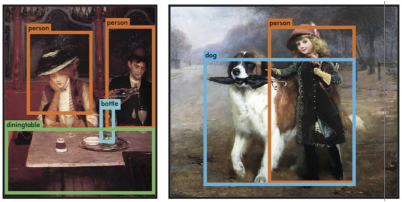
Machine Learning algorithms have achieved impressive milestones

Object detection (YOLO)



Text-to-Image Generation (DALL-E)

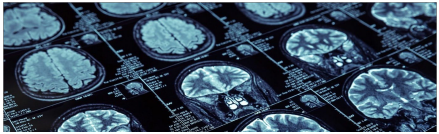
prompt: "an armchair in the shape of an avocado"

Image Generation (StyleGAN2)

Text generation (GPT-3)

Title: United Methodists Agree to Historic Split
Subtitle: Those who oppose gay marriage will form their own denomination
Article: **After two days of intense debate, the United Methodist Church has agreed to a historic split - one that is expected to end in the creation of a new denomination, one that will be "theologically and socially conservative," according to The Washington Post. The majority of delegates attending the church's annual General Conference in May voted to strengthen a ban on the ordination of LGBTQ clergy and to write new rules that will "discipline" clergy who officiate at same-sex weddings. But those who opposed these measures have a new plan: They say they will form a separate denomination by 2020, calling their church the Christian Methodist denomination.**

Diagnose with unprecedented accuracy



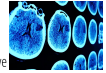
Augment doctors

Top 12 Ways Artificial Intelligence Will Impact Healthcare

Artificial intelligence is poised to become a transformational force in healthcare. How will providers and patients benefit from the impact of AI-driven tools?

How Artificial Intelligence Improves Medical Imaging in Hospitals

Deep learning software, such as artificial intelligence, can improve



Improve patient healthcare and save lifes

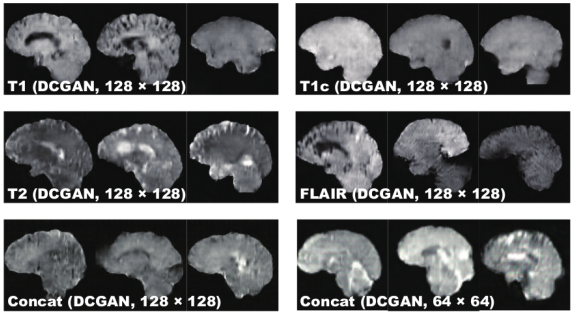
Prediction of clinical variables not always working

No algorithm/33 could predict cognitive scores in Alzheimer's (TADPOLE Challenge, Marinescu 2020)

- Forecasts were very good for clinical diagnosis and ventricle volume -- on the other hand, **predicting ADAS turned out to be very difficult** -- no team was able to generate forecasts that were significantly better than random guessing

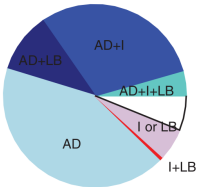
Generated images are crude, not high-resolution, mostly 2D

Brain MRI generation (Han, 2018)



Lack of good labels

- Alzheimer's diagnosis accuracy just 42%



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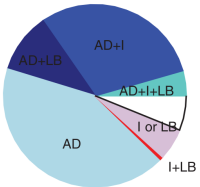
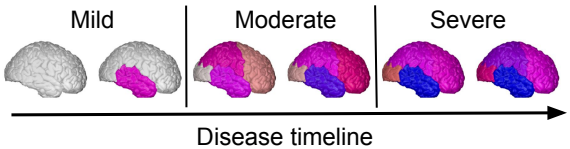


- Labels are categorical instead of continuous



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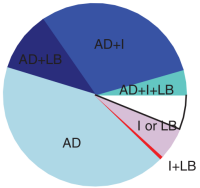

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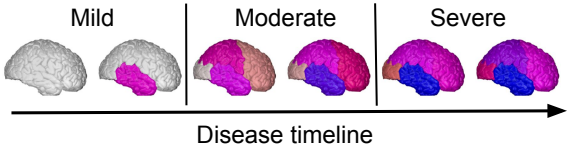
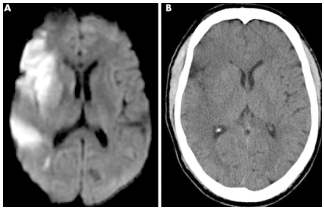


Lack of good input data/signal

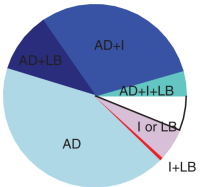
- Limited contrast



Why are Machine Learning models not working on medical applications?

Lack of good labels

- Alzheimer's diagnosis accuracy just 42%



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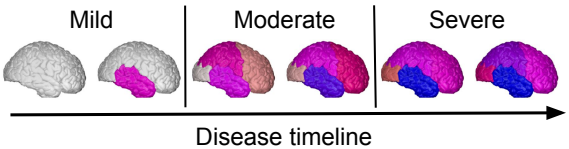

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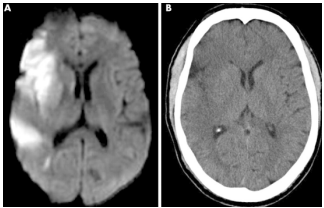
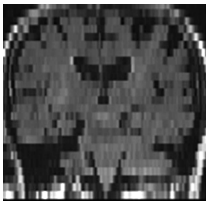
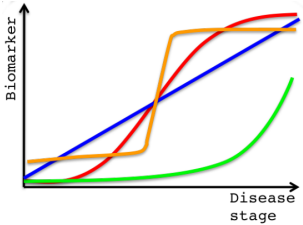


- Low-resolution



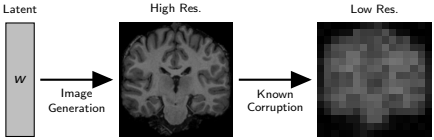
Lack of good labels

Solution: Unsupervised Learning of Continuous Dynamics
= Disease Progression Modelling



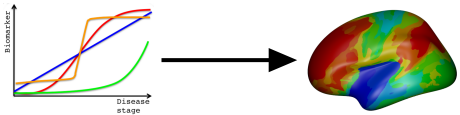
Lack of good input data/signal

Solution: Image Reconstruction
using Deep Generative Models

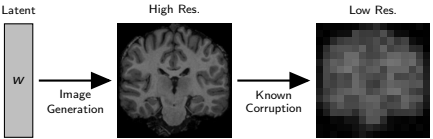


Outline

1. Disease progression modelling of Alzheimer's disease
   1.1 Towards unsupervised clustering of biomarker trajectories



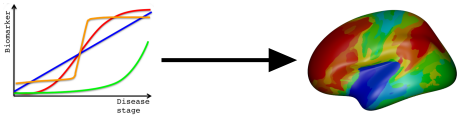
2. Image Reconstruction using Deep Generative Models



3. Future work

Outline

1. **Disease progression modelling of Alzheimer's disease**
   1.1 Towards unsupervised clustering of biomarker trajectories



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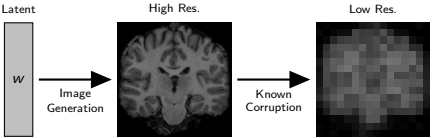

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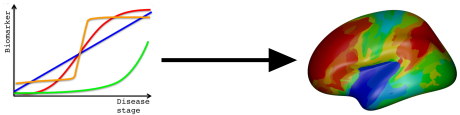

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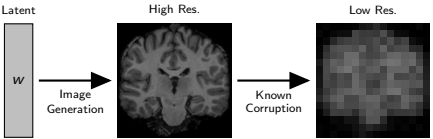

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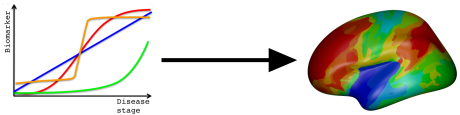

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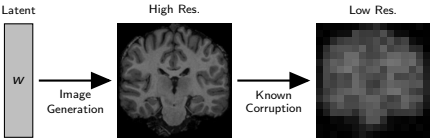
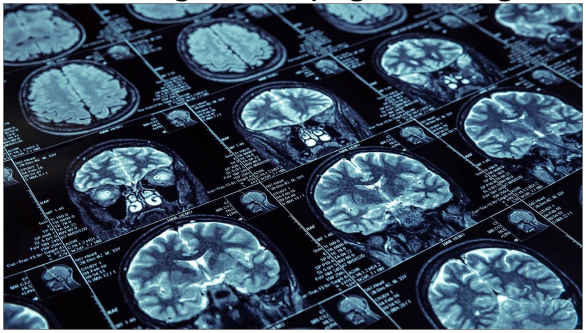


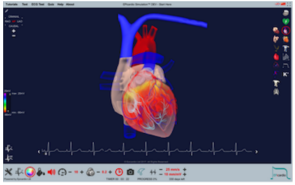
3. **Future work**

Accurate diagnosis and prognosis through AI

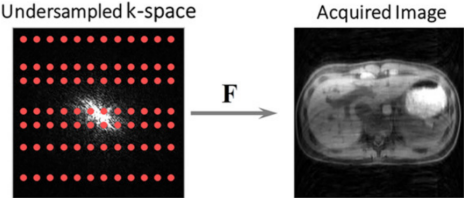


AI to augment humans

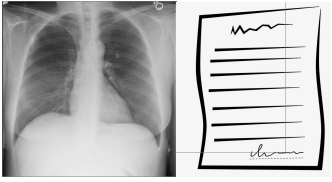
Biological simulators



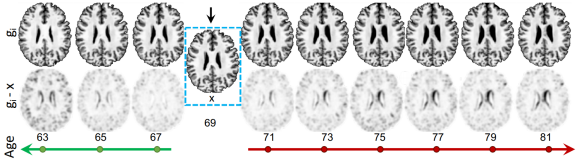
Better and faster reconstruction of medical images



Multimodal modelling
images + text + structural data



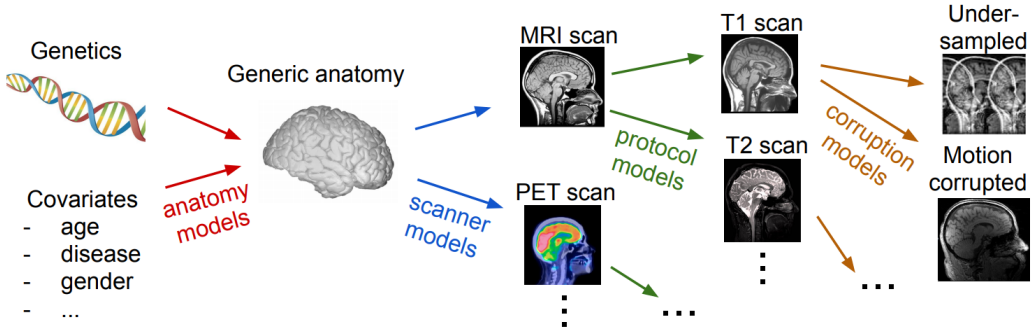
Disease Progression Modelling



Future work: Brain tissue and anatomy simulator

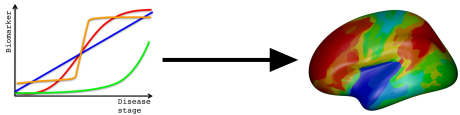
Simulator for brain anatomy from genetics:

- Using deep generative models
- Accouting for distributions shifts
- Following causal principles



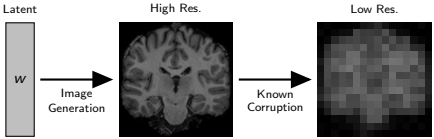
Problem: Lack of good labels

Solution: Unsupervised Learning through Disease Progression Modelling



Problem: Lack of good input data

Solution: Image Reconstruction using Deep Generative Models



Long-term vision

Accurate diagnosis and prognosis through AI

AI to augment humans