



# A story about Medical AI engineering

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Alexander Selvikvåg Lundervold

[allu@hvl.no](mailto:allu@hvl.no); [lundervold.net](mailto:lundervold.net)



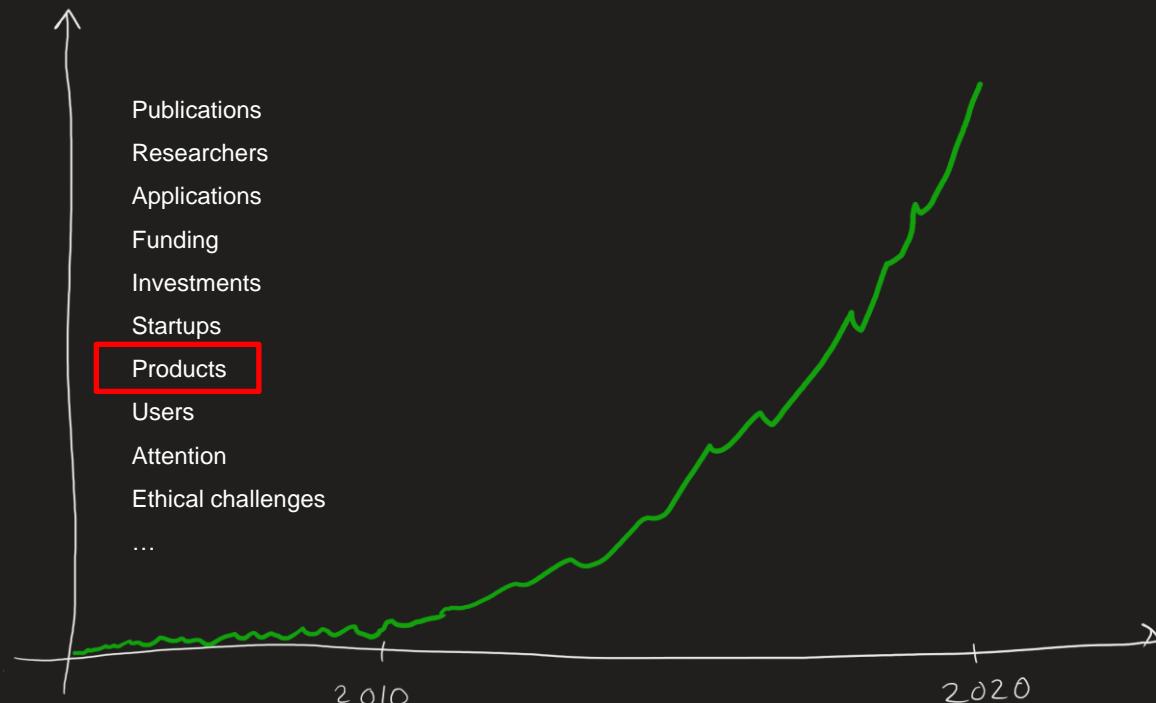
Western Norway  
University of  
Applied Sciences



## Artificial intelligence

# Machine learning

# Deep learning



# Cercare Medical



ARTERYS

aidoc.

Quantib

Combinostics

Quibim

NICOLAB

BRAINLAB

QYNAPSE

SIEMENS  
Healthineers

braintale

QUBIO<sup>tech</sup>

PIXYL

ADVANTIS

AlgoMedica

MEDICAL IMAGING  
BRAINOMIX

All of these target neuro areas, and all are available on the European market (CE marked)

mediaire

imagilys

icometrix

BioMind®

AIRAméd  
artificial intelligence in radiology

Avicenna. AI  
empowering radiology with AI

VUNO®  
View the Invisible, Know the Unknown

viz.ai

neurophet

iSchemaView RAPID™

DeepTrace

BRAIN SCAN

JLK

Imaging Biometrics  
CREATING THE STANDARD  
An IQ-AI Company



SyntheticMR

quare.ai

CIRCLE  
NEUROVASCULAR IMAGING



GRAYLIGHT  
MEDICAL IMAGING SOFTWARE



## Products

Find the artificial intelligence based software for radiology that you are looking for.  
All products listed are available for the European market (CE marked).

Subspecialty: Modality: CE: CE class: FDA class: Sort by:

Neuro All All All All last modified

Search... Search

72/198 results



Avicenna.AI

### CINA-ICH

Intracranial Hemorrhage detection, notification

The CINA-ICH solution provides automated detection and prioritization of acute intracerebral hemorrhage on non-contrast CT (NCCT).

Subspecialty: Neuro  
Modality: CT

Read more

CE: Class I - MDD   
FDA: Class II

Information source: Vendor  
Certification verified: Yes



Avicenna.AI

### CINA-LVO

large vessel occlusion detection, notification

The CINA-LVO solution is designed to automatically detect and prioritize acute large vessel occlusions on CTA.

Subspecialty: Neuro  
Modality: CT

Read more

CE: Class I - MDD   
FDA: Class II

Information source: Vendor  
Certification verified: Yes



Avicenna.AI

### CINA-ASPECTS

Automated ASPECT score, visual localization information

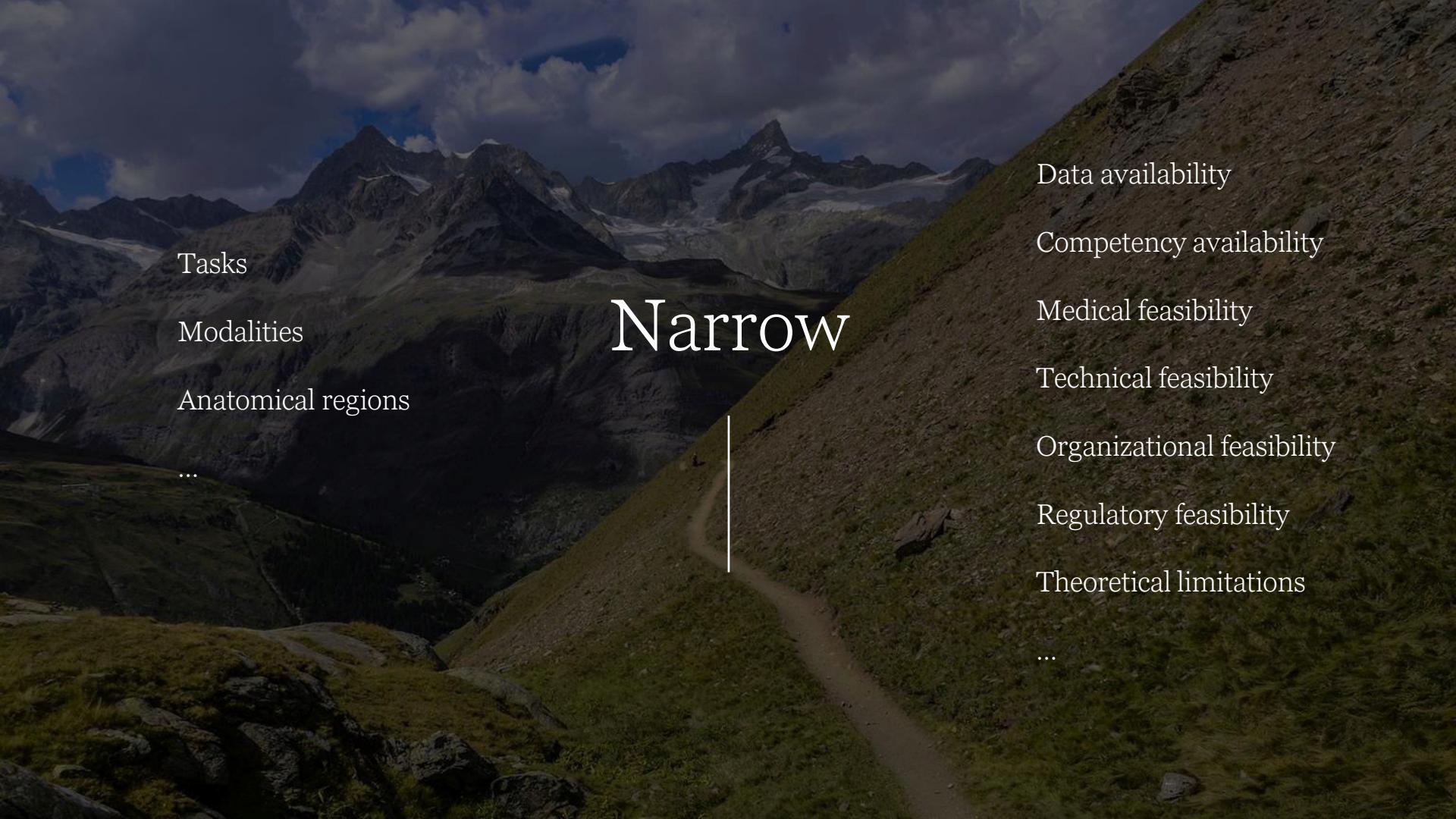
CINA-ASPECTS is an AI-based automatic tool that aids the assessment of acute ischemic stroke. Beyond providing the ASPECT Score for both sides of the brain, CINA-ASPECTS provides an heat map ...

Subspecialty: Neuro  
Modality: CT

Read more

CE: Class I - MDD   
FDA:

Information source: Vendor  
Certification verified: Yes

The background of the slide is a photograph of a mountainous region. In the foreground, there's a grassy slope with some rocks. A dirt path starts from the bottom left and winds its way up and to the right. In the middle ground, there's a valley with more greenery and a small stream or river. The background features a range of mountains with sharp peaks, some of which have snow or ice on them. The sky is filled with large, white clouds.

Tasks

Modalities

Anatomical regions

...

# Narrow

Data availability

Competency availability

Medical feasibility

Technical feasibility

Organizational feasibility

Regulatory feasibility

Theoretical limitations

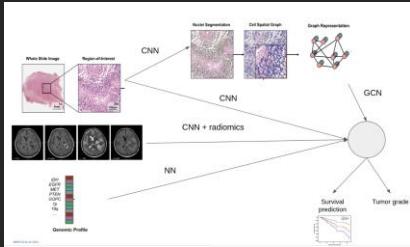
...

The research side is somewhat broader...

...trying to investigate how to integrate heterogeneous data about patients and disease processes.

Two examples:

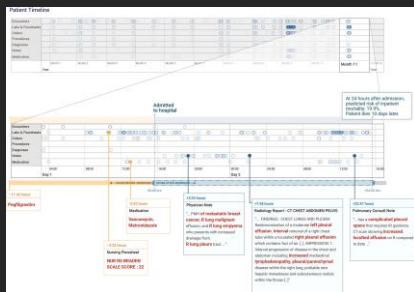
### *Integrated diagnostics*



Chen et.al. IEEE Trans Med Imaging, 2022, [10.1109/TMI.2020.3021387](https://doi.org/10.1109/TMI.2020.3021387)

From brain tumor imaging and genetics to survival prediction

### *Deep learning and electronic health records*



From EHR to length-of-stay and in-hospital mortality

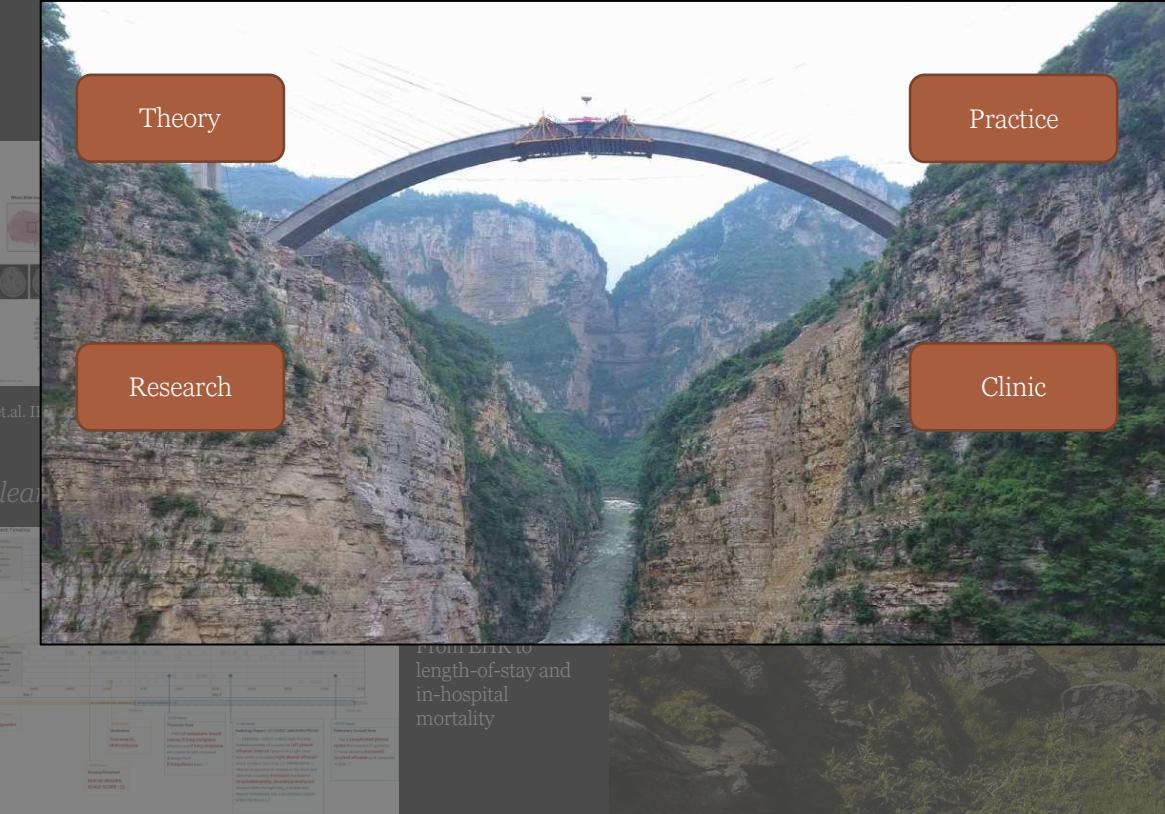
Rajkomar et.al., NPJ Digit Med, 2018, [10.1038/s41746-018-0029-1](https://doi.org/10.1038/s41746-018-0029-1)



The research side is somewhat broader...

...trying to investigate how to integrate heterogeneous data  
about patients and disease processes.

Two examples:





Machine learning in medicine



A wide-angle photograph of a majestic mountain range under a bright blue sky with scattered white clouds. The mountains are rugged, with exposed rock faces and patches of green vegetation. In the foreground, there are several small, vibrant green lakes nestled in the valleys. A large, semi-transparent blue oval is positioned in the center-left of the image. Inside the oval, the text "Practical machine learning" and "&" is written in a white sans-serif font. Below that, the words "Machine learning engineering" are written in a smaller, italicized white sans-serif font.

Practical machine learning  
&  
*Machine learning engineering*





Machine  
learning



Machine learning

Machine learning



Machine  
learning



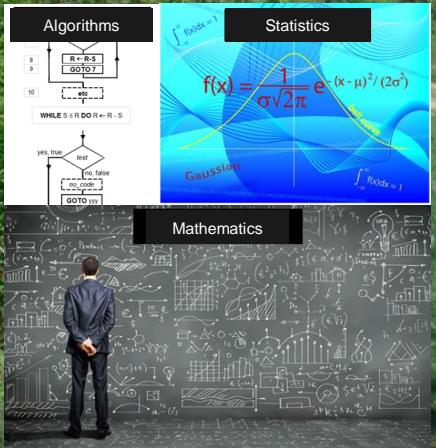
Machine learning  
models

Machine learning  
engineering

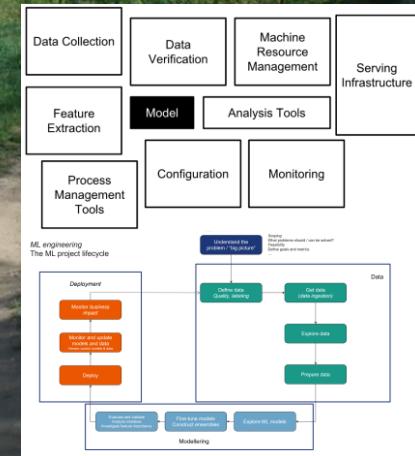


Machine learning

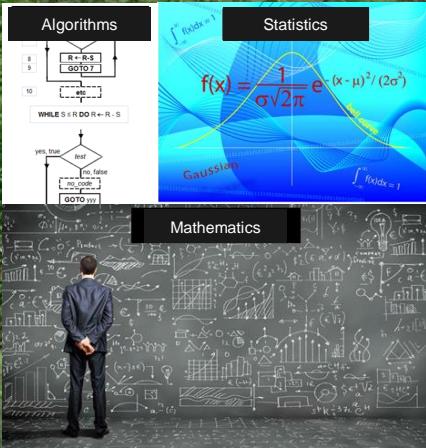
## Machine learning models



## Machine learning engineering



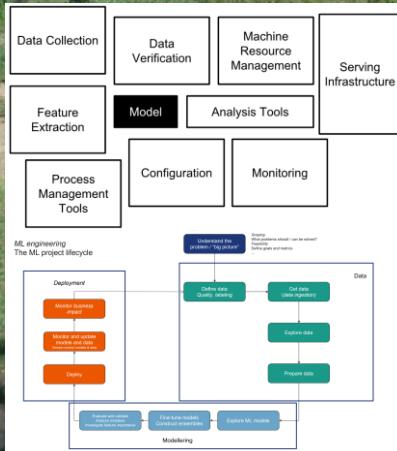
## Machine learning models



Machine  
learning



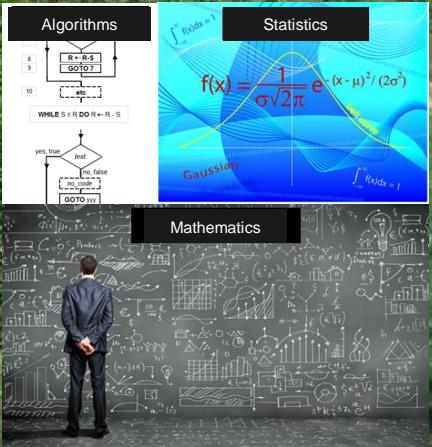
## Machine learning engineering



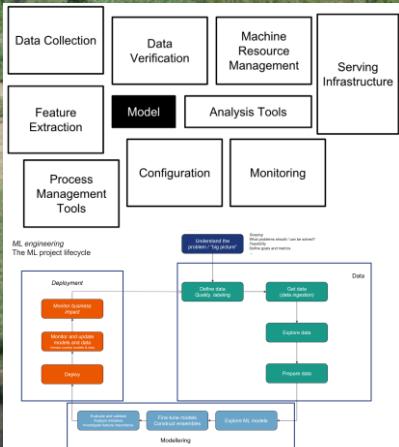
# Machine learning



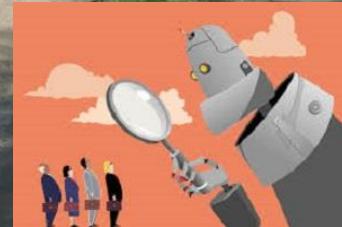
## Machine learning models



## Machine learning engineering



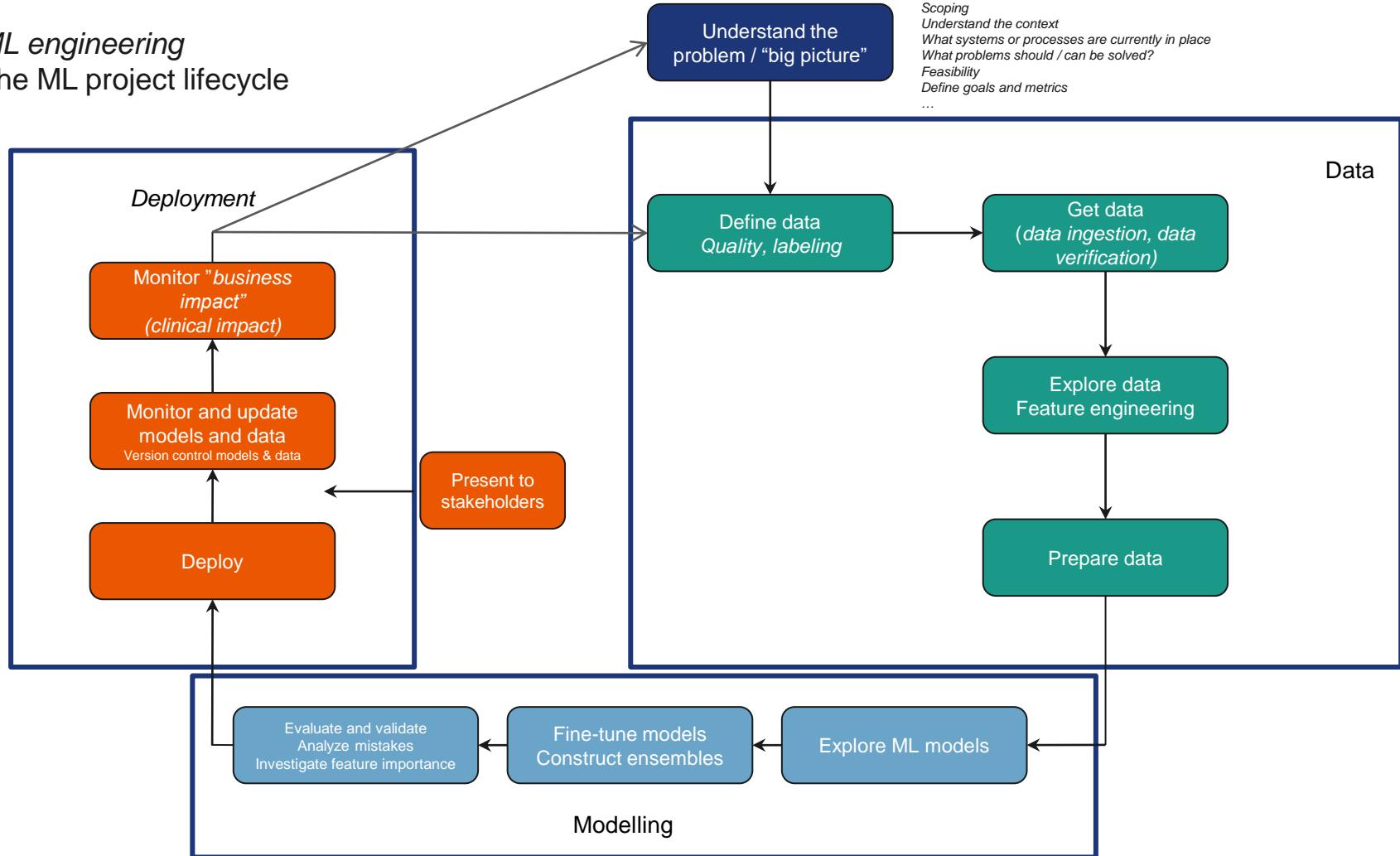
## Data and society



How do you make a machine learning-based solution?

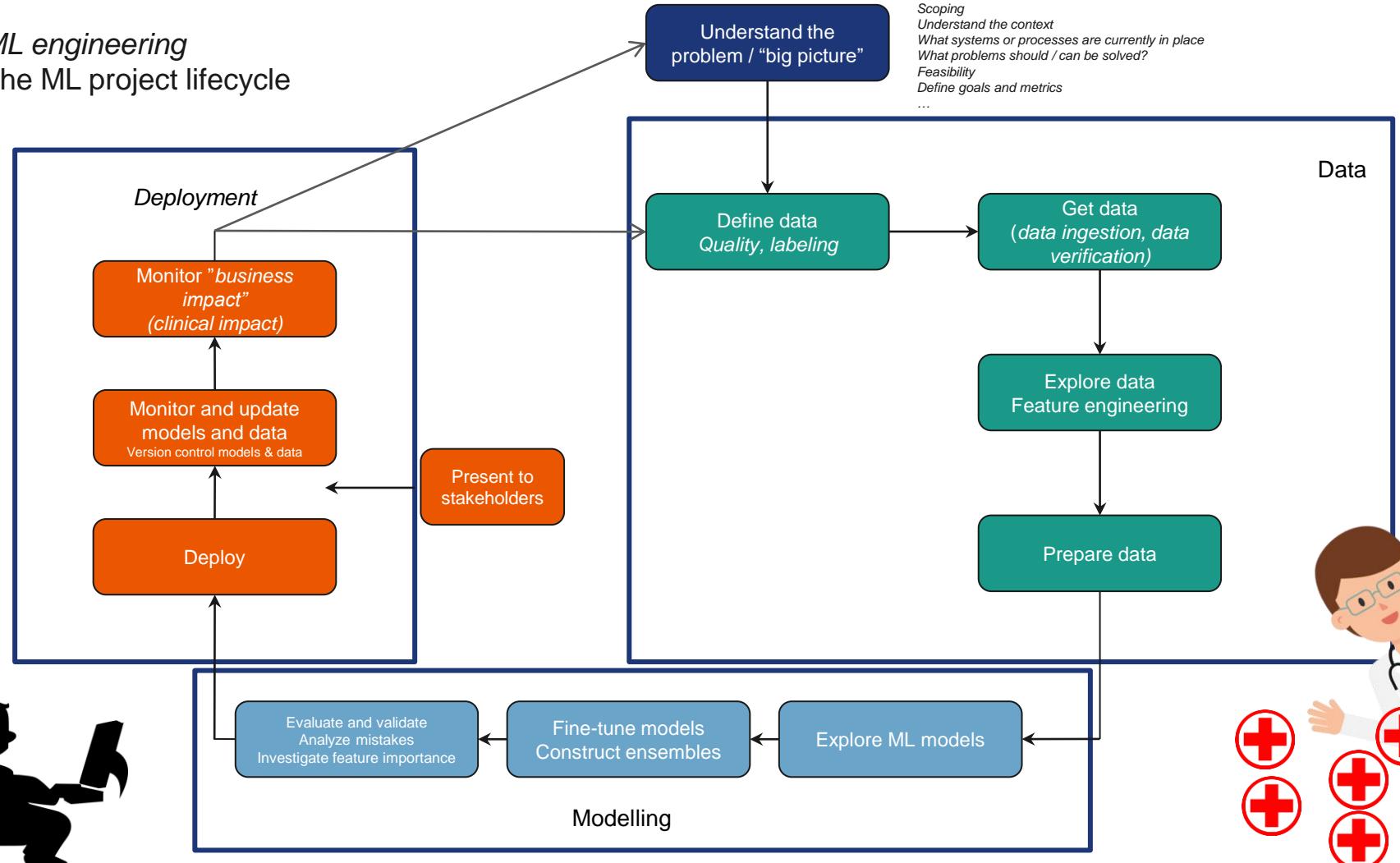
# ML engineering

## The ML project lifecycle

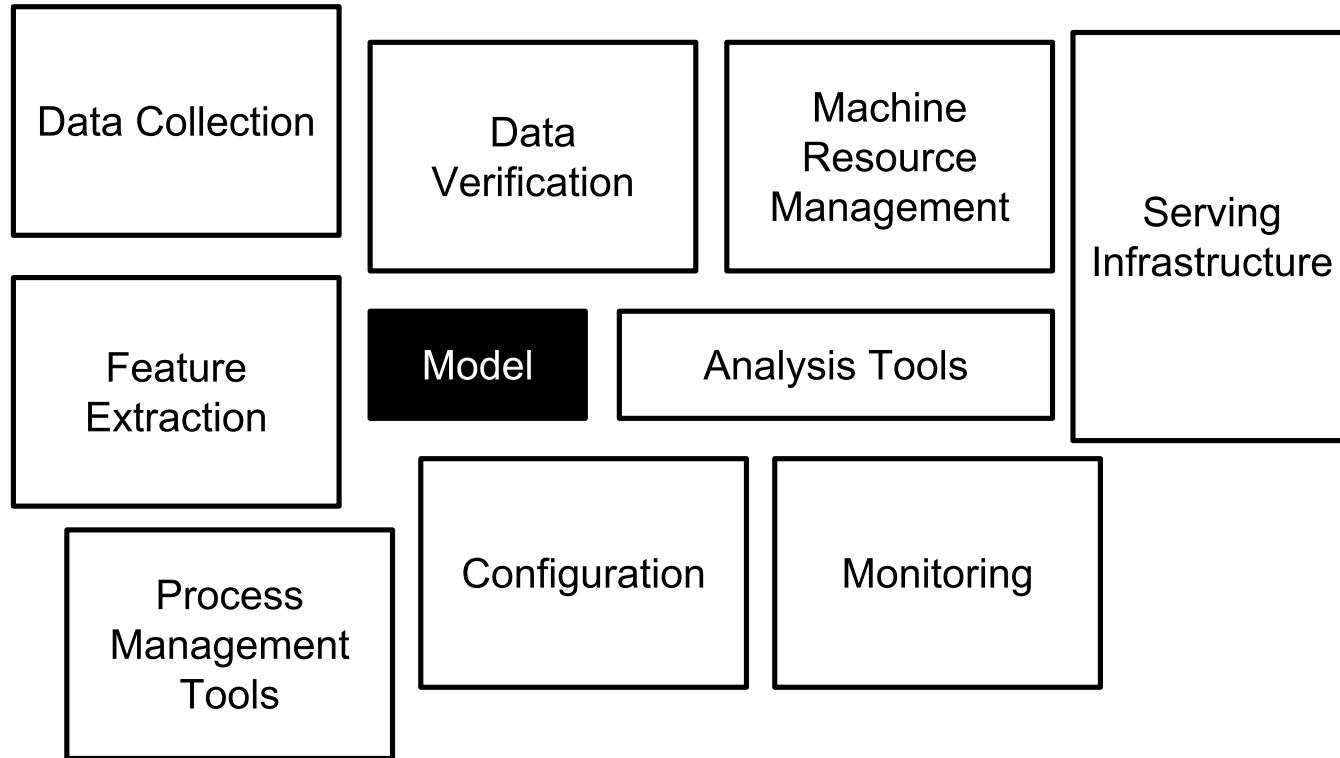


# ML engineering

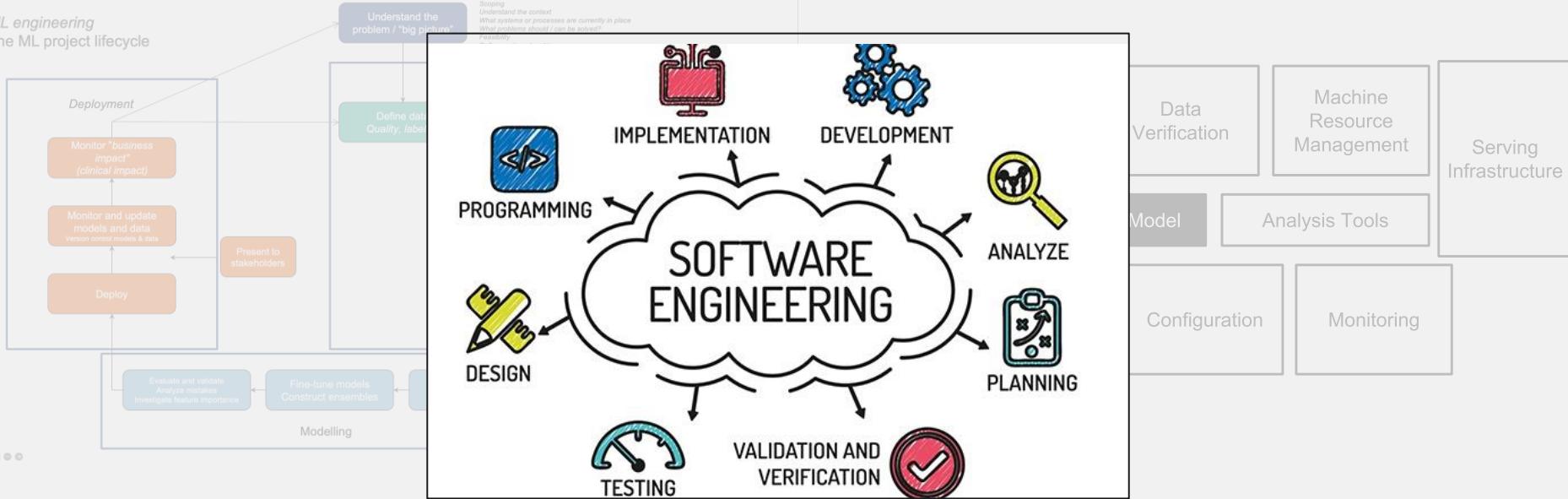
## The ML project lifecycle



Model



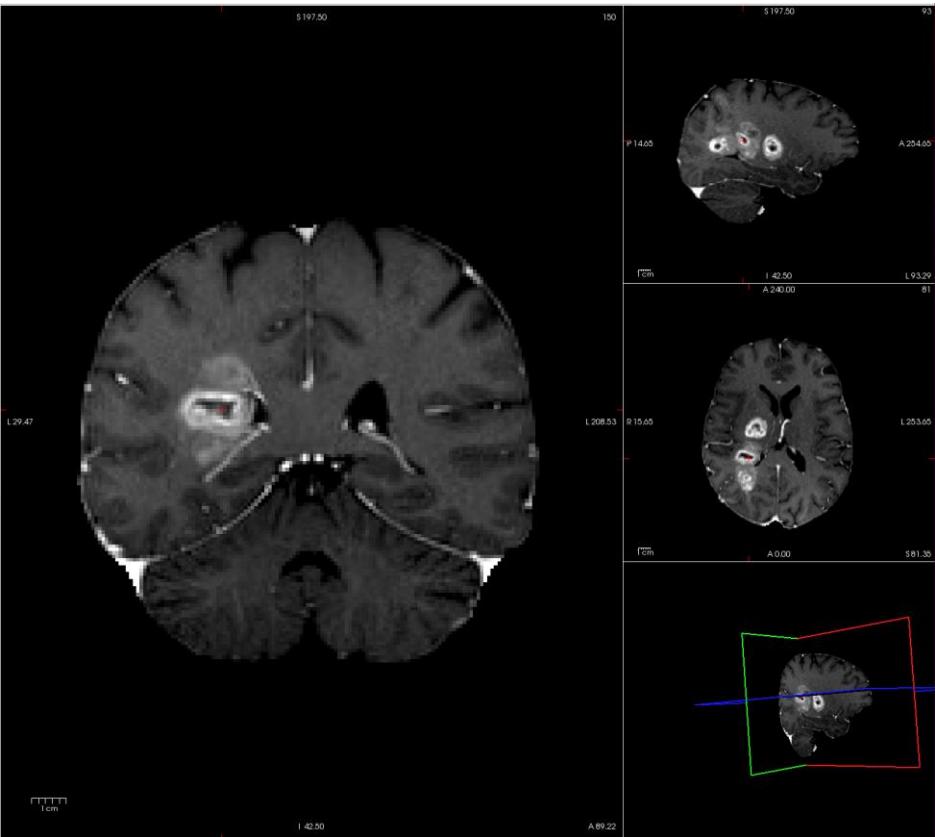
*ML engineering*  
The ML project lifecycle



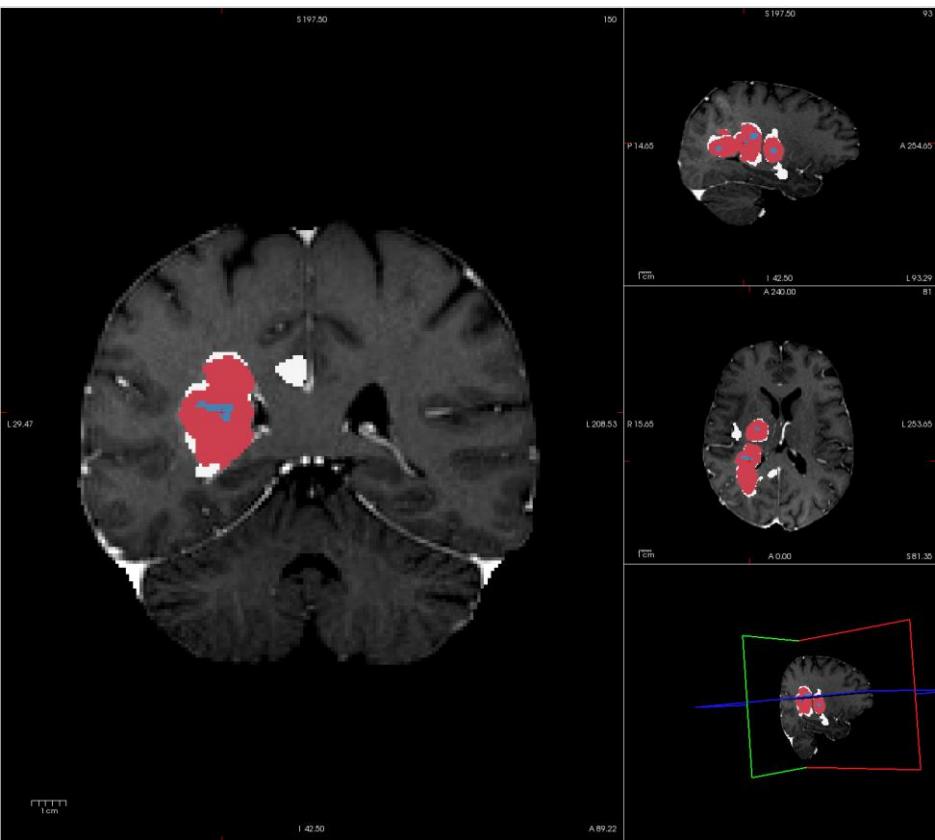


Model

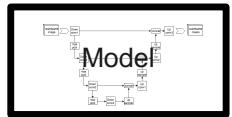
Model



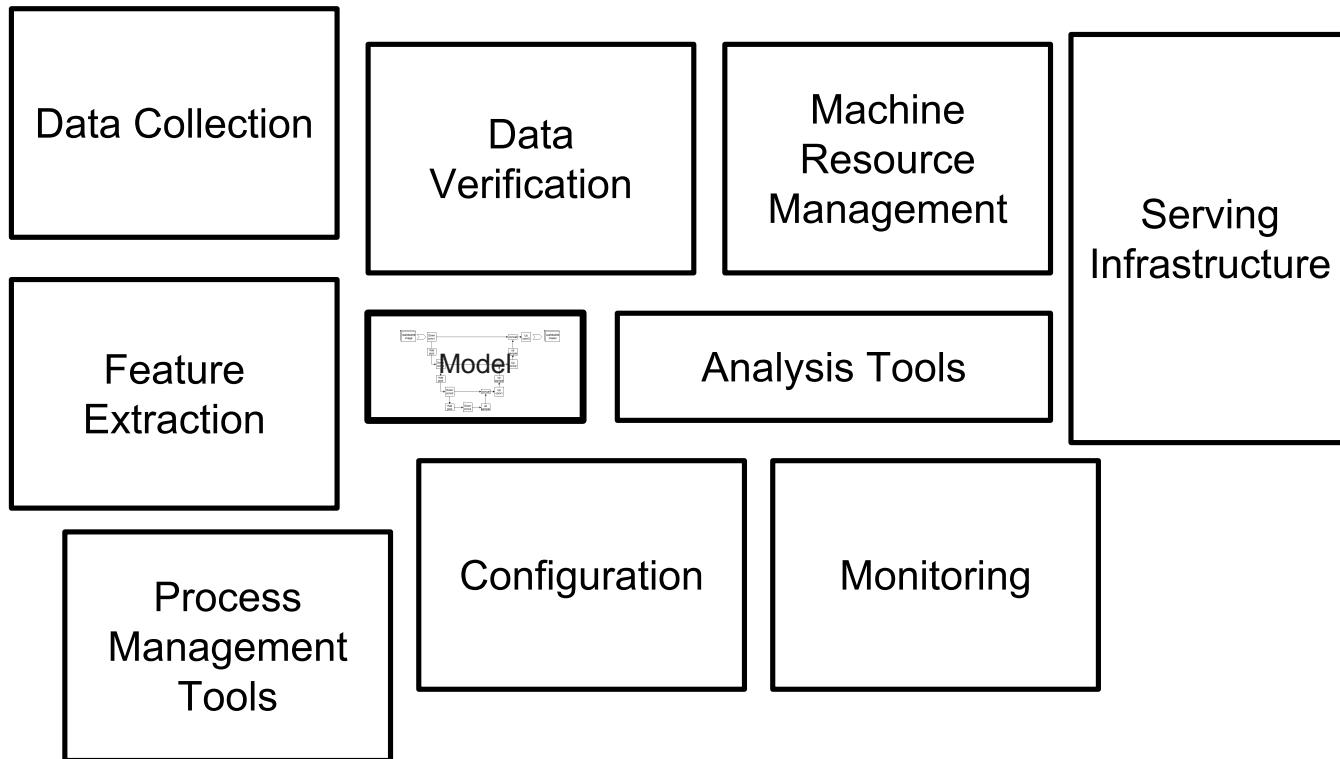
Model







In radiology, solutions must be compatible with existing infrastructure!





Hauke Bartsch  
Computer Science



Zhanbolat  
Satybaldinov  
Software  
engineering

In radiology, solutions must be compatible with existing infrastructure.

# Research Information System for the Western Norway Regional Health Authorities

medical research data in Helse Førde, Bergen, Fonna, and Stavanger

## Partners

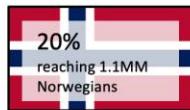
Researchers – Mohn Medical Imaging and Visualization  
Healthcare professionals – Radiology  
Technologists – Helse Vest IKT  
Funding – The Research Council of Norway

## Features

Data migration, anonymization, exchange, and data processing  
Commercial image archiving and viewing platform  
Electronic data capture (eCRF)

## Hospital infrastructure for research

Connects 4 major hospitals and 30 treatment centers



<https://github.com/mmiv-center/Research-Information-System>

# AI workflows

User driven activity supporting deep learning on medical images with training and prediction inside the hospital system.

Open-source code development see:

[github.com / mmiv-center / Research-Information-System / tree / master / components / Workflow-Image-AI](https://github.com/mmiv-center/Research-Information-System/tree/master/components/Workflow-Image-AI)



**Workflows**

**Workflows with access to project data**

Currently there is only a single workflow allowed per user. This workflow needs a copy of the project data. Use the hamburger menu to specify which series should be called (select statement).

Your image will be called given two arguments to the `Workflow-Image-AI` folder. We expect your program to return one JSON object containing computed data.

Enter token (linked to project). Generated [here](#).

Uploaded container for this token is .

**Activate this container**

Select statement for data [\(help\)](#)

```
1  /*
2   *      SELECT study
3   *      FROM study
4   *      WHERE series named "T1" HAS
5   *          SeriesDescription regexp "MPRAGE.T1$"
6   */
7   SELECT series
8   WHERE series named "T1" HAS
9   NumImages > 100
10
```

**Job list**

The job list populates after a successful select statement. You might receive more or less data. The buttons allow a job to be deleted or to release resources allocated to the user.

At the beginning of the next section distributions for a number of values are shown. In order to be able to rank the datasets based on the *normality* of the calculated measures a numeric value and a color code is assigned to each job. Under certain restriction this rank can be used to identify possibly problematic cases for review.

A workflow-integrated brain tumor segmentation system based on fastai and MONAI

Carsten Ditlev-Simonsen  
Jostein Rådmannsøy Digernes

Master's thesis in Software Engineering at  
Department of Computer science, Electrical engineering and Mathematical sciences,  
Western Norway University of Applied Sciences

Department of Informatics,  
University of Bergen

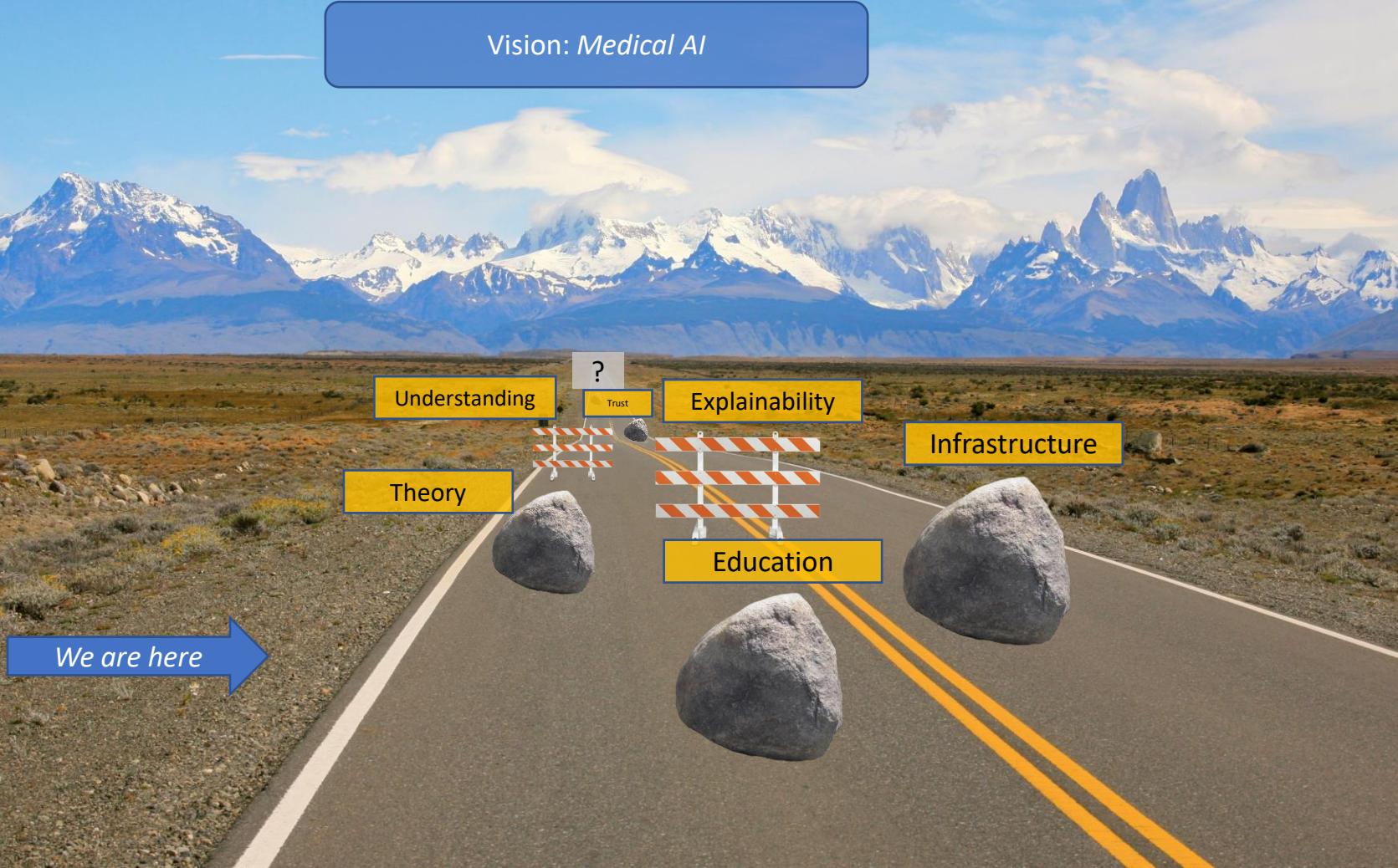
May 9, 2022

 Western Norway  
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## Vision: *Medical AI*



# The development of Medical AI should happen with medical experts in the driver's seat \*

in tight collaboration with (all the right kind of) scientists  
and technologists

A blue arrow pointing to the right, containing the text "We are here".

We are here

**The development of AI for domainX  
should happen with domainX  
experts in the driver's seat \***

in tight collaboration with (all the right kind of) scientists  
and technologists

A blue arrow pointing to the right, containing the text "We are here".

We are here

A yellow double line on a road surface, with a large grey rock in the center lane.

infrastructure  
Education