ICAI Deep-Dive

ICAI Innovation Center for Artificial Intelligence

e/MTIC Eindhoven MedTech Innovation Center

e/MTIC AI-Lab

HYBRID EVENT 12 MAY 2022

Data Series I:

MEDICAL DATA USAGE

SPEAKERS

Maarten de Rijke (UvA)
ICAI scientific director and Distinguished University Professor AI & IR at UvA

Kees van der Klauw
Manager NL AI Coalition,
e/MTIC ecosystem manager

Sjoerd Mentink
Philips Program Manager Public-Private Partnerships

Nicola Pezzotti
Senior Scientist Philips Research and TU/e Assistant Professor

Jon Pluyter
Senior Usability Designer at Philips Experience Design

Ya-Suei Cheng - *Moderator*
Community manager ICAI

Kees van der Klauw
Manager NL AI Coalition, e/MTIC ecosystem manager

How data sharing and AI play an essential role in e/MTIC

e/MTIC
Eindhoven MedTech Innovation Center

… and introducing e/MTIC and Health Data Platform

Institutionalised collaboration of regional partners

e/MTIC
Eindhoven MedTech Innovation Center

- Eindhoven MedTech Innovation Center (e/MTIC) is a large-scale research collaboration between:
  - + TU/e
  - + Catharina Hospital
  - + Maxima Medical Center
  - + Kempenhaeghe
  - + Philips
- ~100 PhD students
- Cycling distance
- ‘Fast track to clinical innovation’
- Cardio-vascular, Perinatal, Sleep (extension to Oncology and Neurology)
- ICAI – Health AI-lab since March 2021

e/MTIC approach to innovation

e/MTIC
Eindhoven MedTech Innovation Center

multidisciplinary research and data exchange

impactful publications

international exposure

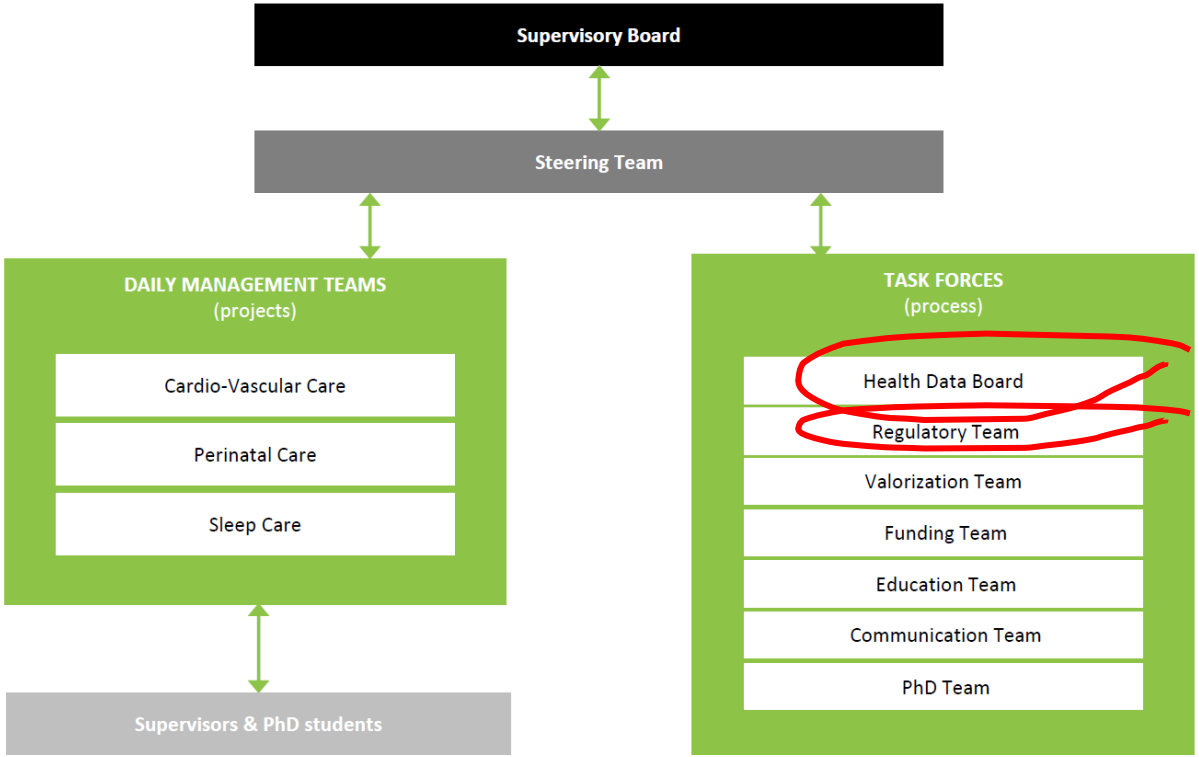
real impact on healthcare

valuable IP generation

new generation of scientists, engineers, and innovators

e/MTIC Organisation

e/MTIC
Eindhoven MedTech Innovation Center



e/MTIC - Health Data Portal (HDP)

- Strong increase in research data & AI opportunities
  - + Many unique retrospective databases
  - + Increasing prospective data from remote monitoring
  - + X-silo collaboration and data sharing required
- Still cumbersome to exploit
  - + Privacy & Security regulation and interpretation
  - + Lack of standardization, interoperability
  - + Dispersed medical sector, lack of orchestration
  - + Walk-around rather than break-through
- Health Data Portal to facilitate researchers
  - + Hybrid FAIR/federative and local cloud
  - + Best of components integration
  - + Part of HealthRI network, regional node
  - + Beyond e/MTIC

e/MTIC and the Health Data Portal

Eindhoven MedTech Innovation Center

YouTube link:
https://youtu.be/tldJA6i_OrM

Health Data Portal (*under construction*)

Eindhoven MedTech Innovation Center

A structural solution for sharing and analysing data for research in (but not limited to) Healthcare

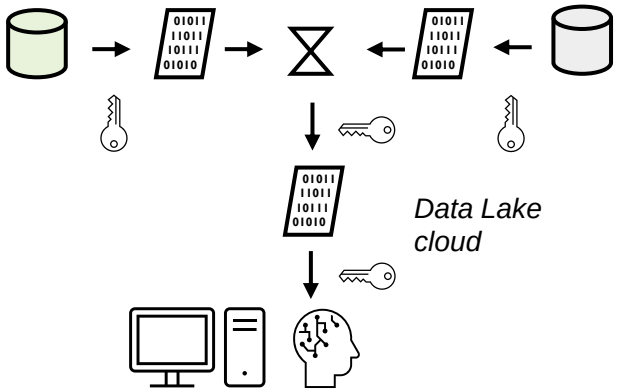
which

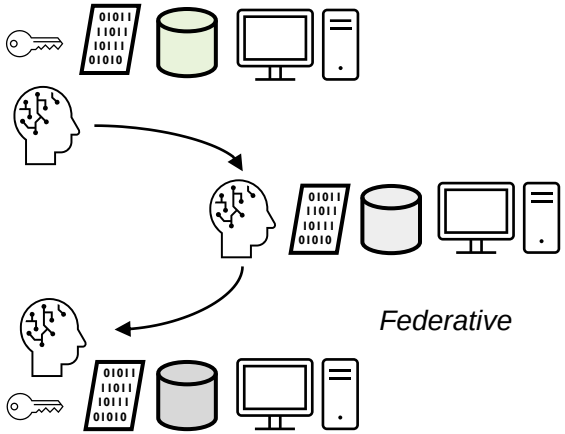
- Enables and facilitates data sharing across different legal entities
- Users/researchers and data owners unburdens
- Is maintained and updated
- Respects and incorporates data ownership
- Facilitates finding relevant data sources (metadata catalogue)
- Offers a set of analysis tools / algorithms
- Offers workflow support
- Meets all regulatory requirements (GDPR, Data Protection, reproducibility, …)

‘Data Lake’ vs. Federative data sharing

methods to comply with legal requirements

Eindhoven MedTech Innovation Center





- Ownership with source, data is selectively and temporarily shared in pseudonymised way
- Algorithm/analyses on combined data
- Limited requirements on data formats
- Shared computing power

- Data remains with source, access to be granted
- Circulating algorithm visits data
- Requirements on data formats (FAIR)
- Decentralized analysis, local computing power

- Always: quality of data, reproducibility, catalogue, consent

Conclusions

- e/MTIC structural collaboration with focus on ‘fast track to clinical innovation’

- Increasingly data driven, AI applications
  - + Data sharing and analysis across domains
  - + Retrospective data sets
  - + Prospective data sets, real time patient monitoring

- Unburdening of researchers by
  - + Regulatory Team
  - + Health Data Portal (as part of HealthRI network)
  - + Operational in the course of 2022

Nicola Pezzotti
Senior Scientist Philips Research and TU/e Assistant Professor

Trustworthy AI for Medical Image Formation

/MTIC
Eindhoven MedTech Innovation Center

Nicola Pezzotti

PHILIPS

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

TU Delft
Delft University of Technology

Inria
INVENTEURS DU MONDE NUMÉRIQUE

open technologies
Optical 3D Scanner

Google AI

LUMC

Acquisition → Image Formation → Image Analysis → Quantification → Diagnosis → Reporting

Acquisition → Image Formation → Image Analysis → Quantification → Diagnosis → Reporting

IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 35, NO. 5, MAY 2016 1153

Guest Editorial
Deep Learning in Medical Imaging: Overview and Future Promise of an Exciting New Technique

I. INT

DEEP learning is a grov
and has been termed or
gies of 2013 [1]. Deep learn
neural networks, consisting
levels of abstraction and im
To date, it is emerging as th

GANs for Medical Image Analysis

Salome Kazeminia[a,1], Christoph Baur[b,1], Arjan Kuijper[c], Bram van Ginneken[d], Nassir Navab[b], Shadi Albarqouni[b], Anirban Mukhopadhyay[a]

[a]Department of Computer Science, TU Darmstadt, Germany
[b]Computer Aided Medical Procedures (CAMP), TU Munich, Germany
[c]Fraunhofer IGD, Darmstadt, Germany
[d]Radboud University Medical Center, Nijmegen, The Netherlands

Abstract

Generative Adversarial Networks (GANs) and their extensions have carved open many exciting ways to tackle well known and challenging medical image analysis problems such as medical image de-noising, reconstruction, segmentation,

4 IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, VOL. 21, NO. 1, JANUARY 2017

Deep Learning for Health Informatics

Daniele Ravì, Charence Wong, Fani Deligianni, Melissa Berthelot, Javier Andreu-Perez, Benny Lo,

Abstract—With a
the role of data ana
rapidly in the last d
ing interests in the
models based on r
Deep learning, a te
neural networks, is
tool for machine lea
artificial intelligence
power, fast data sto
tributed to the rapid
its predictive power
timized high-level fe

A Survey on Deep Learning in Medical Image Analysis

Geert Litjens, Thijs Kooi, Babak Ehteshami Bejnordi, Arnaud Arindra Adiyoso Setio, Francesco Ciompi, Mohsen Ghafoorian, Jeroen A.W.M. van der Laak, Bram van Ginneken, Clara I. Sánchez

Diagnostic Image Analysis Group
Radboud University Medical Center
Nijmegen, The Netherlands

Abstract

Deep learning algorithms, in particular convolutional networks, have rapidly become a methodology of choice for analyzing medical images. This paper reviews the major deep learning concepts pertinent to medical image analysis and summarizes over 300 contributions to the field, most of which appeared in the last year. We survey the use of deep learning for image classification, object detection, segmentation, registration, and other tasks. Concise overviews are provided of studies per application area: neuro, retinal, pulmonary, digital pathology, breast, cardiac, abdominal, musculoskeletal. We end with a summary of the current state-of-the-art, a critical discussion of open challenges and directions for future research.

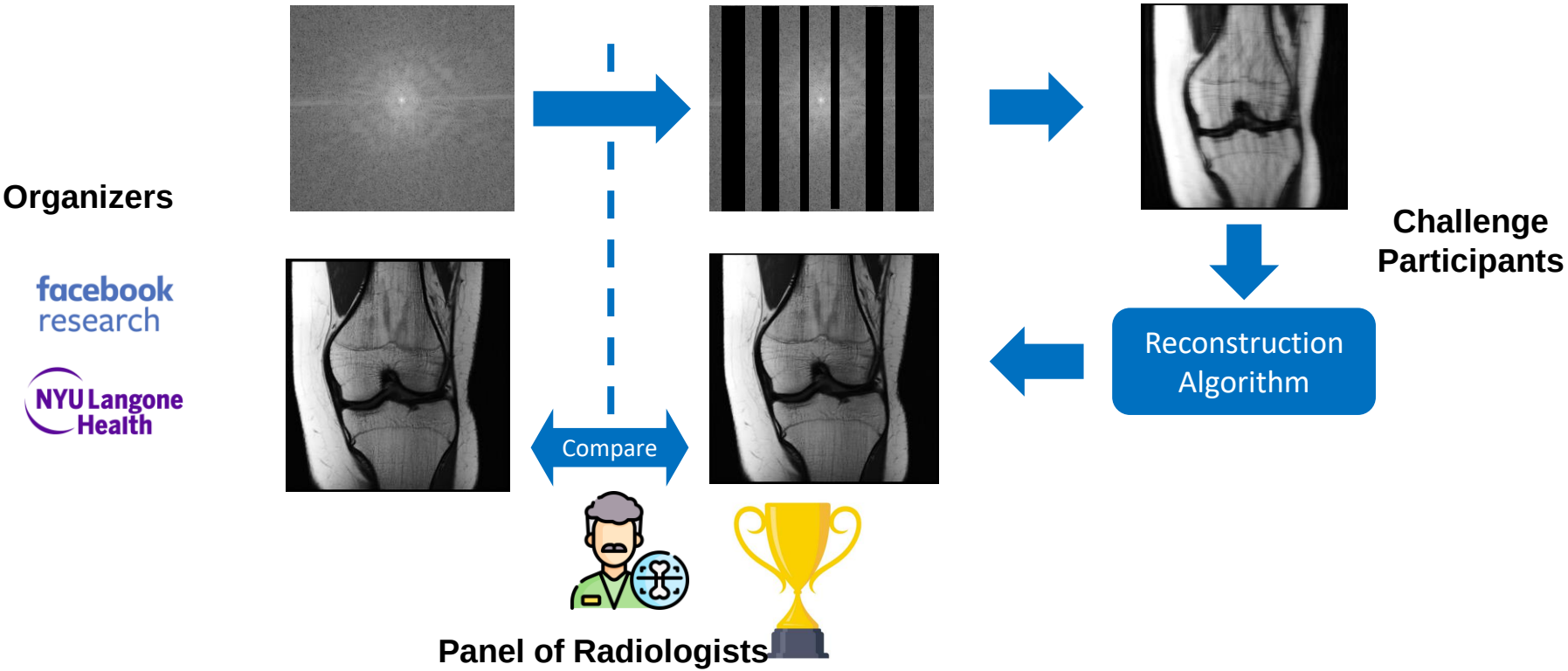
Keywords: deep learning, convolutional neural networks, medical imaging, survey

Acquisition → Image Formation → Image Analysis → Quantification → Diagnosis → Reporting

Acquisition and Image Formation are the foundations of the Imaging Chain

Hybrid Models
&
Simulations

Artificial Intelligence: the fastMRI challenge



The Philips teams

Philips & LUMC
Philips – LUMC

AI-msterdam
Philips – UvA – AUMC – NKI

Winners of the challenge

Single-coil 4x

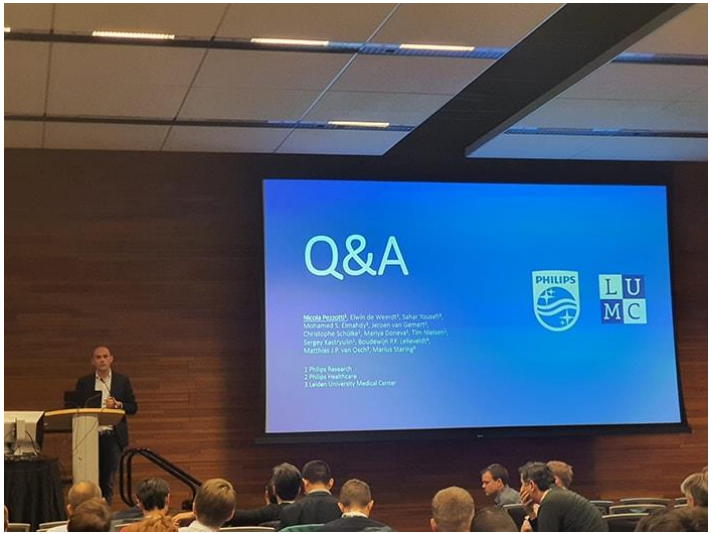
Philips & UvA

Multi-coil 4x

Philips & LUMC (co-winners)

Multi-coil 8x

Philips & LUMC



Presentation at NeurIPS 2019

Jeroen Tas • 2nd
Chief Innovation & Strategy Officer and Member of the Execut...
15h • Edited •

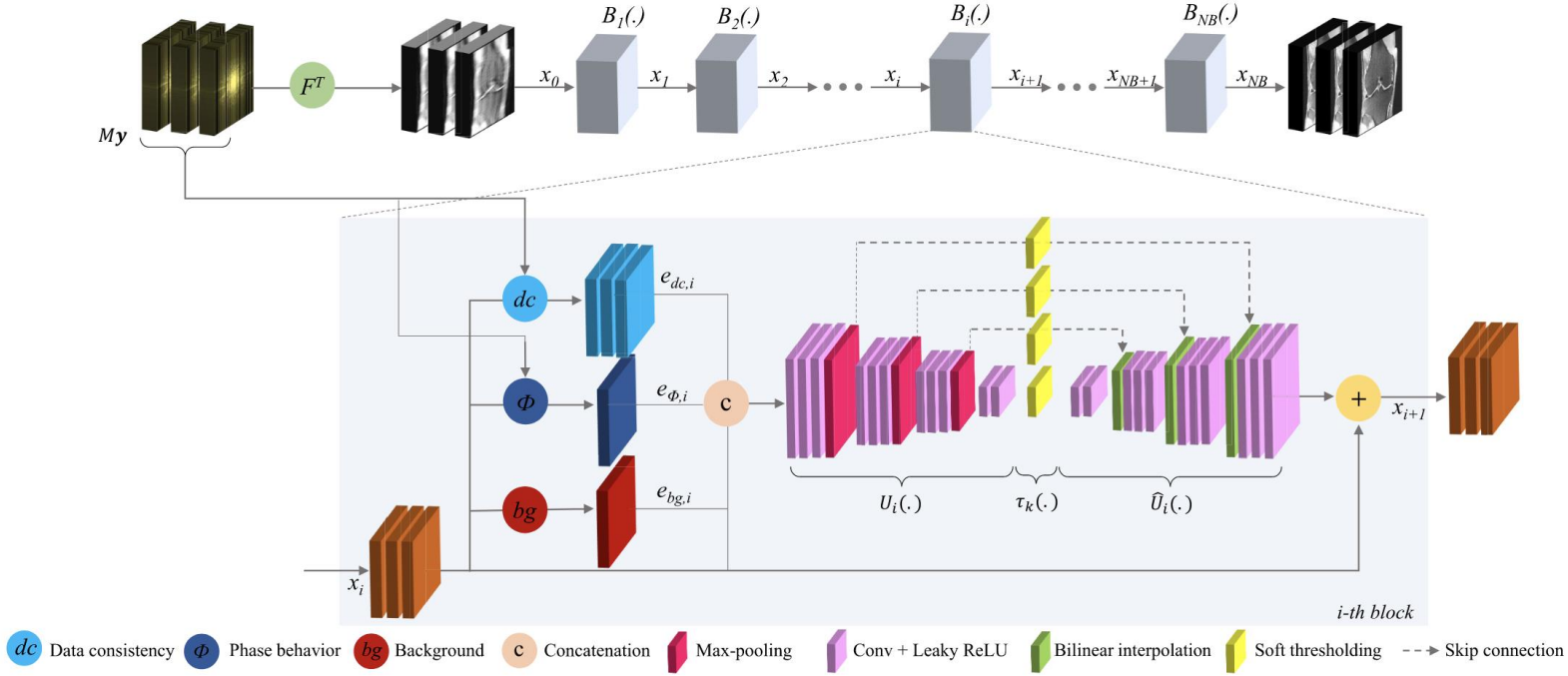
+ Follow ···

AI enables better, faster and more precise diagnosis of disease. NYU and Facebook hosted the fast MRI AI challenge. Philips and their acedemic partners from universities of Leiden and Amsterdam won 2 out of 3 categories! We continue to reduce MR scan time and create better patient experiences at lower cost of diagnosis. Max Welling Mark van Buchem Joland Rutgers Milan Petkovic Richard Kemkers Nicola Pezzotti

UNITED IMAGING HYPERFINE BioMedIA

Competitors and world leading research labs participated

A Hybrid Model to Ensure Trustworthiness



Pezzotti et al., An Adaptive Intelligence Algorithm for Undersampled Knee MRI Reconstruction, IEEE Access, 2020

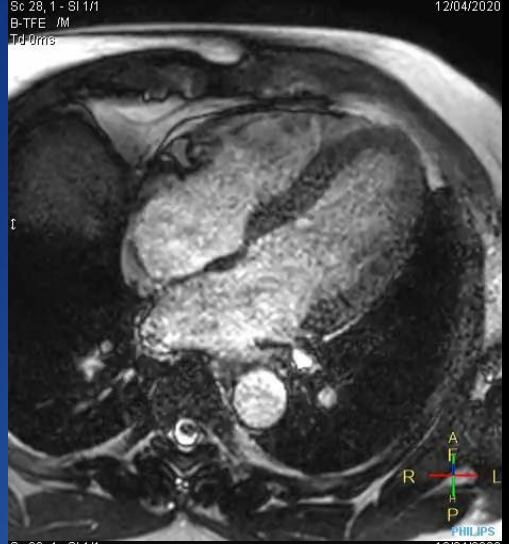
PHILIPS

SmartSpeed

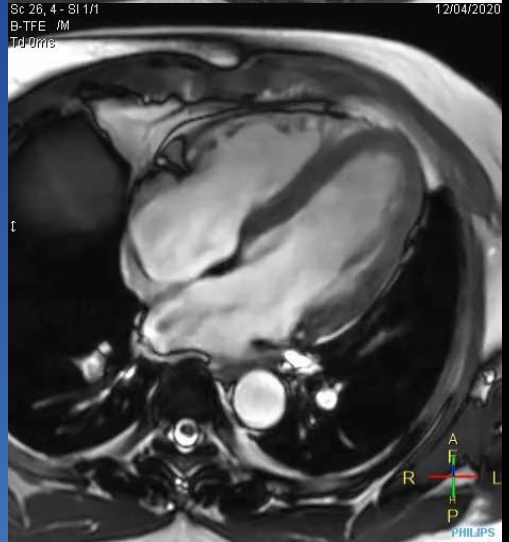
Science brief

Philips SmartSpeed.
No compromise.

Image quality and speed at your fingertips.



Conventional Acceleration
8.3s
1.5x1.5x6.0mm

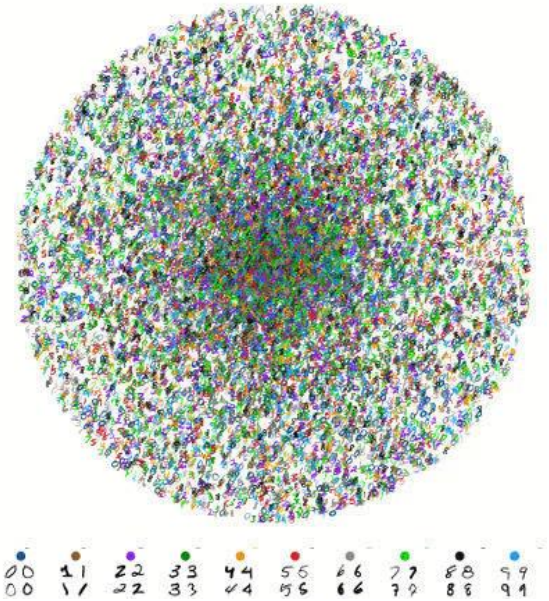


SmartSpeed
8.3s
1.5x1.5x6.0mm

Courtesy: Tokyo Metropolitan Police Hospital, Japan. Elition X 3.0T

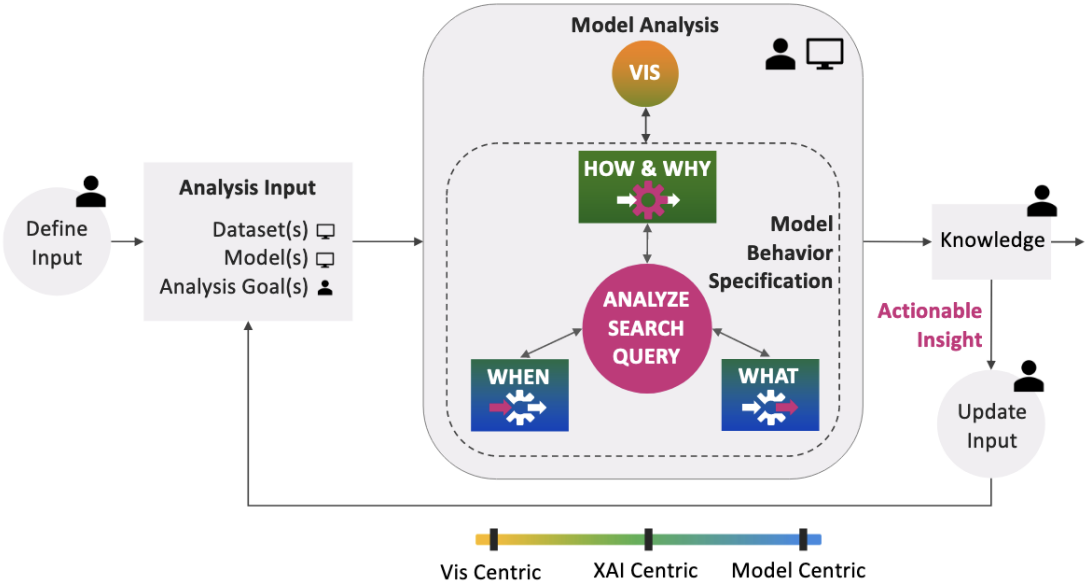
Understanding Models through Their Operating Domain

Pezzotti et al., DeepEyes: Progressive Visual Analytics for Designing Deep Neural Networks, IEEE TVCG, 2017



https://ai.googleblog.com/2018/06/realtime-tsne-visualizations-with.html

Pezzotti et al., GPGPU linear complexity t-SNE optimization, IEEE TVCG, 2019



X WHEN : *Input Space*

When does the model behavior occur?

C1 : Dataset size
C2 : Input dimensionality
C5 : Output type
C6 : Data interpretability

f HOW & WHY : *Model Space*

How does the model behave? Why?

C3 : Architectural complexity
C4 : Output dimensionality
C5 : Output type

Y WHAT : *Output Space*

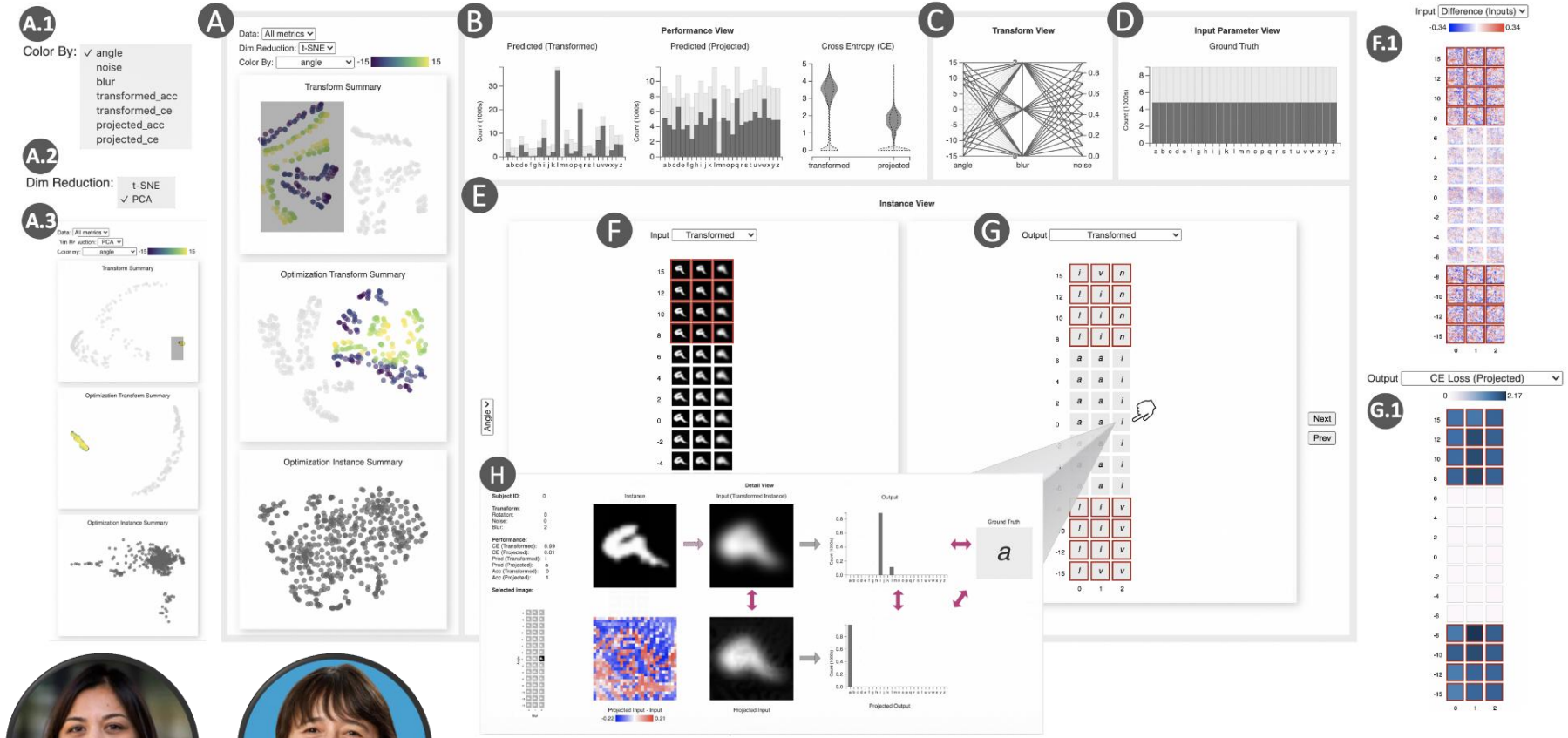
What is the model behavior?

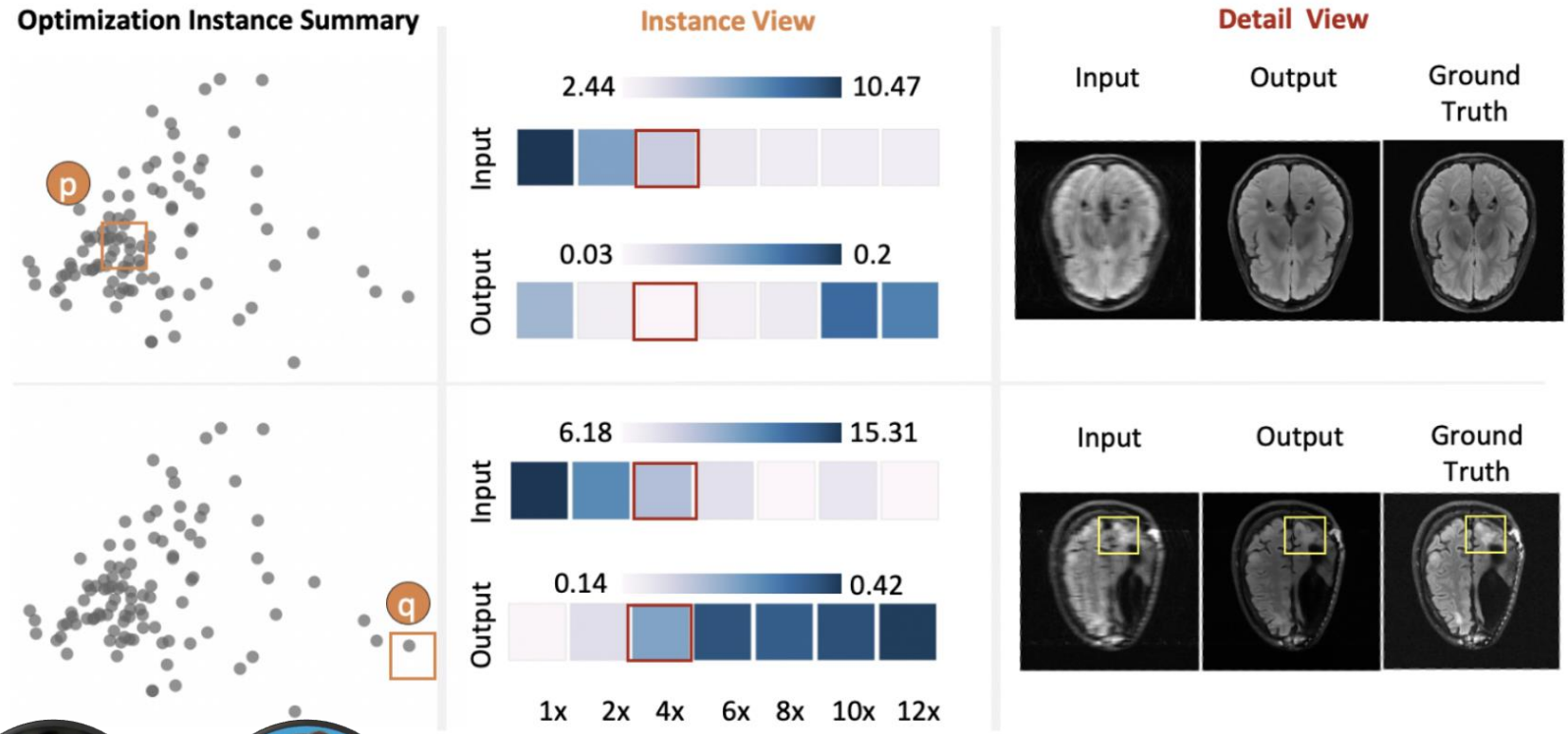
C4 : Output dimensionality
C5 : Output type
C6 : Data interpretability

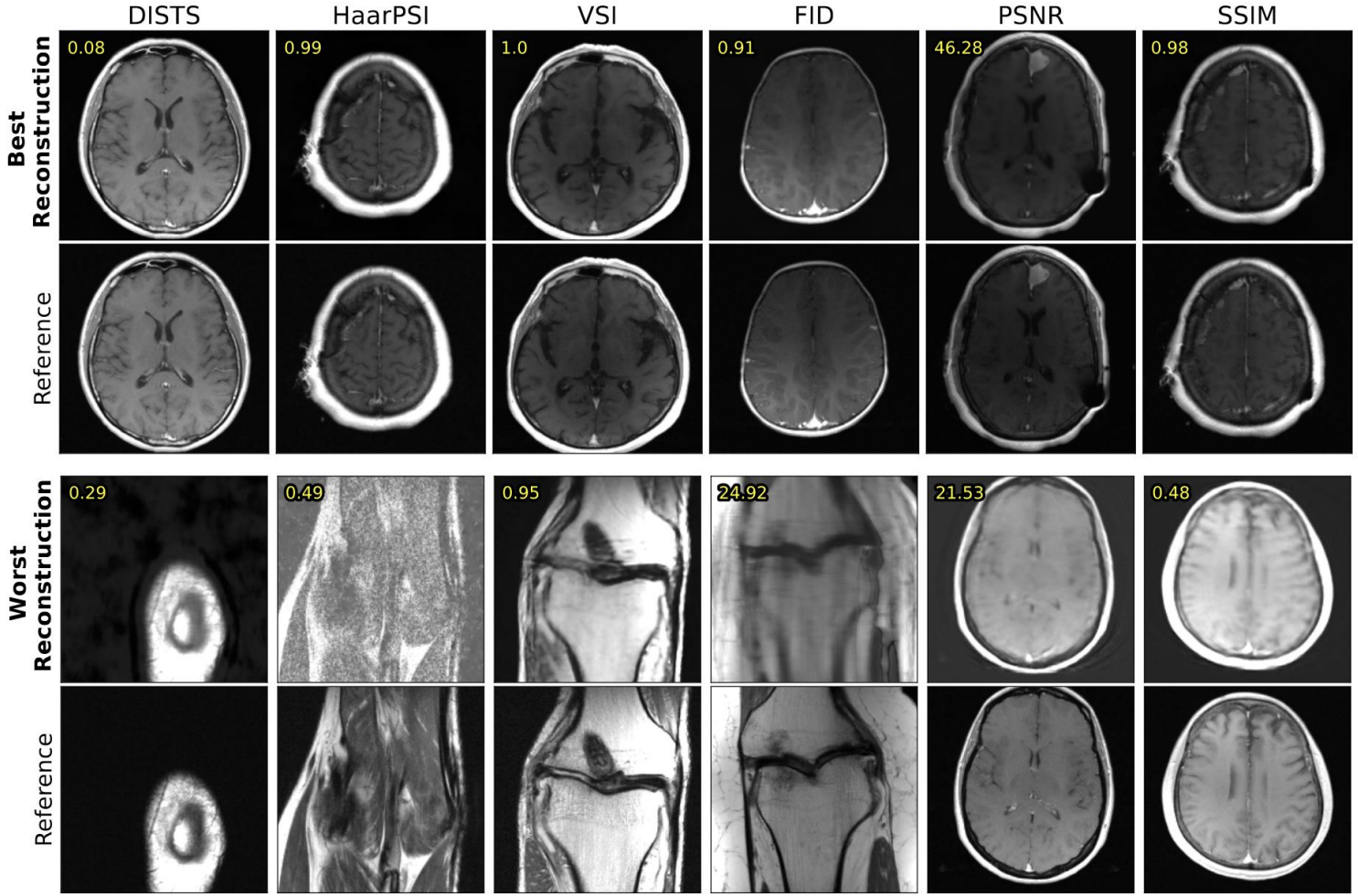
ANALYZE, SEARCH & QUERY

Supporting user tasks and workflows

C7 : Input-output relations
C8 : Multiple user workflows


A.1
Color By:
angle
noise
blur
transformed_acc
transformed_ce
projected_acc
projected_ce
A.2
Dim Reduction:
t-SNE
PCA
A.3
A
Transform Summary
Optimization Transform Summary
Optimization Instance Summary
B
Performance View
Predicted (Transformed)
Predicted (Projected)
Cross Entropy (CE)
transformed
projected
C
Transform View
angle
blur
noise
D
Input Parameter View
Ground Truth
E
Instance View
F
Input
Transformed
G
Output
Transformed
Next
Prev
H
Detail View
Instance
Input (Transformed Instance)
Output
Ground Truth
Projected Input - Input
Projected Input
Projected Output
F.1
Input
Difference (Inputs)
G.1
Output
CE Loss (Projected)


Optimization Instance Summary
Instance View
Detail View
p
q
2.44
10.47
Input
0.03
0.2
Output
Input
Output
Ground Truth
6.18
15.31
Input
0.14
0.42
Output
1x
2x
4x
6x
8x
10x
12x
Input
Output
Ground Truth



Kastryulin et al., Image Quality Assessment for Magnetic Resonance Imaging, arXiv, 2022

Data Access
and
Co-Creation

ICAI Innovation Center for Artificial Intelligence

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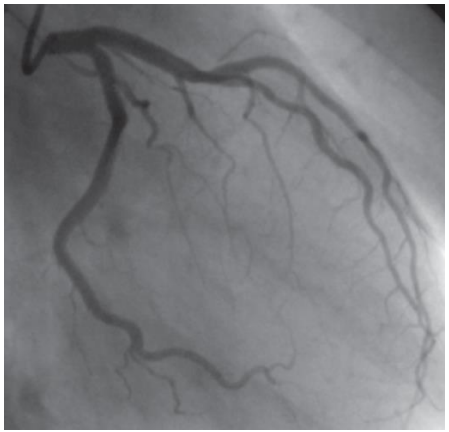
e/MTIC AI-Lab

Artificial Intelligence in Percutaneous Coronary Interventions (PCI)

AI has the potential to enhance PCI procedures performed in the CathLab in two areas: 1) Clinical support, 2) Operational efficiency and workflow. This project seeks to develop strongly improved AI approaches for accurate evaluation of the coronary vessel tree in X-ray angiographic images, as a basis for improved decision making in PCI. For example as Clinical support for the right sizing and deployment of stents. To increase Operational efficiency it targets automation of the case reporting by jointly identify the elements and deduce information from the data-rich environment.



3D reconstruction of coronary artery tree from limited views

PHILIPS TU/e

LUMC, Universiteit Leiden en Philips intensiveren samenwerking voor snellere MRI door kunstmatige intelligentie

8 oktober 2021 • *PERSBERICHT*

Het Leids Universitair Medische Centrum (LUMC), de Universiteit Leiden en Philips vormen samen een van de 17 AI-labs binnen het ROBUST consortium dat geselecteerd is voor ondersteuning vanuit de NWO. Het doel van deze samenwerking is om met kunstmatige intelligentie MRI-scans te versnellen.

Het LUMC en Philips zijn in 2019 een samenwerking aangegaan om het maken van MRI-scans te versnellen. Op dit moment duurt een MRI-scan namelijk een kwartier tot een half uur, met uitschieters naar een uur. Al die tijd moet de patiënt stilliggen in een nauwe en luidruchtige omgeving. Dit is vaak een oncomfortabele ervaring. Daarnaast levert het problemen op als de patiënt tijdens het scannen toch beweegt, de MRI-scan wordt dan minder scherp waardoor afwijkingen niet goed zichtbaar zijn.

Kwaliteit behouden

Om deze problemen te verhelpen hebben onderzoekers zich tot doel gesteld om een techniek te ontwikkelen waarmee elke MRI-scan in minder dan vijf minuten gemaakt kan worden. Dit doen ze door gebruik te maken van kunstmatige intelligentie die met minder data een MRI-beeld kan creëren. Hiermee kan de scantijd aanzienlijk verkort worden, zonder verlies van kwaliteit. Dit heeft niet alleen voordelen voor de patiënt, want een kortere scanduur zorgt ook voor meer efficiëntie op radiologie-afdelingen. Onderzoekers van het LUMC en Philips lieten al in een *proof-of-concept*-studie zien dat dit haalbaar is, en wonnen de internationale FASTMRI wedstrijd met hun AI.

Scientific Directors

Philips Data Principles

At Philips, we are committed to ethical use of data in our mission to improve people's lives through meaningful innovation. When using personal data [1], we aim to benefit our customers, patients, and society as a whole. To ensure we handle and use data with great care, we diligently apply the following principles.

Security
We ensure the security of all data entrusted to us. We operate under global security policies that guide our activities to protect against vulnerabilities and manage any incidents.

Read more about our approach to security ›

Privacy
We handle all personal data with integrity in compliance with all applicable privacy regulations of the countries in which we operate. We adhere to the Philips Code of Conduct – our binding corporate rules – that governs data transfers and processing within our company. When our business partners process personal data on our behalf, we ensure that they comply with our security and privacy requirements.

Read more about our privacy policy ›

Beneficial
We aim to create innovative solutions that benefit our customers, patients, and society as a whole. We use your personal data in line with your reasonable expectations.

https://www.philips.com/a-w/about/philips-data-principles.html

Jon Pluyter
Senior Usability Designer at Philips Experience Design

Advancing cancer care with human-centered AI

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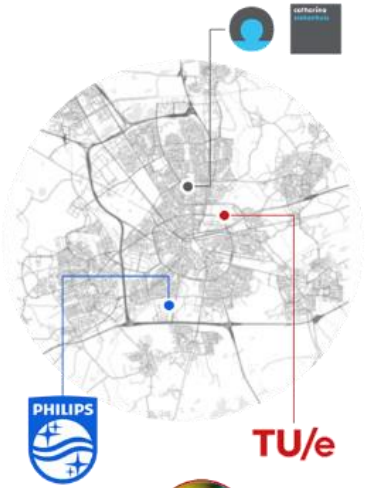
Eindhoven MedTech Innovation Center

Advancing Cancer Care with Human-Centered AI

Philips Research & Experience Design, CZE, TU/e | May 12th, 2022

e/MTIC oncology team

e/MTIC
Eindhoven MedTech Innovation Center



Jon Pluyter
Usability Designer

Bin Yu
Data Designer

Dimitrios Mavroeidis
Data Scientist

Nick Tasios
Data Scientist

Igor Jacobs
Clinical Scientist

John van der Ven
Scientist

Luc Geurts
Strategic Designer

Agnese Gualandi
Design intern

Laura Ruijs
Design intern

Mathias Funk
Associate Prof ID

Lin-Lin Chen
Dean & Prof ID

Misha Luyer
Surgeon Oncologist

Joost Nederend
Radiologist

Kasper van der Wulp
Resident radiology

Lotte Ewals
PhD candidate
Technical Medicine

Fons vd Sommen
Assistant professor EE
Signal Processing & Machine learning

Terese Hellström
PhD candidate EE
Medical Image analysis

Susan Hommerson
e/MTIC Clinical Regulatory

Mark Ramaekers
PhD candidate
Surgery

Rianne Verhees
Radiologist

Ben vd Borne
Pulmonologist, Oncologist

Banu Swampillai
Maastricht University
Faculty of Health

Christiaan Viviers
PhD candidate EE
Computer vision

Nick Ruijs
PhD candidate ID

Sanne Okel
Intern. EE

5 take-aways

Eindhoven MedTech Innovation Center

1. **Experience makes or breaks outcomes** (and adoption)
2. **Early realistic AI simulation** pivoted everything (proposition, AI development, UX design)
3. **Design** and evaluate **beyond performance** (clinical value, workflow, trust, decision making)
4. **Intuitive and apparently simple** by really understanding how clinicians think
5. Good experience needs **close interdisciplinary collaboration accross institutions**

e/MTIC
Eindhoven MedTech Innovation Center

e/MTIC contact:
info@emtic.nl | www.emtic.nl | LinkedIn e-mtic

e/MTIC Partners:

catharina een santeon ziekenhuis | Kempenhaeghe | máxima medisch centrum | PHILIPS | TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

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HYBRID EVENT 12 MAY 2022

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MEDICAL DATA USAGE