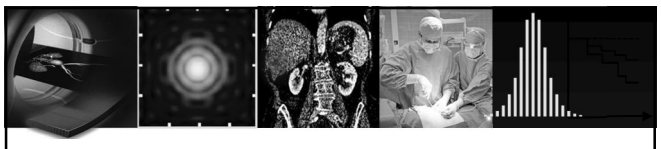


Towards measuring outcome in radiological optimisation

CORES symposium 2018 - Tampere

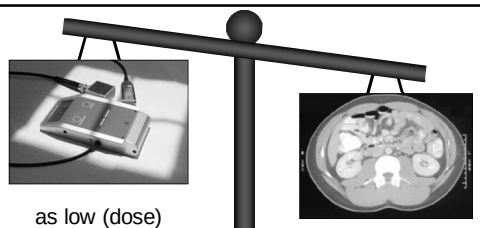
HELSINKI UNIVERSITY
DEPARTMENT OF PHYSICS

HUS Medical Imaging Center

Mika Kortesniemi
Adjunct Professor, Chief Physicist, PhD
HUS Medical Imaging Center
University of Helsinki
Meilahti Hospital, Dept. of Radiology

Outline

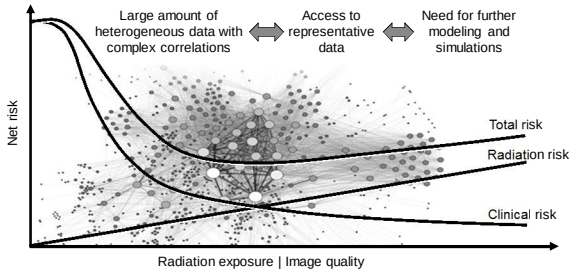
- Developing optimisation process
- Quantification from measurable physics parameters towards more comprehensive and effective clinical parameters
- Radiomics – providing tools for quantification



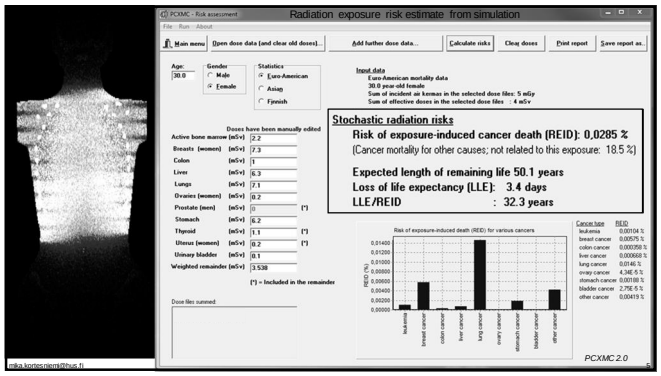
as low (dose) as reasonably achievable

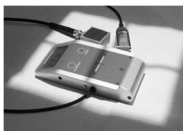
Adequate image quality as a fundamental requirement

Optimisation by comprehensive risk model – combining clinical risk and radiation risk

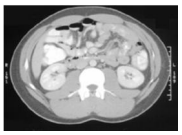


Samei, Järvinen, Kortesniemi et al. 2018

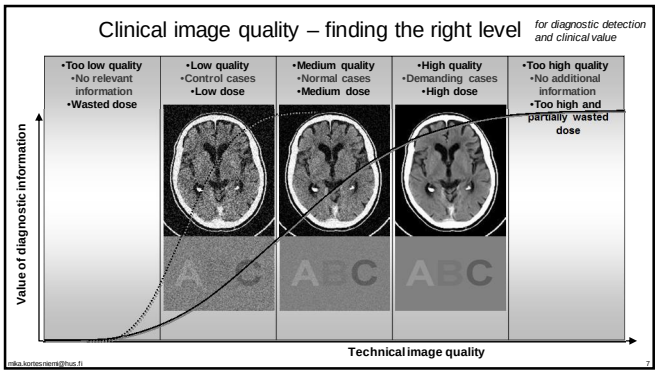


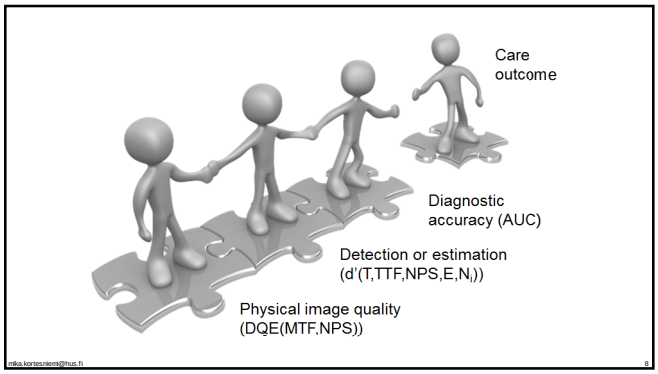


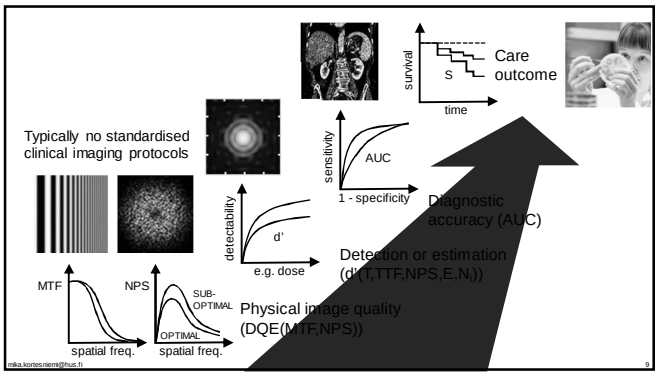
ALARA
as low (dose) as reasonably achievable

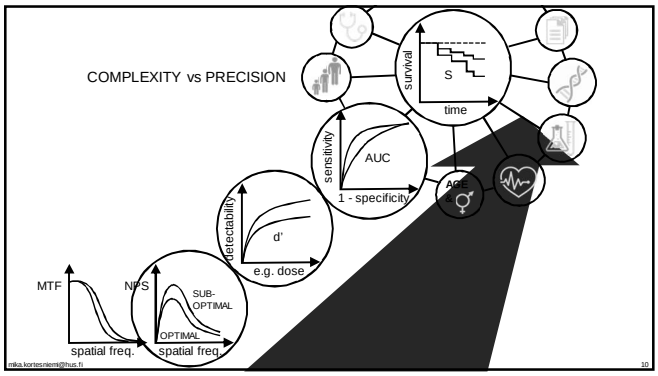


AHARA
as high (clinical benefit) as reasonably achievable









Radiomics – method for quantification

Radiomics = field of medical study that aims to extract large amount of quantitative features from medical images using data-characterisation algorithms.

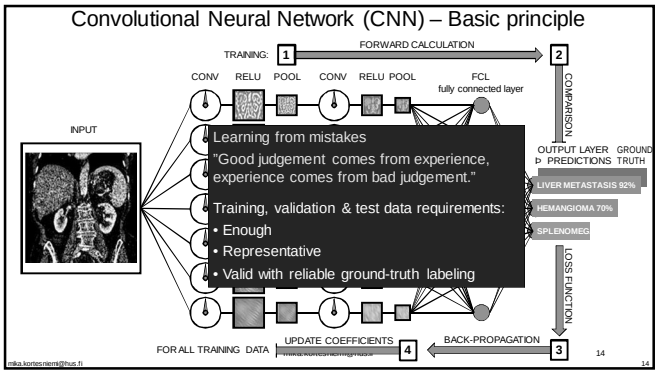
Machine learning = type of artificial intelligence that allows software applications to become more accurate in predicting outcomes without being explicitly programmed.

Radiomics – method for quantification

Radiomics = field of medical study that aims to extract large amount of quantitative features from medical images using data-

Mac ows
softw ting

DETECTION – ESTIMATION TASKS
Æ LOCALISATION
Æ SEGMENTATION
Æ CLASSIFICATION
Æ OUTCOME PREDICTION


Convolutional Neural Network (CNN) – Basic principle
TRAINING:
FORWARD CALCULATION
CONV
RELU
POOL
CONV
RELU
POOL
FCL
fully connected layer
COMPARISON
INPUT
Learning from mistakes
"Good judgement comes from experience, experience comes from bad judgement."
Training, validation & test data requirements:
• Enough
• Representative
• Valid with reliable ground-truth labeling
OUTPUT LAYER
PREDICTIONS
GROUND TRUTH
LIVER METASTASIS 92%
HEMANGIOMA 70%
SPLENOMEG
LOSS FUNCTION
FOR ALL TRAINING DATA
UPDATE COEFFICIENTS
BACK-PROPAGATION
mika.kortesniemi@hus.fi
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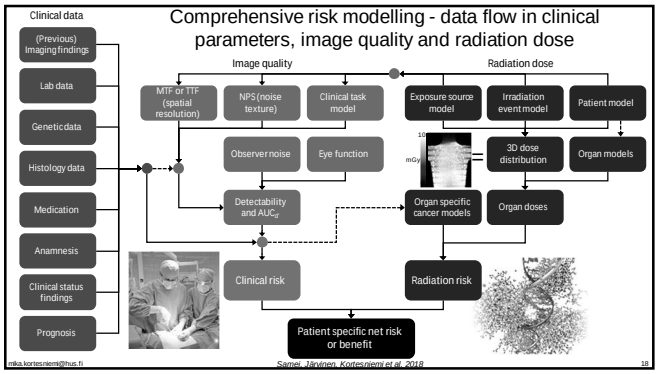
Clinical data
Comprehensive risk modelling - data flow in clinical parameters, image quality and radiation dose
(Previous) Imaging findings
Lab data
Genetic data
Histology data
Medication
Anamnesis
Clinical status findings
Prognosis
Image quality
Radiation dose
MTF or TTF (spatial resolution)
NPS (noise texture)
Clinical task model
Exposure source model
Irradiation event model
Patient model
Observer noise
Eye function
3D dose distribution
Organ models
Detectability and AUCd
Organ specific cancer models
Organ doses
Clinical risk
Radiation risk
Patient specific net risk or benefit
Sarmo, Järvinen, Kortesniemi et al. 2018
mika.kortesniemi@hus.fi
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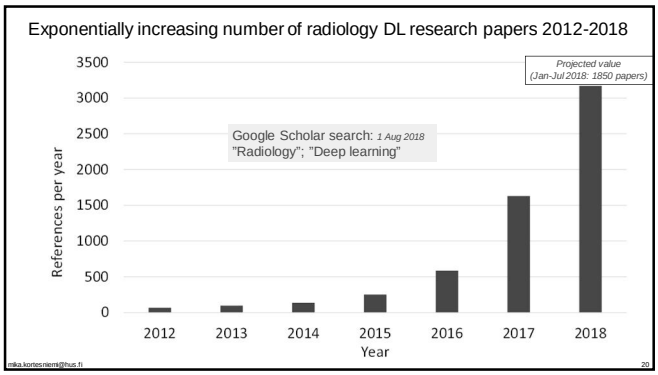
Exponentially increasing number of radiology DL research papers 2012-2018
Projected value (Jan-Jul 2018: 1850 papers)
Google Scholar search: 1 Aug 2018
"Radiology"; "Deep learning"
References per year
Year
3500
3000
2500
2000
1500
1000
500
0
2012
2013
2014
2015
2016
2017
2018
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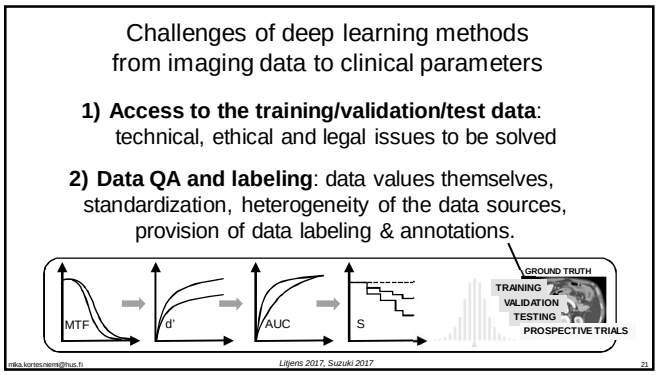
20


Challenges of deep learning methods from imaging data to clinical parameters
1) Access to the training/validation/test data: technical, ethical and legal issues to be solved
2) Data QA and labeling: data values themselves, standardization, heterogeneity of the data sources, provision of data labeling & annotations.
MTF
d'
AUC
S
GROUND TRUTH
TRAINING
VALIDATION
TESTING
PROSPECTIVE TRIALS
Liljens 2017, Suzuki 2017
mika.kortesniemi@hus.fi
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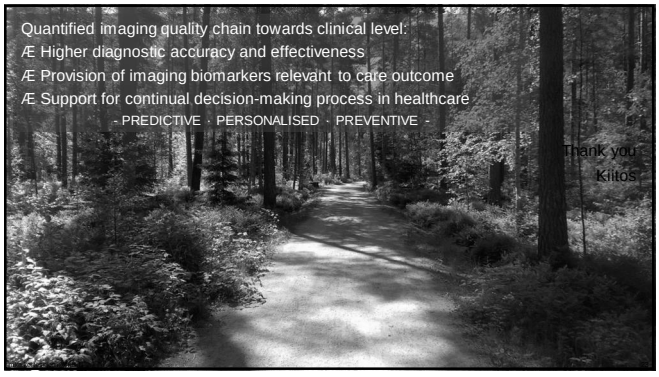
Need for verification and validation
AI technology shows considerable potential for aiding radiology's transition to value-based healthcare, but these methods must be verified & validated Þ shown to provide quantifiable benefits:
• improving care outcome
• increasing health
• reducing costs
• streamlining processes
• avoiding errors
• ensuring consistent quality


Quantified imaging quality chain towards clinical level:
Æ Higher diagnostic accuracy and effectiveness
Æ Provision of imaging biomarkers relevant to care outcome
Æ Support for continual decision-making process in healthcare
- PREDICTIVE · PERSONALISED · PREVENTIVE -
Thank you
Kiitos