

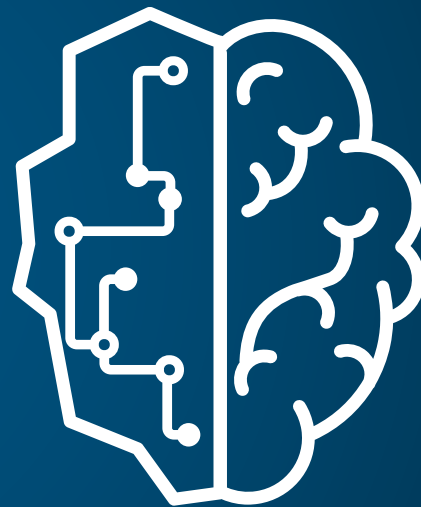
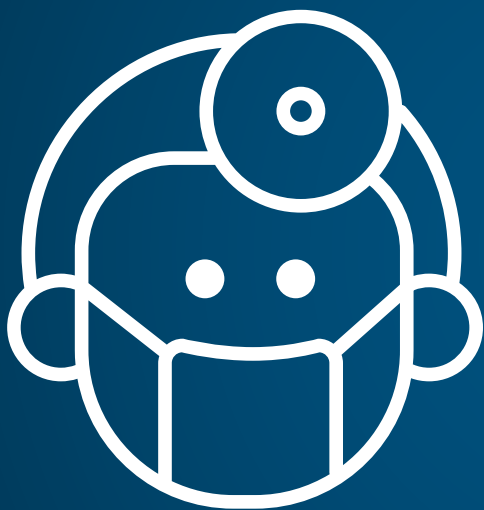


Analytics & Healthcare

Joost Huiskens, MD

+31 6 414 57 395

Joost.Huiskens@sas.com

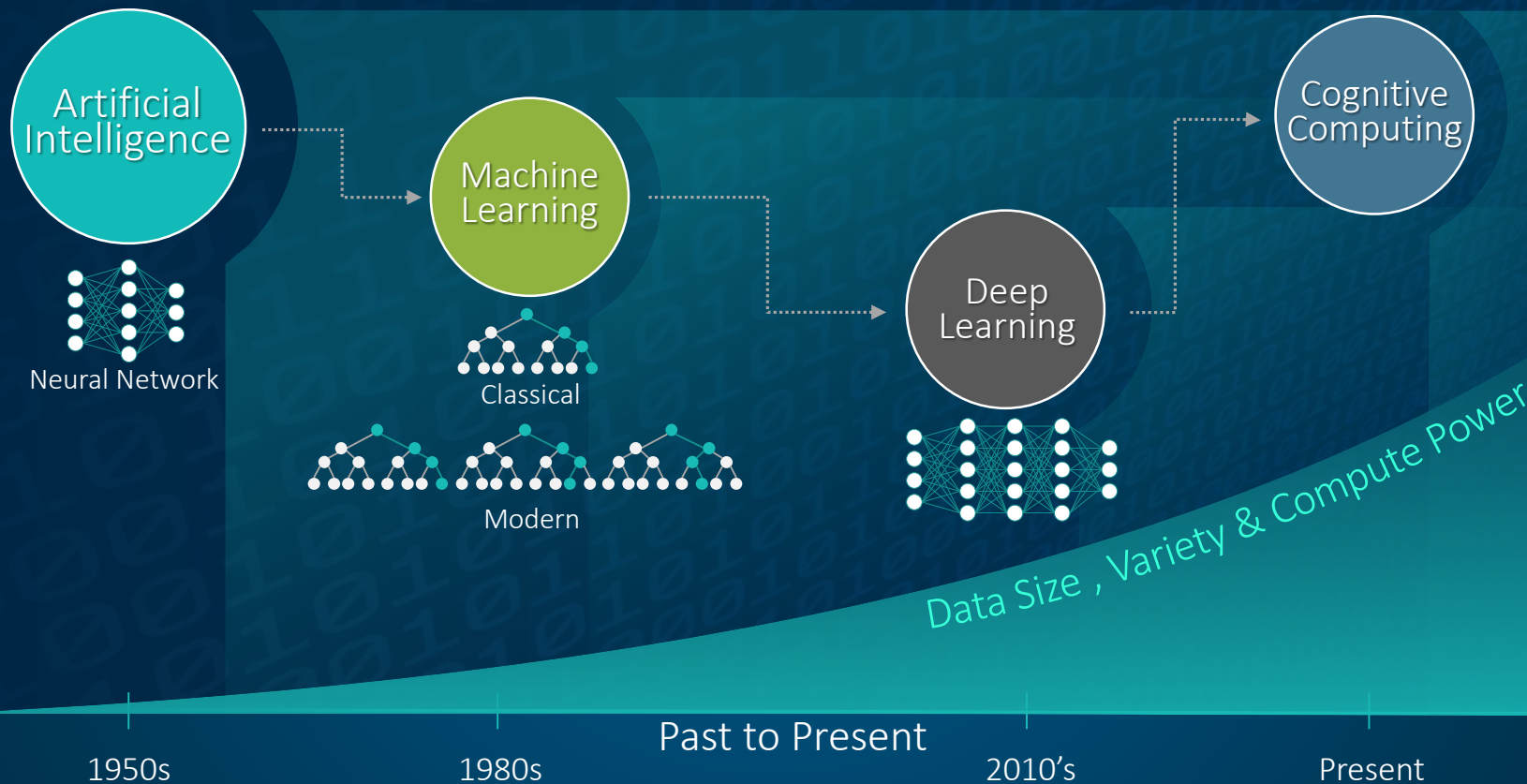




Artificial Intelligence (AI)

Computer science wherein computer algorithms are trained to perform tasks typically associated with human intelligence

Evolution





AI augments human abilities
and becomes a part of our digital world.

Analytics & Healthcare

Software as a medical device

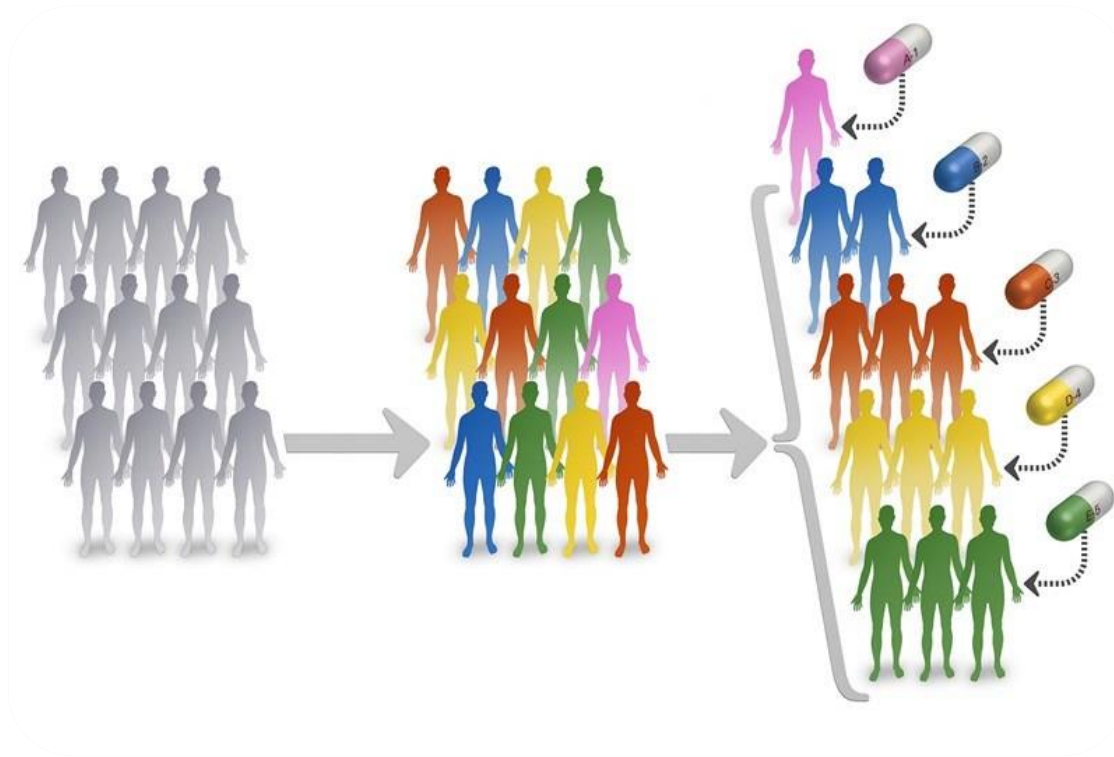
Care processes


Business processes



Nature Medicine: Januari 2019

Personalized medicine





Case 1:

Lung cancer

The Cancer Genome Atlas

Data journey

Mutation



Copy
Numbers



Methylation



mRNA



miRNA



Proteomics



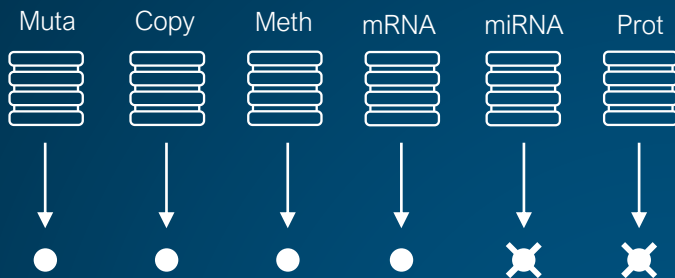
Clinical



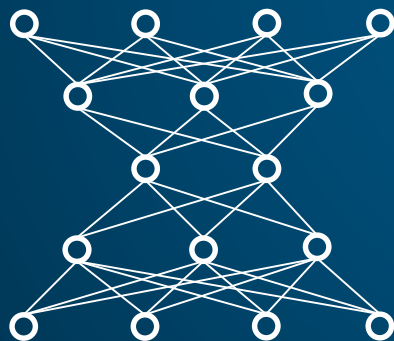
Challenge

To do analysis based on a patients'
entire omics

Omics



Data
Prep



Auto
Encoder

Personal multi-omics
fingerprint



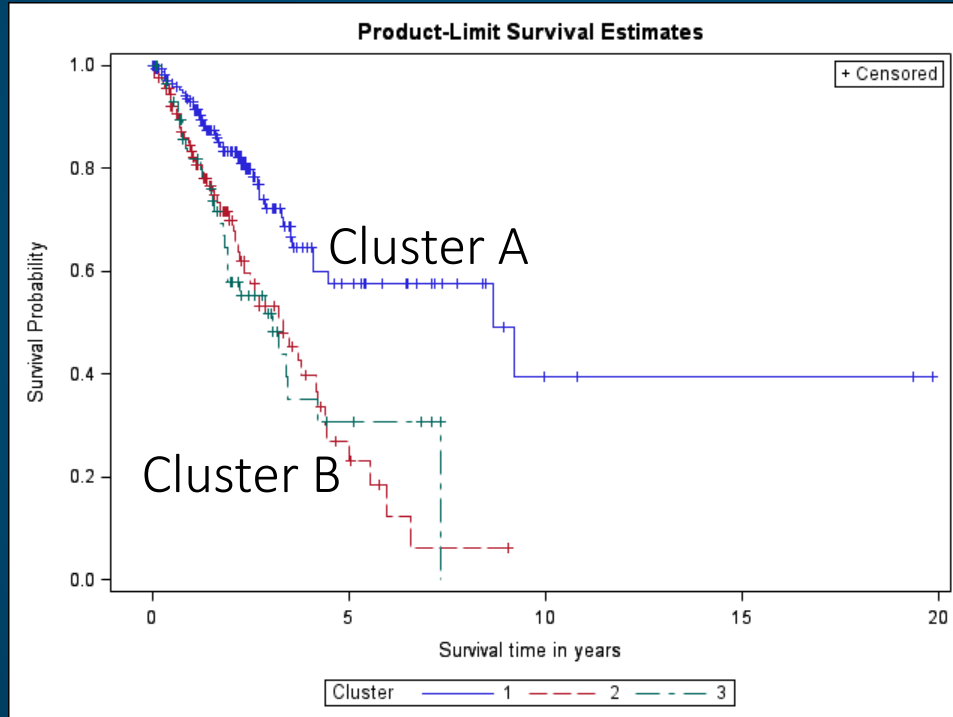
Clustering




Classification

Key findings

Survival curve adenocarcinoma

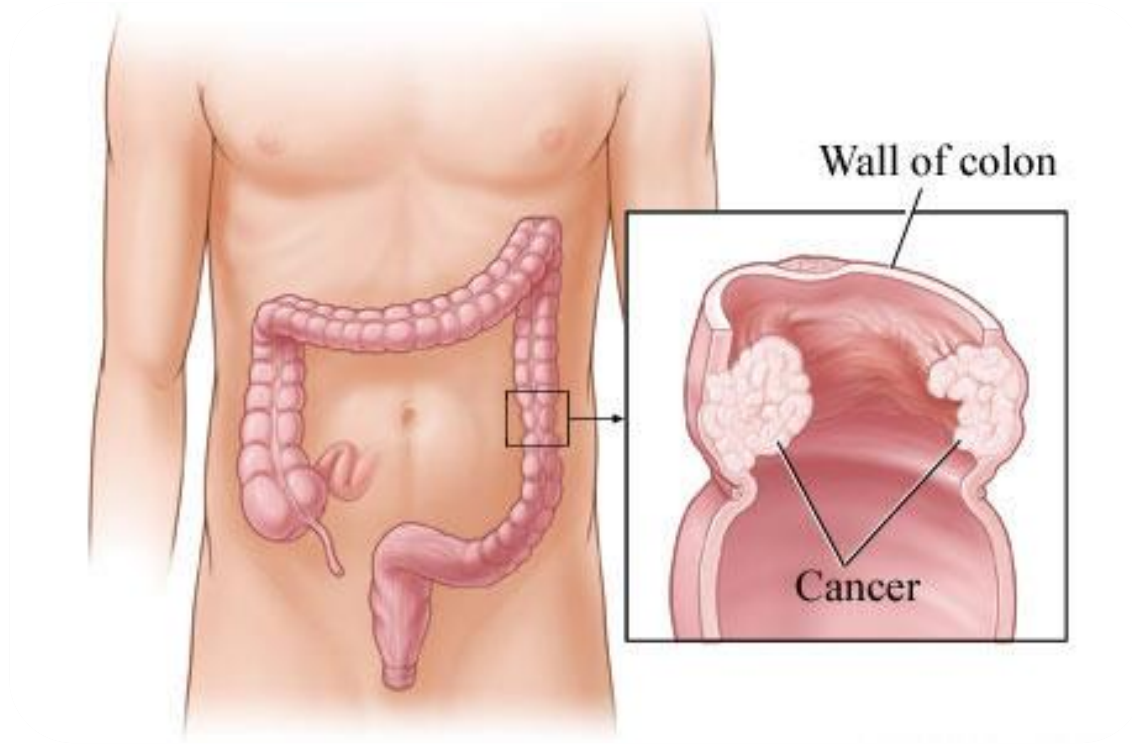




Case 2:

Treatment of Colorectal Liver Metastases

Colorectal cancer



Colorectal liver metastases



Why?

- Outcomes vary between patients
- Progression despite operation
- Prevent unnecessary surgery & chemo

Deliverables

- Chemo response assessment
 - *Recognition of liver metastases*
 - *Recognition of location & relation*
 - *Radiomics & Genomics*

Diagnosis is not the clinical problem...





available at www.sciencedirect.com



journal homepage: www.ejconline.com



New response evaluation criteria in solid tumours: Revised RECIST guideline (version 1.1)

E.A. Eisenhauer^{a,*}, P. Therasse^b, J. Bogaerts^c, L.H. Schwartz^d, D. Sargent^e, R. Ford^f,
J. Dancey^g, S. Arbuck^h, S. Gwytherⁱ, M. Mooney^g, L. Rubinstein^g, L. Shankar^g, L. Dodd^g,
R. Kaplan^j, D. Lacombe^c, J. Verweij^k

Target lesions



RECIST

Response (30%)

Stable disease

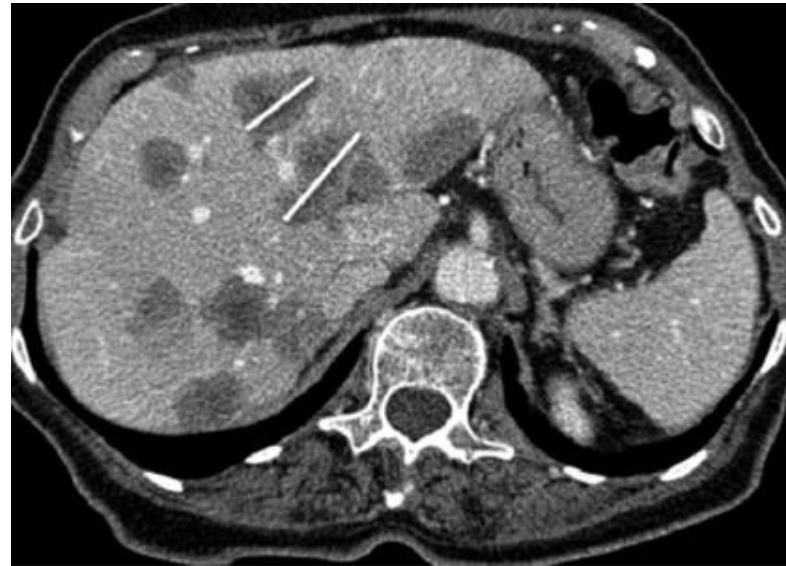
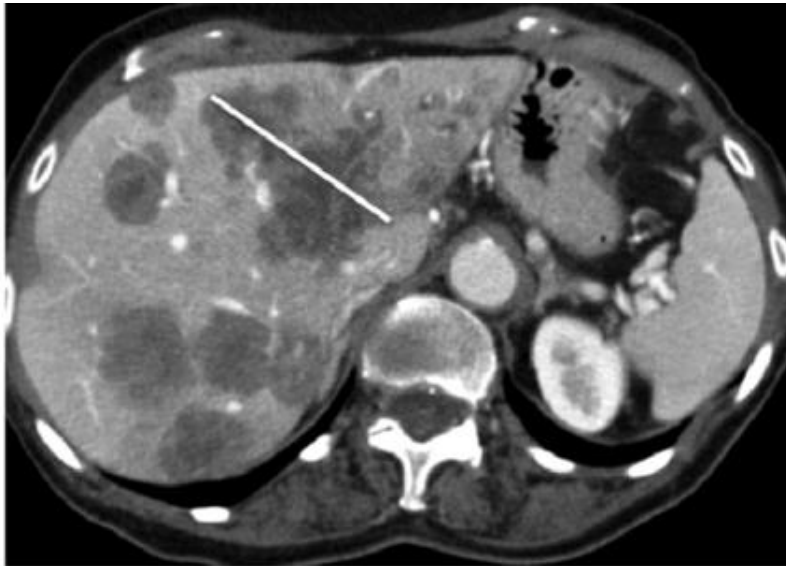
Progression (20%)



Response to chemotherapy



Response to chemotherapy



Response to chemotherapy

European Journal of Cancer 53 (2016) 5–15



Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.ejcancer.com



Review

Observer variability in RECIST-based tumour burden measurements: a meta-analysis



Soon Ho Yoon ^{a,b}, Kyung Won Kim ^c, Jin Mo Goo ^{a,b,d},
Dong-Wan Kim ^e, Seokyoung Hahn ^{f,*}

Response to chemotherapy

Inter-observer variability occurs in both
measuring the tumor burden and calculating the interval change

Response to chemotherapy

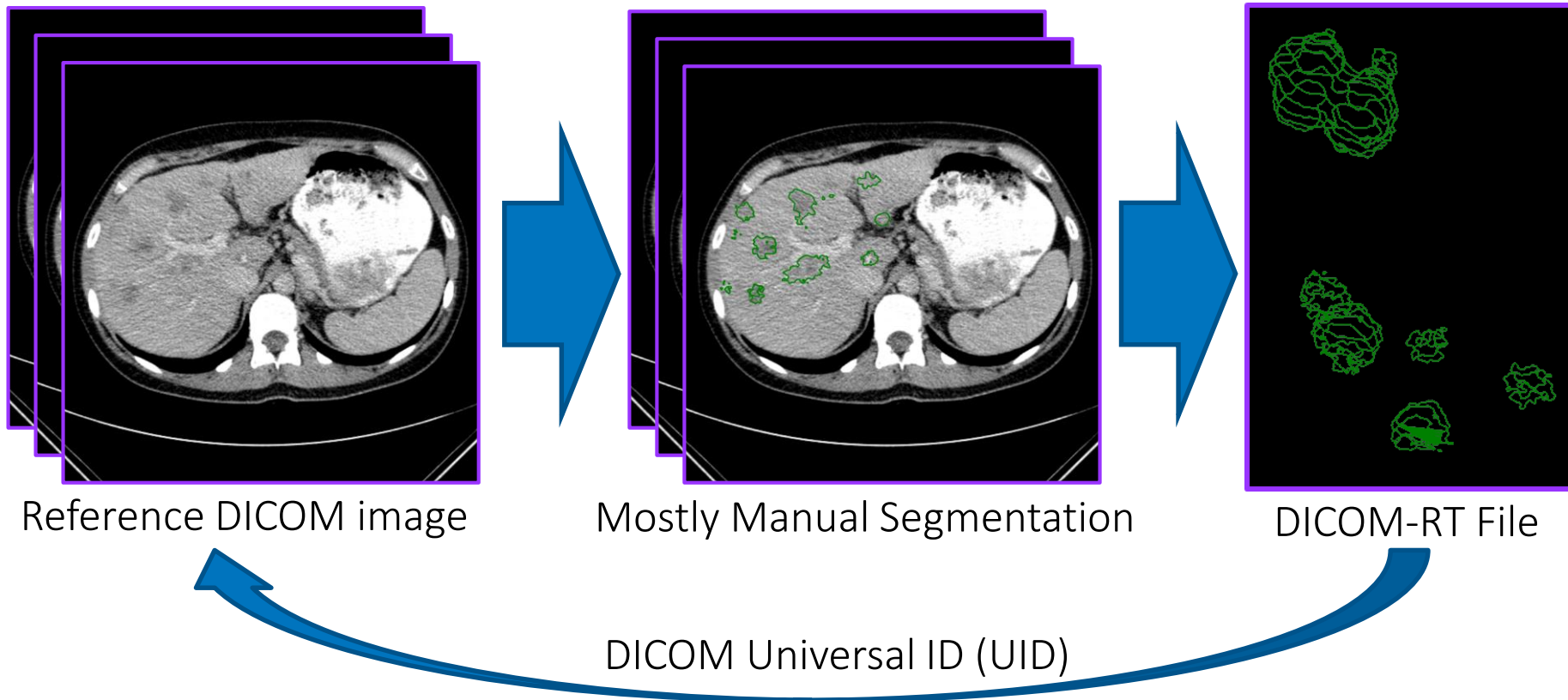
Different selection of target lesions is another major
cause of observer variability

Response to chemotherapy

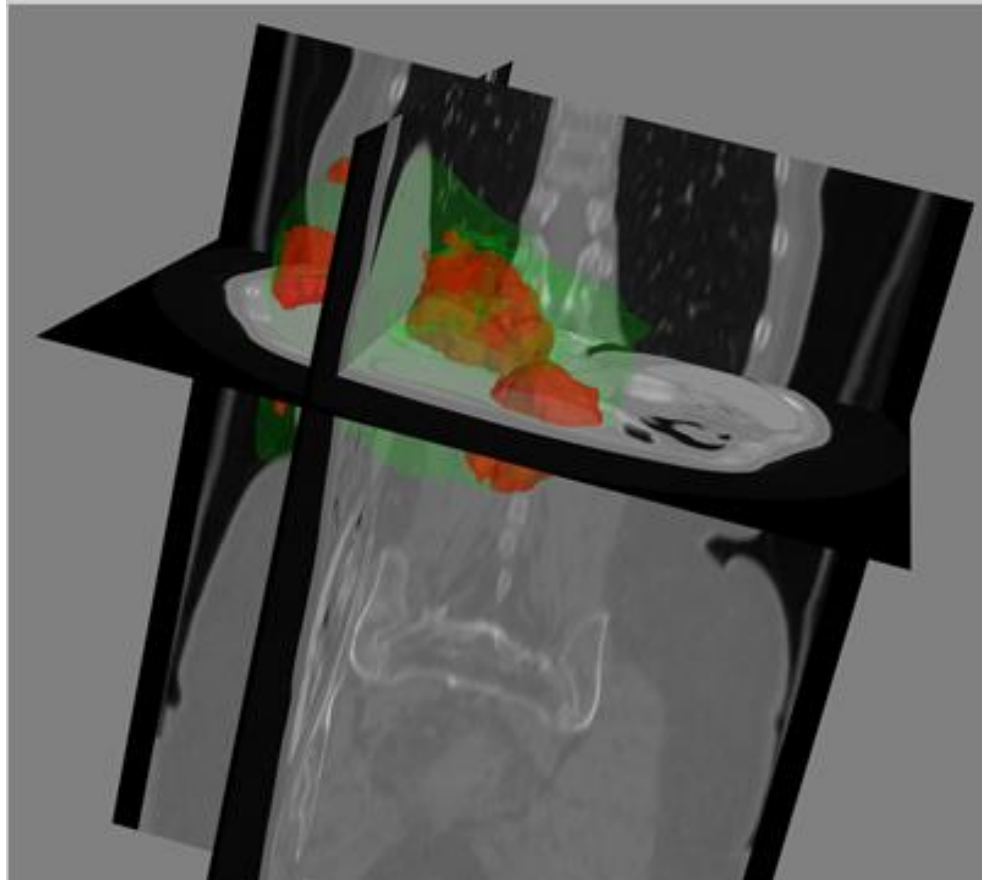


Compare CT scans on a pixel level

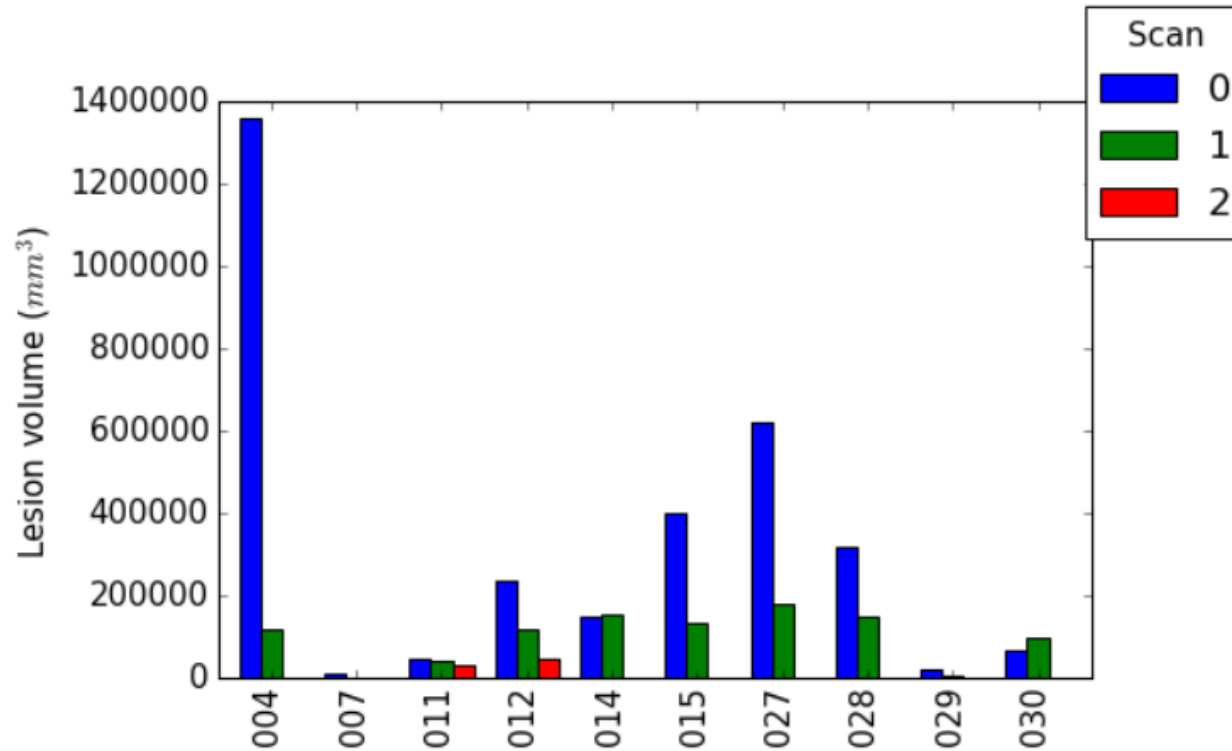
DICOM-RT Contour Data



Lesion & Liver surfaces along with original CT



Total Lesion Volume



Grayscale-Based Metrics

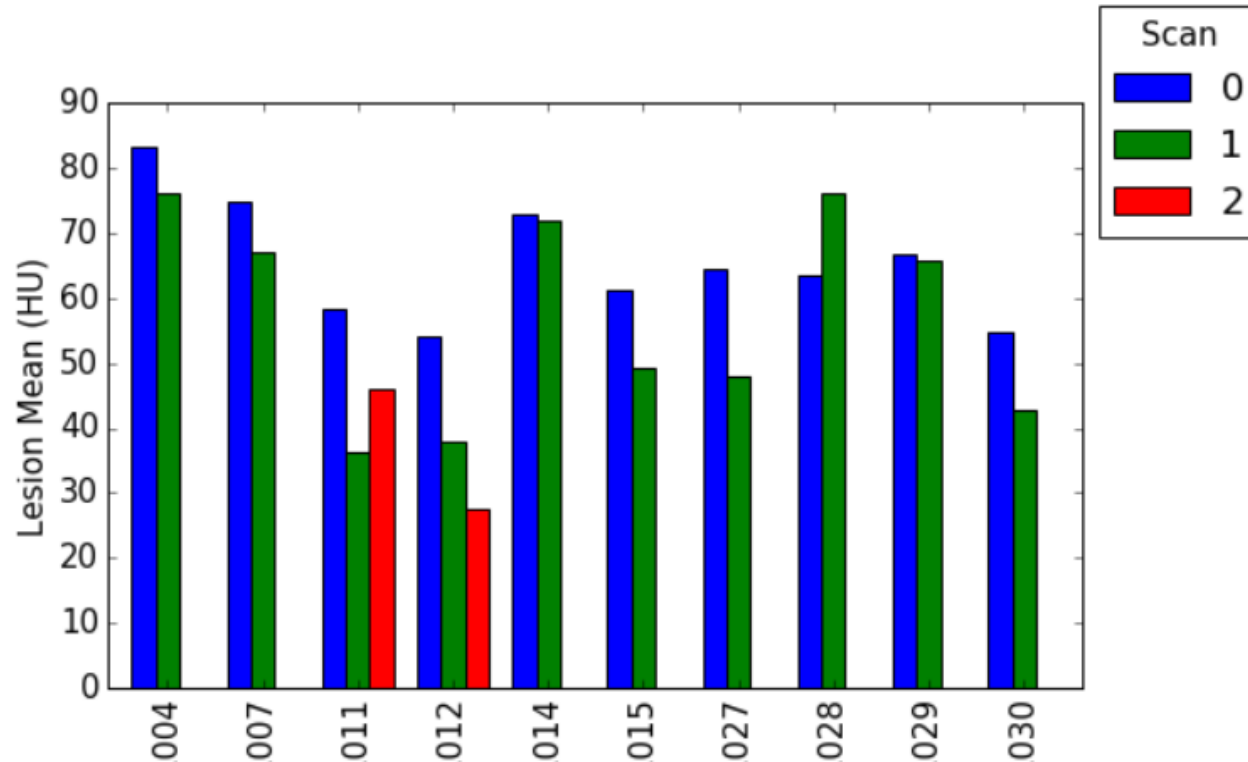


Pre-Chemo

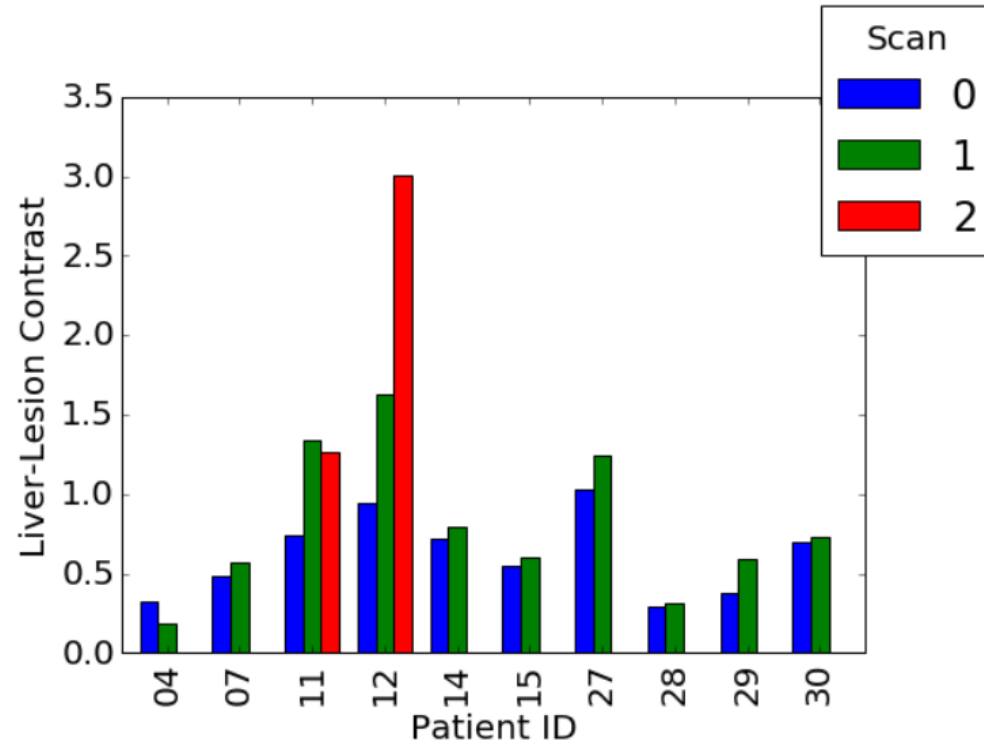


Post-Chemo

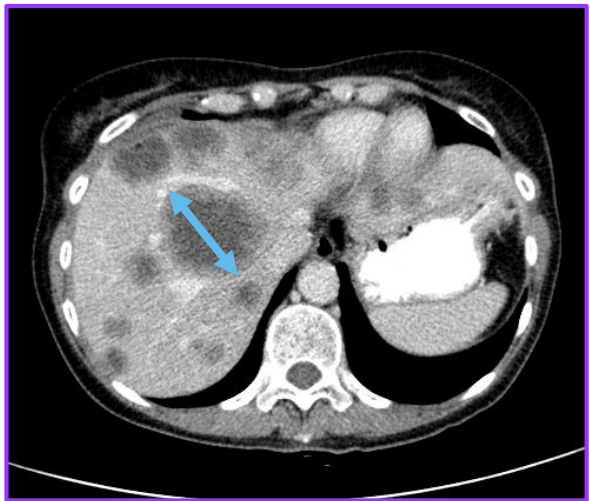
Mean Lesion Pixel Intensity



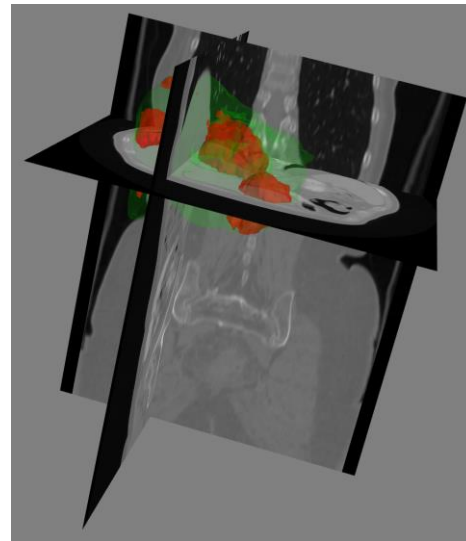
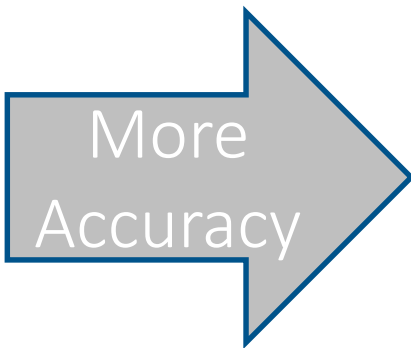
Liver-Lesion Contrast



New Response Assessment Criteria



RECIST



SAS Viya

Decreasing Subjectivity & Labor

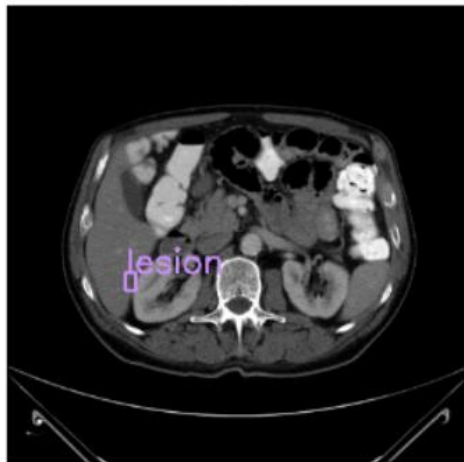
Tumor Size Assessment With Little to No Subjectivity & Labor



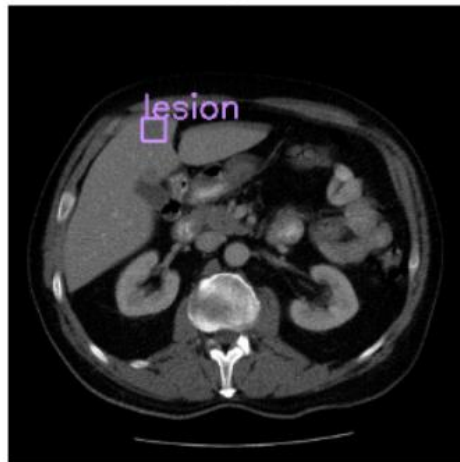
Use deep learning object detection bounding box size
as surrogate for tumor size?

Data Prep

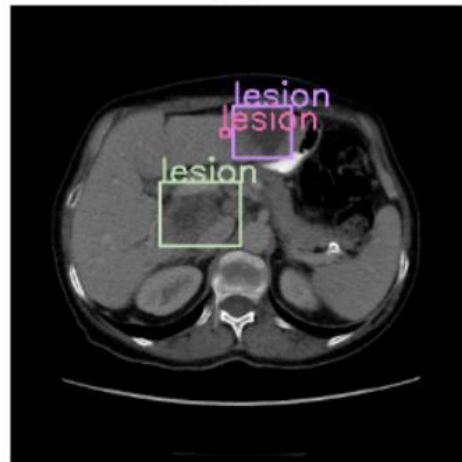
0



5



10

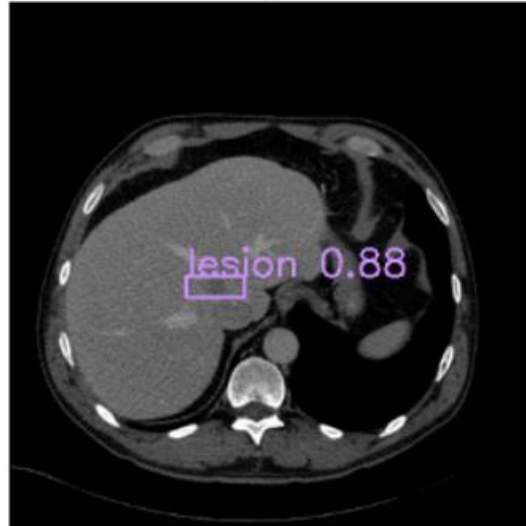


Test the Model

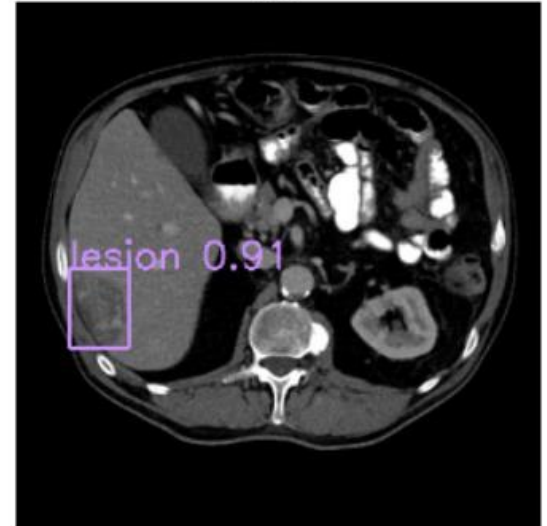
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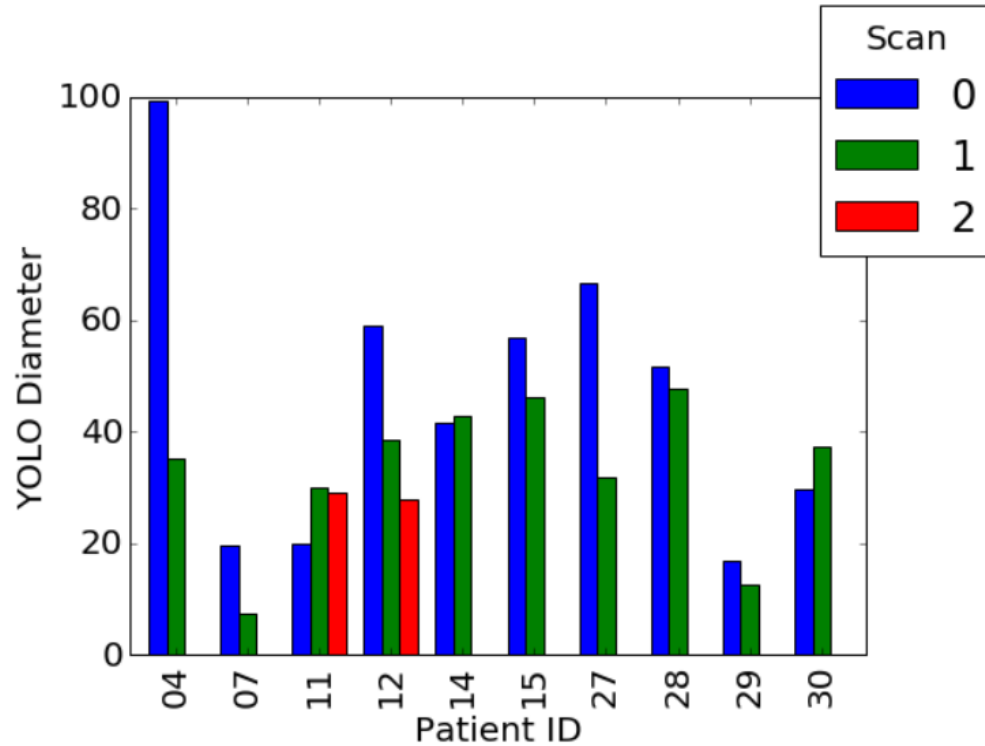
5



10



Performance of Automatic Lesion Detection



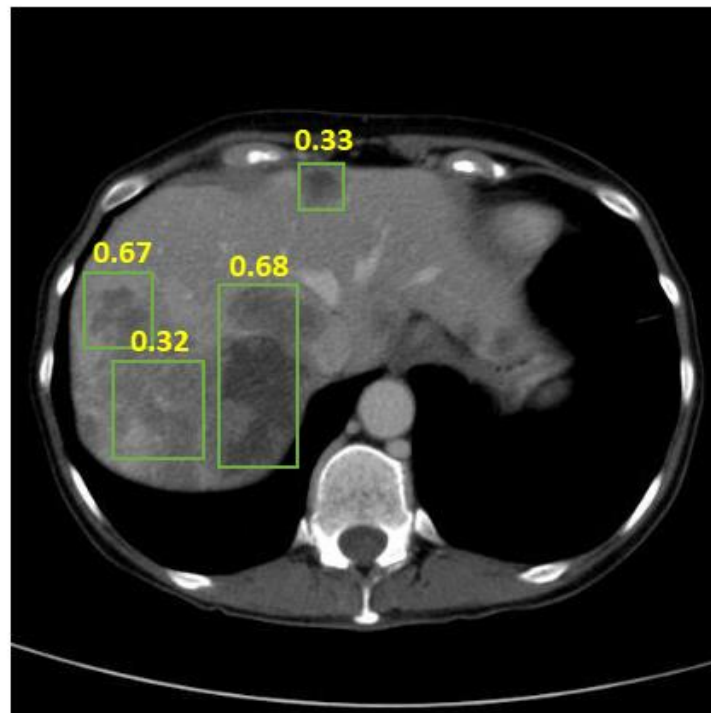
Summary

- Medical Image Processing
- Augmentation with Machine Learning
- Power of Combining Data Sources

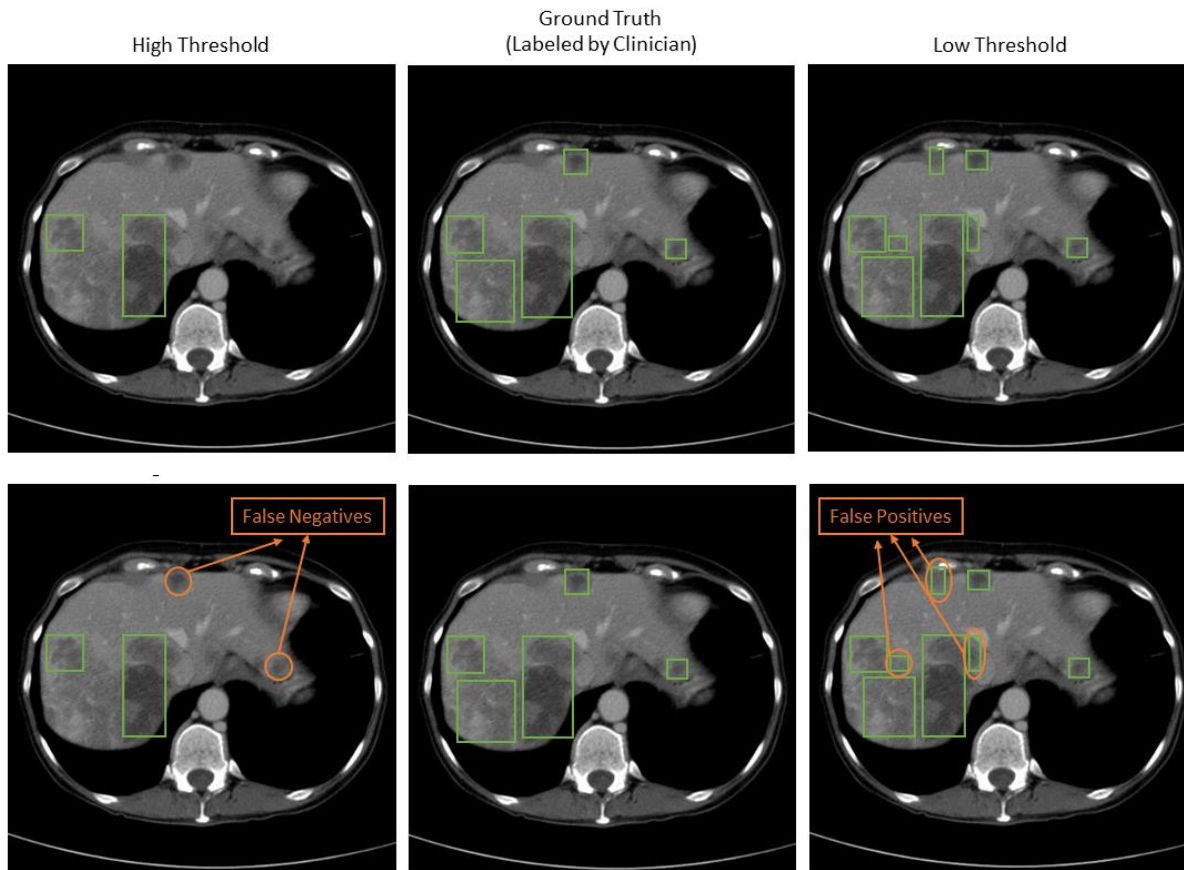
Such automation raises questions

Interpretability uses a mathematical understanding of the outputs of a machine learning model

Interpretability

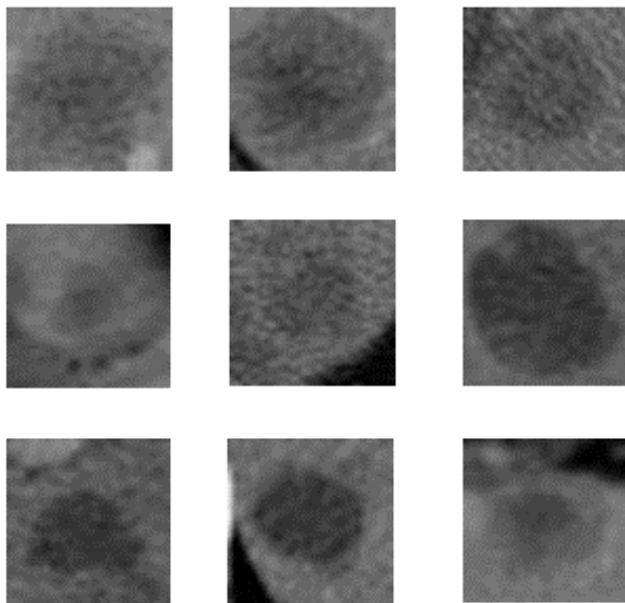


Interpretability

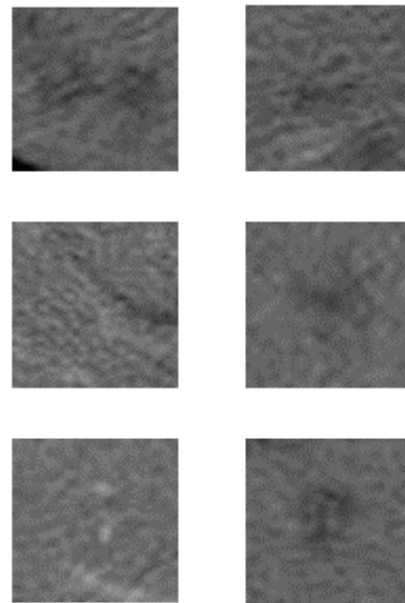


Interpretability

High Confidence Detections



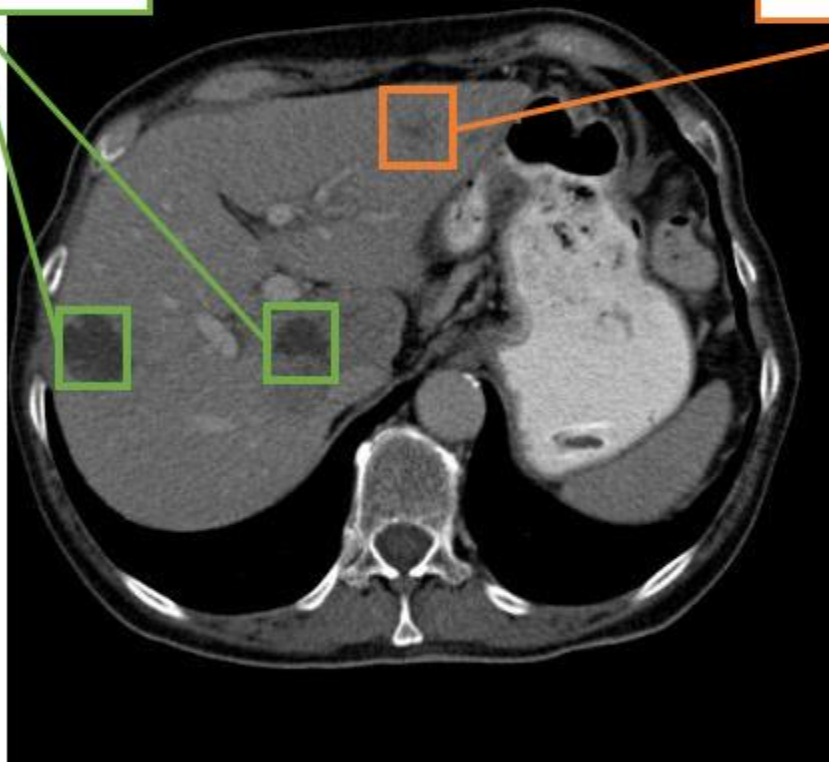
Marginal Cases



Interpretability

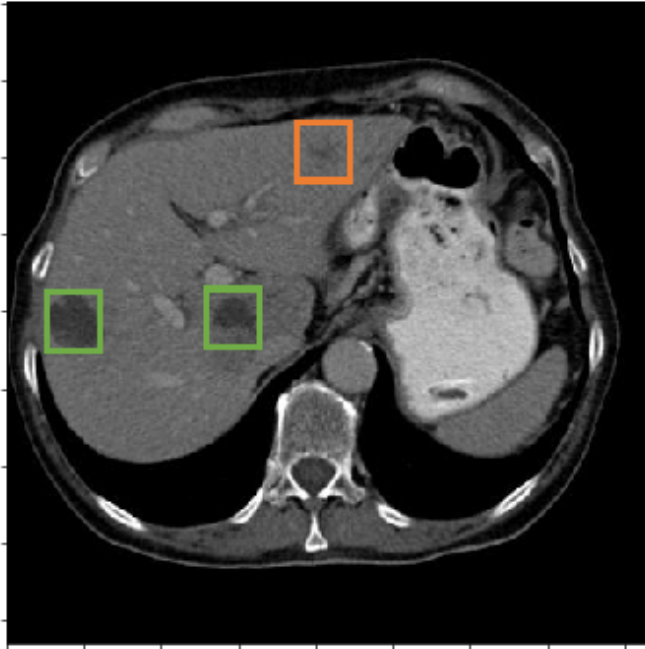
High probability
lesion detections

“Marginal Case”
Low confidence
lesion detection

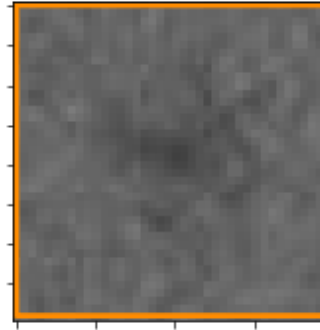


Report for the clinician

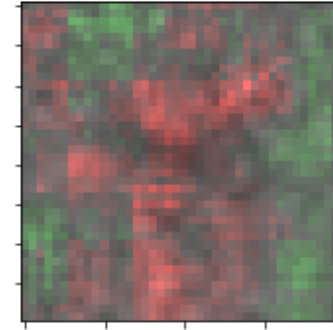
Report



Potential Lesion



Explanations



The model has found two lesions with high probabilities (green boxes) and one potential lesion (orange box) from the scan. The potential lesion area and the explanations are shown above. The red pixels in the explanations highlight the area that contributes to the lesion prediction according to the model. The green pixels highlight the area that the model finds unlikely to contain a lesion.

“Substantial translation or implementation of
AI into clinical use has not yet transpired” ¹

Tupolev 1960-90



2015: Boeing 787



Computer Program Beats Doctors Distinguishing Brain Tumors from Radiation Changes

NEUROSCIENCE NEWS • SEPTEMBER 16, 2016

ARTIFICIAL INTELLIGENCE | BRAIN CANCER | FEATURED | NEUROLOGY | 8 MIN READ

Summary: According to a new study, a computer program was almost twice as accurate as neuroradiologists in determining whether abnormal brain tissue seen on an MRI scan was due to radiation or brain cancer.

Source: Case Western Reserve.



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MEDICINE | News Center



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Computers trounce pathologists in predicting lung cancer type, severity

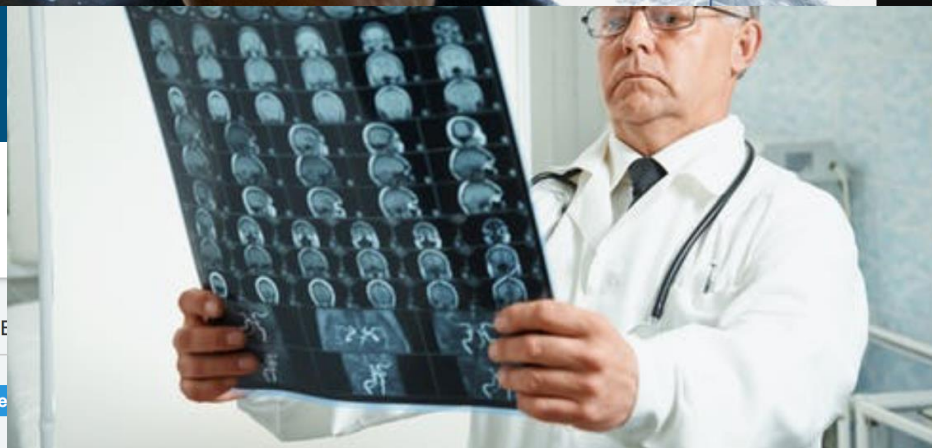
Automating the analysis of slides of lung cancer tissue samples increases the accuracy of tumor classification and patient prognoses, according to a new study.

Futurism

NEWS

FEATURES

VIDEOS



It takes time for a human to become good at diagnosing ailments, but that learning is lost when they retire.
Shutterstock/Poprotskiy Alexey

Digital diagnosis: intelligent machines do a better job than humans

January 17, 2016 7.17pm GMT

What

is

desirable?



Deep Learning for Identifying Metastatic Breast Cancer

Dayong Wang Aditya Khosla* Rishab Gargeya Humayun Irshad Andrew H Beck

Beth Israel Deaconess Medical Center, Harvard Medical School

*CSAIL, Massachusetts Institute of Technology

{dwang5, hirshad, abeck2}@bidmc.harvard.edu khosla@csail.mit.edu

rishab.gargeya@gmail.com

Abstract

The International Symposium on Biomedical Imaging (ISBI) held a grand challenge to evaluate computational systems for the automated detection of metastatic breast cancer in whole slide images of sentinel lymph node biopsies. Our team won both competitions in the grand challenge, obtaining an area under the receiver operating curve

lyon Grand Challenge 2016 (Camelyon16) to identify top-performing computational image analysis systems for the task of automatically detecting metastatic breast cancer in digital whole slide images (WSIs) of sentinel lymph node biopsies¹. The evaluation of breast sentinel lymph nodes is an important component of the American Joint Committee on Cancer's TNM breast cancer staging system, in which patients with a sentinel lymph node positive for metastatic

Deep learning system's + pathologist



Increased the pathologist's AUC from 0.966 to 0.995

Approximately 85 % reduction in human error rate

Artificial intelligence should help
the doctor at his or her job.

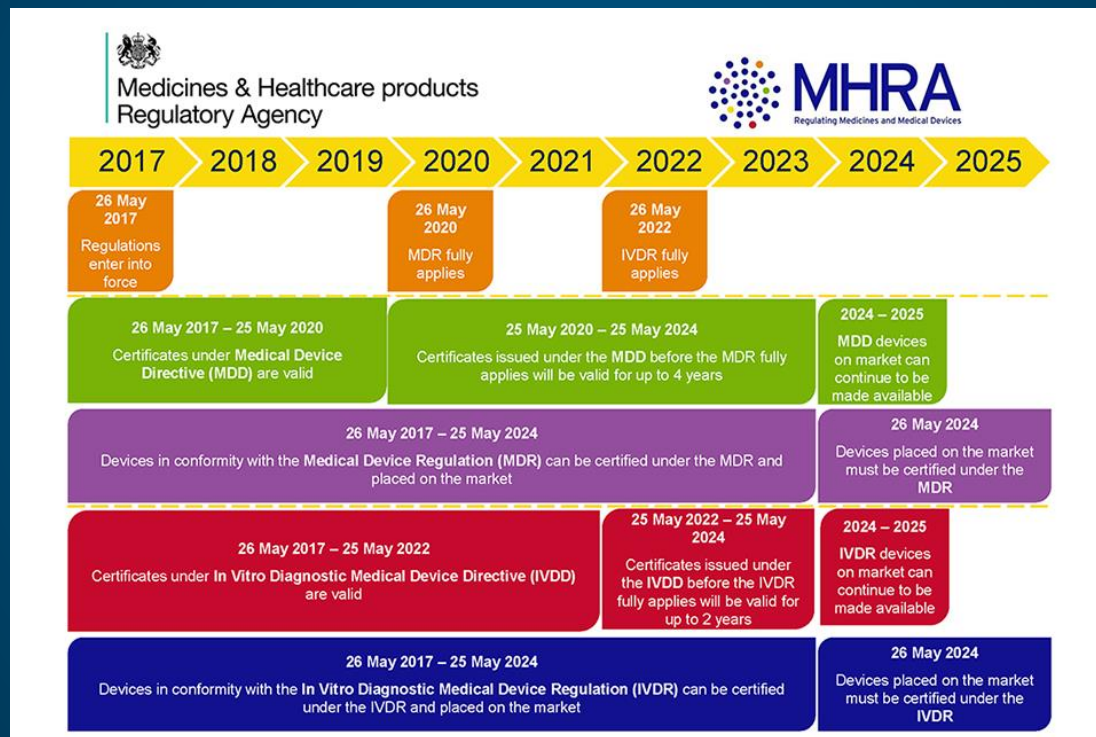
Regulation

The use of artificial intelligence

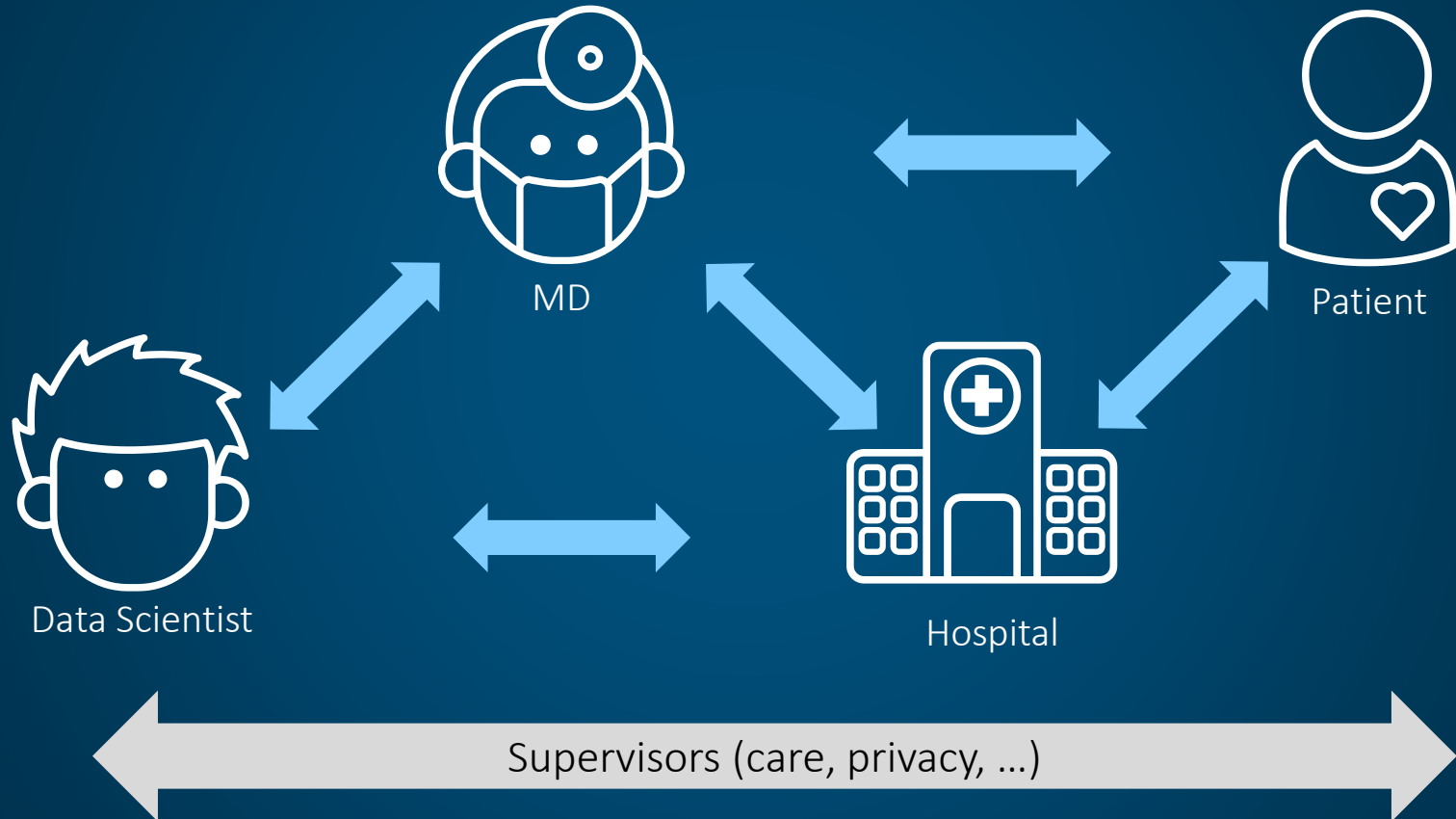
Software as a Medical Device

diagnosis, prevention, monitoring, treatment or alleviation
of disease

The future: new Medical Device Regulation (MDR) (EU) 2017/745



Healthcare AI Stakeholders



Acceptance goes beyond regulation

XAI





Productionalization of analytics in healthcare setting

Productionalization of analytics in healthcare setting

Metaphor to Modeling

Discover - Ingredients



Deploy - Treatment



Productionalization of analytics in healthcare setting

Metaphor to Modeling

Discover - Ingredients



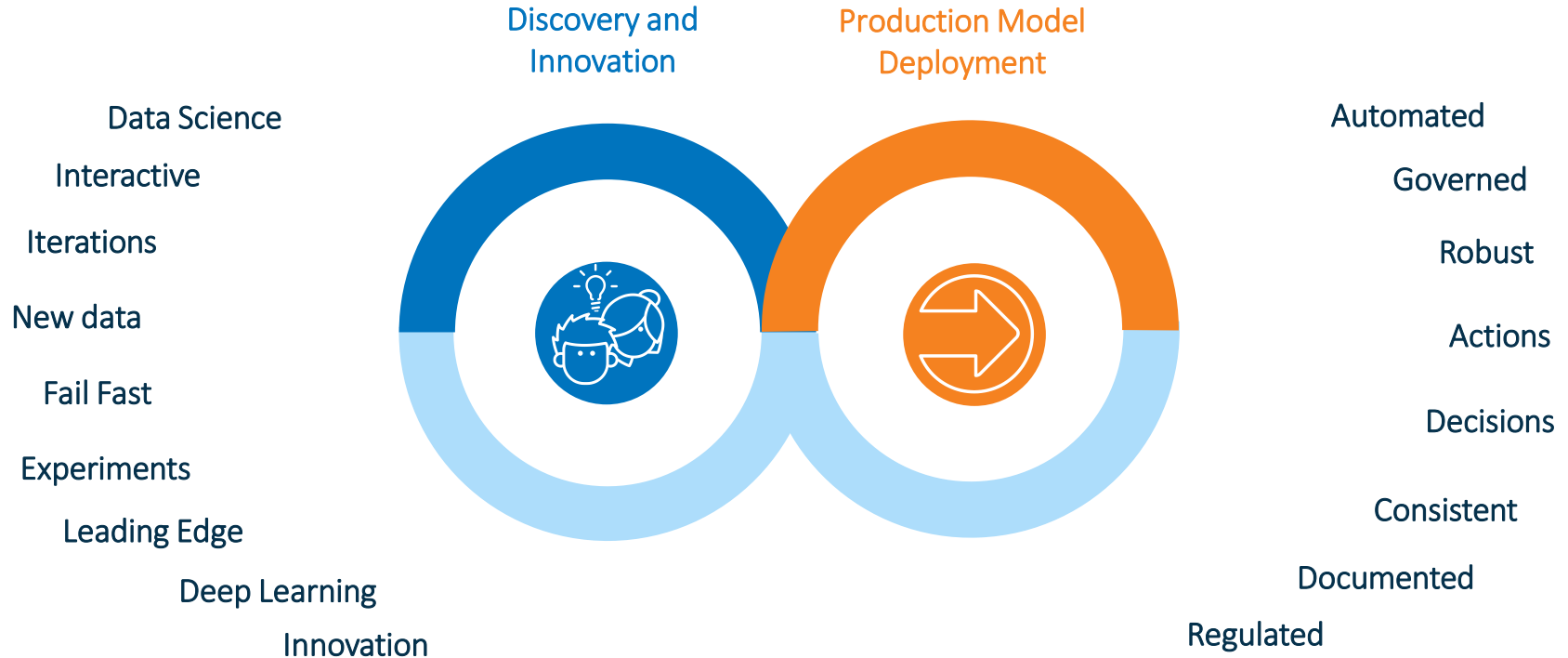
Develop - Products



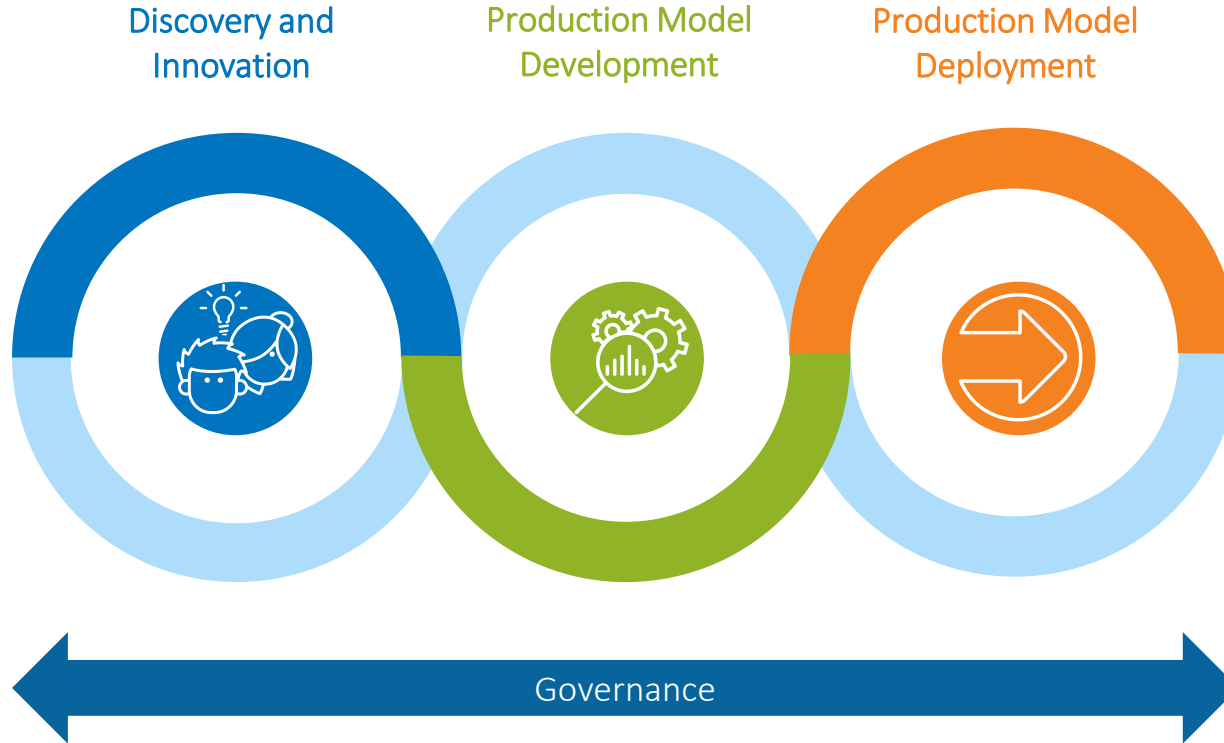
Deploy - Treatment



Analytical Processes



Analytical Processes



Developing an Enterprise Analytics Culture

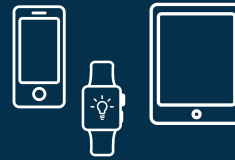
Four critical elements



PEOPLE



PROCESS



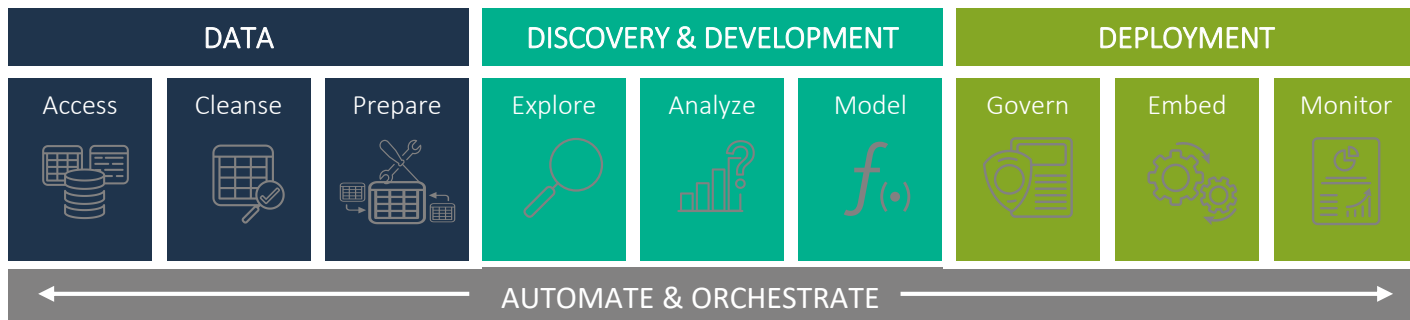
TECHNOLOGY



DATA

Operationalization of Analytics in healthcare

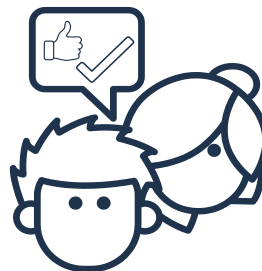
An End-to-End Open Analytical Platform



Time to Value



Performance



Personnel



Oversight &
Governance



CHOICE

CONTROL

PROGRAMMING
LANGUAGES

TALENT

DATA SOURCES

ANALYTIC
TECHNIQUES

CHOICE



CONTROL

SCALABILITY

DATA & MODEL
GOVERNANCE

SECURITY
& PRIVACY

DEPLOYMENT

A successful data driven hospital
needs a centralized data strategy for
business operations & care

Artificial Intelligence & Healthcare

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