Imagine 2029: Our data, our health, our care – 20th anniversary of EHTEL

EHTEL 2019 Symposium

Kindly hosted by TIC Salut Social — Technology, innovation and digital transformation.

13:00 – 14:30 [S3]

Aula 1
First Floor

Artificial Intelligence in Use – AI Literacy for All

Mapping the field. Insights and use case highlighting what AI means today and will mean in the future for the practice of healthcare as well as the (self-)management of health and wellness.

Session Chair: Siri Bjørvig, Norwegian Centre for E-Health Research, Tromsø

Machine Learning, Health Analytics and AI in Healthcare: Lessons from Norway
Alexandra Makhlysheva, Maryam Tayefi, Norwegian Centre for E-Health Research, Tromsø

Scaling up AI in Health Systems
Francisco Lupiañez-Villanueva, Open Evidence, Barcelona, Spain

Artificial Intelligence in Use - Operating Rooms
Rachelle Kaye, Assuta Medical Centres and Michael Attias, Razor Labs, Israel

AI Friendly Data Management in Clinical Research: Using TrialComplete in Cardiology
Johannes Stemmer, T-Systems Iberia, Barcelona / Telekom Healthcare Solutions, Germany

Q&A and Conclusions by the Session Chair

#EHTEL_Symposium #EHTEL_BCN @ehtel_eHealth

Norwegian Centre for
E-health Research

Machine Learning, Health Analytics and AI in Healthcare: Lessons from Norway

Alexandra Makhlysheva, senior advisor

Maryam Tayefi, researcher

EHTEL Symposium. December 3-4, 2019. Barcelona

What is health analytics?

- Process of deriving insights from health data to make informed healthcare decisions

Big pressure on healthcare

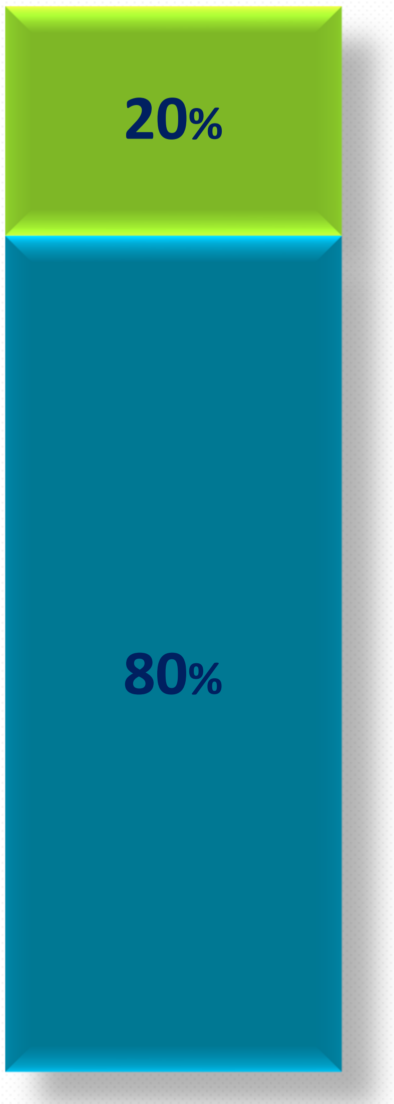
- Changes in demographics and disease picture:
  - Greater proportion of older people
  - Chronic diseases
  - Patients with multimorbidity
  - Increased need for long-term treatment and follow-up
- Lack of specialists

Big pressure on healthcare

- Have to reduce costs without reducing treatment quality and patients’ security
- Preserve patients’ privacy and confidentiality

Characteristics of health data

- In multiple places and different formats
- Can be structured or unstructured
- Developing continuously
- Complex
- Strict regulatory requirements for data reuse



Structured data

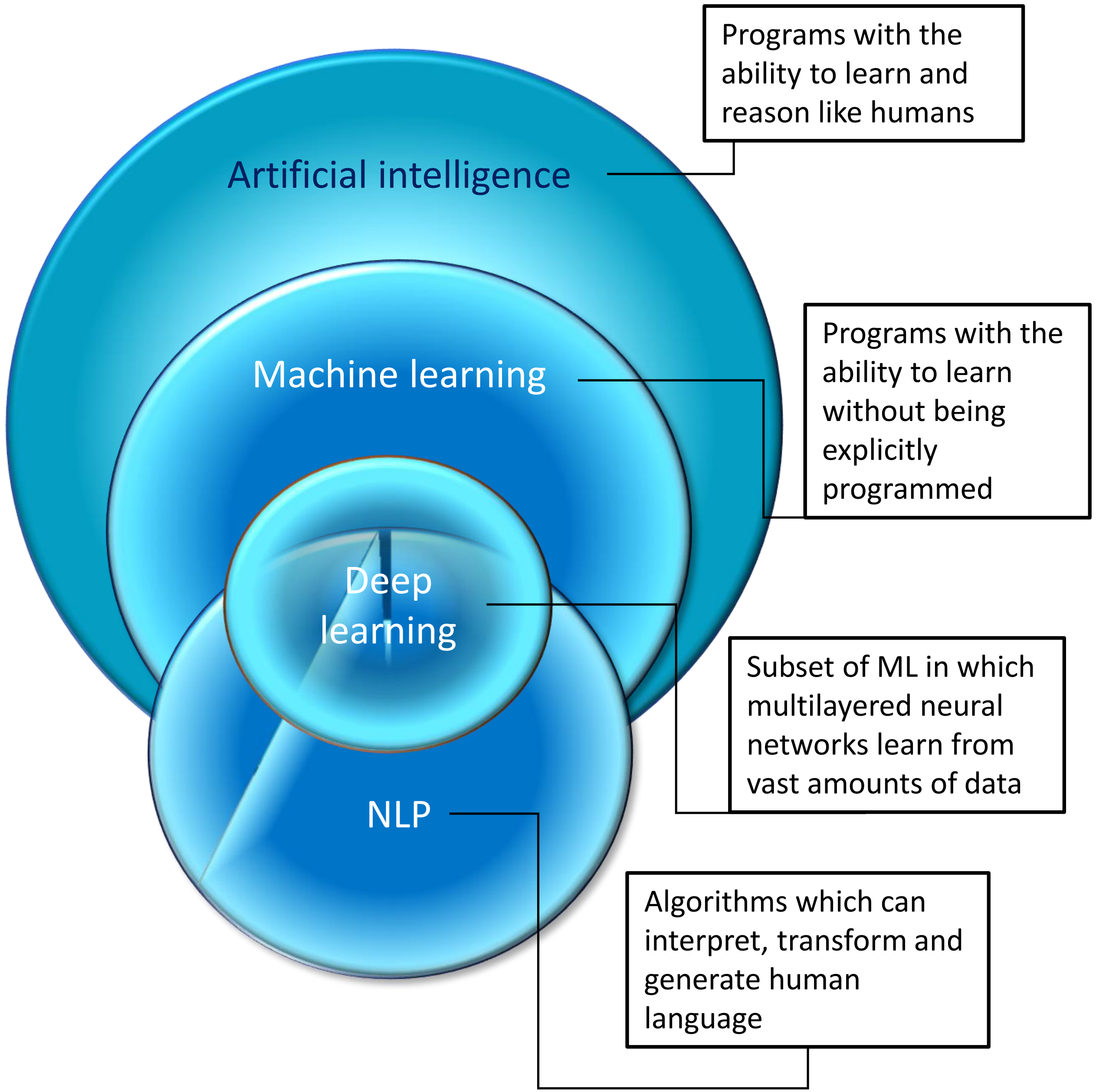
- Laboratory data
- Diagnoses
- Medication lists

Unstructured data

- Free text
- Images
- Video
- Genomics data

Technologies for health analytics

- Machine learning
- Natural language processing
- Deep learning

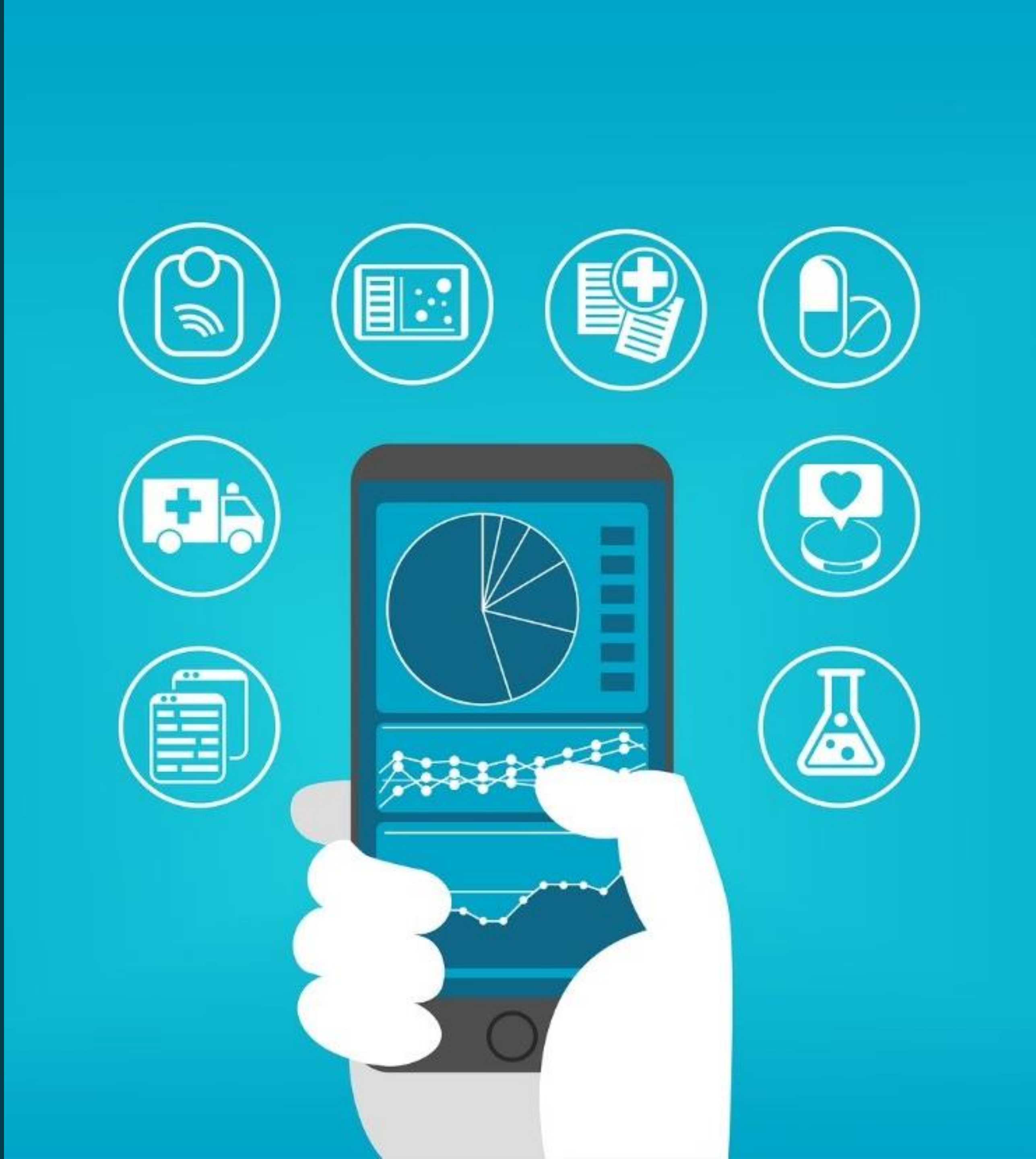


Artificial intelligence

- capability of a machine to imitate intelligent human behavior
- ***General AI:*** systems that can think, learn, reason and communicate on the same level as humans
- ***Narrow AI:*** solves very specific problems which require a certain level of “intelligence”. Applied in healthcare

Machine learning

- sub-area of AI
- collection of mathematical and computer science techniques for knowledge extraction from large data sets, and the use of these techniques for classification, prediction and estimation problems



Benefits of machine learning in healthcare

- Reduction of administrative costs
- Clinical decision support
- Cutting down on fraud and abuse
- Better care coordination
- Improved patient wellbeing/health

Challenges for machine learning in healthcare

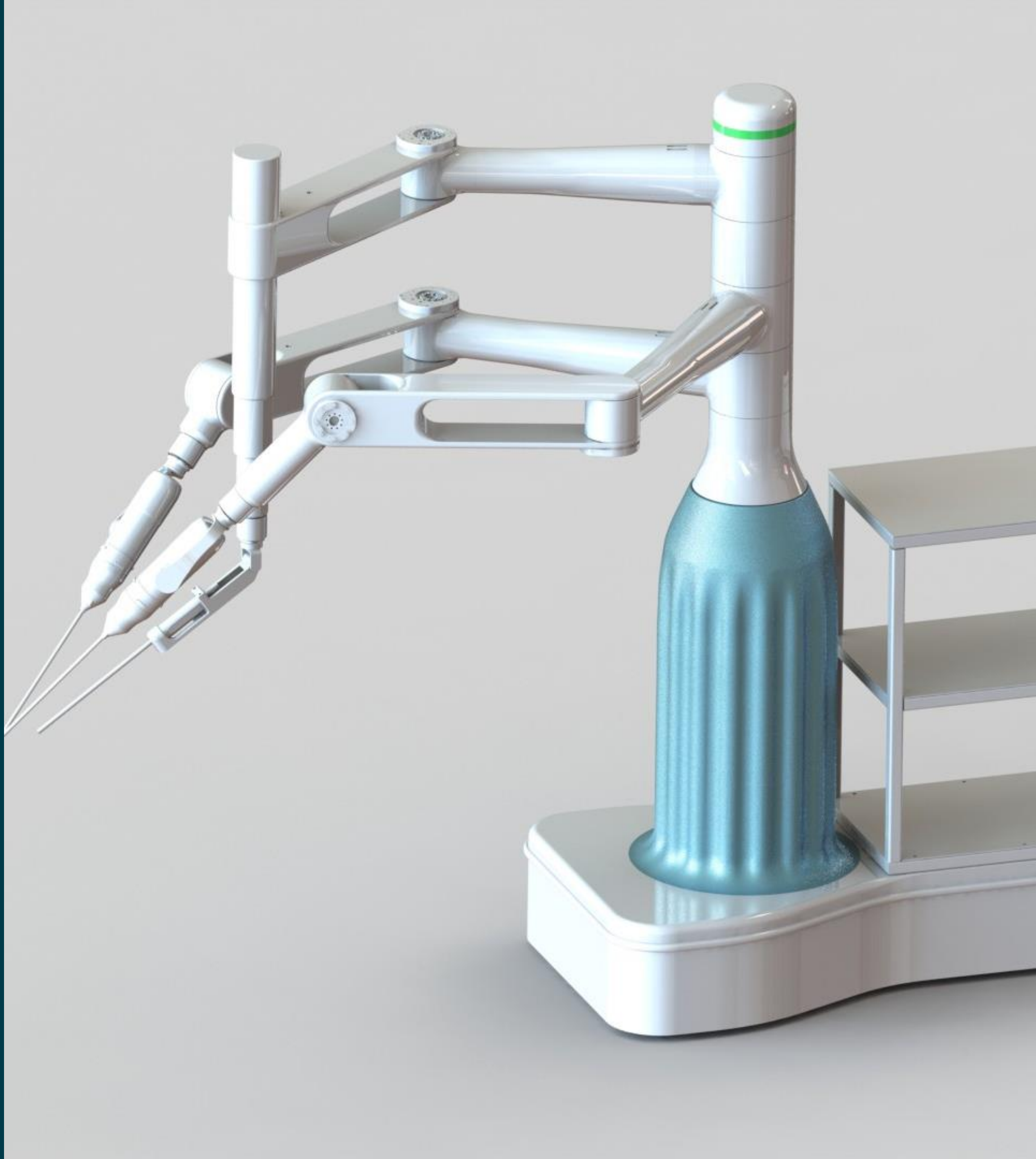
- Data governance
- Algorithm interpretability
- Breaking down data silos and encouraging a data-centric view
- Standardizing/ streamlining electronic health records
- Overdiagnosis

Examples of machine learning in healthcare

- Diagnosis in medical imaging
- Treatment queries and suggestions
- Drug discovery/drug development
- Improved care for patients with multiple diagnoses
- Development of clinical pathways

Examples of machine learning in healthcare

- Population risk management
- Robotic surgery
- Personalized medicine/ precision medicine
- Automatic treatment/recommendation
- Performance improvement

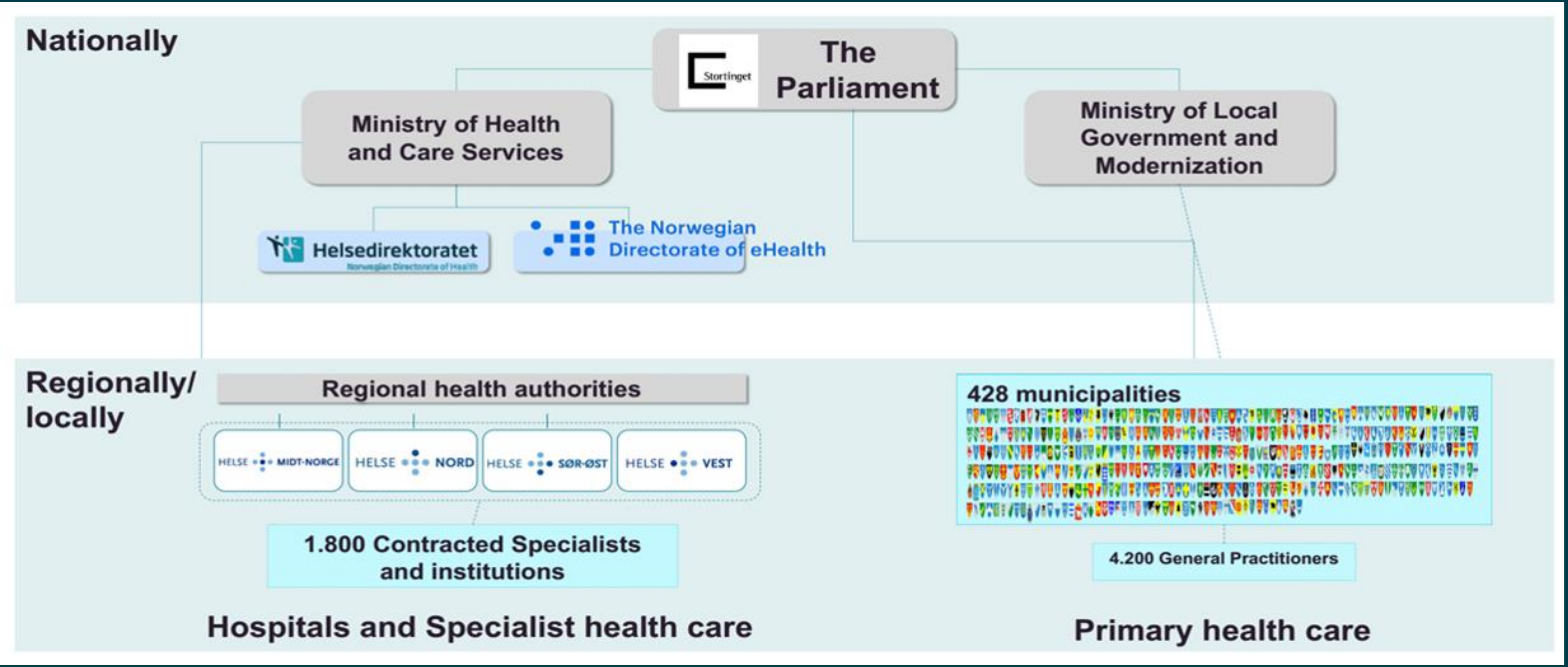


Disruptive areas in healthcare

- Interpretation of medical images
  - Most developed, rapidly developing
- Prognostics
  - Not that mature
- Diagnostics
  - Complex area, needs time to be ready for use in practice

Lessons from Norway

Norwegian Health and Care Services



Norwegian e-health

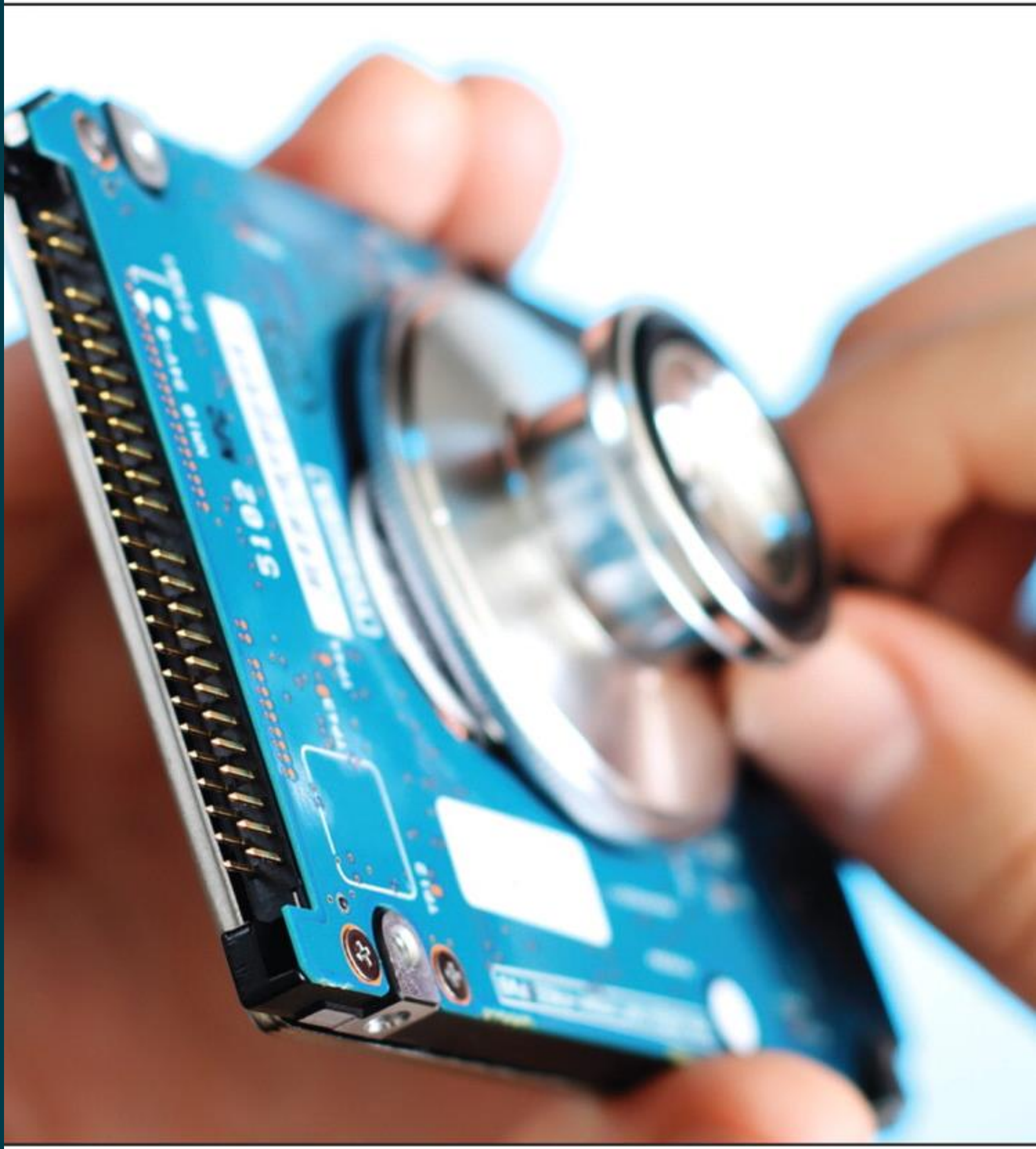
- Billions are invested in information- and communication technologies within health nationally
- Knowledge will ensure that money is wisely and effectively spent, benefitting societal needs
- Directorate of e-health was established on January 1st, 2016
- An instrument to realize political aims

One citizen – one health/medical record

Health personnel must have simple and secure access to patient and user information.
Citizens must have access to simple and secure digital services.
Data must be accessible for quality improvement, health surveillance, governance and research.

Challenges in secondary use of health data in Norway

- Data is distributed across institutions and sharing is difficult
- Lack of laws and infrastructure



Background for health analytics in Norway

- Health registries with high-quality population-wide data
- Early digitization of healthcare
- A uniform, single-payer healthcare system
- Personal ID numbers identifying citizens on all levels of care

- Environmental and social media data
- Electronic health records
- Registries
- Genomics
- Medical imaging
- Claims databases
- Patient monitoring devices

National health registries

- Registries with high-quality population-wide data
- Personally identifiable information that is not based on consent

Register		
1. Medical Birth Registry of Norway	2. Registry of Pregnancy Termination	3. Norwegian Cardiovascular Disease Registry
4. Cause of Death Registry	5. Norwegian Prescription Database (NorPD)	6. Norwegian Immunisation Registry
7. Norwegian Surveillance System for Communicable Diseases	8. The Norwegian Surveillance System for Antibiotic Use and Healthcare-Associated Infections	9. Norwegian Surveillance System for Antimicrobial Drug Resistance (NORM)
10. Norwegian Surveillance System for Virus Resistance	11. Norwegian Patient Register (NPR)	12. Norwegian Information System for the Nursing and Care Sector
13. Municipal Patient and User Registry*	14. Cancer Registry of Norway	15. Genetic screening of newborns**
16. ePrescription database**	17. Registry of the Norwegian Armed Forces Medical Services	18. Medical Archives Registry

Source: https://www.fhi.no/en/more/access-to-data/about-the-national-health-registries2/

Privacy and security concerns and AI: GDPR

- Principle of legality, fairness and transparency
- Purpose limitation principle
- Principle of data minimization

Norwegian machine learning research groups in healthcare

- Norwegian University of Science and Technology (NTNU)
- University of Agder
- University of Oslo
- University of Tromsø
- Oslo University Hospital
- Simula Research laboratory and Simula Met
- BigMed
- BigInsight
- SINTEF
- Norwegian Centre for E-health Research

Norwegian University of Science and Technology (NTNU)

- Automatic real-time 3D segmentation of all heart chambers
- Automatic detection of blood vessels in real-time from ultrasound images
- Improving self-management of non-specific low back pain
- Clinical decision support

University of Agder, Centre for Artificial Intelligence Research (CAIR)

- Detecting allergy through EHR notes
- Breast cancer
- Human-interpretable rules for high-accuracy text categorization with medical applications

UiT – The Arctic University of Norway

- Predicting and preventing postoperative complications for better quality of care by leveraging data from EHR
- Early detection of anastomosis leakage before the actual complication occurs

University of Oslo

- AI-aided diagnostics of colorectal polyps during colonoscopy
- Part of the BIGMED project at Oslo University Hospital for integrating patient health record information with genomics data

Simula Research Laboratory and SimulaMet

- Personalized cancer screening, with a particular focus on cervical cancer, by utilizing existing registries and health data intelligently

BigMed

- Metastatic colorectal cancer
- Sudden cardiac death
- Rare diseases

Oslo University Hospital

- Diagnosis and prognostication to improve treatment of cancer: lung, colorectal and prostate cancer
- Clinical decision support

BigInsight

- Improving treatment predictions for patients with cancers
- Prediction of synergy between drugs and effect of the drug combination with data from cancer cell lines
- Prediction of cancer drugs sensitivity with large-scale in vitro drug screening

SINTEF

- Research and development in ultrasound and image processing for cancer, cardiovascular disease, and muscle/skeletal disorders (together with NTNU and St Olav’s Hospital)

Norwegian Centre for E-health Research

- Exploring electronic phenotyping for clinical practice in Norway: gaining knowledge on EHR phenotyping and identifying its clinical relevance in Norwegian settings
- NorKlinText: gaining knowledge on NLP for EHR data
- PCRN infrustructure: extracting patient health data from EHR for quality-assured clinical studies in Norwegian general practice

Norwegian Centre for E-health Research

- Health analytics report has been read by Norwegian health authorities and is considered in National health and hospital plan 2020-2023

Norwegian Centre for E-health Research

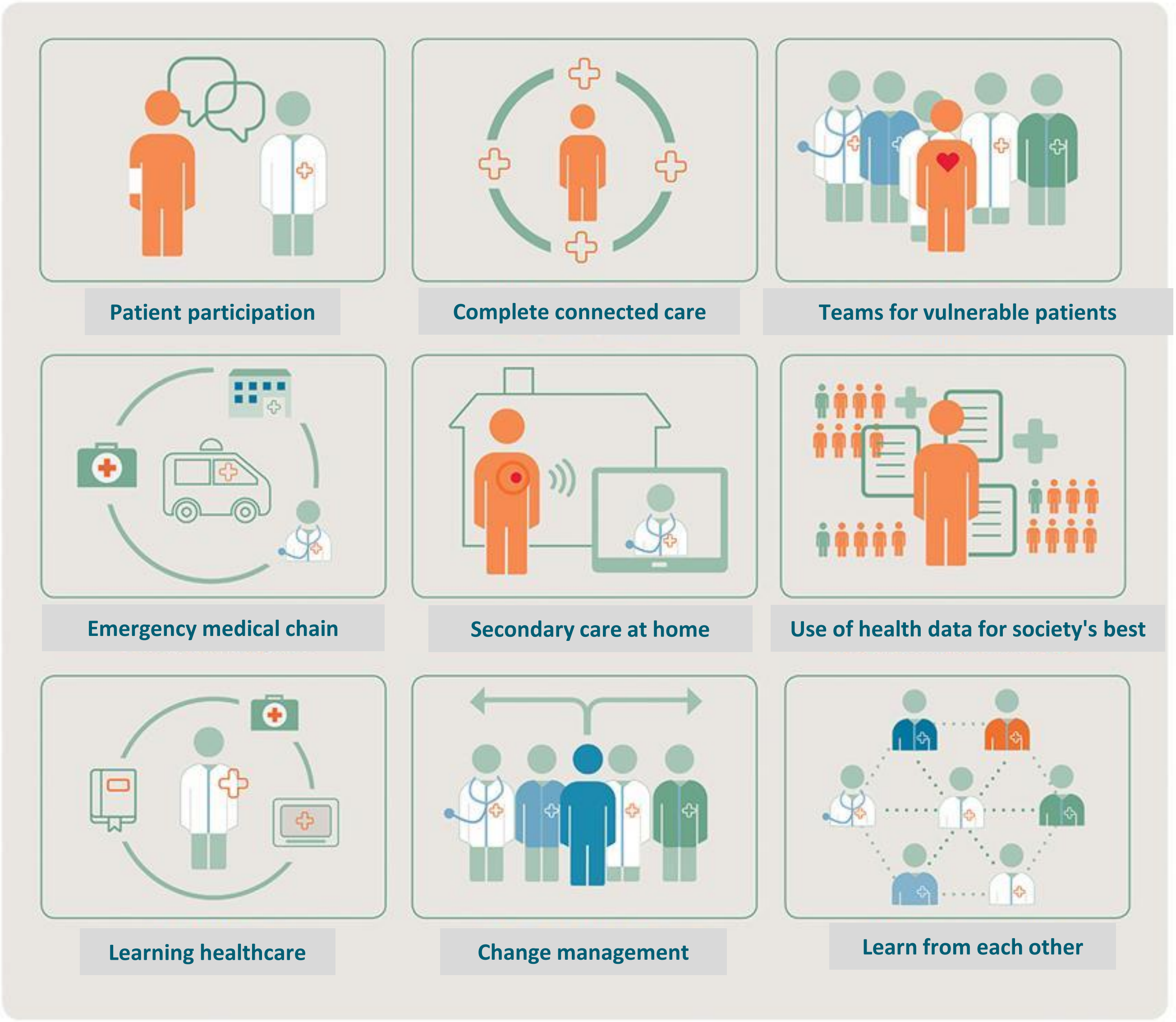
REPORT 04/2018

Health Analytics

Makhlysheva A., Budrionis A., Chomutare T., Nordsletta A.T., Bakkevoll P.A., Henriksen T., Hurley J.S., Bellika J.G., Blixgård H., Godtliebsen F., Skrøvseth S.O., Solvoll T., Linstad L.

National health and hospital plan 2020-2023

- Government wants to:
  - use artificial intelligence in healthcare and increase health data sharing to improve healthcare
  - facilitate personalized medicine



Source: https://www.regjeringen.no/no/dokumenter/nasjonal-helse--og-sykehusplan-2020-2023/id2679013/sec1#id0007

Norwegian Centre for
E-health Research

Thank you for attention!

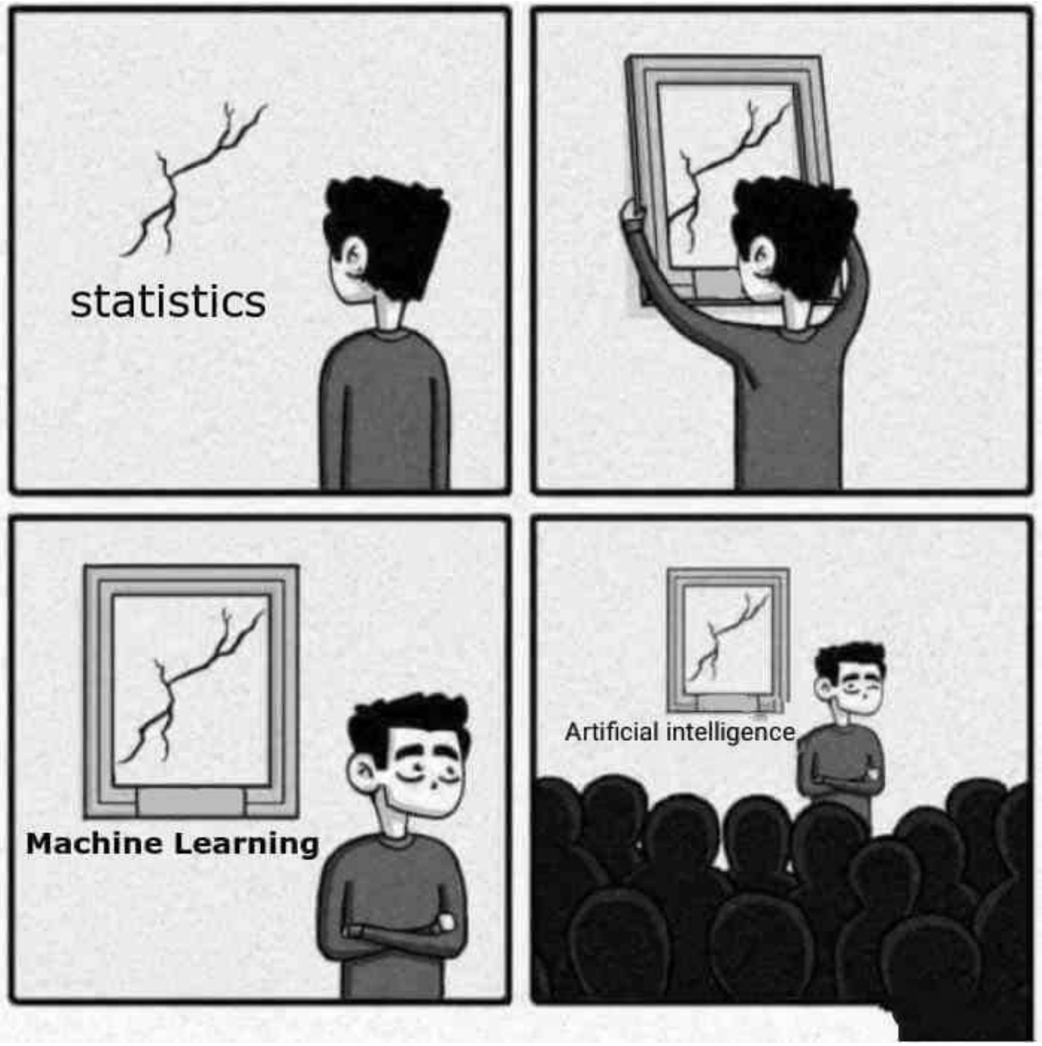
Questions?

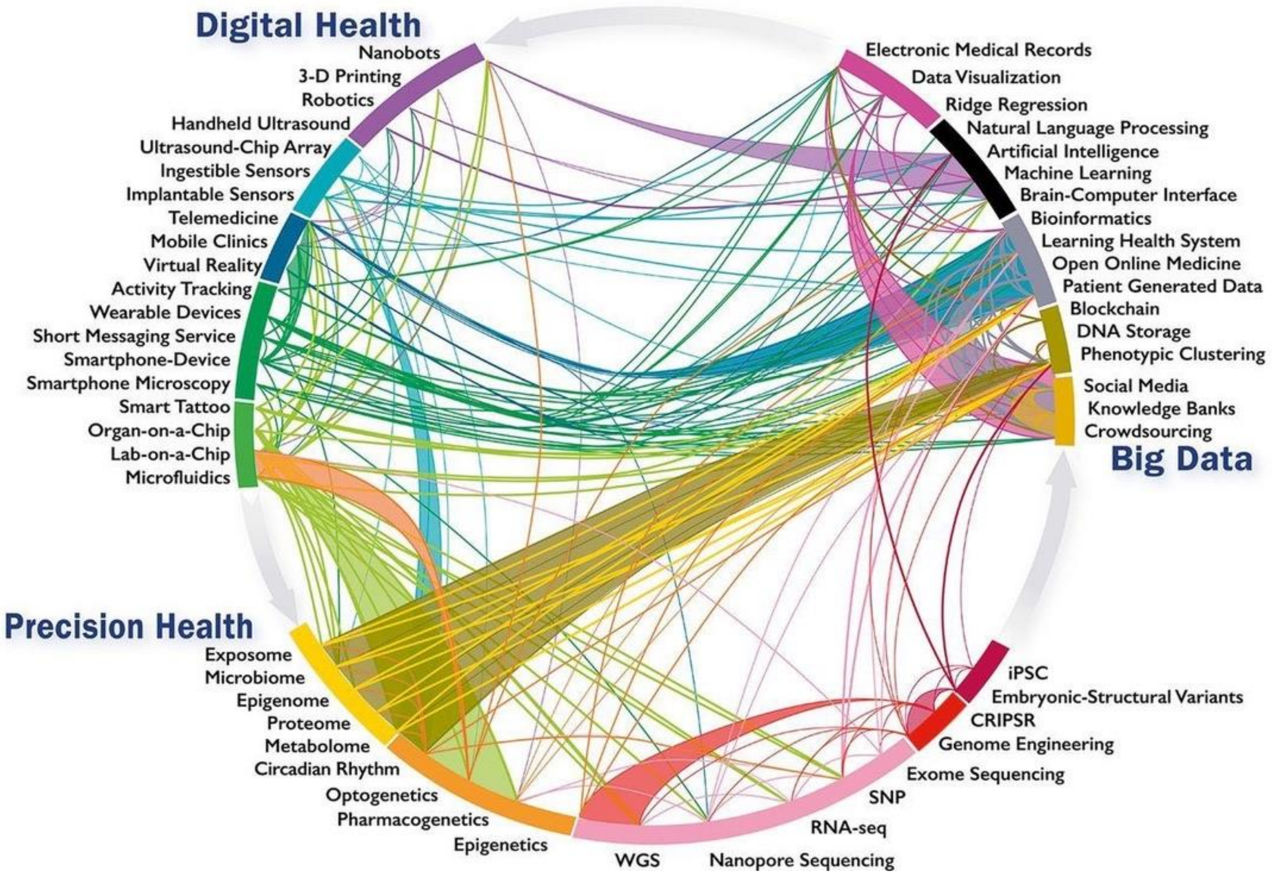
Artificial Intelligence in Use – AI Literacy for All

Scaling up AI in Health Systems

Francisco Lupiáñez-Villanueva - flupianez@open-evidence.com - @flupianez
Open Evidence
Universitat Oberta de Catalunya

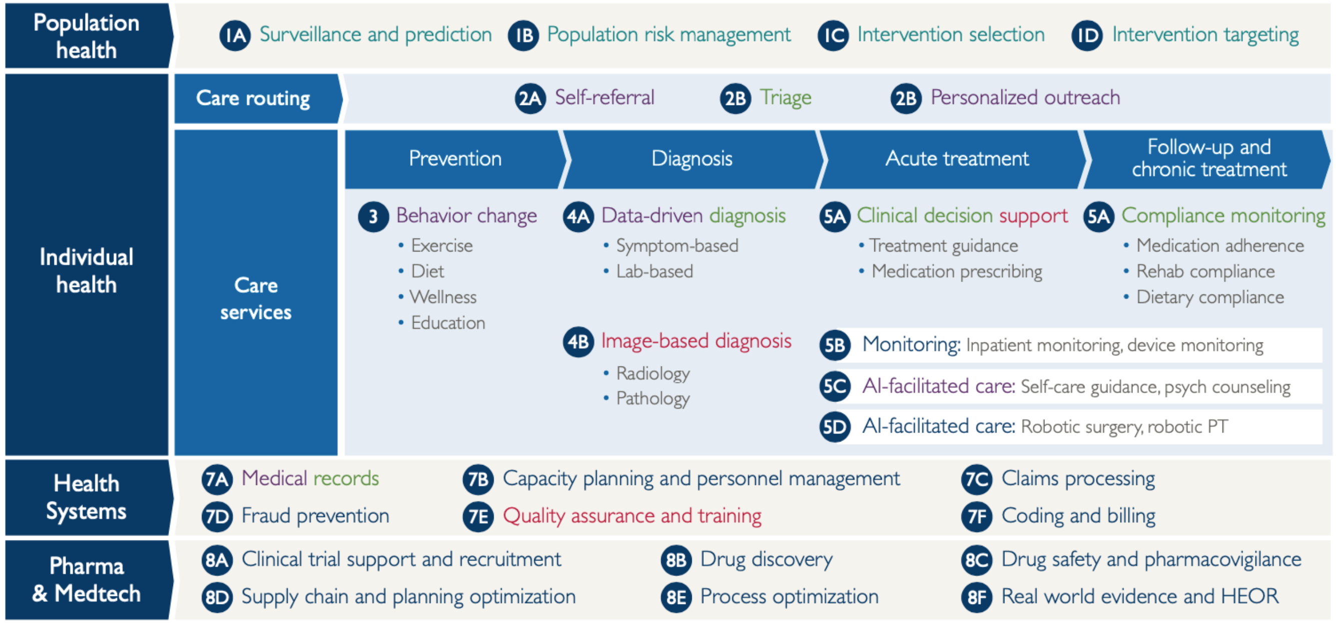
Artificial Intelligence in Use – AI Literacy for All



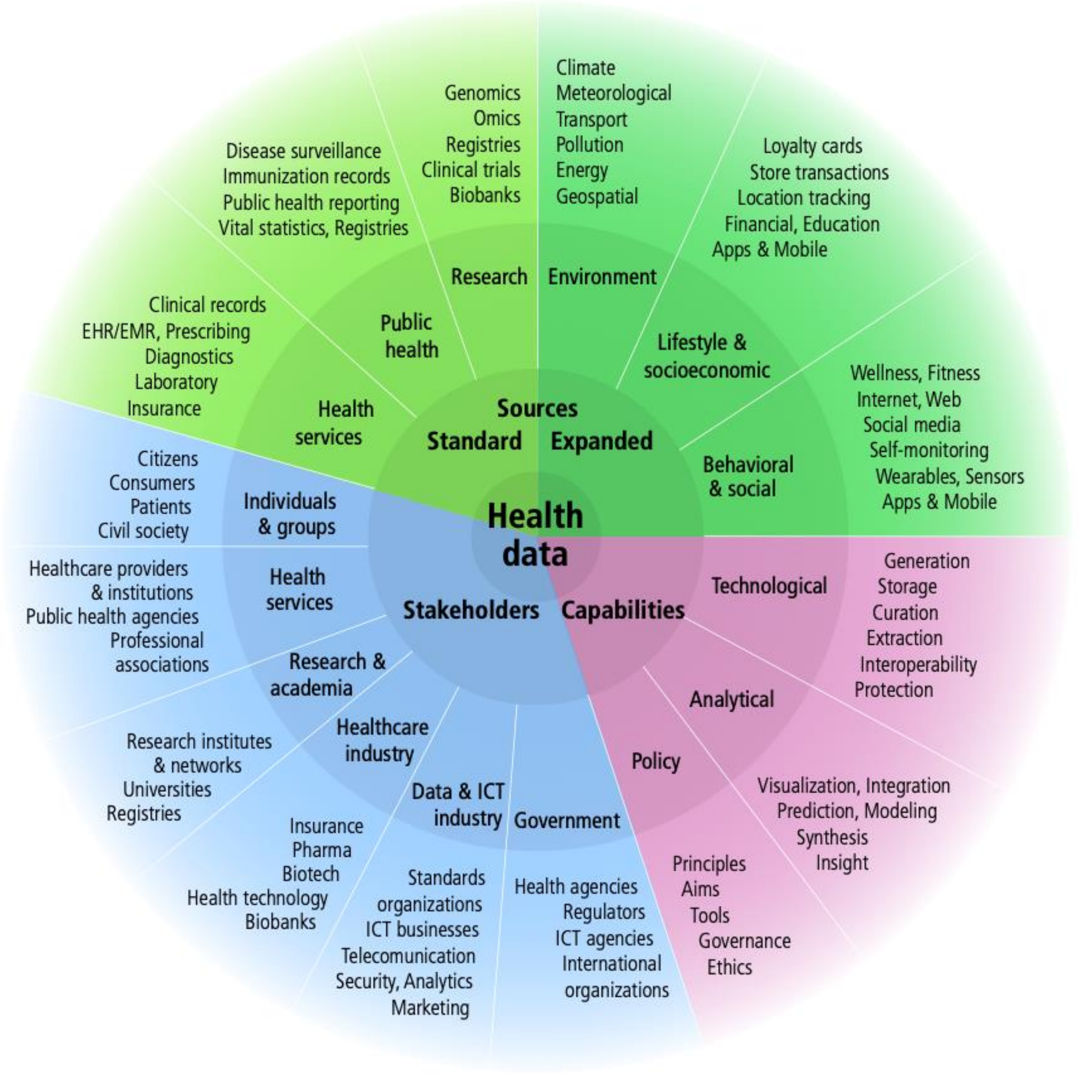


Evolving landscape of AI

OPEN EVIDENCE

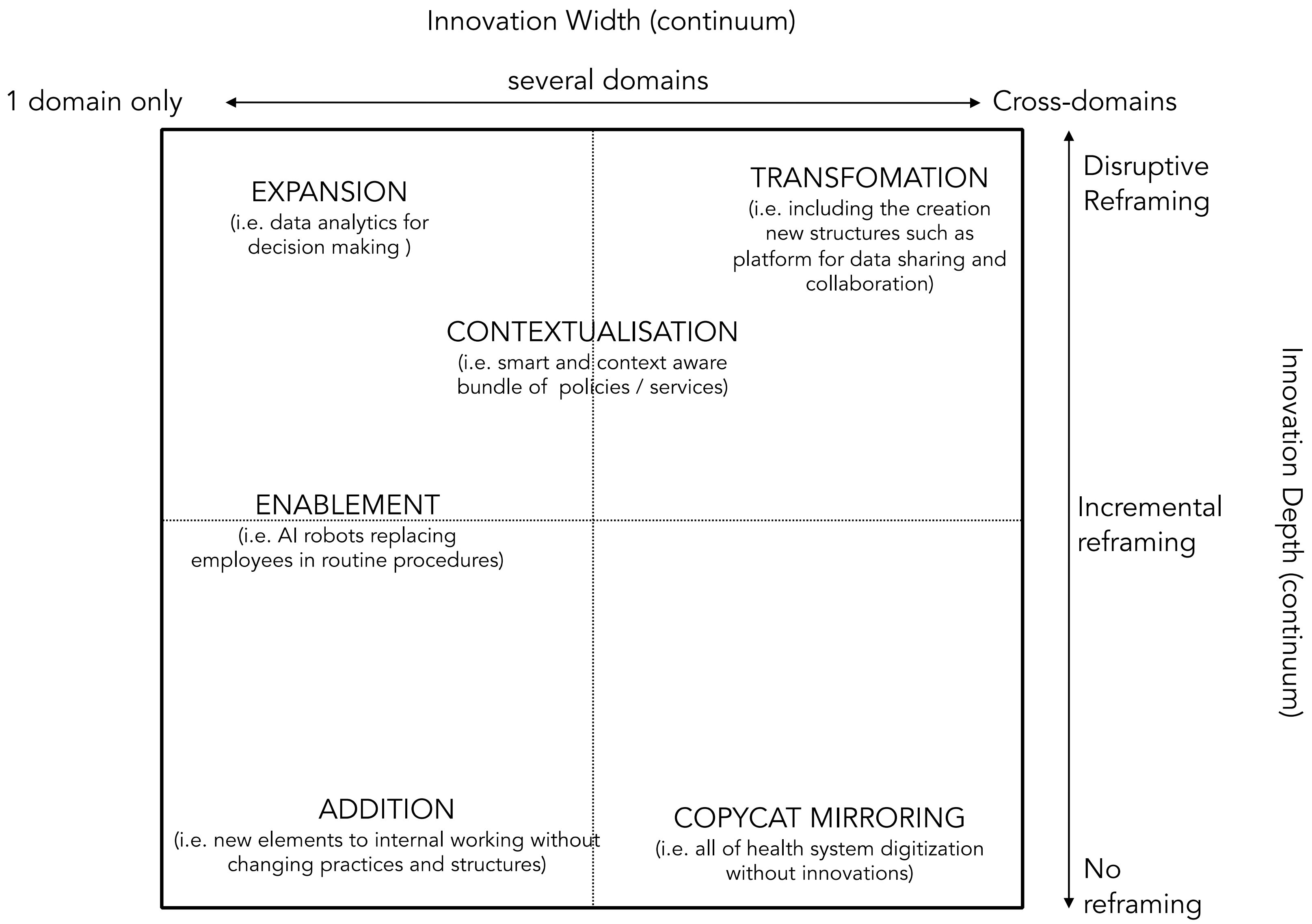


U.S. Agency for International Development



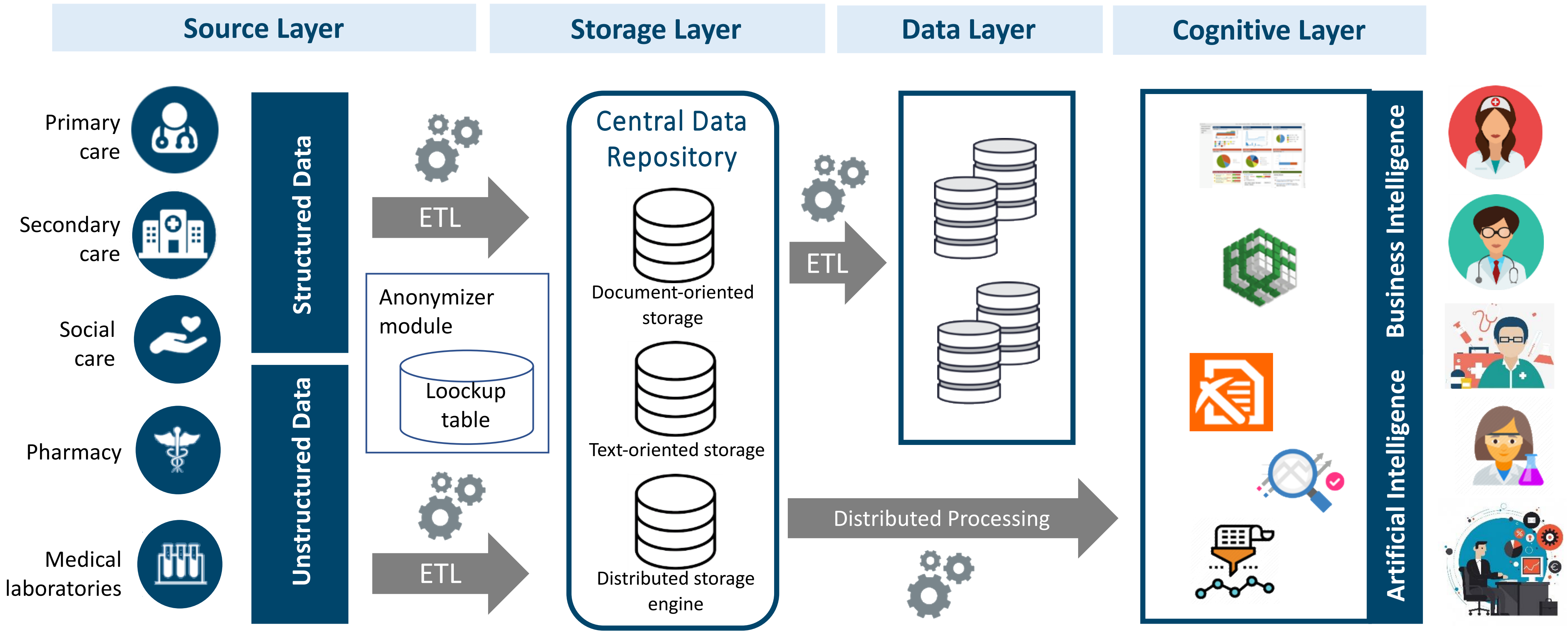
E. Vayena, J. Dzenowagis, M. Langfeld, 2016

How AI innovation can transform health systems and policy-making



Open Evidence, 2019

Solving real problems with Real World Data



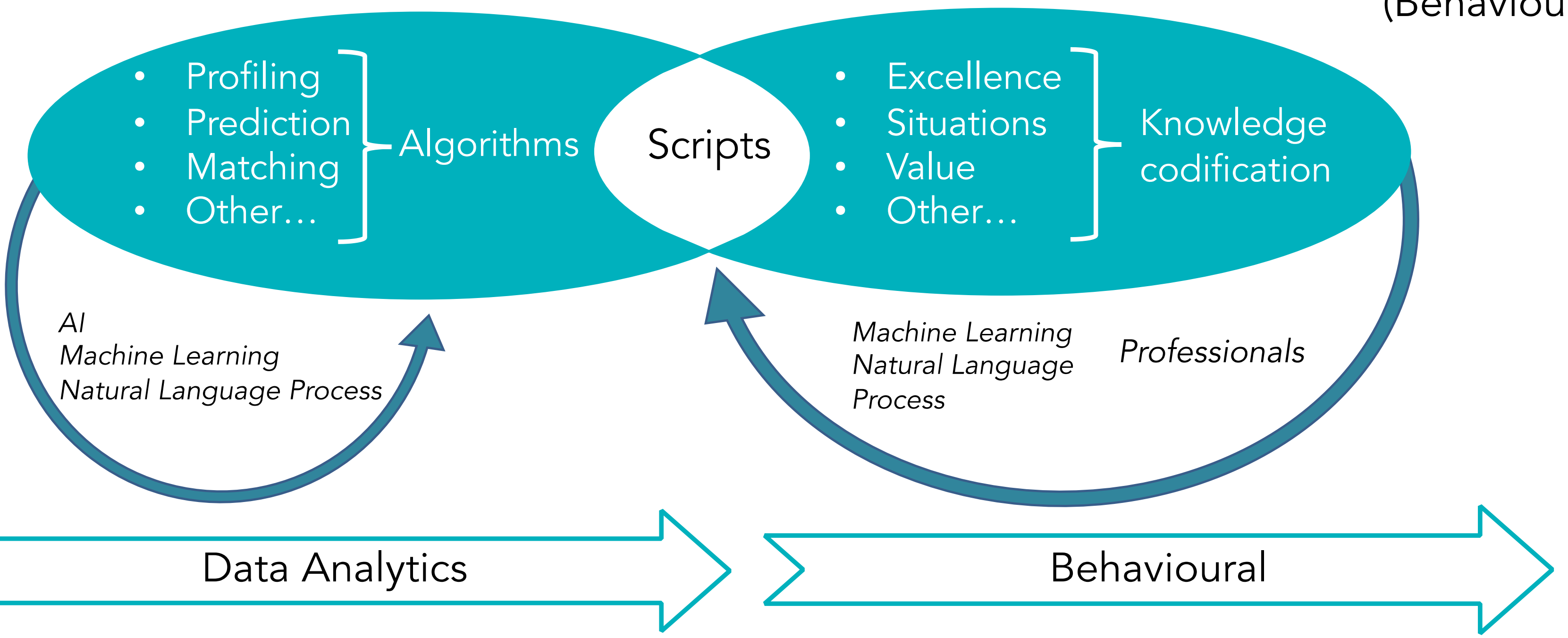
It is not just about AI

Combining a systemic intervention based on advanced data analytics and new scripts and techniques for front-end professionals based on behavioural principles and institutional settings.

System
(Data analytics)

Big data plus behavioural

Organisation
(Behavioural approach)



- Predictive algorithms
- Decision trees
- Improved data infrastructure

- New scripts for front end professionals
- Decision-making
- Transformation

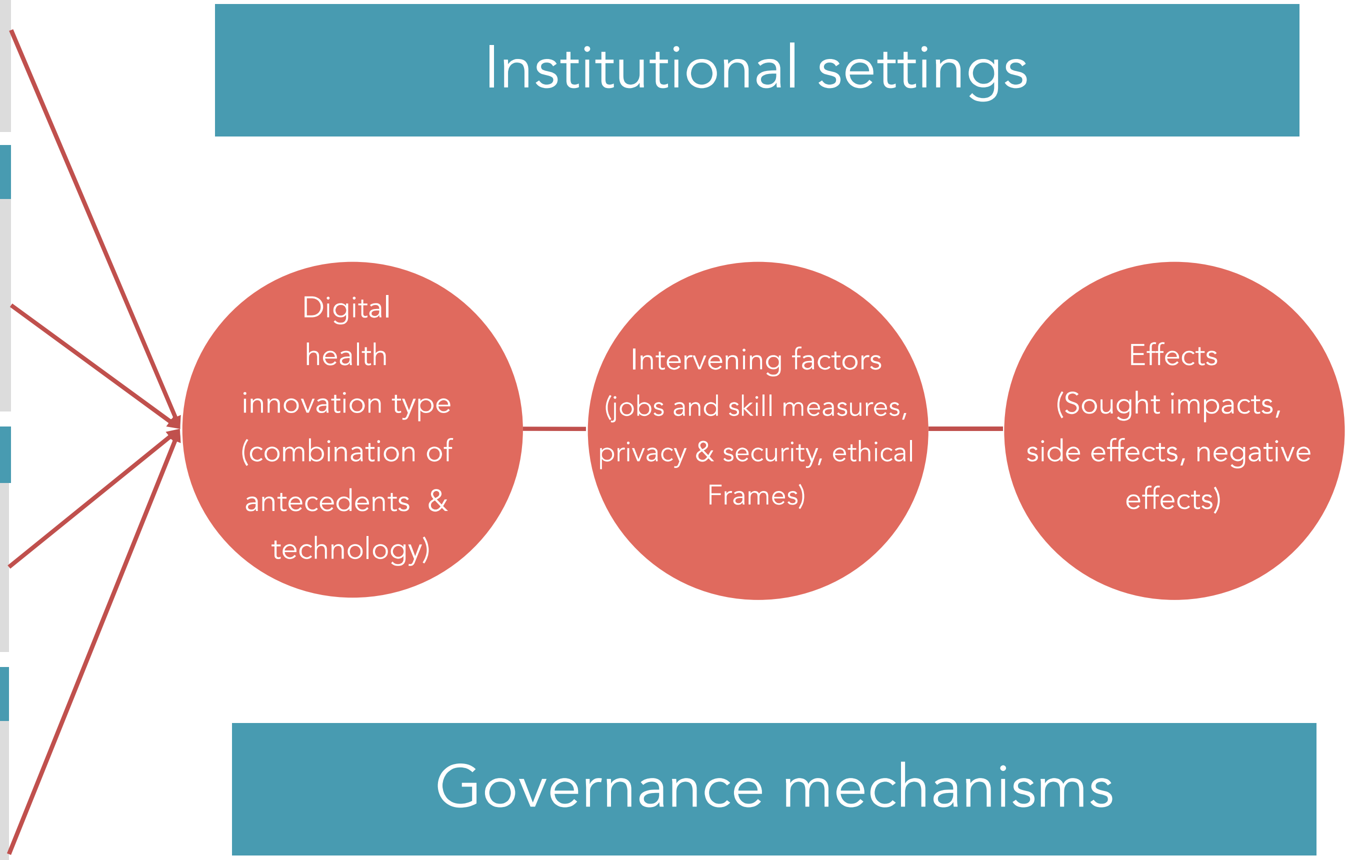
Organisational and institutional settings matter

Environmental level
- Environmental pressure
- Participation in network
- Regulatory aspects
- Compatible agencies adopting the same innovation
- Competition with other organisations

Organisational level
- Slack resources
- Leadership style
- Degree of risk aversion/room for learning
- Incentives/rewards
- Organisational structures

Innovation level
- Ease in use of innovation
- Relative advantage
- Compatibility
- Trialability

Individual level
- Employee autonomy
- Knowledge, skills and creativity
- Demographic aspects
- Commitment and satisfaction with jobs
- Shared perspective and norms
- Innovation acceptance



Open Evidence, 2019

Predicting hospital outpatient attendance

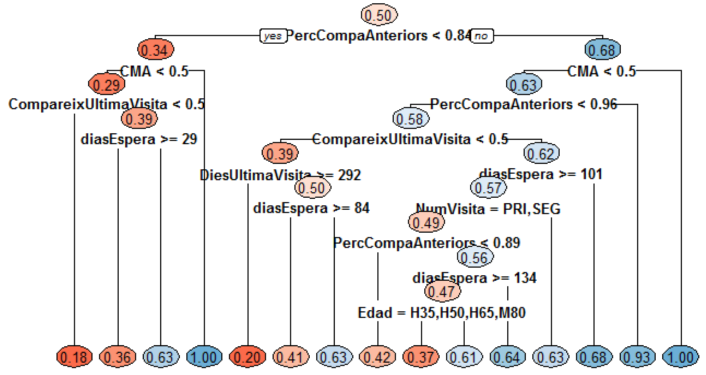
OPEN EVIDENCE

Modelling

- Metric to optimize: Sensitivity (% of correctly identified absent patients from the total of absences)
- Chosen model: Decision Trees
- ML problem to solve: Unbalanced classification
- Stratification strategy: 75% train / 25% test
- Parameter optimization: 5-fold cross validation (complexity factor and max depth of the tree)
- Predictor variables:
  - Socio-demographic (5): Age, sex, nation, …
  - Medical appointment (8): Date, time, doctor, treatment, type, …
  - Historical (4): Number of past appointments, % of absence, …

Dermatology

- Accuracy: 73.49%
- Sensitivity: 79.90%
- Prospective validation: 123/157 absences correctly predicted (78.34%)



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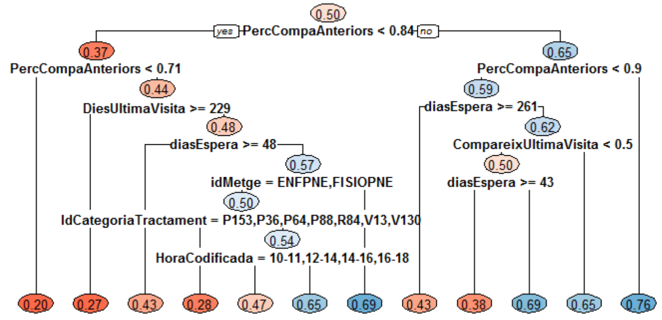
Pneumology

- Accuracy: 64.61%
- Sensitivity: 71.38%
- Prospective validation: 81/116 absences correctly predicted (69.83%)



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Piloting hospital outpatient attendance

OPEN EVIDENCE

Set up:

- Time interval: 8 weeks
- Population: 2537 medical appointments (1702 DER, 835 PNE)
- Type of pilot study: Intervention VS Control

Approach:

1. Extract all the medical appointments for the next week
2. Transform the variables to adapt them to the ML model
3. Execute the model and obtain the patients that won't come to the appointment. Split in control and intervention, stratification by age and sex.
4. Call each patient from the intervention group to remind the appointment.

Metric	Dermatology	Pneumology	Total
Located patients (intervention)	69%	68%	69%
Absence intervention	13.42%	16.49%	14.38%
Absence intervention (located)	6.69%	11.90%	8.29%
Absence intervention (not located)	27.82%	25.81%	27.18%
Absence control	26.38%	23.41%	25.43%
Absence	17.27%	15.89%	16.75%
Absence (Historical)	20.81%	18.12%	19.87%

Badalona Serveis Assistencials

From reports to actionable knowledge

OPEN EVIDENCE

Manual review of Anatomical Pathology (AP) reports and recording of the findings.

- TNM
- FIGO
- GLEASON
- ESTROGEN
- PROGESTERON
- HER – protooncogén
- CK19
- ECADHERINA
- FENLUM
- NOTTINGHAN
- KI67
- P53

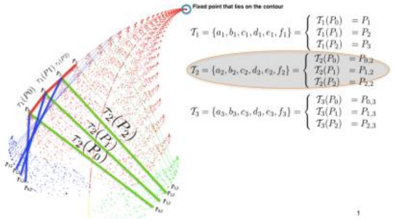
Dataset with 14,188 manually annotated reports.

75% of the samples are used to adjust the models and the extraction rules.

The parameters and rules of the extraction model are adjusted with the training samples.

The trained model and the results of the training set are obtained.

25% of the samples are stored in a *drawer*.



The model is applied on the test set to obtain the final extraction metrics.

ICO Institut Català d'Oncologia

Pla director d'oncologia

Focused Natural Language Processing

OPEN EVIDENCE

Próstata, RTU: - Adenocarcinoma acinar prostático incidental, con grado de Gleason: 7, patron combinado: 3+4, que afecta 5% de la muestra. (pT1a) - Hiperplasia nodular muscular y glandular benigna (33,4 g).

Pròstata (lóbulo derecho, biopsias múltiples): - ADENOCARCINOMA INFILTRANTE, GRADO DE DIFERENCIACIÓN DE GLESON COMBINADO 4+3= 7/10.

A) MUESTRA NO REMITIDA.B) "VEJIGA" (BMN): FRAGMENTOS DE PARED VESICAL EN LOS LÍMITES DE LA NORMALIDAD. AUSENCIA DE MALIGNIDAD EN LOS CORTES EXAMINADOS.C) ""FRAGMENTOS DE RESECCIÓN TRANSURETRAL DE TUMOR VESICAL"INFILTRACIÓN DE PARED VESICAL POR ADENOCARCINOMA DE ORIGEN PROSTÁTICO (positividad inmunohistoquímica para PSA y negatividad para GATA-3 y UROPLAKINA), GLEASON 9 (4+5).

A/ Pròstata, lòbul dret, biòpsies per punció:- ADENOCARCINOMA PROSTÀTIC ACINAR, GRUP DE GRAU 1/5 (ISUP 2014, OMS 2016) (GLEASON 3+3), AFECTANT MENYS DE 5% DEL TEIXIT (EN DOS DE SIS CILINDRES, SENSE INVASIÓ PERINEURAL).B/ Pròstata, lòbul esquerre, biòpsies per punció:- ADENOCARCINOMA PROSTÀTIC ACINAR, GRUP DE GRAU 1/5 (ISUP 2014, OMS 2016) (GLEASON 3+3), AFECTANT MENYS DE 5% DEL TEIXIT (EN DOS DE SIS CILINDRES, SENSE INVASIÓ PERINEURAL).

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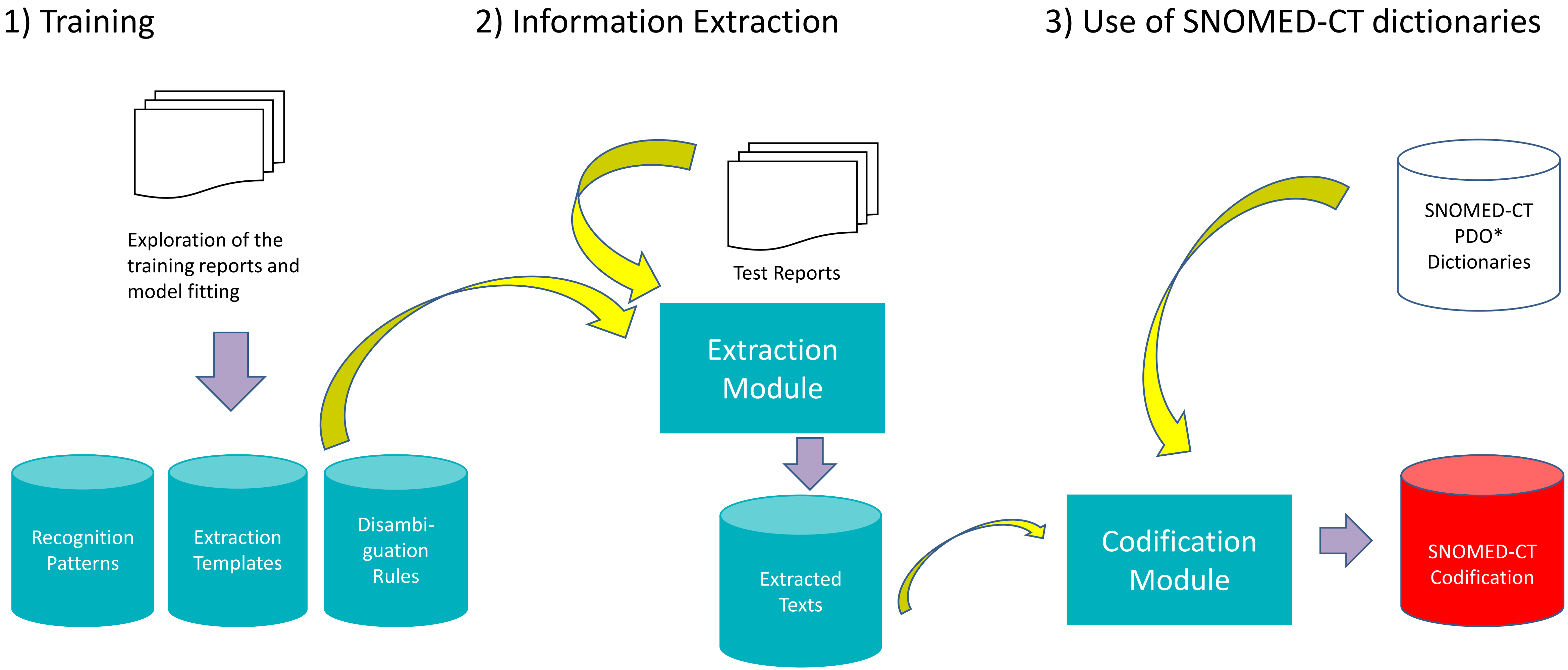
Pla director d'oncologia

Using interoperability and standards



* PDO: *Plan Director de Oncología* (Director of Oncology Plan)

Tested and transparent results

OPEN EVIDENCE

$$\text{Precision} = \frac{tp}{tp + fp}$$

$$\text{Recall} = \frac{tp}{tp + fn}$$

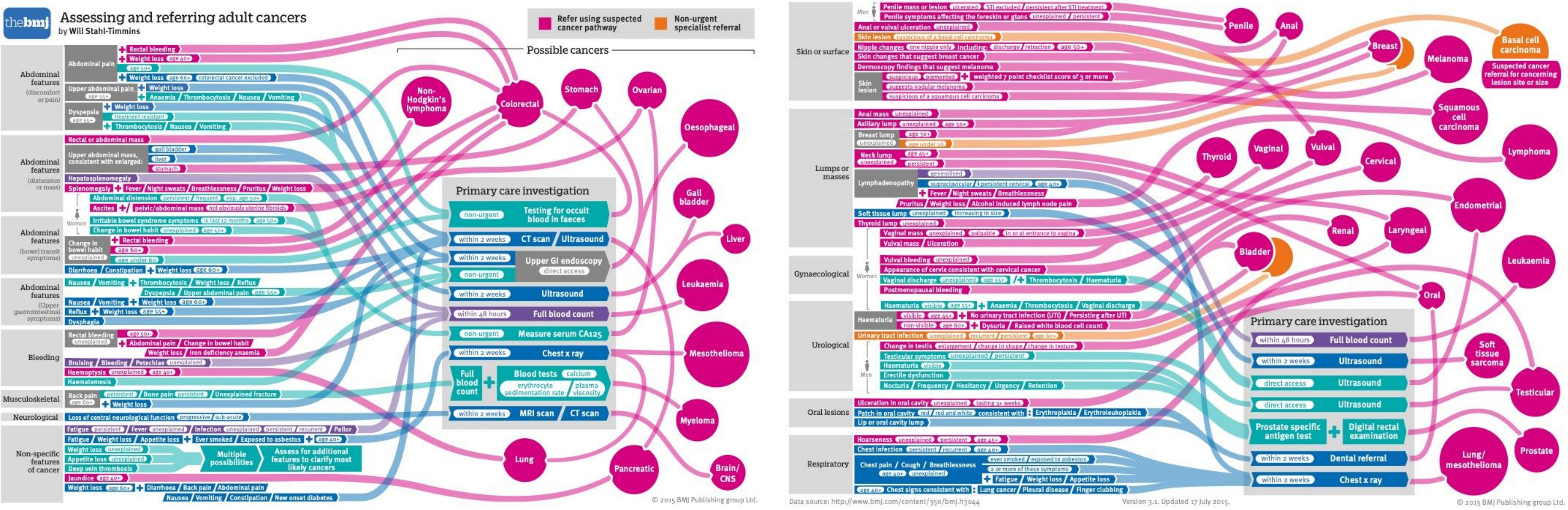
$$F_1 = \frac{2}{\frac{1}{\text{recall}} + \frac{1}{\text{precision}}} = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}.$$

Indicator	Dataset	No. of Reports	No. of Abbreviations	Recall	Precision	F1-Score
TNM	Train	10.647	4.948	95,29	99,01	97,10
TNM	Test	3.550	1.597	95,24	98,83	97,00
Gleason	Train	10.647	896	98,32	100	99,15
Gleason	Test	3.550	318	98,43	100	99,21
Figo	Train	10.647	182	93,53	100	96,66
Figo	Test	3.550	52	94,34	98,04	96,15

From AI and RWD to Value based care

OPEN EVIDENCE

New information extraction templates (Biomarkers, genomic indicators, molecular concentrations, etc.) and **data linkage**



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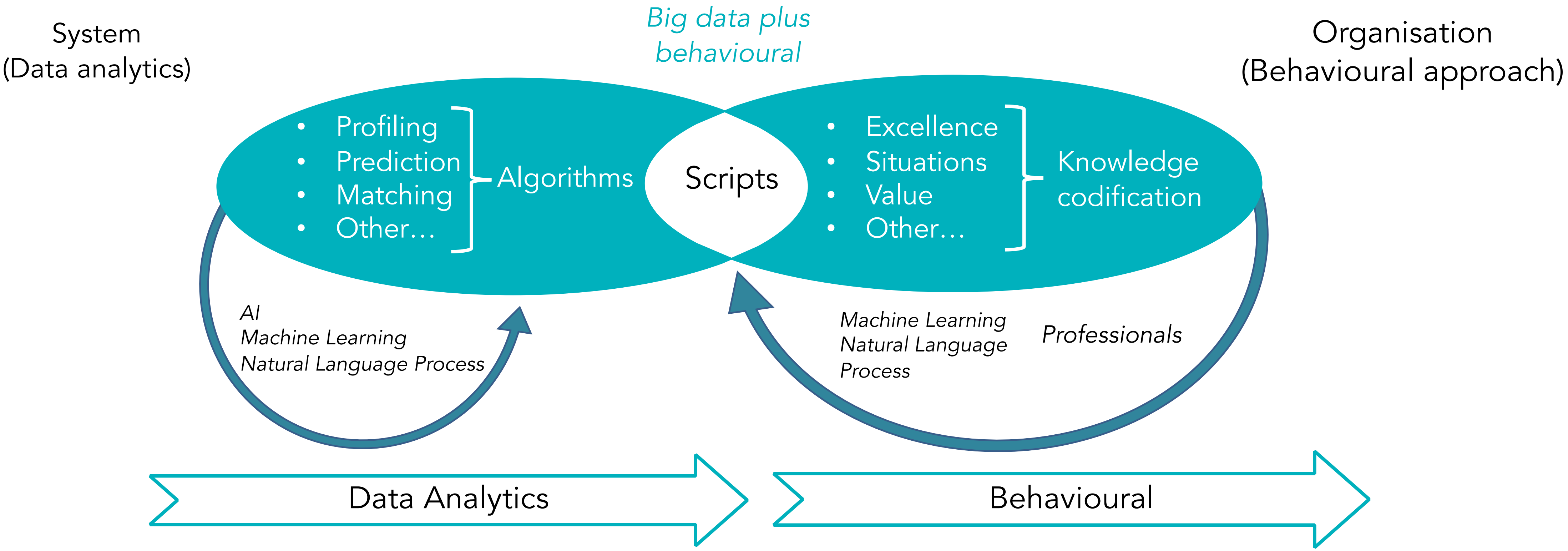

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Thank you!

Francisco Lupiáñez-Villanueva - flupianez@open-evidence.com - @flupianez
Open Evidence
Universitat Oberta de Catalunya

Assuta Medical Centers

Raising Health Standard

General Background

- The State of Israel has developed one of the world's leading healthcare systems, delivering cutting-edge medical care to its citizens
- Assuta network is Israel's largest and leading chain of private hospitals and medical centers owned by Maccabi Healthcare Services Israel's 2nd largest H.M.O.

Working in Assuta:

- Around 4,000 Employees
- **Around 2,000 Specialist Doctors**

Operating Theater - Types of Surgeries

Major procedures

Cardio-Thoracic (incl. TAVI); Neurosurgery / Spine; Robotic Surgery: Complex Abdominal Surgery; Bariatric Surgery; Joint Replacement; Urology, Gynecology; Head & Neck surgeries- new approach…

Medium procedures

Mastectomies; Laparoscopies; Arthroscopies; Plastic surgery, E.N.T; Ophtalmology…

Minor procedures

Biopsies; Hernia; Excisions…

Leading in
Information Technologies

A comprehensive and integrative approach

EMR - Electronic Medical Record

LIS - Laboratory Information System

RIS - Radiology Information System & PACS

ERP - Administrative missions

CRM - Customer Relationship Management

Assuta T Tel Aviv Hospital

Assuta’s flagship hospital in Tel Aviv

a standard of medical excellence

Assuta Tel Aviv Hospital Operating Theatres and Intensive Care Unit

- More than 42,000 surgical procedures annually
- 19 operating rooms, 230 hospital beds for surgical care
- 14 ICU beds in a large spacious unit, with physical separation between them
- Isolation rooms inside the unit
- Advanced monitoring system

The challenge –Optimizing the work flow in the Operating theatre complex

- Scheduling – uneven utilization
- From the doctor to hospital staff to the schedule – human error
- Every hour that an operating room stands idle
  - Financial loss
  - Unnecessary queues
  - Wasted time for patients and families
  - Wasted time for surgeons and OR staff

The Solution - AI to the Rescue

Razor-Labs provides AI products and innovation to solve complex business and operational challenges.

Razor Labs is a trusted partner of organizations in their journey to the future by helping them maximizing **ROI from AI.**

2016 Year Founded | **70+** Employees | **55+** Projects Completed

The Problem

over 150 surgeries/day

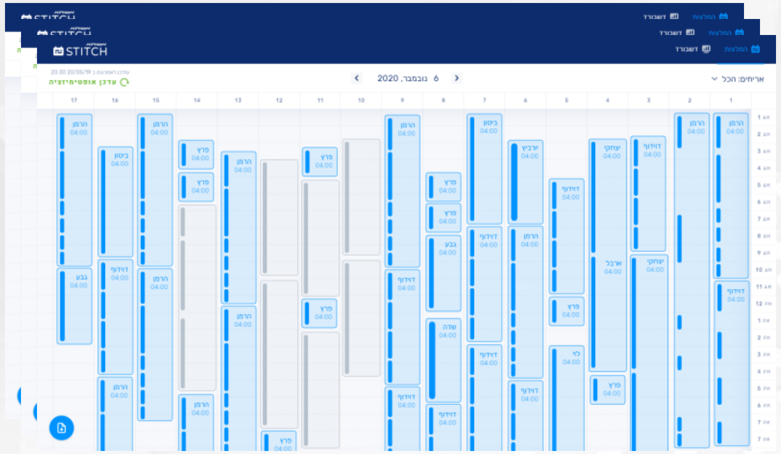
Restrictions & Limitations

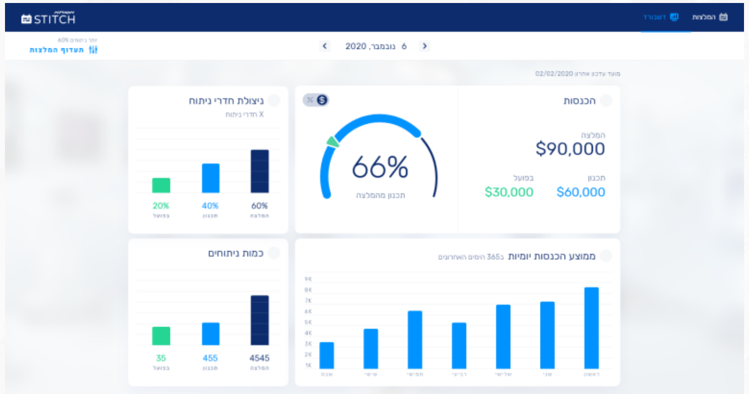
10 days simultaneous

scheduling

Constant changes

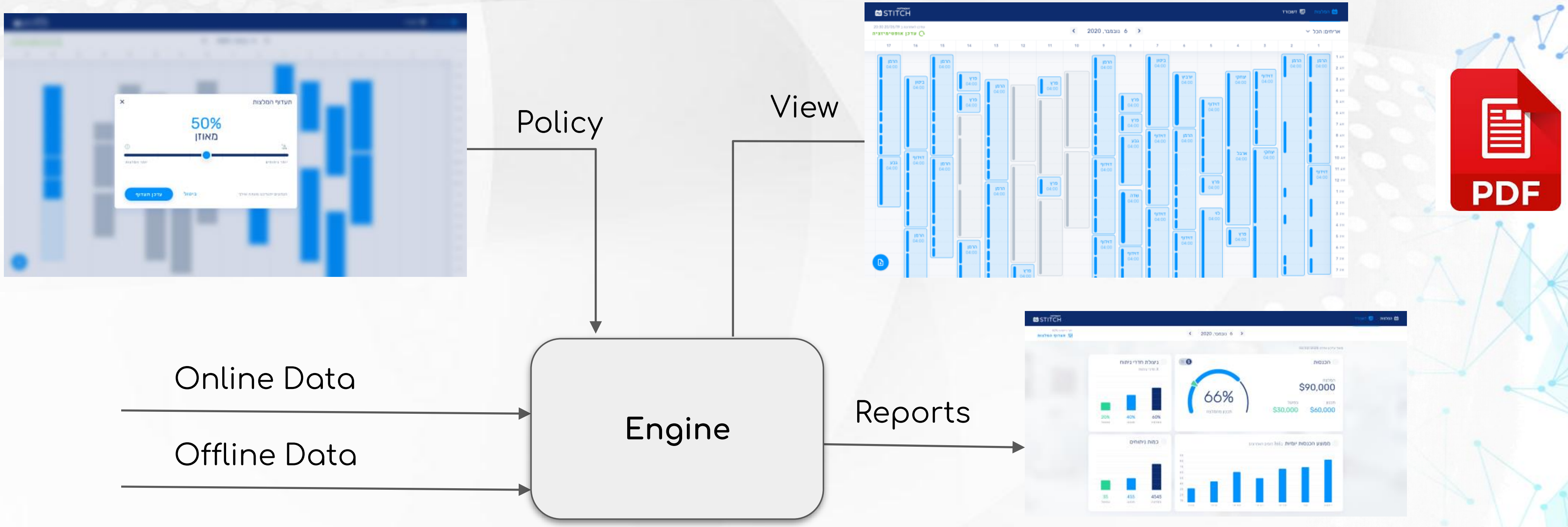
The Solution - AI to the Rescue





razorlabs

The Solution



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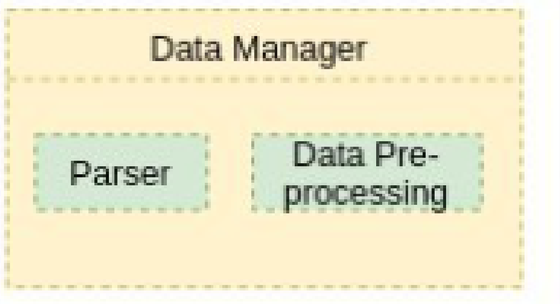
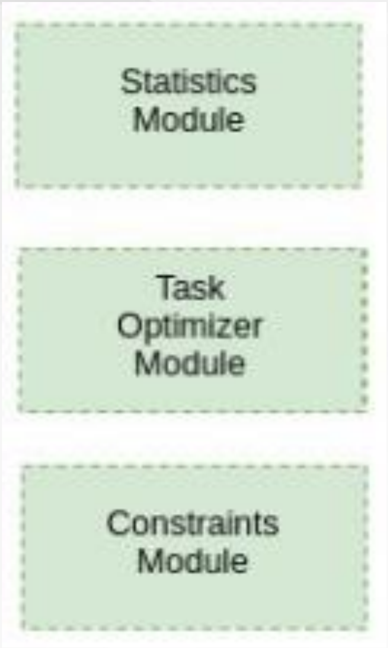
The Solution





- Input data

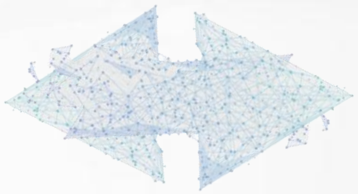
- Data analysis
- Modular 'brain'

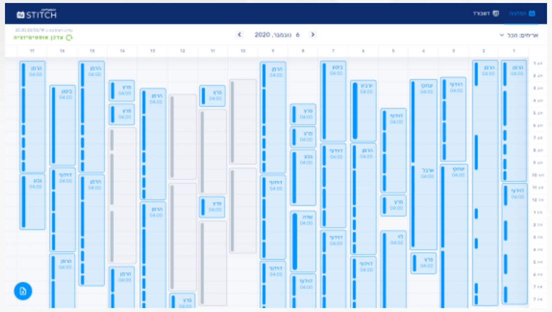
- Outputs

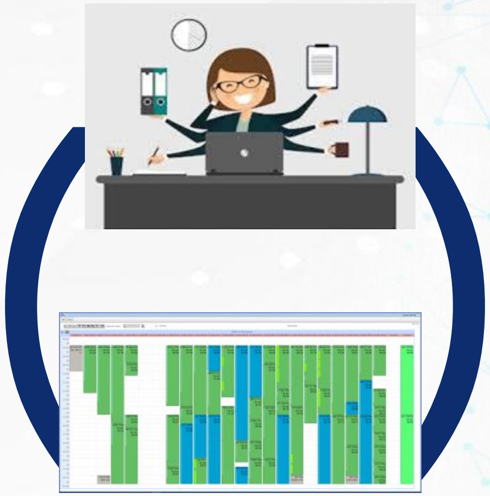
The Solution - Data

- 10 years of historical data from legacy system
  - Surgeries
  - Patients
  - Doctors
  - Pricing
  - Resources
  - Planned vs. actual
- List of restrictions and constraints
  - Equipment
  - Procedures
  - Doctors
  - Staff skills
  - Rooms

The Vision - Fully Automated AI Optimization







razorlabs

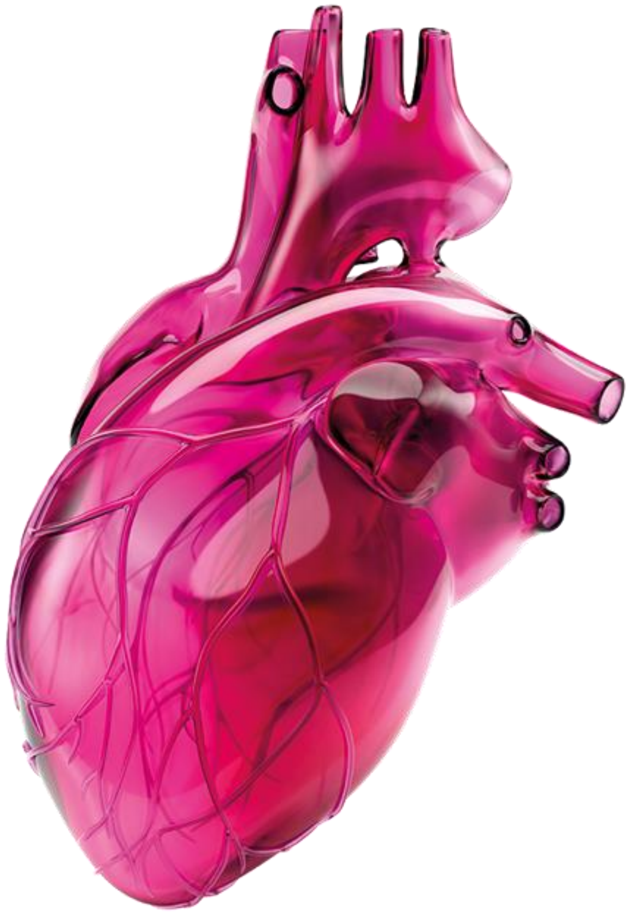
THANK YOU

IMAGING IN CLINICAL TRIALS

at Deutsches Zentrum für Herz-Kreislaufforschung e.V.

Barcelona, November 2019

WHO IS DZHK

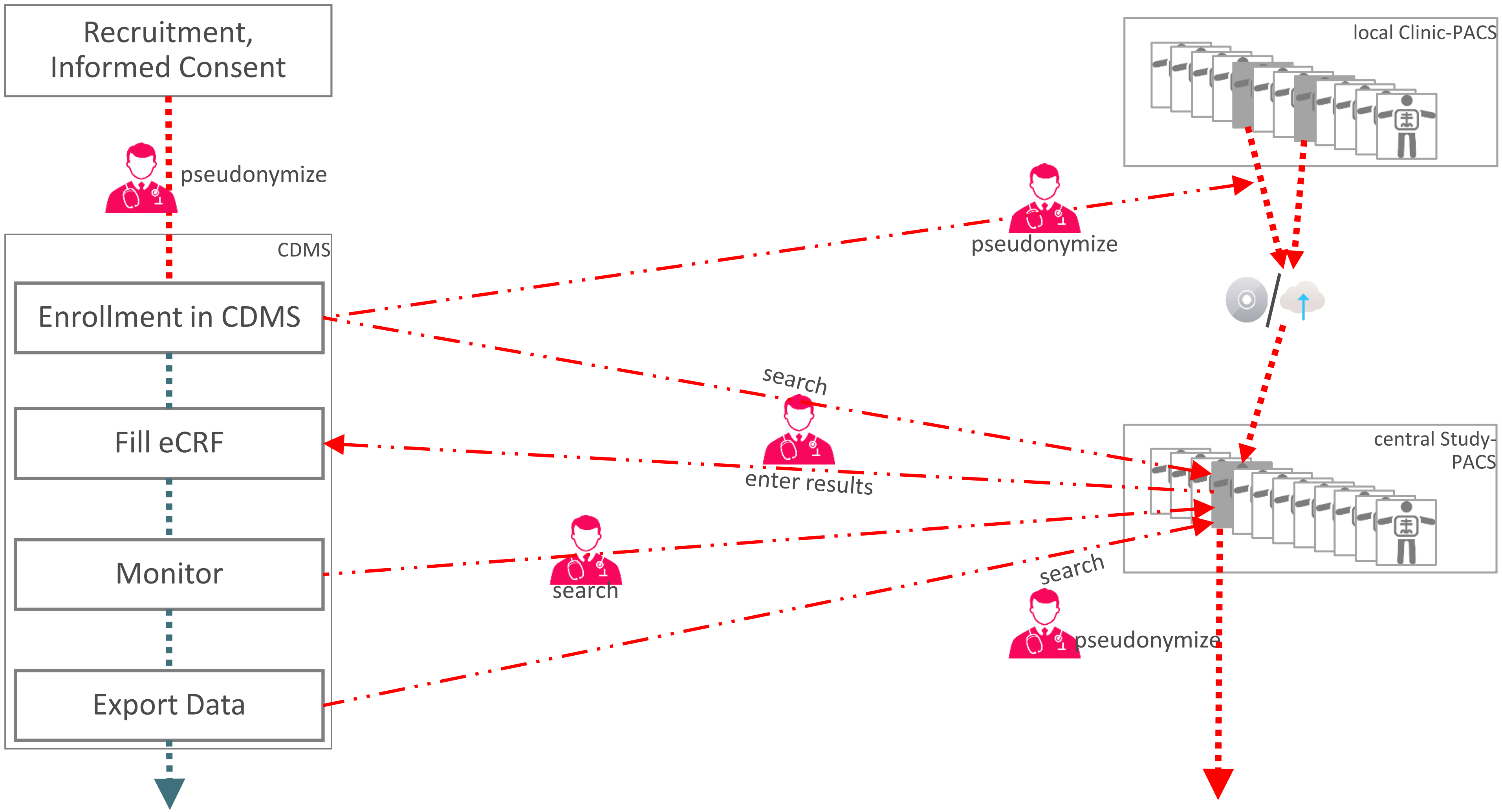


Deutsches Zentrum für Herz-Kreislauf-Forschung eV

- ✓ Established in 2012 by German Federal Ministry of Education and Research
- ✓ Governmentally funded Organization, 40 m€ per Year
- ✓ 32 Members, mostly German University Hospitals, among these (Charité, Heidelberg, LMU Munich,UKE Hamburg)
- ✓ Fosters cooperation in basic and clinical research
- ✓ Translation cardiovascular research into better patient care
- ✓ Currently 16 Investigator Initiated Clinical Trials (IICT)
- ✓ Over 100 Study Sites involved

DZHK
DEUTSCHES ZENTRUM FÜR
HERZ-KREISLAUF-FORSCHUNG E.V.

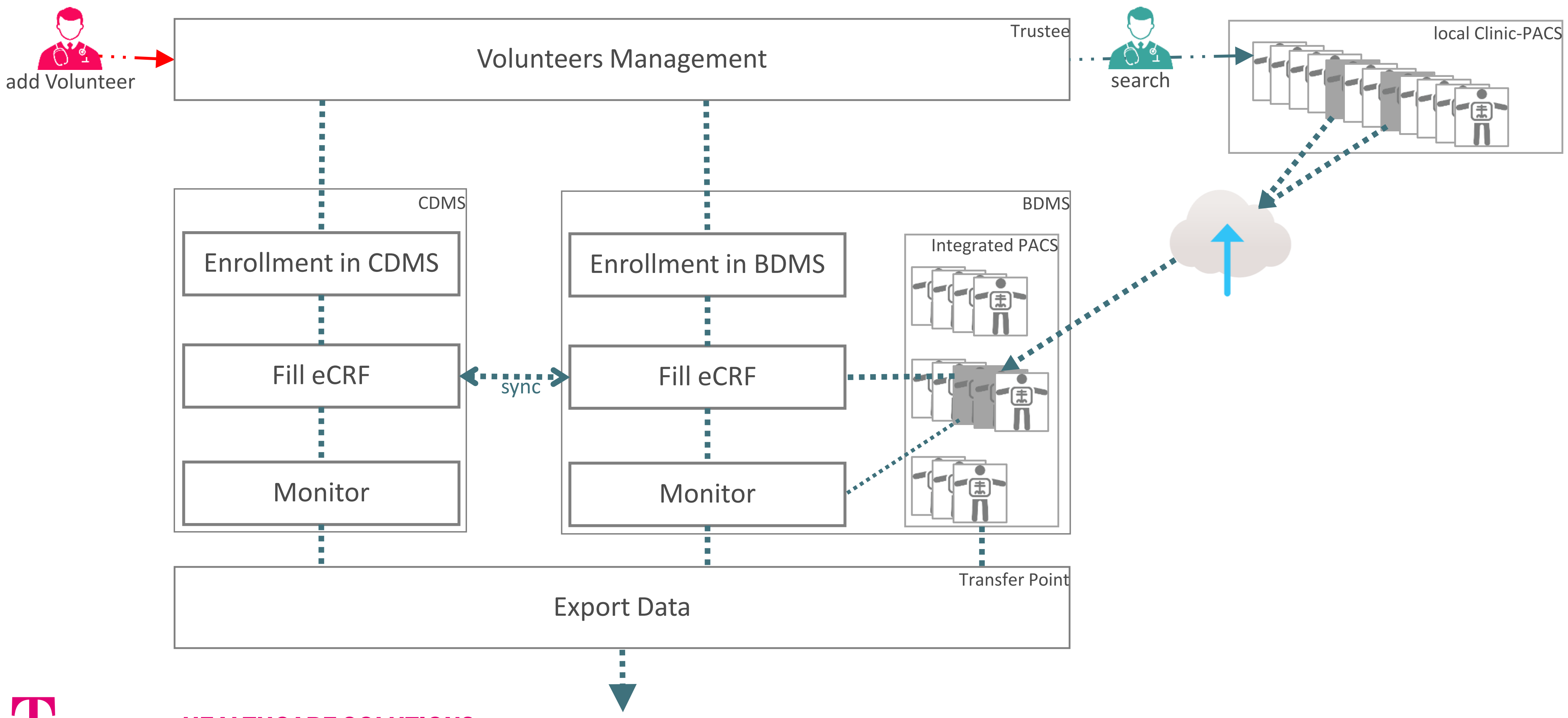
TYPICAL WORFLOW: SEPARATE DOCUMENT HANDLING



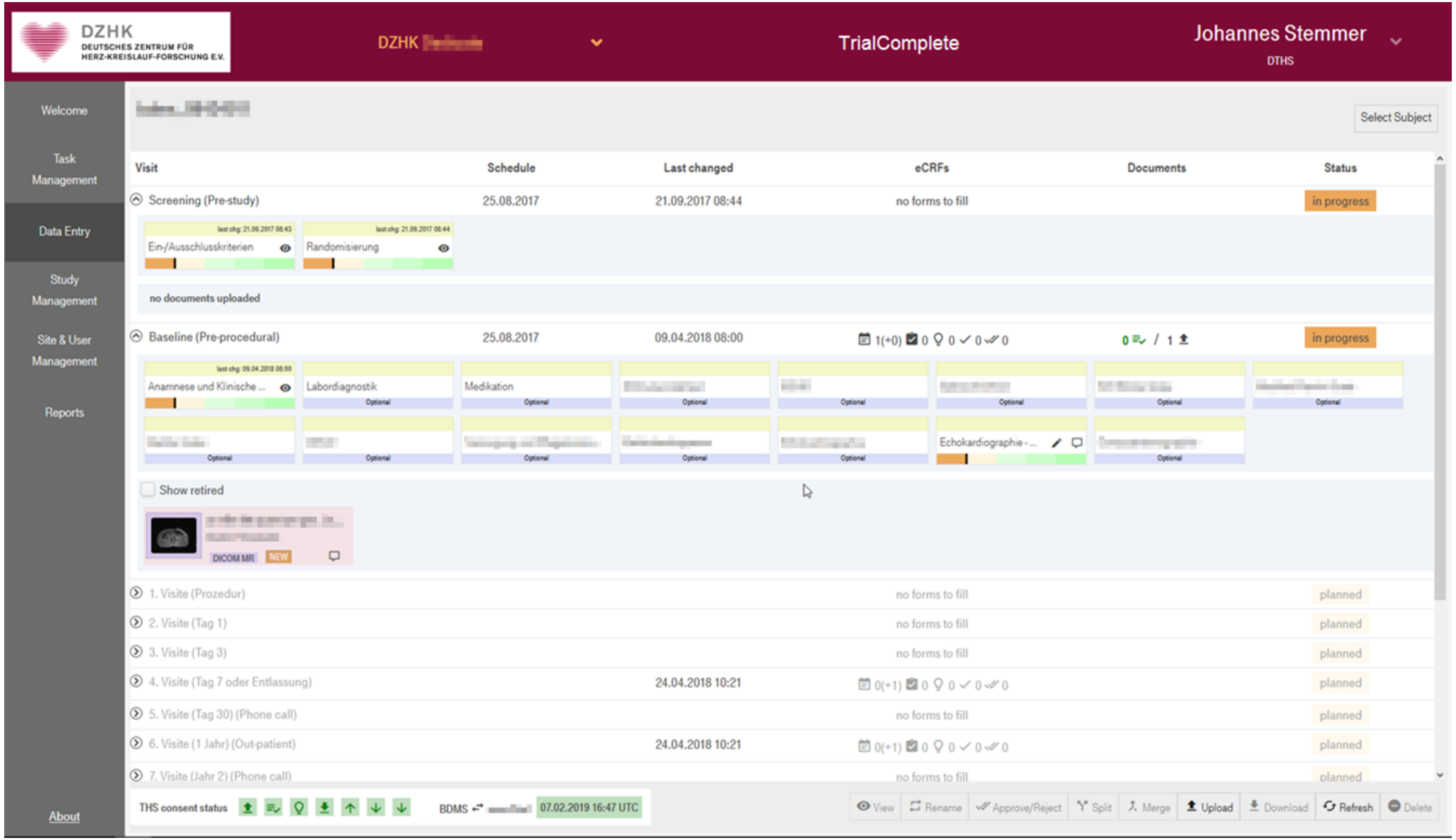
OBJECTIVES FOR IMPLEMENTATION OF BDMS
(„BILDDATENMANAGEMENT“ - IMAGE PROCESSING CDMS)

- Integration of documents into managed process of data provision for re-use
- Integration without media disruption
- Appropriate role/rights concept
- Fully synchronized integration into DZHK ecosystem
- Documented/reproduceable document handling workflow
- High level of Data Privacy, according to TMF e.V. Data Privacy Concept
  - ✓ Integrated concept for consent management according to GDPR
  - ✓ Pseudonymization – separated from clinical data
  - ✓ Individual pseudonyms per system
  - ✓ Appropriate procedures for subject withdrawal
  - ✓ Integrated data sharing re-pseudonymization procedures

DZHK WORKFLOW: INTEGRATED DOCUMENT HANDLING



IMPRESSION OF ESTABLISHED SYSTEM



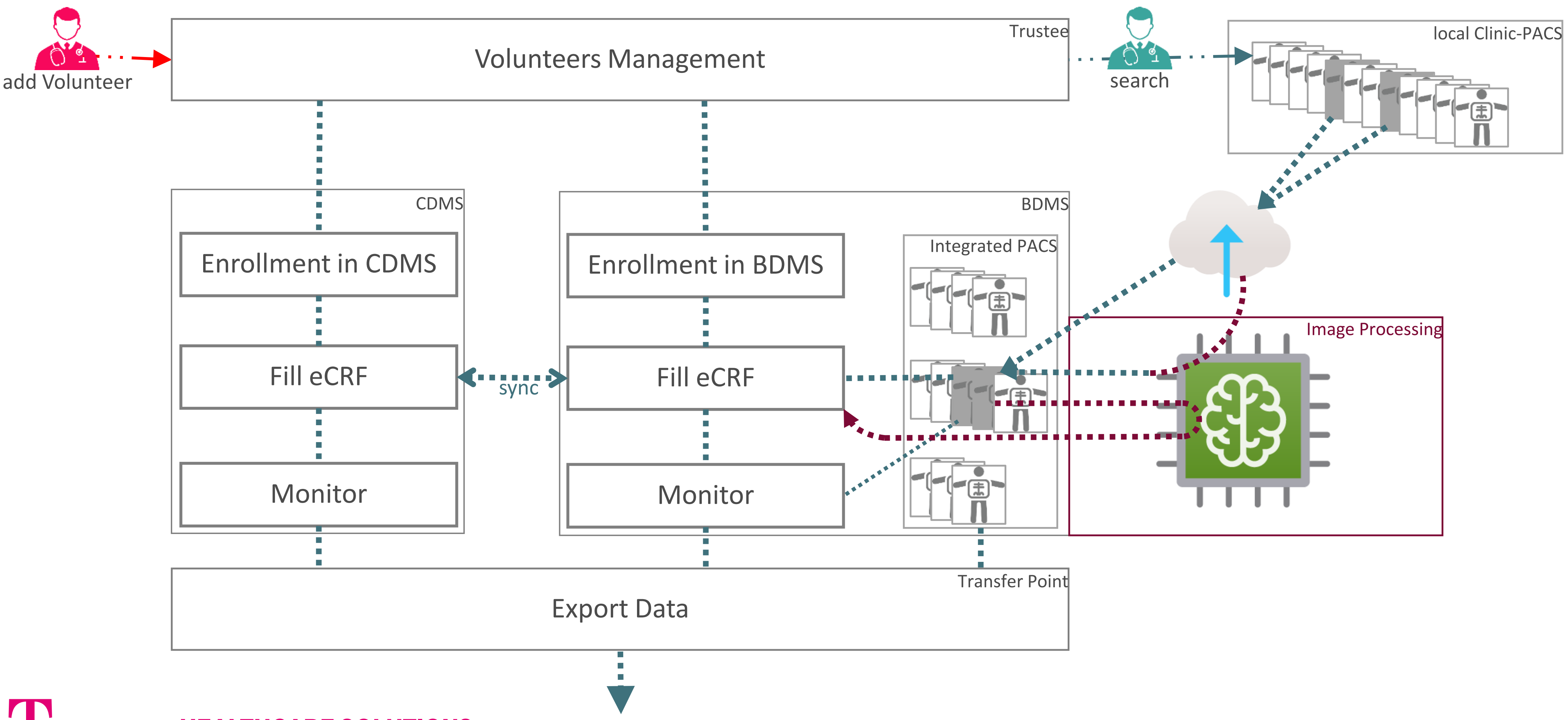
IMPLEMENTATION OF INTEGRATED DOCUMENT HANDLING: LESSONS LEARNED

- Performance: Data Privacy cost Time
  - ✓ Periodic Background Synchronization
  - ✓ Precautionary token generation

- Synchronization: Standardization helps
  - ✓ Synch with non-imaging CDMS based on CDISC ODM
  - ✓ Still, SOP‘s needed to adjust divergent operative principles

- Automatization, responsibility, sequencing of procedures:
  - ✓ Subject Merge and Withdrawal driven by Trustee: sequenced procedures, such as block Interfaces, assign ToDo‘s, coordinate Responses
  - ✓ Export Data driven by Transfer Point: sequenced procedures, such as re-use request, identification of appropriate data, coordinated release decision

NEXT STEPS: IMAGE PROCESSING WITH AI



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