AI in Healthcare and Lifesciences

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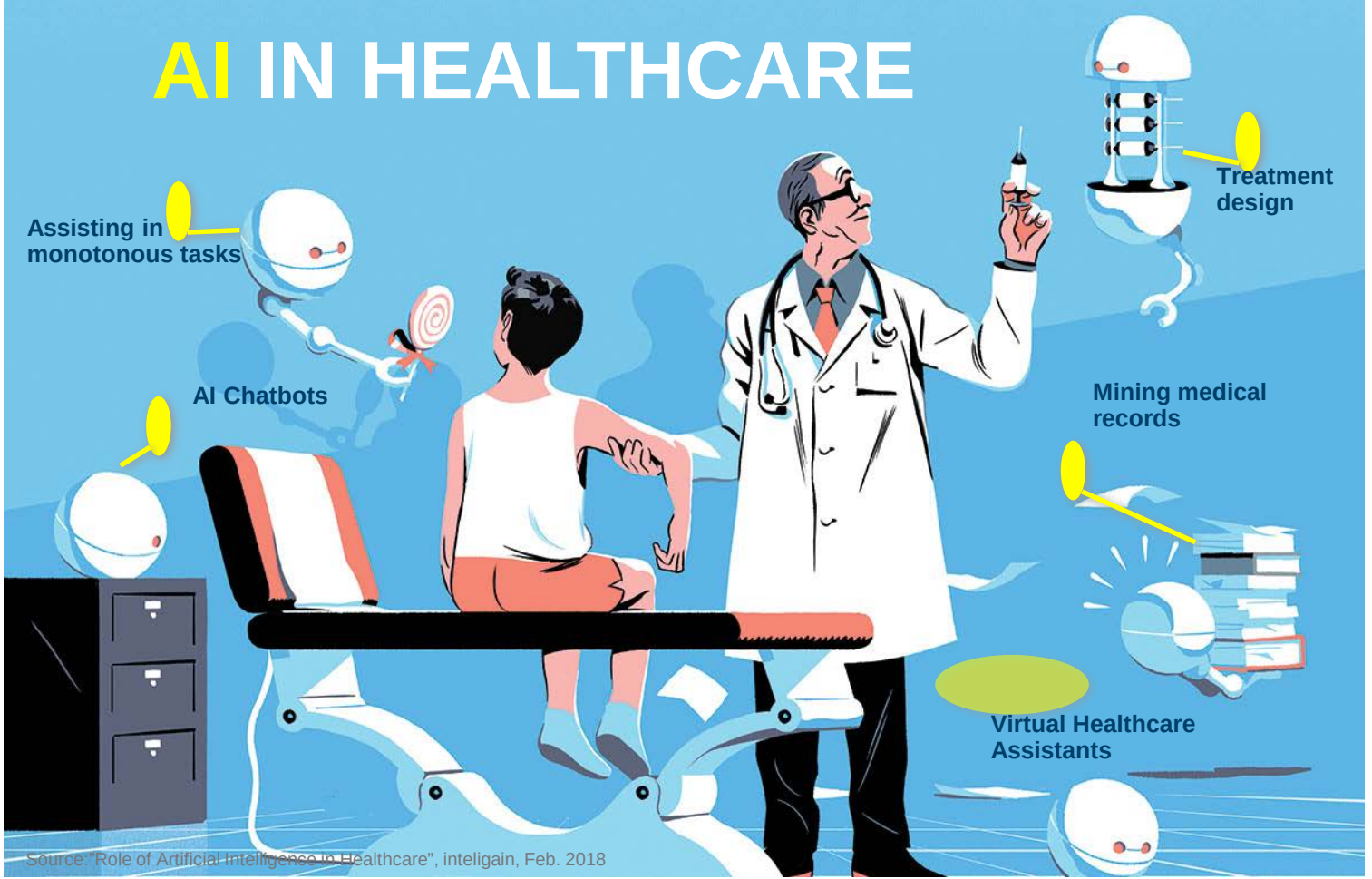
Swiss Medtech Day/ June 6th, 2019

AI IN HEALTHCARE



Source: "Role of Artificial Intelligence in Healthcare", inteligain, Feb. 2018

Role of AI in Healthcare and Lifesciences: expected impact

$6.6 Billion by 2021

the marker for AI in Healthcare (1)

$150 Billion by 2026

annual savings for the US Healthcare economy (2)

50%

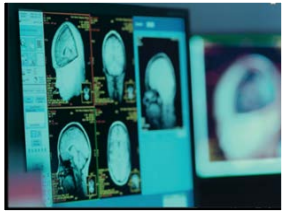
reduced treatment costs (1)

30-40%

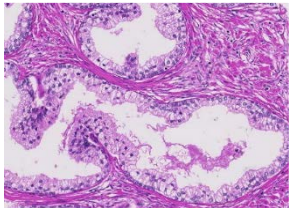
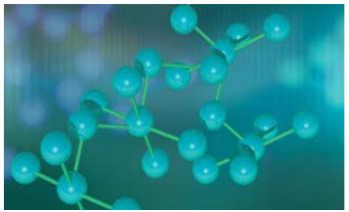
improvement in outcomes (1)

(1) Frost &Sullivan, “Artificial Intelligence and Cognitive Computing Systems in Healthcare”, 2016
(2) Accenture, “Artificial Intelligence: Healthcare’s New Nervous System”, 2017

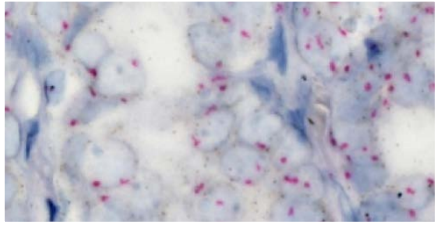
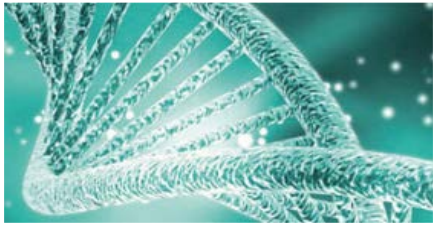
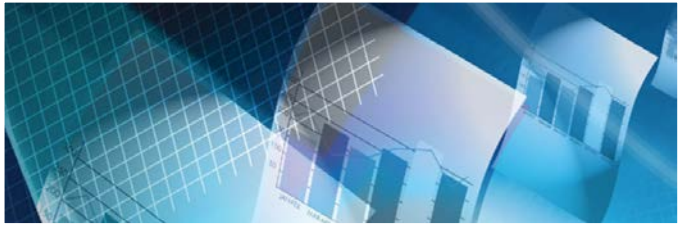
Everything starts at the data






AI principles

- The purpose of AI is to augment human intelligence
- Data and insights belong to their creator
- New technology, including AI systems, must be transparent and explainable

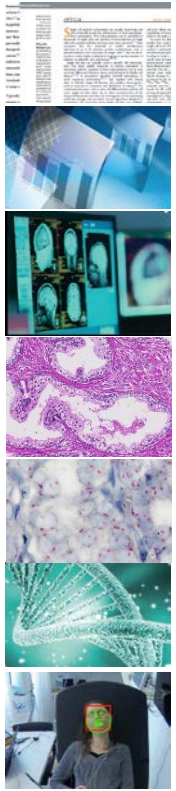
Trust
Requires accurate and understandable evidence

Compliance
GDPR, FDA

Redress, Accountability, Liability
Judicial system, healthcare

Safety
Need to predict behavior under changes in data

AI for Healthcare: Data driven, human centric, explainable, actionable



Data ingestion

- Data preprocessing
- Error correction
- Noise removal
- Data security and privacy
- Multiple languages
- Handwritten text
- Scanned/faxed

Information extraction

- Ontologies
- Word embeddings
- Learn from small cohorts
- Annotation free
- Class unbalance
- Data uncertainty
- Continuous learning
- Diagram Understanding
- Interpretability
- Multimodal integration

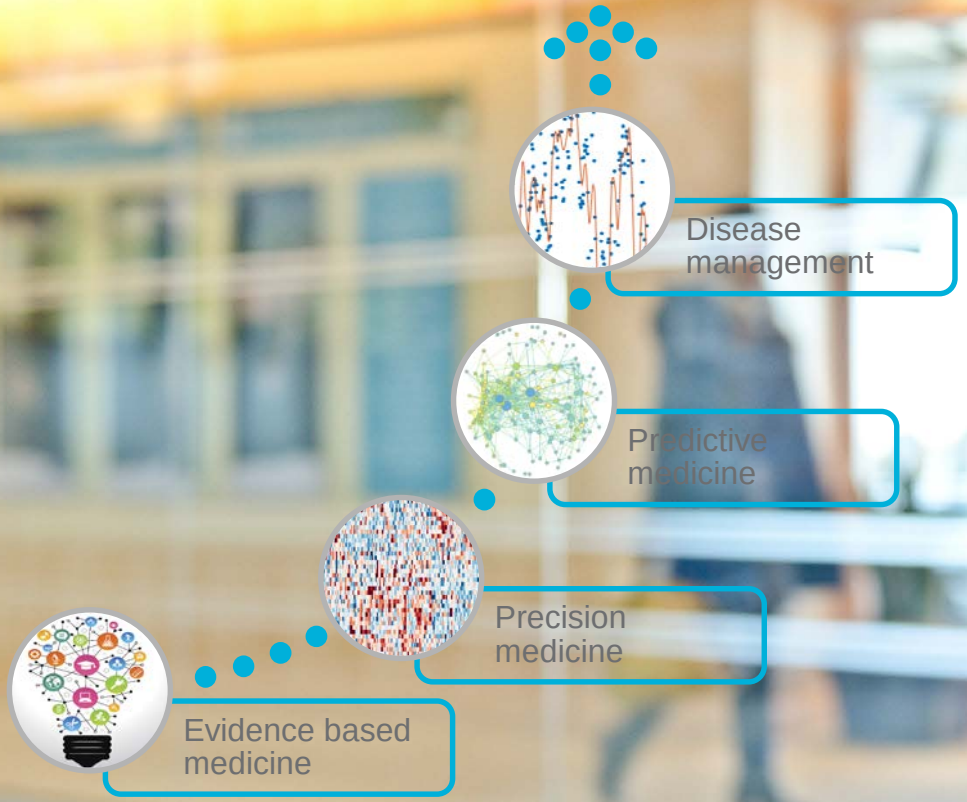
Knowledge generation

- Knowledge base
- *-*-interactions *={gene, protein, drug, …}
- Semantic representation of knowledge
- Relation detection
- Explainable decisions
- Multimodal integration

Insights generation

- Reasoning
- Decision support
- Recommender systems
- Patient similarity
- Anomaly detection
- Behavioral analysis
- Personalized learning
- Monitoring
- Dialog (“Next best question”)

Role of AI in Healthcare and Lifesciences



Role of AI in Healthcare and Lifesciences

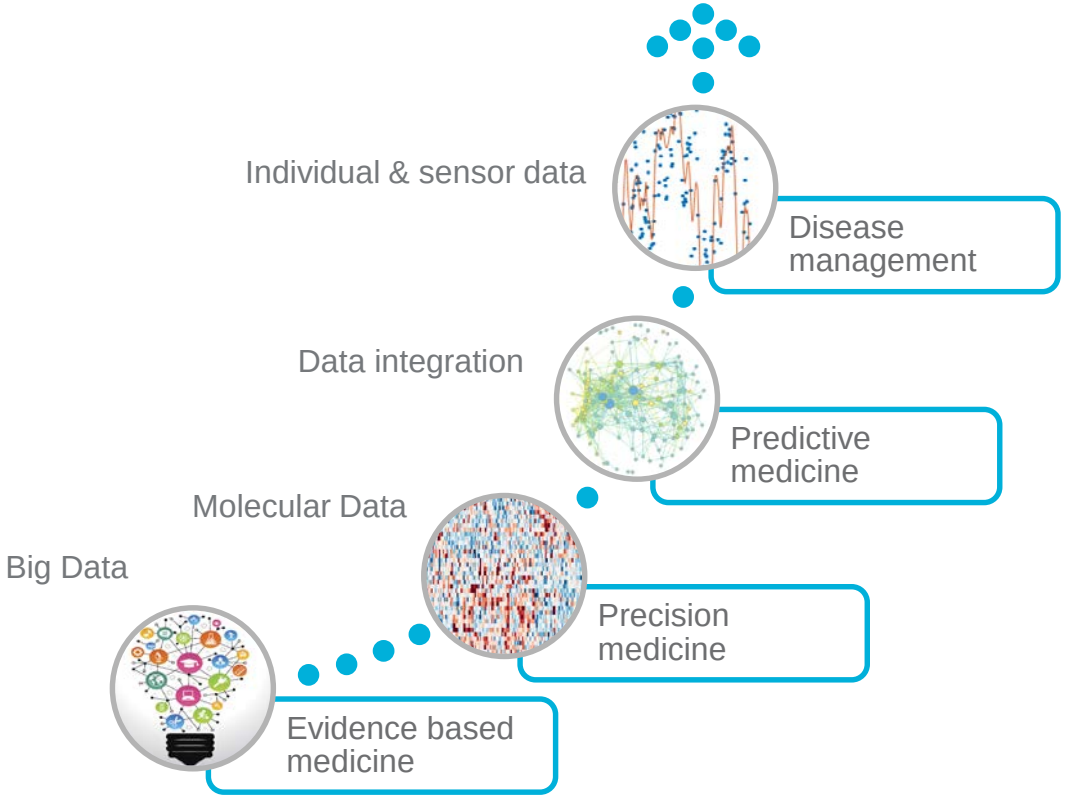
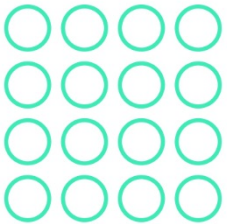
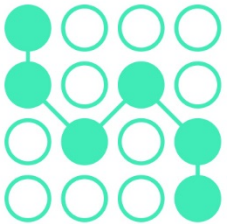


Photo by jesse orrico on Unsplash

Improving Access Using AI

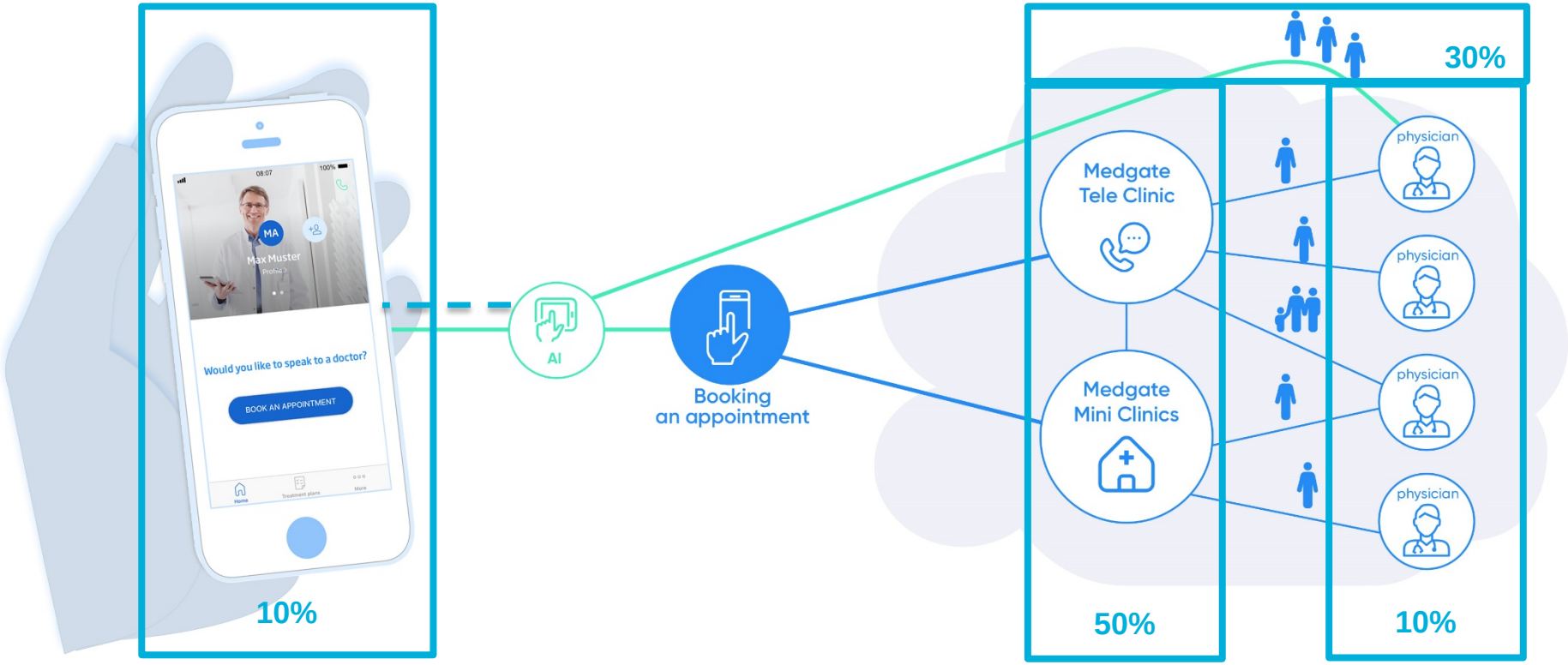




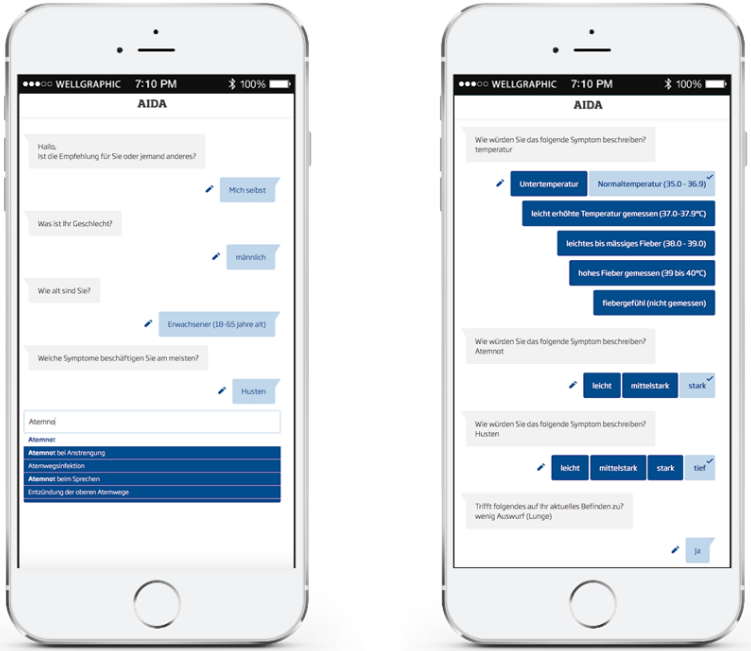
More than **7.4 million** teleconsultations **over 18 years** generated a huge amount of **data.**

Connect data **using an AI-System** to **help the patient** choose **the right type of care at the right time.**

AI for Decision Support System for Patients



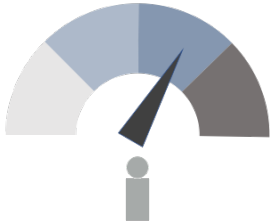
Demo of the app



AI for Decision Support Systems – Explainable AI on clinical data

Visualization of attention factors from neural networks can be used to explain the rationale of a recommendation

smoker | blood | syndrome | headache | vomiting blood | vomit | heavy vomiting
foreign body sensation | nothing visible | itching | hard object got into eye
no peripheral neurological symptoms | diabetes typ 1 | angina pectoris | shortness of breath | chest pain on the right
finger burn injury | movement possible | pressure on chest on the left | electric shock | pressure on chest
impetigo | mouth rash | minimal state of consciousness | temperature 38.0-39.0 °C | vomiting

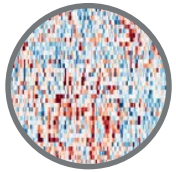


Each line represents the symptoms extracted for an urgent patient case file. The darker the colour, the higher the attention factor for a symptom.

Determine medical urgency from reported symptoms highlighting their importance

Girardi et al., Explainable Deep Learning on Clinical Data, LOUHI, 2018@EMNLP

Drug discovery



- **Pharmaceutical industry** has the **largest R&D business spending** of any industry (**19% of the total R&D spending** worldwide) [2]

- **Anticancer compounds** in particular, take the lion's share of drug discovery R&D efforts

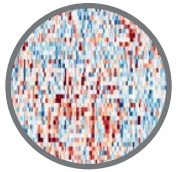
- **Anticancer compounds** account for **34.1 % of all drugs** in global R&D pipeline in 2018 (5212 of 15267 drugs) [2]

- Despite all R&D spending and efforts **serendipity and chance still play a big role** in new drug discovery

The low success rate has been attributed to lack of a systematic way to accumulate and leverage years of R&D to achieve higher success rates [1]

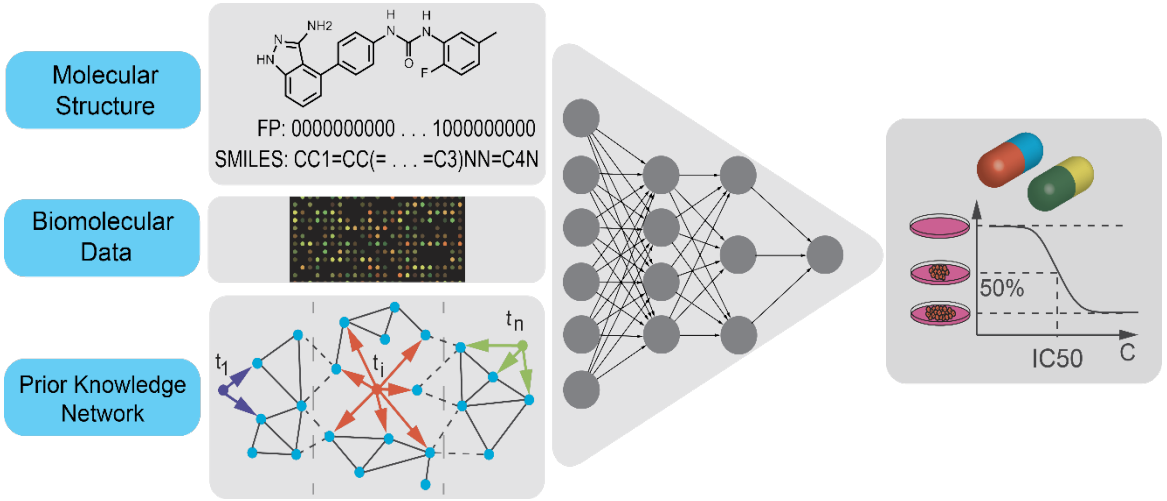
[1] E. Petrova, Innovation and marketing in the pharmaceutical industry, Springer, 2014, pp. 19–81.
[2] I. Lloyd, A. Shimmings, and P. S. Scrip, "Pharma R&D Annual Review 2017," Available Pharmaintelligence Inf. Comresourcesproduct-Contentpharma-Rd-Annu.-Rev.-2018 Accessed June 25 2018, 2017.

PaccMann – drug sensitivity prediction via deep learning



- **Multi-modal prediction of IC50 drug sensitivity.**

  Three key data modalities that influence anticancer drug sensitivity: biomolecular measurements of cancer cells (gene expression, copy number alteration etc.), a network of known interactions between the biomolecular entities and the chemical structure of the anticancer compounds.



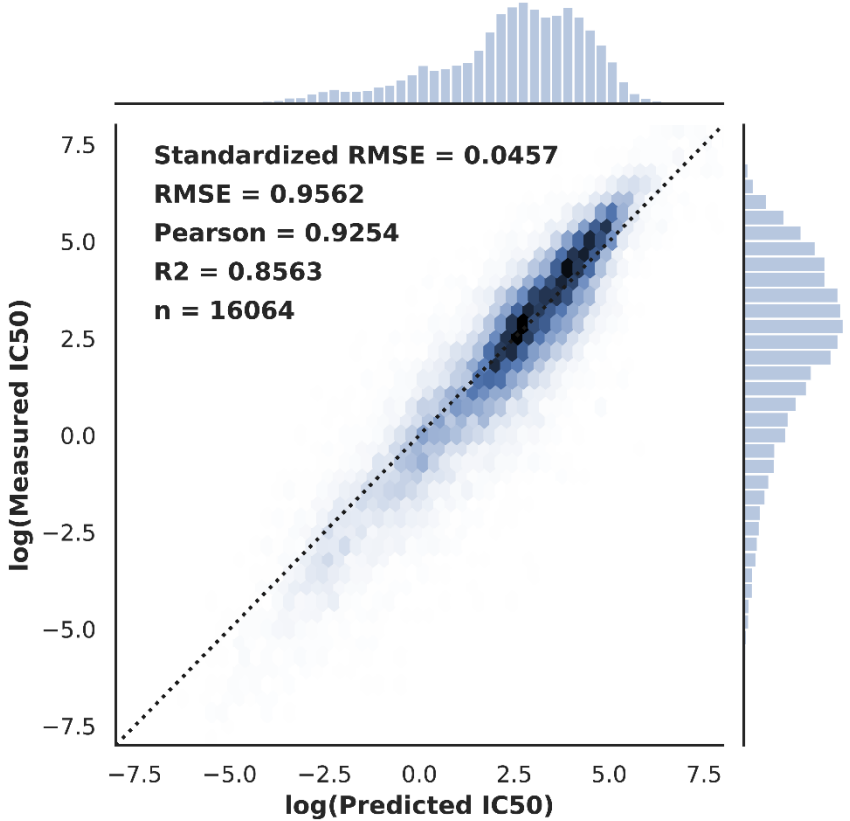
Oskooei, Born, Manica et al., PaccMann: Prediction of anticancer compound sensitivity with multi-modal attention-based neural networks, MLMM NeurIPS, 2018
Manica, Oskooei, Born et al., Towards explainable anticancer compound sensitivity prediction via multimodal attention-based convolutional encoders, under review.

PaccMann Architecture – Multiscale convolutional attentive (MCA) encoder

MCA Encoder

- Three convolutional channels with variable kernel size and a residual channel
- MCA Enables capturing various molecular sub-structures
- Interpretable – Via contextual attention mechanism on the SMILES and gene attention on the cell

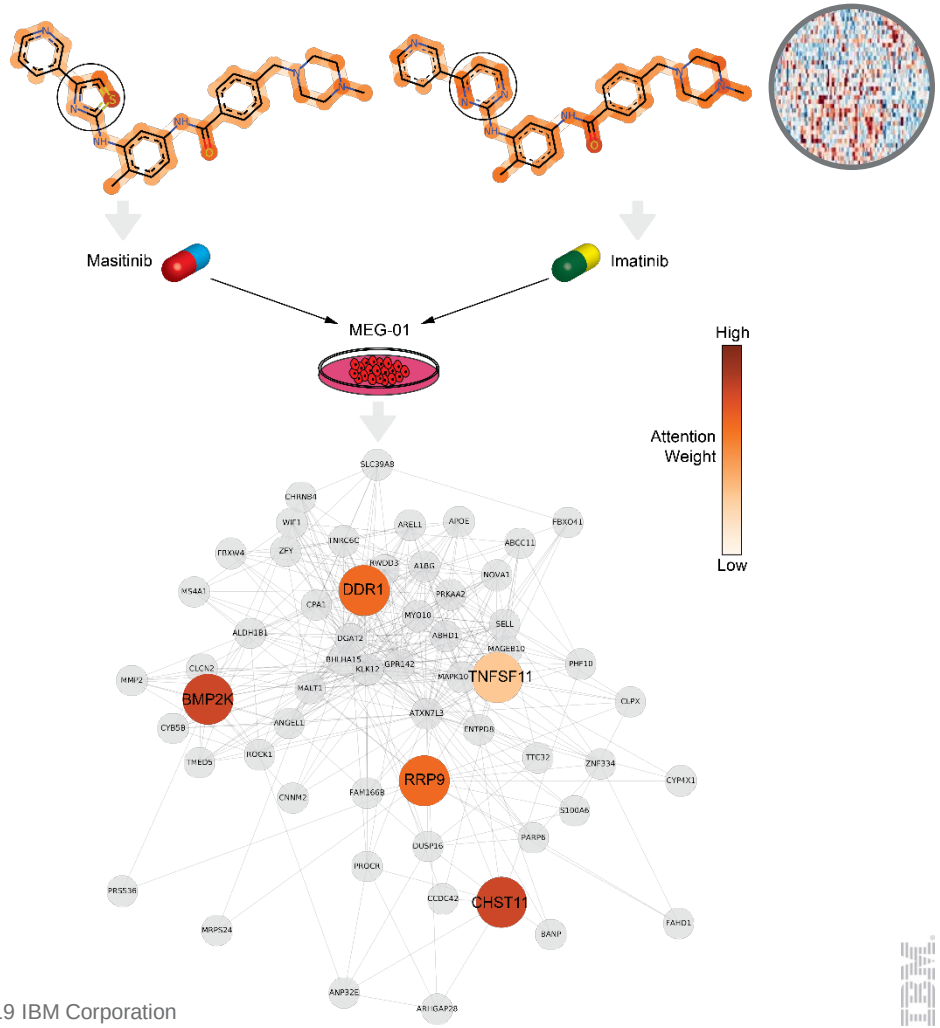
PaccMann performs well in predicting IC50 drug sensitivity for unseen cell-drug pairs



PaccMann Interpretability

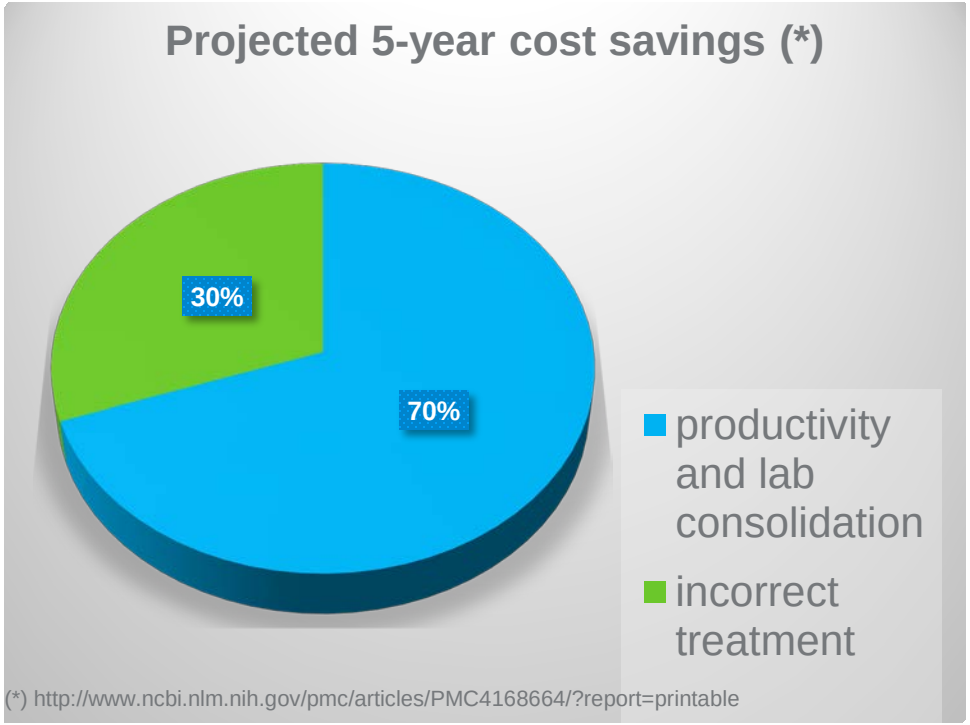
- The model is explainable and interpretable through gene and atom attention weights

- PaccMann gives high weight to important functional groups and relevant biomarkers in a leukemia cancer cell line



ibm.biz/paccmann-aas

Computational Pathology



Cost Savings:

"$17.8 million the projected 5-year total cost savings

"$3 million per year savings from FEDEX costs

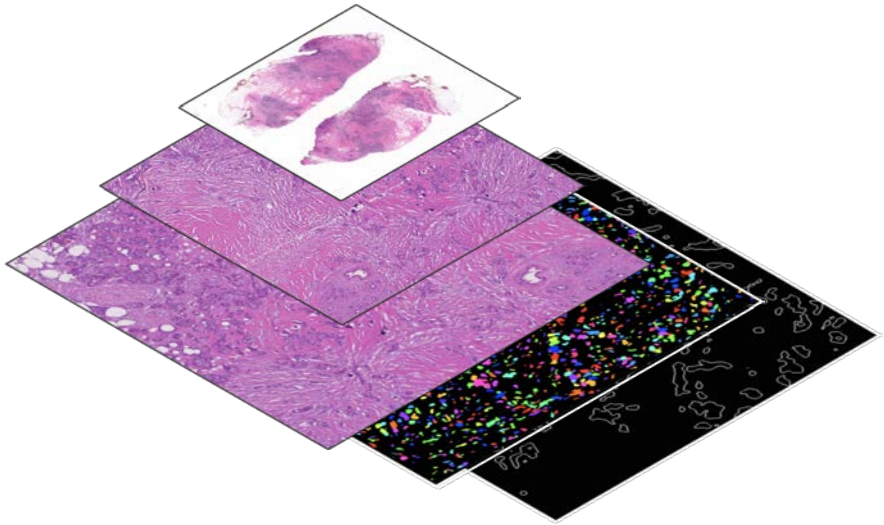
Digital Cartography

- Mapping of information in multiresolution **spatial** data for geography representation
- Visualization of **context** at multiple levels (hemisphere, landscape, street level)
- Context relevant **interaction** information (e.g., location of closest restaurants or distance calculations)
- Enables **personalized decision** (e.g., area close to school vs. ability to bike to work)

HistoCartography

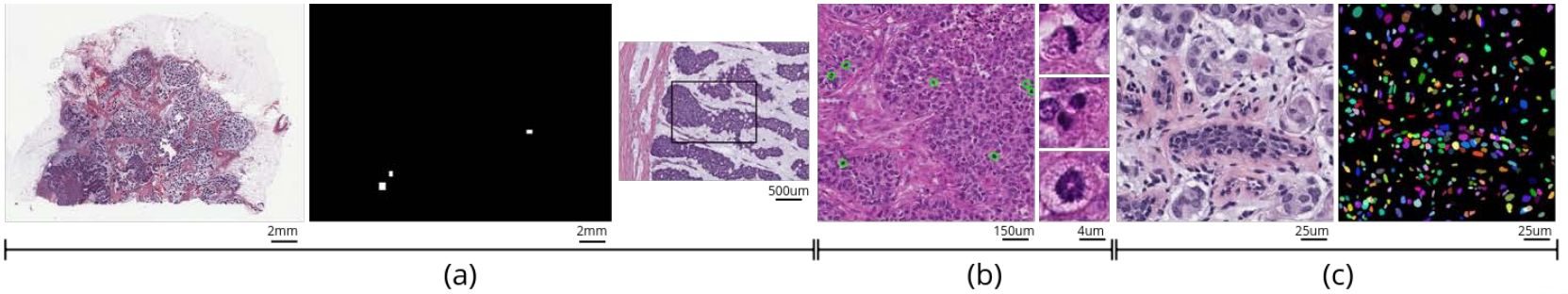
Multiple resolutions

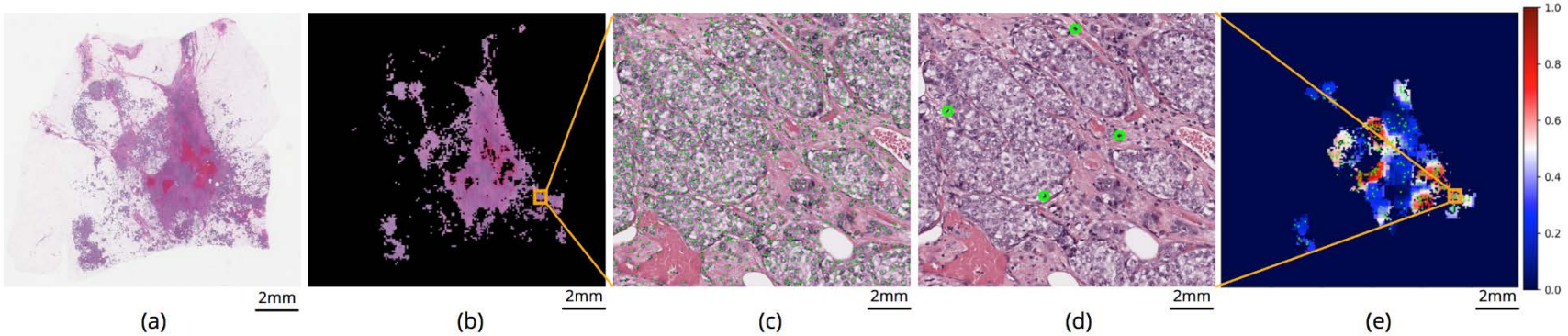
- Mapping of information in multiresolution **phenotypic** and **molecular expression** data for pathogenesis representation
- Visualization of **context** at multiple levels (organ, cellular formations, molecular level)
- Context relevant **relational** information (e.g., location of glands, or cell formations to region boundaries)
- Enables **interpretable personalized decision** at **whole slide image** and **local** scale (e.g., studying heterogeneity, grading or scoring)

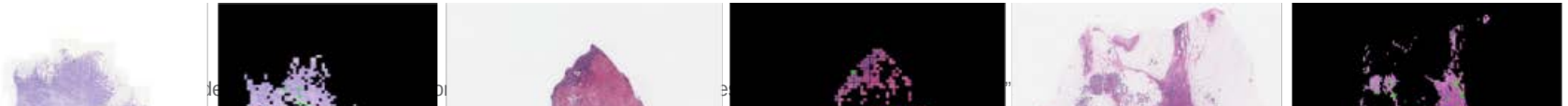


Multiple semantics

Context Aware Mitotic Activity





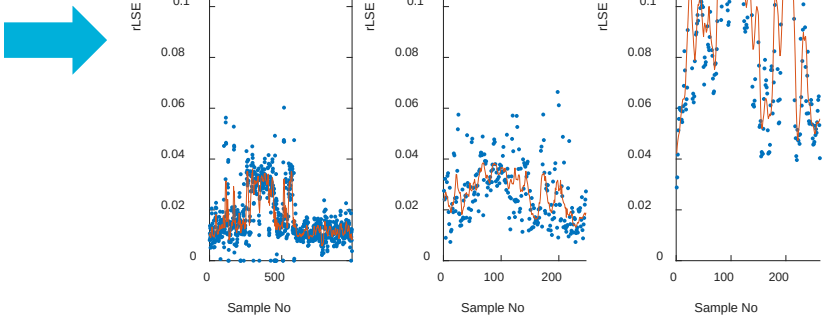


AI for Video-based patient monitoring – Epilepsy

Normal

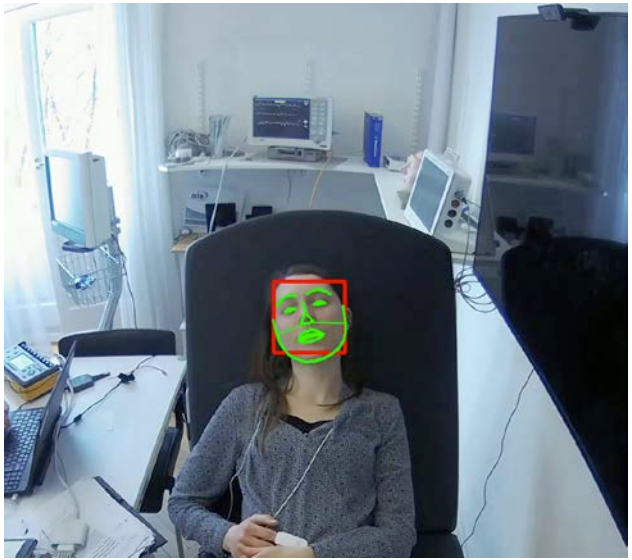
Epileptic event

Videos from University Hospital Zurich

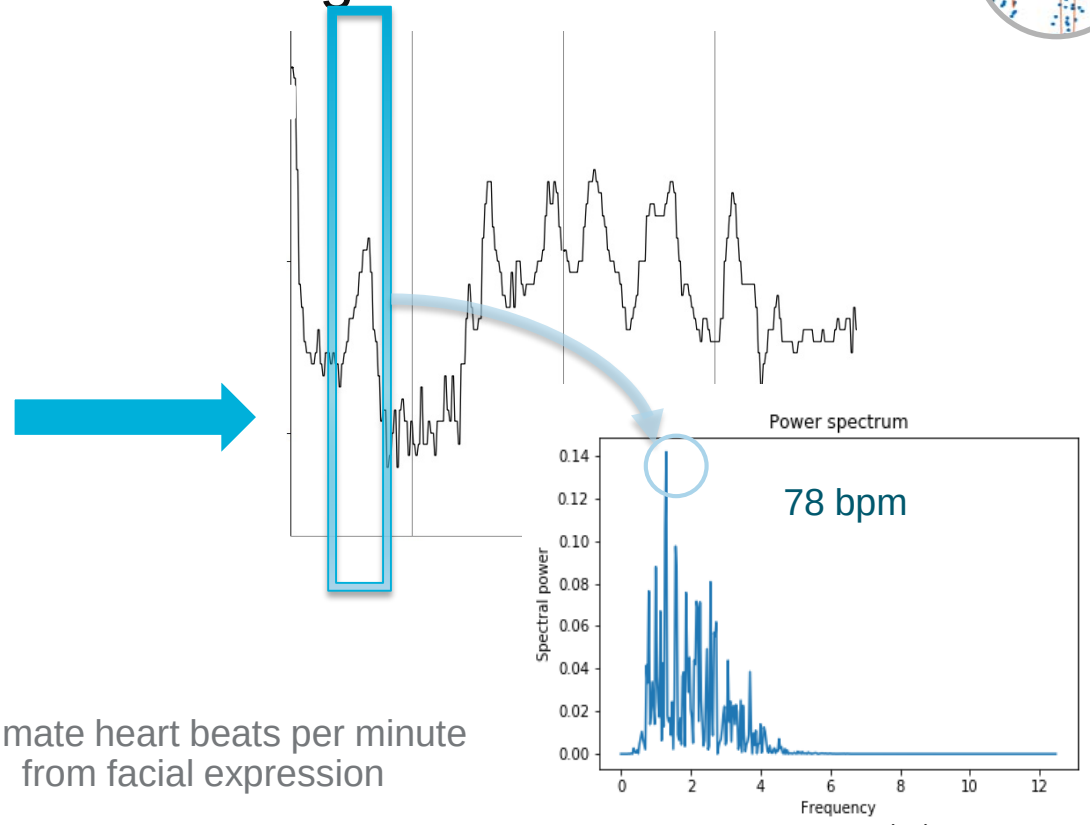


Anomaly detection to raise alert in case of epileptic events

AI for Video-based patient monitoring – Hearth rate estimati



Video of team member



Estimate heart beats per minute
from facial expression

Summary: AI in Healthcare and Lifesciences

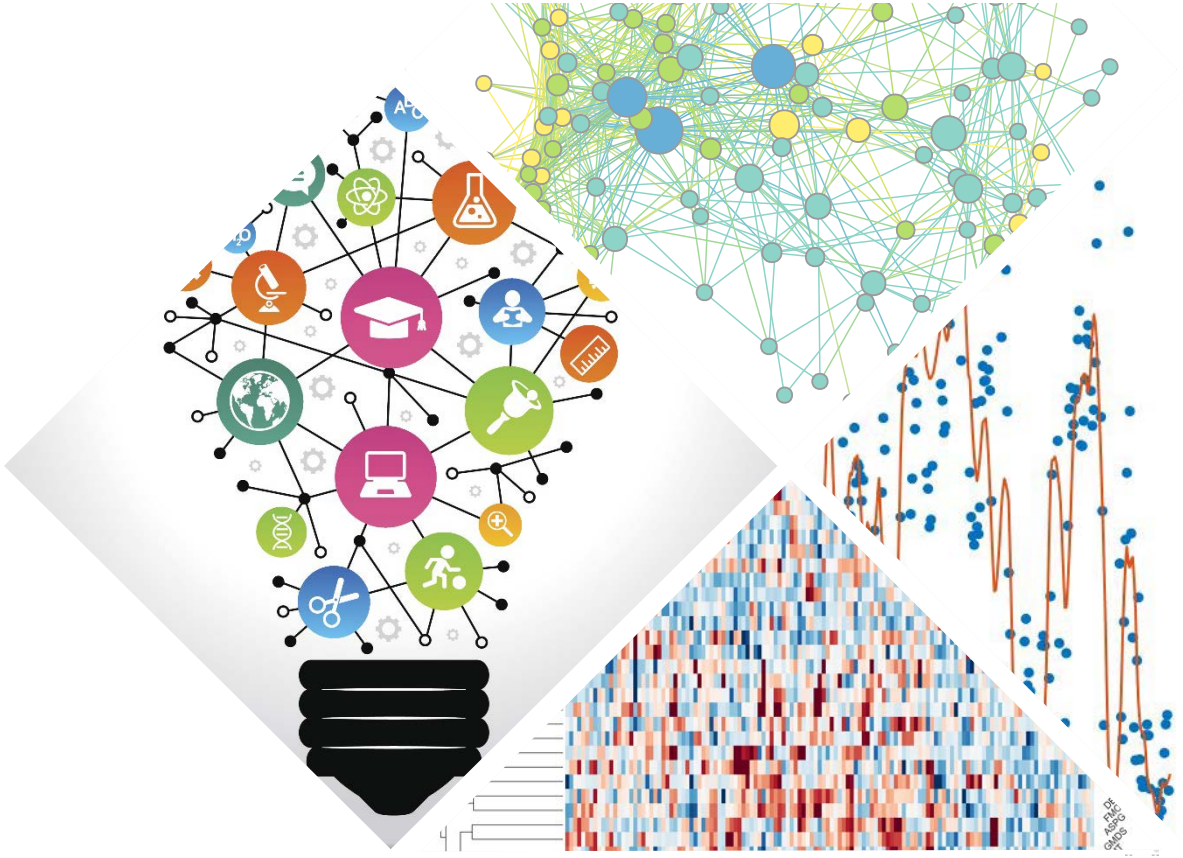
Learn from multimodal data

Build domain knowledge that enhances human understanding

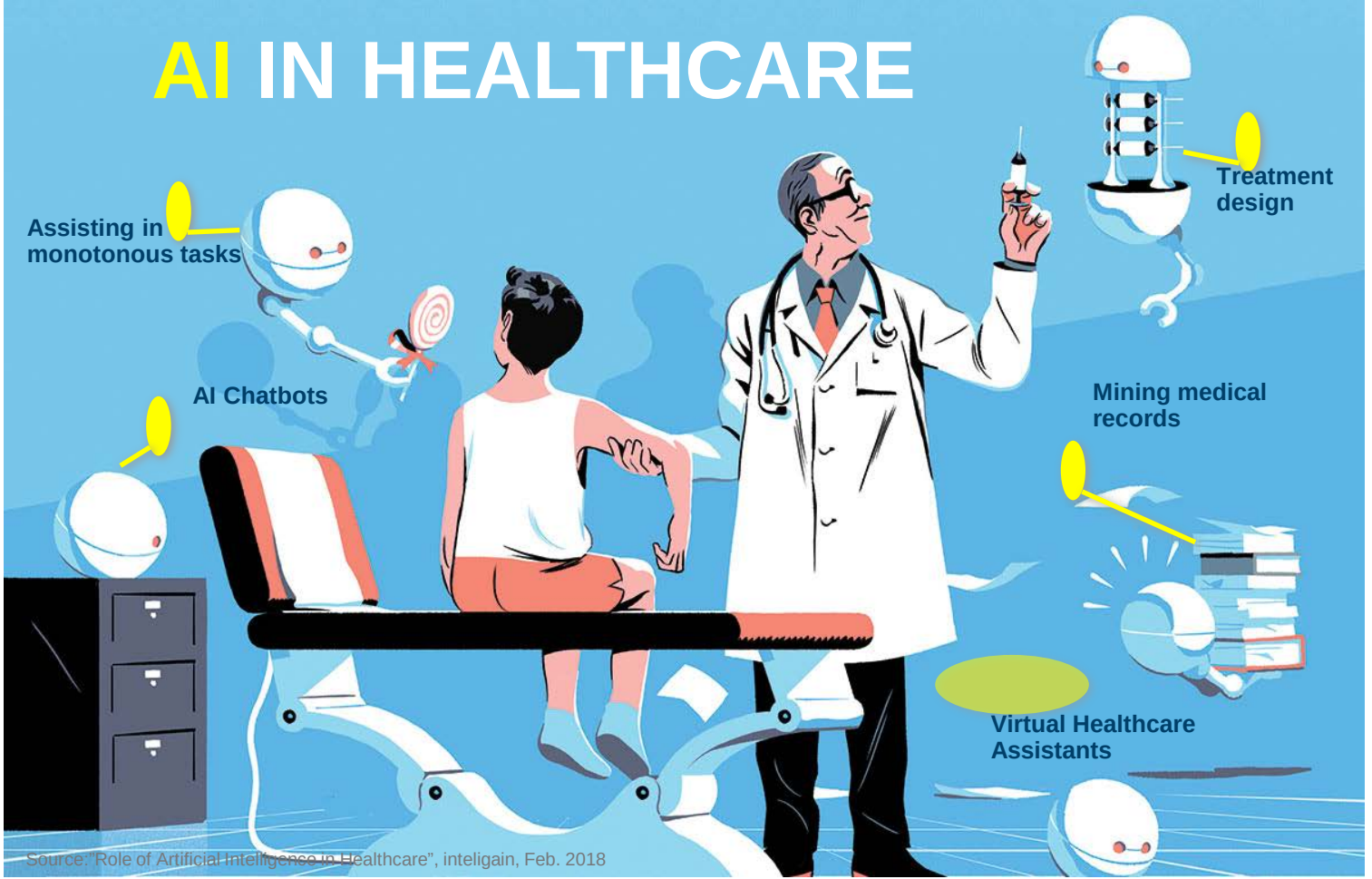
Provide interpretable insights

Provide actionable insights

Summary: AI in Healthcare and Lifesciences



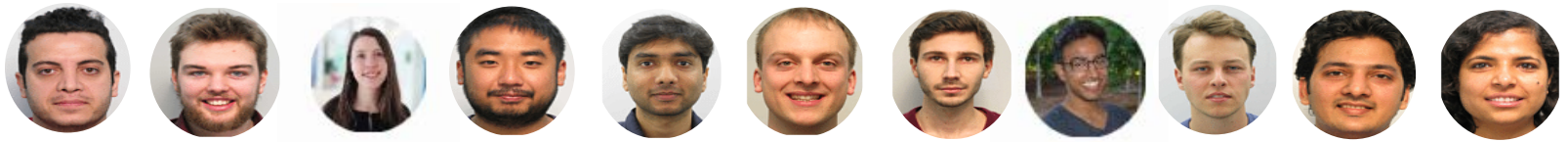
AI IN HEALTHCARE



Source: "Role of Artificial Intelligence in Healthcare", inteligain, Feb. 2018

The team

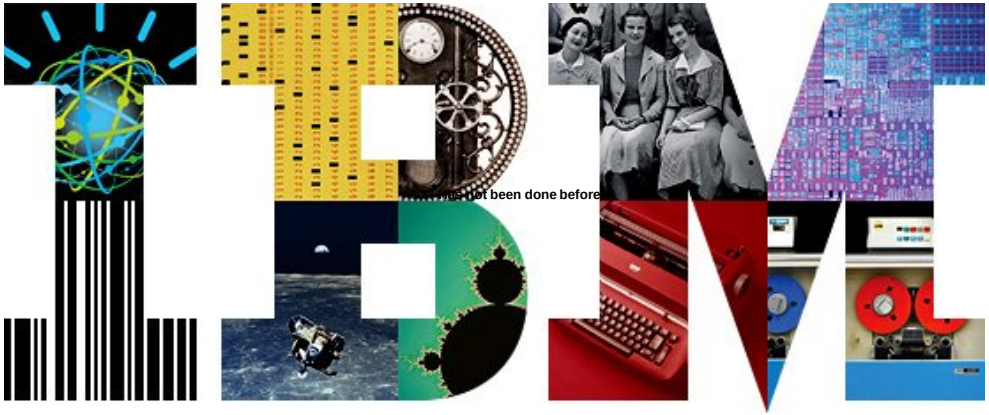
Andreas Antonio Chiara Doug Ivan Maria Marianna Matteo Matthias



Ali Adam Anca An-Phi Bhavesh Cyril Guillaume Kevin Mario Pushpak Sonali

Alvaro Jannis Yusef

Thank You!



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