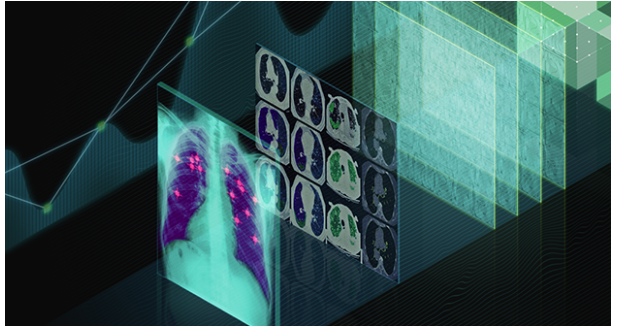


Modern Data Science Technologies in Healthcare



Prof. Dr. Alexander Schönhuth
M.Sc. Maren Knop

Faculty of Technology, Bielefeld University

**Organiza-
tional matters**

**Introduction
Healthcare
Technologies**

**Key
Technologies**

**Where is it
headed?**

**Organiza-
tional matters**

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Organizational matters

- ❖ Presentation (Homework) in groups of 2-3
- ❖ 2 days (6 presentations per day)
- ❖ 30 min + 10 min discussion
- ❖ Mandatory to attend 8/12 presentations for passing
- ❖ Upload slides and homework to corresponding assignment in the “LernraumPlus”:
<https://lernraumplus.uni-bielefeld.de/course/view.php?id=9840>
- ❖ List of Literatur will be uploaded in “Lernraum+” on APRIL 30.

Organizational matters

April 30 - May 16	Group assignment and determination of dates for presentation
May 17	Deployment of group assignment in the Lernraum+
May 21	Q&A about schedule and requirements
May 17 - July 09	Time for preparation
To be determined	Days of Presentation
Two weeks after presentation	Deadline for uploading slides and first draft of homework

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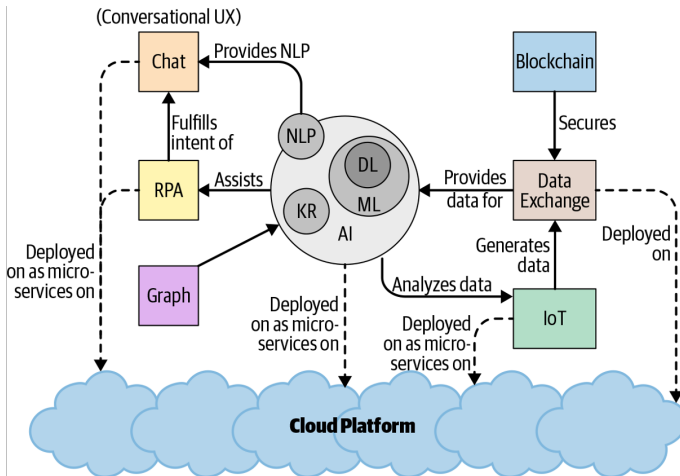
**Where is it
headed?**

Introduction Healthcare Technologies

Healthcare has been slower to adopt new technologies compared to many other sectors for several reasons:

- ❖ Complex ecosystem
- ❖ Fragmented healthcare data stored in diverse sources and formats
- ❖ Complex healthcare and privacy regulations
- ❖ Physicians' desire that technology not intrude on caregiving
- ❖ Concerns regarding ability to maintain security of patient health data
- ❖ Reluctance of clinicians and providers to trust new technologies

Introduction Healthcare Technologies



Source: State of Healthcare Technology - O'Reilly (2020)

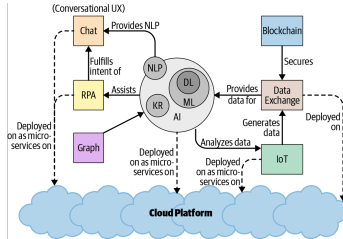
**Organiza-
tional matters**

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**Where is it
headed?**

Key Technologies



Data Sources:
Genomics,
Internet of
Things (IoT)

**Data Storage
and Providing:**
Graph
Databases,
Blockchain

**Data
Analytics:**
Artificial
Intelligence (AI)

Genomics

- ❖ The first human genome, sequenced in 2003, cost \$3 billion and took 13 years to complete \Rightarrow The cost is now in the range of \$1,000, and the sequencing time is measured in hours
- ❖ provide new insights for precision and personalized medicine
- ❖ Integrating genomics data with claim, EHR, and lab data will give a comprehensive view of patients
- ❖ improve the ability to predict disease, monitor health, and personalize treatment

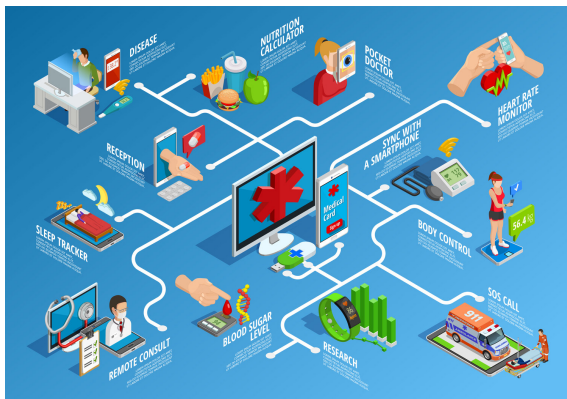


Source: irishtimes (2019)

Internet of Things (IoT)

- ❖ Devices (sensors, wearables) are becoming more connected to the internet and more intelligent
- ❖ using that network connection to gather data and trigger actions based on that data
- ❖ According to a report by CISCO, by 2030, 500 billion devices will be connected, which is approximately equivalent to 58 smart devices per person on our planet
- ❖ Managed and deployed in combination with Machine Learning and Deep Learning models

Internet of Things (IoT)



Source: The Internet of Things-Missing Link to Smart Healthcare (2019)

Health-related data collected from IoT and ambient computing systems: Patient-generated health-data (PGHD)

Concepts

Ambient Assisted Living

- ❖ Computing that is invisible, contextually aware and responsive to interactions with physical world
- ❖ Refers to the idea of gathering data and performing computing tasks in the background

Concepts

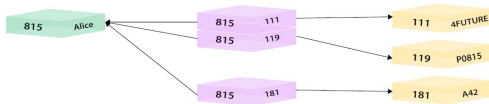
Ambient Assisted Living

- ❖ Computing that is invisible, contextually aware and responsive to interactions with physical world
- ❖ Refers to the idea of gathering data and performing computing tasks in the background

Domain	Sensors
Activity recognition	Button, microphone, accelerometer, kinect
Virtual monitoring	Heart rate, temperature, glucose meter, electromyography
Surrounding environment	Air temperature, moistness, carbon monoxide, carbon dioxide, glow

Graph Technologies

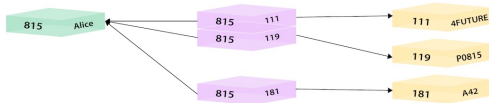
Relational database:



Source: Relational - Person and Department tables

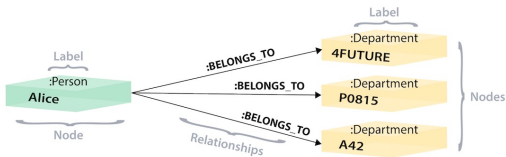
Graph Technologies

Relational database:



Source: Relational - Person and Department tables

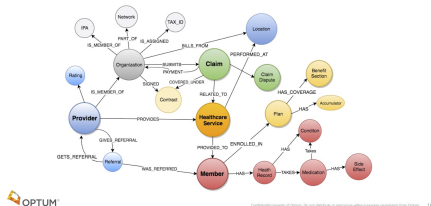
Graph database:



Source: Graph - Alice and 3 Departments as nodes

Graph Technologies

Healthcare Network Graph

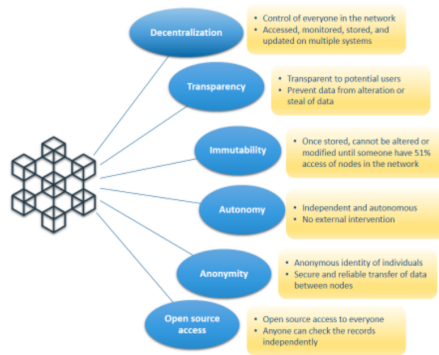


Source: Connecting Healthcare (2020)

- ❖ Healthcare data is complex. This complexity comes in many forms, but the primary factors are the many relationships and high variability within the data.
- ❖ Rapid flexible changes to the organization of the data

Blockchain

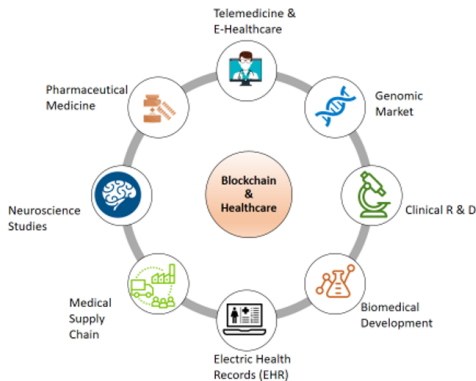
- ❖ Dedicated to the exchange of a new virtual currency called Bitcoin
- ❖ Ledger on which transactions are chronologically recorded in a cooperative and tamperresistant manner
- ❖ New era of cooperation among competing entities toward a common goal
- ❖ Requires density of adoption: a group of organizations must be willing to cooperate



Source: State of Healthcare Technology - O'Reilly (2020)

Blockchain

Domains:



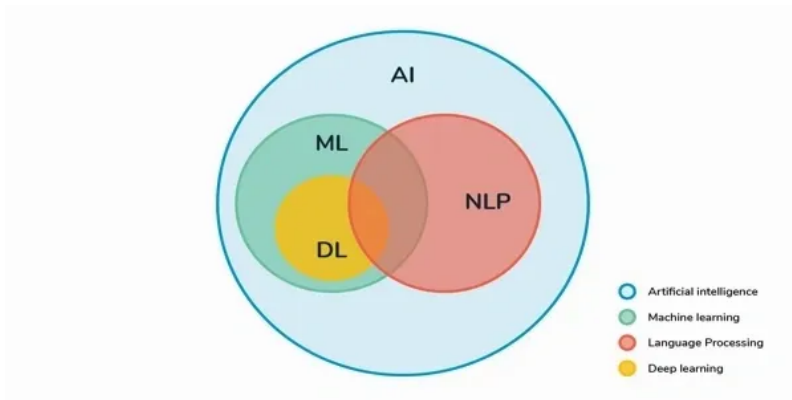
Source: State of Healthcare Technology - O'Reilly (2020)

SWAT:



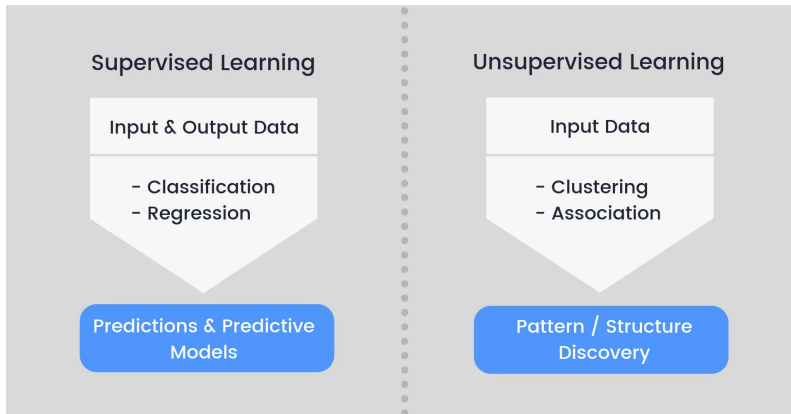
Source: State of Healthcare Technology - O'Reilly (2020)

Artificial Intelligence (AI)



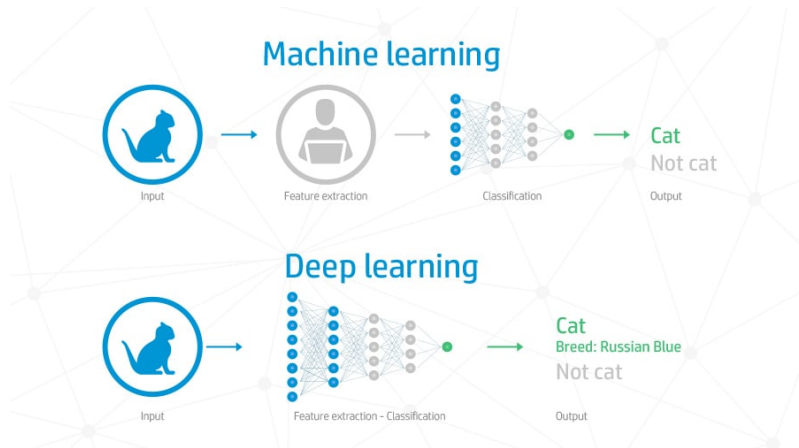
Source: Artificial Intelligence, Deep learning, Machine learning and Natural Language Processing(NLP) - GOODAUDIENCE (2018)

Classic Machine Learning (ML)



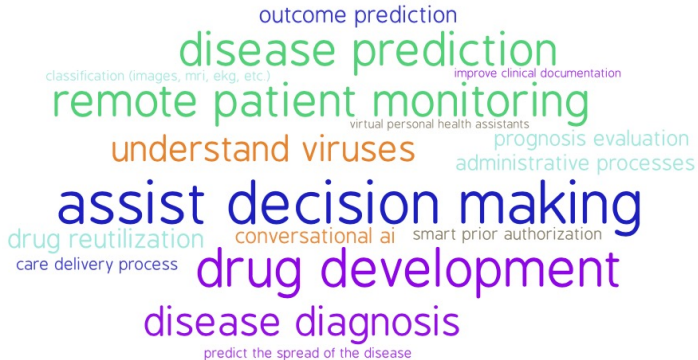
Source: Supervised vs. Unsupervised Machine Learning - INDUSTRY 4.0 INSIGHTS (2019)

Deep Learning (DL)



Source: Machine learning and deep learning 101 - Network Technologies (2018)

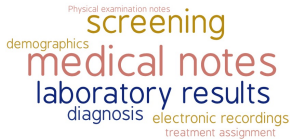
How AI solves Healthcare Challenges?



Source: <https://wordart.com/create>

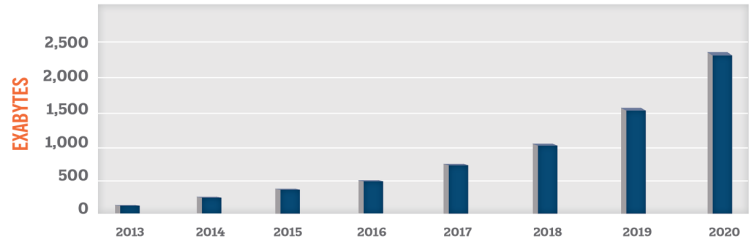
How AI solves Healthcare Challenges?

Possible applications:



Source: <https://wordart.com/create>

GROWTH IN HEALTHCARE DATA



Source: Bytes to Bucks: The Valuation of Data (2019))

Deep Learning in Healthcare

Commonly used DL algorithms:

- ❖ Convolutional Neural Networks (CNN)
- ❖ Recurrent Neural Networks (RNN)
- ❖ Deep Belief Network
- ❖ Deep Neural Network

Deep Learning in Healthcare

Commonly used DL algorithms:

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DL examples:

- ❖ Detect skin cancer from clinical images
- ❖ Detect referable diabetic retinopathy through the retinal fundus photographs
- ❖ ...

Natural Language Processing in Healthcare

Large proportions of clinical information: narrative text (unstructured)

NLP comprises processing those unstructured data

Natural Language Processing in Healthcare

Large proportions of clinical information: narrative text (unstructured)

NLP comprises processing those unstructured data

NLP examples:

- ❖ Reading chest X-ray reports would assist the antibiotic assistant system to alert physicians for the possible need for anti-infective therapy
- ❖ Automatically monitor laboratory-based adverse effects
- ❖ Extracting the keywords from narrative clinical notes

Barriers

- ❖ One of the biggest challenges is explaining
- ❖ Invariants, causal graphs, and deep probabilistic programming are all promising effects intended to address these limitations
- ❖ Regulations: lack of standards to assess the safety and efficacy of AI systems

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tional matters**

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headed?**

Where is it headed?

Diagnostic

- ❖ Predict *rare* diseases
- ❖ Assist decision making in diagnosing
- ❖ Minimize diagnostic errors
- ❖ Precision medicine will become a routine part of every person's medical care

Health monitoring

- ❖ Remote monitoring
- ❖ Comprehensive view of patients
- ❖ Provide a historical and real-time, whole person view of health

Reduce costs

- ❖ monitoring, evaluating, and configuring the sensitive medical data
- ❖ No more trial-and-error treatment

Where is it headed?

Data handling

- ❖ Genetic testing will be included in EHR systems
- ❖ Improve data accuracy and redundancy
- ❖ Structured healthcare data
- ❖ Improving data interoperability
- ❖ Shifting ownership of personal health data from health systems to consumers
- ❖ clinical data will be more secure and reliable

More efficient communication

- ❖ Communication between patients and doctors will be more accessible and more efficient
- ❖ Enables clinicians to spend more time with patients
- ❖ Improved Explainability
- ❖ All the records of patients will be available to all the entities involved

Treatment

- ❖ **Real-time clinical decision support and recommendations**
- ❖ Personalize Treatment
- ❖ Reduces friction and delays in healthcare system
- ❖ Reduction of unnecessary tests and treatments
- ❖ Improving treatment outcome
- ❖ Every person can have access to the same healthcare quality for a low price