Iterata AG Medical Services
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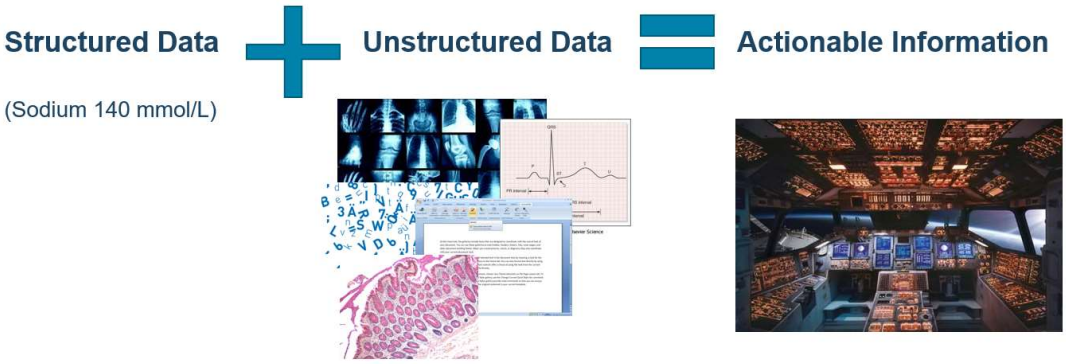
Actionable Clinical Information - bring analytics to life

Iterata Health Platform supports several methods and analytic tools for the identification of cluster which in turn supports the decision-making process.

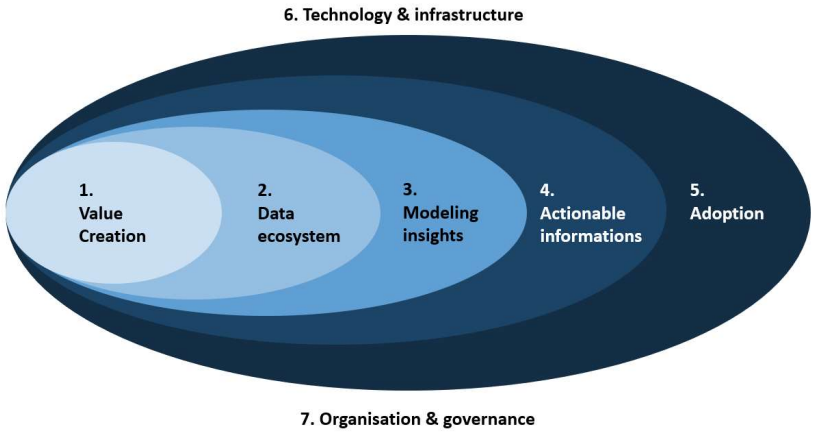
Big Data Definition for a Healthcare Enterprise

The act of combining large amounts of structured and large amounts of unstructured data for the purpose of generating of pro-and retrospective actionable information in near real-time.



Actionable Clinical Information - bring analytics to life

Becoming data-driven, providing everything from specific expertise on discrete issues to holistic transformations spanning strategy design, build, implement and capability building



Artificial Intelligence (AI)

Artificial Intelligence (AI) = ability of a machine to perform cognitive functions (perceiving, reasoning, learning, interacting with the environment, problem solving). One form of it is:

Machine Learning (ML)

Machine-leaning algorithms detect patterns and learn how to make predictions and recommendations by processing data and experiences, rather than by receiving explicit programming instructions. The algorithm is trained and then adapted to response to new data.

Types of ML

- **supervised learning:** an algorithm uses training data and feedback from humans to learn the relationship of a given in- and output. The input data has to be classified as well as the type of behavior you want to predict. The algorithm then calculates what it has learned on new data.
  Procedure:
  1. human labels input data and defines the output variable
  2. the algorithm is trained on data to find the connection between in- and output
  3. when the algorithm is sufficiently accurate, it is applied to new data
  Examples: decision tree, linear regression

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- **unsupervised learning:** only the input data is given. This type is used when the user cannot classify the data and the algorithm should find patterns and classify the data.

  Procedure:

  1. the algorithm receives unlabeled data
  2. it infers a structure from the data
  3. the algorithm identifies groups of data that show similar behavior

  Examples: K-means clustering, hierarchical clustering

- **reinforcement learning:** an algorithm learns to perform a task by trying to maximize rewards it receives for its actions. It can be used if there is not a lot of training data, if you cannot define the ideal end state or to learn about the environment you have to interact with it.

  Procedure:

  1. the algorithm takes an action on the environment
  2. it receives a reward if the action brings the machine a step closer to maximizing the total reward available
  3. the algorithm optimizes for the best series of actions by correcting itself over time

  Examples: optimizing trading strategies

explainable artificial intelligence (XAI)

set of techniques that help show how a machine-learning algorithm comes up with a set of outputs. It allows humans to better understand outputs from complex, «black-box» models and helps decision makers know the relevant features driving the output. Can be used for complex machine-learning models.

Model → Data and prediction → Explanation → Human makes decision

Deep learning

Deep learning a type of machine learning that can process a wider range of data resources, requires less data preprocessing by humans, can produce a more accurate result than traditional ML approaches. Interconnected layers of software-based calculators («neurons» from a neuronal network) ingest large amounts of input data and process them through multiple layers that learn increasingly complex features of the data at each layer.

Reduces error rates in for example image classification, facial recognition, and voice recognition.

- **convolutional neural network (CNN):** a multilayered neural network with a special architecture designed to extract increasingly complex features of the data at each layer to determine the output. Can be used for unstructured data sets.

  1. CNN receives an image and it processes as a collection of pixels
  2. in the hidden layers, it identifies unique features
  3. the CNN can now classify a different image

  Examples: diagnose health diseases from medical scans

- **recurrent neural network (RNN):** a multilayered neuronal network that can store information in context nodes, allowing it to learn data sequences and output a number or another sequence. Can be used for time-series data or sequences.

  1. a RNN neuron receives a command that indicates the start of a sequence
  2. the neuron receives the first word and then outputs a vector of numbers that feeds back into the neuron to help it «remember» that it received the first word. After that the same process with the second word and so on.
  3. after receiving another word, the neuron assigns a probability to every word in the given vocabulary that could complete the sentence. It will complete the sentence with a word with the highest probability according to the words before.

- **Transformer:** uses special mechanisms calls «attention heads» to help it understands each word means when used in a particular context. Can mainly be used for language-processing.

- **Generative adversarial network (GAN):** combination of two networks, a generator and a discriminator that compete against each other to perform a task, which eventually results in better performance of the required task. Can be used when insufficient amounts of data are available to train an algorithmic model. GANs create new, synthetic data that is representative of actual data.

  1. the generator produces synthetic data of the underlying data that is good enough to «fool» the discriminator. The discriminator works to distinguish between data that is genuine and synthetic.

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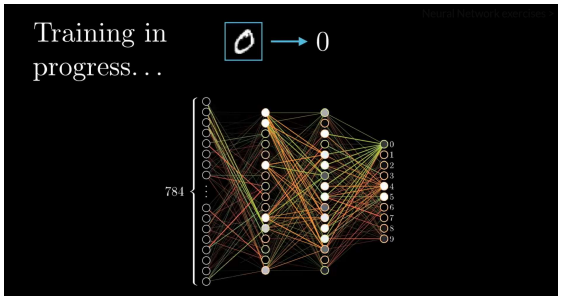
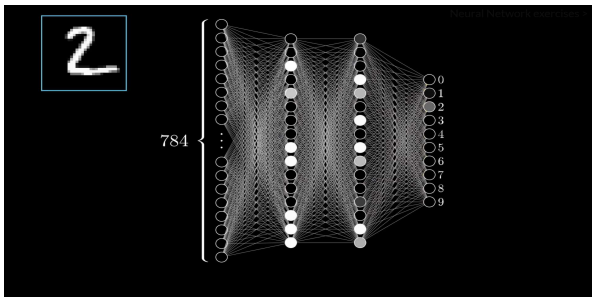
Examples

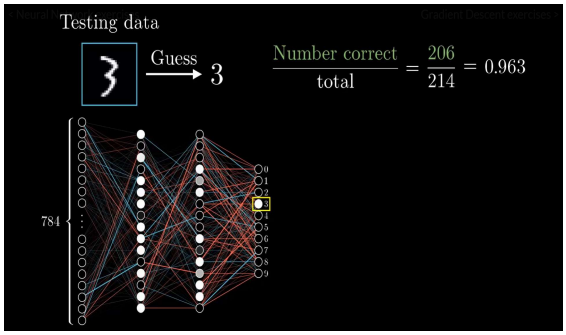
Cluster recognition & Training

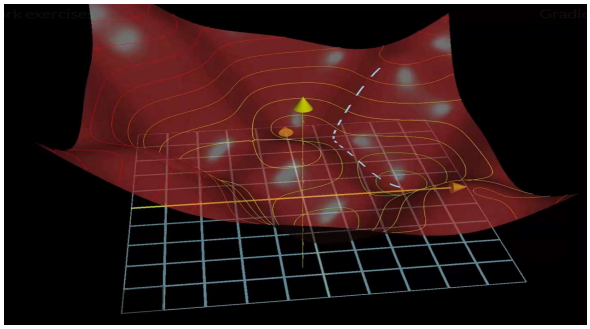
Cluster recognition can be important in various fields, like in medicine, where patterns of symptoms or medication combinations can be identified, in pharma industries to identify the demographical distribution of their products, but also in other fields like the banking and insurance system.

A classifier distributes data points into different categories. However, in a first step, the system needs to get familiar with the different categories and needs to be trained to decide which data point belongs in which category. So, a classifier learns by means of a training data set who the input data is related to the category/class. For example, if the system has to decide whether a face belongs to the gender male or female, it first has to learn which features distinguishes between these two categories. In this step, the data is structured and labeled manually, and an appropriate learning rate has to be set. After labelling, the network architecture is defined and then trained. Before using it on the actual data of interest, it needs to be validated.
In a data set with sensitive data (personal data), an expert takes over the assembling of an appropriate training set to maximize the sensitivity. The aim is to get as less false negative and false positive results as possible.
After the training phase and minimizing the error rate, the algorithm can be applied on to the data of interest.
More complex opportunities can be developed as well. We are currently working on a tool that should facilitate the classification of chest x-rays where data is compared to a training set including different pictures of x-rays with different diagnoses. This supports the decision-making process enormously.









Examples

- Medical diagnosis, Radiological classification, structuring of medical history data to extract only a certain part

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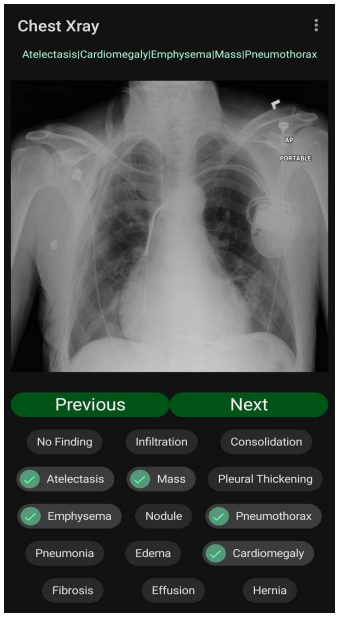
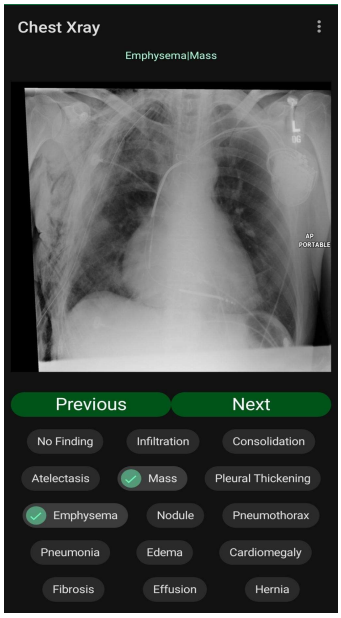
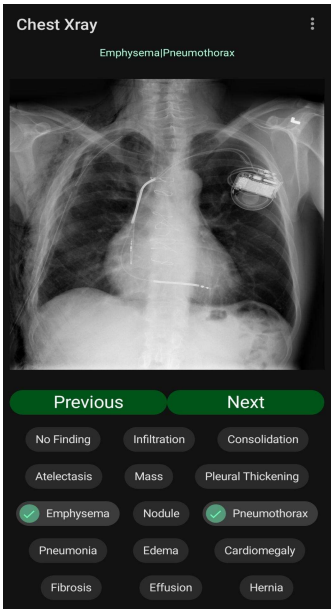
Chest Xray: Machine Learning Validation & Classification

Source NHI: https://nihcc.app.box.com/v/ChestXray-NIHCC

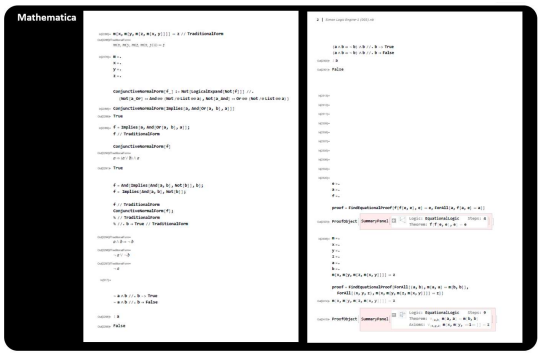




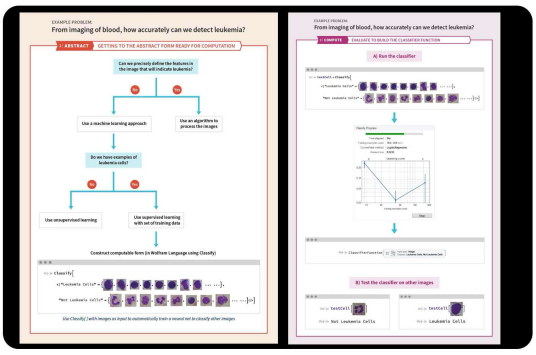


No Finding	60 361
Infiltration	19 894
Effusion	13 317
Atelectasis	11 559
Nodule	6331
Mass	5782
Pneumothorax	5302
Consolidation	4667
Pleural_Thickening	3385
Cardiomegaly	2776
Emphysema	2516
Edema	2303
Fibrosis	1686
Pneumonia	1431
Hernia	227

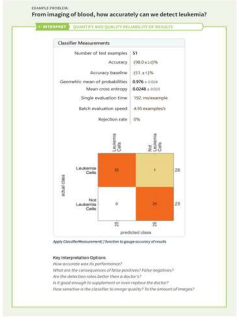
No Finding	60 361
Infiltration	9547
Atelectasis	4215
Effusion	3955
Nodule	2705
Pneumothorax	2194
Mass	2139
Effusion | Infiltration	1603
Atelectasis | Infiltration	1350
Consolidation	1310
Atelectasis | Effusion	1165
Pleural_Thickening	1126
Cardiomegaly	1093
Emphysema	892
Infiltration | Nodule	829
Atelectasis | Effusion | Infiltration	737

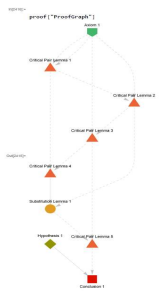


Logic Engine – Classifier



Classifier – Expert Trained Set (Neuronal Network)





Classifier Measurement

Speed on

1. Descision-Support
2. Novel Tools (Werkzeuge)
3. Tools for Domain usable / fast available