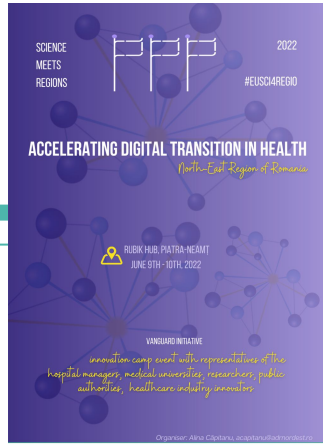
“Alexandru Ioan Cuza” University of Iasi

Faculty of Computer Science

iMAGO•MOL
Clusterul Regional Inovativ de Imagistică Moleculară și Structurală Nord-Est



The Role of AI in Medical Diagnosis

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Rubik HUB, Piatra Neamț
June 9, 2022

Content

Artificial Intelligence

Computer Vision

Virtual and Augmented Reality

Using AI in Medical Projects

Conclusions

Garry Kasparov vs Deep Blue, IBM's supercomputer

The first Kasparov vs. Deep Blue clash happened in 1996, but the very first challenge involving the Soviet chess master and computers took place in fact in 1985, when Garry Kasparov defeated 32 machines simultaneously

A year later, in 1997, with the promise that Deep Blue would be even more developed and "prepared", Garry Kasparov accepted IBM's proposal for a rematch against their computer

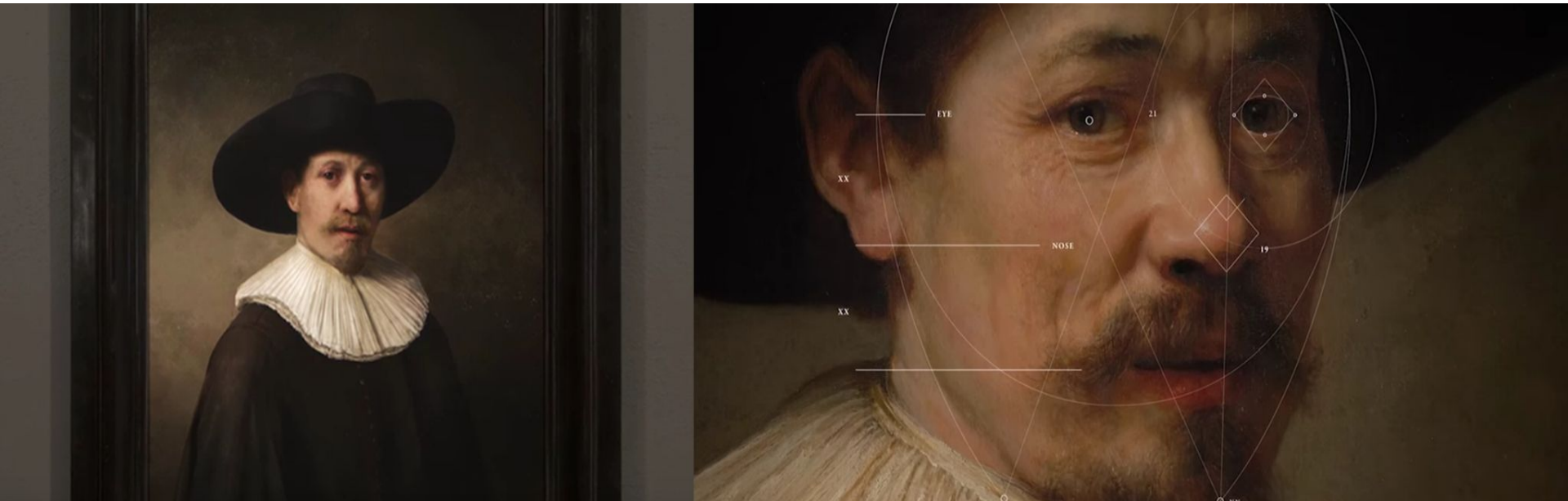
AlphaGo

AlphaGo is a computer program that plays the board game Go, developed by DeepMind Technologies

In October 2015, the AlphaGo became the first computer Go program to beat a human professional Go player without handicap on a full-sized 19×19 board

Painting

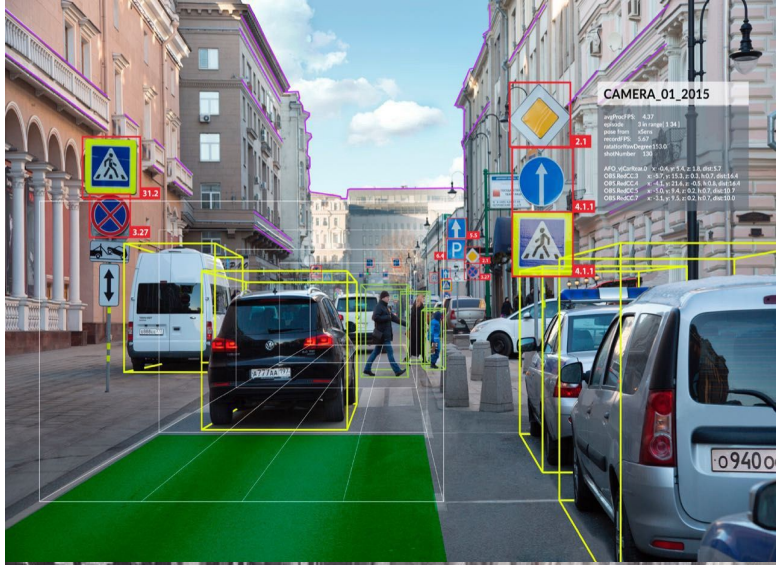
A new "Rembrandt" painting unveiled in Amsterdam is not the work of the Dutch master Rembrandt van Rijn at all, but rather the creation of a combination of technologies including facial recognition, AI, and 3D printing

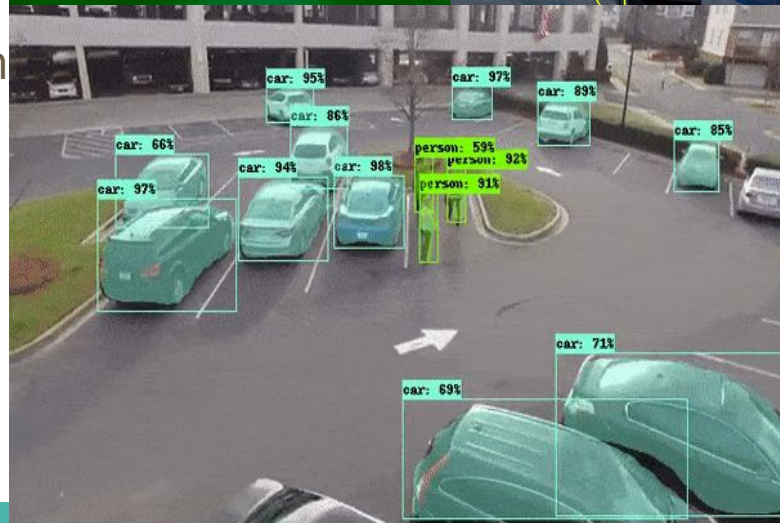


Computer Vision (CV)

CV is **a subsection of artificial intelligence** that emphasizes *developing and refining techniques that let machines capture and understand various digital images and video content*

Today we live in reality awash in visual information According to HubSpot, **54% of consumers want their favorite brands to deliver more video content**. Forbes suggests that *websites, exposing a great deal of video content, make average users spend 88% more time on their pages*



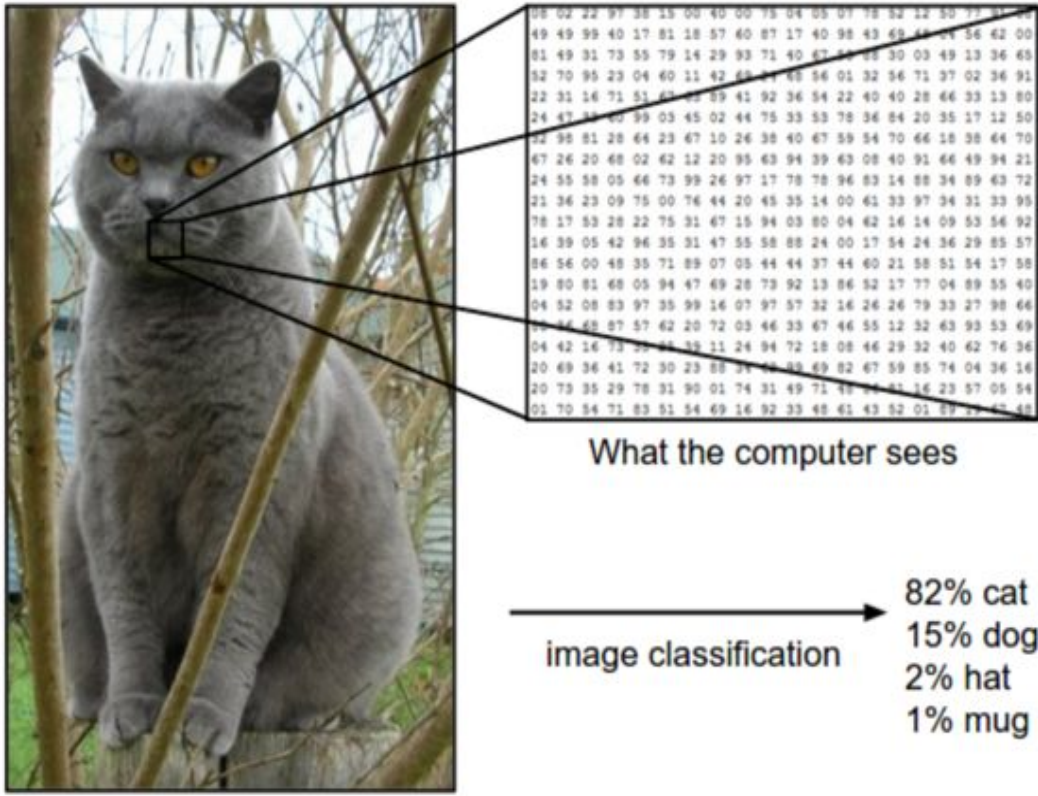


What Are the Goals of Computer Vision and How It Works?

A fundamental task in computer vision has always been **image classification**

Deep learning in image recognition and classification: *computers can automatically generate and learn features* (distinctive characteristics and properties)

Based on several features, machines predict what is on the image and show the level of probability



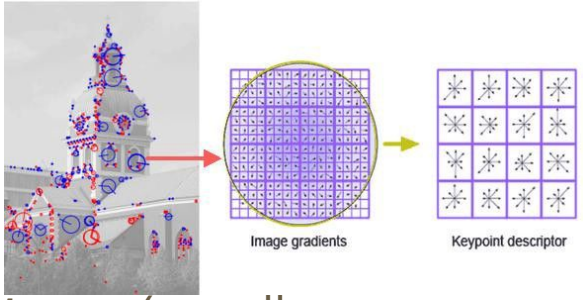
Support vector machines (SVMs)

SVMs are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis

https://medium.com/@dataturks/understanding-svms-for-image-classification-cf4f01232700

1. Dataset (images + tags)
2. Feature extraction
3. Create a SVM classifier
4. Classify a new image

Features



Features can be classified into two categories: **Local features** (usually geometric), **Global features** (usually topological or statistical)

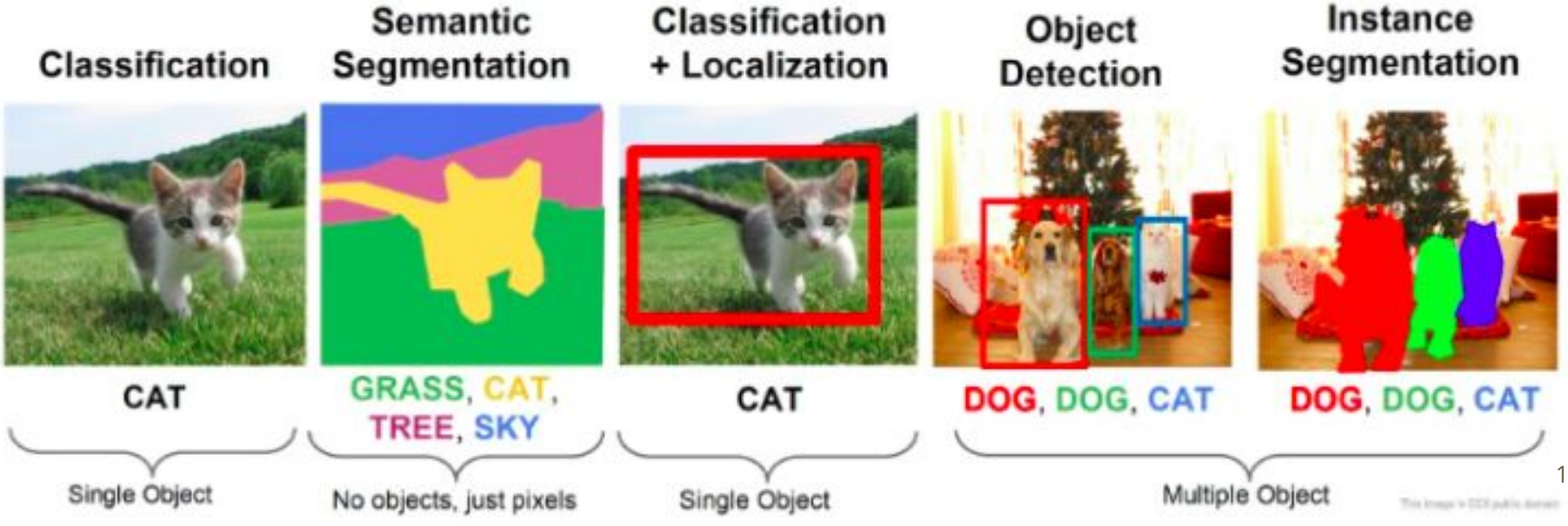
Statistical Features: derived from statistical distribution of points

Global Transformation and Series Expansion Features: invariant to global deformations like translation and rotation. 1. Fourier Transform, 2. Rapid Transform, 3. Hough Transform, 4. Gabor Transform, 5.Wavelets, 6. Moments

Geometrical and Topological Features: encode some knowledge about the contour of the object or may require some knowledge as to what sort of components make up that object

Convolutional Neural Networks (CNNs)

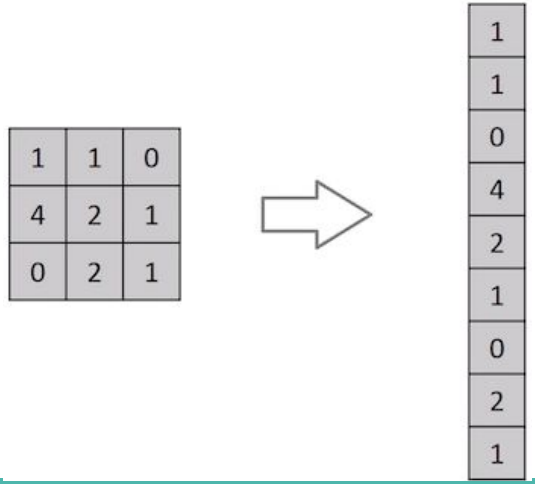
CNNs leverage **spatial information**. First, we see *single pixels*, then from that we recognize *simple geometric forms*, and more sophisticated elements such as *objects, faces, human bodies, animals*, and so on

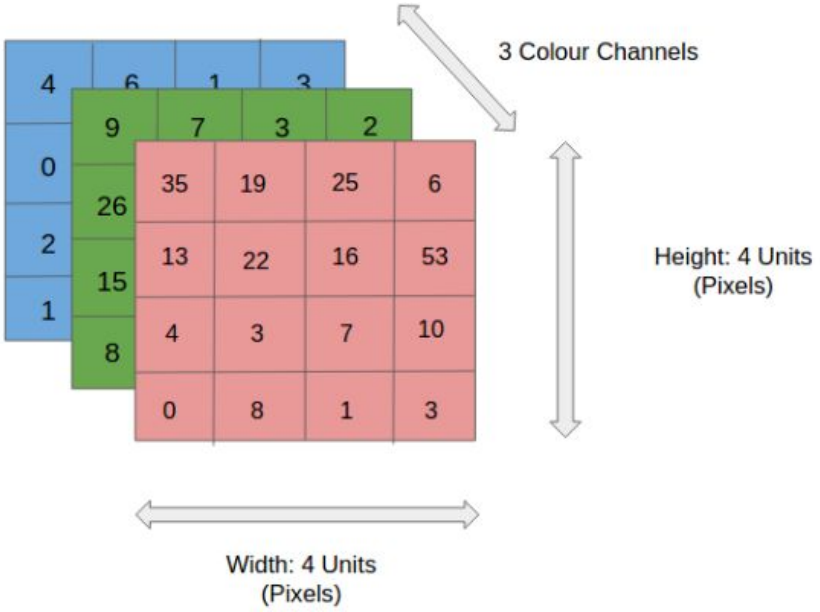


CNN - Pixel Transformation

A CNN is a Deep Learning algorithm which can **take in an input image**, assign importance (*learnable weights and biases*) to various aspects/objects in the image and be able to differentiate one from the other

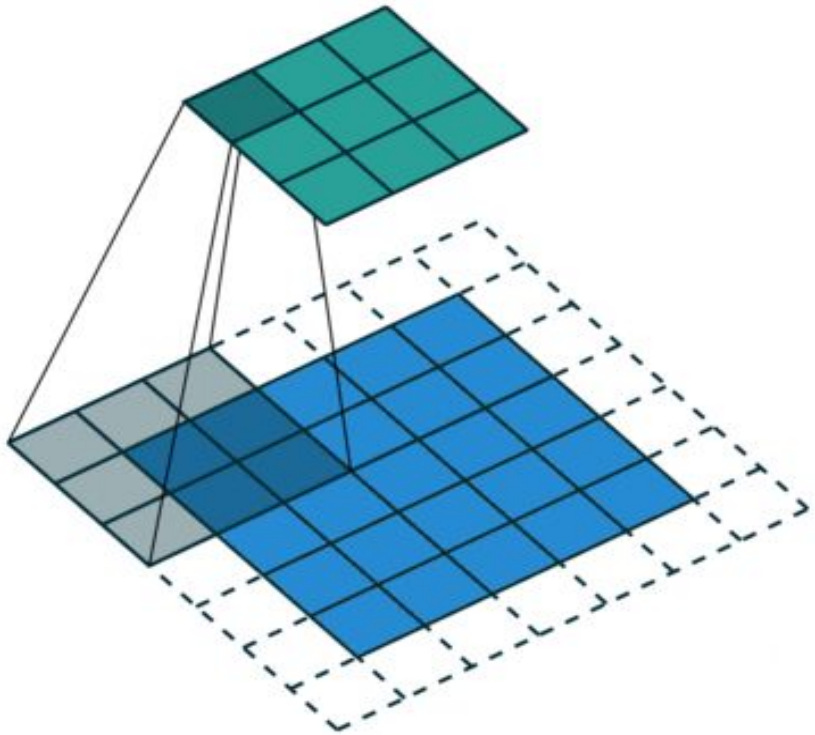
Pixel transformation (from 2D to 1D)





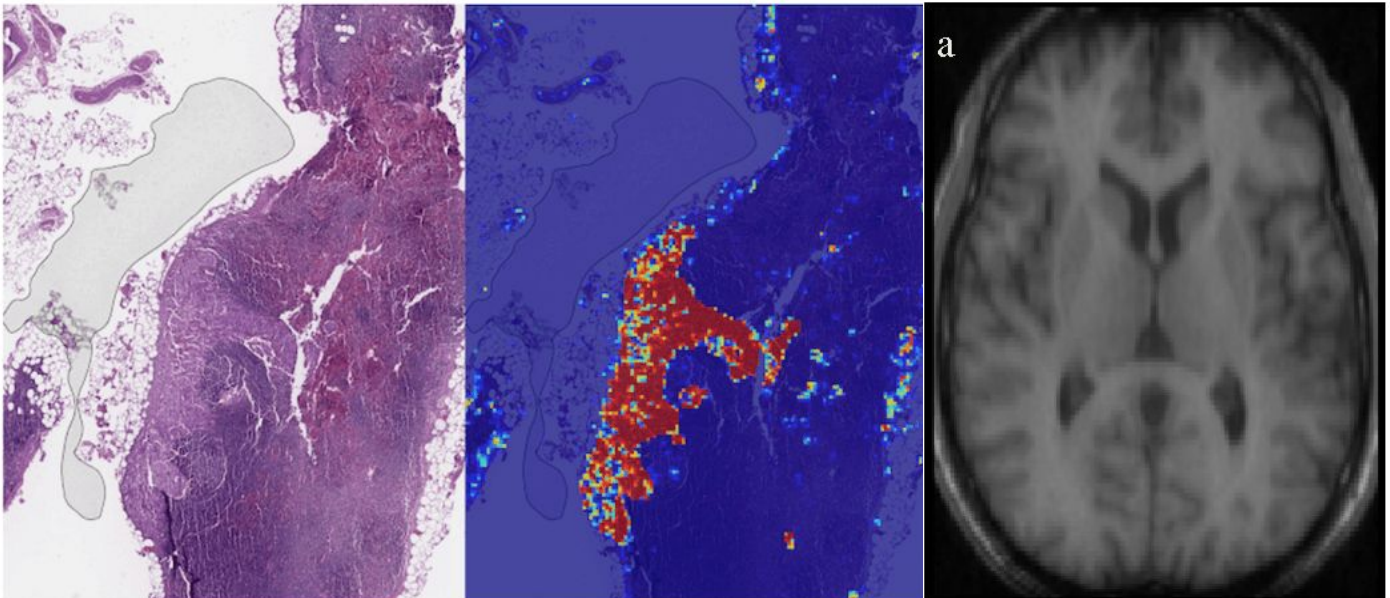
Convolution Layer – The Kernel

5x5x1 image => 3x3x1 image



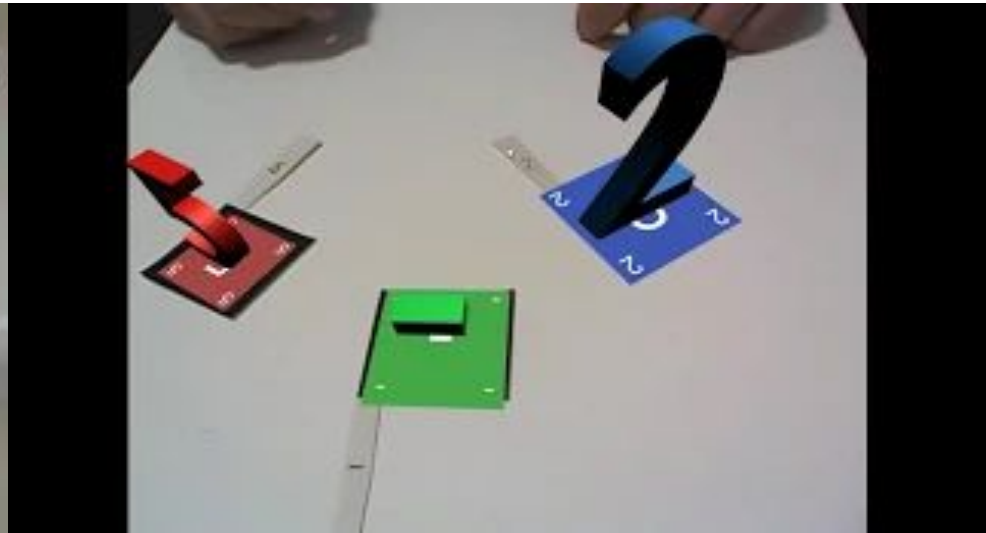
Medical Image Segmentation

The idea of segmentation **is to teach computers to process an image at a pixel level and understand it**. In simple words, *computers can segment an image, paint objects in the image with different colors, and predict what is on it*



AI Augmented Reality For Education

AR/VR have the **potential to improve the learning process** and **better motivate and engage students**. Students have a range of VR tutorials and modeling sessions where t*hey can obtain hands-on experience and polish up their techniques*



AR - Haptic Displays

Haptic, from the Greek, relates to **physical contact or touch**

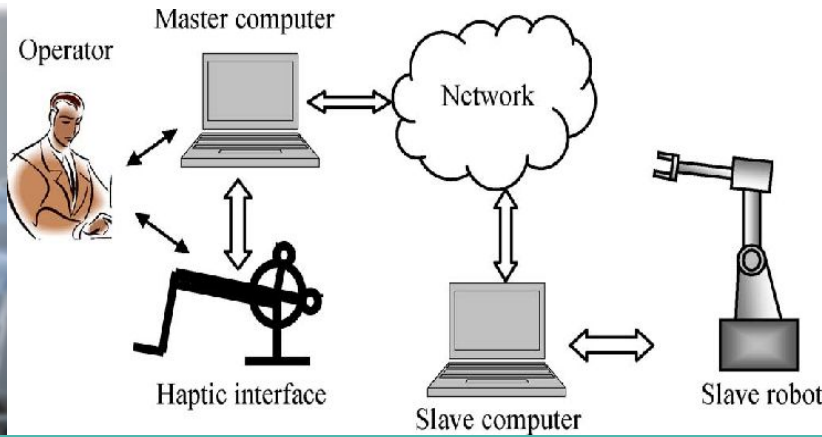
The nature of the haptic interface dictates that it is a form of **both input and output**: *as output it is physical stimuli displayed by the computer*, and because of its *physical connection to the participant, it is also an input device to the computer*

Haptic perception **involves the combined sensations of kinesthesia and taction**

AR - Haptic Displays - Applicability

Use of haptic display in VR is on the rise in applications that involve **training or evaluation of manual tasks**, such as **medical operations or serviceability testing of mechanical equipment**

An example of the latter is a **virtual wrench constrained-by the haptic display system-to only those movements possible in the real world**



VR and AR for Healthcare

The innovation empowers healthcare professionals to provide better diagnosis and make surgery safer. Using AI coupled with CV and AR, *surgeons can now place surgical incisions more precisely and prevent tissue damage*


xvision
Sagittal
Axial
Augmedics
xvision

Using AI in Medical Projects

Tuberculosis (2D images and CT Scans)

Atrial Fibrillation (ECG)

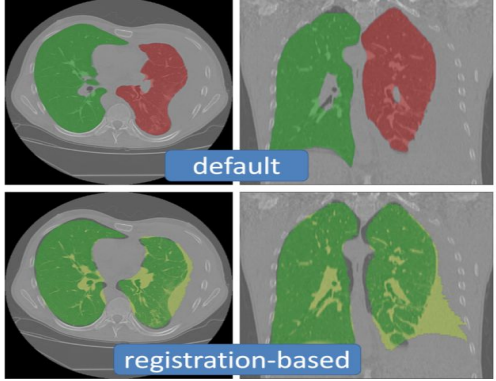
Colorectal Cancer (Numerical data)

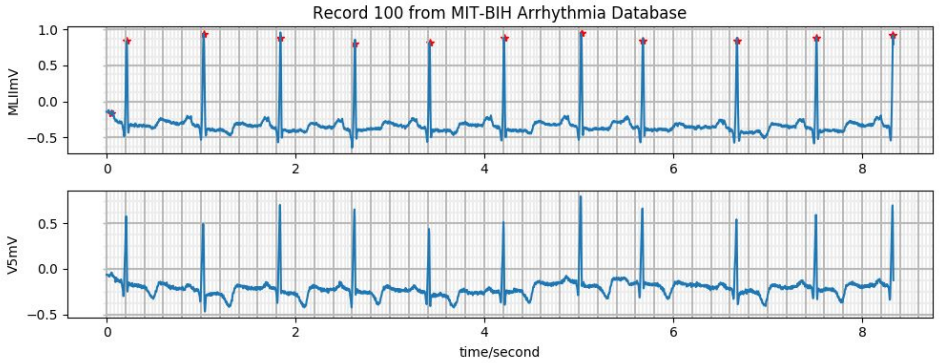
Stroke (2D images)

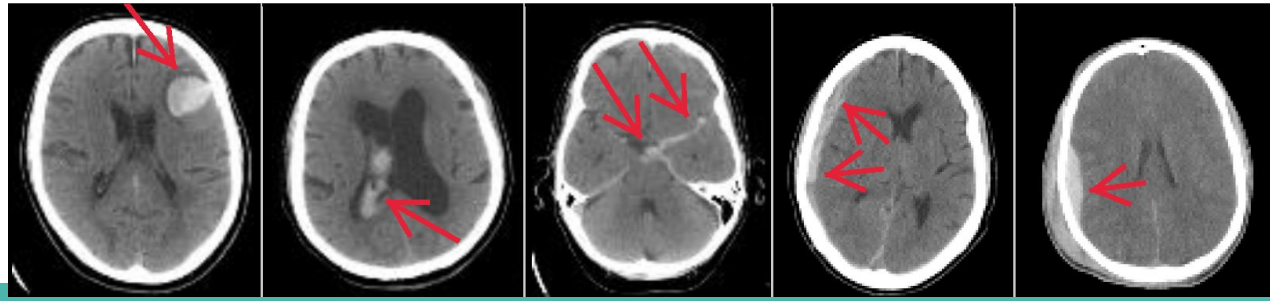
RSNA (2D images)

Alzheimer (2D images)

Sound processing







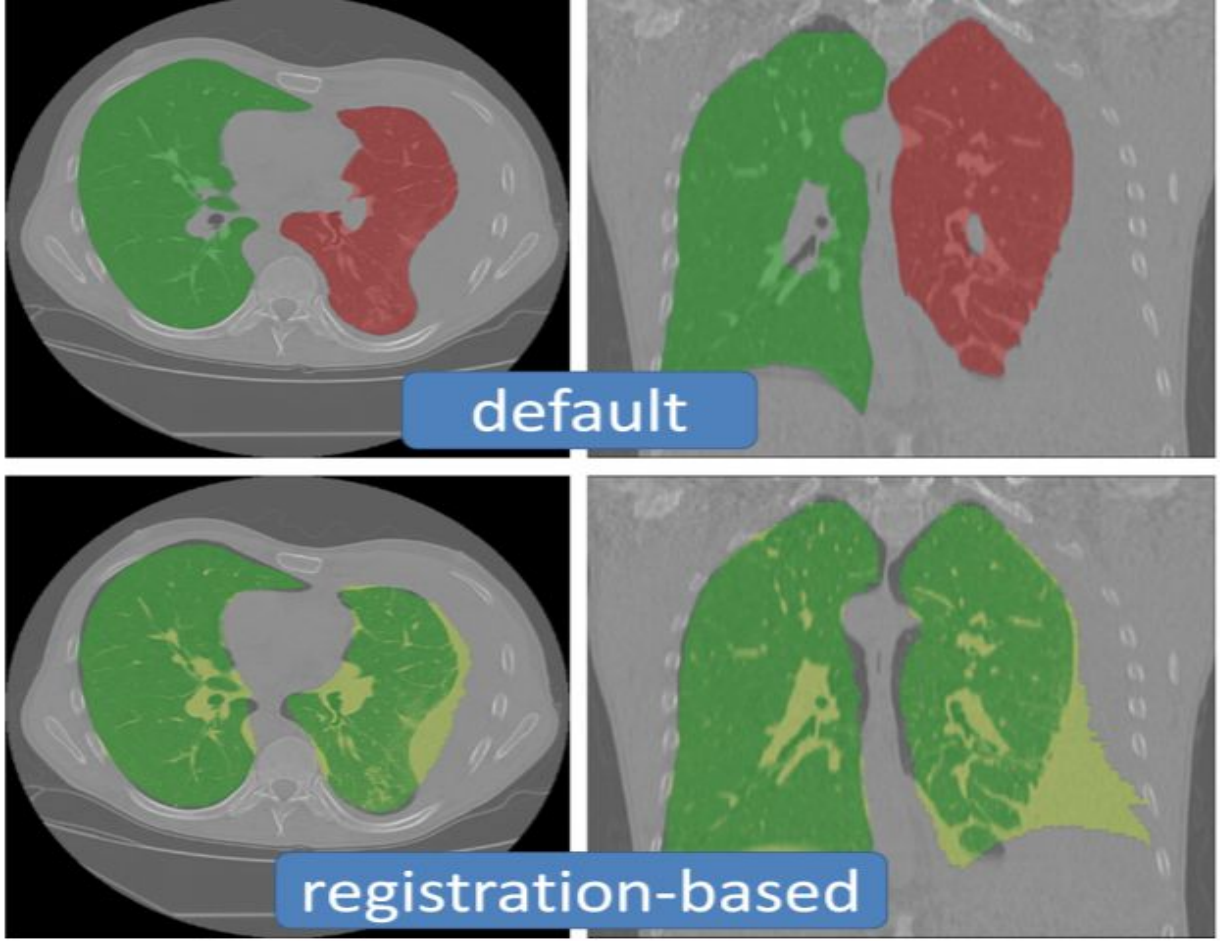


Fig. 1. CT image of a TB patient having pleurisy with the default lung masks (top) and the lung masks obtained via registration-based approach (bottom).

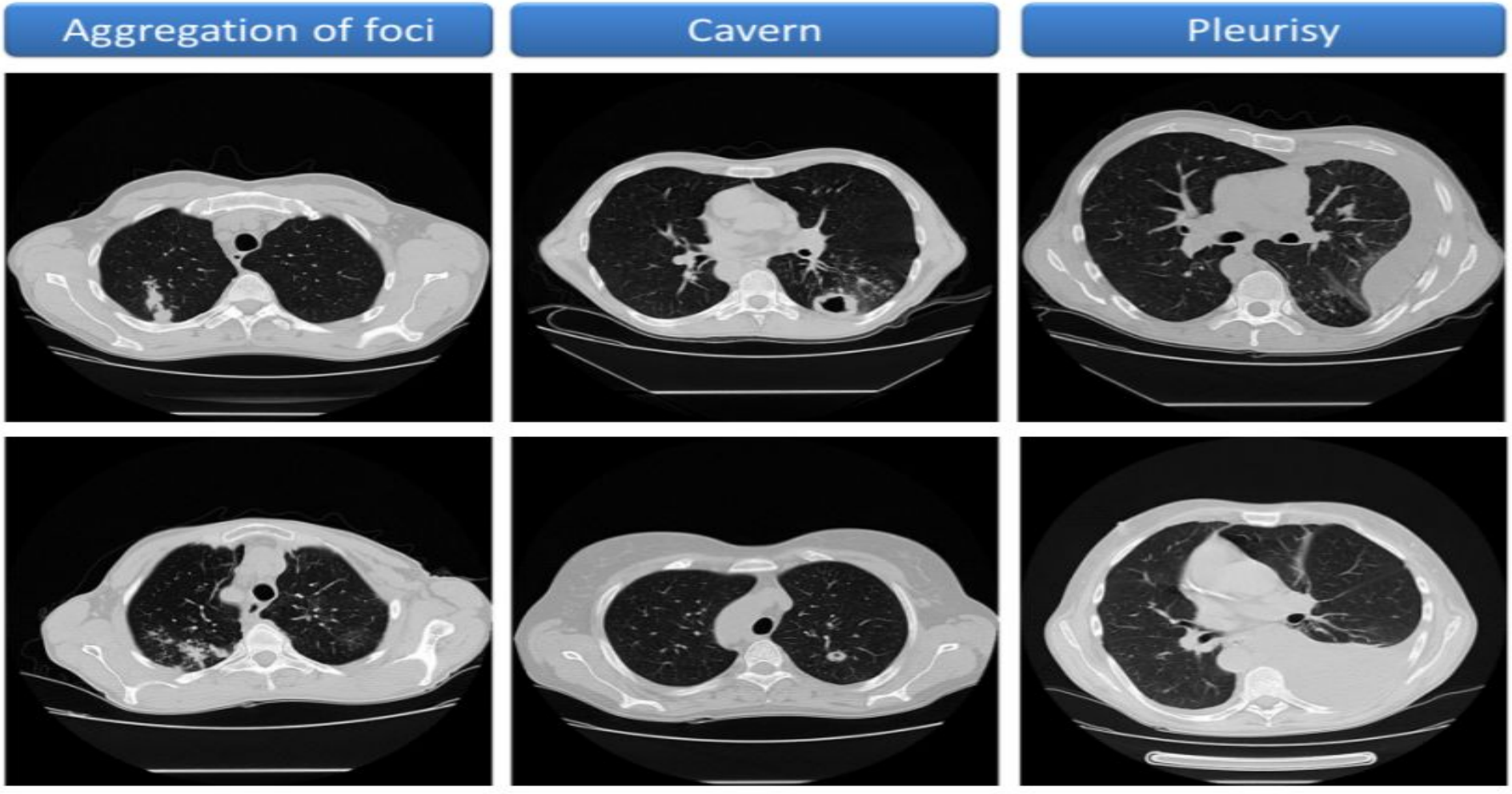
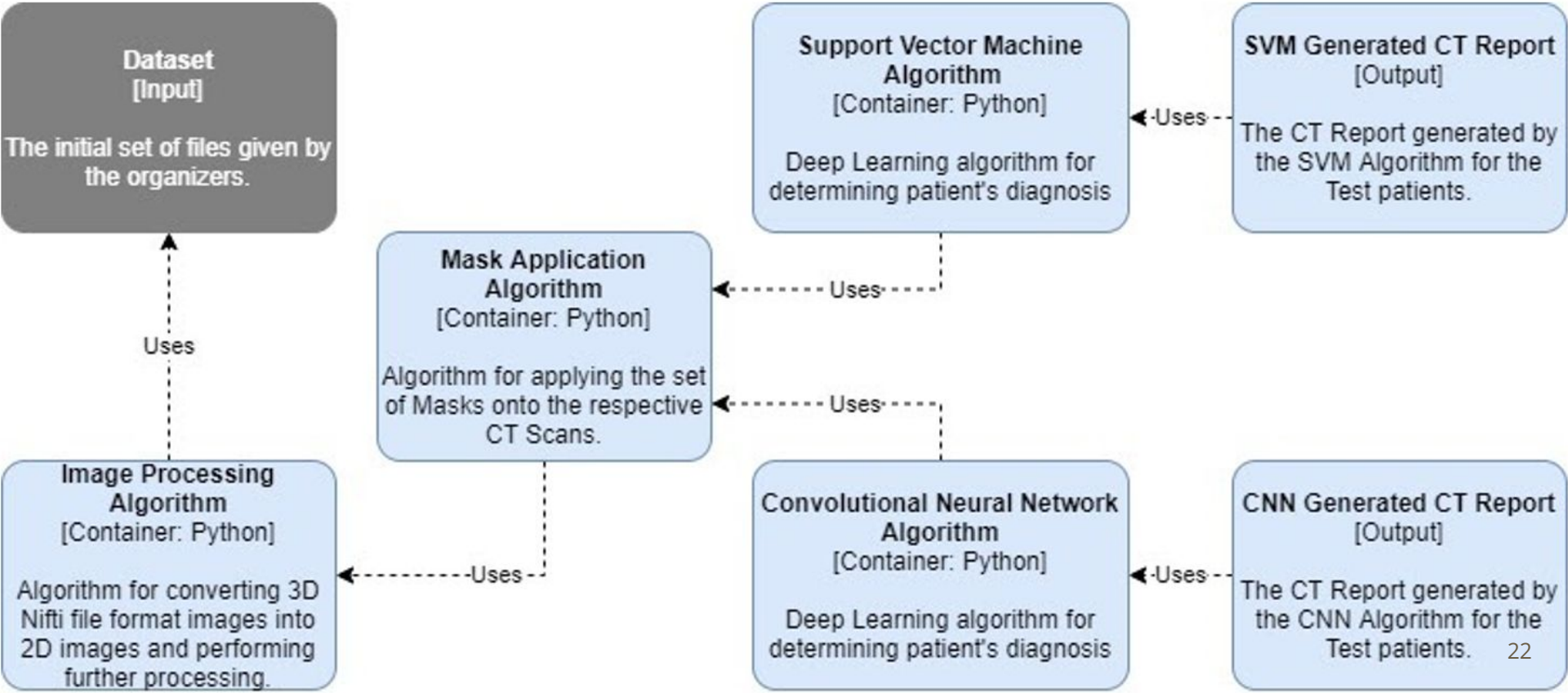


Fig. 2. Slices of typical CT images with three types of the TB-related findings.

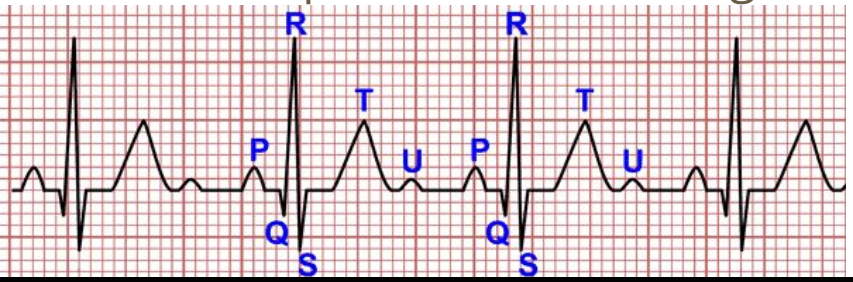
Tuberculosis - Alexandra, Cristian

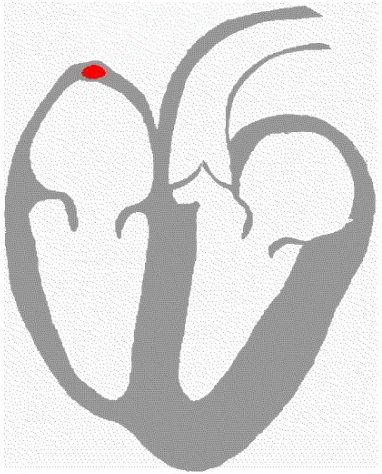


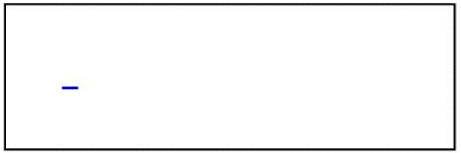
ECG Biometrics

A way to identify persons by the morphology of the electrocardiogram, identification based on differentiated characteristics

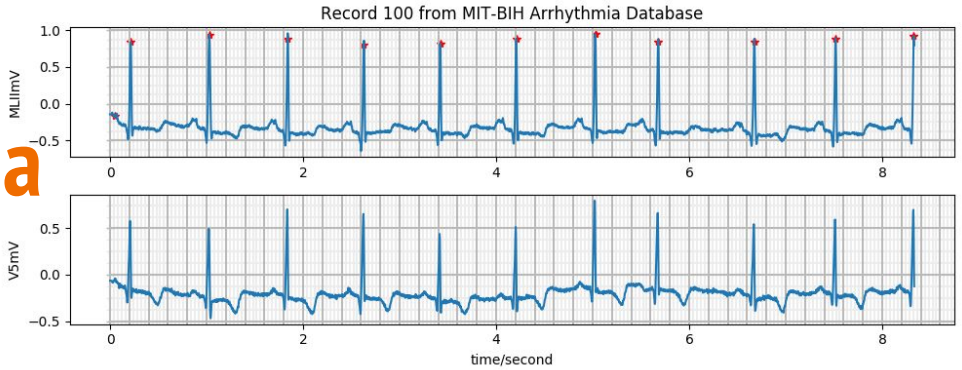
Features: points P and T along with the QRS complex







Atrial Fibrillation - Camelia

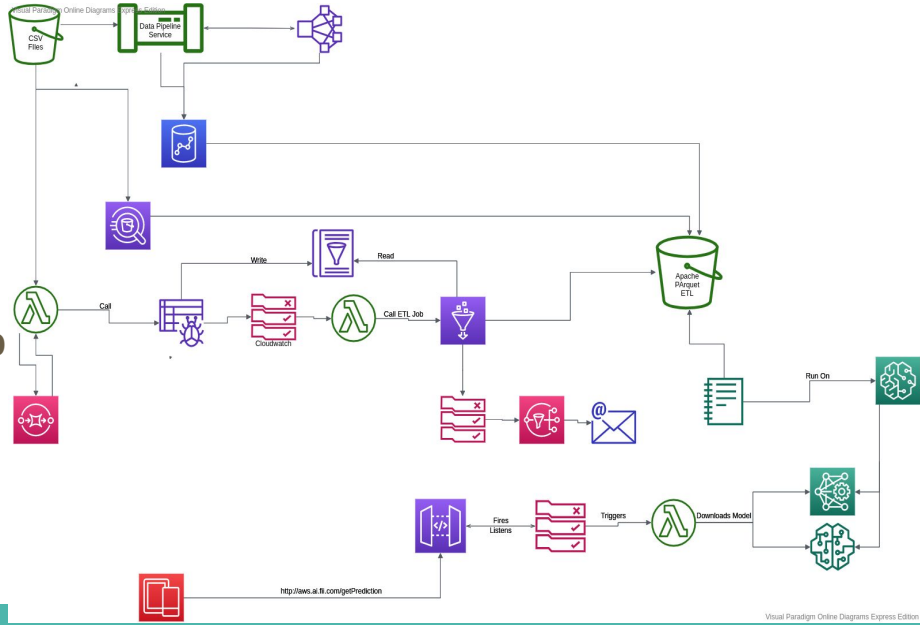


In collaboration with **Alexandru Burlacu**

Data 87,554 train individuals and around 21,892 test individuals from the PTB and MIT DB datasets available open-source

- BNN (Bayesian Neural Network) ~ 90%
- CNN Conv 1D ~ 95%
- RNN Model ~ 88%
- CNN Conv 1D with preprocessing ~ **98%**

Other solutions ~ 97.5



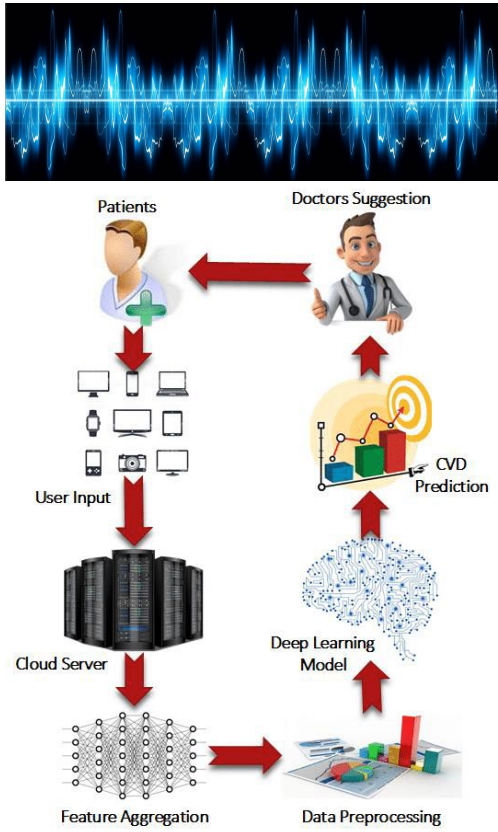
Sound Processing - Improve Patient Health - Mihai C.

Project with two parts:

Diagnosis - using machine learning methods (e.g., neural networks, decision trees) on audio data, determine the presence/absence of a disease;

Treatment - using various methods (machine learning & data mining) on text data, provide guidance in terms of medication, nutrition, daily activities, etc.

The information the medic and patient receive needs to be trustworthy and clear (e.g., it should be explained why an illness was found).



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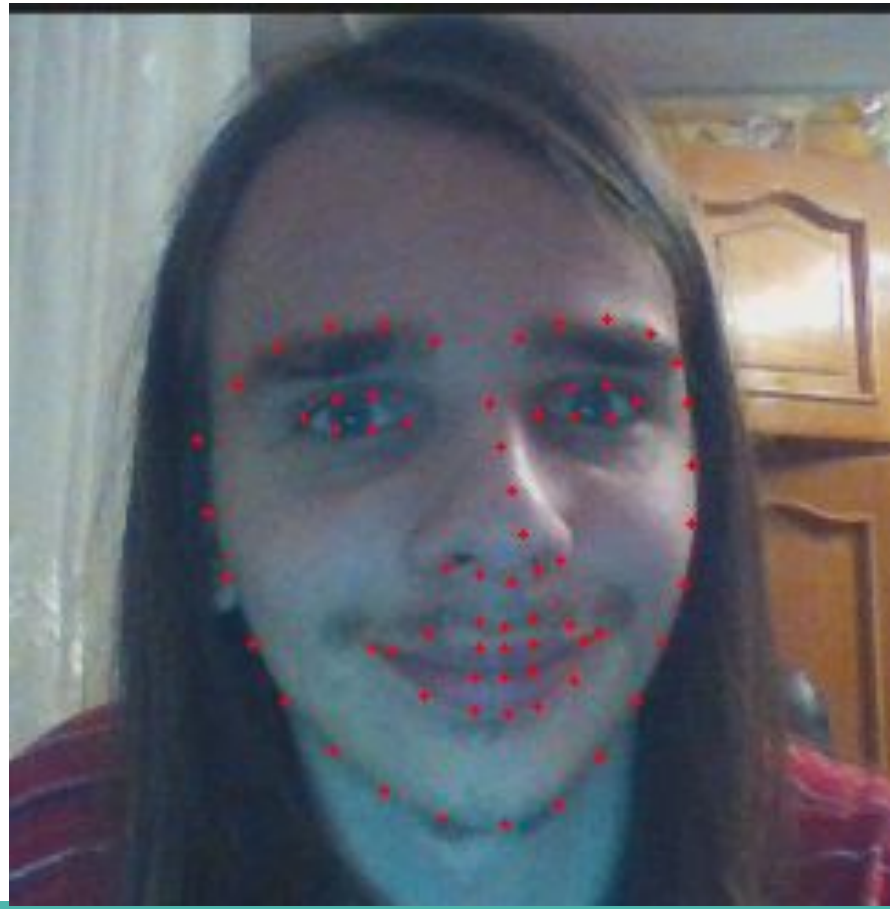
Hack4Life, Be a Stroke Hero

Hack4Life, Be a Stroke Hero, first hackathon dedicated to early detection of stroke signs and mapping the nearest relevant hospitals for stroke management within North-East Region, was organized IMAGO-MOL Cluster on 15th of February 2020

Stroke - Mihnea

Face Asymmetry formula:

- **mouth asymmetry**
- **eye asymmetry**
- **general asymmetry of the face**
- **the final score**



REVERT Project - ImagoMol

taRgeted thErapy for adVanced colorEctal canceR paTients - Horizon 2020, SC1-BHC-02-2019: Systems approaches for the discovery of combinatorial therapies

Address at systems level the **pathophysiology of advanced colorectal cancer in patients responding well or poorly to therapies, with the goal to design an optimal strategy for therapeutic interventions depending on patients' features**

https://www.imago-mol.ro/revert-targeted-therapy-for-advanced-colorectal-cancer-patients/

https://cordis.europa.eu/project/id/848098

REVERT - Partners

- SAN RAFFAELE ROMA SRL (IT)
- AZIENDA ULSS 4 VENETO ORIENTALE (IT)
- MALMO UNIVERSITY (SE)
- GENXPRO GMBH (GE)
- FEDERAL INSTITUTE FOR MATERIALS RESEARCH AND TESTING (GE)
- UMEA UNIVERSITY (SE)
- BIOVARIANCE GMBH (GE)
- FUNDACION UNIVERSITARIA SAN ANTONIO (ES)
- REGIONAL INSTITUTE OF ONCOLOGY IASSY (RO)
- INSTITUTO MURCIANO DE INVESTIGACIONES BIOSANITARIAS – HOSPITAL UNIVERSITARIO SANTA LUCIA (ES)
- LUXEMBOURG INSTITUTE OF HEALTH (LU)
- CLUSTERUL REGIONAL INOVATIV DE IMAGISTICA MOLECULARA SI STRUCTURALA NORD-EST (RO)
- OLOMEDIA SRL (IT)
- UNIVERSITY OF ROME TOR VERGATA (IT)

REVERT - How?

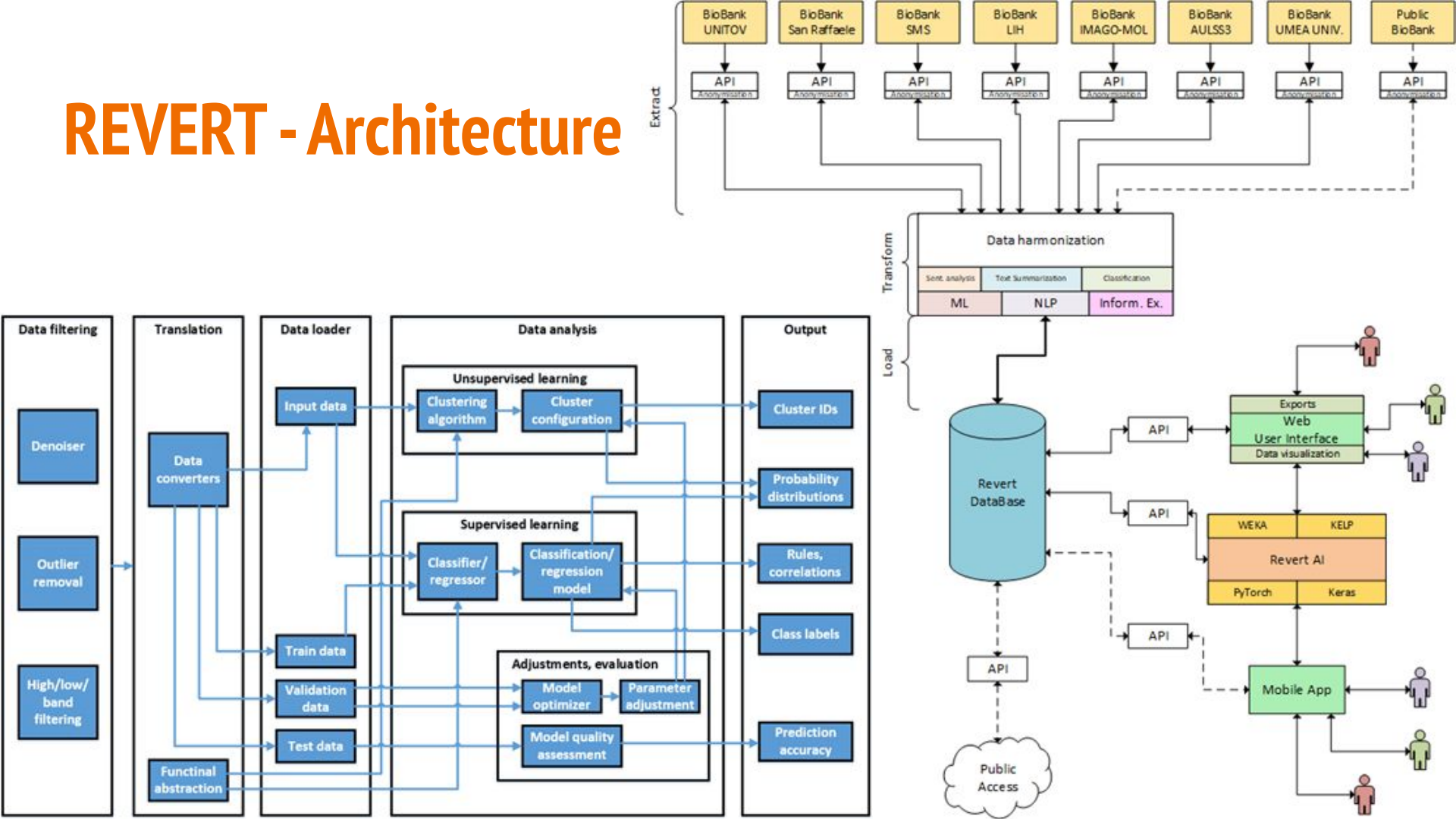
The goal will be achieved using a **large number of standardised biobank samples and clinical databases from several clinical European centres**, including known and new potential prognostic biomarkers

Following the **AI-based data analysis, results will be evaluated for the REVERT-DataBase impact on survival and quality of life in prospective clinical trials**

The project will also generate a broad network among industrial and academic partners focused on the **development of personalised medicine**

Date of Birth
Sex
Age
ECOG
SBP
DBP
BMI
W/H
Smoking habit
Alcohol consumption
Coffee consumption
IBD
Unbalanced dietary intake
Date of symptoms onset
Comorbidity index
Concurrent treatment
Cancer familiarity
CRC Sidedness
Histology
GRADING
T stage at diagnosis
N stage at diagnosis
M stage at diagnosis
Venous invasion
Perineural invasion
Leucocyte infiltrate
Immunoscore (CD8, CD3)
Tumor deposits
Tumor budding
Cytoplasmic pseudofragments
Tumour growth pattern
K-RAS mut
N-RAS mut
BRAF mut
EGFR mut
MSI
PIK3CA
PDL1
CIMP status
HER2-neu
Date of primary surgery
Date of NDJ
Type of NDJ

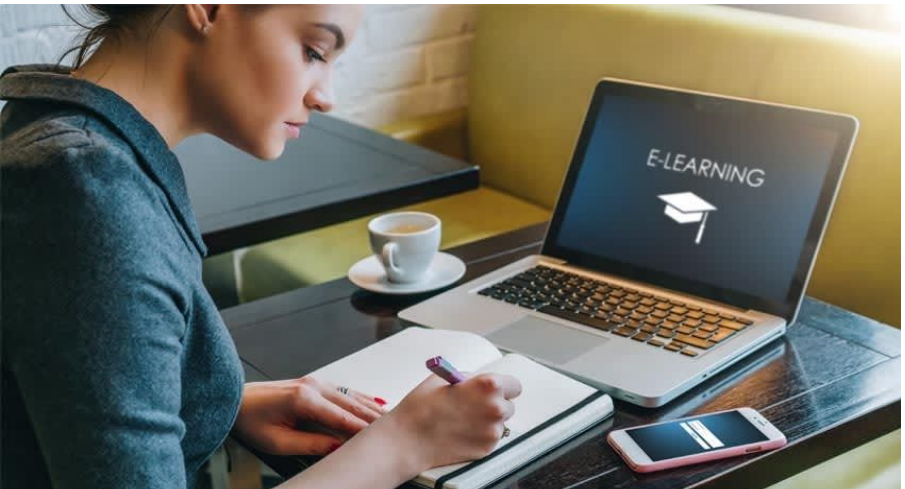
REVERT - Architecture

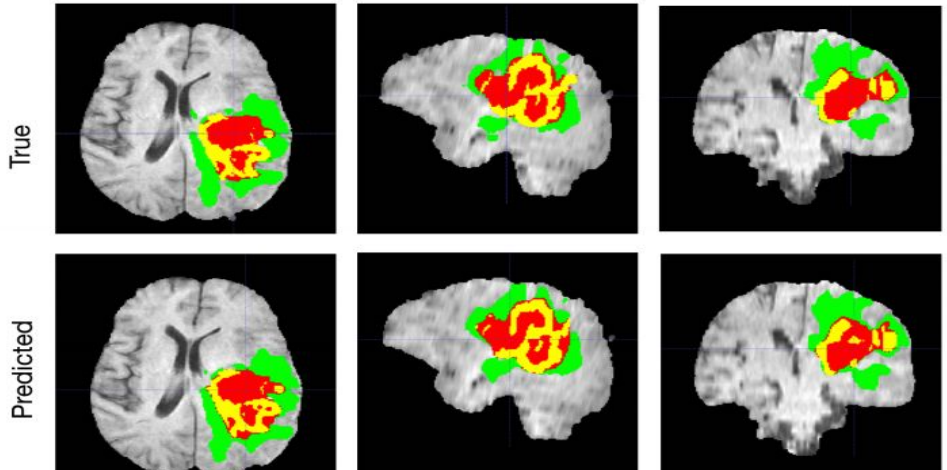


Conclusions

AI can help us **manage large volumes of data**, based on which to create complex models that will later help us in rapid diagnosis

AI **can identify small differences** (color, shape, sound) that are not perceptible to the human eye or ear and can signal abnormalities

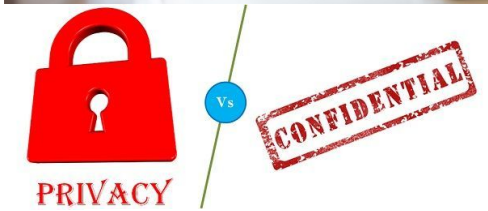




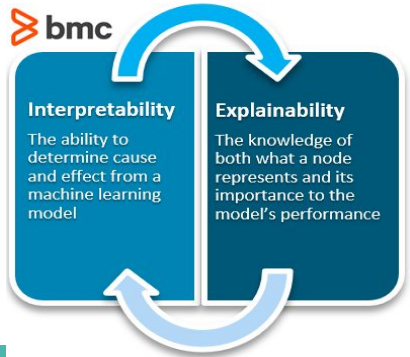
Current and Future Work

Medical expertise is very important - ImagoMol Cluster helps us to collaborate and to work at common projects

Issues are related to data **confidentiality and privacy**



Another problem is related to the **trust we have in the solutions offered by AI**



Links

Adrian Iftene (2020) *Using Artificial Intelligence in Medicine*

Adrian Iftene (2020) *Introduction to mixed reality*
https://profs.info.uaic.ro/~adiftene/Scoala/2021/IMR/index.html

AR/VR Projects from Faculty of Computer Science

https://www.youtube.com/watch?v=ldO33rPhKXc&list=PLddW60TN_y-WsMfQoEcz-O-6QdZJ8wZ3y


thank
you