# Artificial Intelligence in Medicine


دکتر نسیبه رادی راز

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دانشگاه علوم پزشکی و خدمات بهداشتی درمانی ایران

## عنوان دوره آنلاین:

# هوش مصنوعی در پزشکی با رویکرد بالینی

# Online Course: Artificial Intelligence in Medicine with Clinical Approach

| Course Topics | عناوین بیست و چهار جلسه | تاریخ جلسات |
|---|---|---|
| Artificial Intelligence (AI) in medicine | معرفی هوش مصنوعی در پزشکی | ۲۸بهمن ۱۴۰۲ |
| AI and Fuzzy systems and its applications in medicine | هوش مصنوعی و سیستم های فازی در پزشکی | ۵ اسفند ۱۴۰۲ |
| Machine Learning and its applications in medicine | یادگیری ماشین و کاربردهای آن در پزشکی | ۱۲اسفند۱۴۰۲ |
| Evolutionary systems and its applications in medicine | الگوریتم های بهینه سازی تکاملی و کاربردهای آن در پزشکی | ۱۹اسفند ۱۴۰۲ |
| Neural networks and deep neural networks in medicine | شبکه های عصبی و شبکه های عصبی عمیق در پزشکی | ۲۵فروردین ۱۴۰۳ |
| Application of AI in Early Detection of Disease | کاربرد هوش مصنوعی در تشخیص زودهنگام بیماری ها | ۱ اردیبهشت ۱۴۰۳ |
| Swarm Intelligence and multi-agent/swarm in medicine | هوش ازدحامی، سیستم های چند عامله/ازدحامی در پزشکی | ۸اردیبهشت ۱۴۰۳ |
| Application of AI in Cancer | کاربردهای هوش مصنوعی در سرطان | ۲۲اردیبهشت ۱۴۰۳ |
| Application of AI in surgery | کاربردهای هوش مصنوعی در جراحی | ۲۹ اردیبهشت ۱۴۰۳ |
| Applications of AI in Neurology | کاربردهای هوش مصنوعی در مغز و اعصاب | ۵ خرداد ۱۴۰۳ |
| Application of AI in Internal Medicine | کاربردهای هوش مصنوعی در پزشکی داخلی | ۱۲ خرداد ۱۴۰۳ |
| Applications of AI in cardiovascular | کاربردهای هوش مصنوعی در قلب و عروق | ۱۹ خرداد ۱۴۰۳ |
| Applications of AI in Breast Disease | کاربردهای هوش مصنوعی در بیماری های پستان | ۲۶ خرداد ۱۴۰۳ |
| Application of AI in Ophthalmology | کاربردهای هوش مصنوعی در چشم پزشکی | ۲ تیر ۱۴۰۳ |
| Application of AI in Nephrology | کاربردهای هوش مصنوعی در نفرولوژی | ۹ تیر ۱۴۰۳ |
| Application of AI in Otorhinolaryngology | کاربردهای هوش مصنوعی در گوش و حلق و بینی | ۱۶ تیر ۱۴۰۳ |
| Application of AI in Gynecology and obstetrics | کاربردهای هوش مصنوعی در زنان و مامایی | ۲۳ تیر ۱۴۰۳ |
| Application of AI in pediatric medicine | کاربردهای هوش مصنوعی در پزشکی اطفال | ۳۰ تیر ۱۴۰۳ |
| Application of AI in anesthesia | کاربردهای هوش مصنوعی در بیهوشی | ۶ مرداد ۱۴۰۳ |
| Application of AI in emergency medicine | کاربردهای هوش مصنوعی در پزشکی اورژانس | ۱۳ مرداد ۱۴۰۳ |
| Applications of artificial intelligence in orthopedics | کاربردهای هوش مصنوعی در ارتوپدی | ۲۰ مرداد ۱۴۰۳ |
| Application of AI in pain management | کاربردهای هوش مصنوعی در مدیریت درد | ۲۷ مرداد ۱۴۰۳ |
| Application of AI in pharmacology | کاربردهای هوش مصنوعی در داروسازی | ۳ شهریور ۱۴۰۳ |
| Application of AI in dentistry | کاربردهای هوش مصنوعی در دندان پزشکی | ۱۰ شهریور ۱۴۰۳ |

# Artificial Intelligence (AI)

- **A Multidisciplinary field of study:**

  Computer Engineering + Control Engineering+

  Linguistics+ Cognitive Sciences + …

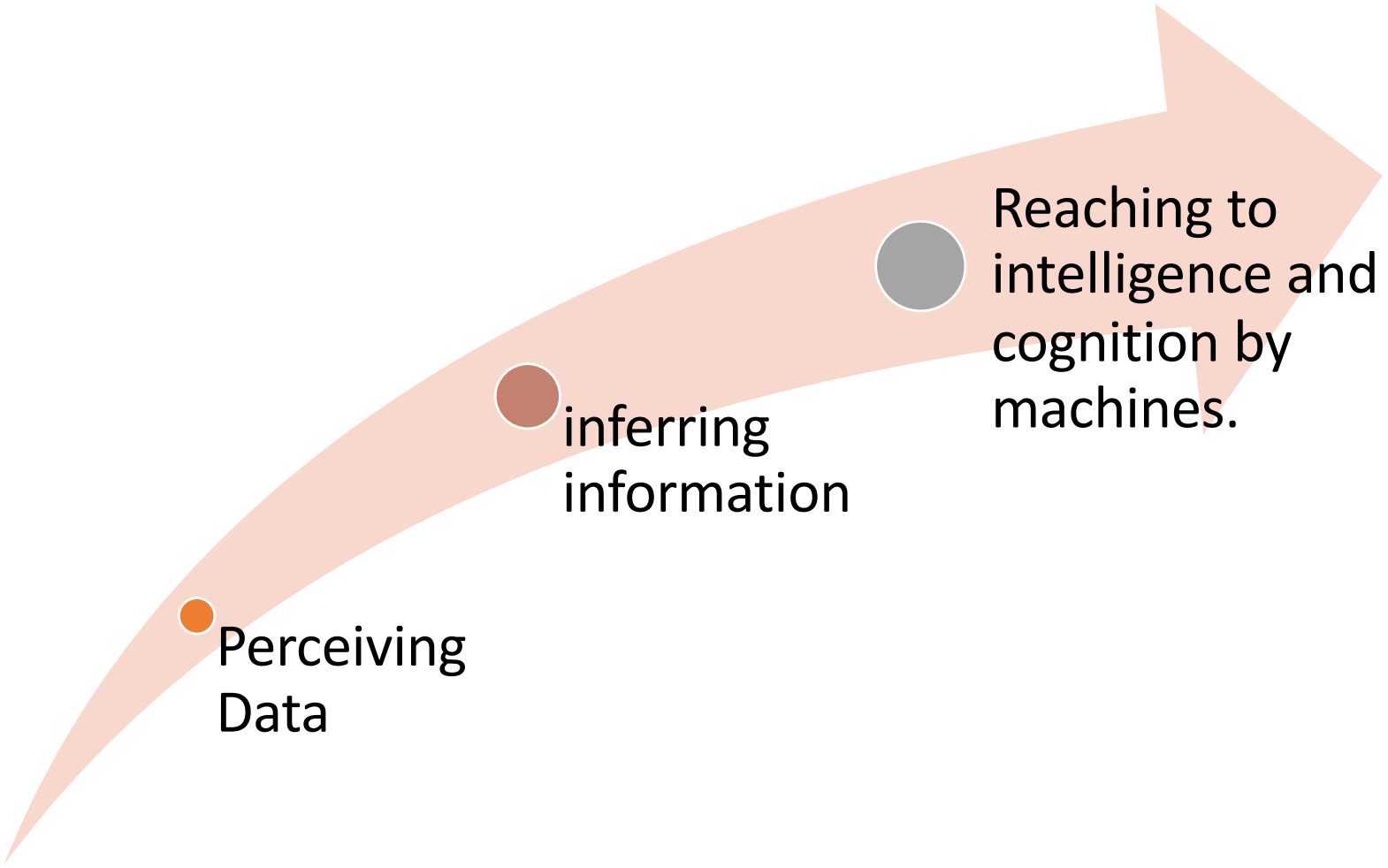
Mathematical Equations for Systems Representation

Programming for Systems Creation

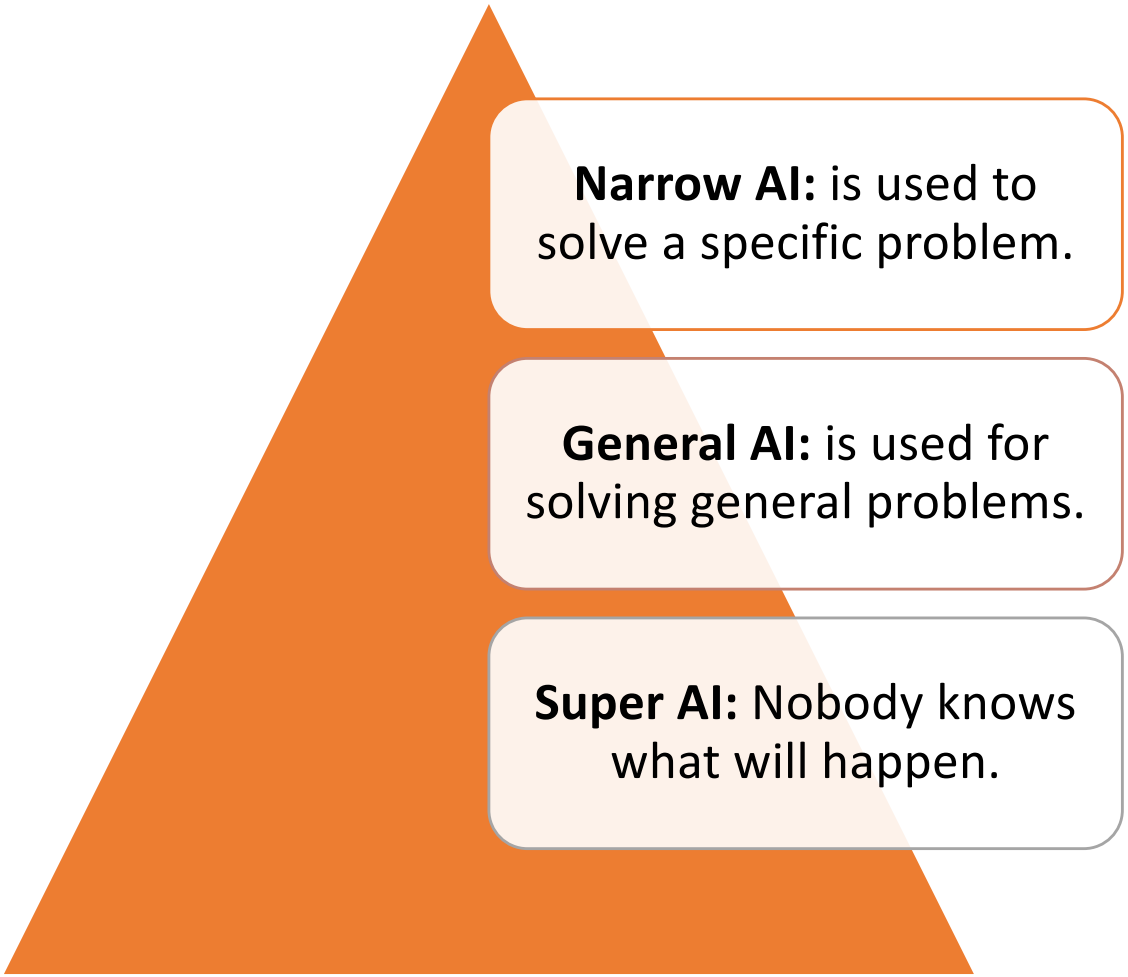
Hardware for Systems Processing

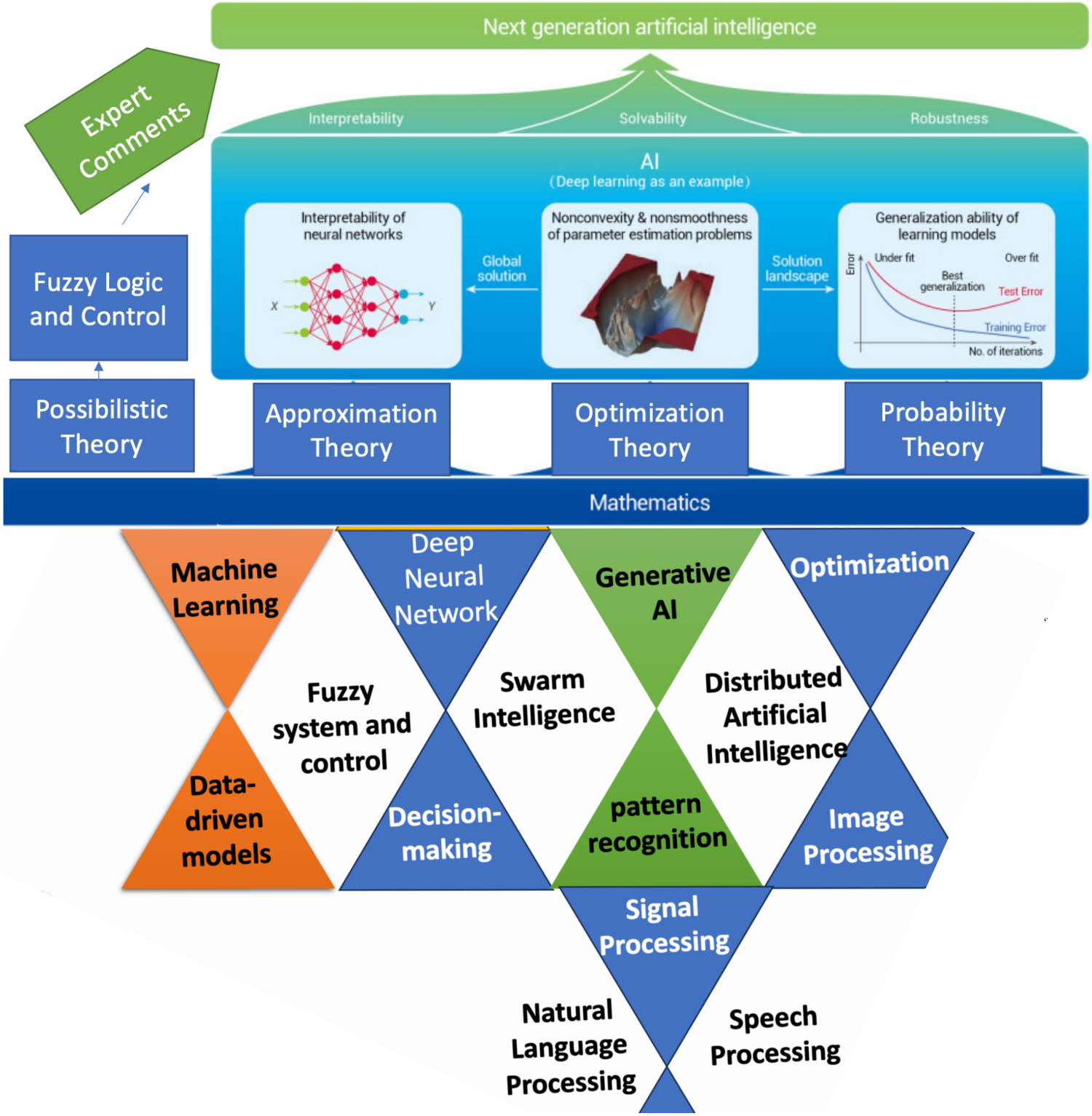
Cognitive Approaches for Human-Machine Interaction

# AI Aim is …

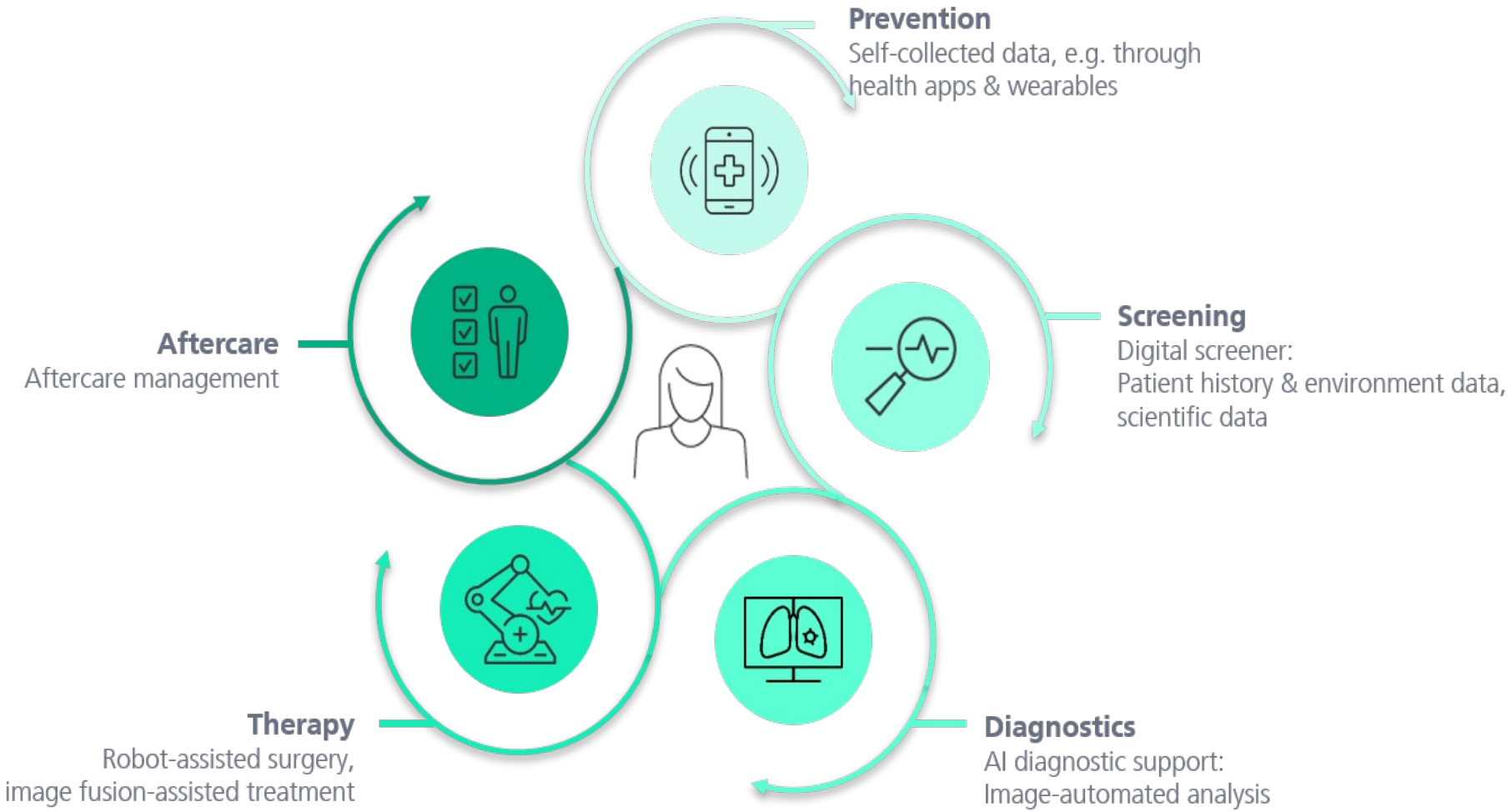

Reaching to intelligence and cognition by machines.
inferring information
Perceiving Data

# Type of AI

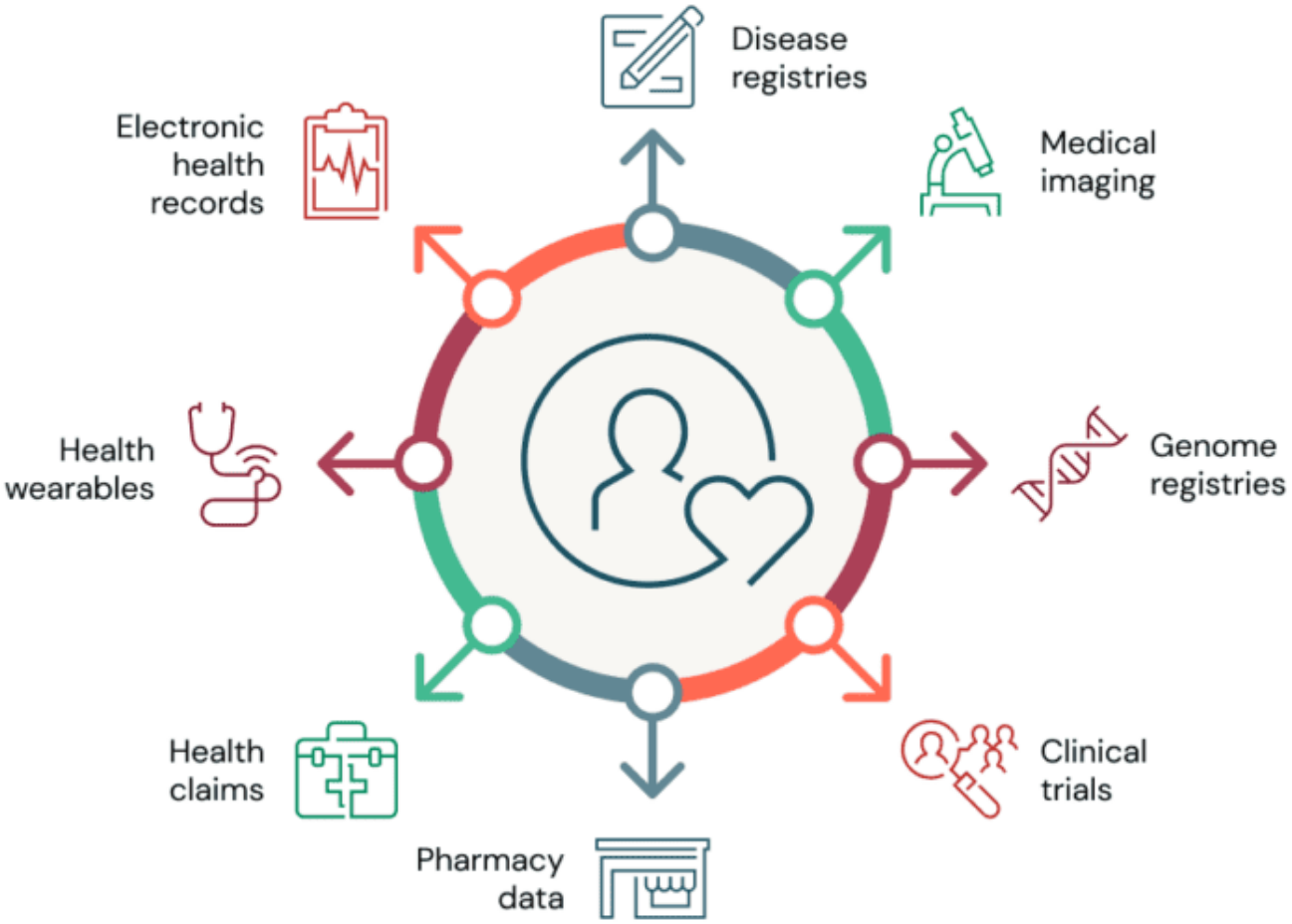

**Narrow AI:** is used to solve a specific problem.
**General AI:** is used for solving general problems.
**Super AI:** Nobody knows what will happen.


Next generation artificial intelligence
Expert Comments
Interpretability
Solvability
Robustness
AI
(Deep learning as an example)
Interpretability of neural networks
X
Y
Global solution
Nonconvexity & nonsmoothness of parameter estimation problems
Solution landscape
Generalization ability of learning models
Error
Under fit
Over fit
Best generalization
Test Error
Training Error
No. of iterations
Fuzzy Logic and Control
Possibilistic Theory
Approximation Theory
Optimization Theory
Probability Theory
Mathematics
Machine Learning
Deep Neural Network
Generative AI
Optimization
Fuzzy system and control
Swarm Intelligence
Distributed Artificial Intelligence
Data-driven models
Decision-making
pattern recognition
Image Processing
Signal Processing
Natural Language Processing
Speech Processing

# The digital patient journey

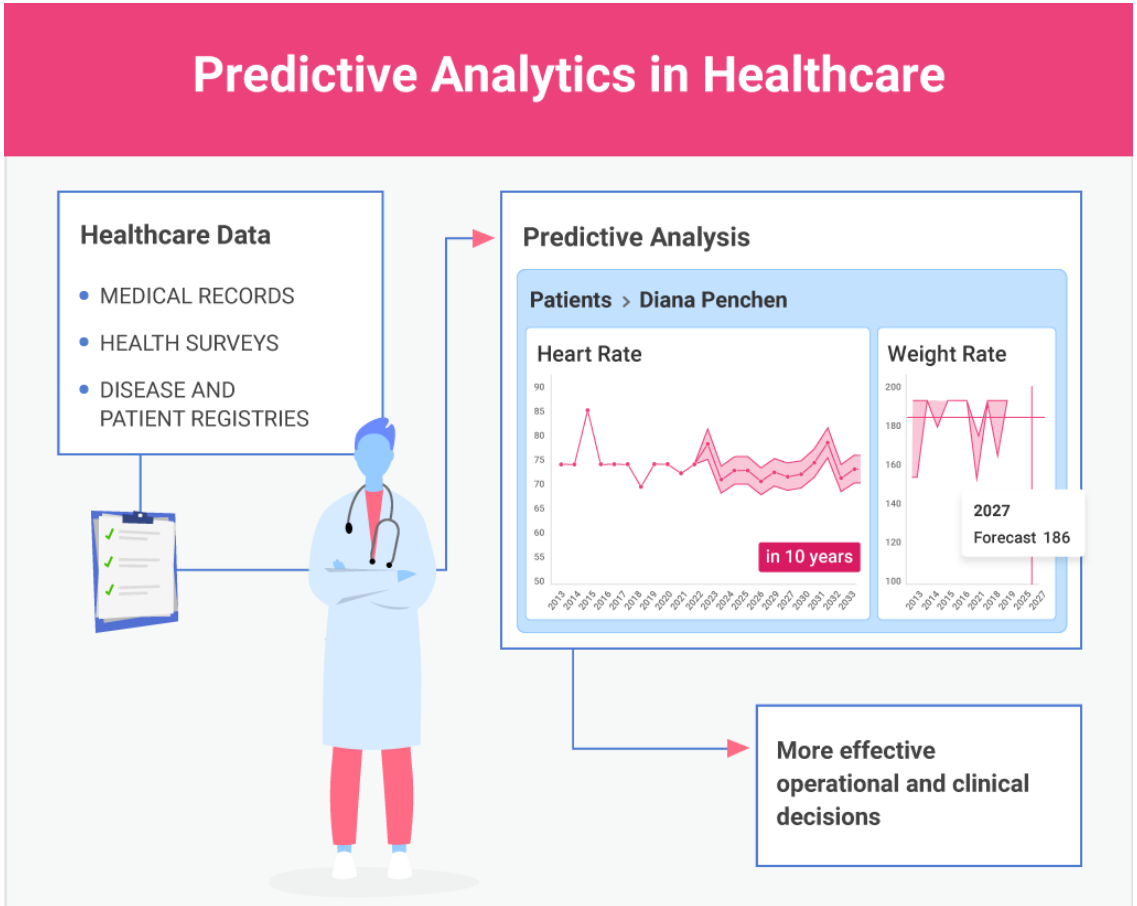


# A single patient produces 80+ megabytes of medical data every year



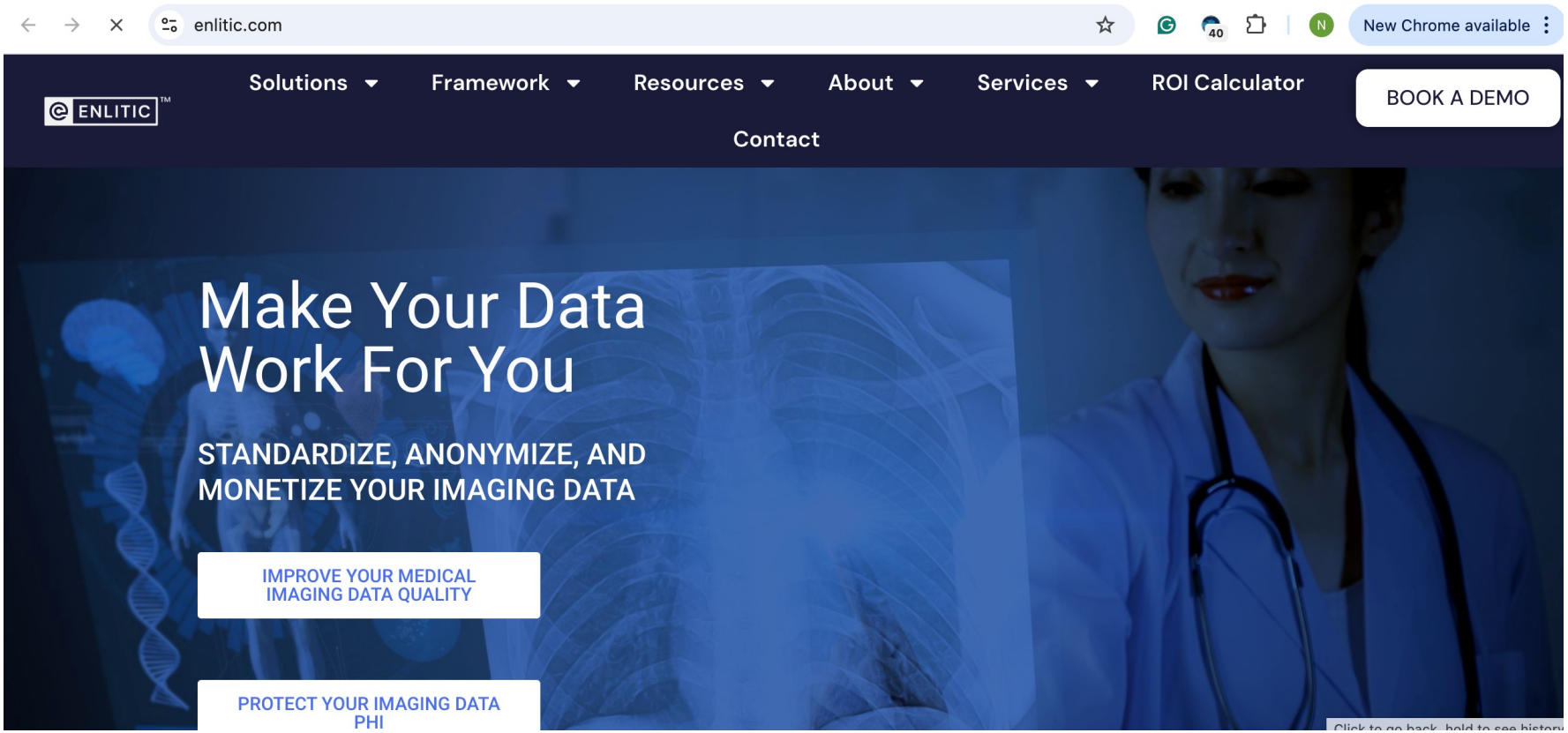
# Predictive analytics

- The ability to monitor patients and prevent patient emergencies before they occur by analyzing data for key indicators.



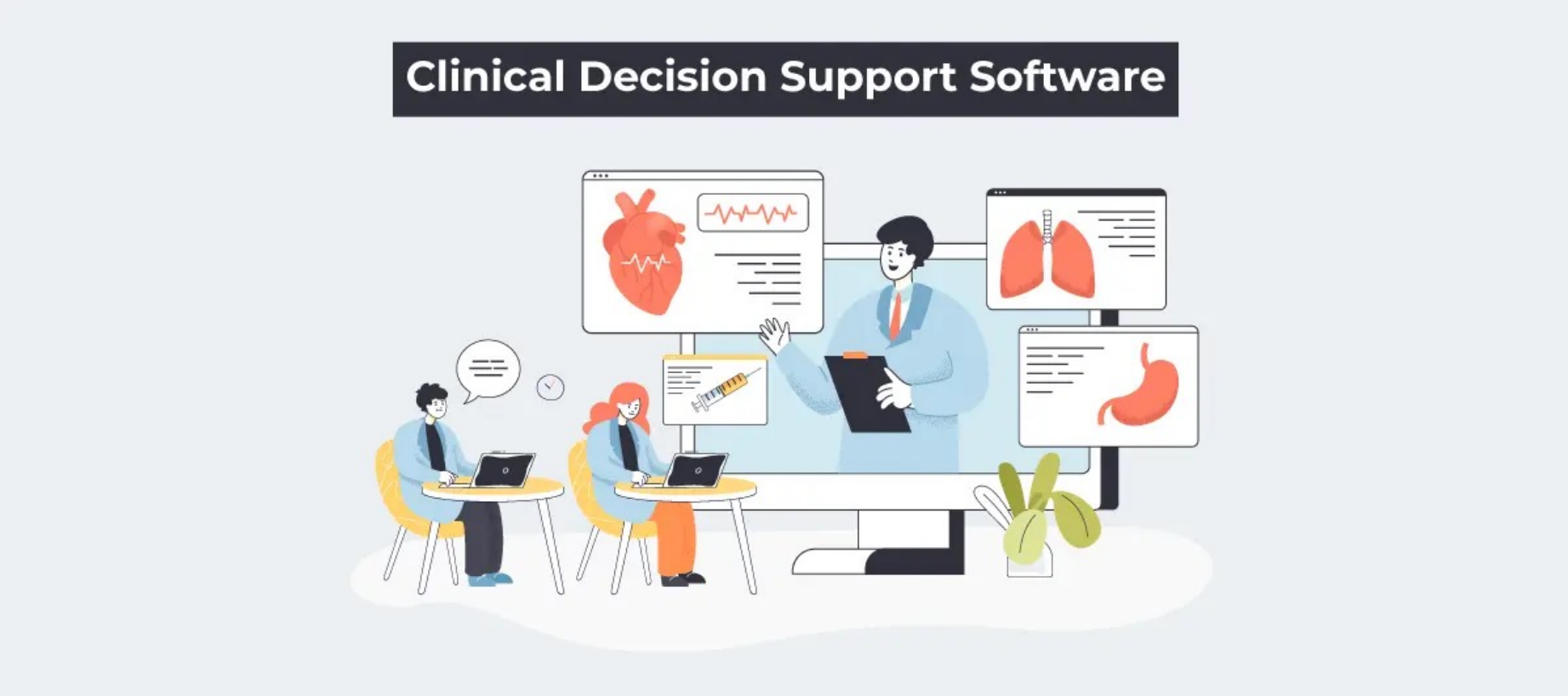
# Managing medical imaging data

Reduce mundane data routing tasks for PACS administrators



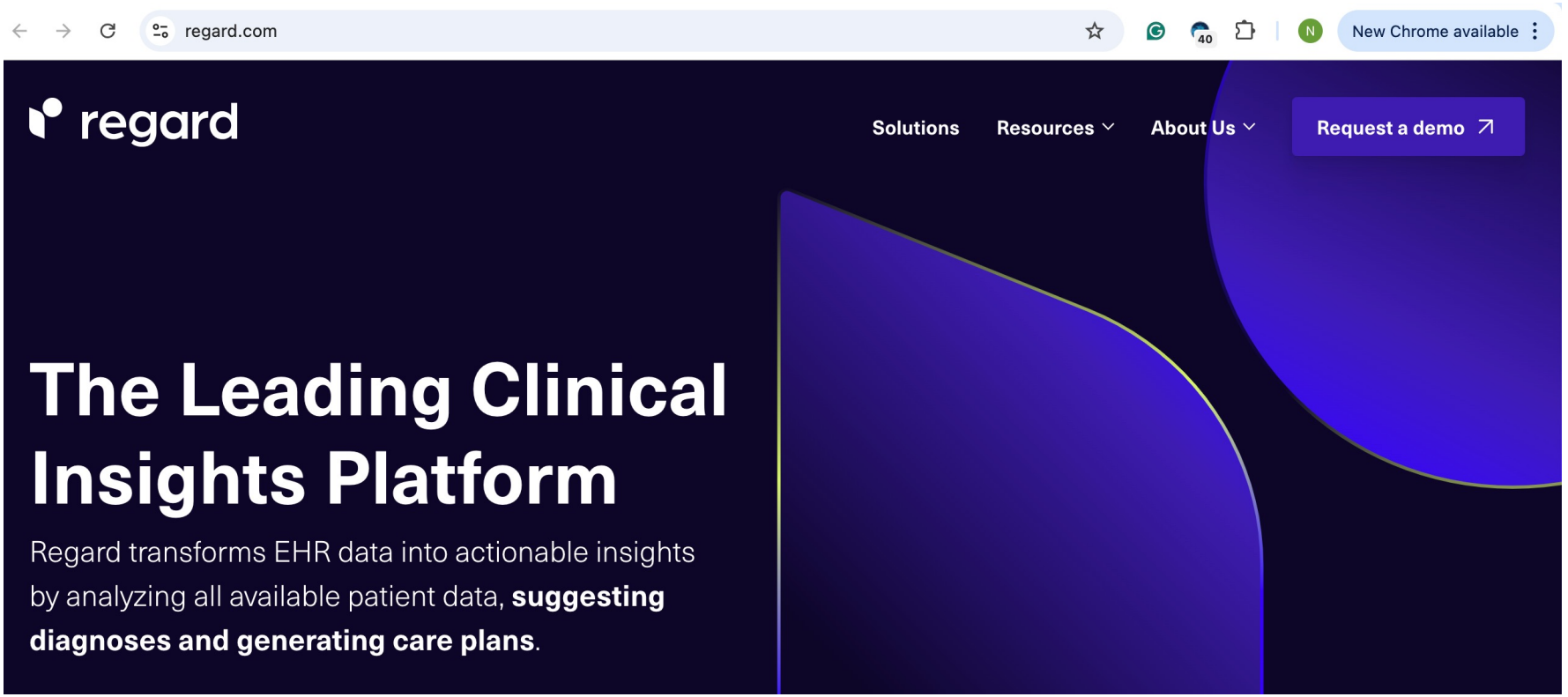
# Clinical decision support and healthcare analytics

The treatment cost calculator provides real-time estimates of costs

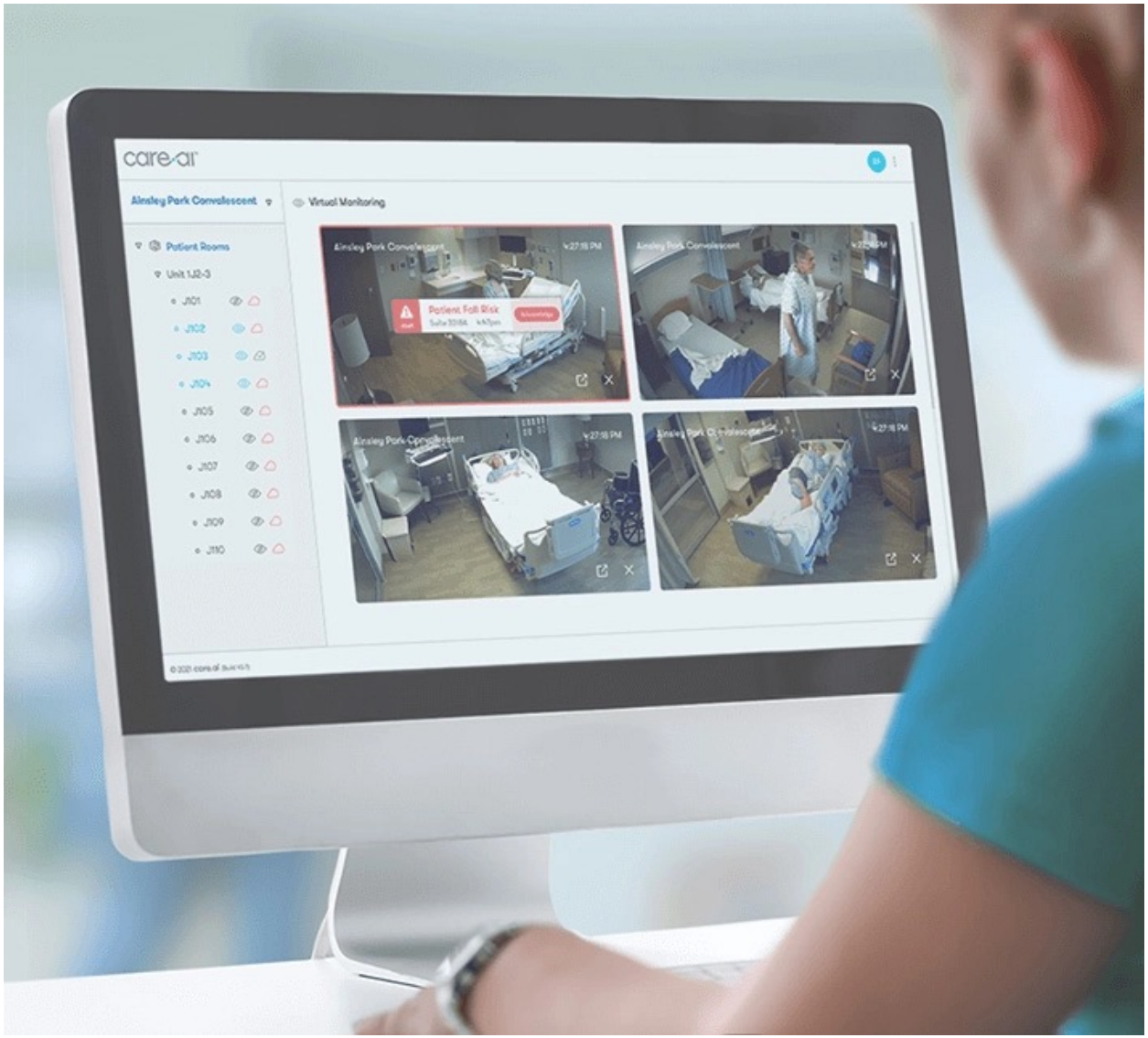


# Automating clinical tasks

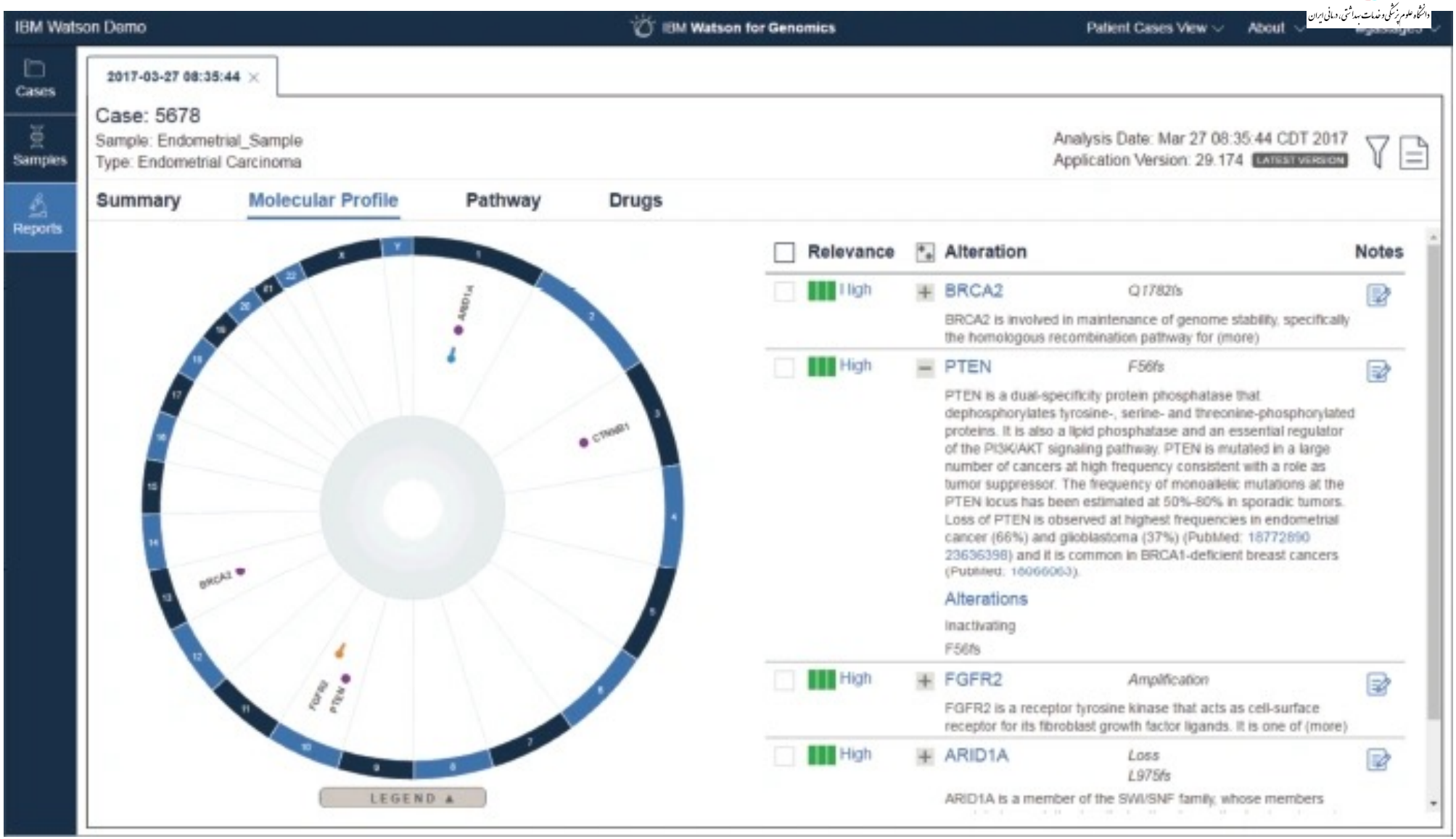
Reduce clinician burnout



# AI-Assisted Virtual Nursing Smart from The Start™

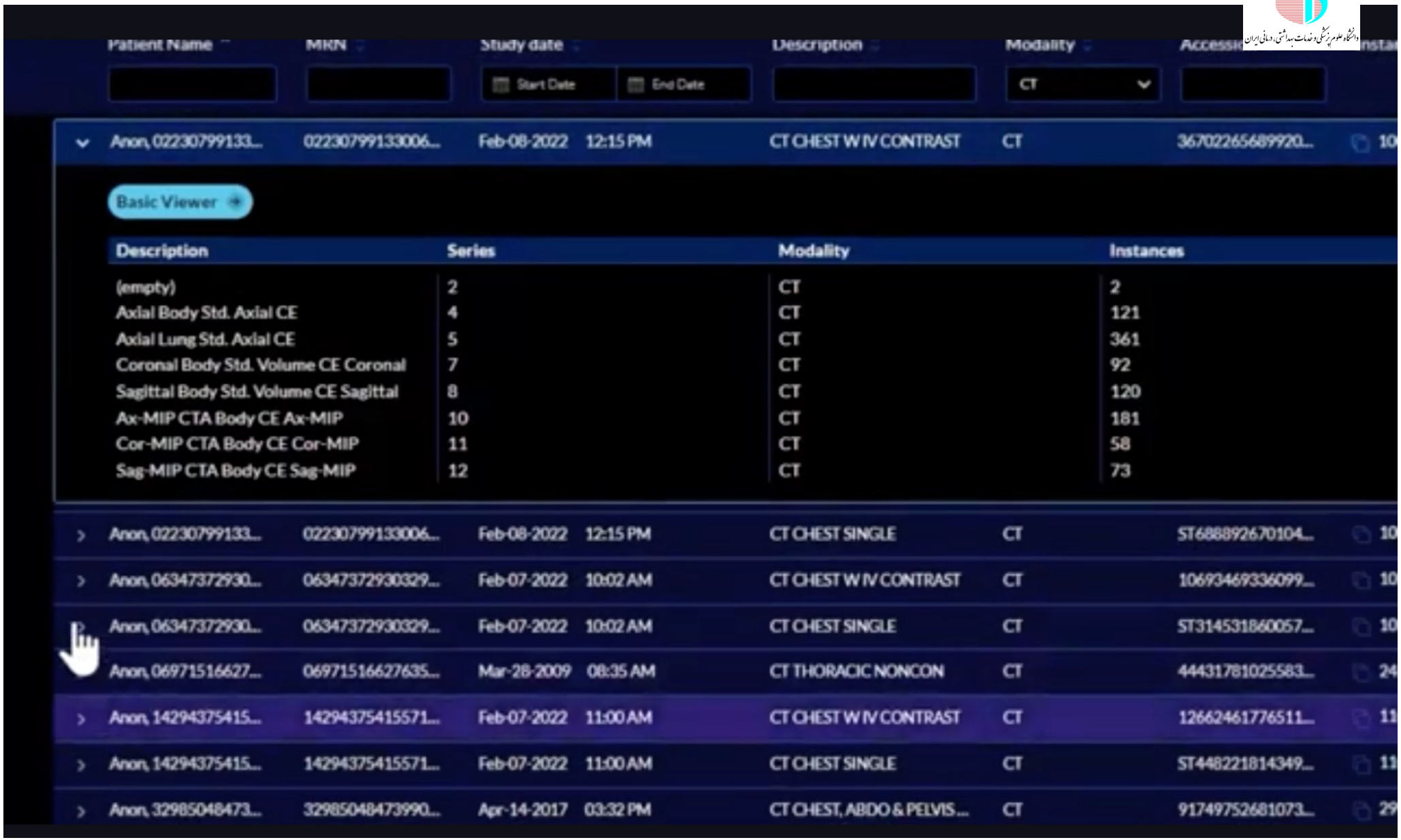


# IBM Watson for Oncology


IBM Watson Demo
IBM Watson for Genomics
Patient Cases View
About
Cases
Samples
Reports
2017-03-27 08:35:44
Case: 5678
Sample: Endometrial_Sample
Type: Endometrial Carcinoma
Analysis Date: Mar 27 08:35:44 CDT 2017
Application Version: 29.174
LATEST VERSION
Summary
Molecular Profile
Pathway
Drugs
ARID1A
CTNNB1
BRCA2
FGFR2
PTEN
LEGEND
Relevance
Alteration
Notes
High
BRCA2
Q1782fs
BRCA2 is involved in maintenance of genome stability, specifically the homologous recombination pathway for (more)
High
PTEN
F56fs
PTEN is a dual-specificity protein phosphatase that dephosphorylates tyrosine-, serine- and threonine-phosphorylated proteins. It is also a lipid phosphatase and an essential regulator of the PI3K/AKT signaling pathway. PTEN is mutated in a large number of cancers at high frequency consistent with a role as tumor suppressor. The frequency of monoallelic mutations at the PTEN locus has been estimated at 50%-80% in sporadic tumors. Loss of PTEN is observed at highest frequencies in endometrial cancer (66%) and glioblastoma (37%) (PubMed: 18772890 23636398) and it is common in BRCA1-deficient breast cancers (PubMed: 16066063).
Alterations
Inactivating
F56fs
High
FGFR2
Amplification
FGFR2 is a receptor tyrosine kinase that acts as cell-surface receptor for its fibroblast growth factor ligands. It is one of (more)
High
ARID1A
Loss
L975fs
ARID1A is a member of the SWI/SNF family, whose members

# Medical Image Analysis

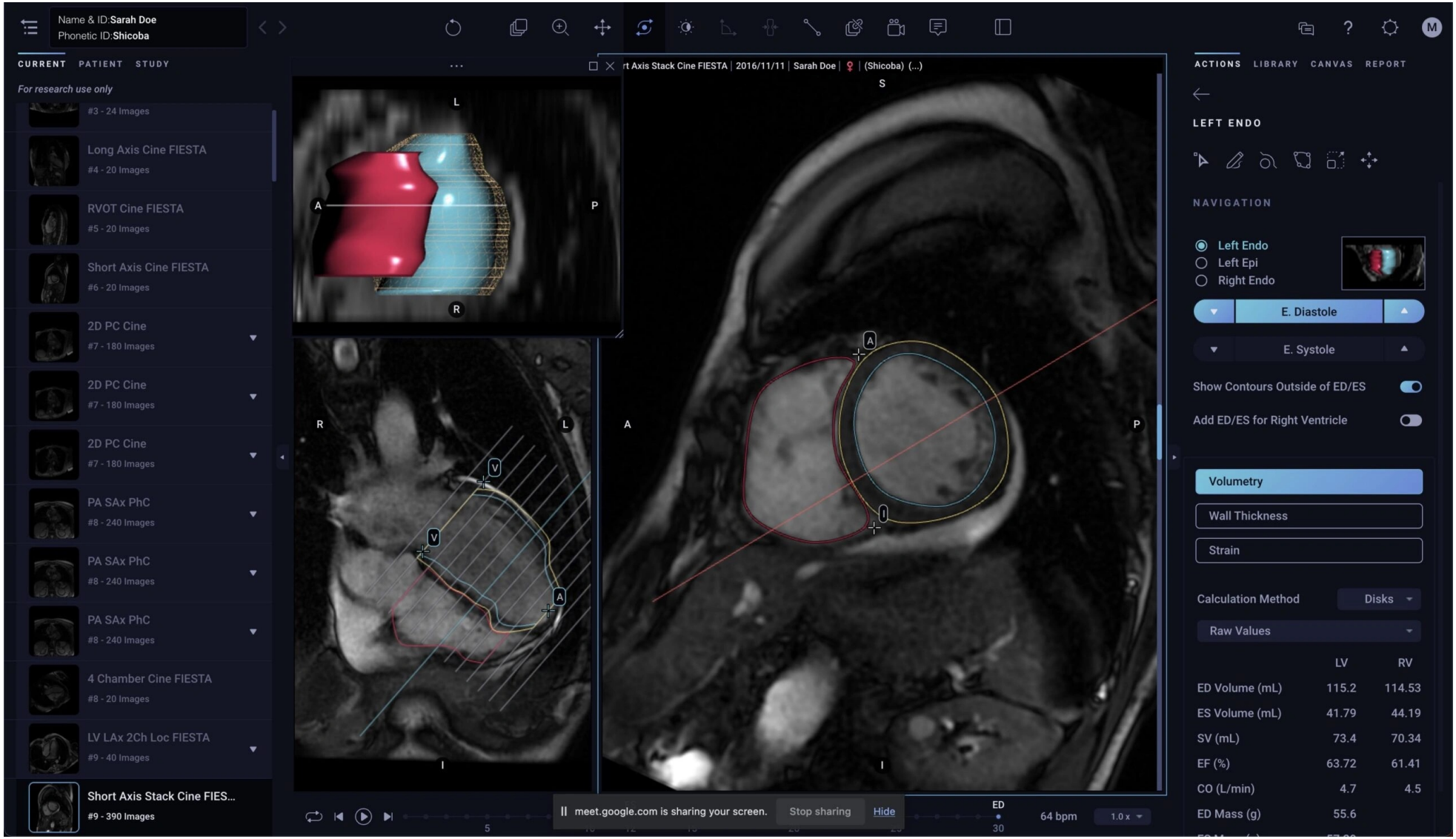
- AI platform designed to revolutionize medical image analysis.
- Leveraging advanced deep learning algorithms, ENDEX can process and analyze a wide range of medical images, including X-rays, CT scans, MRIs, and ultrasounds, with exceptional accuracy and speed.
- This powerful platform empowers healthcare providers with valuable insights, enabling earlier diagnosis, more effective treatment planning, and improved patient outcomes.


Patient Name
MRN
Study date
Start Date
End Date
Description
Modality
CT
Anon, 02230799133...
02230799133006...
Feb-08-2022
12:15 PM
CT CHEST W IV CONTRAST
CT
367022656899 20...
Basic Viewer
Description
Series
Modality
Instances
(empty) 2 CT 2
Axial Body Std. Axial CE 4 CT 121
Axial Lung Std. Axial CE 5 CT 361
Coronal Body Std. Volume CE Coronal 7 CT 92
Sagittal Body Std. Volume CE Sagittal 8 CT 120
Ax-MIP CTA Body CE Ax-MIP 10 CT 181
Cor-MIP CTA Body CE Cor-MIP 11 CT 58
Sag-MIP CTA Body CE Sag-MIP 12 CT 73
Anon, 02230799133...
02230799133006...
Feb-08-2022
12:15 PM
CT CHEST SINGLE
CT
ST688892670104...
Anon, 06347372930...
06347372930329...
Feb-07-2022
10:02 AM
CT CHEST W IV CONTRAST
CT
10693469336099...
Anon, 06347372930...
06347372930329...
Feb-07-2022
10:02 AM
CT CHEST SINGLE
CT
ST314531860057...
Anon, 06971516627...
06971516627635...
Mar-28-2009
08:35 AM
CT THORACIC NONCON
CT
44431781025583...
Anon, 14294375415...
14294375415571...
Feb-07-2022
11:00 AM
CT CHEST W IV CONTRAST
CT
12662461776511...
Anon, 14294375415...
14294375415571...
Feb-07-2022
11:00 AM
CT CHEST SINGLE
CT
ST448221814349...
Anon, 32985048473...
32985048473990...
Apr-14-2017
03:32 PM
CT CHEST, ABDO & PELVIS ...
CT
917497526810 73...

IDx-DR is an FDA-approved autonomous AI system designed to revolutionize medical diagnosis, particularly in the realm of ophthalmology.

- Medical Vision's AI solutions lie in their ability to analyze medical images such as X-rays, CT scans, and MRIs with remarkable speed and accuracy.
- By employing advanced deep learning algorithms, these solutions can detect abnormalities and provide diagnostic insights that assist radiologists and other healthcare professionals in making more informed clinical decisions.

# Arterys Cardio AI



- Advanced deep learning algorithms to automate the quantification of various cardiac parameters, including cardiac function, blood flow, and tissue characterization.
- By rapidly and accurately analyzing cardiac MRI images, Cardio AI provides clinicians with valuable insights that aid in the diagnosis and management of cardiovascular conditions.

# Personalized Diabetes Management

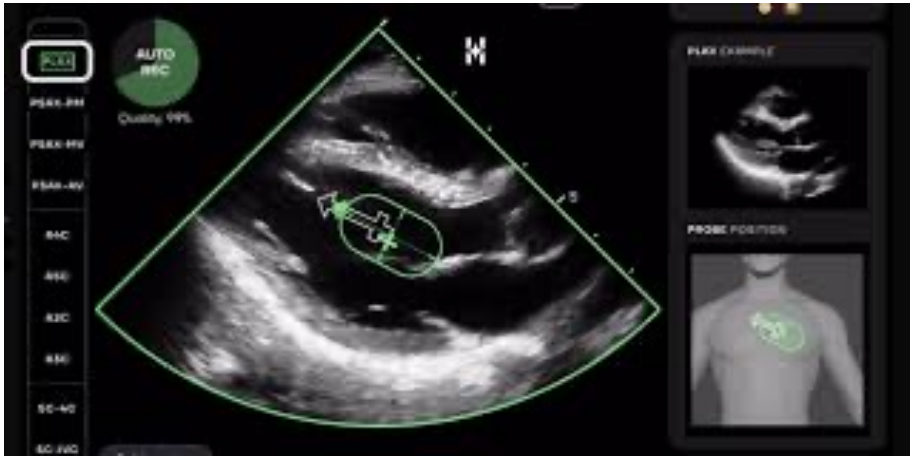
- Using AI, DreaMed Diabetes tailors insulin management plans for individuals with diabetes, optimizing blood sugar control.

# Tempus: Precision Cancer Care

- Tempus employs AI to analyze clinical and molecular data, aiding oncologists in making informed decisions for personalized cancer treatment.

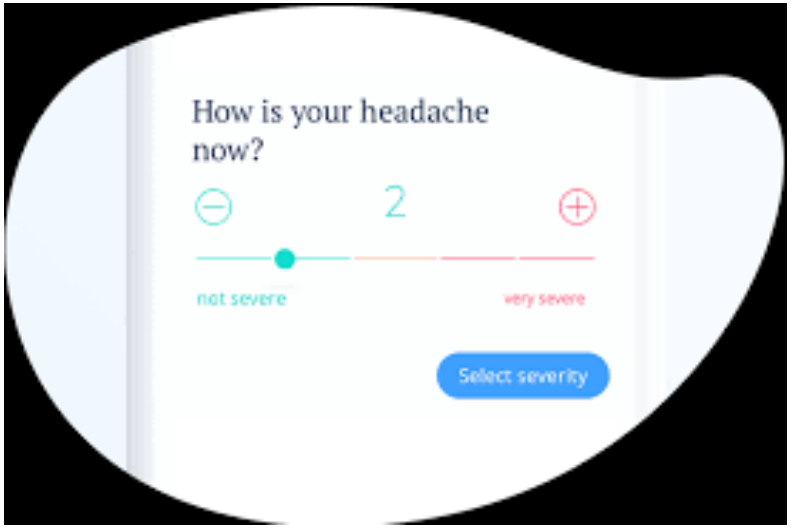
# Ultrasound Imaging with AI

- Butterfly Networ: Integrating AI into handheld ultrasound devices, Butterfly Network enhances image interpretation and assists healthcare providers in making quicker diagnostic decisions.



# Symptom Checker and Triage

- Ada Health's AI-powered app evaluates symptoms and provides personalized health information, guiding users on whether to seek medical attention.

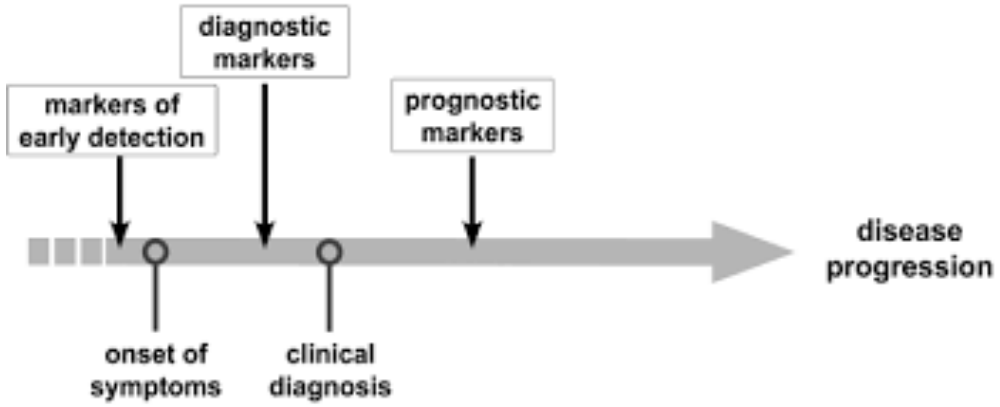



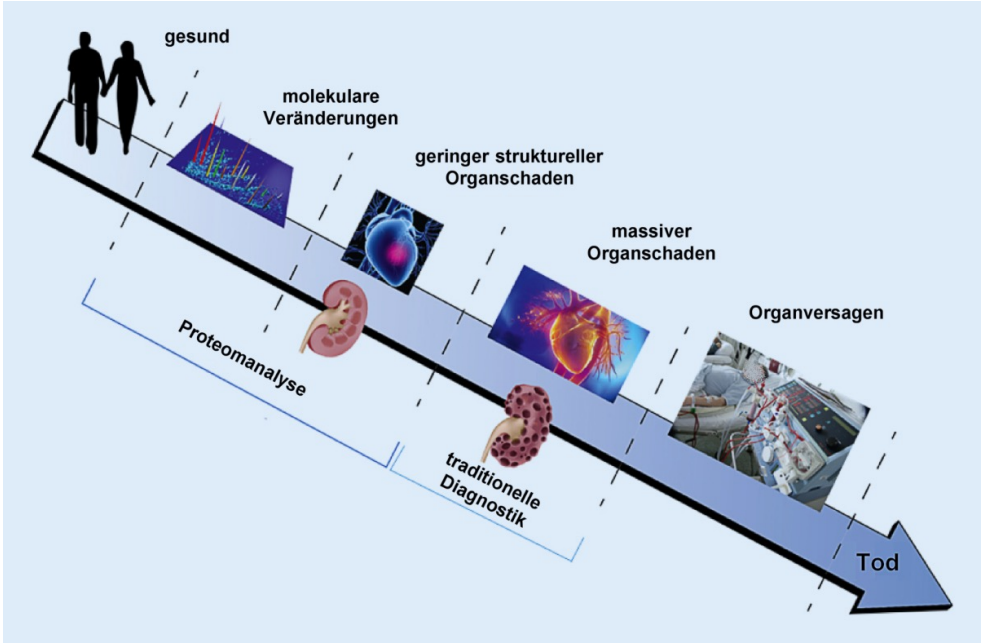
# AI-Powered Virtual Health Assistant

- Buoy Health's AI assists users in understanding their symptoms, offering personalized advice, and helping navigate the healthcare system.

# Early Disease Detection

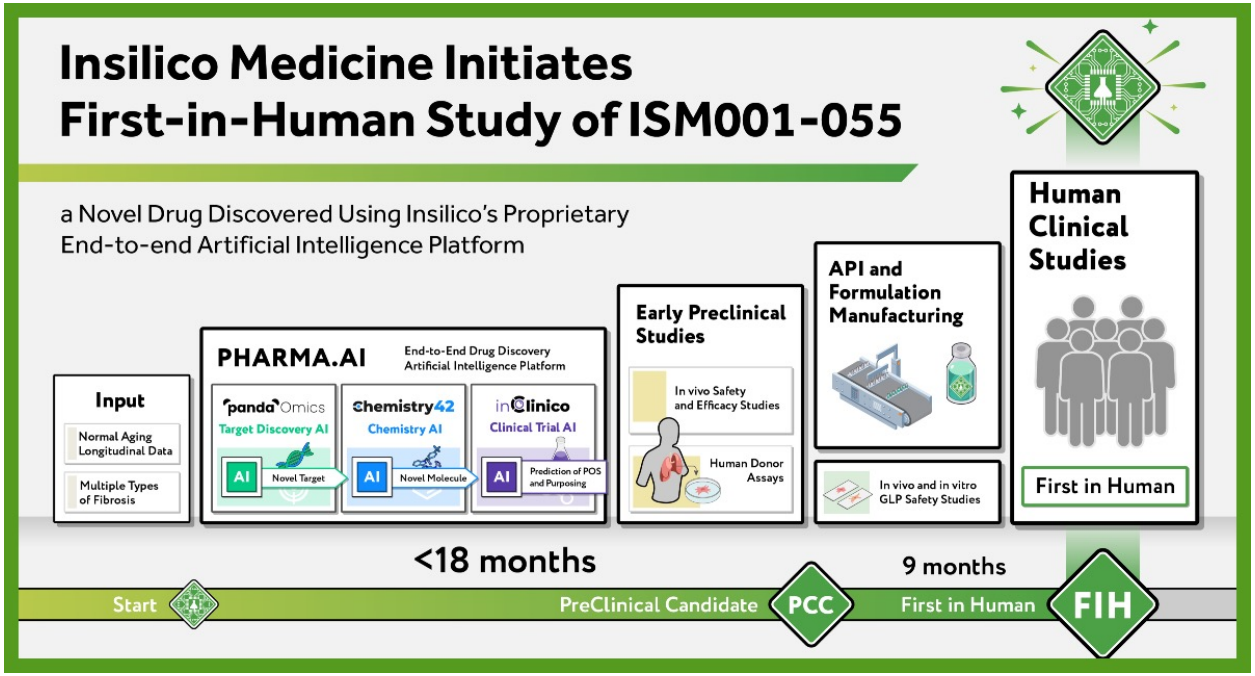
- Prognos utilizes AI to analyze clinical and diagnostic data, focusing on early detection of diseases such as cancer and diabetes.



# Insilico Medicine: Drug Discovery Acceleration

- Insilico Medicine employs AI for drug discovery, accelerating the identification of potential drug candidates and optimizing the development process.

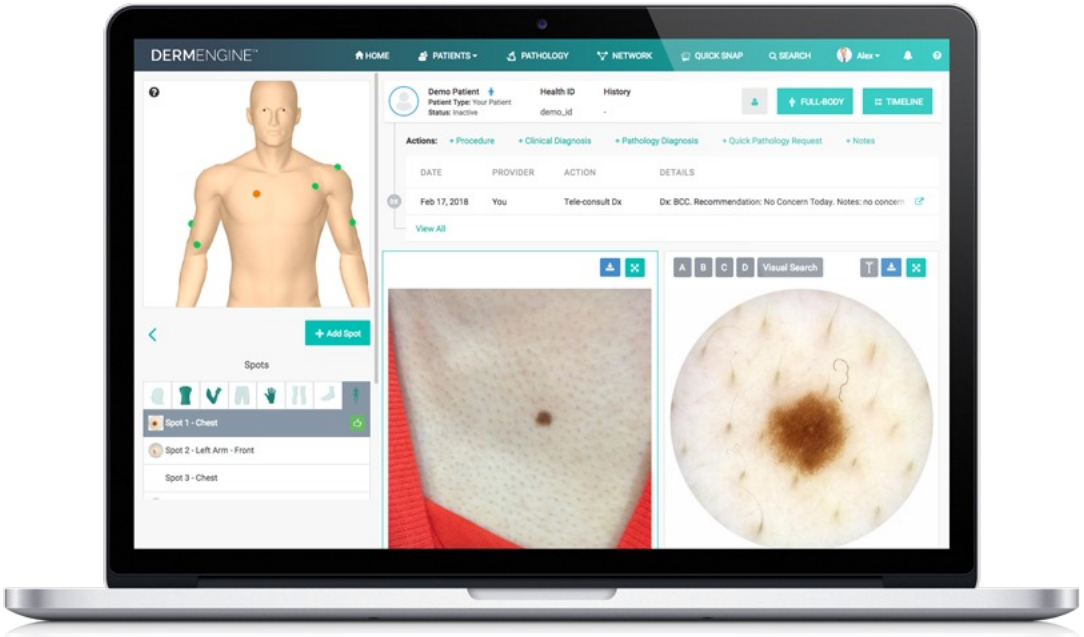


# Cancer Support and Monitoring

- CancerAid's AI app supports cancer patients by providing personalized information, monitoring symptoms, and offering a virtual support system.

# Anatomi: Dermatology Diagnostics

- Anatomi utilizes AI to analyze skin images, aiding in the early detection of skin conditions and assisting dermatologists in their diagnoses.



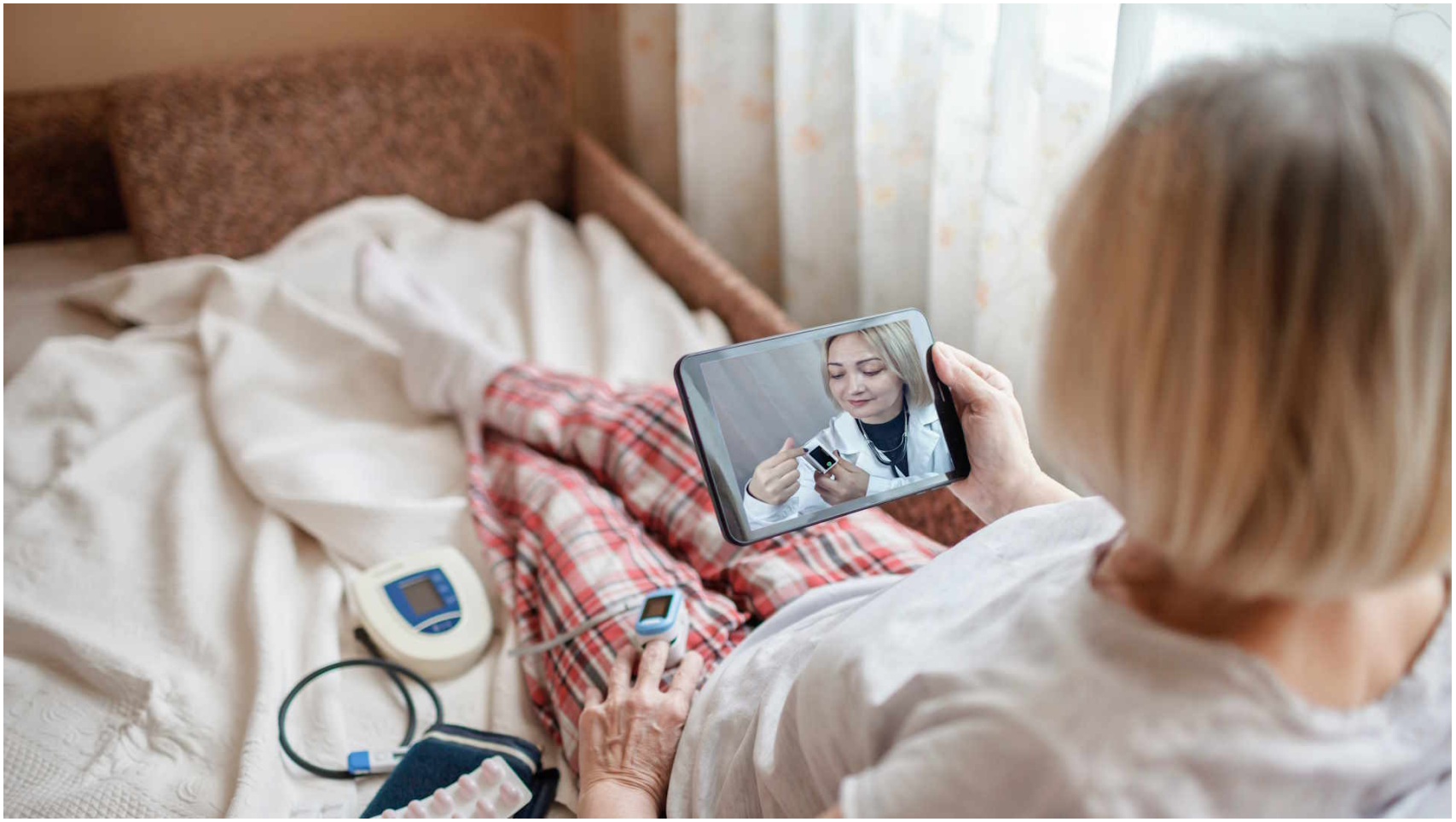

16.49
4G
ST. BONAVENTURE
DERMATOLOGY
Select an option to continue
Request urgent care
Send in a photo of a skin problem or concern to request an urgent visit.
Request medication refill visit
Send in a photo of your problem to request a refill without an office visit (existing patients).
Access skin monitoring
Monitor moles, acne or anything else visible on your skin.
CONTINUE

# Remote Patient Monitoring

- Adastra employs AI for remote patient monitoring, enabling healthcare providers to track patient health data and intervene promptly when needed.



current

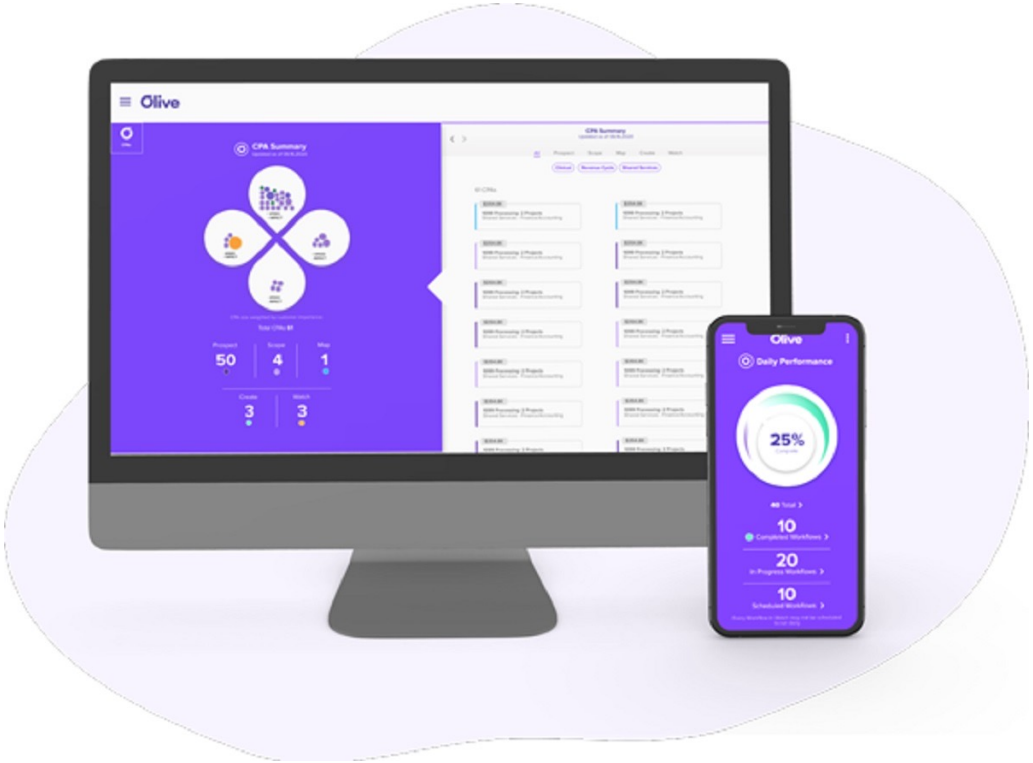


# Holistic Symptom Analysis

- K Health utilizes AI to analyze symptoms comprehensively, offering users a holistic understanding of their health concerns and recommendations for further actions.

# Hospital Operations Optimization

- Olive AI streamlines hospital operations using AI, optimizing resource allocation, automating tasks, and enhancing overall efficiency in healthcare settings.



# Human Dx: Collaborative Diagnostic Platform

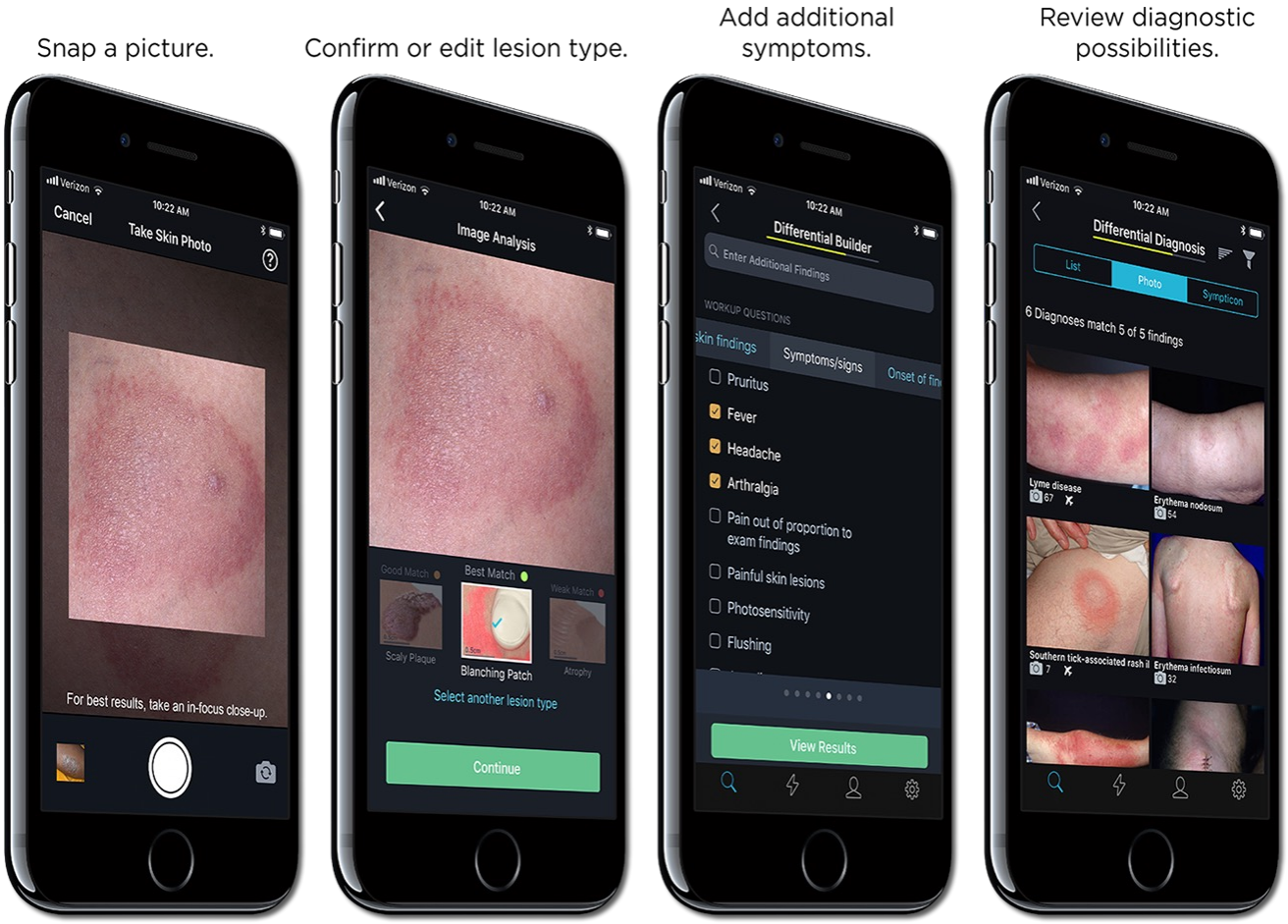
- collaborative diagnostics by leveraging AI to assist healthcare professionals in diverse specialties, promoting collective expertise for accurate and efficient diagnoses.

# AI-Driven Telemedicine

- Adastra's AI not only excels in remote patient monitoring but also facilitates AI-driven telemedicine, connecting patients with healthcare professionals for virtual consultations and timely interventions.

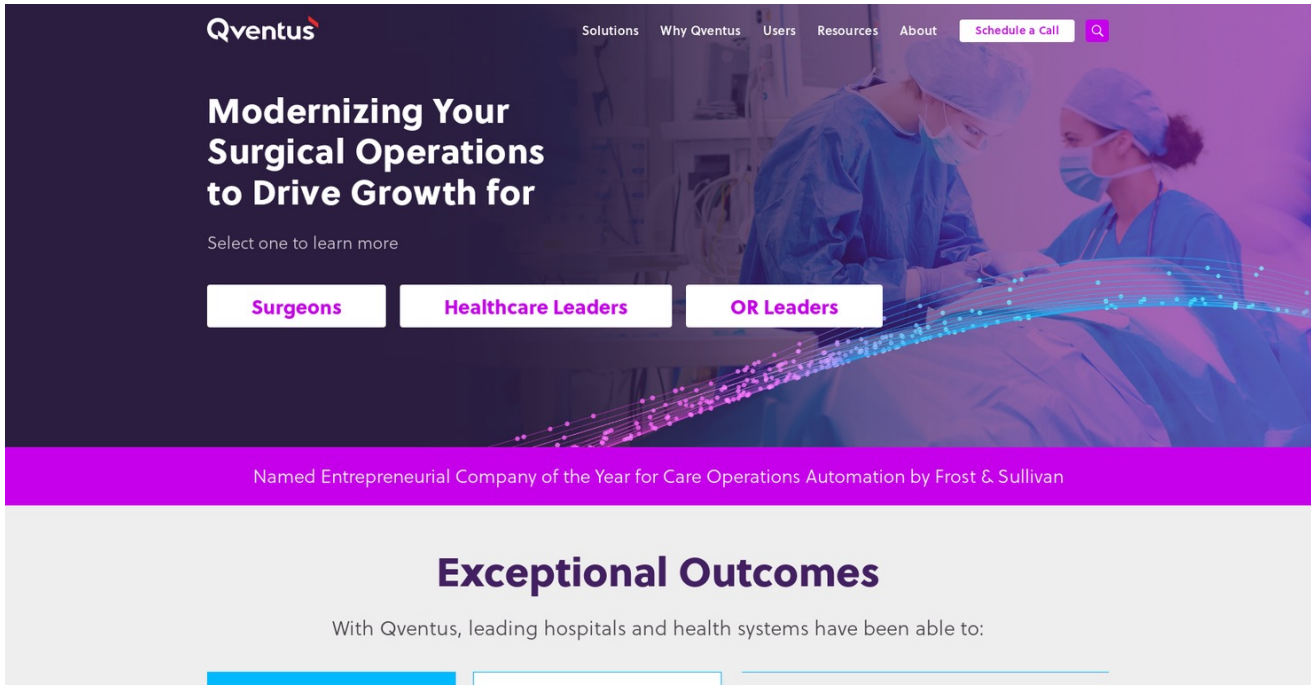
# Visual Diagnostic Aid

- VisualDx utilizes AI to assist healthcare professionals in visually diagnosing a wide array of medical conditions, providing a visual reference tool for accurate and efficient diagnoses.



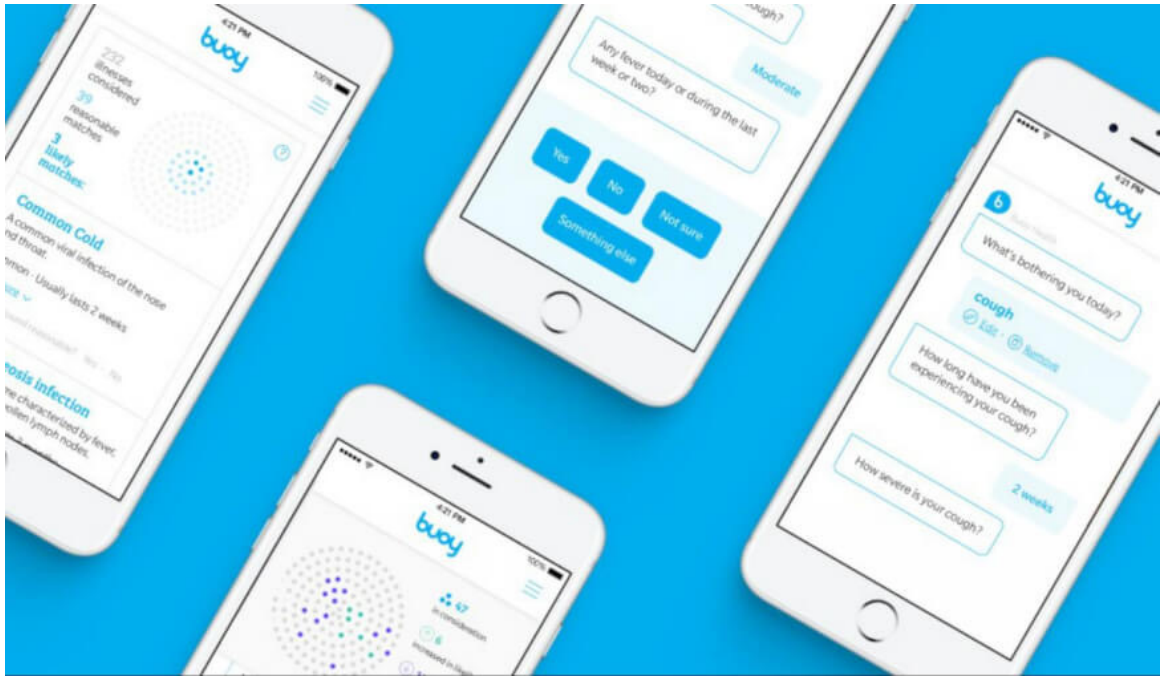
# AI for Operational Efficiency

- Qventus employs AI to enhance operational efficiency in healthcare organizations, optimizing workflows, reducing wait times, and ensuring a more streamlined and patient-centric experience.



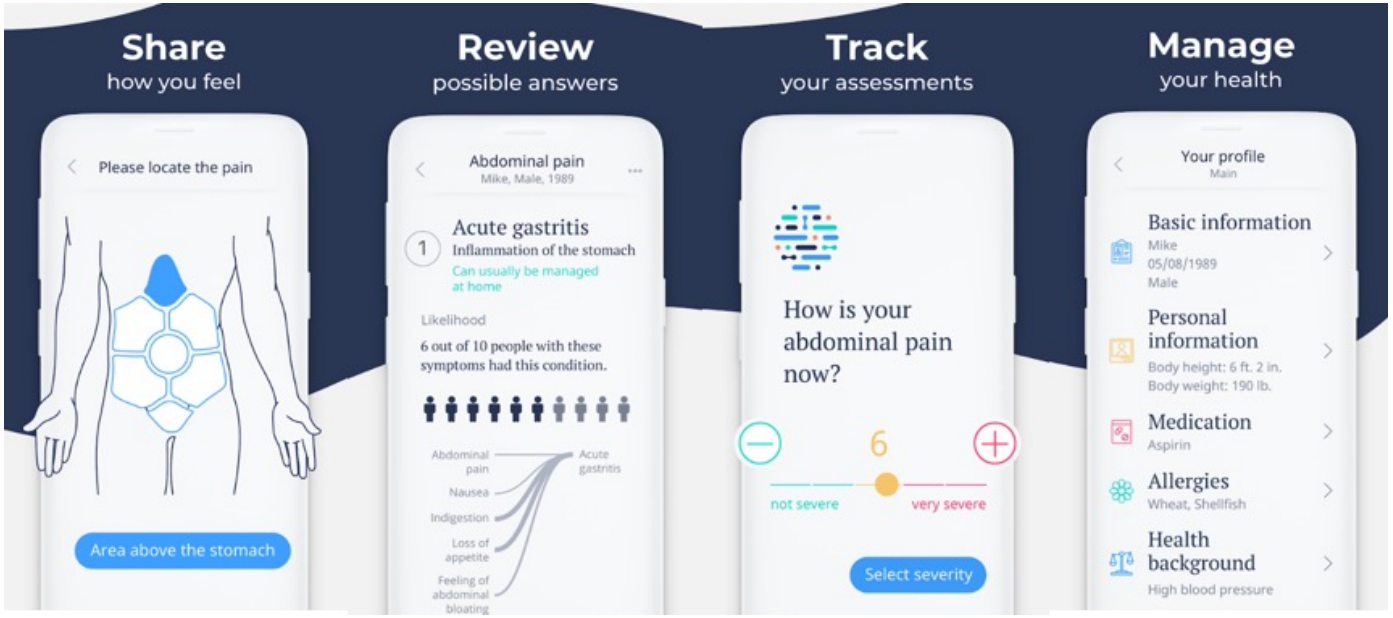
# Buoy Labs: Digital Health Guidance

- Buoy Labs extends beyond its virtual assistant, offering digital health guidance through AI, providing users with insights on various health topics and preventive measures.



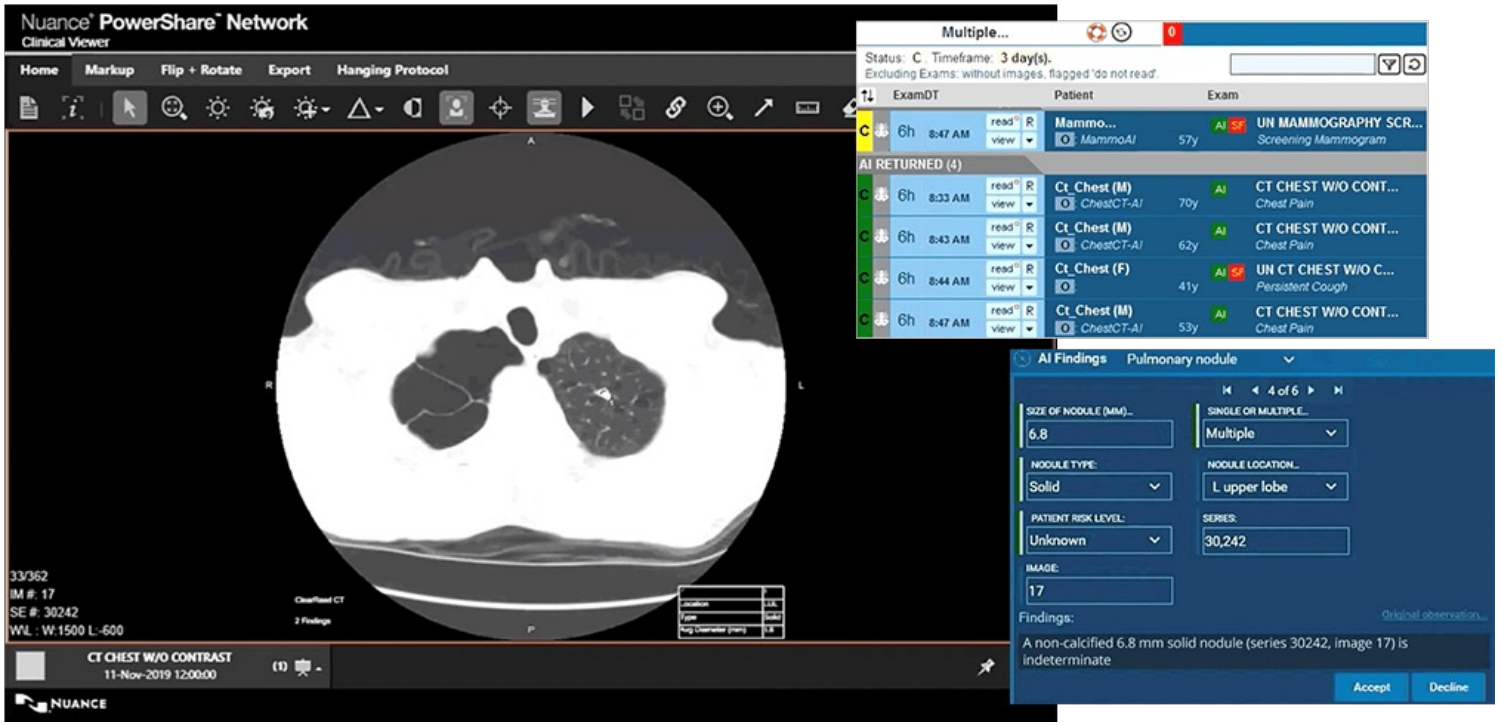
# Ada: AI-Driven Health Companion

- Ada's AI-driven health companion goes beyond symptom checking, offering personalized health insights, preventive advice, and continuous support for users on their health journeys.



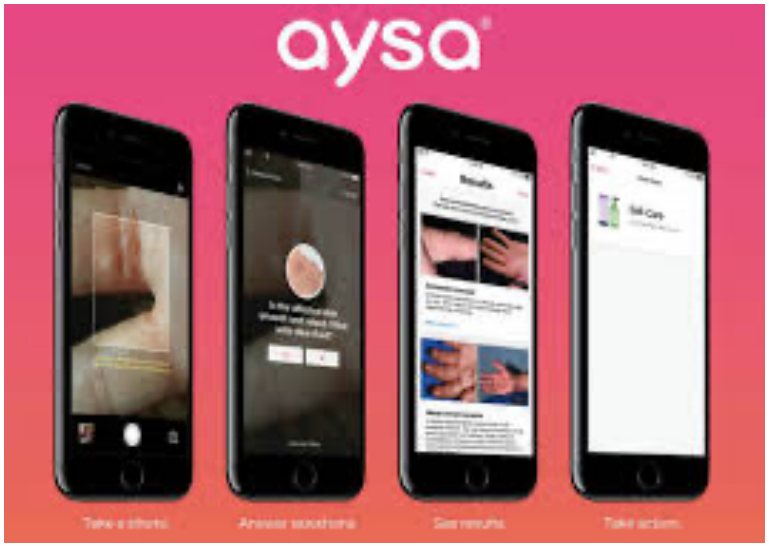
# Nanox: AI-Powered Medica Imaging

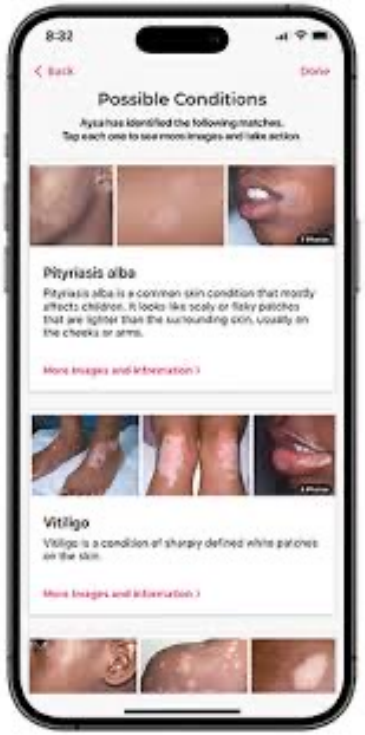
- Nanox integrates AI into medical imaging, aiming to make diagnostic imaging more accessible globally through cost-effective and innovative solutions.



# Aysa: AI Dermatology Assistant

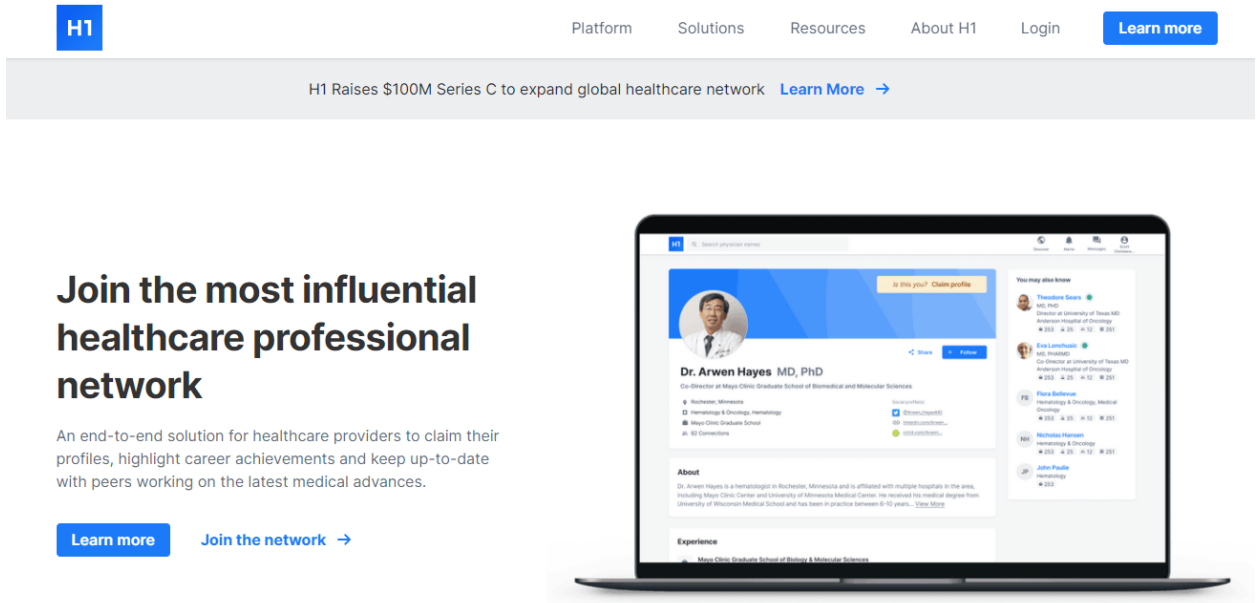
- Aysa utilizes AI to assist in dermatological diagnoses, empowering users to receive preliminary insights into skin conditions and guiding them on potential next steps.



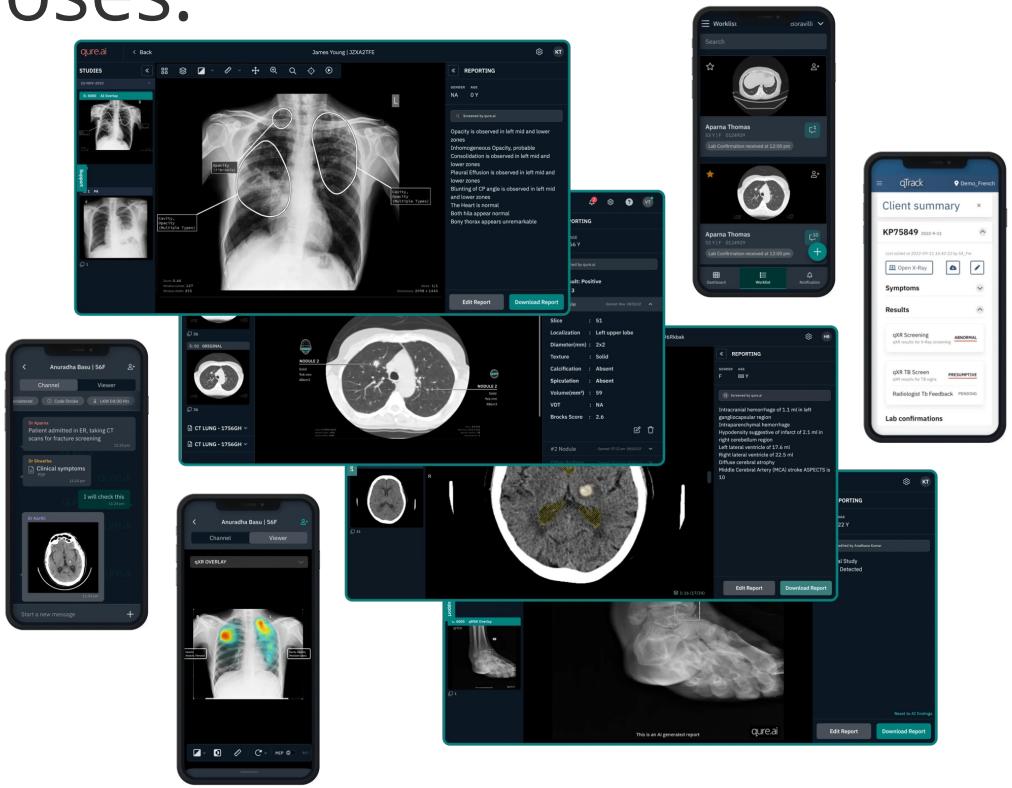
# Healthcare Professionals Network

- H1 utilizes AI to connect healthcare professionals, facilitating networking and collaboration for knowledge exchange, enhancing the collective expertise in the medical community.



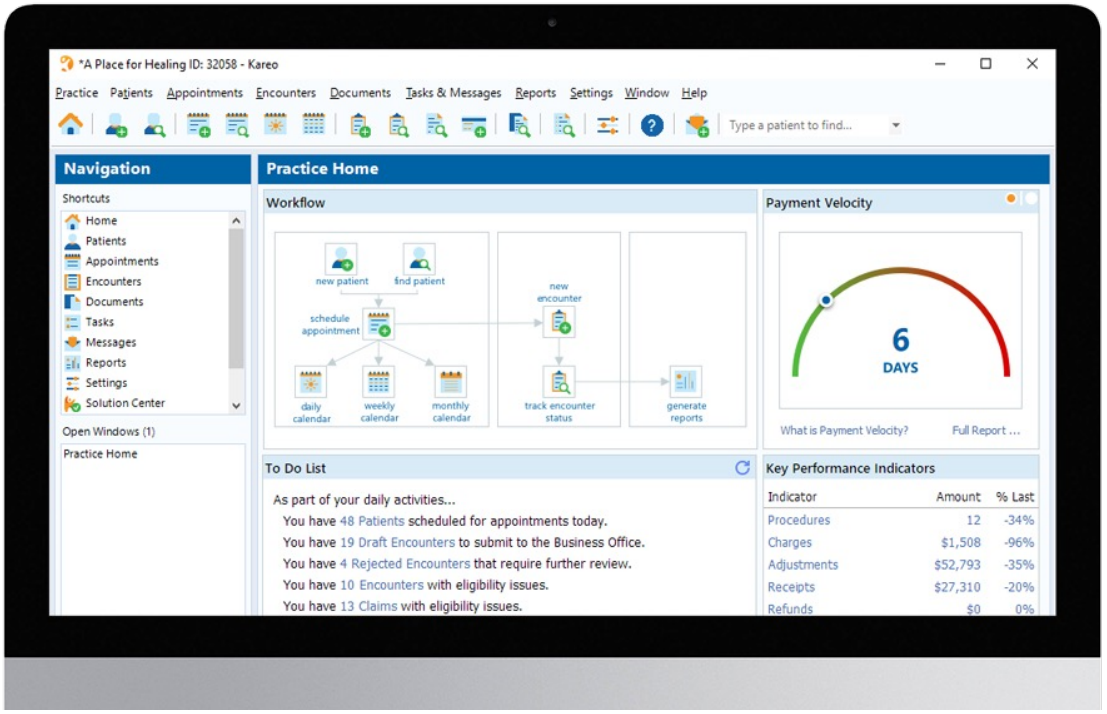
# Qure.ai: Radiology AI Solutions

- Qure.ai focuses on AI solutions for radiology, enhancing the interpretation of medical images and contributing to more accurate and timely diagnoses.

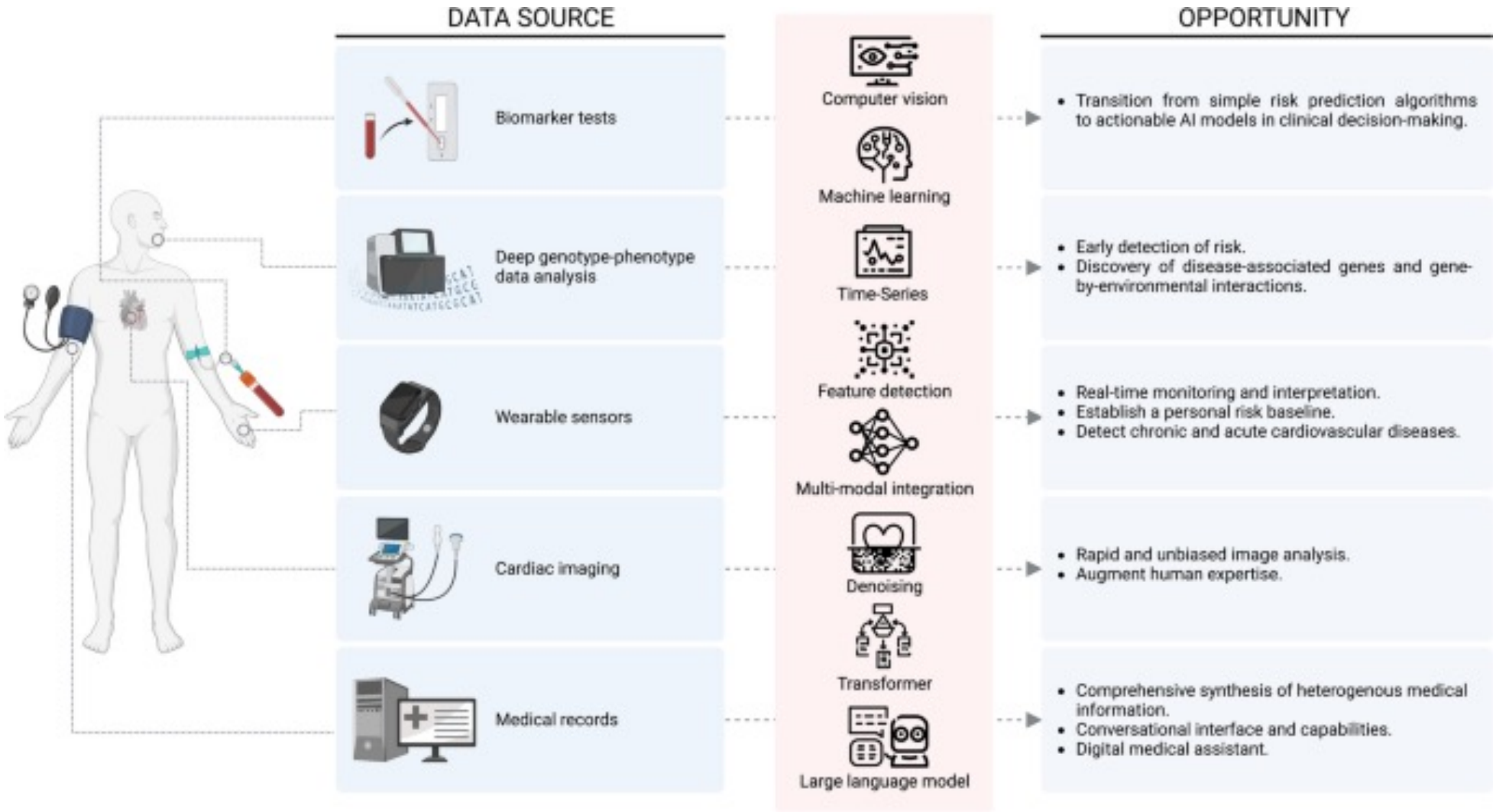


# Kareo: AI-Enhanced Medical Billing

- Kareo incorporates AI to streamline medical billing processes, reducing administrative burdens for healthcare providers and improving overall billing efficiency.



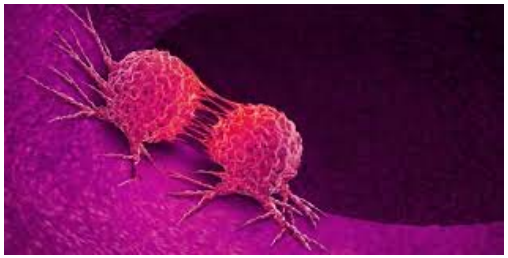
# AI and **disease risk prediction models**



# Early Detection of Disease

New Tools
New Biopsy
Non-invasive

New type of Data
in all scale

Complex for human understanding
proper for AI



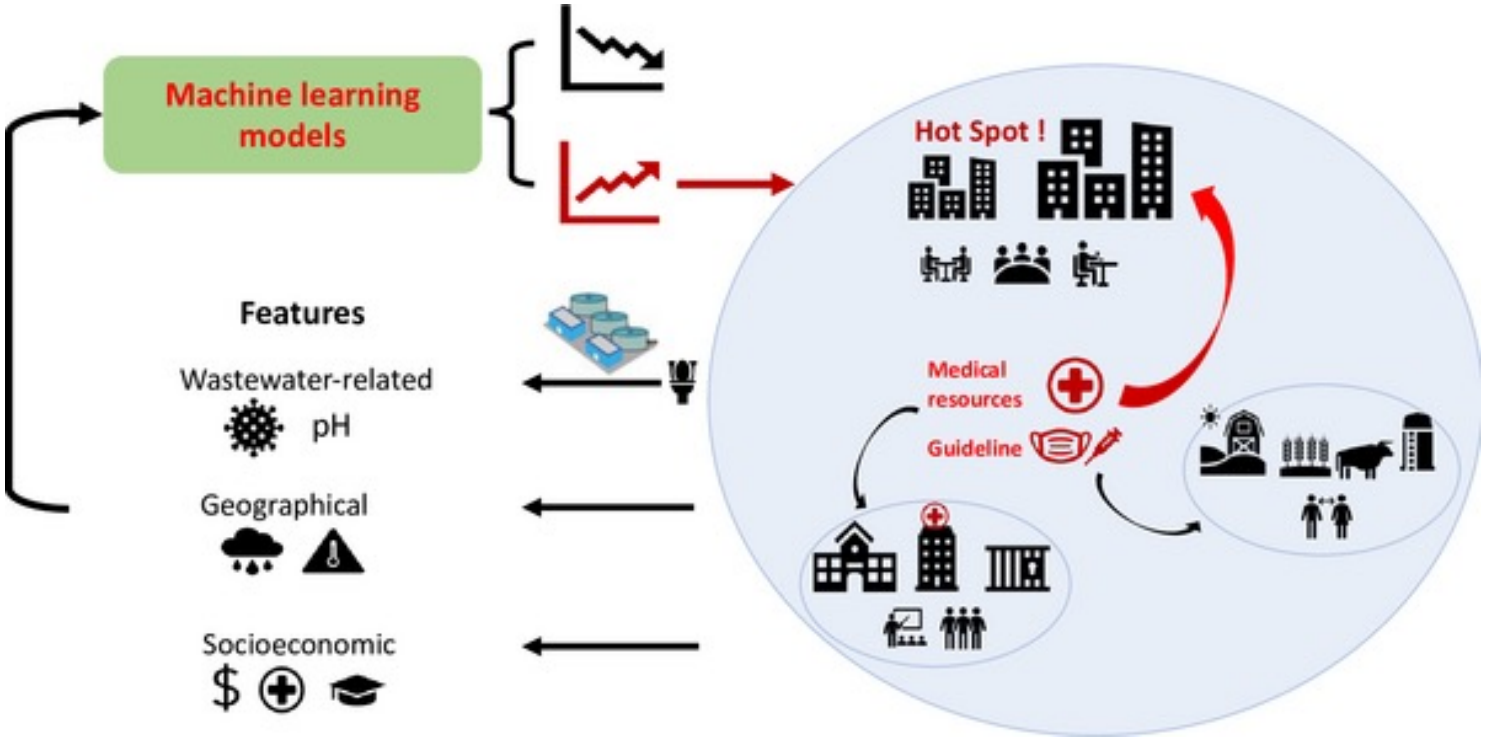
Patient data
Patient family and ancestors ' data
Patient environment data
Doctor evaluation

# Predict outbreaks and epidemics

What conditions are right or wrong for an outbreak to happen?

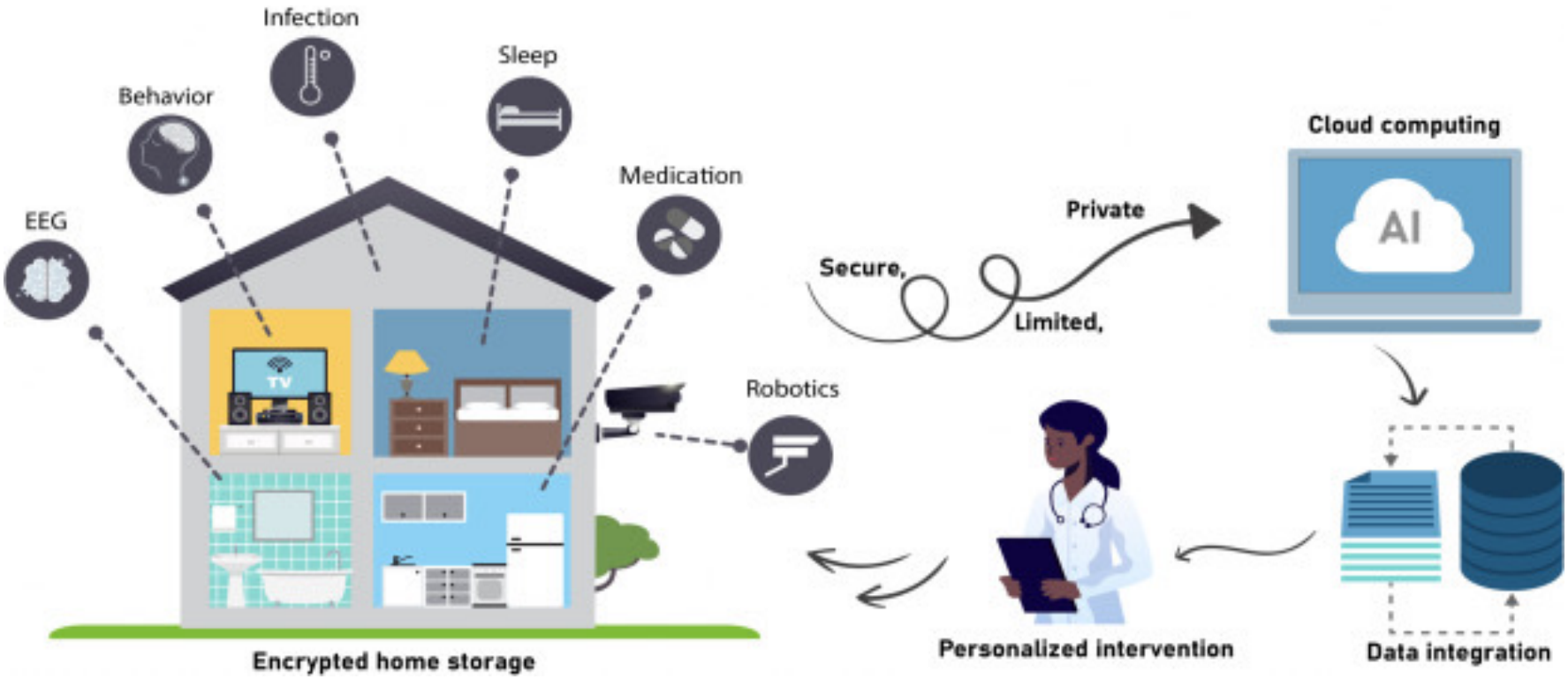
Now, if this outbreak is going to happen, can we create a model for what it's going to look like?

If we have that model, how can we avoid it happening? How can we slow it down? How can we best treat it?”



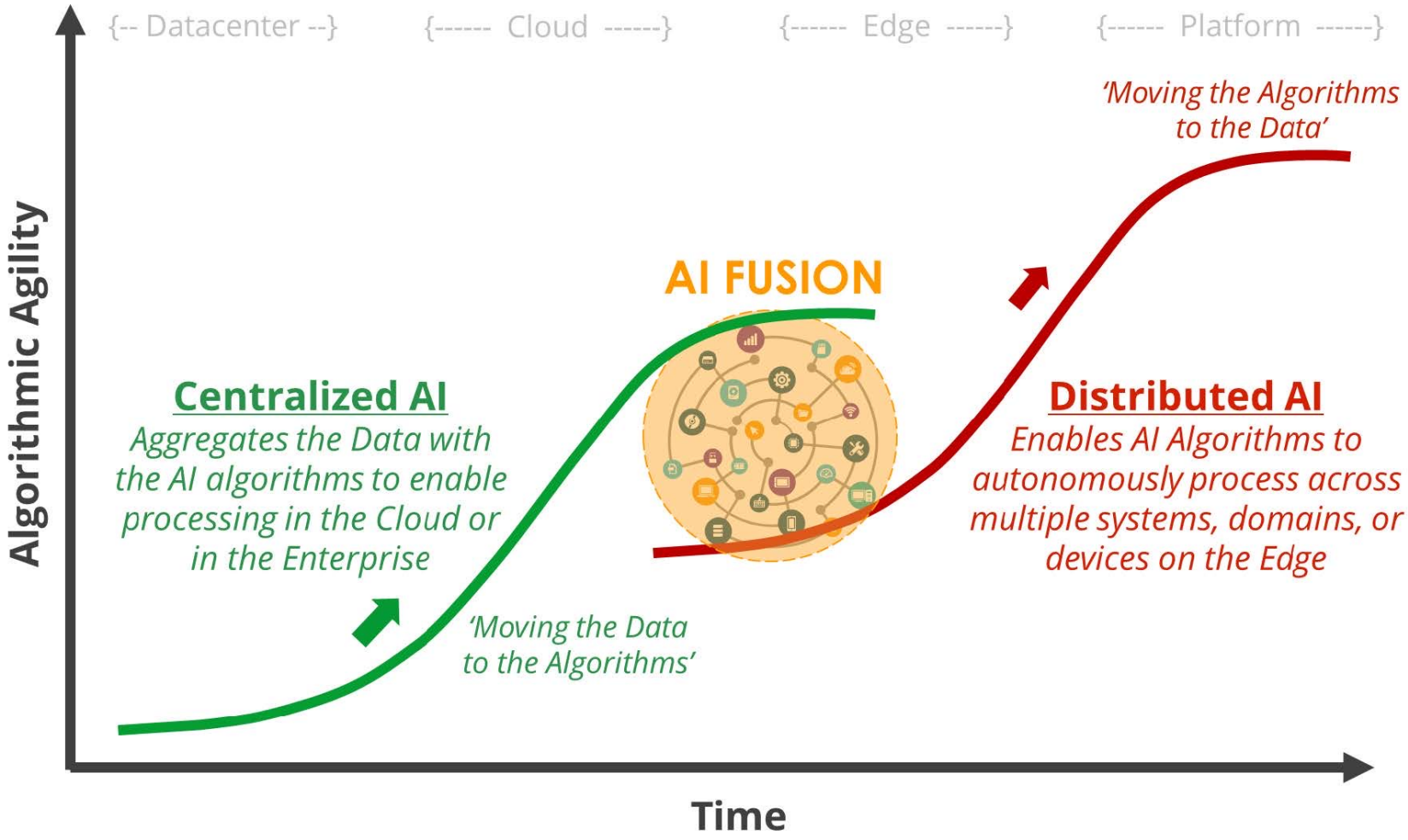
# AI-based Patient Monitoring

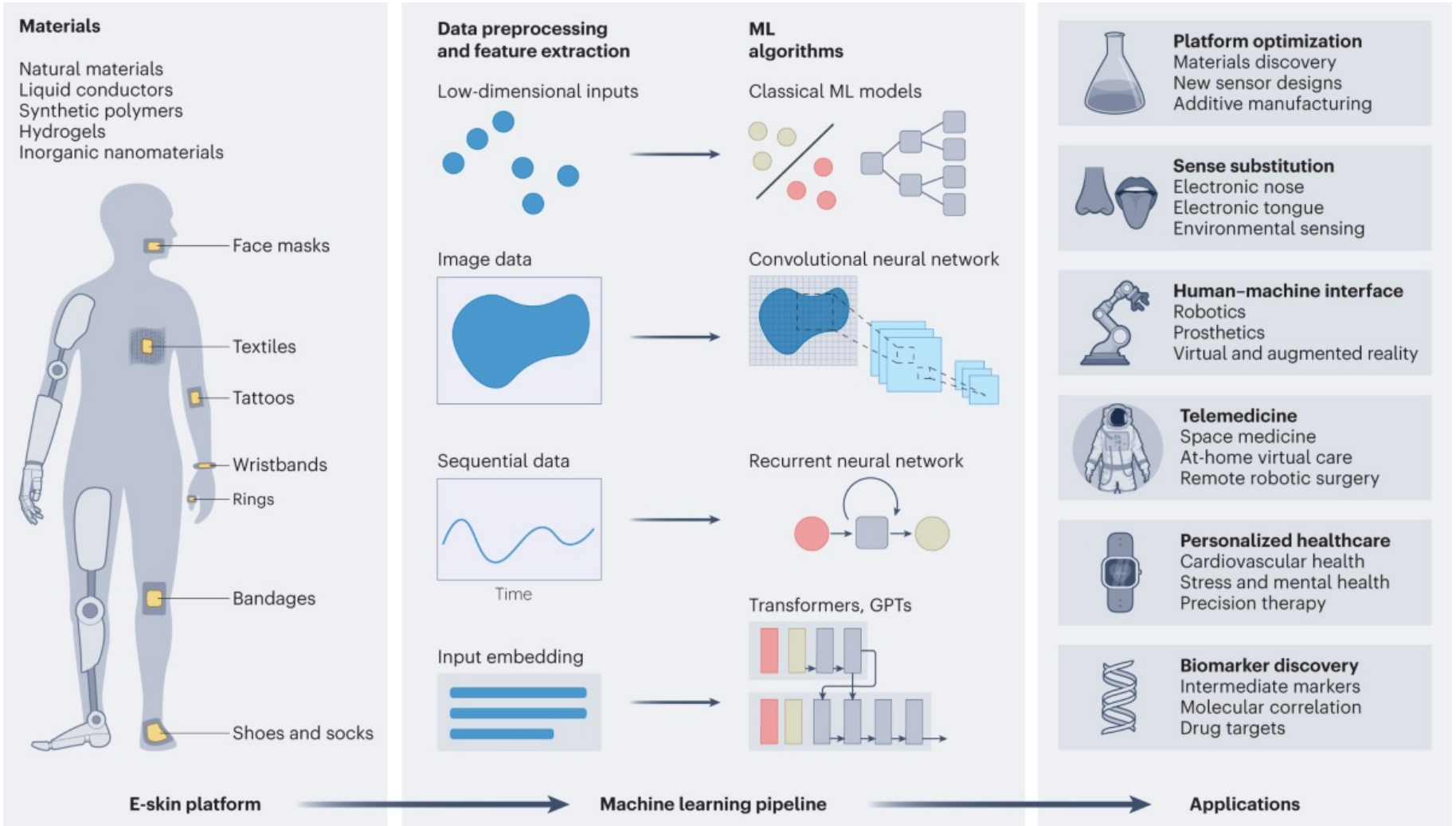
# AI-based Patient Monitoring



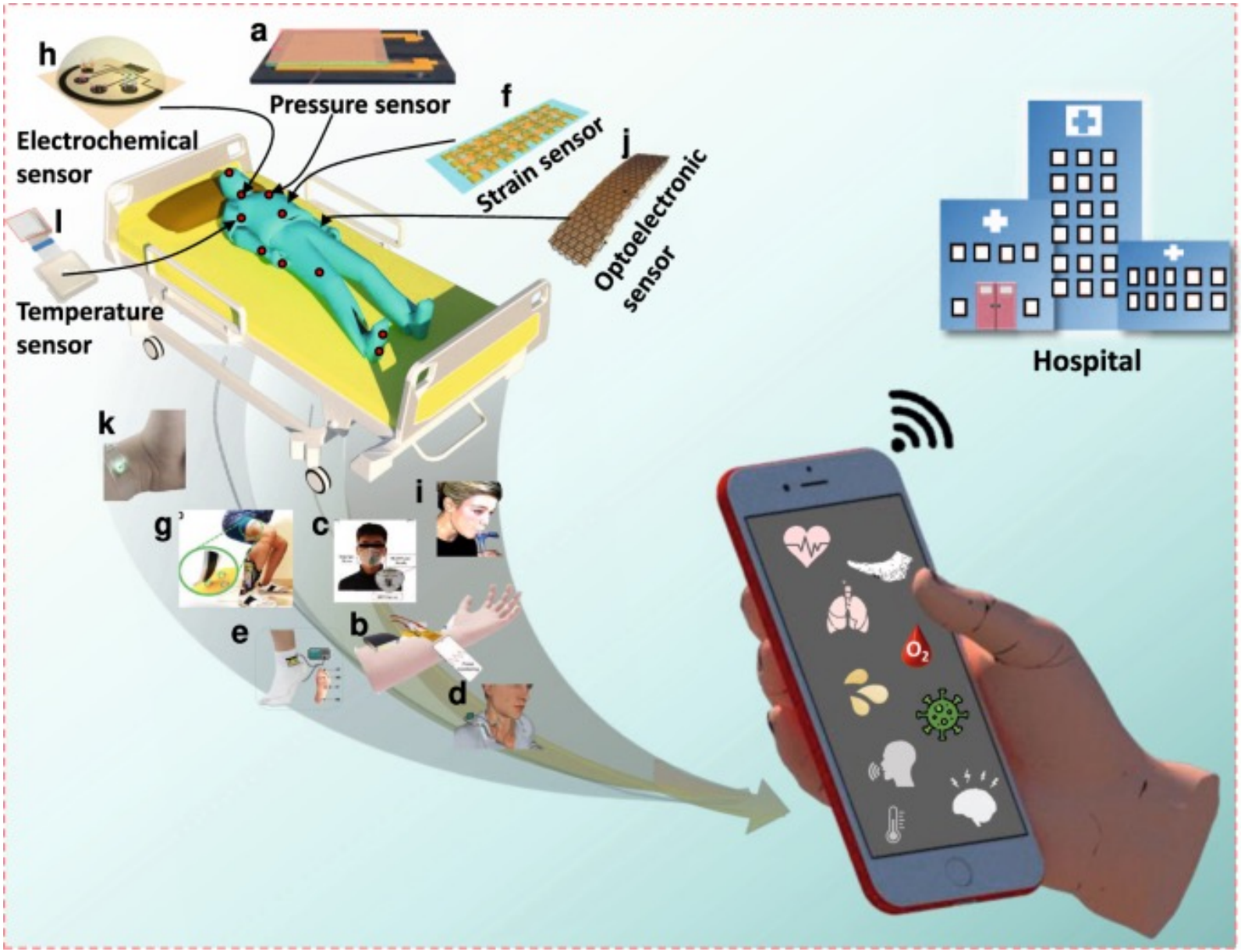
# Distributed Artificial Intelligence

dedicated to the development of distributed solutions for problems



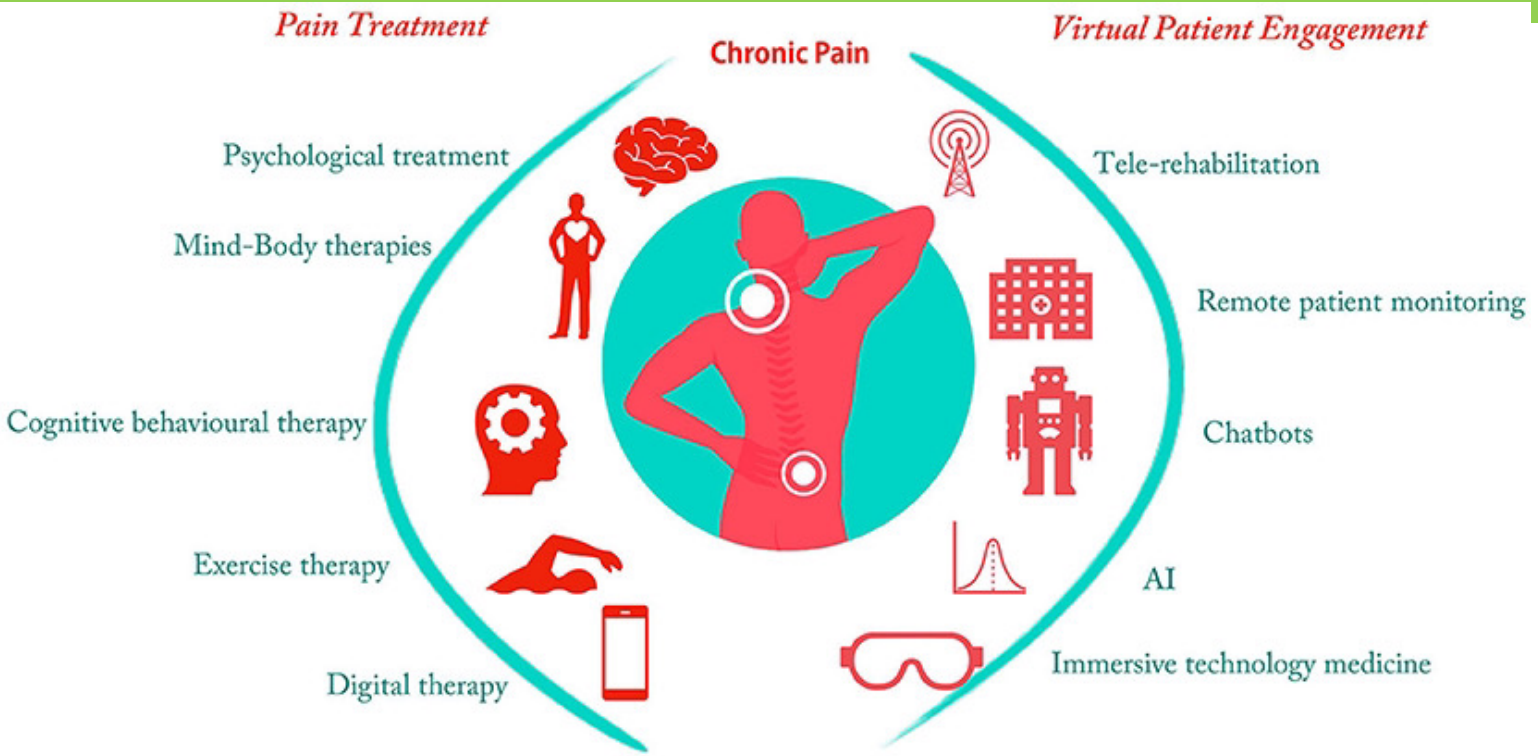

Materials
Natural materials
Liquid conductors
Synthetic polymers
Hydrogels
Inorganic nanomaterials
Face masks
Textiles
Tattoos
Wristbands
Rings
Bandages
Shoes and socks
Data preprocessing and feature extraction
ML algorithms
Low-dimensional inputs
Classical ML models
Image data
Convolutional neural network
Sequential data
Recurrent neural network
Time
Transformers, GPTs
Input embedding
Platform optimization
Materials discovery
New sensor designs
Additive manufacturing
Sense substitution
Electronic nose
Electronic tongue
Environmental sensing
Human–machine interface
Robotics
Prosthetics
Virtual and augmented reality
Telemedicine
Space medicine
At-home virtual care
Remote robotic surgery
Personalized healthcare
Cardiovascular health
Stress and mental health
Precision therapy
Biomarker discovery
Intermediate markers
Molecular correlation
Drug targets
E-skin platform
Machine learning pipeline
Applications

# Telehealth

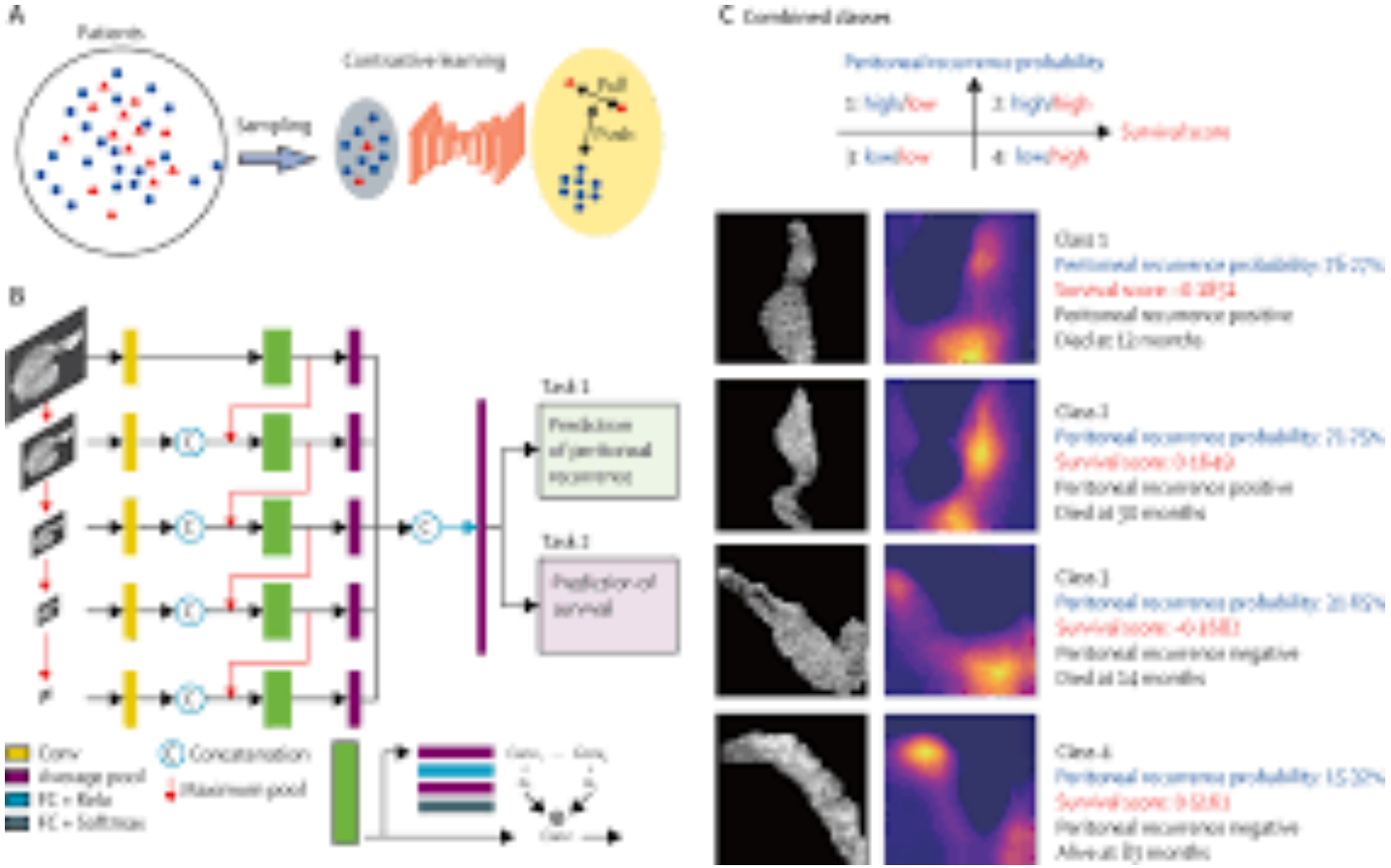

a
Pressure sensor
h
Electrochemical sensor
f
Strain sensor
j
Optoelectronic sensor
l
Temperature sensor
Hospital
k
i
g
c
b
e
d
$O_2$

# Pain Management

- Attempted AI application in pain management has a wide range from the processing of brain imaging for identifying pain to prediction of opioid dose response using biomarkers



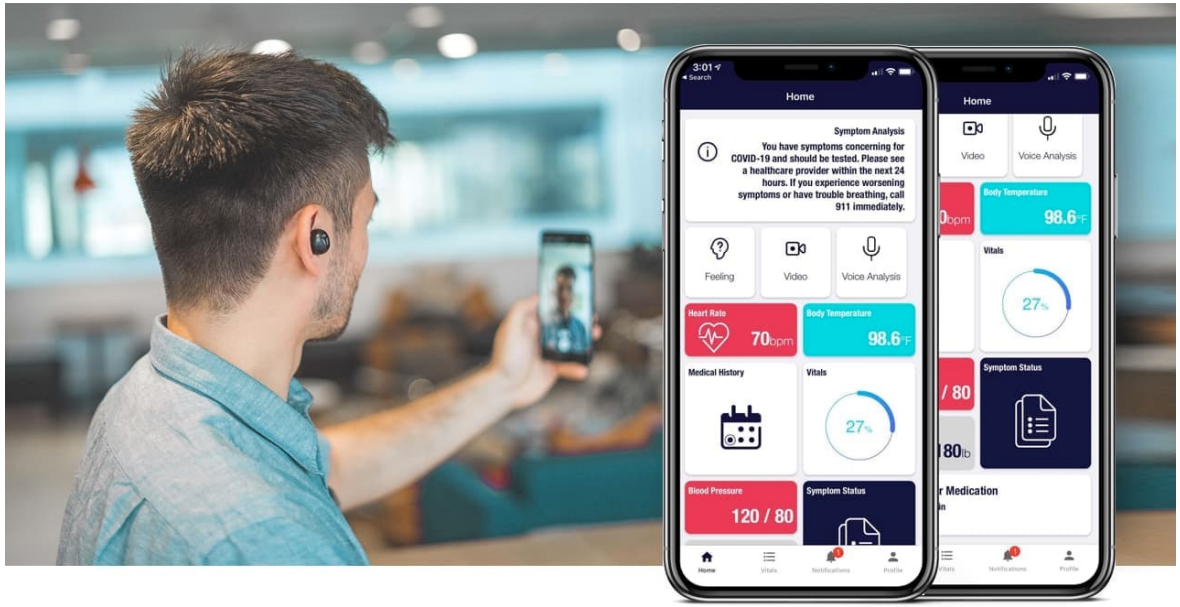
# Cancer Recurrence Prediction



Guihong Wan et al., Prediction of early-stage melanoma recurrence using clinical and histopathologic features," npj Precision Oncology volume 6, Article number: 79 (2022)

# Headache

- AI-based diagnostic model.
- AI assisted triage of headache patients to appropriate clinicians.



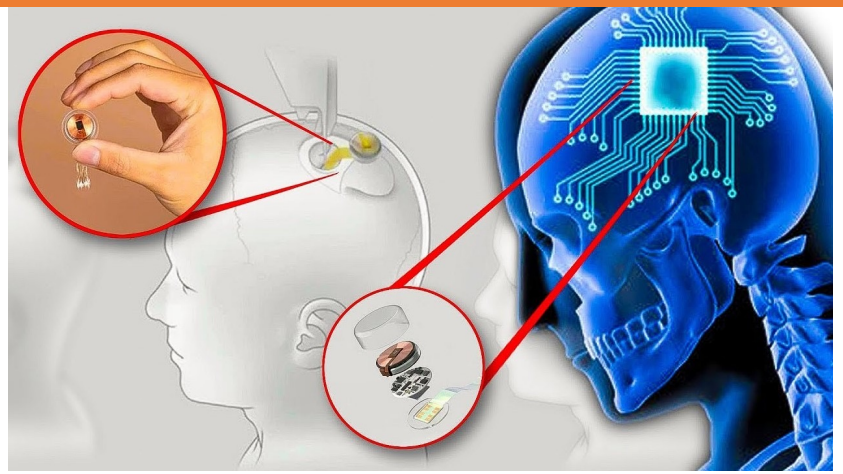

A short selfie video: Using Stress, vital signs, such as heart rate, respiration, and blood pressure that infer vital signs from videos using AI.

The role of AI in headache medicine: potential and Peril, American Headache Society, 2023.

# Robotics and Automatior

neural interface

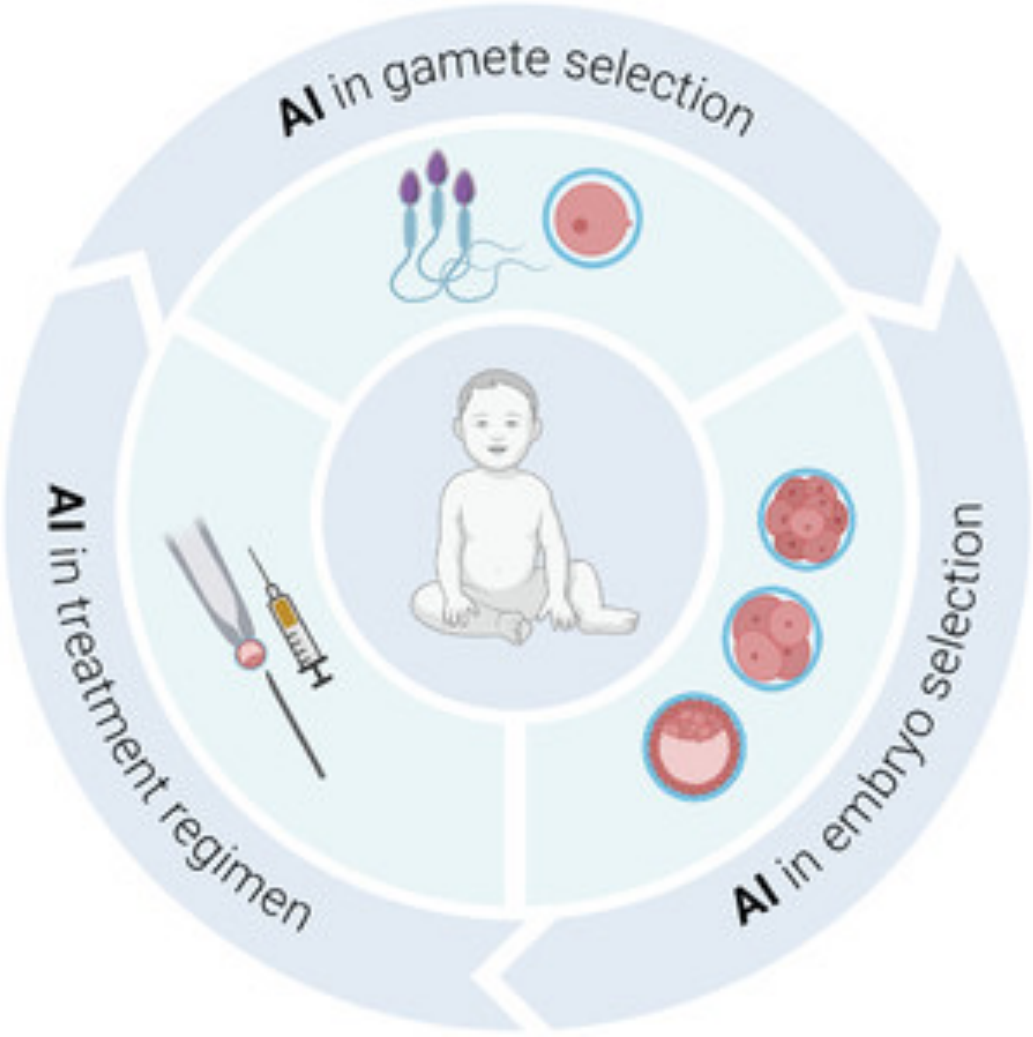
linking the human brain to an external AI system



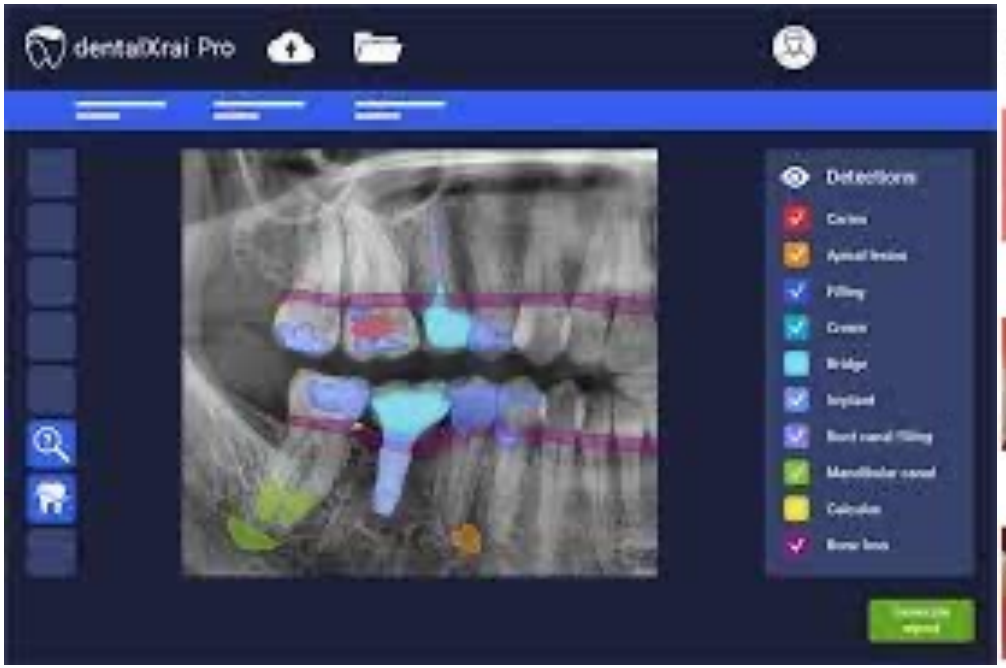
control prosthetic limbs

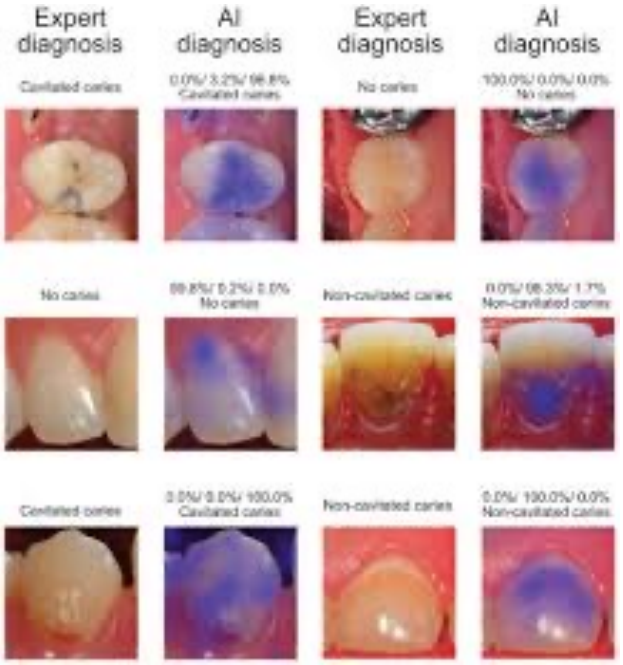
people with disabilities

# Artificial intelligence in Fertility technologies

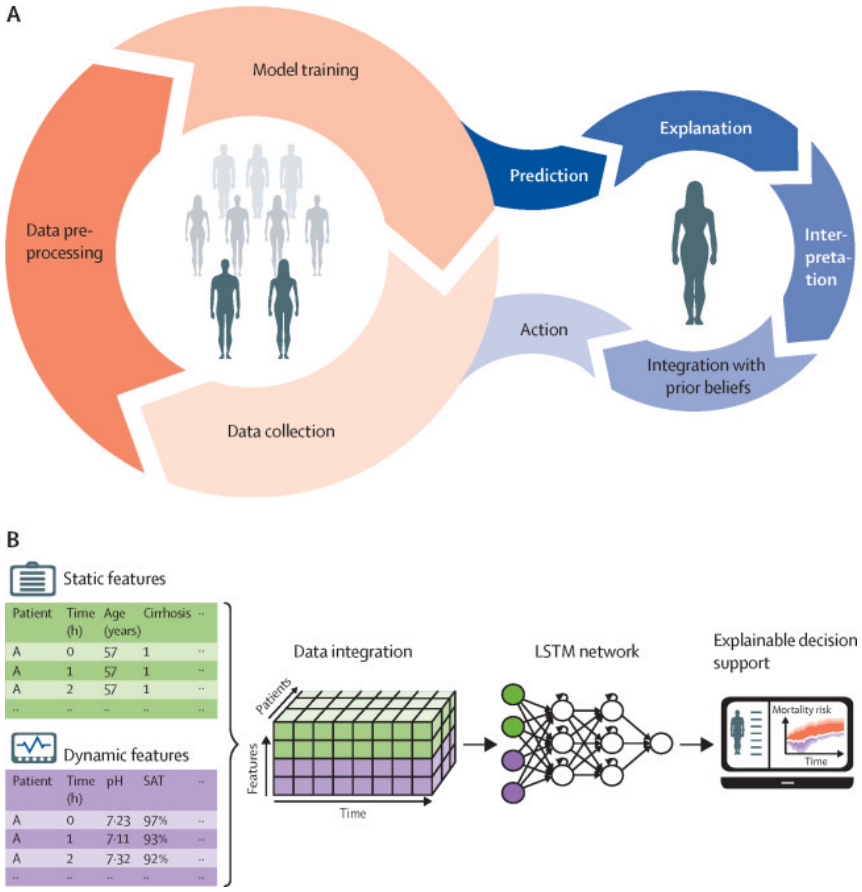


# AI and Dentistry



# Predicting Mortality and Morbidity




Predicting 180-day mortality for women with ovarian cancer using machine learning and patient-reported outcome data, Scientific Reports volume 12, Article number: 21269 (2022)

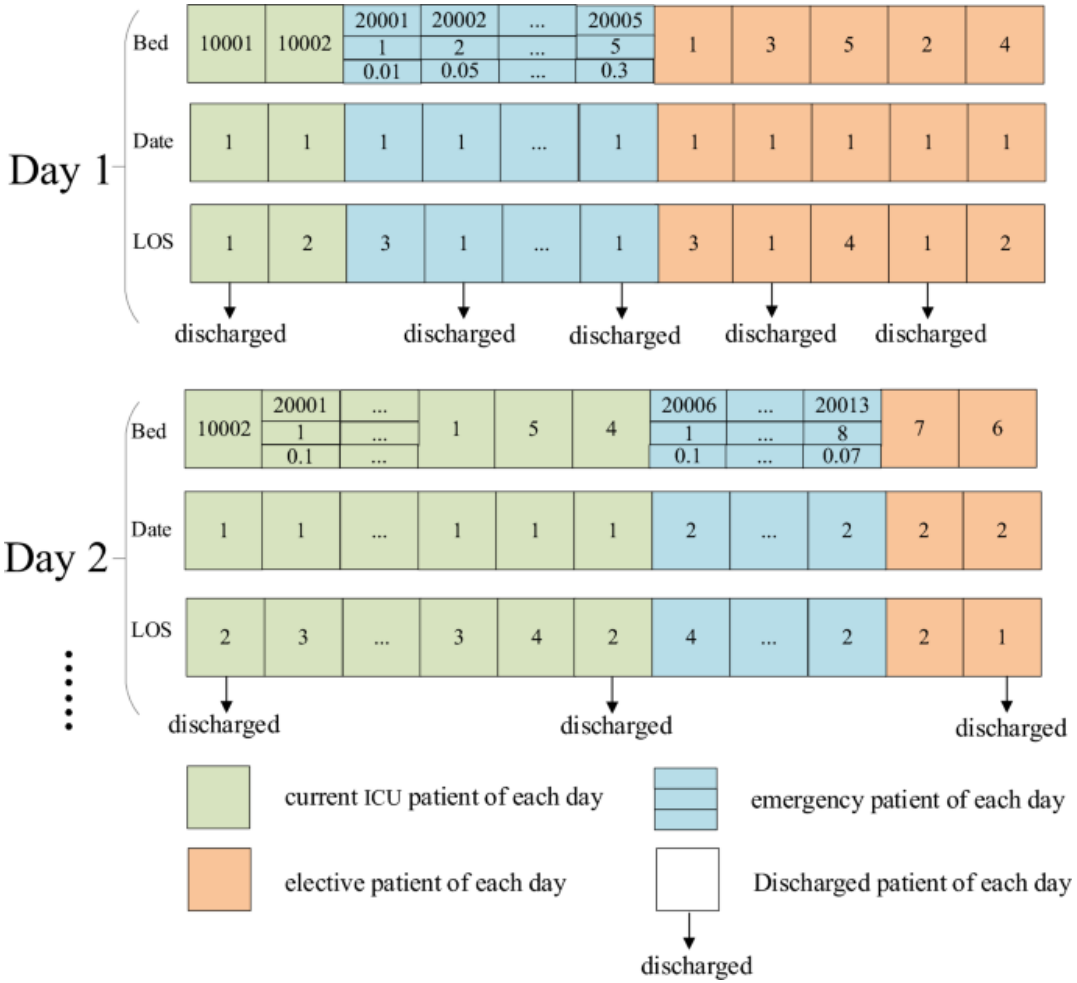
# Early-stage sepsis detection

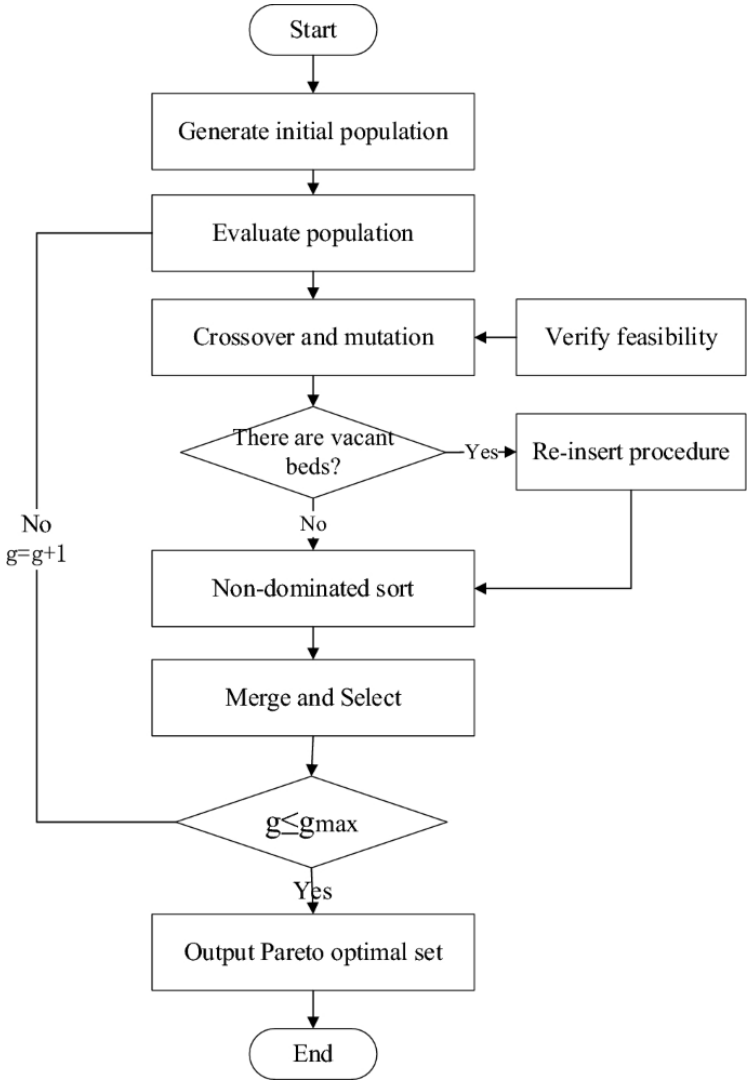
- Early-stage sepsis can be tricky to diagnose.
- Some electronic health record systems emit sepsis alerts when a patient shows signs of organ dysfunction and two out of four symptoms are detected: fever, elevated heartbeat, rapid breathing and high white blood cell count.
- However, because many illnesses share those symptoms, erroneous warnings are common.

# Identifying patients with sepsis at the right time

- Identify at-risk patient 6 hours earlier from EHR

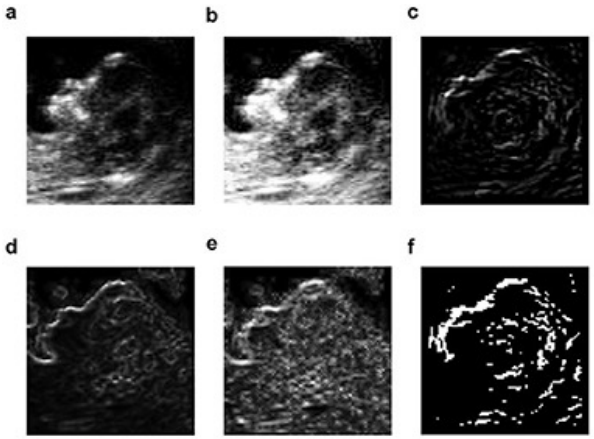
# ICU/operating Room Scheduling Optimization



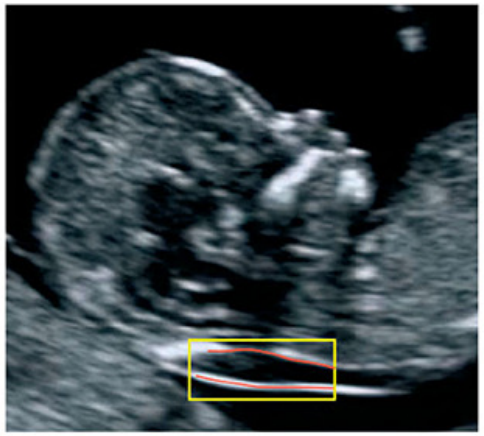




**Two-stage multi-objective optimization for ICU bed allocation under multiple sources of uncertainty,** *Scientific Reports* **volume 13**, Article number: 18925 (2023)

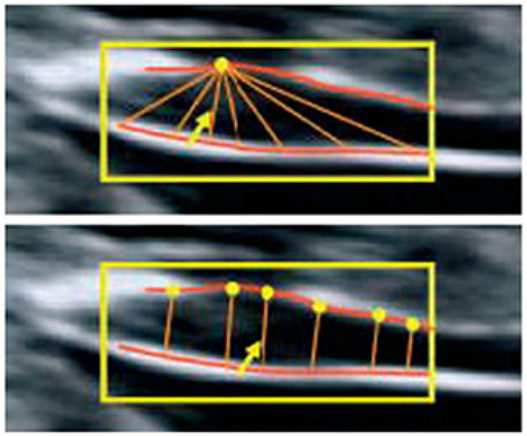
# Optimization and Obstetrics and Gynecology



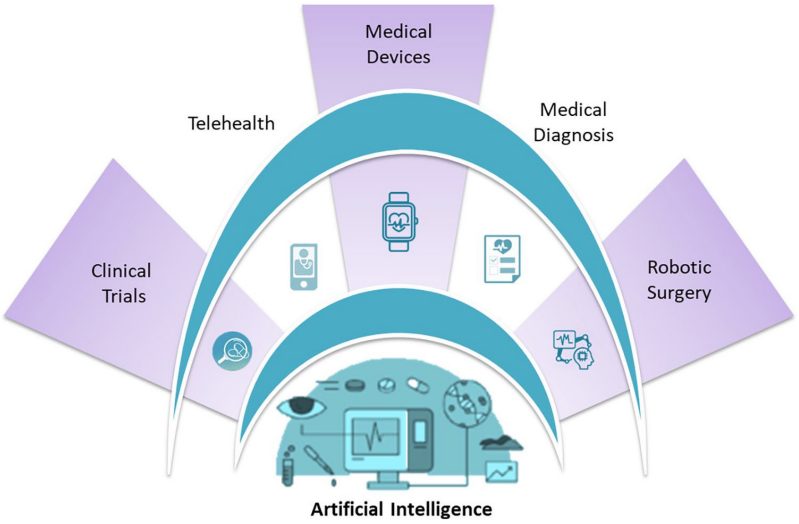

Automatic mid-sagittal plane detection

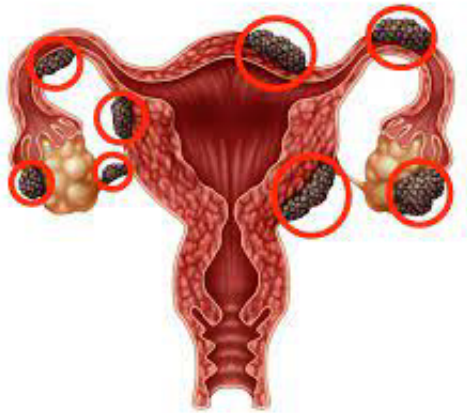


Automatic segmentation of the nuchal membrane and the edge of the soft tissue overlying the cervical spine

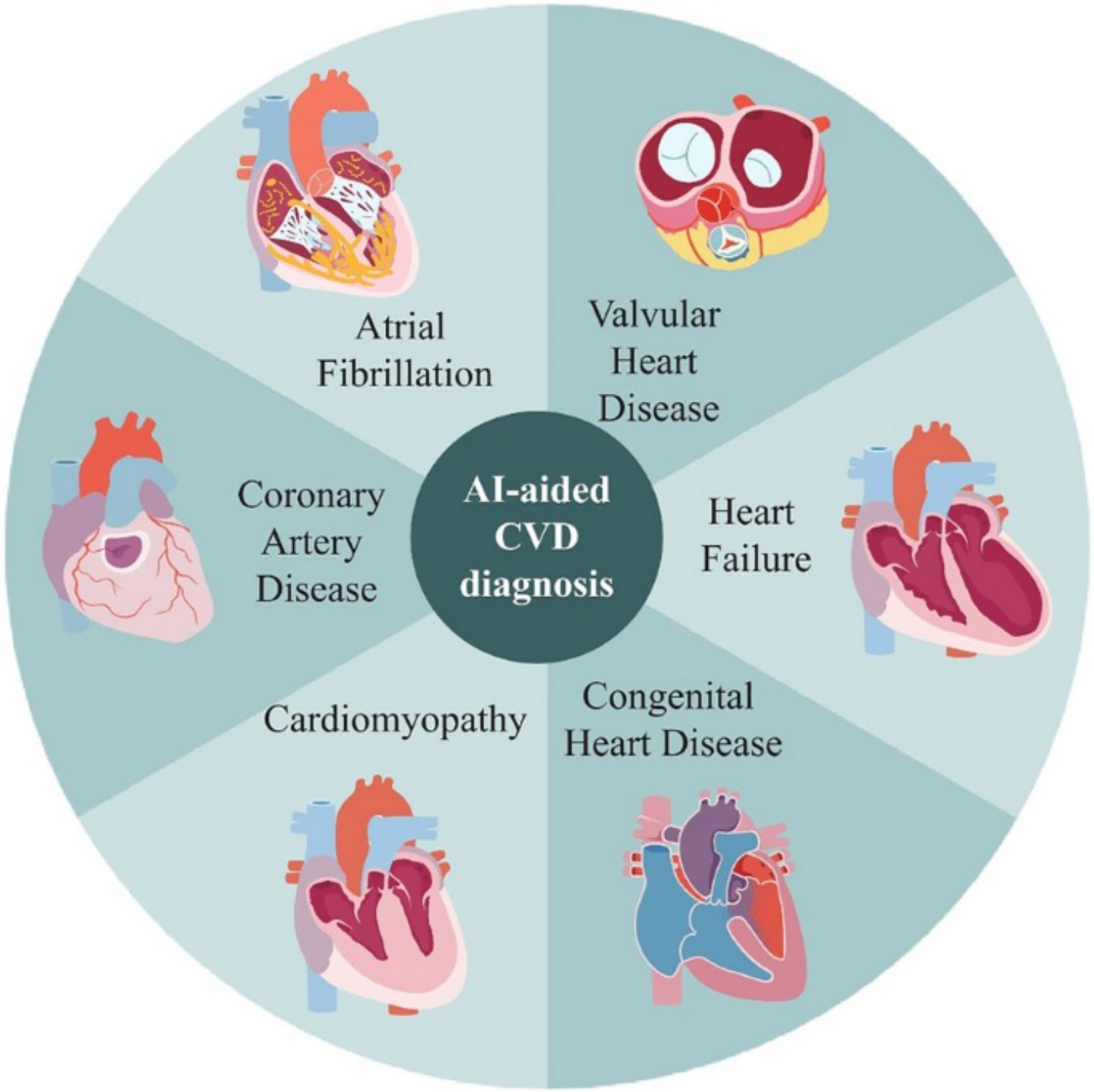


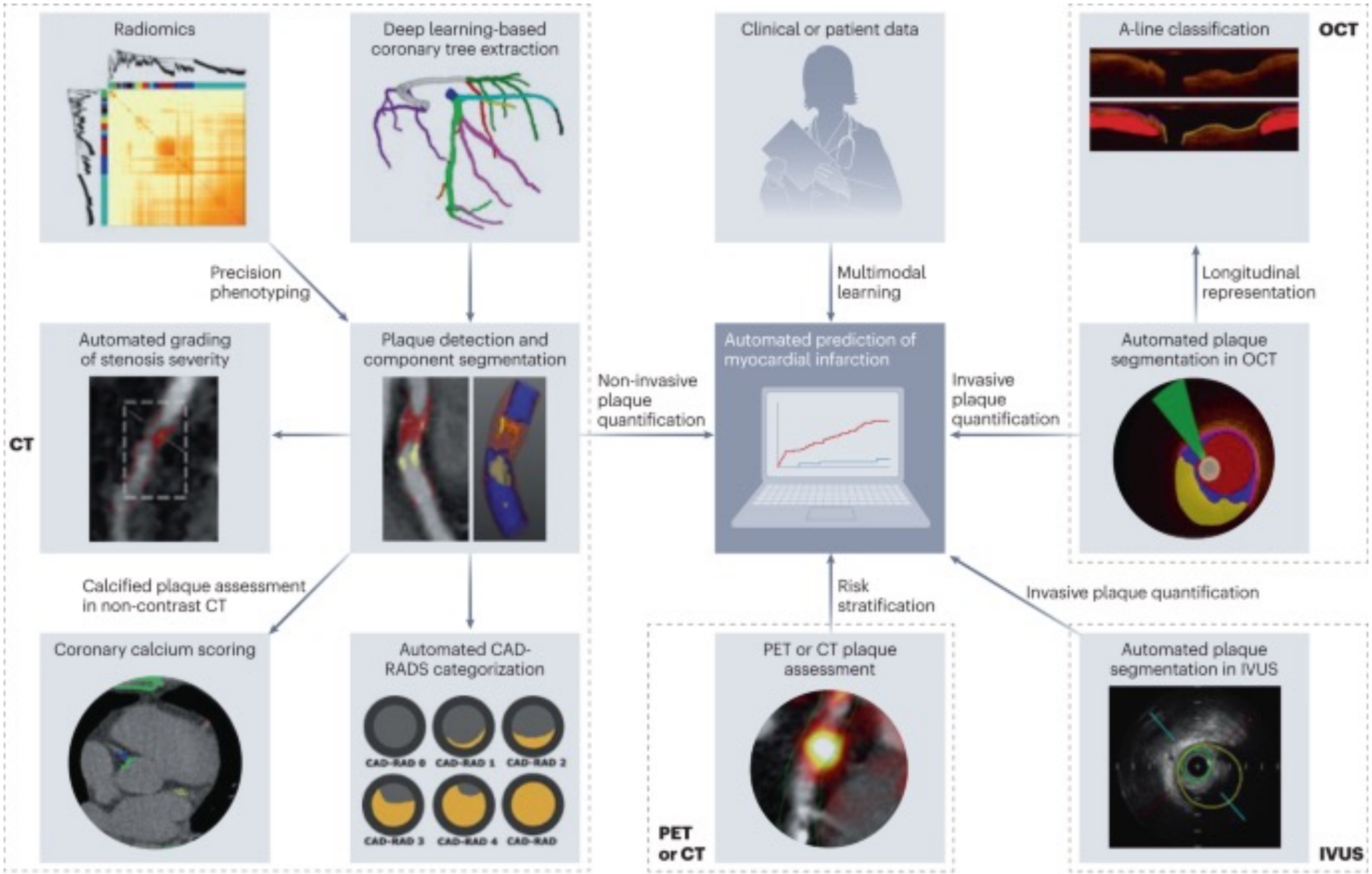
Calculates the minimum vertical distance between the two lines and computes the



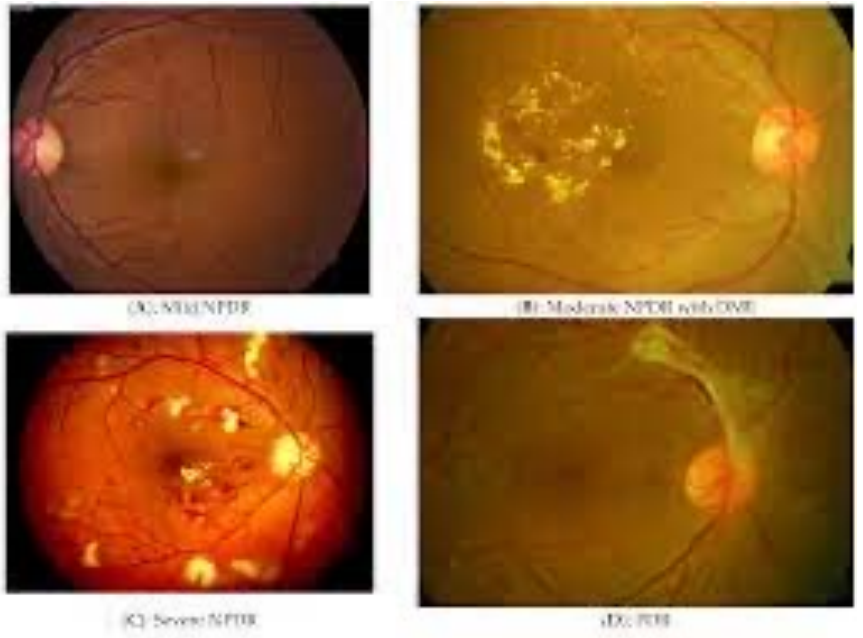
endometriosis


Atrial Fibrillation
Valvular Heart Disease
Coronary Artery Disease
AI-aided CVD diagnosis
Heart Failure
Cardiomyopathy
Congenital Heart Disease



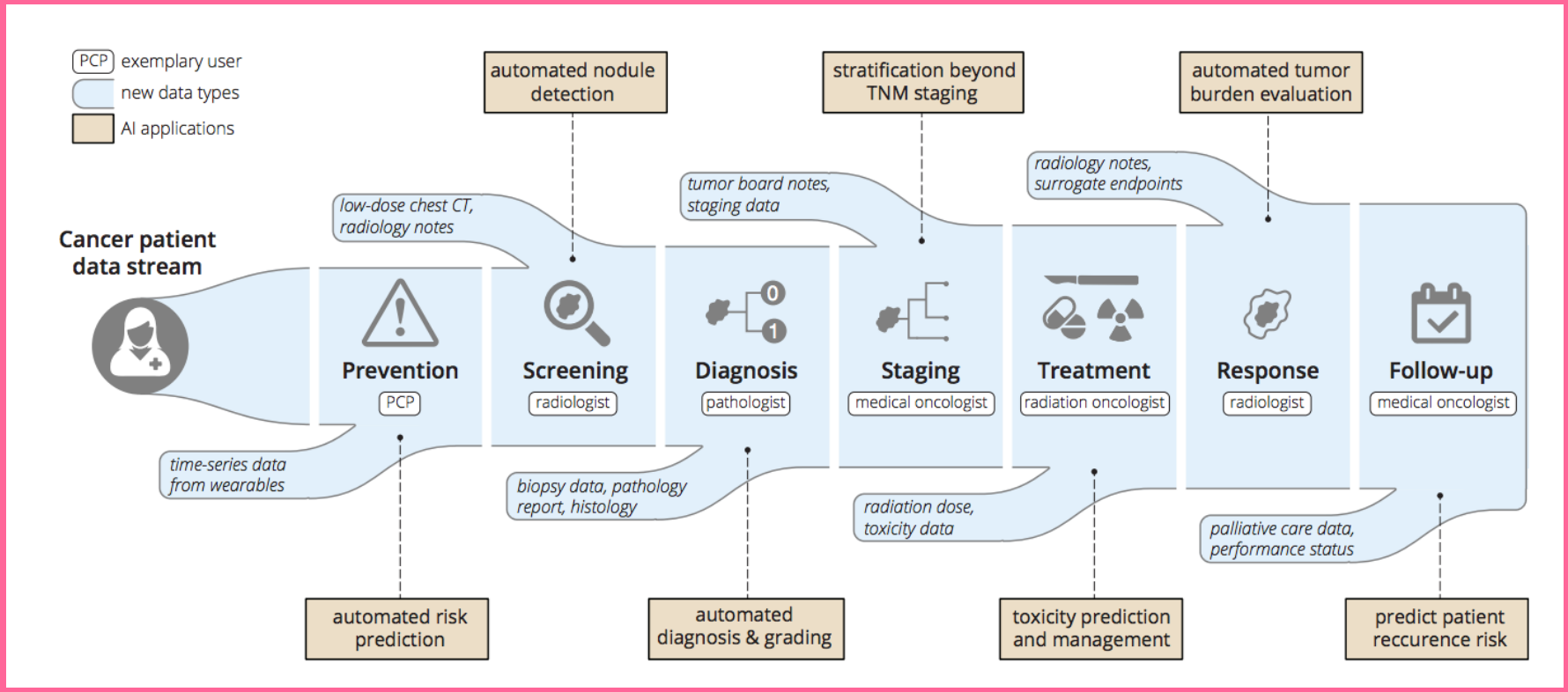
# Diabetes

Some strategies include self-management, wearable devices, and remote monitoring. continuous glucose monitor insulin pumps using AI and big analytics among people with Type 1 diabetes

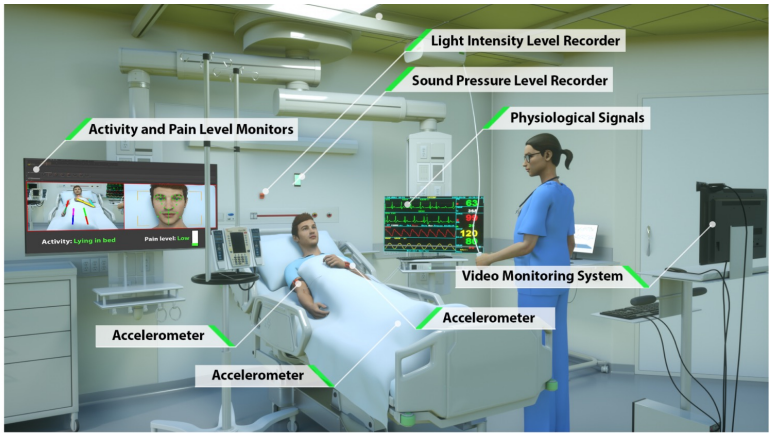


For example, it can offer retinopathy detection from retinal images

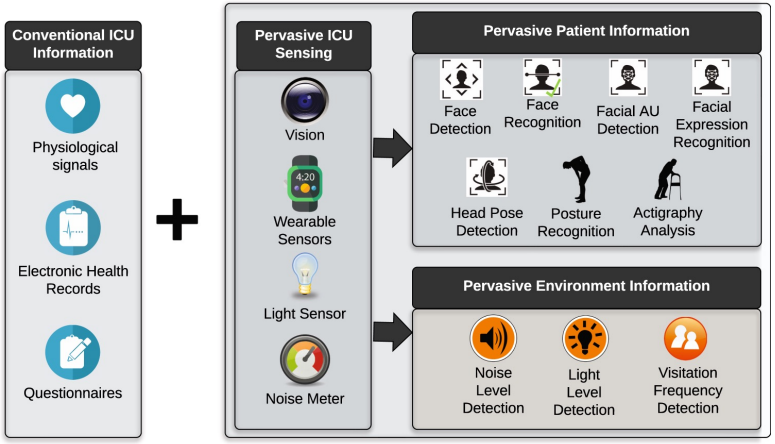
# Intelligent Oncology



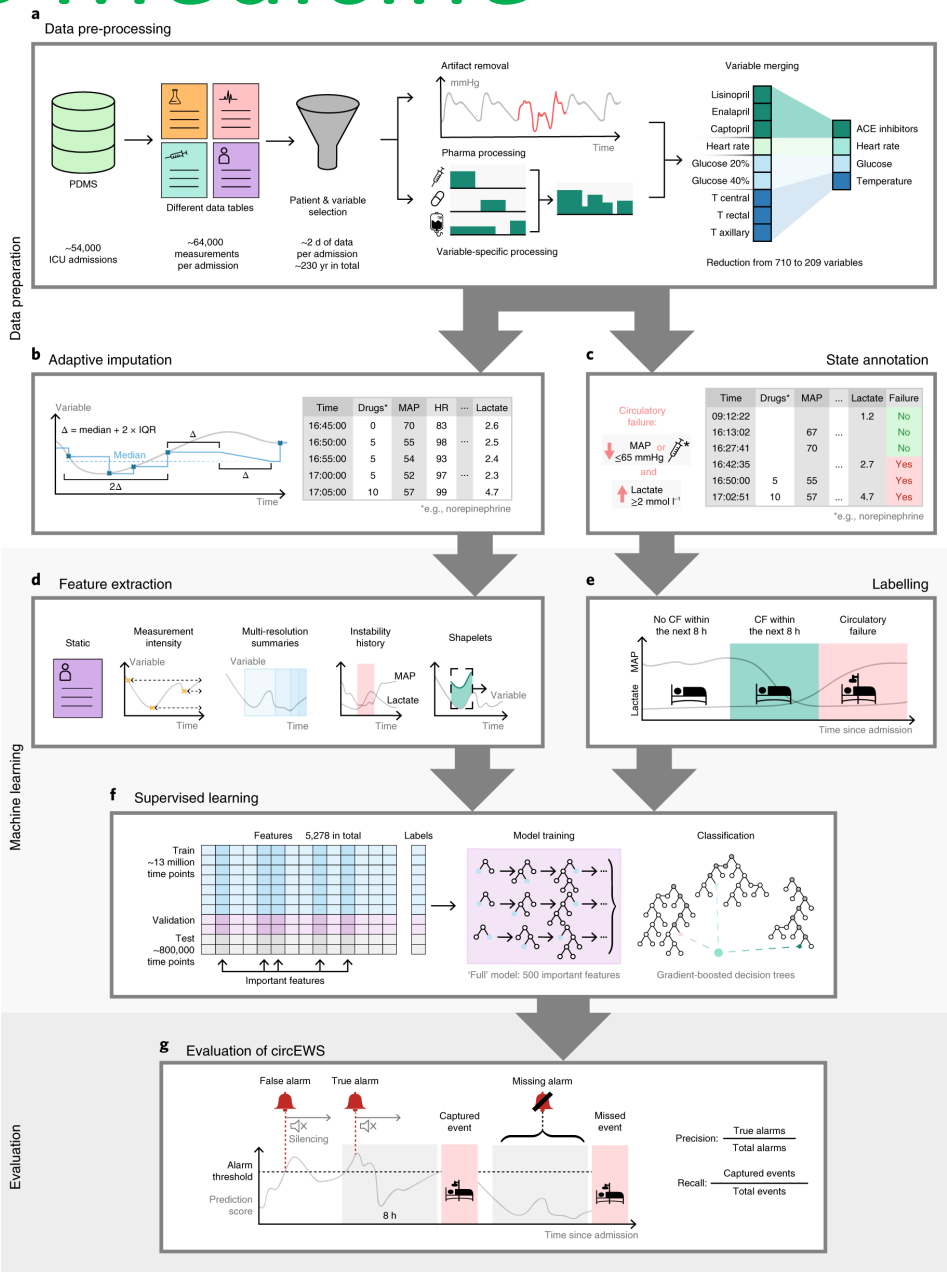
# Intensive care Medicine



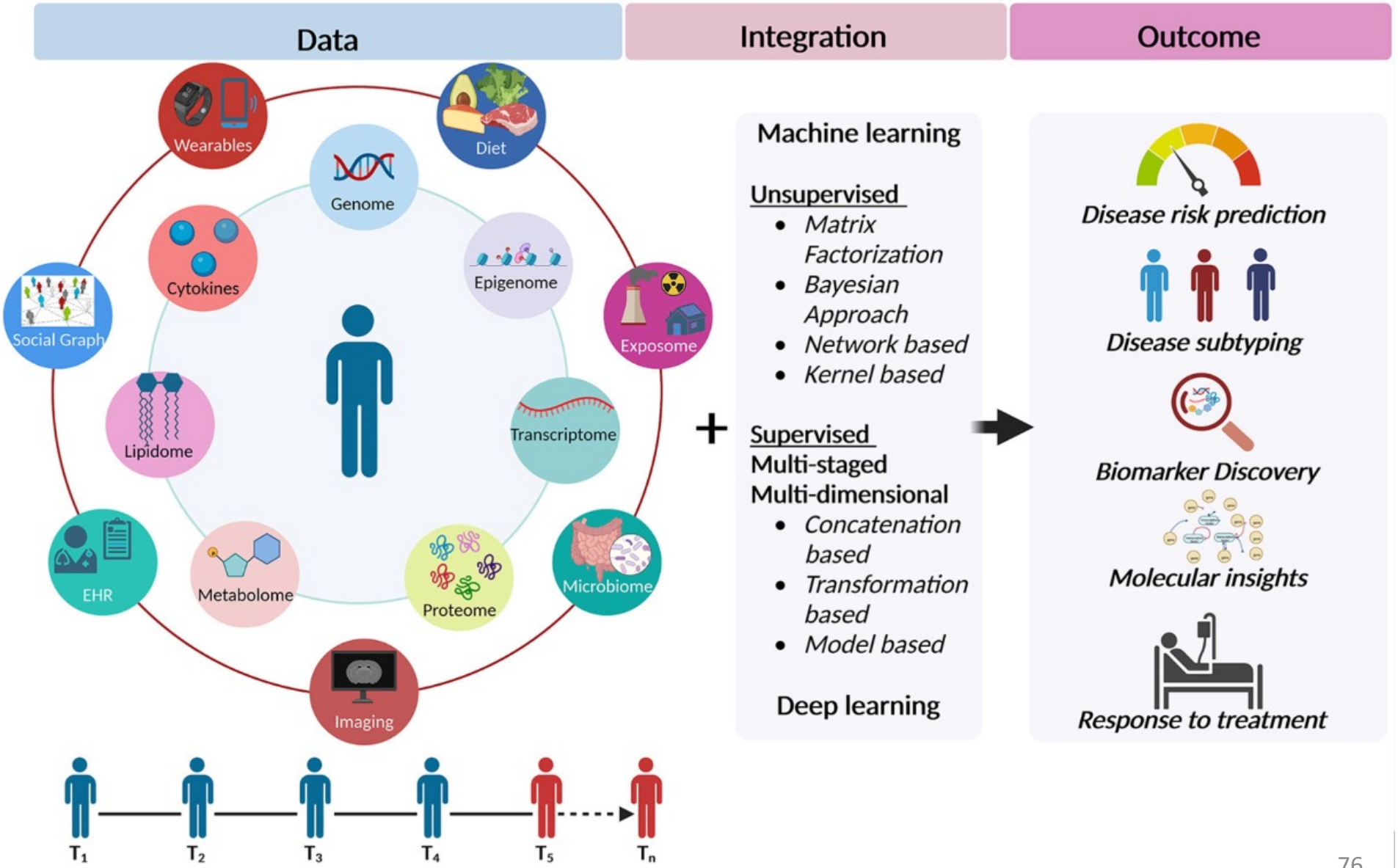

a)




b)



# AI in Obesity



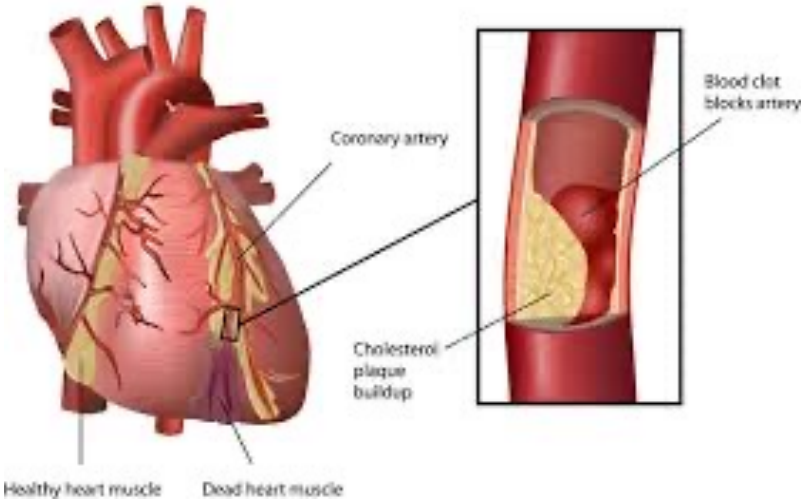
# AI and **healthy diet**

Obesity is a major risk factor

Cancers

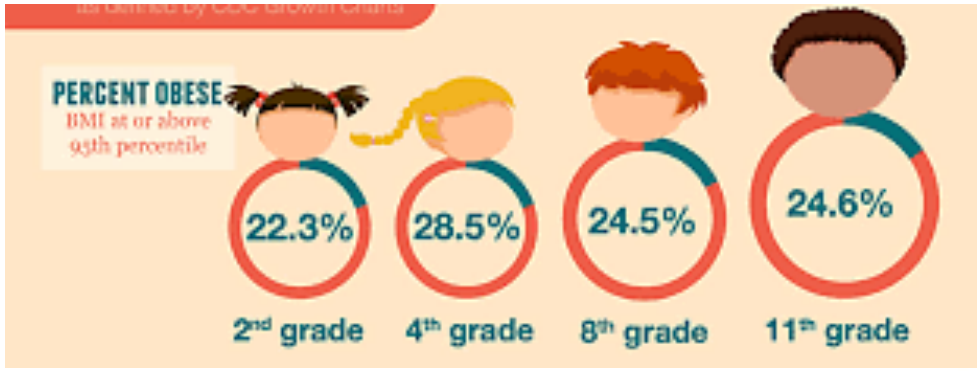

Polycystic Ovary Syndrome (PCOS)

Cardiovascular disease




Diabetes

# A prediction model for childhood obesity risk using the machine learning method




At an early age

Obesity in Children

automatically identify children with a higher risk

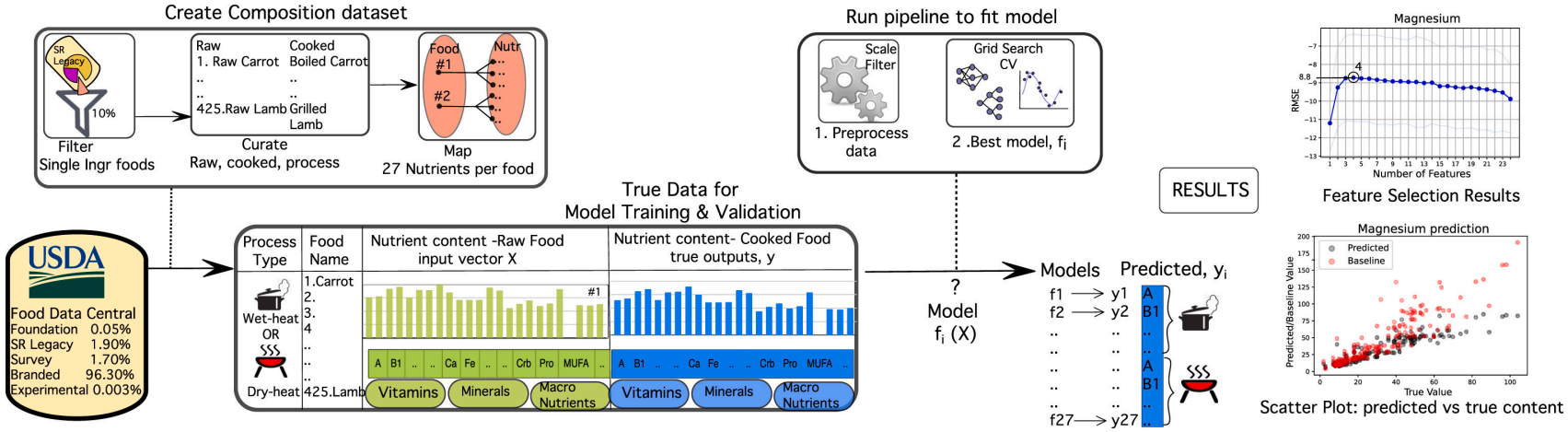
early intervention

*Scientific Reports* **volume 13**, Article number: 10122 (2023)

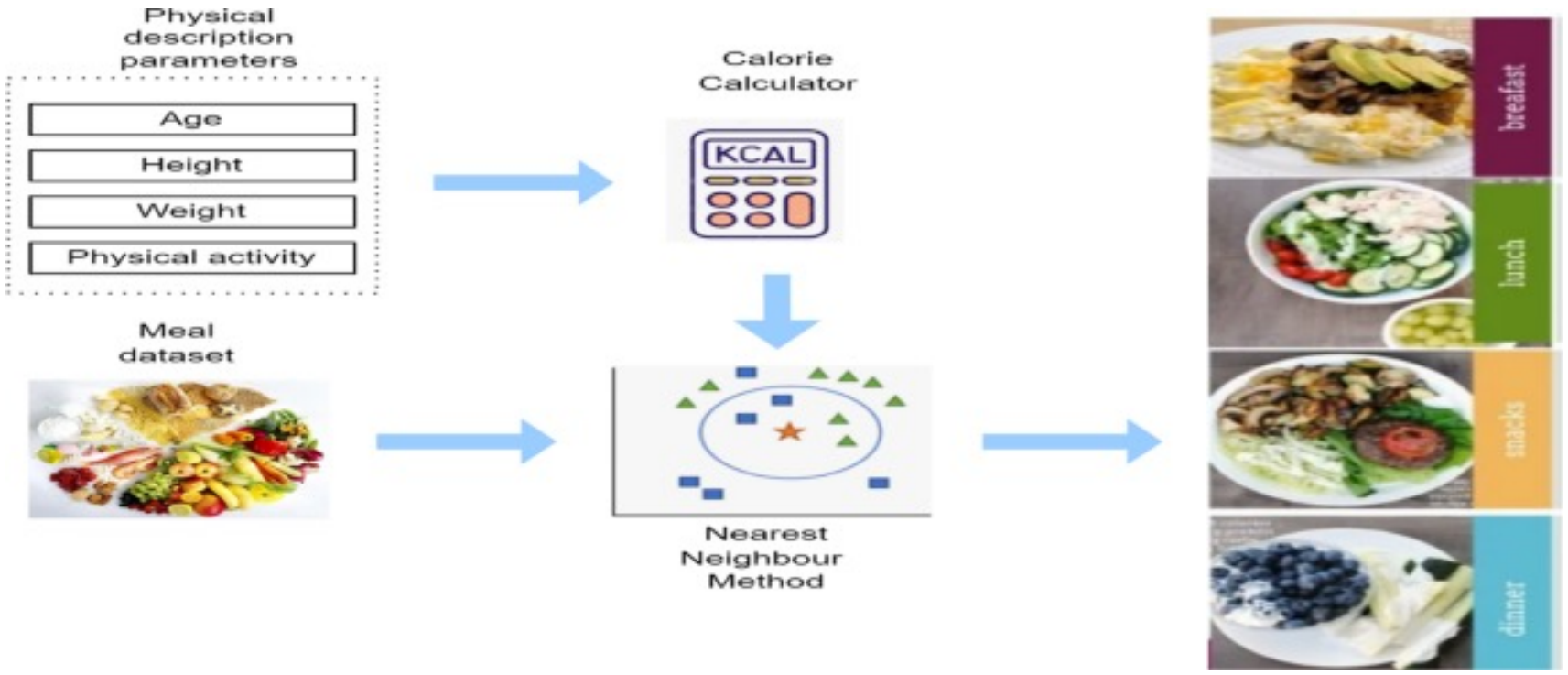
# Recommender Systems

Assist patients in developing sustainable and satisfying low-energy-dense eating habits

# Estimate the nutrients in food



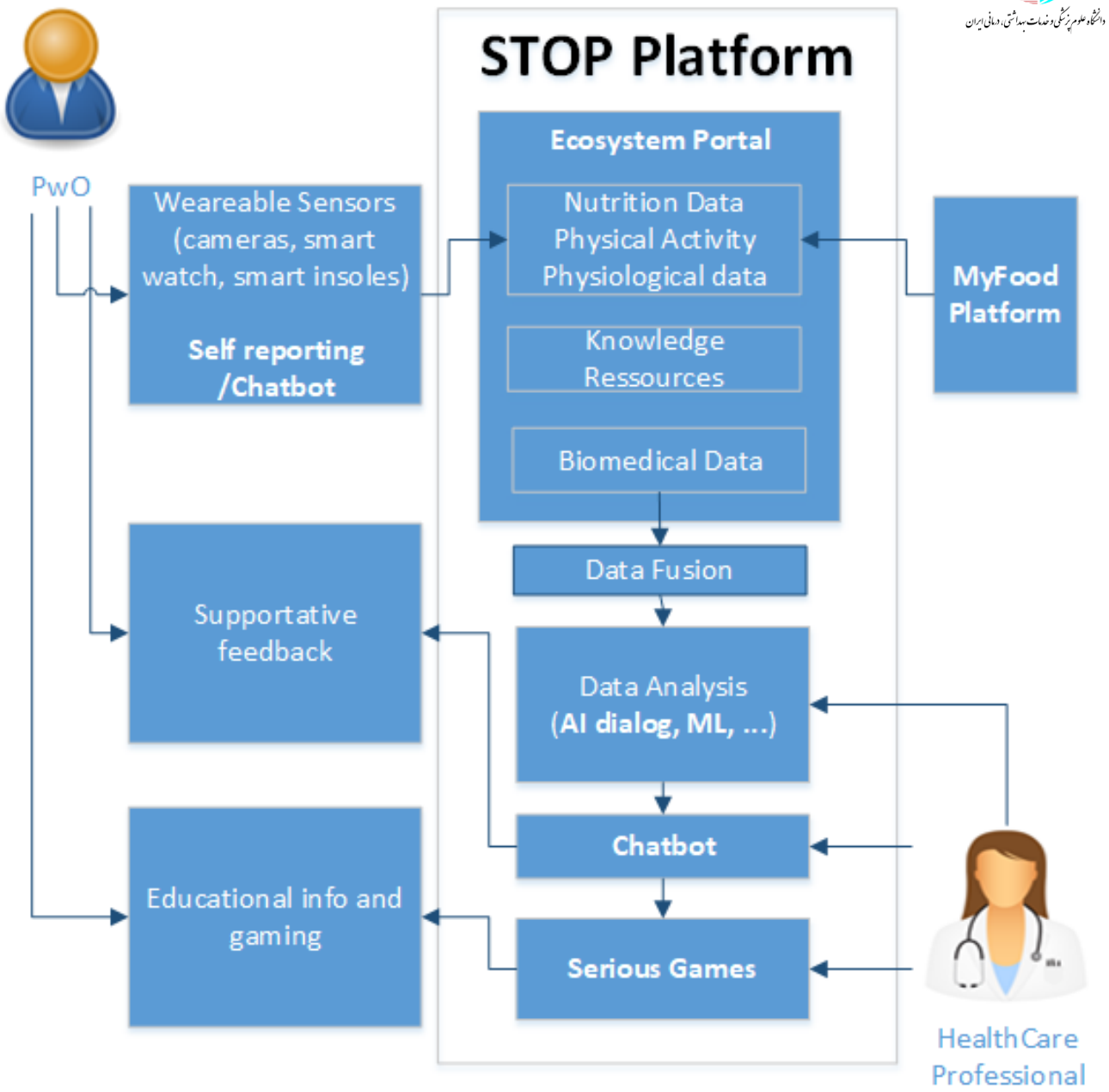
# A machine learning model to predict meals as per the caloric requirements




Predicting risk of obesity and meal planning to reduce the obese in adulthood using artificial intelligence Original Article Published: 12 October 2022 Volume 78, pages 458–469, (2022)

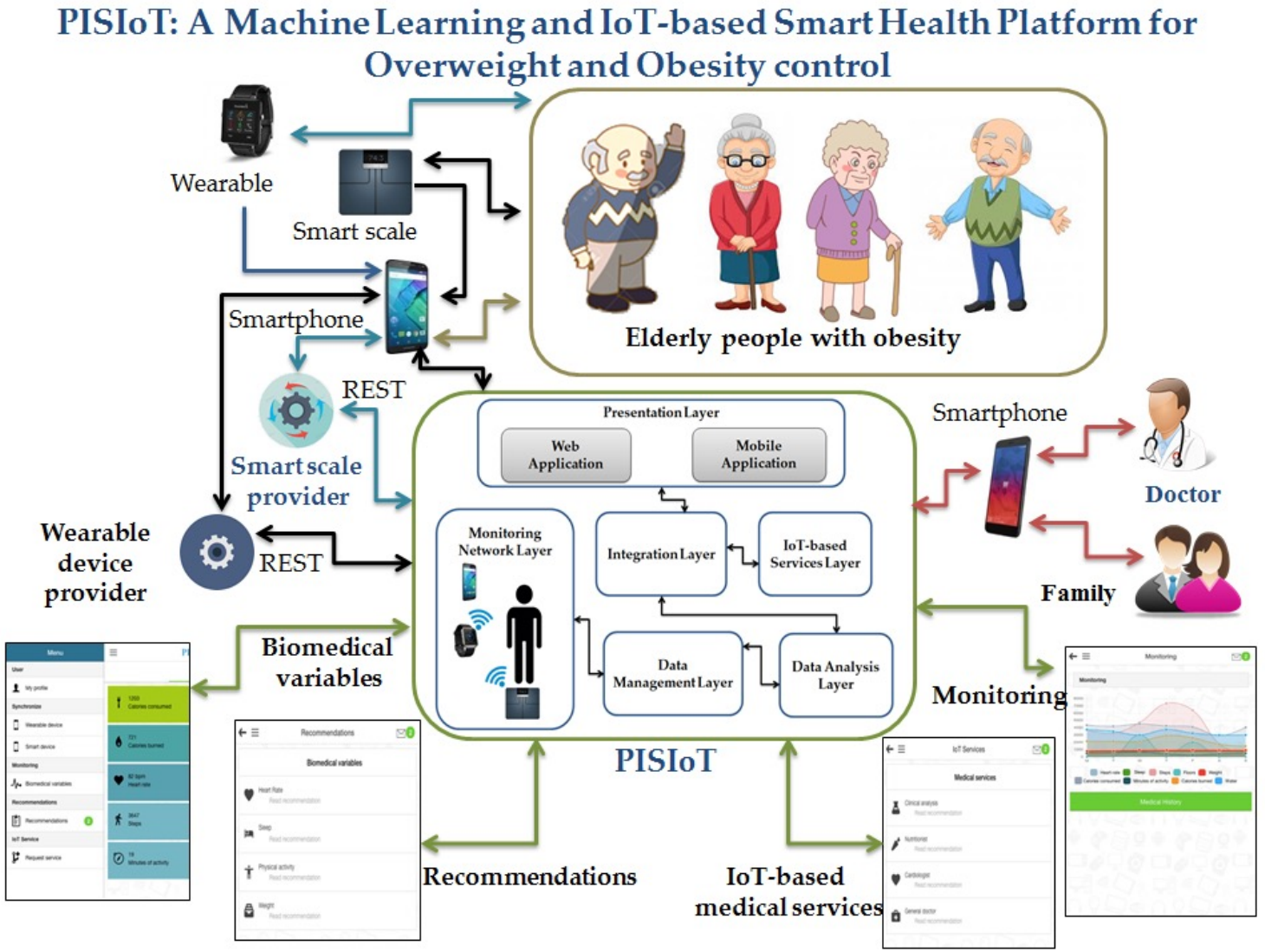
# Chatbot

Stop Obesity Platform features a chatbot that tailors recommendations on nutrition and exercise according to people's health data and emotions.

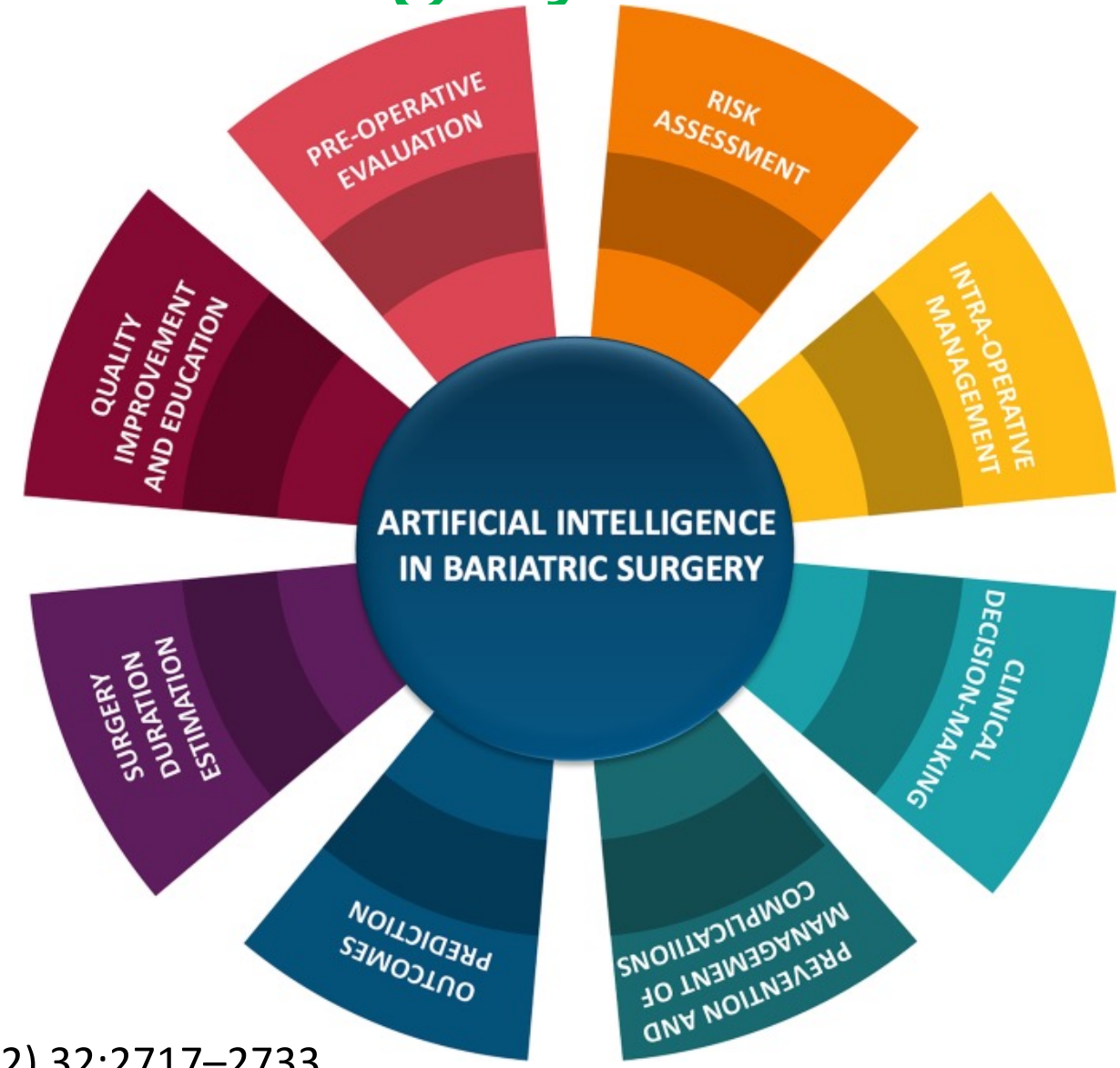



https://cordis.europa.eu/project/id/823978/reporting

# A Machine Learning and IoT-Based Smart Health Platform for Overweight and Obesity Control



# Role of artificial intelligence (AI) in bariatric surgery




Obesity Surgery (2022) 32:2717–2733

# Nutrition in strokes

# AI in Nutrition in the pediatric intensive care unit

# Physical activity and obesity

# Note that!!

Artificial Intelligence in Medicine is an Augmented Medicine

AI is not your replacement — it is an assistant

# Challenges and Questions

- How do we ensure the ethical use of AI in healthcare?
- What are the regulatory frameworks that need to be in place for the safe and effective use of AI?
- How do we measure the quality and accuracy of AI in healthcare?

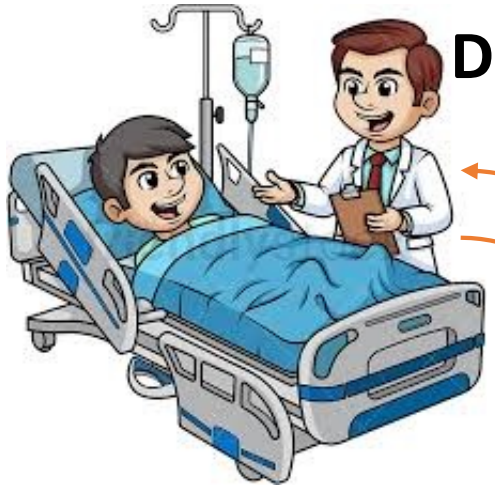
# 8-AI Medical Application

| | |
|---|---|
| Prevention | Screening |
| Early Detection | Diagnosis |
| Recurrence Prediction | Critical Decision Making |
| Treatment Selection and Analysis | Mortality and Morbidity Prediction |
| Triage | … |


Hospital

In the Hospital

Pre Hospital

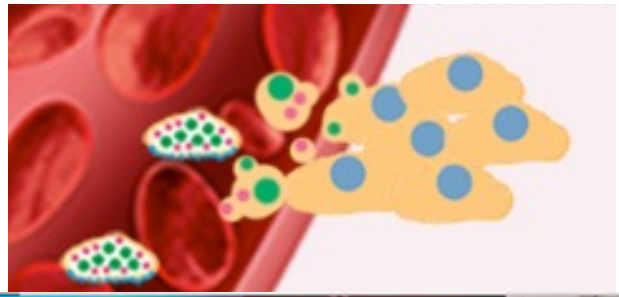


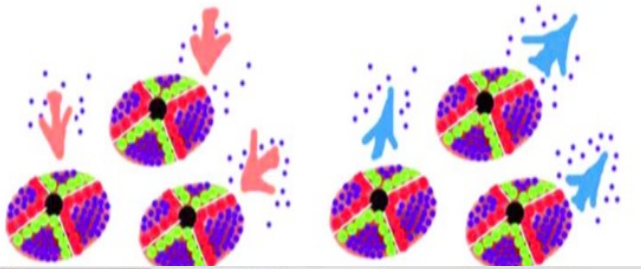
Doctor

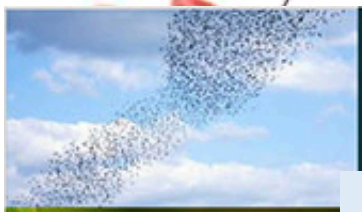
Patient

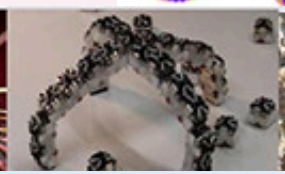
Home

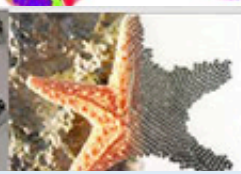
Post Hospital at Home

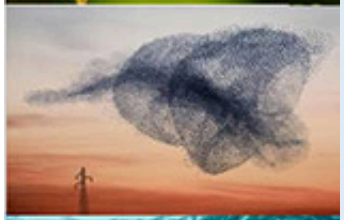













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**MA, Ph.D., and Postdoc in Artificial Intelligence and Robotics**

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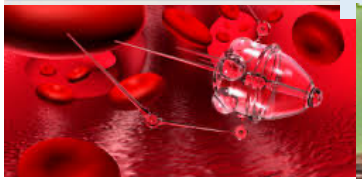
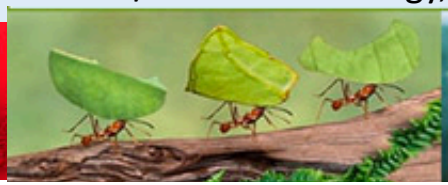
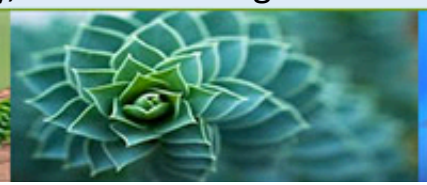
**Email:** radyraz.n@iums.ac.ir , radyraz@mail.um.ac.ir,
radyraz@yahoo.com

**Research Interest:**

Artificial Intelligence, Artificial Intelligence in Medicine, Complex Systems, Biomimicry, Cognitive Science, Swarm Intelligence, Nanomedicine, Targeted Drug Delivery, Early Detection of Disease, Swarm Nano Robotics, Cancer Research, Fuzzy Logic and Control, Soft Computing, Neural Networks, Machine Learning, Multi-agent Systems, Distributed Decision Making, Biomarkers, Biophysics, Nature Inspired Algorithms, Computational Cellular/Molecular Biology, Protein Folding







Artificial Intelligence for Good (AI for Good)