دانشگاه علوم پزشکی و خدمات بهداشتی، درمانی ایران

Breast Disease Cancer Research Center

ARTIFICIAL INTELIGENCE IN BREAST & ONCOLOGY

DR NAHID NAFISSI
Associated professor
IUMS

20th century : ***industrial age***

approach to medicine was according to symptoms and lab test

21st century: ***information age***

Approach to medicine is according to OMICS

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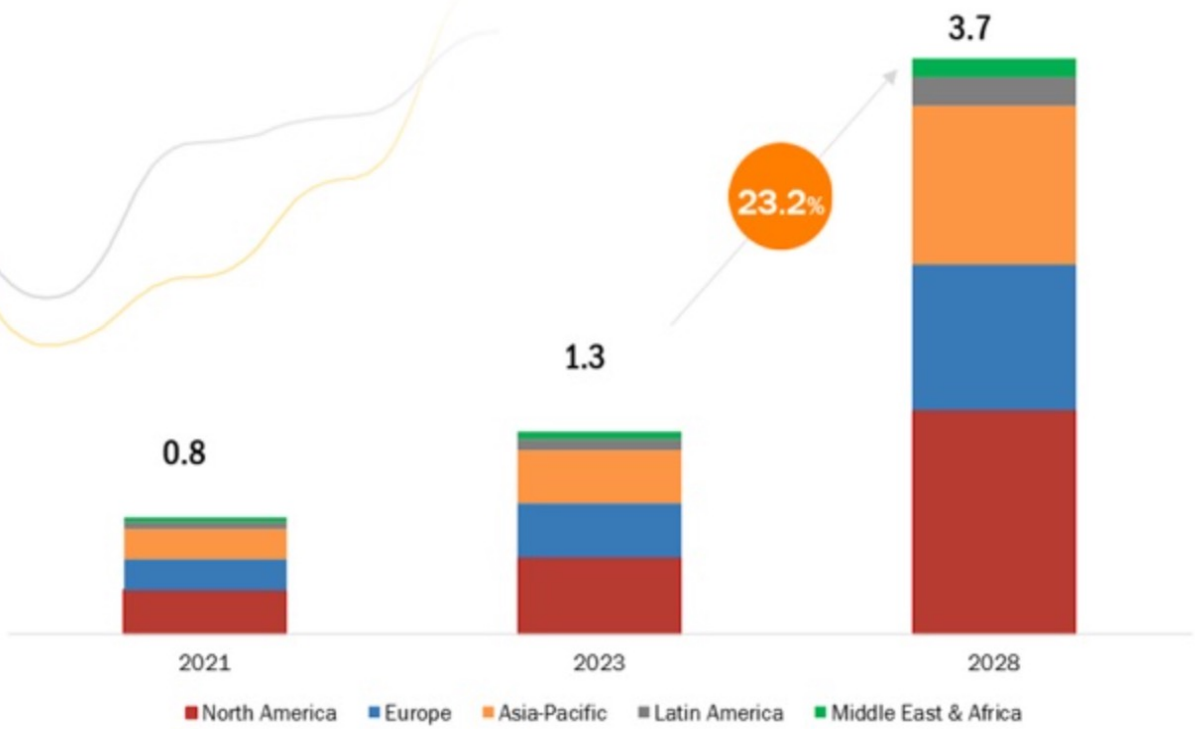
AI IN MEDICAL DIAGNOSTICS MARKET

GLOBAL FORECAST TO 2028 (USD BN)

CAGR OF

23.2%

The global AI in medical diagnostics market is expected to be worth USD 3.7 billion by 2028, growing at a CAGR of 23.2% during the forecast period.



Oncology informatics

provide the caregiver and patient insight on the current knowledge base with respect to
gene sequencing and personalized medicine, tailored to the patient's own expressed preferences.

If patients choose to know, oncology informatics can help inform them of their own unique expected outcomes given the best evidence to date.

Diagnosis of Neoplasia

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Symptoms
- Weight loss
- Rectal bleeding
- Persistent cough

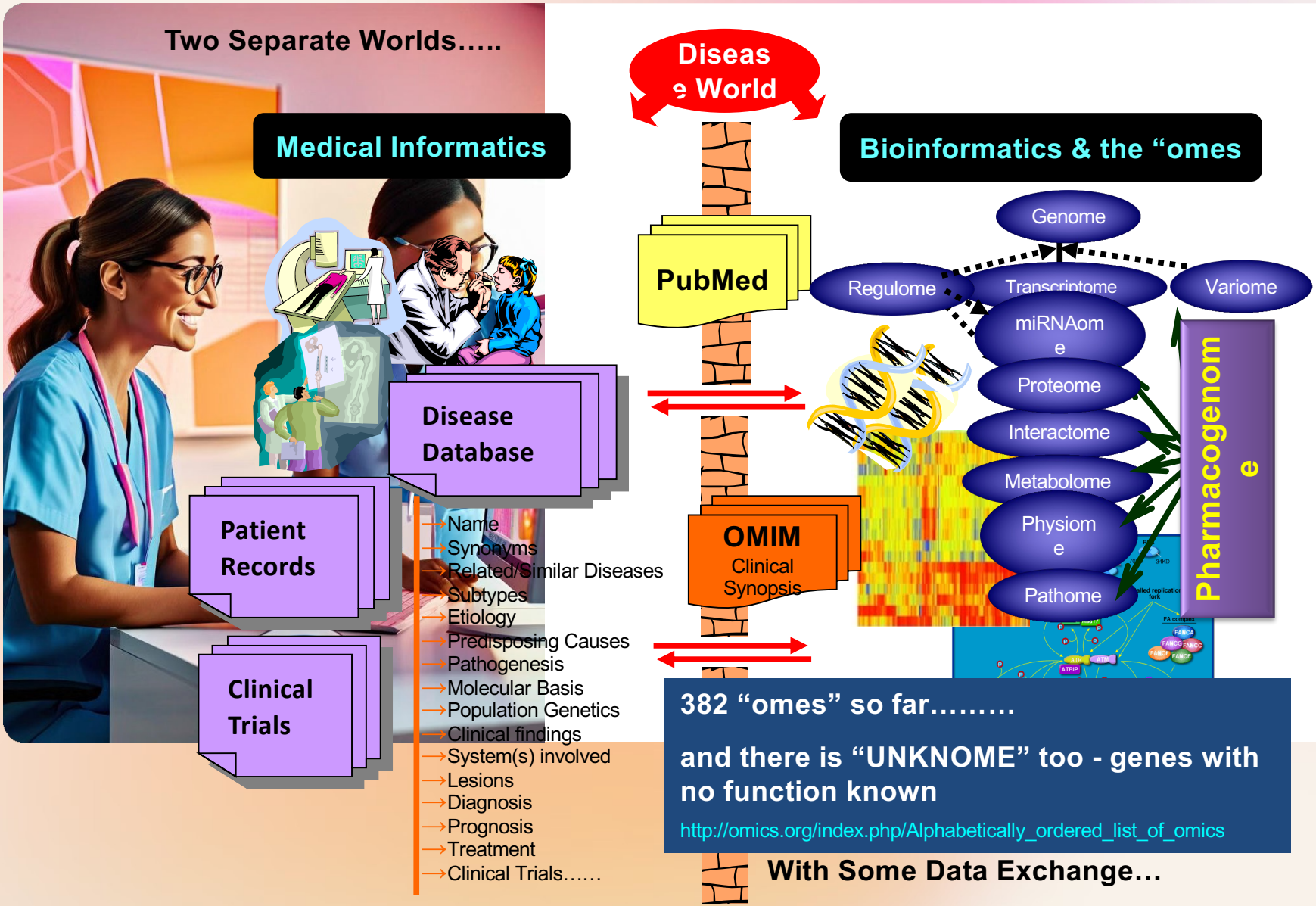
Screening
- Pap smear
- Mammogram
- Occult blood

Incidental
- Radiology
- > ~1 gm (10^9 cells)

Biopsy → Histopathology → Staging

Autopsy → Histopathology

Autopsy → Staging


Two Separate Worlds…..
Medical Informatics
Diseas
e World
Bioinformatics & the "omes
PubMed
Genome
Regulome
Transcriptome
Variome
miRNAom
e
Proteome
Interactome
Metabolome
Physiom
e
Pathome
Pharmacogenom
e
Disease
Database
Patient
Records
Clinical
Trials
OMIM
Clinical
Synopsis
Name
Synonyms
Related/Similar Diseases
Subtypes
Etiology
Predisposing Causes
Pathogenesis
Molecular Basis
Population Genetics
Clinical findings
System(s) involved
Lesions
Diagnosis
Prognosis
Treatment
Clinical Trials……
382 "omes" so far……
and there is "UNKNOME" too - genes with no function known
http://omics.org/index.php/Alphabetically_ordered_list_of_omics
With Some Data Exchange…

In cancer

the ability to identify variations
in disease processes at the
subcellular level
is catalyzing an era of precision medicine :
treatment can be oriented to the genetic disruptions of an individuals' specific cancer cell and
then optimized to target the molecular drivers of an individual patient's unique expression of the disease

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, information age technologies will allow care teams to
adopt an approach to care that will be
predictive,
preemptive,
precise,
participative
in nature.

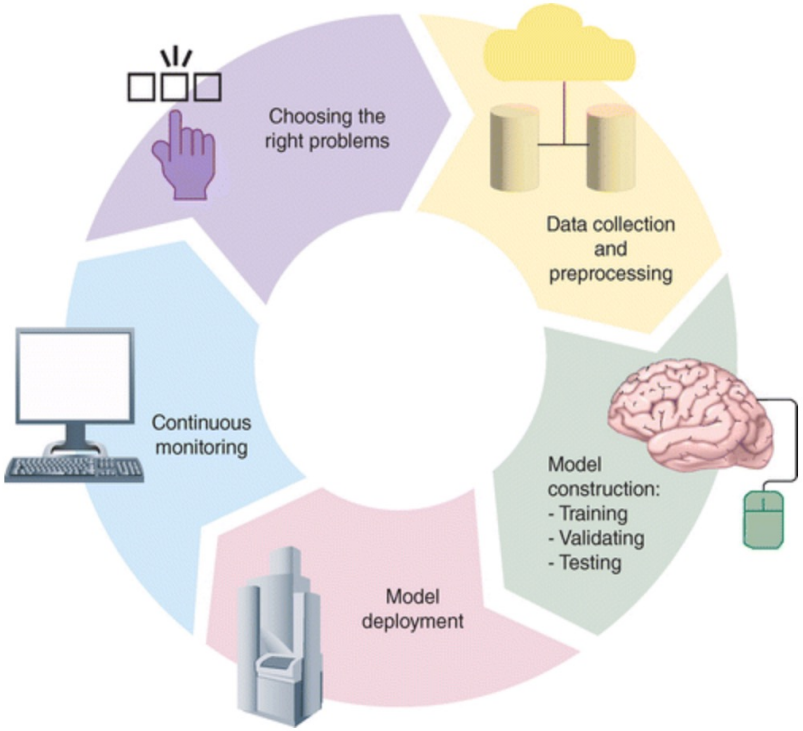
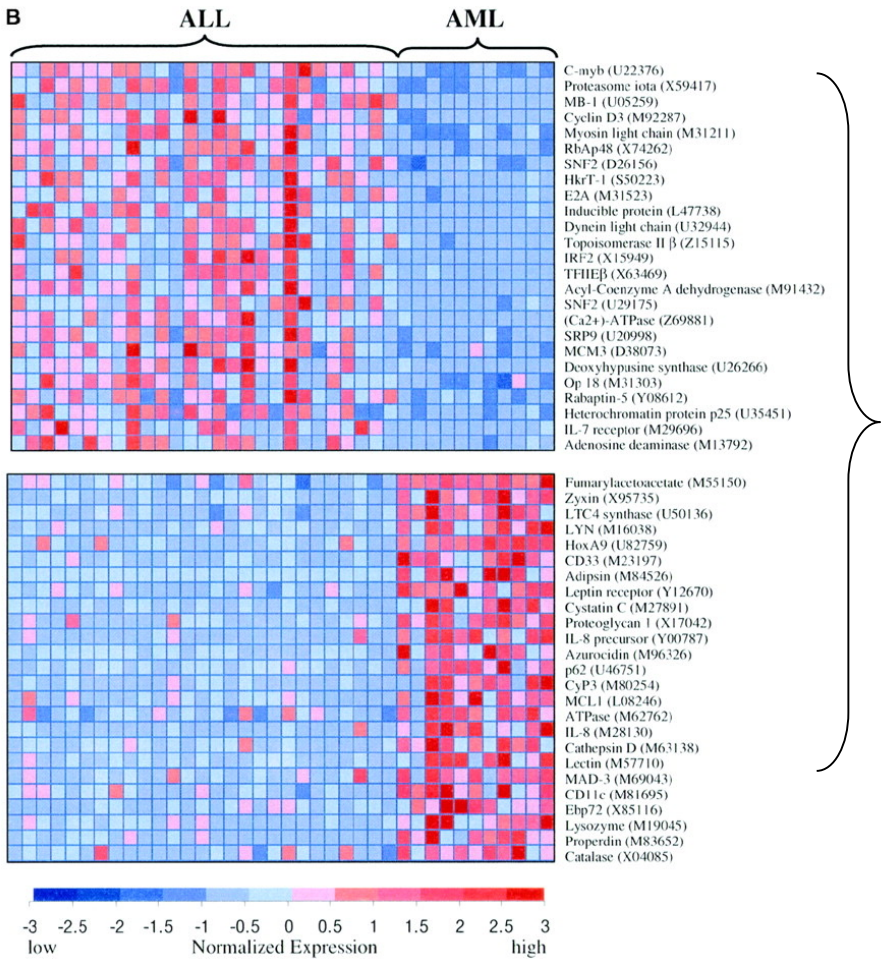


Figure 1. Artificial intelligence flywheel.

Graphic representation of the artificial Intelligence and data cycle for building effective and responsible machine learning models for healthcare.

Molecular Signatures

computational or mathematical models that link high-dimensional molecular information to phenotype of interest



Molecular Signatures

Gene markers

New drug targets

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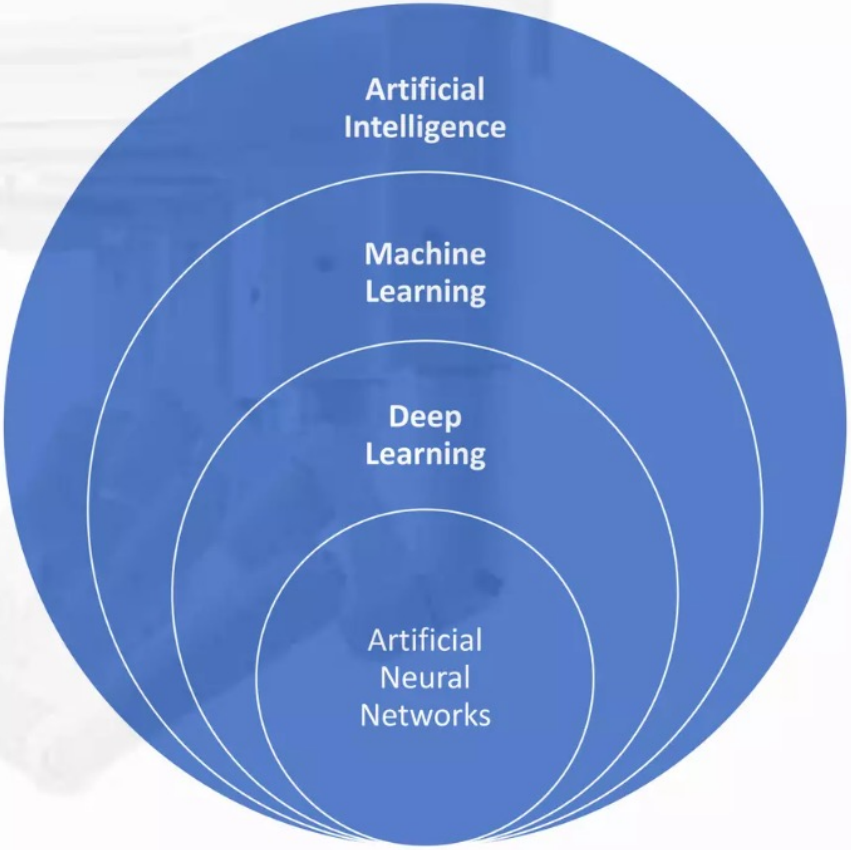
BIG DATA

Artificial intelligence (AI) is intelligence—perceiving, synthesizing, and inferring information—demonstrated by machines, as opposed to intelligence displayed by non-human animals or by humans.

Machine learning (**ML**) is a field devoted to understanding and building methods that let machines "learn" – that is, methods that leverage data to improve computer performance on some set of tasks

Deep learning is part of a broader family of machine learning methods, which is based on artificial neural networks with representation learning . Learning can be supervised , semisupervised or unsupervised.

Artificial neural networks (**ANNs**), usually simply called neural networks (NNs) or *neural nets*, are computing systems inspired by the biological neutral networks that constitute animal brains.



Gamma works best on Chrome.
For the best experience, open this page in Chrome.

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Introduction to AI in Breast Cancer

Advances in artificial intelligence (AI) are revolutionizing the field of breast cancer care. From early detection to personalized treatment, AI is empowering healthcare providers to deliver more accurate and efficient care, ultimately improving outcomes for patients.

NN

Breast Cancer Screening and Diagnosis

Mammography

AI-powered analysis of mammograms can identify subtle abnormalities with high precision, leading to earlier detection of breast cancer.

MRI and Ultrasound

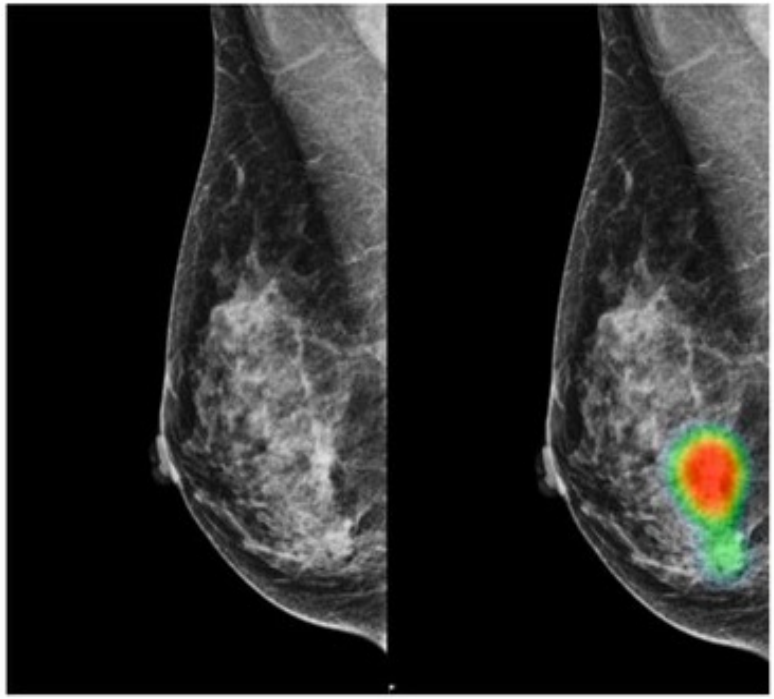
AI algorithms can interpret complex medical imaging data, enhancing the accuracy of breast cancer diagnosis and staging.

Biopsy Analysis

AI-driven pathology can provide rapid and reliable evaluation of biopsy samples, expediting the diagnostic process.

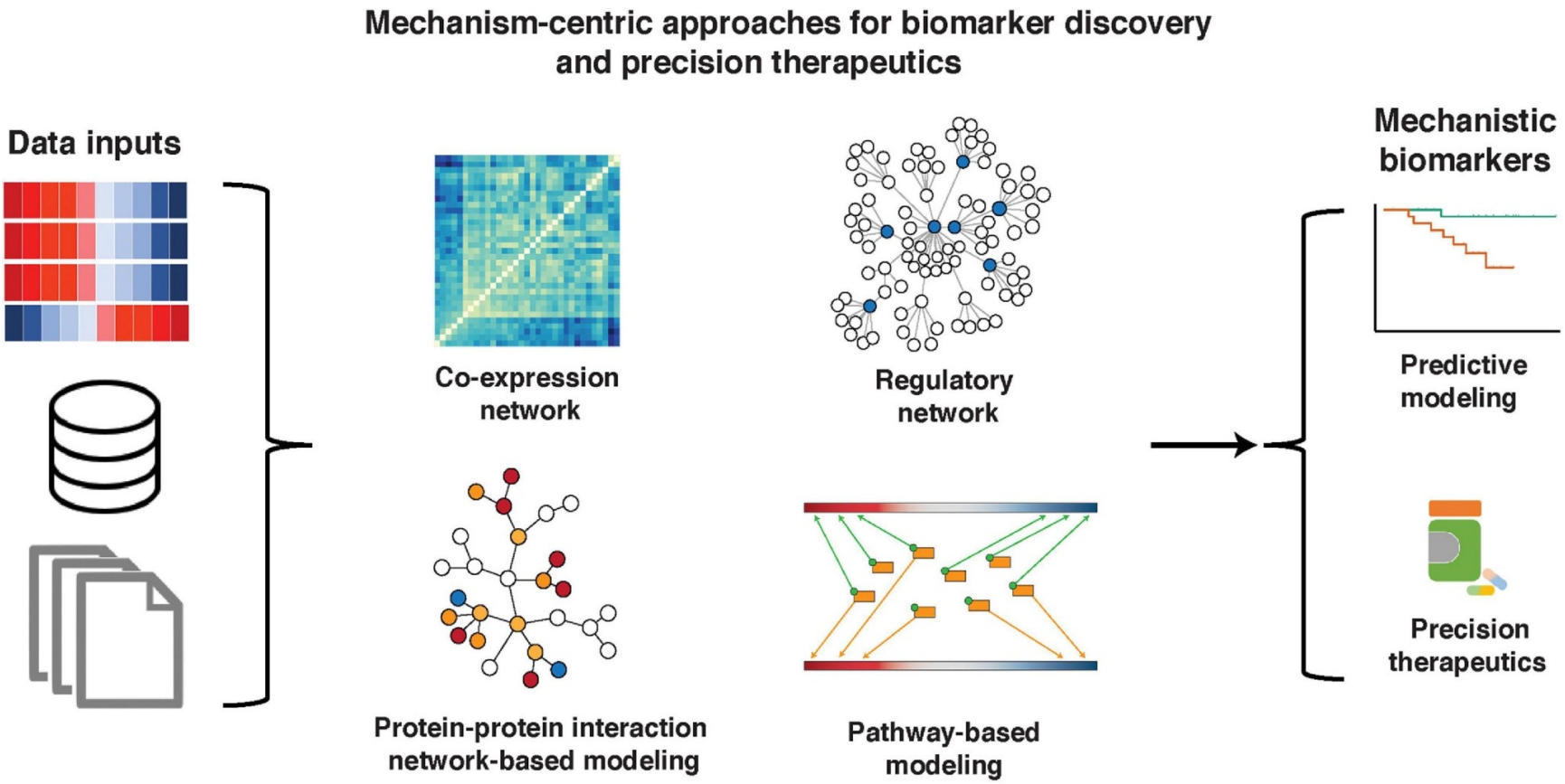
AI for screening breast cancer

Radiomic



Scott Mayer McKinney et al, “International evaluation of an AI system for breast cancer screening,” Nature volume 577, pages89–94 (2020)

AI for Biomarker Discovery



Mechanism-Centric Approaches for Biomarker Detection and Precision Therapeutics in Cancer, Front. Genet., 02 August 2021.

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Recent molecular mignatures available for patient care

Agendia

mammaprint™

targetprint™

cuppprint™

Clarient

CLARiENT

Prostate Gene Expression Profile

CLARiENT

Clarient Insight™ Dx Breast Cancer Profile

Prediction Sciences

PREDICTION SCIENCES

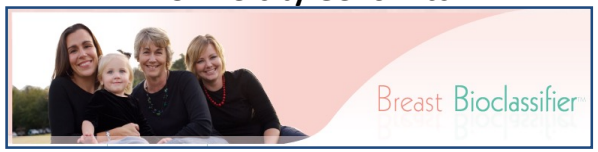
RapidResponse™ c-Fn Test

LabCorp

LabCorp Laboratory Corporation of America

OvaSure

University Genomics



Genomic Health

oncotype DX® Breast Cancer Assay

Veridex

BioTheranostics

BIO THERANOSTICS A BIOMÉRIEUX COMPANY

Theros CancerTYPE ID

BIO THERANOSTICS A BIOMÉRIEUX COMPANY

Breast Cancer Index

Applied Genomics

AGI MAMMOSTRAT®

AGI PULMOTYPE™

AGI PULMOSTRAT™

Power3

BC-SeraPro™

Correlogic Systems

OVACHECK®

A TRADEMARK OF CORRELOGIC SYSTEMS, INC.

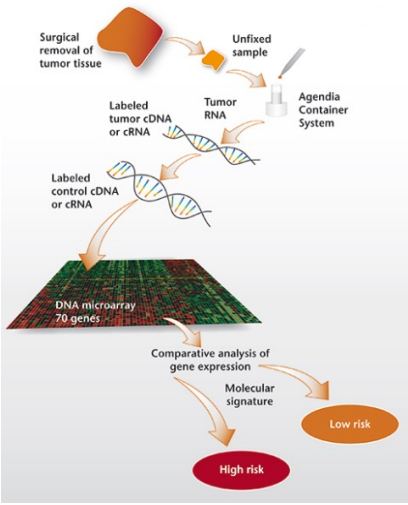
MammaPrint

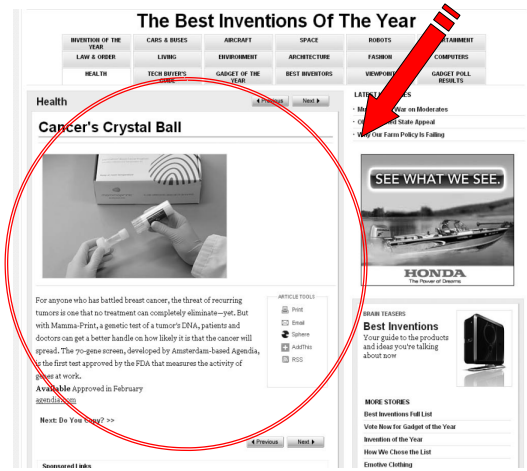
Developed by Agendia (www.agendia.com)

- 70-gene signature to stratify women with breast cancer that hasn't spread into "low risk" and "high risk" for recurrence of the disease
- Independently validated in >1,000 patients
- So far performed 12,000 tests
- Cost of the test is $3,200

Indication:

- for node negative women under 61 years of age with tumors of less than 5 cm.





AI-Powered Imaging Analysis

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Detection

AI algorithms can identify suspicious lesions in medical images with unprecedented accuracy, reducing the risk of missed or delayed diagnoses.

Classification

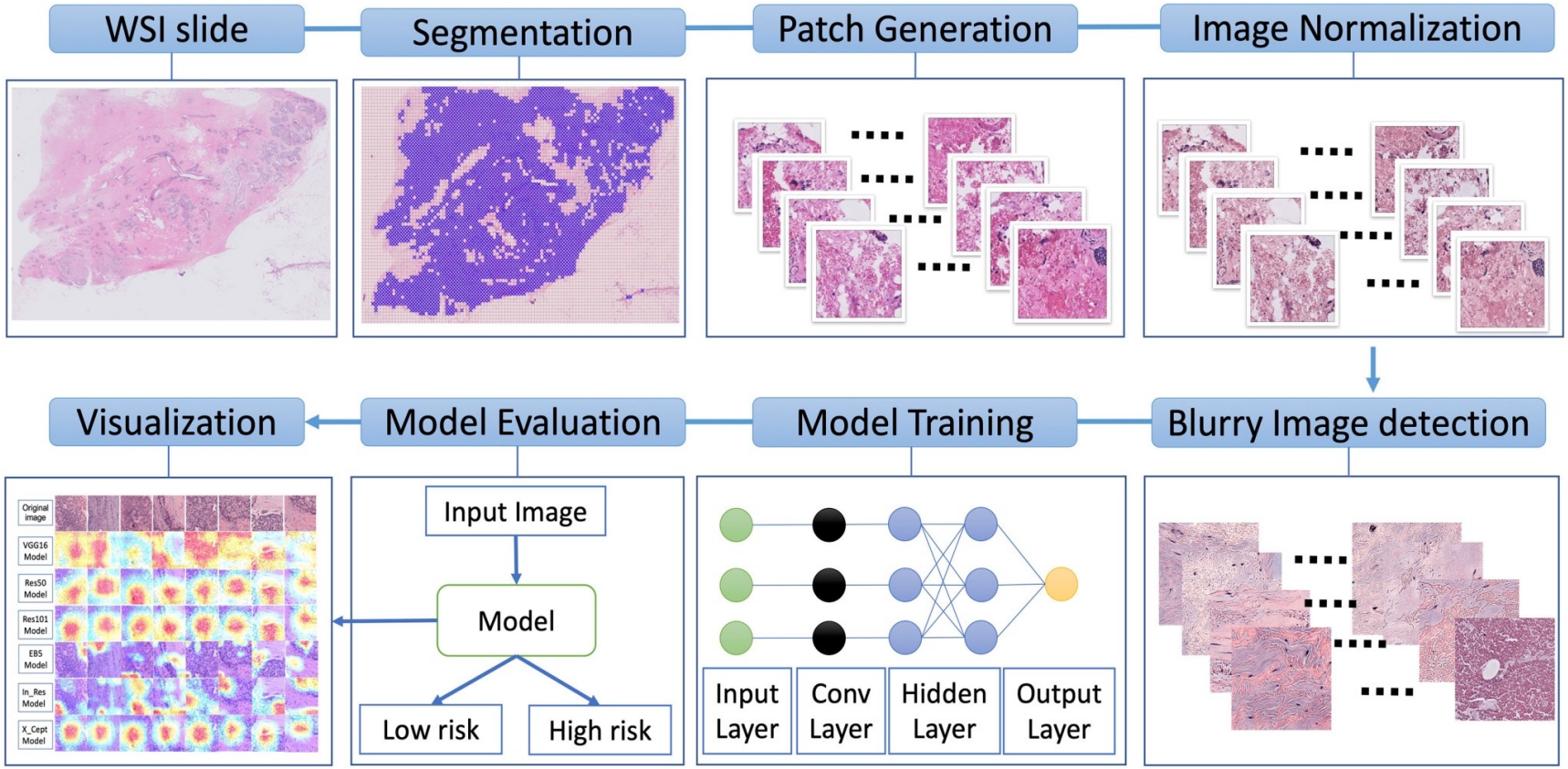
AI models can classify breast cancer subtypes and predict their aggressiveness, guiding personalized treatment strategies.

1 2 3

Segmentation

AI can precisely delineate the boundaries of tumors, enabling more targeted and effective treatment planning.

AI in digital pathology for Breast Cancer Recurrence Prediction



Prediction of Breast Cancer Recurrence Using a Deep Convolutional Neural Network Without Region-of-Interest Labeling, Front. Oncol., 21 October 2021.

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Predictive Modeling for Prognosis

Risk Assessment

AI models can evaluate a patient's risk of developing breast cancer, enabling proactive screening and prevention strategies.

Treatment Response

AI can predict a patient's likely response to different treatment options, informing personalized therapy plans.

Survival Prediction

AI-powered prognostic models can estimate a patient's long-term outcomes, helping guide treatment and supportive care decisions.

Monitoring and Early Detection of Recurrence

1

Continuous Monitoring

AI-powered wearable devices and remote monitoring systems can track a patient's health status and detect early signs of cancer recurrence.

2

Early Intervention

By identifying potential relapses quickly, AI can enable timely interventions and improve the chances of successful treatment.

3

Improved Outcomes

Early detection of recurrence, combined with personalized treatment plans, can significantly enhance the long-term prognosis for breast cancer patients.

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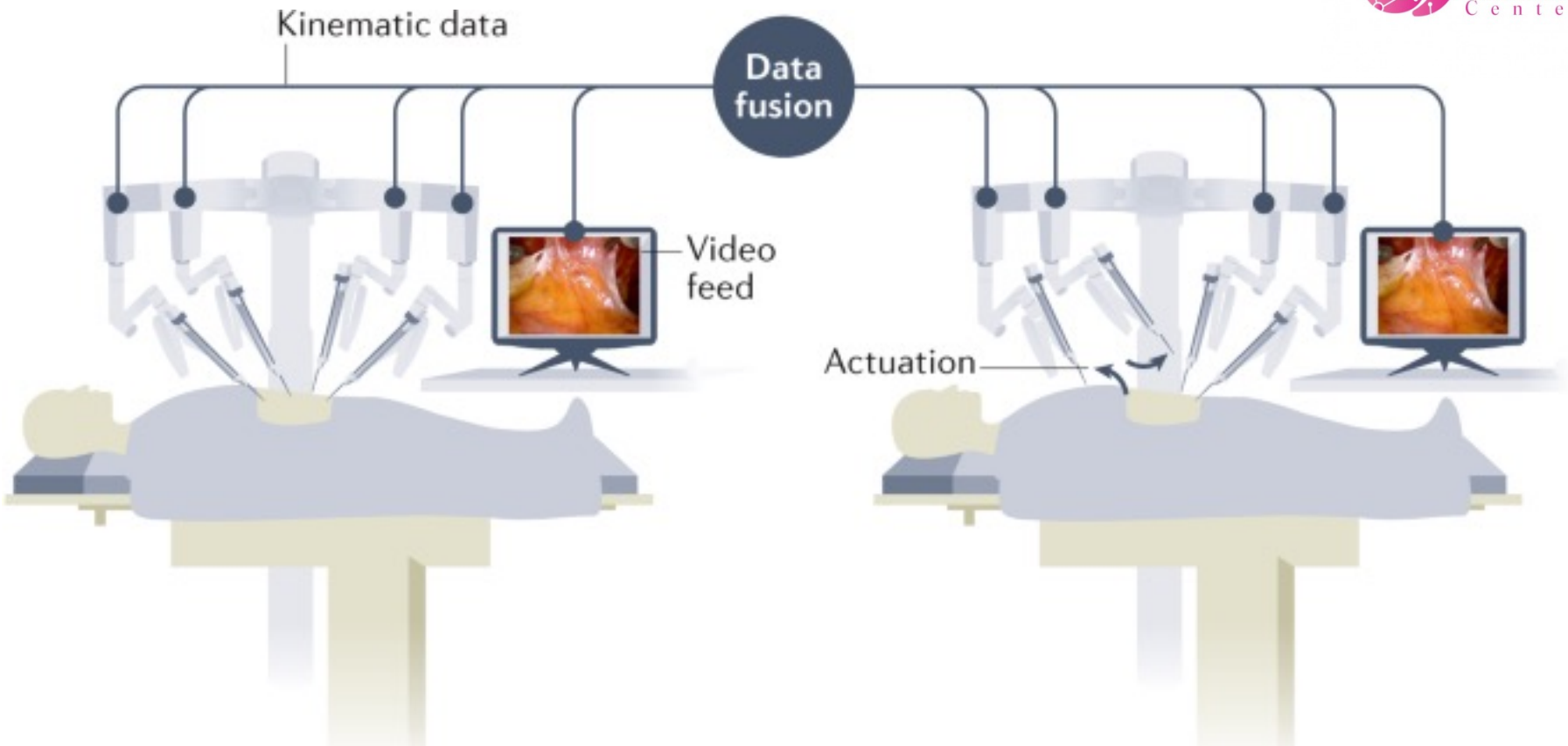
da Vinci Si
da Vinci Xi
da Vinci S
da Vinci SP

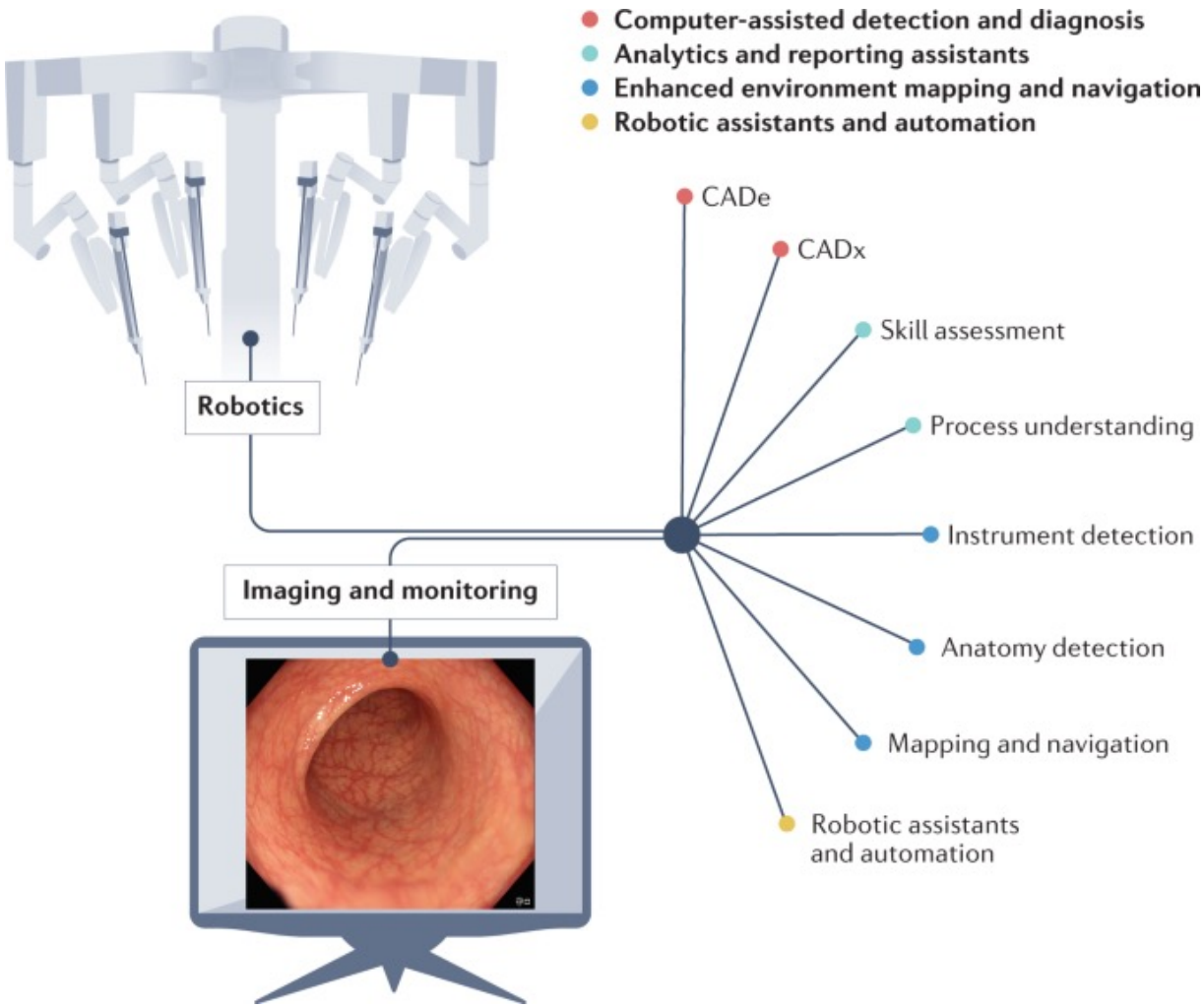


Major challenges
- Costs
- Practitioner learning curve
- Limited surgical tools and imaging modes
- Operative time

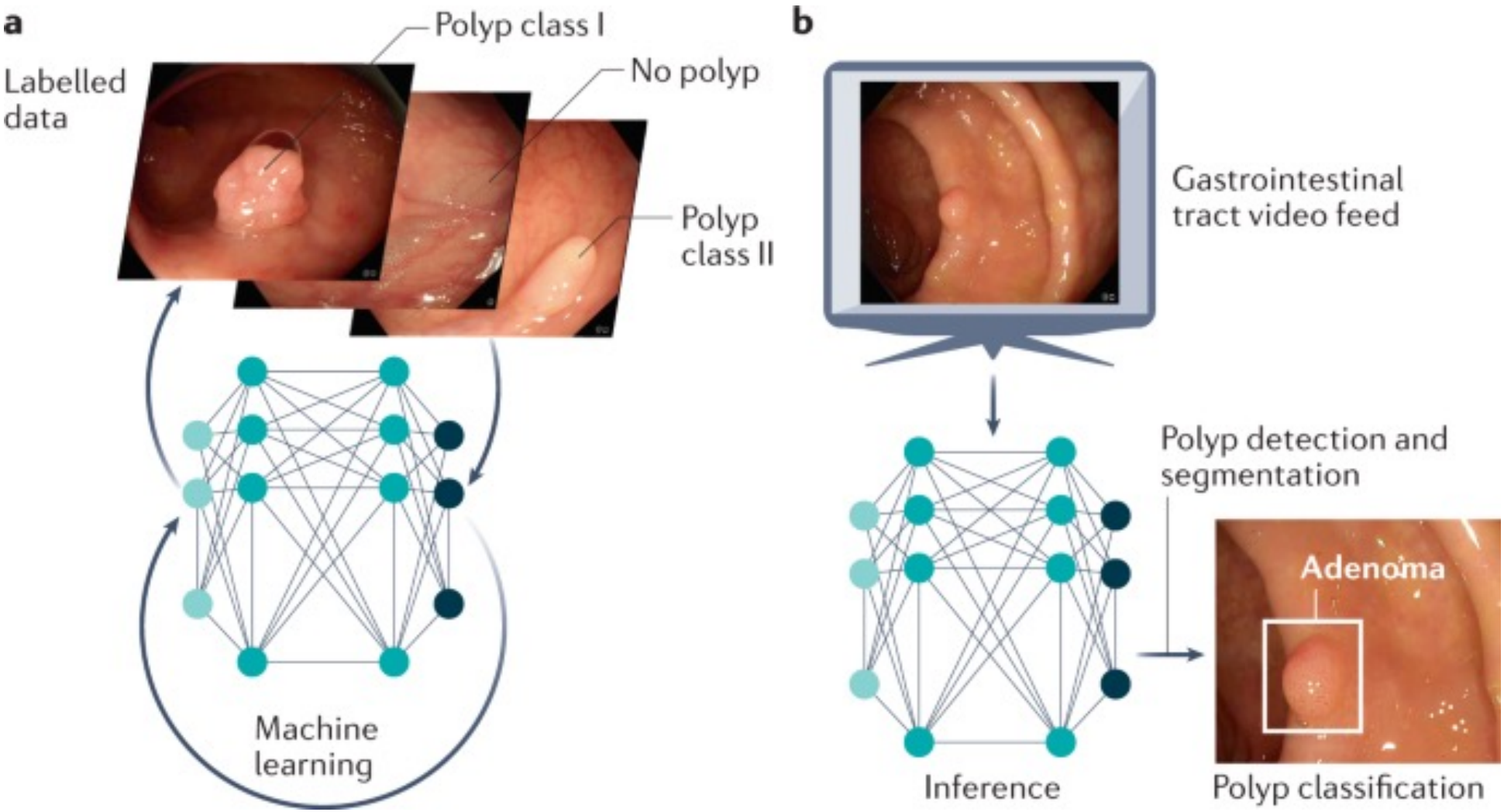
AI capabilities
- Enhanced visualization, for example, scene segmentation, lesion detection, surgical tool pose estimation
- Guided navigation and tool actuation
- Surgical workflow analysis

Nature Reviews Gastroenterology & Hepatology **volume 20**, pages171–182 (2023)

AI and Robotic Surgery

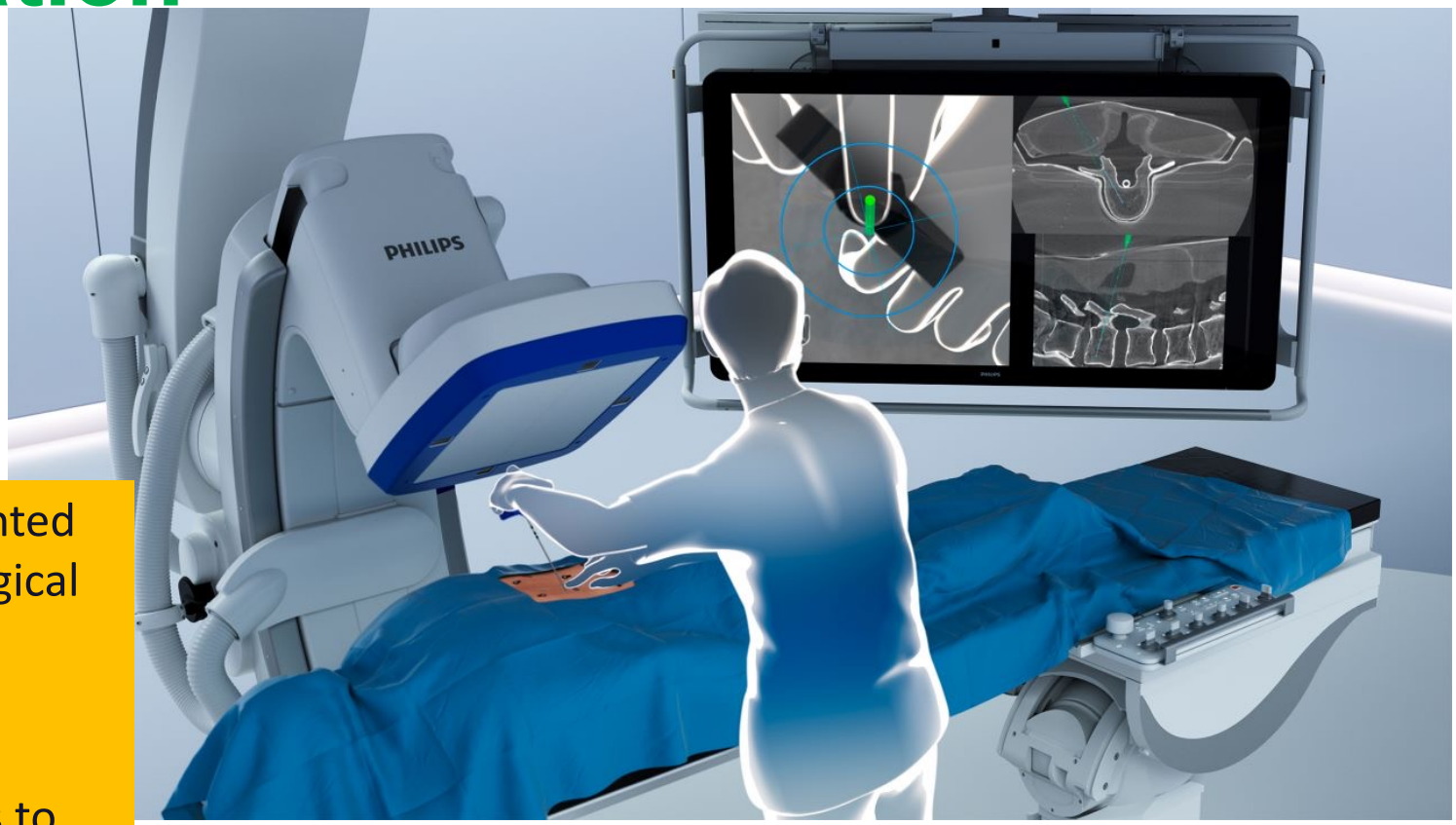


Nature Reviews Gastroenterology & Hepatology **volume 20**, pages171–182 (2023)



Nature Reviews Gastroenterology & Hepatology **volume 20**, pages171–182 (2023)

Augmented Reality and Surgica Navigation



ClarifEye is an augmented reality (AR)-based surgical navigation system developed by health technology solutions company Royal Philips to assist minimally invasive spine surgeries in a hybrid operating room.

Personalized Treatment Recommendatio

Targeted Therapy

AI can help identify the most effective targeted therapies based on a patient's unique genetic profile and tumor characteristics.

Medication Optimization

AI algorithms can analyze a patient's clinical data to suggest the optimal dosage and combination of medications.

Radiation Therapy

AI can optimize radiation therapy plans, ensuring precise targeting of tumors while minimizing exposure to healthy tissues.

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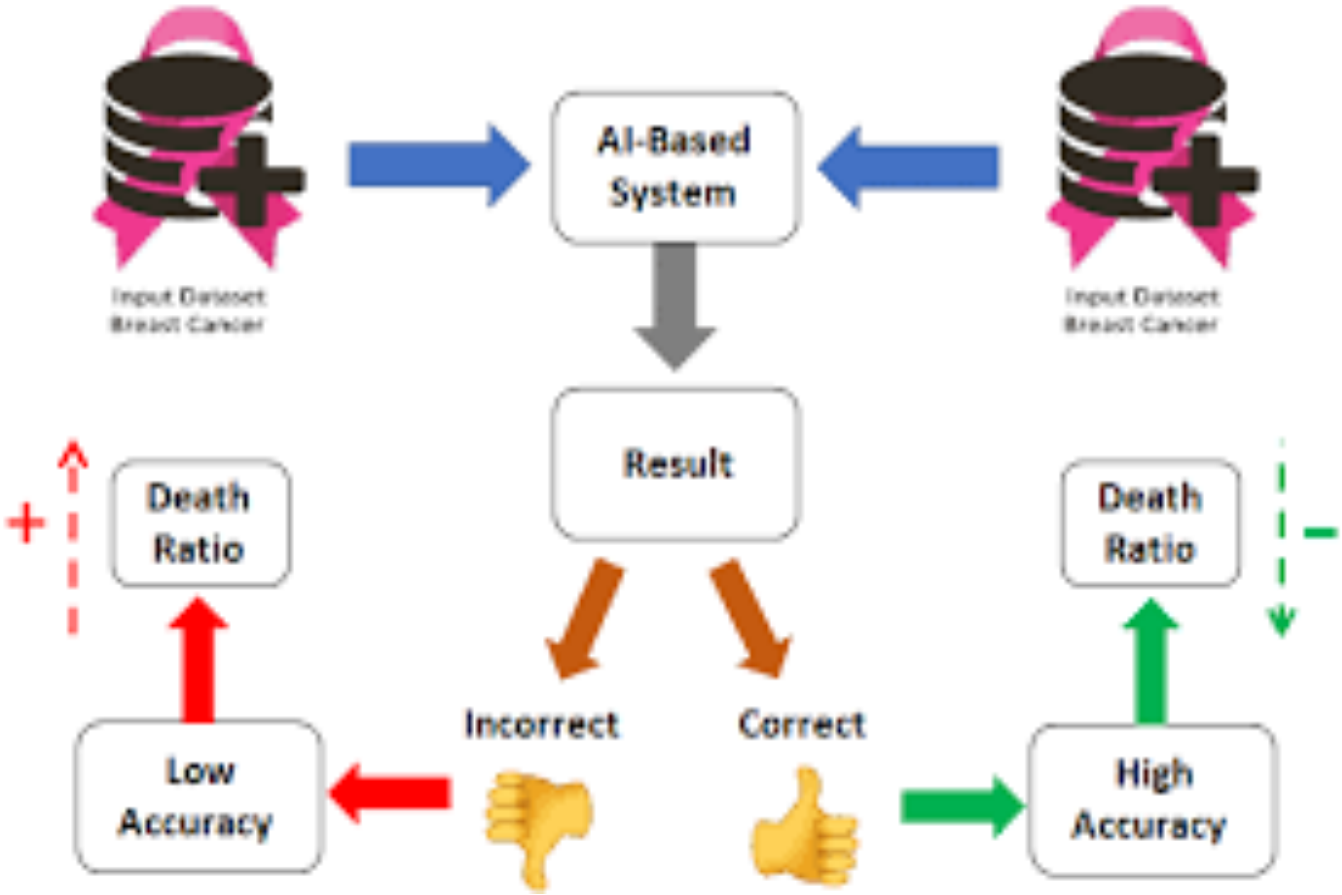
AI for :Mortality & Morbidity Prediction



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)

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Ethical Considerations in AI-Driven Breast Cancer Care

1

Bias and Fairness

Ensuring AI systems are trained on diverse and representative data to avoid perpetuating biases in diagnosis and treatment.

2

Privacy and Security

Protecting patient data and maintaining strict privacy protocols in the use of AI-powered healthcare solutions.

3

Transparency and Explainability

Developing AI models that are transparent and explainable, allowing healthcare providers to understand the reasoning behind their recommendations.

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Future Outlook and Ongoing Research

Advancements in Deep Learning	Improved algorithms and computational power will enable more sophisticated AI models for breast cancer analysis.
Multimodal Data Integration	Combining imaging, genomic, and clinical data will lead to more comprehensive and accurate AI-driven decision-making.
Real-Time Monitoring	Wearable devices and continuous monitoring will allow for earlier detection of changes and faster interventions.
Automated Workflows	AI-powered automation will streamline various aspects of breast cancer care, improving efficiency and reducing clinician workload.

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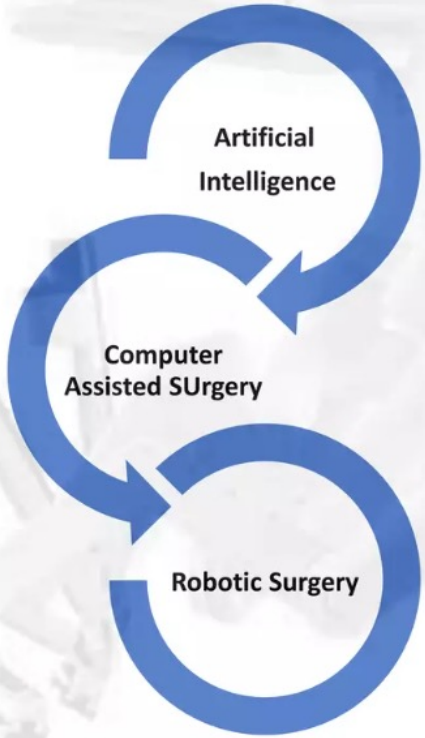
Conclusion: the future belongs to AI & Robotics!



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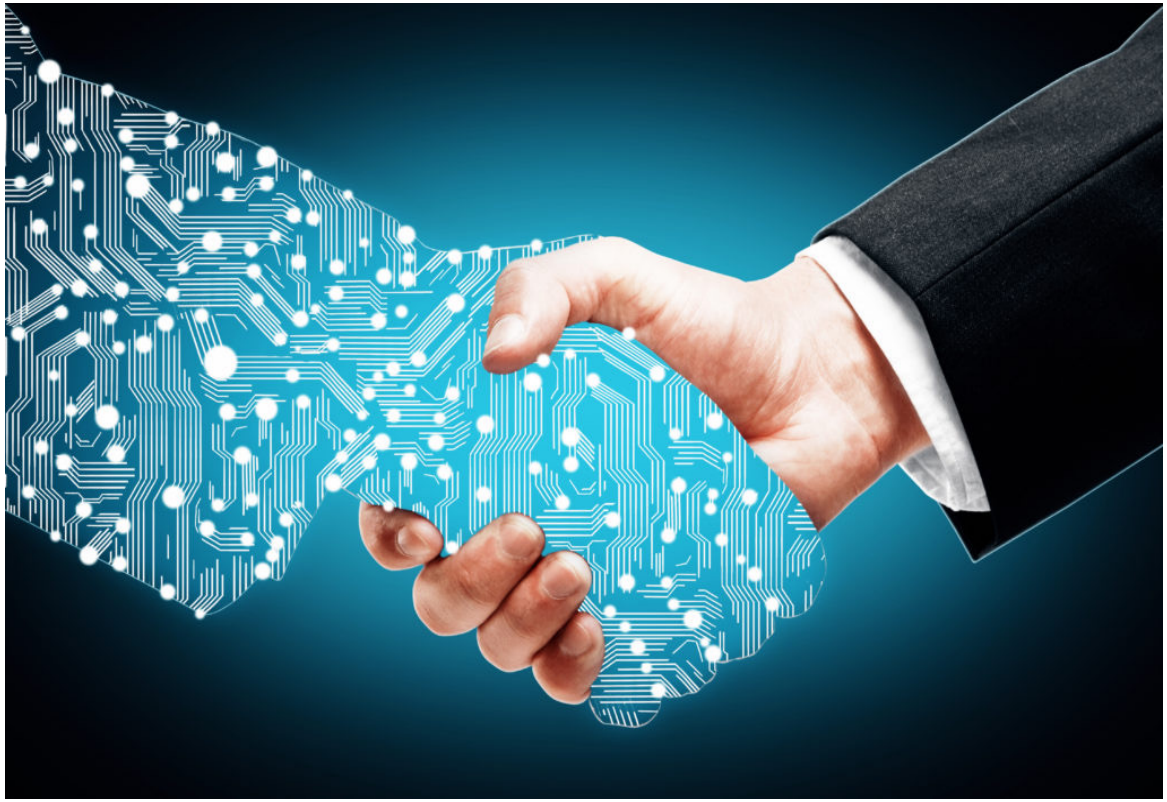

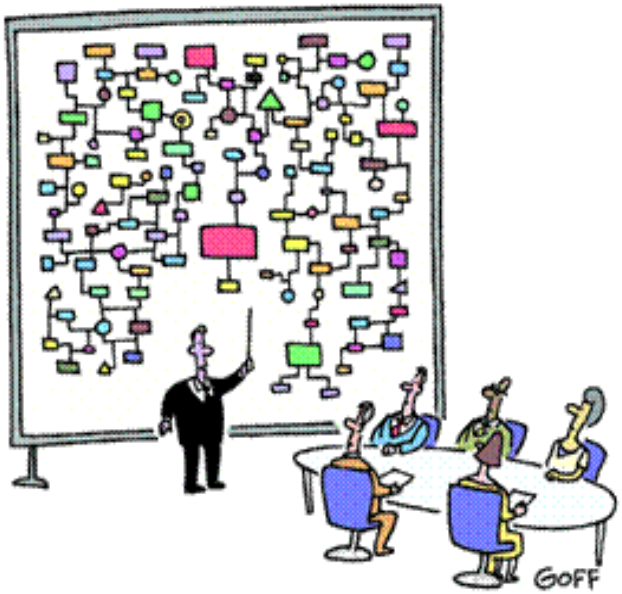

"And that's why we need a computer."

THANK YOU