

INTRODUCTION TO AI FOR LIFE SCIENCES

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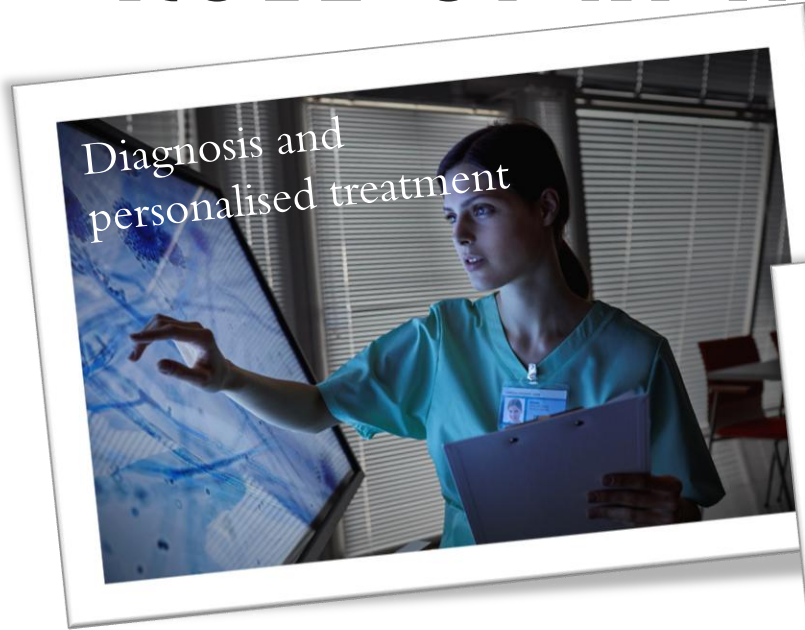




AI IN HEALTHCARE

- Digital technologies and Artificial Intelligence (AI) are transforming medicine, medical research and public health
- Use of AI technologies for health holds great promise and has already contributed to important advances in fields such as **drug discovery**, **genomics**, **radiology**, **pathology** and **prevention**
- AI could improve the delivery of health care, such as **prevention**, **diagnosis** and **treatment** of disease
- Already changing how health services are delivered in several countries

ROLE OF AI IN HEALTHCARE





ROLE OF AI IN HEALTHCARE

DIAGNOSIS AND PERSONALISED TREATMENT

- Assess the relative risk of disease
- Predict illness or major health events before they occur
- Make faster, more accurate diagnoses
- Provide personalized treatments tailored to a person's genes, lifestyle and environment

ROLE OF AI IN HEALTHCARE

CLINICAL CARE

- The evolving role of patient in clinical care
- The shift from hospital to home-based care
- Extend clinical care beyond the formal healthcare system



A blurred photograph of people walking in a hallway, overlaid on a light gray grid pattern. The image is partially cut off by a white, torn-edge border on the right side of the slide.

ROLE OF AI IN HEALTHCARE

PUBLIC HEALTH AND PUBLIC HEALTH SURVEILLANCE

- Health promotion
- Disease prevention
- Surveillance and emergency preparedness
- Outbreak response

ROLE OF AI IN HEALTHCARE

HEALTH RESEARCH AND DRUG DEVELOPMENT

- Improve human understanding of disease
- Identify new disease biomarkers
- Labour-intensive to a capital- and data-intensive drug discovery
- Accelerate the development of new medicines
- Improve the repurposing of existing medicines





ROLE OF AI IN HEALTHCARE

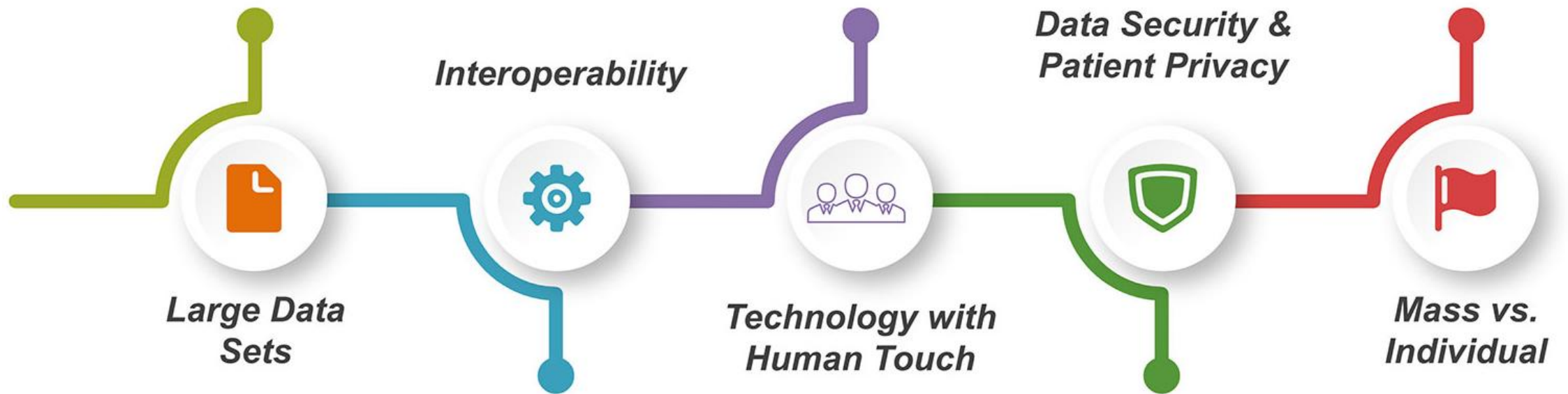
HEALTH SYSTEMS MANAGEMENT AND PLANNING

- Optimization of the medical supply chain
- Identifying and eliminating fraud and waste
- Scheduling patients
- Optimize the allocation of health system resources

HEALTH DATA LANDSCAPE



HEALTH DATA ANALYSIS



USE CASES

PRECISION MEDICINE



DRUG DISCOVERY



GENE THERAPIES



USE CASES

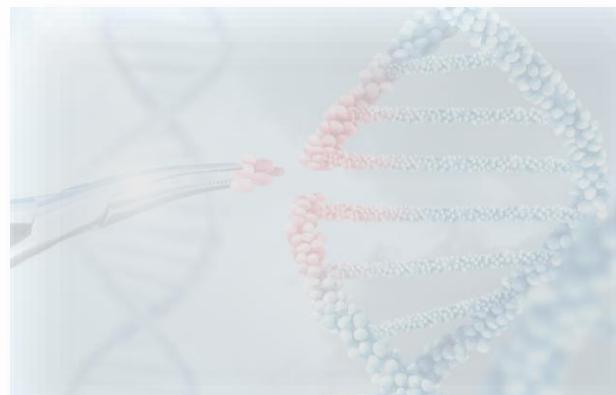
PRECISION MEDICINE



DRUG DISCOVERY



GENE THERAPIES



DATA INTEGRATION TOWARDS PRECISION MEDICINE

What is it?

*“Identifying which approaches will be effective for which patients based on **genetic, environmental, and lifestyle** factors.”*

NRC, NIH, US

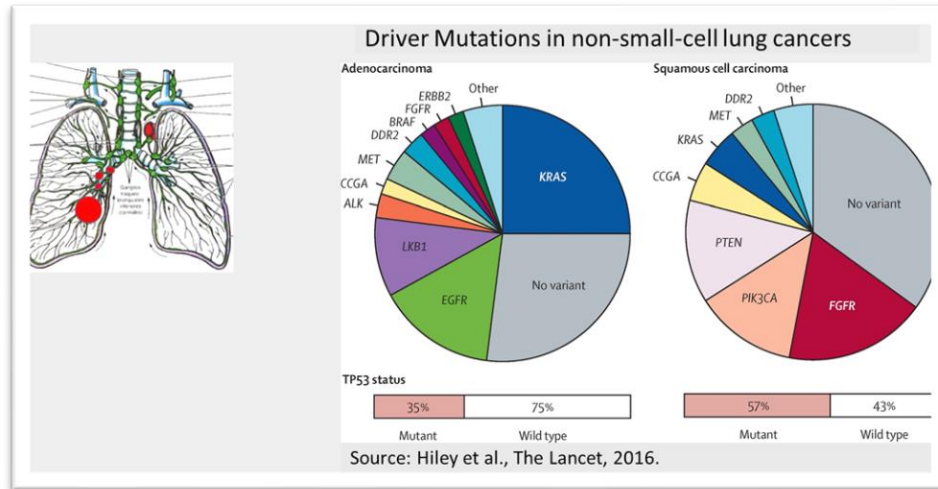
What can it do?

Patient-centered care: treating the person, not the disease

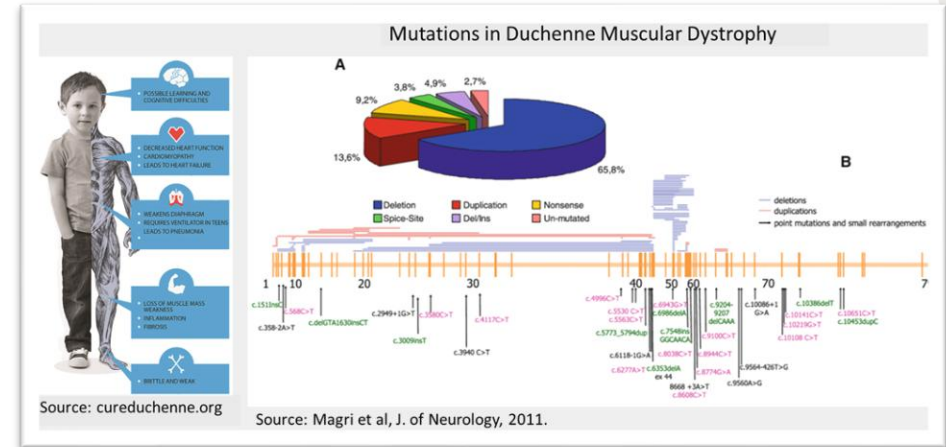
- Optimal therapies for individuals
- Avoid adverse drug reactions
- Reduce treatment costs
- Early detection of disease
- Better prognosis of disease progression
- Facilitate pro-active preventive medicine

EXAMPLES

CANCER

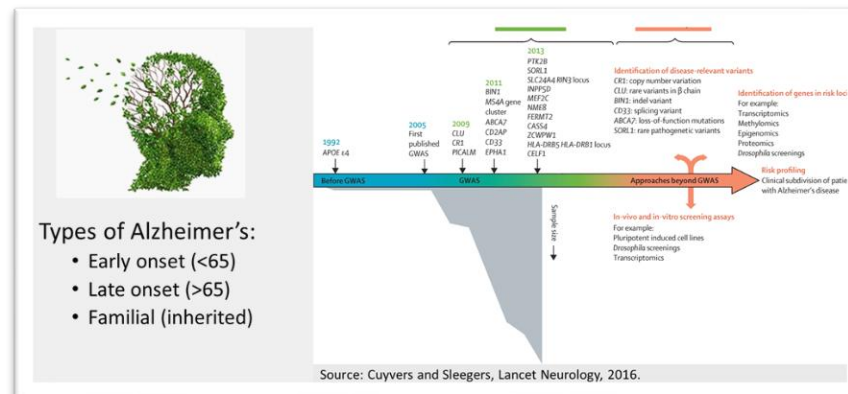


RARE DISEASE



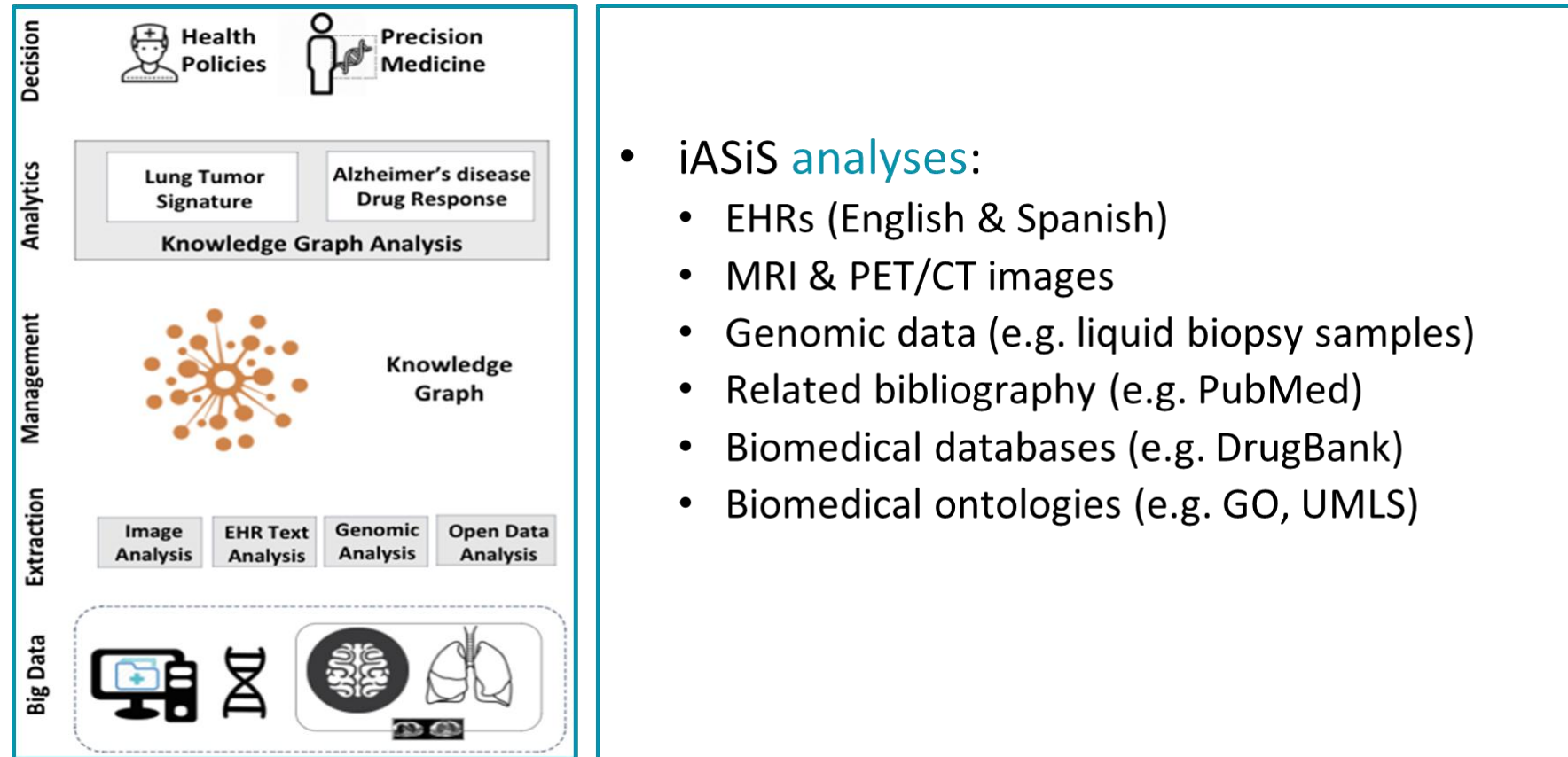
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NEURODEGENERATIVE DISEASE



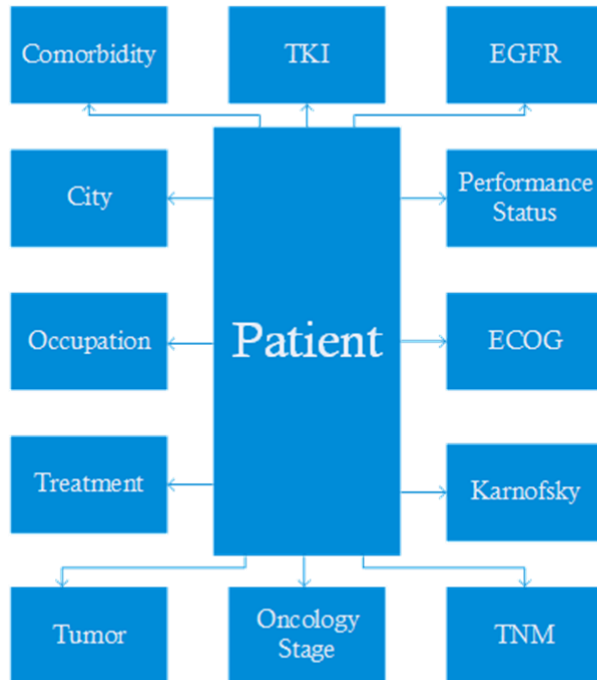


THE IASIS PARADIGM



- iASiS analyses:
 - EHRs (English & Spanish)
 - MRI & PET/CT images
 - Genomic data (e.g. liquid biopsy samples)
 - Related bibliography (e.g. PubMed)
 - Biomedical databases (e.g. DrugBank)
 - Biomedical ontologies (e.g. GO, UMLS)

ELECTRONIC HEALTH RECORDS: LUNG CANCER

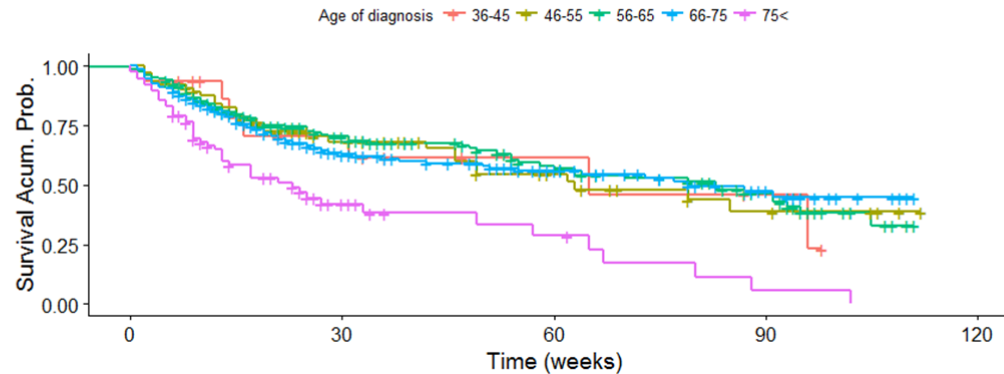


Notes and Reports



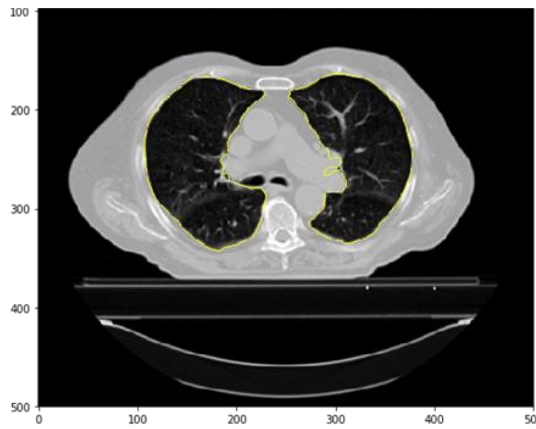
- 1000 patients:
 - 251,730 clinical records
- Improved NLP :
 - Event detection, UMLS, Drugs, Negation detection

Survival Curve all stages

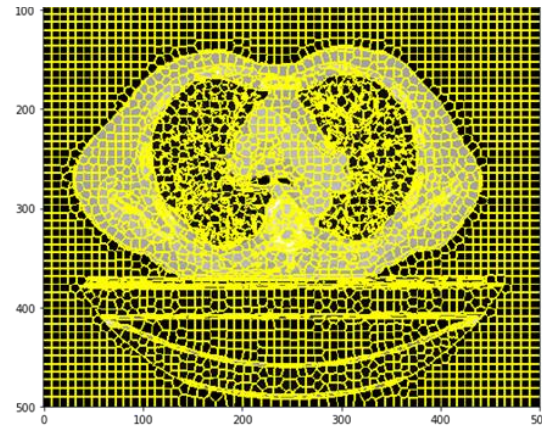




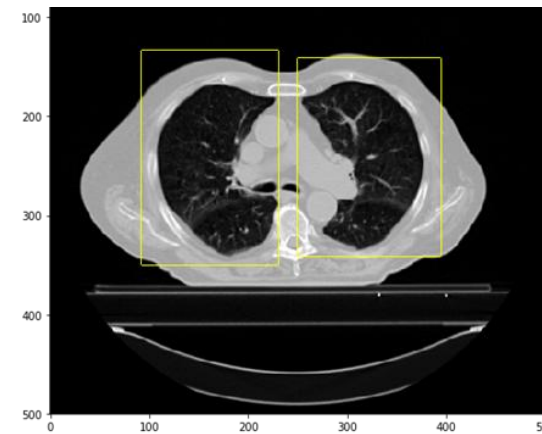
MEDICAL IMAGES



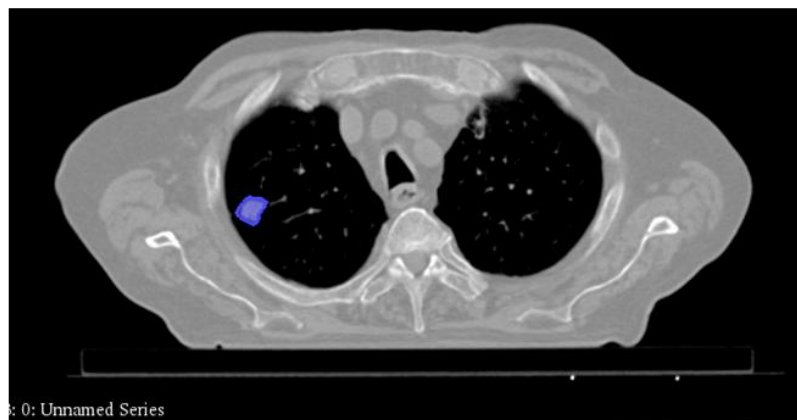
Delimitation



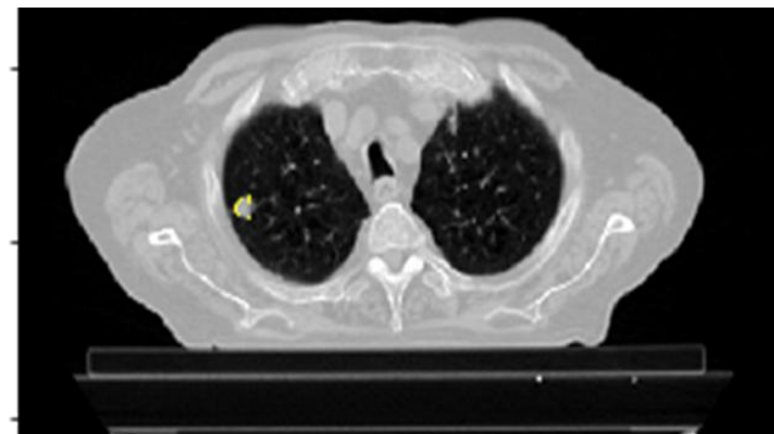
Segmentation



Bounding volumes



Ground truth nodule

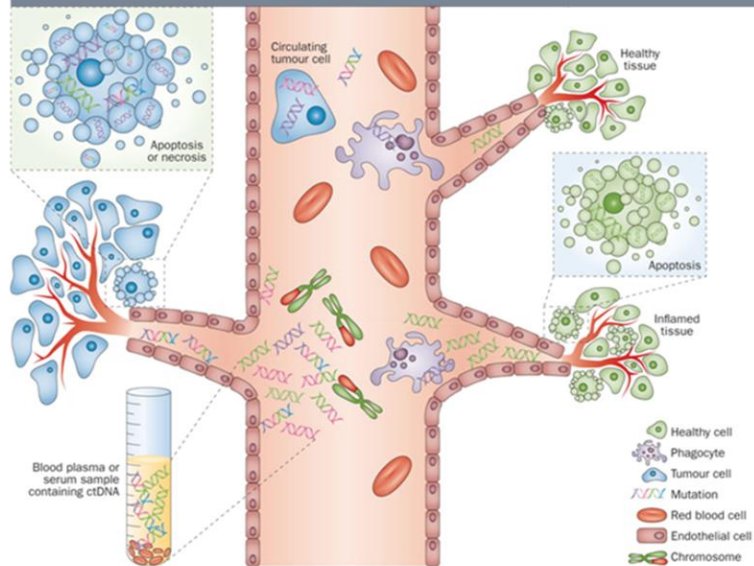


Predicted nodule

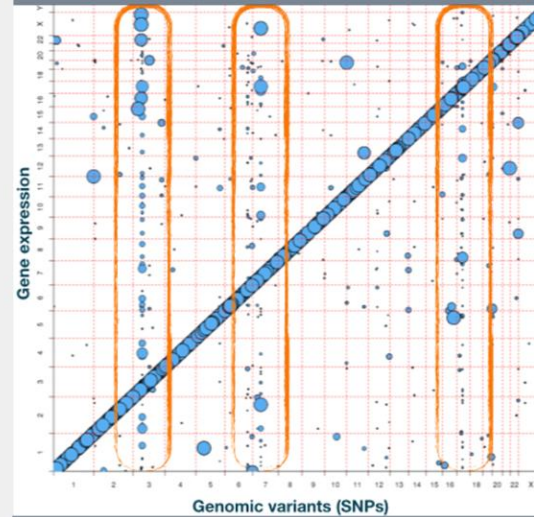


OMICS DATA ANALYSIS

Liquid biopsy: circulating tumor DNA

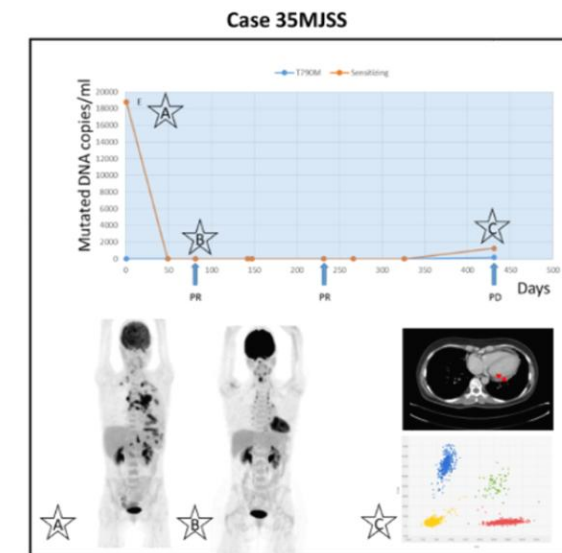


Identification of biomarkers



Source: Joehanes et al.,
Genome Biology, 2017.

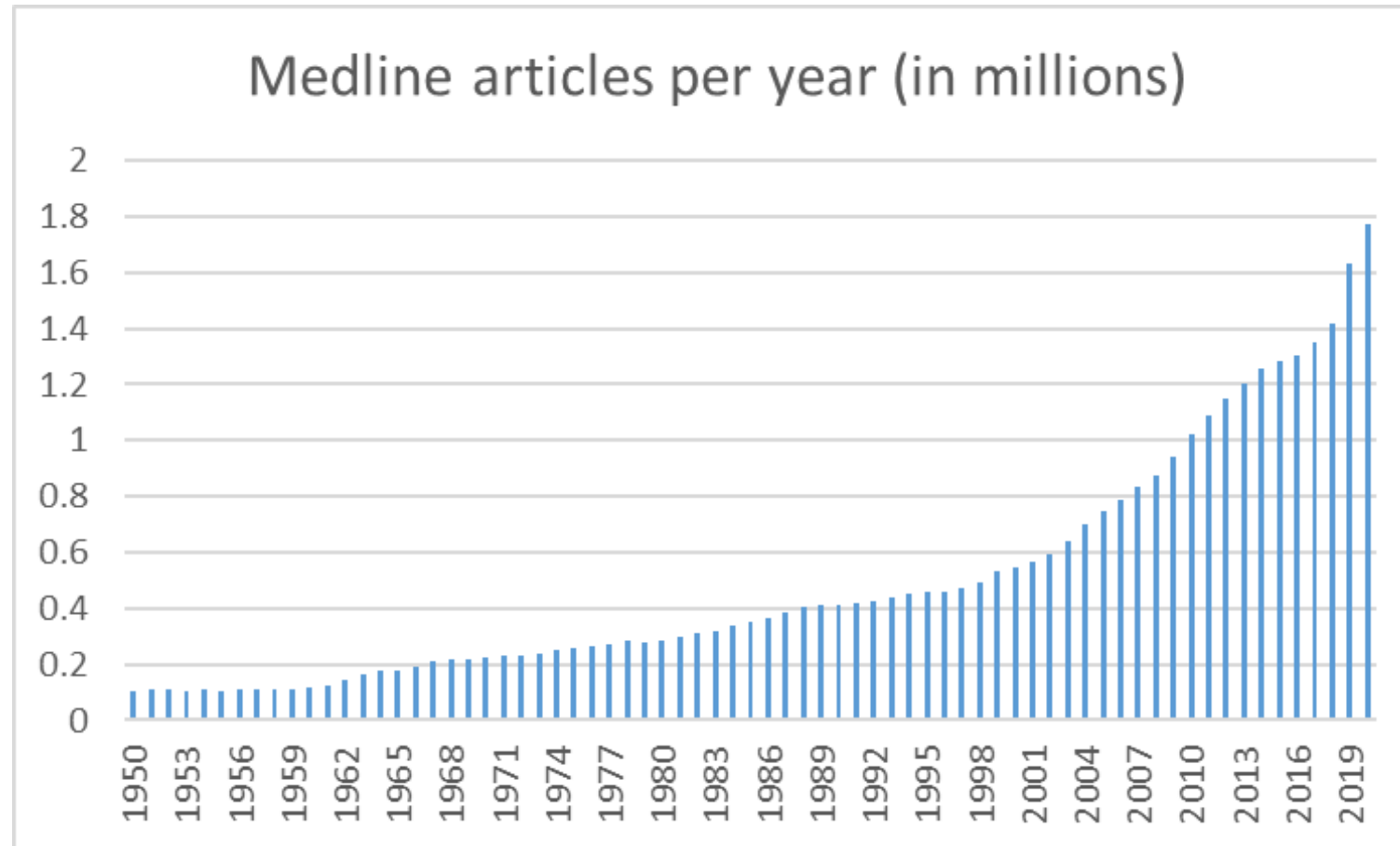
Correlation with treatment outcome



Source: Provencio et al., Oncotarget,
2017.



HEALTH LITERATURE



data source: <http://dan.corlan.net>

HEALTH LITERATURE

Text

“... *venous thromboembolism* being a leading *cause* of *death*. ...”

Ontological entity recognition (UMLS)

- Venous Thromboembolism (C1861172)
- Cessation of life (C0011065)


Relation Extraction

“Venous thromboembolism” CAUSES “Cessation of life”

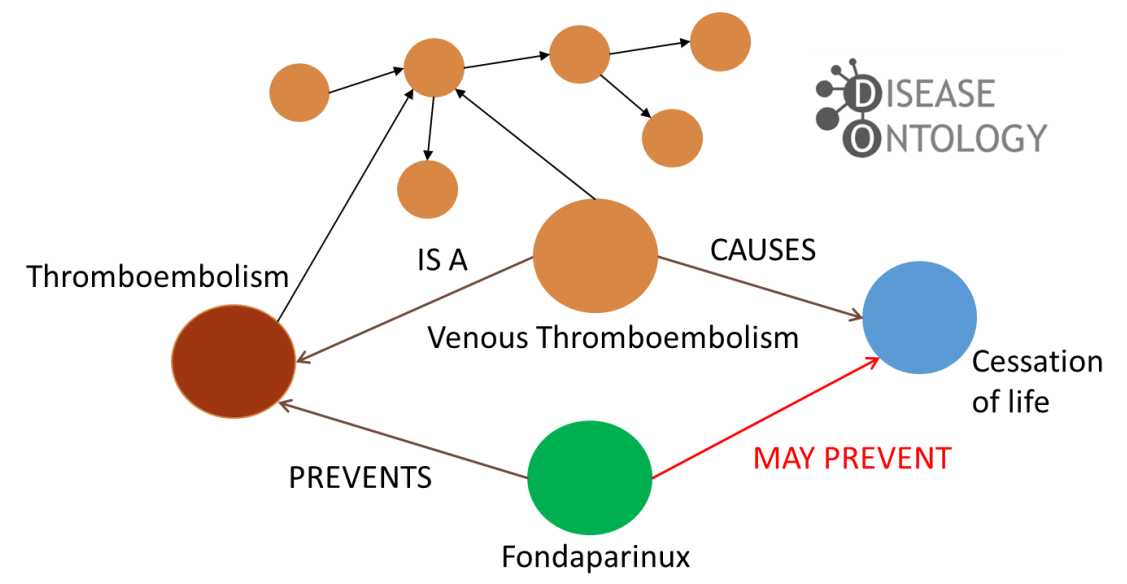




OPEN DATABASES

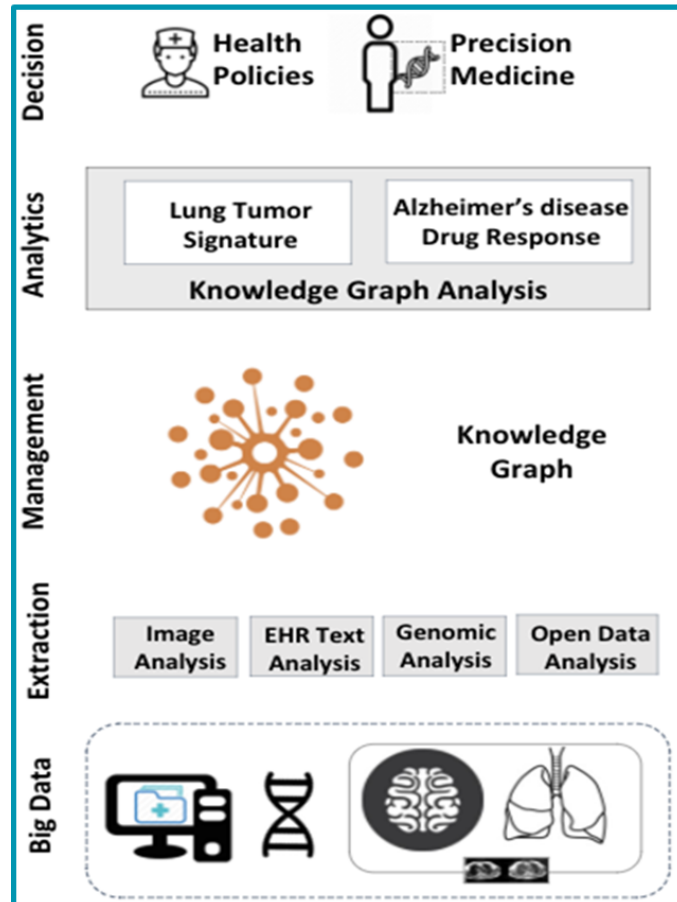
 “Venous Thromboembolism” is a *narrower concept* of “Thromboembolism”

 “Fondaparinux” (C1098510) treats “Thromboembolism”





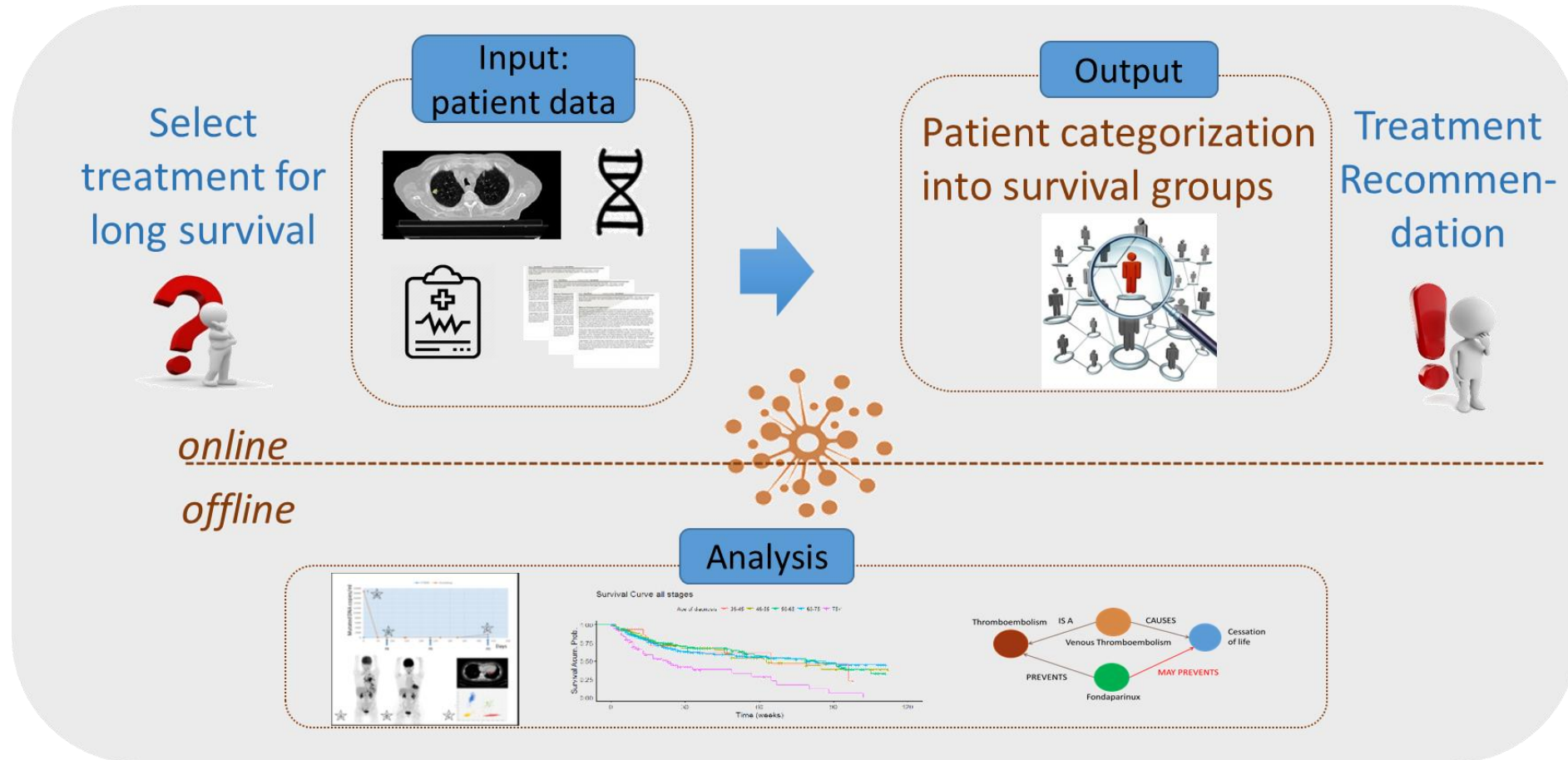
THE INTEGRATED FRAMEWORK



- Extracted knowledge is fused in the iASiS **knowledge graph**
 - Unified semantic schema
 - Linked data
 - Machine-processable knowledge
- iASiS **end-users will be able to:**
 - Receive answers along with justifications
 - Identify patterns in patient populations
 - Make more informed decisions
- All steps of data management and analytics enforce **privacy** and **access** control



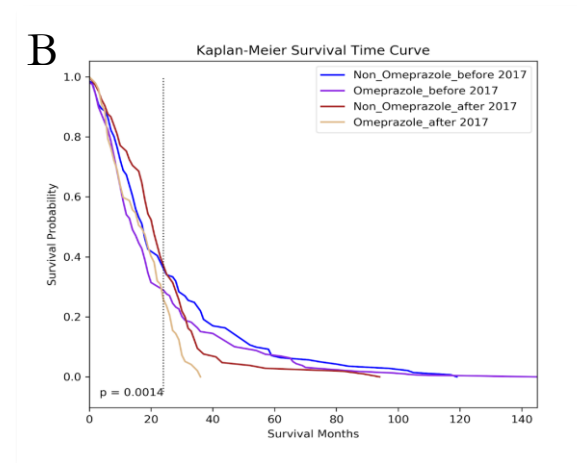
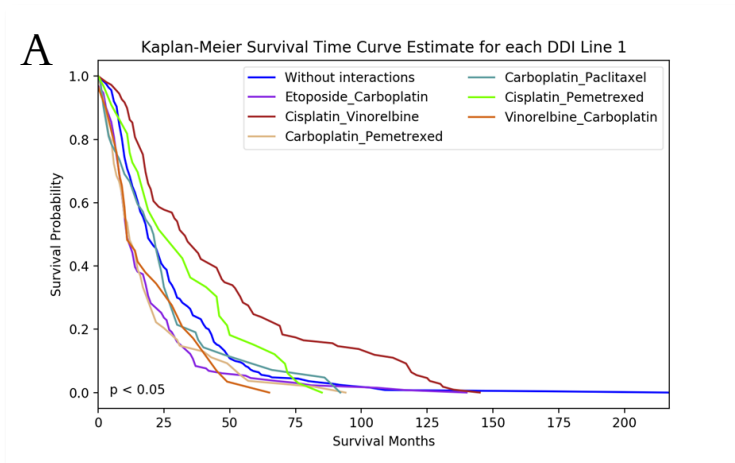
LUNG CANCER TREATMENT





LUNG CANCER: TOXICITIES

- Exploring IASIS knowledge graph, we observed, with statistical significance, a difference among the different chemotherapy schemes (figure A)
 - the combination with vinorelbine and cisplatin is the most effective one
 - the combination of vinorelbine and carboplatin is the most toxic one
- Drug-Drug Interactions (DDIs) with non-oncological drugs (figure B): Omeprazol, is known to decrease the efficiency of several oncological treatments



USE CASES

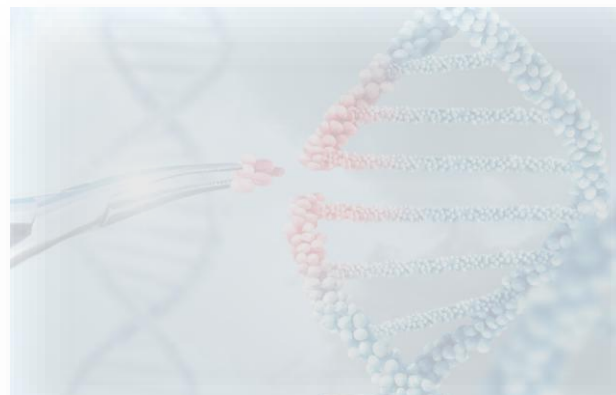
PRECISION MEDICINE



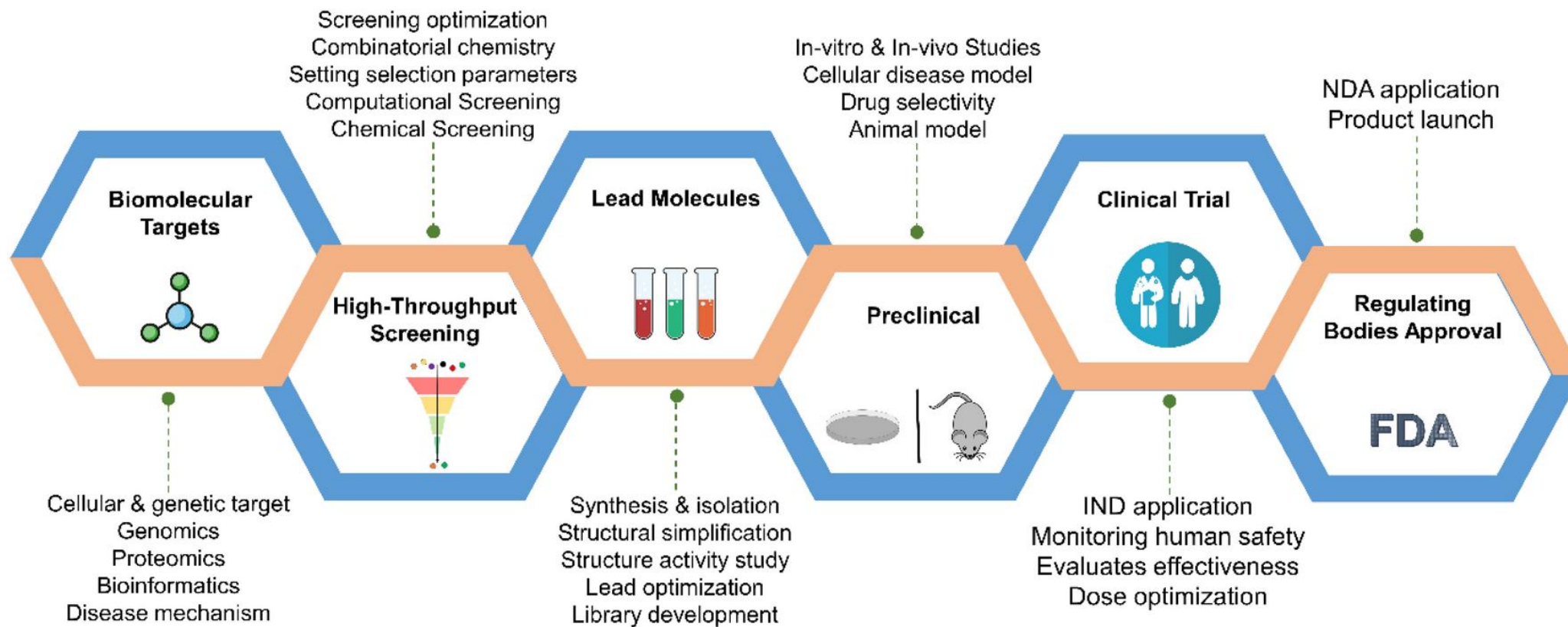
DRUG DISCOVERY



GENE THERAPIES



ACCELERATING DRUG DISCOVERY WITH AI



USE CASES

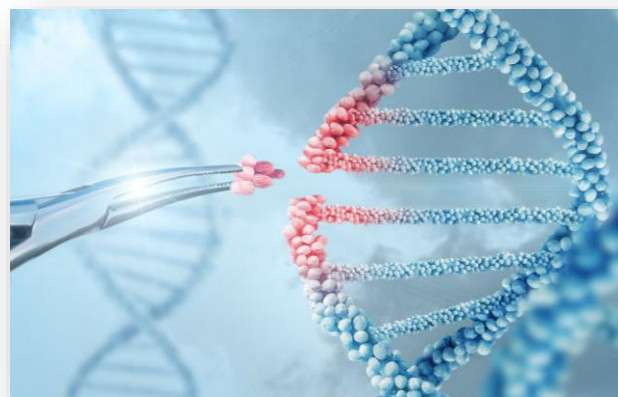
PRECISION MEDICINE



DRUG DISCOVERY

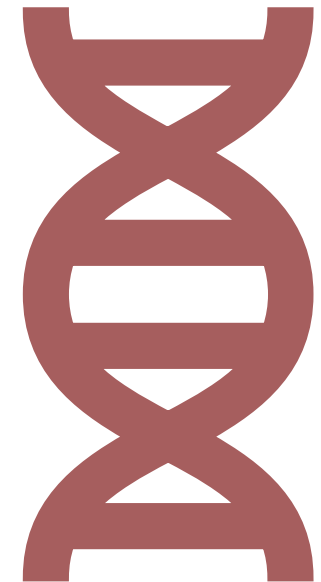


GENE THERAPIES



GENE THERAPIES

- Gene therapies can work by several mechanisms:
 - Replacing a disease-causing gene with a healthy copy of the gene
 - Inactivating a disease-causing gene that is not functioning properly
 - Introducing a new or modified gene into the body to help treat a disease



GENE THERAPIES

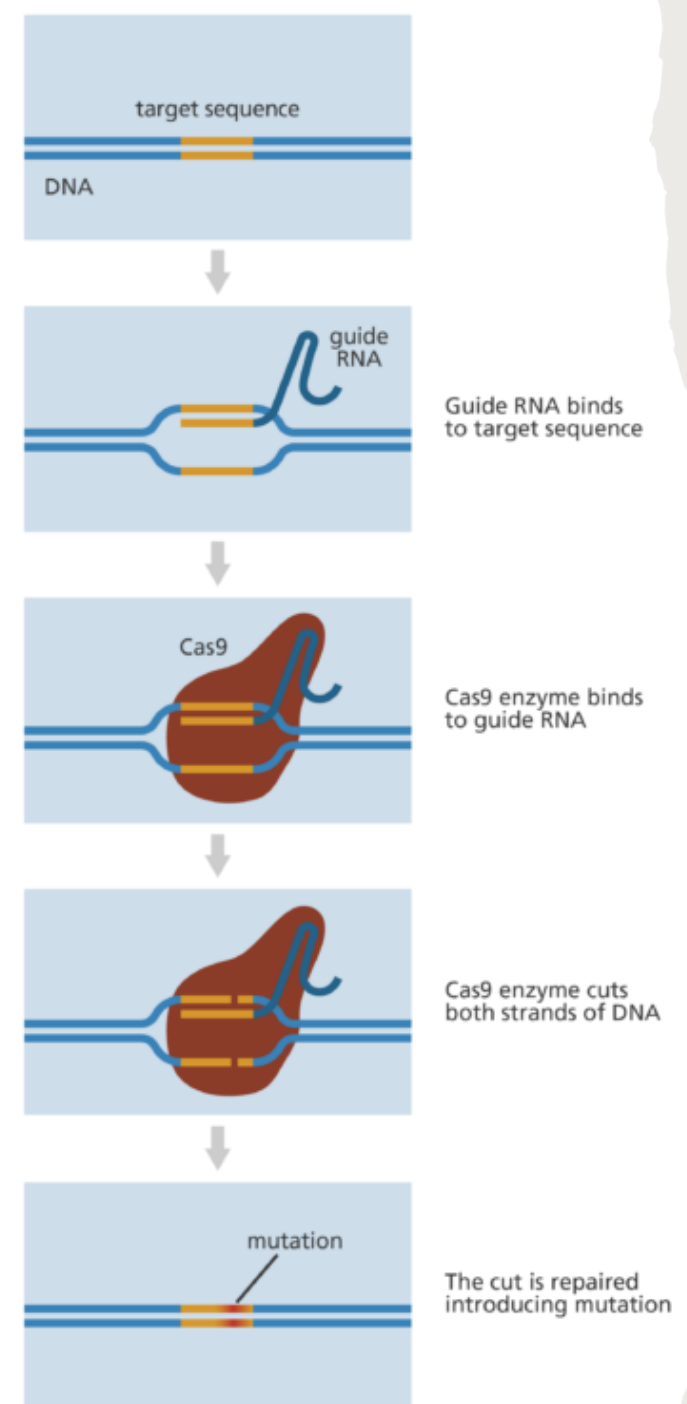
DNA-based therapies focus on changing or fixing the actual genes

RNA-based therapies work on the RNA, controlling how much protein is made or preventing harmful proteins from being produced

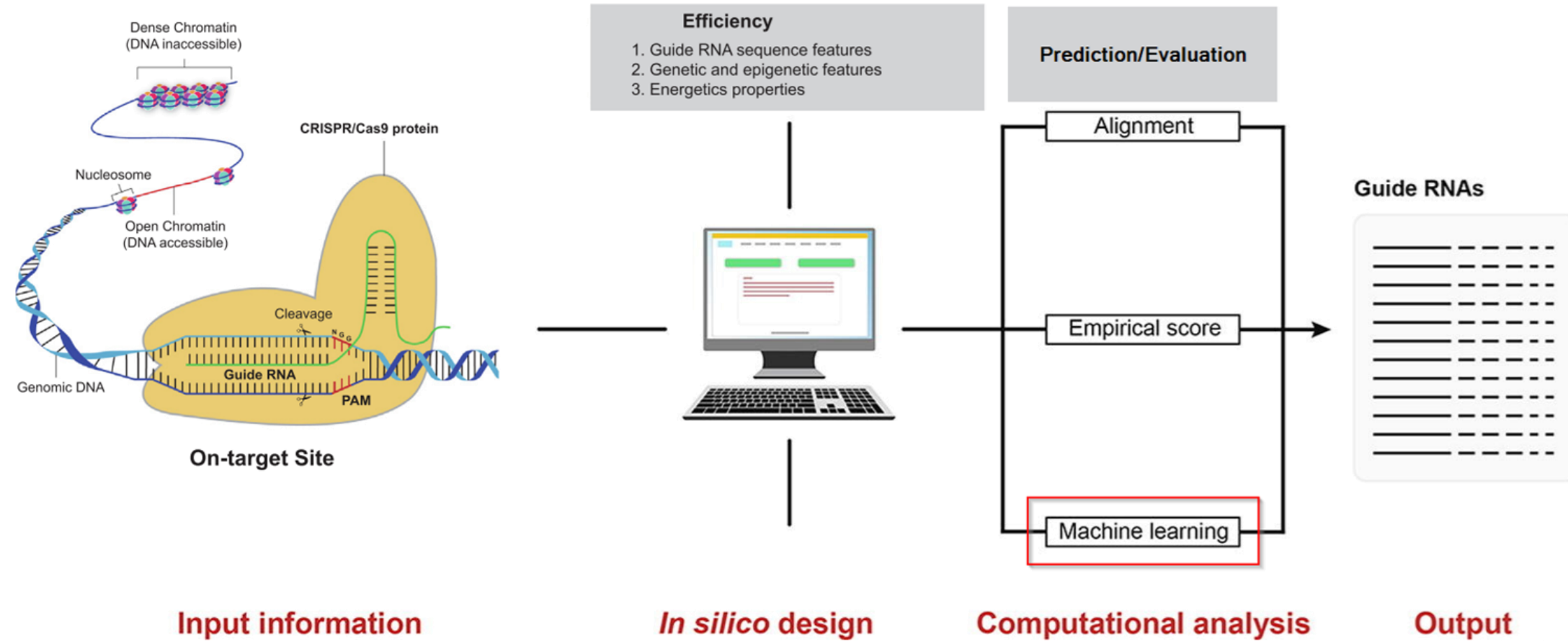
Both DNA and RNA-based therapies are important tools in modern medicine, offering different ways to treat genetic and other diseases!

CRISPR / CAS9

- Unique technology that enables researchers to edit parts of the genome by altering sections of the DNA sequence.
- Currently the simplest, most versatile and precise method of genetic manipulation.



CRISPR-CAS9 GRNA EFFICIENCY PREDICTION MODELS



ETHICAL PRINCIPLES FOR AI USE IN HEALTH

- Assessing whether AI should be used
- Data collection and use
- Responsibility and Accountability for decision-making with AI
- Bias and discrimination associated with AI
- Risks of AI technologies to safety and cybersecurity



THANK YOU