Biobanche di immagini e intelligenza artificiale

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UNIVERSITÀ DI PISA

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Polo Didattico S. Rossore

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IMAGING LAB

Department of Traslational Research

The Imaging Lab is a multidisciplinary laboratory dedicated to frontier research in the study of biomedical images. The Lab is coordinated by Prof. Emanuele Neri, chair of the 3rd Academic Unit of Radiology at S. Chiara Hospital, and Faculty of the Department of Translational Research of the University of Pisa.

The activities of the Lab focus on the development and validation of imaging biomarkers, imaging biobanks and artificial intelligence.

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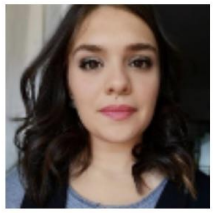

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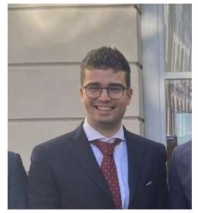

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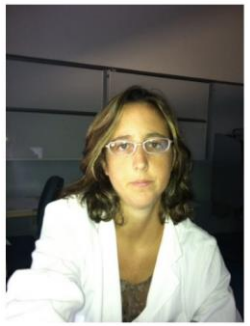

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Insights Imaging
DOI 10.1007/s13244-015-0409-x

STATEMENT

ESR Position Paper on Imaging Biobanks

European Society of Radiology (ESR)

Acknowledgments This article was kindly prepared by the ESR Working Group on Imaging Biobanks (Chair and lead/corresponding author: Emanuele Neri, Members: Bernard Gibaud, Matthias Guenther, Alan Jackson, Hans-Ulrich Kauczor, Luis Marti-Bonmati, Peter Mildenberger, Osman Ratib, Siegfried Trattnig, Aad van der Lugt, Peter Van Ooijen) on behalf of the European Society of Radiology (ESR). It was approved by the ESR Executive Council on 26 March 2015.

1. Imaging biobanks can be defined as "organised databases of medical images and associated imaging biomarkers (radiology and beyond) shared among multiple researchers, and linked to other biorepositories".

2. The immediate purpose of imaging biobanks should be to allow the generation of imaging biomarkers for use in research studies and to support biological validation of existing and novel imaging biomarkers.

3. A long-term scope of imaging biobanks should be the creation of a network/federation of such repositories integrated with the already existing biobanking network.

Biomarker (definition)

Ideally must be a measurement!

A characteristic that is objectively **measured** and evaluated as an indicator of normal biologic processes, pathogenic processes (abnormal biologic processes), or biological responses to a therapeutic intervention

Biomarkers Definitions Working Group.
Biomarkers and surrogate endpoints: preferred definitions and conceptual framework.
Clin Pharmacol Ther. 2001 Mar;69(3):89-95.

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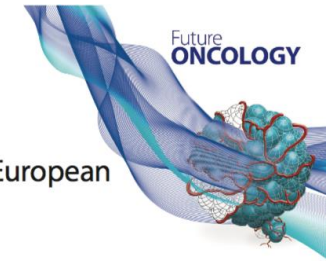
Table 1. Example of biomarkers in oncologic imaging.

Imaging biomarker	Quantification of the pathologic mechanism	Imaging technique involved	Ref.
Volume	Tumor growth and regression	CT, MRI and US	[12]
Perfusion	Tumor angiogenesis/vascularity	CT perfusion, MRI perfusion	[13,14]
Brownian motion of water molecules within a voxel of tissue	Tumor cellularity	MR diffusion-weighted imaging	[15,16]
Texture analysis	Tumor parenchymal structure	CT and MRI	[17]
MR spectroscopy	Intratumoral concentration of various metabolites	MRI	[18,19]
Stiffness	Tumor fybrotic component	US elastography	[20,21]
Glucose metabolism	Tumoral metabolic activity	PET/CT and PET/MRI	[22,23]
CT density	Tissue/material type (solid vs fluid)	CT imaging	
MR signal intensity	Tissue/material type (solid vs fluid)	MRI	
MR fingerprinting	Combination of tissue properties	MRI	[24]

CT: Computed tomography; MR: Magnetic resonance; US: Ultrasound.



PERSPECTIVE

Imaging biobanks in oncology: European perspective

Emanuele Neri*[1] & Daniele Regge[2]

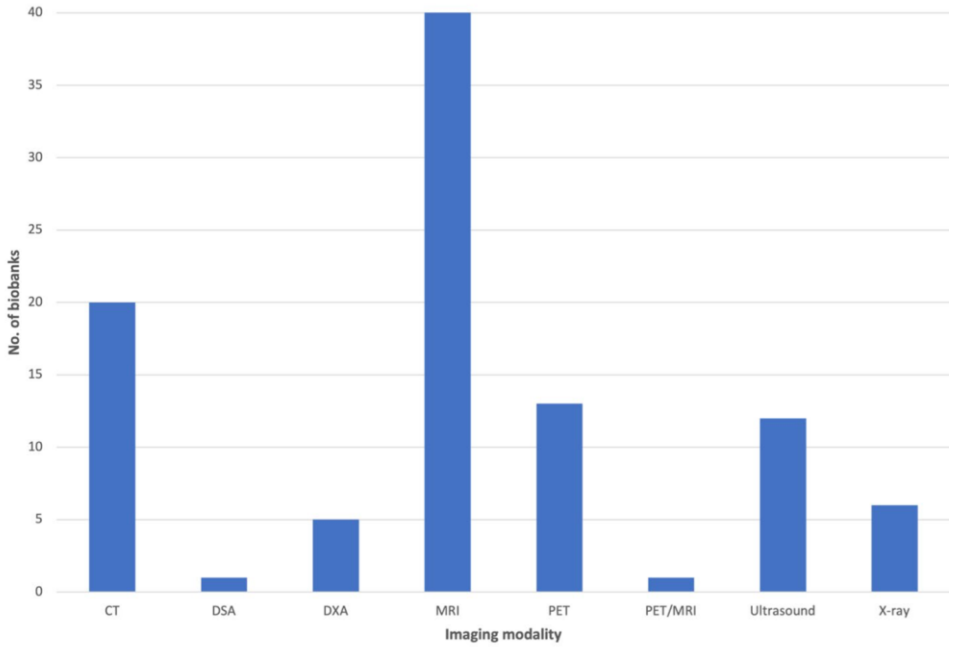
European Radiology (2022) 32:3173–3186
https://doi.org/10.1007/s00330-021-08431-6

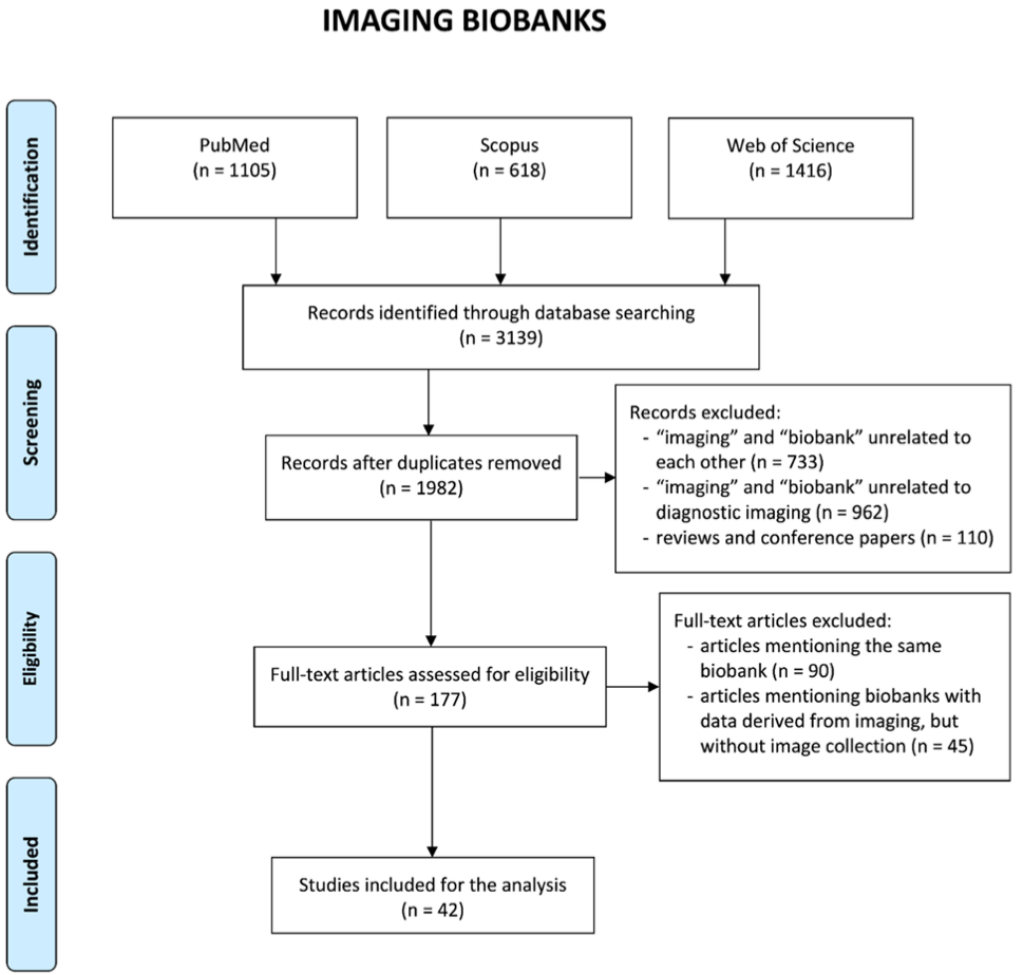
IMAGING INFORMATICS AND ARTIFICIAL INTELLIGENCE

Check for updates

Bridging gaps between images and data: a systematic update on imaging biobanks

Michela Gabelloni[1] · Lorenzo Faggioni[1] · Rita Borgheresi[1] · Giuliana Restante[1] · Jorge Shortrede[1] · Lorenzo Tumminello[1] · Camilla Scapicchio[1] · Francesca Coppola[2,3] · Dania Cioni[1] · Ignacio Gómez-Rico[4] · Luis Martí-Bonmatí[4,5] · Emanuele Neri[1,3]





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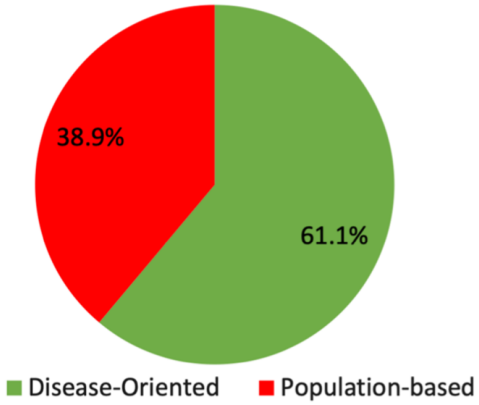

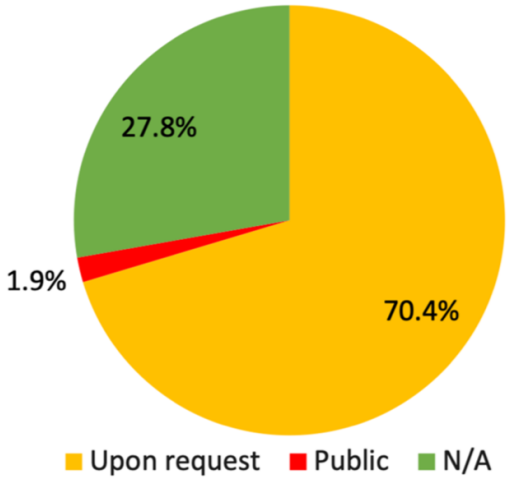

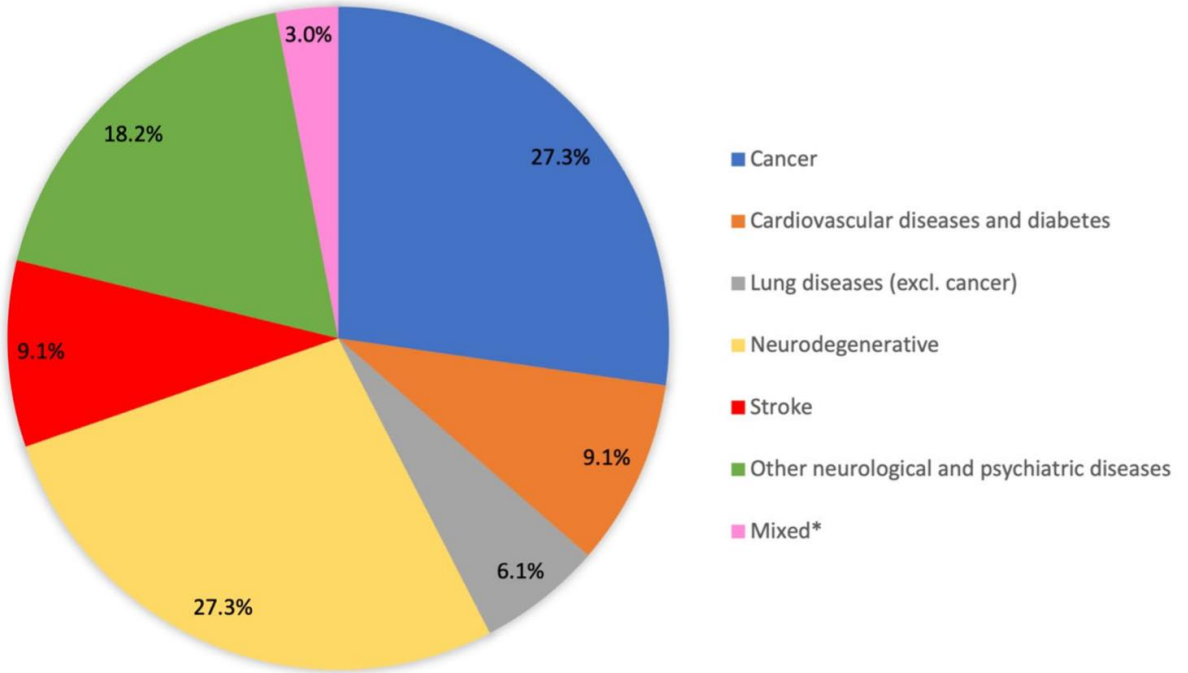

Progetti (UNIPI) finalizzati alla realizzazione di biobanche di immagini

PRIMAGE

Medical imaging
Artificial intelligence
Childhood cancer research

PRedictive **I**n-silico **M**ultiscale **A**nalytics to support cancer personalized dia**G**nosis and prognosis, **E**mpowered by imaging biomarkers.

PRIMAGE is one of the largest and more ambitious European research projects in **medical imaging, artificial intelligence** and **childhood cancer**.

Neuroblastoma

NAVIGATOR

Regione Toscana

NAVIGATOR project aims to boost 4P precision medicine in oncology by advancing translational research based on quantitative imaging and multi-omics analyses, towards a better understanding of cancer biology, cancer care, and, more generally, cancer risk. The project will deliver a technological solution relying on:

- an **open imaging Biobank**, collecting and preserving large amount of quality, standardised imaging data and related omics data in a secure and privacy-preserving model. Data will include CT, MRI and PET data for various tumour settings, clinical data from regional healthcare services, molecular and liquid biopsy data

Colon
Stomaco
Prostata

EUCAN IMAGE

The goal of the EU-funded EuCanImage project is to build a secure, large-scale European cancer imaging platform with capabilities that will advance the application of artificial intelligence (AI) in oncology. The platform will be populated with new data from 25 000 subjects, enabling the investigation of unmet clinical needs, such as the detection of small liver lesions and metastases of colorectal cancer or the evaluation of the molecular subtypes of breast tumours. The platform will be cross-linked to biological and health repositories through the European Genome–phenome Archive, allowing the development of multiscale AI solutions that integrate organ-level, molecular and clinical predictors into novel patient-specific cancer fingerprints. The consortium will build upon several

Colon
Mammella
Fegato

HORIZON 2020

ProCAncer-I

An AI Platform integrating imaging data and models, supporting precision care through prostate cancer's continuum: In Europe, prostate cancer (PC) is the second most frequent type of cancer in men and the third most lethal. Current clinical practices lead to overdiagnosis and overtreatment, necessitating more effective tools for discriminating between aggressive and non-aggressive disease. The EU-funded ProCAncer-I project proposes to develop advanced artificial intelligence models to address unmet clinical needs: diagnosis, metastases detection and prediction of response to treatment. To achieve this, partners will generate a large interoperable repository of health images, and a scalable high-performance computing platform hosting the largest collection of PC Magnetic mages used for developing robust PC AI nsure the rapid clinical implementation of eveloped, the project's robustly monitor performance, accuracy ibility.

Prostata

chAImeleON

The CHAIMELEON project aims to develop a structured repository of health images and related clinical and molecular data on the most prevalent cancers in Europe: lung, breast, prostate and colorectal.

This EU-wide int
facilitate and co
validation of AI t
management.

Colon, Mammella, Prostata

AI4HI League
Artificial Intelligence For Health Imaging

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- https://www.procancer-i.eu/
- https://eucanimage.eu/
- https://chaimeleon.eu/
- https://www.primageproject.eu/

- http://navigator.med.unipi.it/
- *NAVIGATOR: An Imaging Biobank to Precisely Prevent and Predict cancer, and facilitate the Participation of oncologic patients to Diagnosis and Treatment*

Regione Toscana

Tasks del gruppo di ricerca UNIPI

- Coordinamento (progetto NAVIGATOR)
- Raccolta dati (immagini e dati clinici)
- Segmentazione (estrazione volume tumore e macro-ambiente tumorale)
- Analisi radiomica e biomarcatori di immagini
- Data management plan
- Sostenibilità delle biobanche
- Sviluppo di «common data models» di descrizione del contenuto delle biobanche
- Dissemination

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Scapicchio *et al. European Radiology Experimental* (2021) 5:20
https://doi.org/10.1186/s41747-021-00214-4

European Radiology Experimental

METHODOLOGY Open Access

DICOM-MIABIS integration model for biobanks: a use case of the EU PRIMAGE project

Camilla Scapicchio[1*], Michela Gabelloni[1], Sara Maria Forte[1], Leonor Cerdá Alberich[2], Lorenzo Faggioni[1], Rita Borgheresi[1], Paola Erba[1], Fabiola Paiar[1], Luis Marti-Bonmati[3] and Emanuele Neri[1]

Model	Type of metadata
DICOM extensions	Clinical variables
SEDI	DICOM tags
MIABIS	Biological samples and tissues
OMOP CDM	Clinical variables
FHIR	Clinical variables
OMOP on FHIR	Clinical variables
ICGC-ARGO	Cancer-focused clinical variables

Kondylakis *et al. European Radiology Experimental* (2022) 6:29
https://doi.org/10.1186/s41747-022-00281-1

European Radiology Experimental

GUIDELINE/POSITION PAPER Open Access

Position of the AI for Health Imaging (AI4HI) network on metadata models for imaging biobanks

Haridimos Kondylakis[1], Esther Ciarrocchi[2*], Leonor Cerda-Alberich[3], Ioanna Chouvarda[4], Lauren A. Fromont[5], Jose Manuel Garcia-Aznar[6], Varvara Kalokyri[2], Alexandra Kosvyra[4], Dawn Walker[7], Guang Yang[8], Emanuele Neri[2] and the AI4HealthImaging Working Group on metadata models**

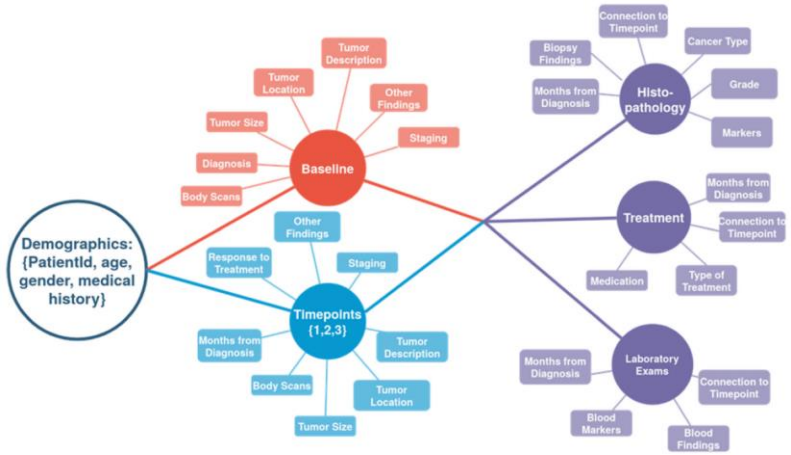

Fig. 3 The design of the INCISIVE data model

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- Intelligenza artificiale un algoritmo capace di eseguire uno o più compiti che richiedono intelligenza quando eseguiti da un essere umano
- Machine learning è un sotto insieme dell'intelligenza artificiale, è un algoritmo capace di imparare a eseguire un compito a partire da dei dati di training
- Deep learning è un sotto insieme del machine learning in cui si usano esclusivamente reti neurali profonde

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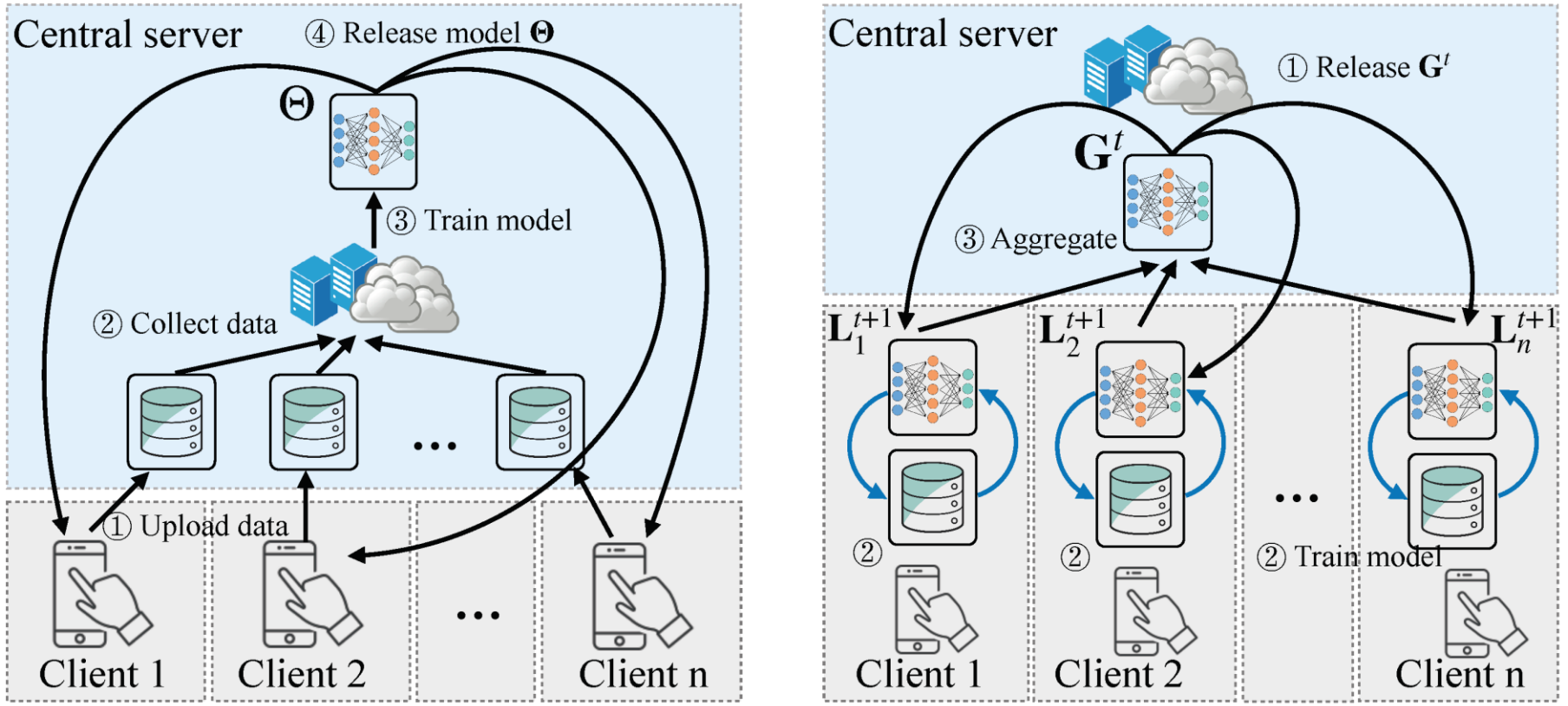

Zhou, X.; Xu, M.; Wu, Y.; Zheng, N. Deep Model Poisoning Attack on Federated Learning. *Future Internet* **2021**, *13*, 73. https://doi.org/10.3390/fi13030073

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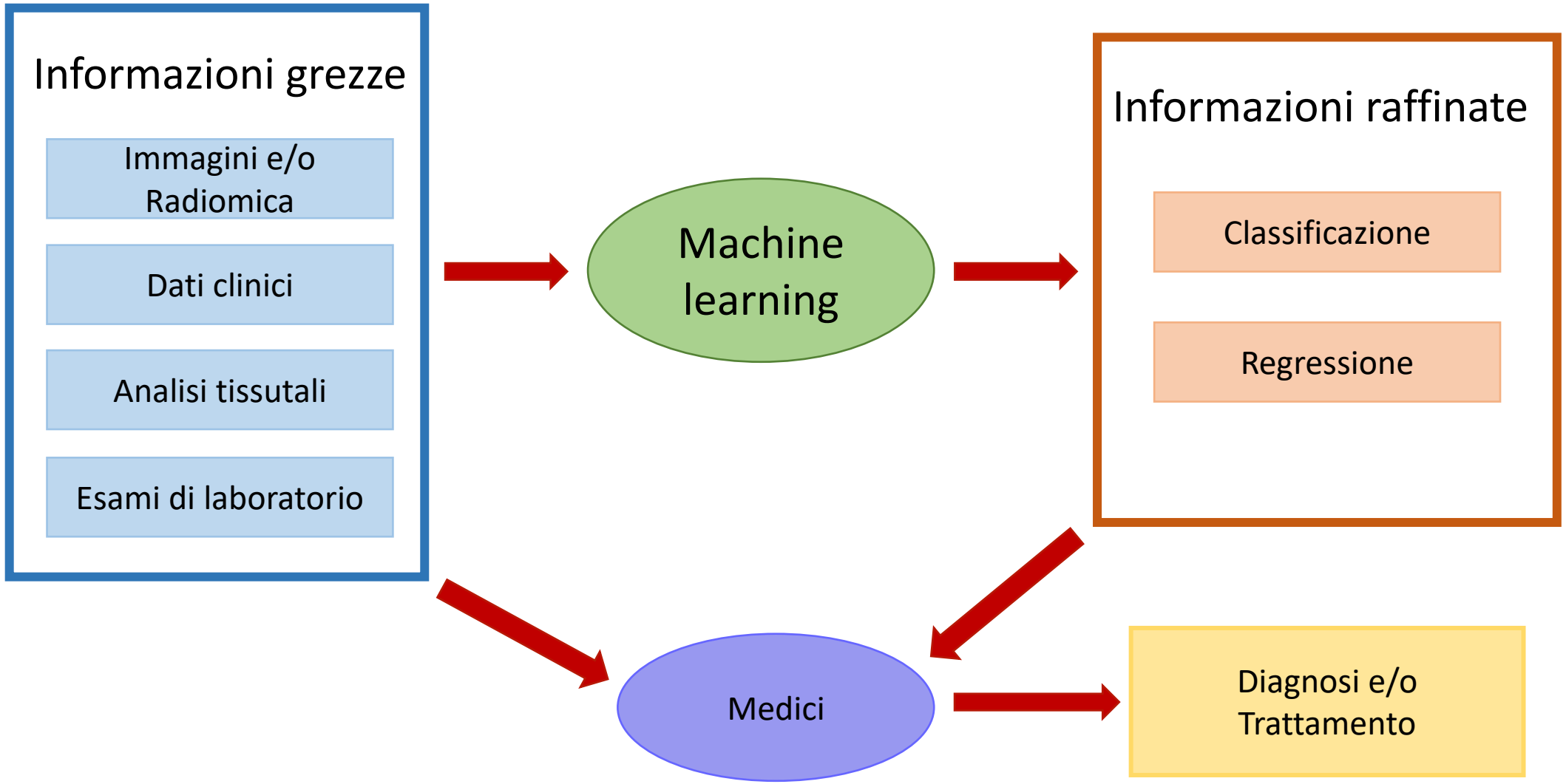

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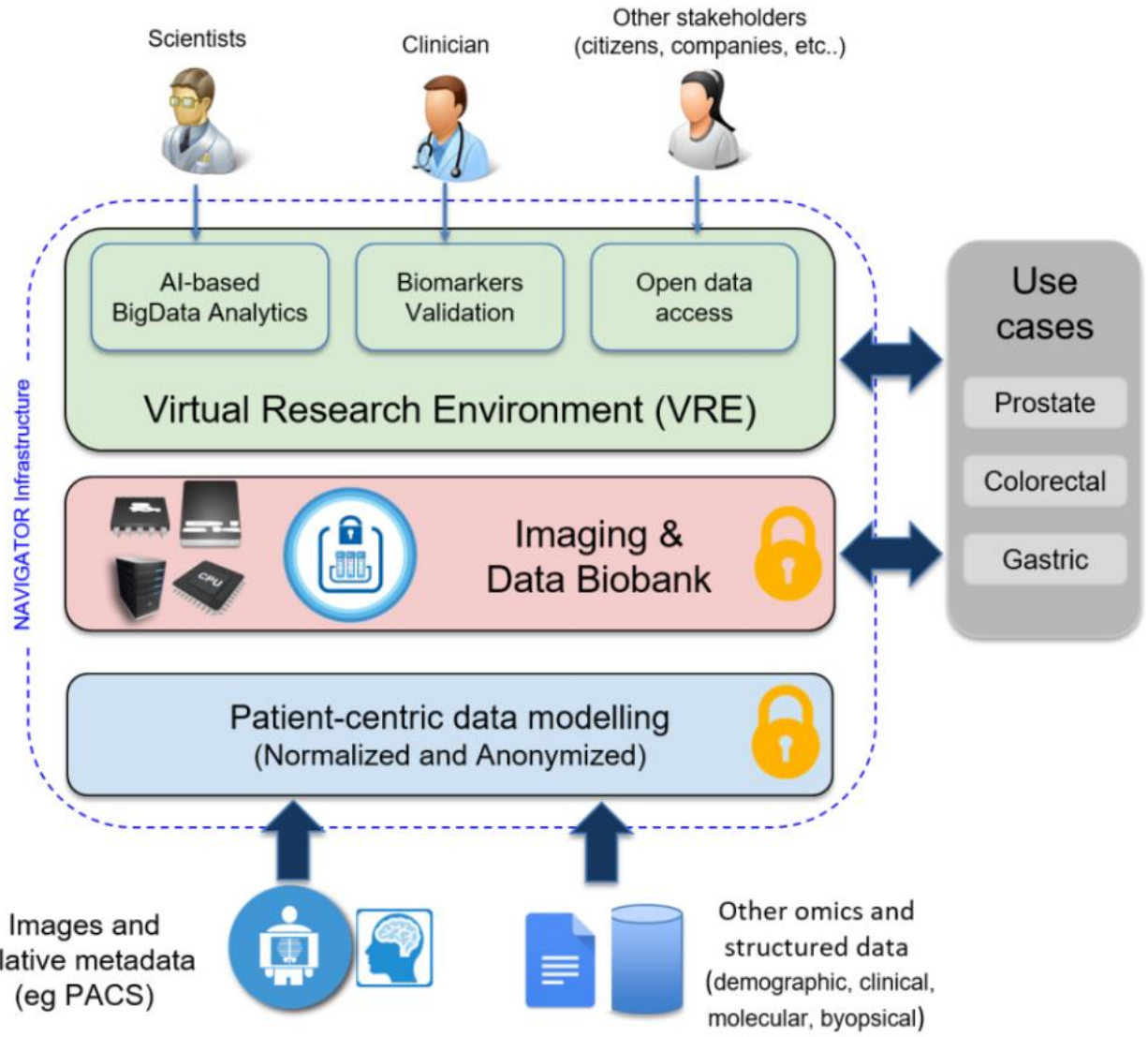
Struttura progetto
Navigator



Grazie per l'attenzione

Domande?