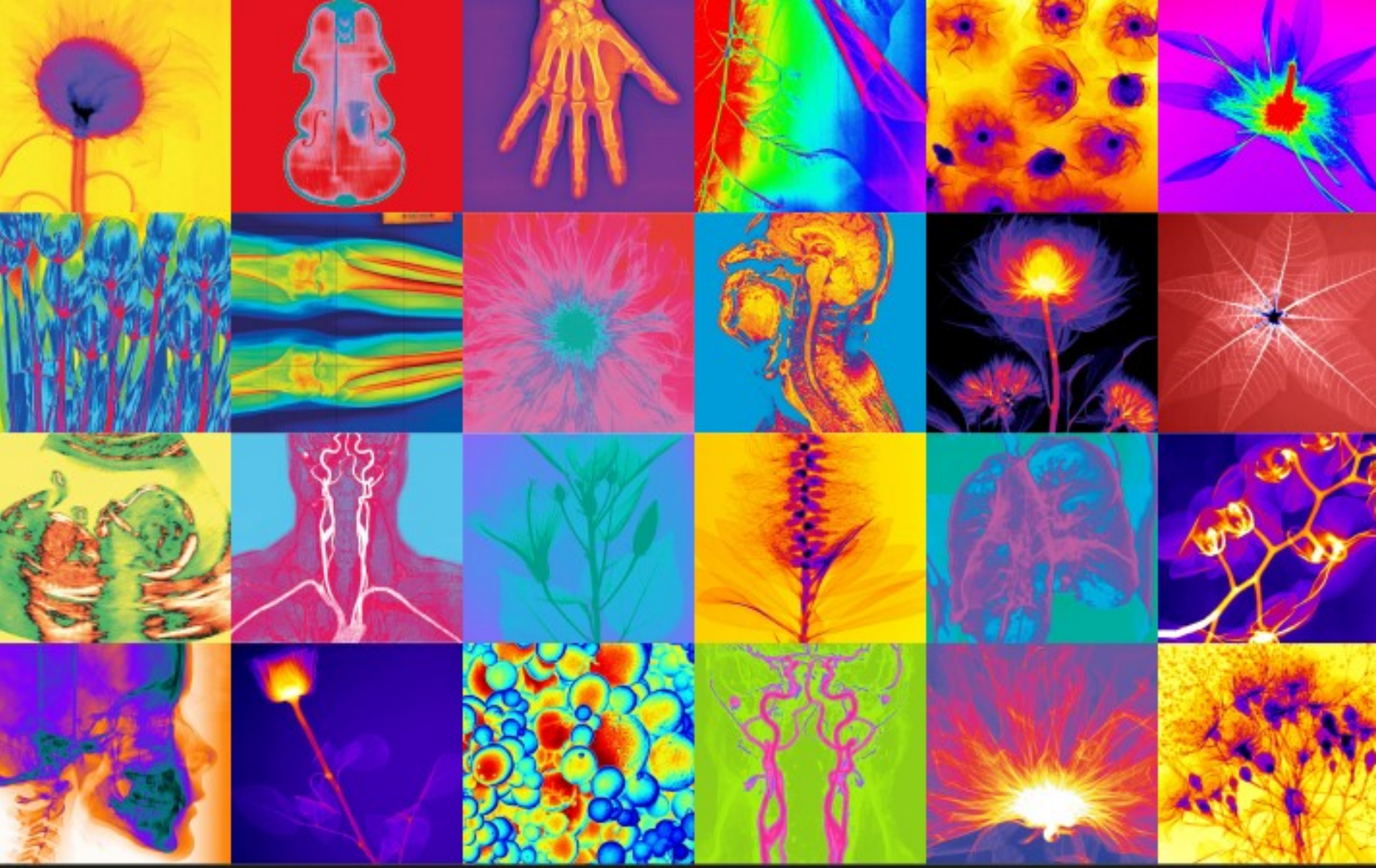


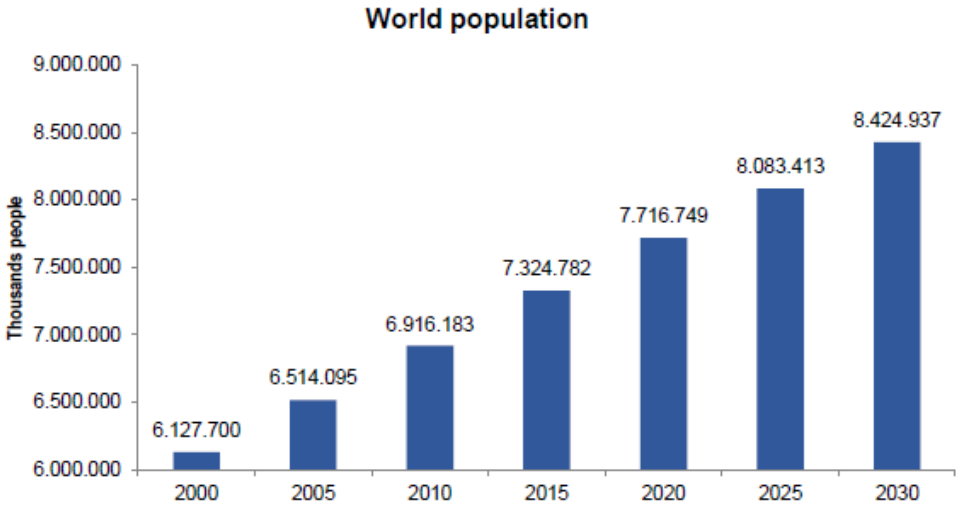
AI & Healthcare: challenges and opportunities

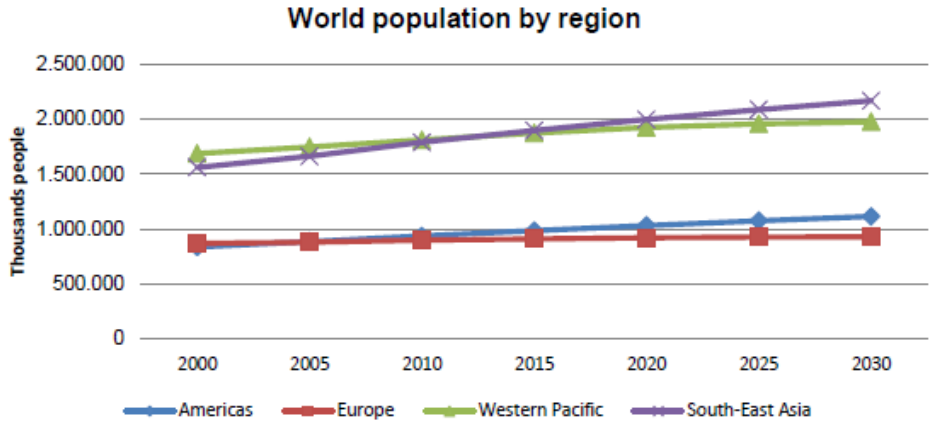
Alessandro Maiocchi – Innovation hub – Bracco SpA

BRACCO

LIFE FROM INSIDE

The World's population overview (1/2)

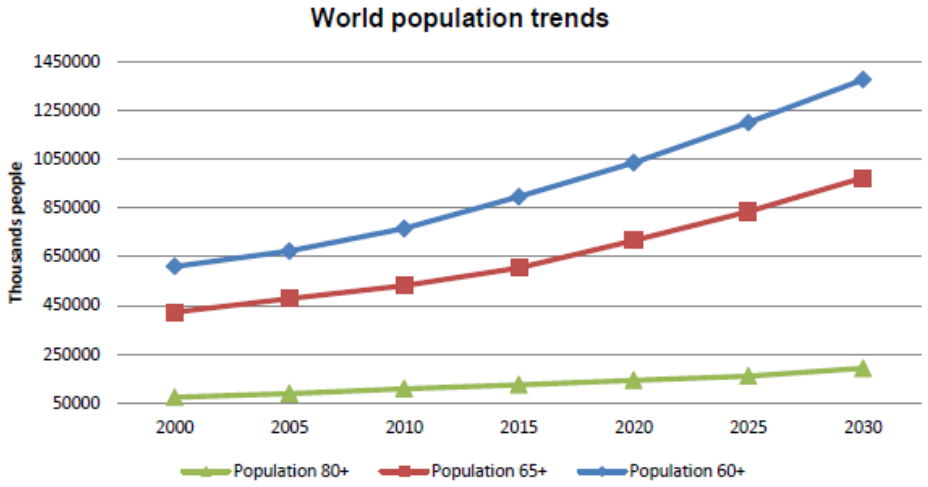


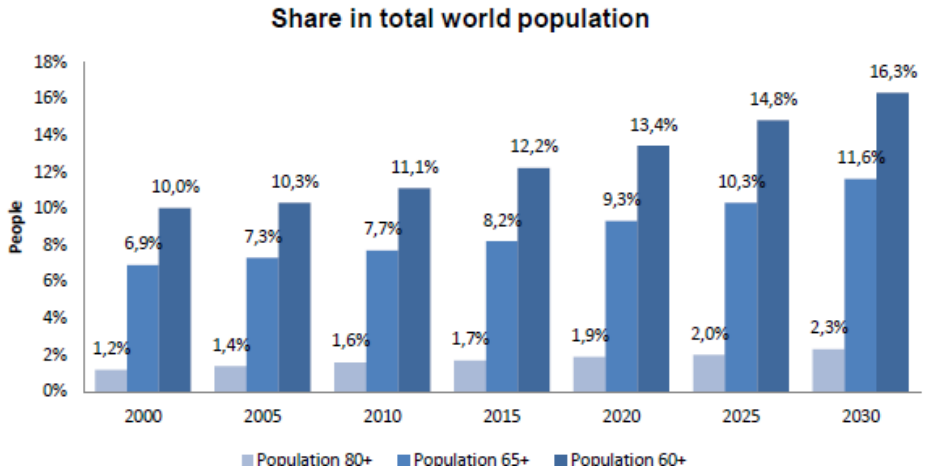


- The world population is projected to **increase by 37,5%** in the time period 2000-2030
- In 2030 there will be around 1,1 billion people more living on Earth than nowadays
- South-East Asia population growth is driven mainly by India, which is projected to reach almost 1,5 billion inhabitants in 2030 (+42% in comparison to 2000) and replacing China as the most populous country in the world
- Affluent countries are polarized in terms of population growth, which may result from immigration and social policies

Source: United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projection Section, World Population Prospects: The 2012 Revision, http://esa.un.org/unpd/wpp/unpp/panel_population.htm

World's population overview (2/2)



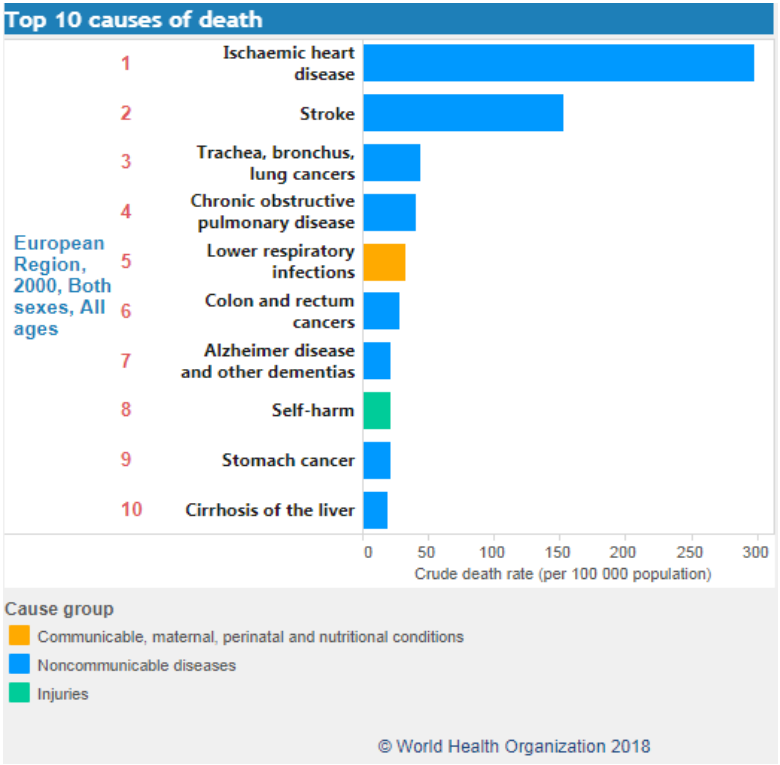


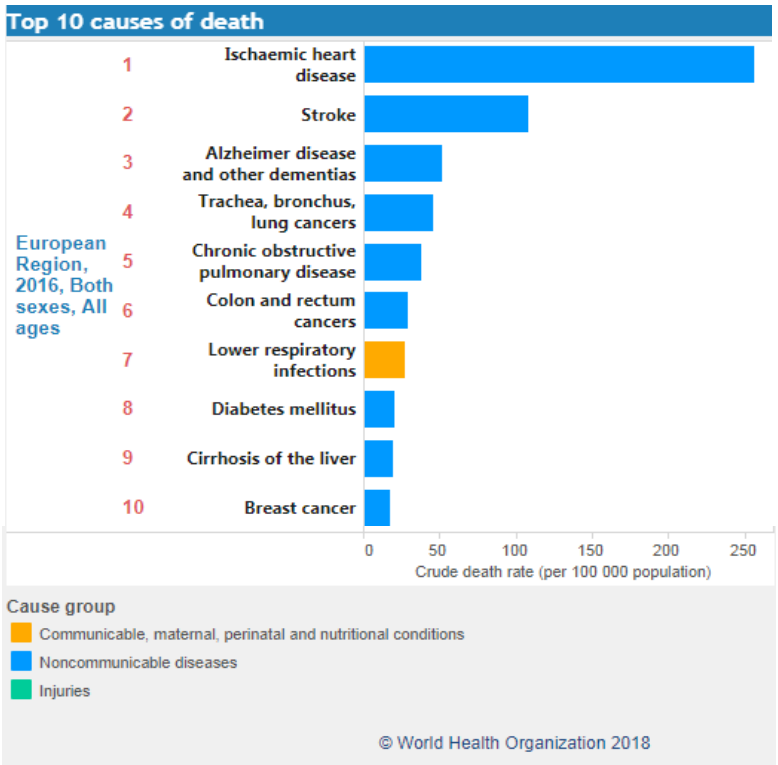
- By 2030 the population of 60+ year-olds will more than double in comparison to 2000
- In 2030 in comparison to year 2000, the group of 80+ year-olds will grow by 163% and 65+ year-olds by 130%
- 16 years from now, one in six inhabitants of the world will have more than 60 years. This can be translated into 1,37 billion people that may require intensified medical care

Source: United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projection Section, World Population Prospects: The 2012 Revision, http://esa.un.org/unpd/wpp/unpp/panel_population.htm

3

Population ageing and new needs





Why Healthcare requires new tools

- Increasing Global Health care expenditure
- Larger geriatric population
- Imbalance between health workforce and patients
- Continuous shortage of nursing and technician staff
- Increasing individual healthcare expenses

Medical practitioners must be supported more efficiently to achieve their tasks with minimal human intervention, a critical factor in meeting increasing patient demand.

Towards a new Medicine model

Medicine of Yesterday (Evidence Based)

Based on science and proven relationships between diagnosis, treatment and outcome

Focus on data from clinical trials in patient populations

Medicine of Today (Personalized/Precision)

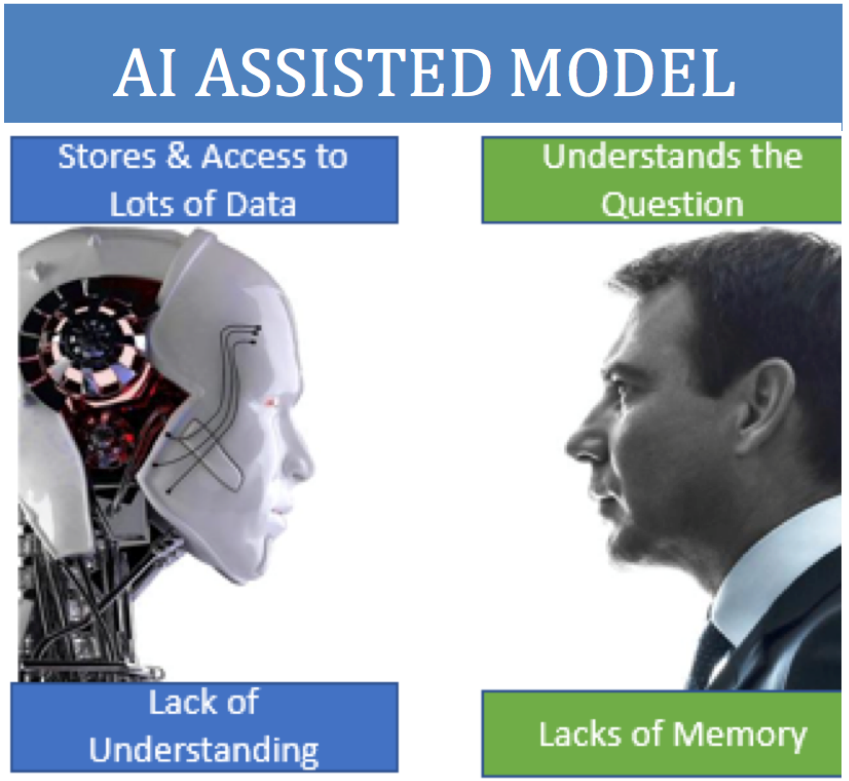
Customization or “personalization” of care based on an individual patient’s characteristics

Precise diagnosis becomes ascendant in importance – (variants of same disease needing different treatments)

Medicine of the future (AI Assisted)

Patient’s care based on big data and AI models

Shift from advanced disease treatments to Early detection and prevention



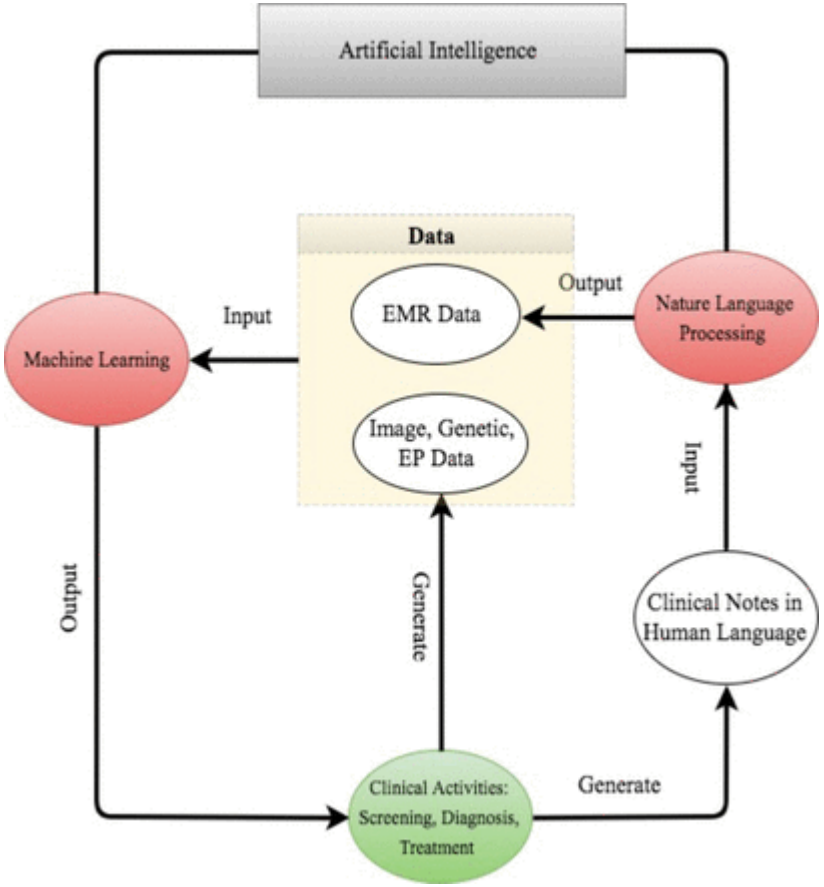
AI- based systems in Healthcare

AI-based systems mainly fall into two major categories.

The first category includes machine learning (ML) techniques that analyse structured data such as imaging, genetic and EP data.

In the medical applications, the ML procedures attempt to cluster patients' traits, or infer the probability of the disease outcomes.

The second category includes natural language processing (NLP) methods that extract information from unstructured data such as clinical notes/medical journals to supplement and enrich structured medical data.



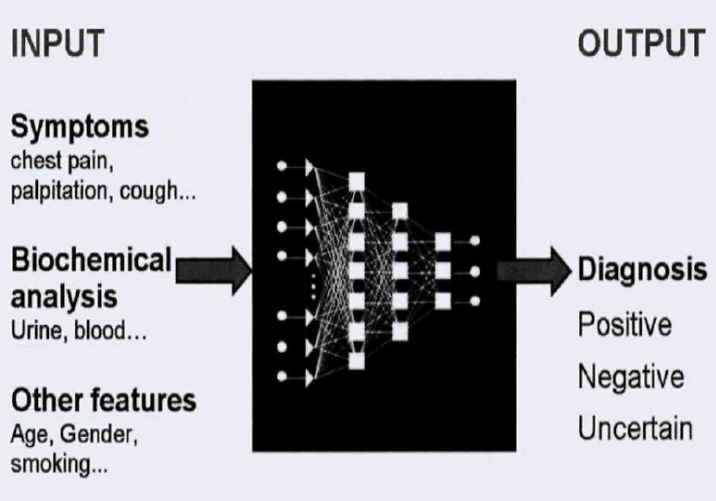
The NLP procedures target at turning texts to machine-readable structured data, which can then be analysed by ML techniques

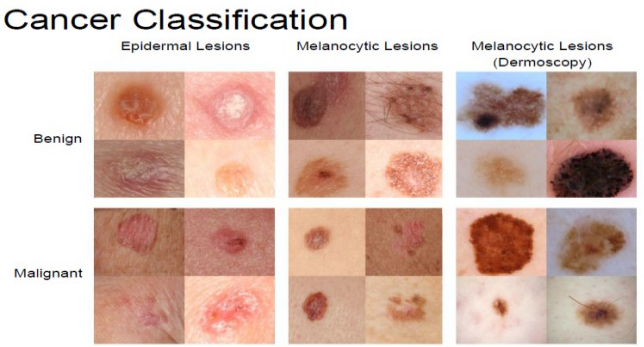
AI & Healthcare: the opportunities

BRACCO
LIFE FROM INSIDE

AI can definitely assist physicians as follows:

- Clinical decision making - better clinical decisions
- Early diagnosis
- Prediction of outcome of the disease as well as treatment
- Personalized therapeutic treatments
- Patient follow-up
- Reduce diagnostic and therapeutic errors
- Increased patient safety and cost savings





AI & Healthcare: the challenges

- **Development costs**
- **Integration issues**
  - *Ethical issues*
  - *Reluctance among medical practitioners to adopt AI*
  - *Fear of replacing humans*
- **Data Privacy and security**
  - *Mobile health applications and devices that use AI*
  - *Lack of interoperability between AI solutions*
- **Data exchange**
  - *Need for continuous training by data from clinical studies*
  - *Data standardization & quality*
  - *Incentives for sharing data on the system for further development and improvement of the system.*
  - *All the parties in the healthcare system, the physicians, the pharmaceutical companies and the patients, have greater incentives to compile and exchange information*
- **State and federal regulations**
- **Rapid and iterative process of software updates commonly used to improve existing products and services**

AI for the Pharma Industry

- What types of AI applications are currently in use in the pharmaceutical industry?
- What tangible results has AI driven in pharma?
- Are there any common trends among these innovation efforts? How could these trends affect the future of pharmaceuticals?

A study from **MIT** has found that only **13.8%** of drugs successfully pass clinical trials. Furthermore, a company can expect to pay between **$161 million to $2 billion** for any drug to complete the entire clinical trials process and get FDA approval.

C.H. WONG, K.W. SIAH, ANDREW W. LO Biostatistics (2019) 20, 2, pp. 273–286

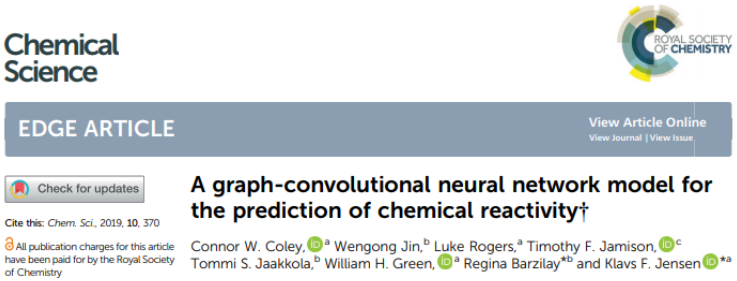
AI in Drug Discovery (1/2)

Machine Learning for Pharmaceutical Discovery and Synthesis Consortium

This group is a collaboration between the pharmaceutical and biotechnology industries and MIT. The goal of the collaborative efforts is to facilitate the design of useful software for the automation of small molecule discovery and synthesis.

Members

AMGEN AstraZeneca BASF We create chemistry BAYER gsk janssen LEO Lilly MERCK NOVARTIS Pfizer SUNOVION


Chemical Science

EDGE ARTICLE

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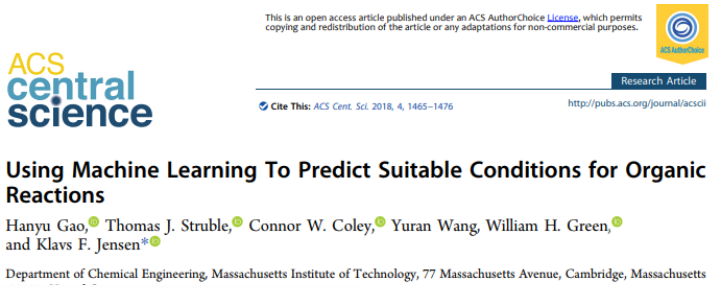
Check for updates

Cite this: Chem. Sci., 2019, 10, 370

All publication charges for this article have been paid for by the Royal Society of Chemistry

A graph-convolutional neural network model for the prediction of chemical reactivity†

Connor W. Coley,[a] Wengong Jin,[b] Luke Rogers,[a] Timothy F. Jamison,[c] Tommi S. Jaakkola,[b] William H. Green,[a] Regina Barzilay*[b] and Klavs F. Jensen*[a]


ACS central science

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Research Article

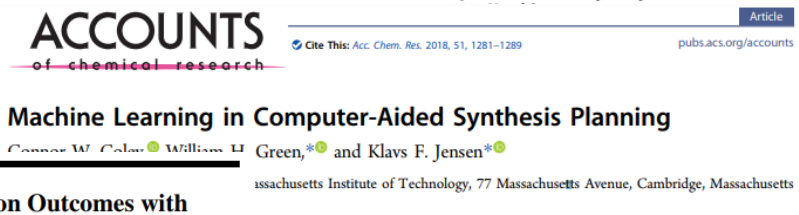
Cite This: ACS Cent. Sci. 2018, 4, 1465−1476

http://pubs.acs.org/journal/acscii

Using Machine Learning To Predict Suitable Conditions for Organic Reactions

Hanyu Gao, Thomas J. Struble, Connor W. Coley, Yuran Wang, William H. Green, and Klavs F. Jensen*

Department of Chemical Engineering, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts


ACCOUNTS of chemical research

Article

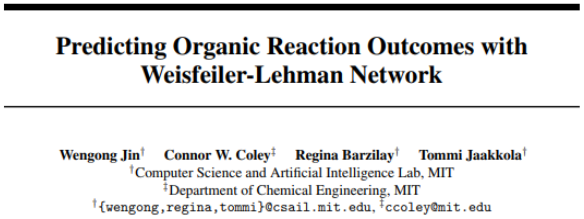
Cite This: Acc. Chem. Res. 2018, 51, 1281−1289

pubs.acs.org/accounts

Machine Learning in Computer-Aided Synthesis Planning

Green,* and Klavs F. Jensen*

ıssachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts


Predicting Organic Reaction Outcomes with Weisfeiler-Lehman Network

Wengong Jin† Connor W. Coley‡ Regina Barzilay† Tommi Jaakkola†

†Computer Science and Artificial Intelligence Lab, MIT

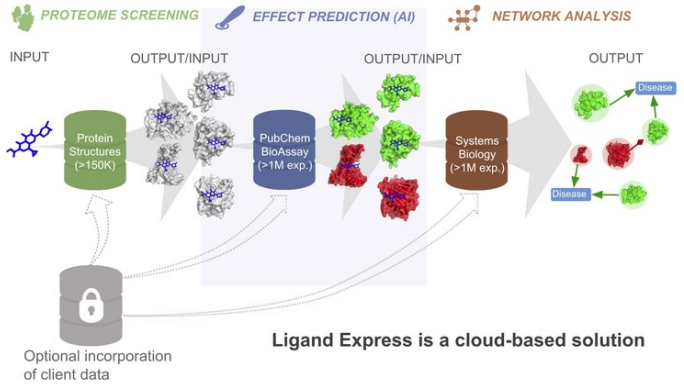
‡Department of Chemical Engineering, MIT

†{wengong,regina,tommi}@csail.mit.edu, ‡ccoley@mit.edu

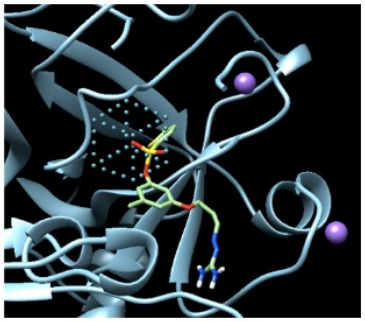
AI in Drug Discovery (2/2)

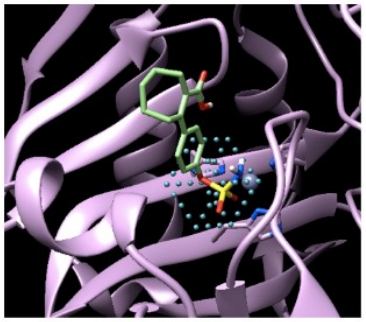
Drug Discovery: scientific efforts towards the identification of molecules that could potentially be developed into a new drug

Cyclica is a biotechnology company that combines biophysics and AI to discover drugs faster, safer, and cheaper. They have partnered with Bayer to create an AI-augmented integrated network of cloud-based technologies



Atomwise developed AtomNet technology, a deep learning neural network application for structure-based drug design and discovery.





AI in Drug Development

Drug Development: Scientific efforts towards the identification of molecules that could potentially be developed into a new drug

Clinical Development: where AI has been used:

a) Identification,screening and engagements of patients for clinical trials (IBM Watson, Brite Health)

b) optimizing drug dosage at an individual level (CURATE.AI)

c) drug adherence in clinical trials (AI.CURE)

d) Analyse clinical trial operations (Mc Kinsey's Quantum Black)

AI in Clinical Applications

Mining Medical Records

Google Deepmind Health:

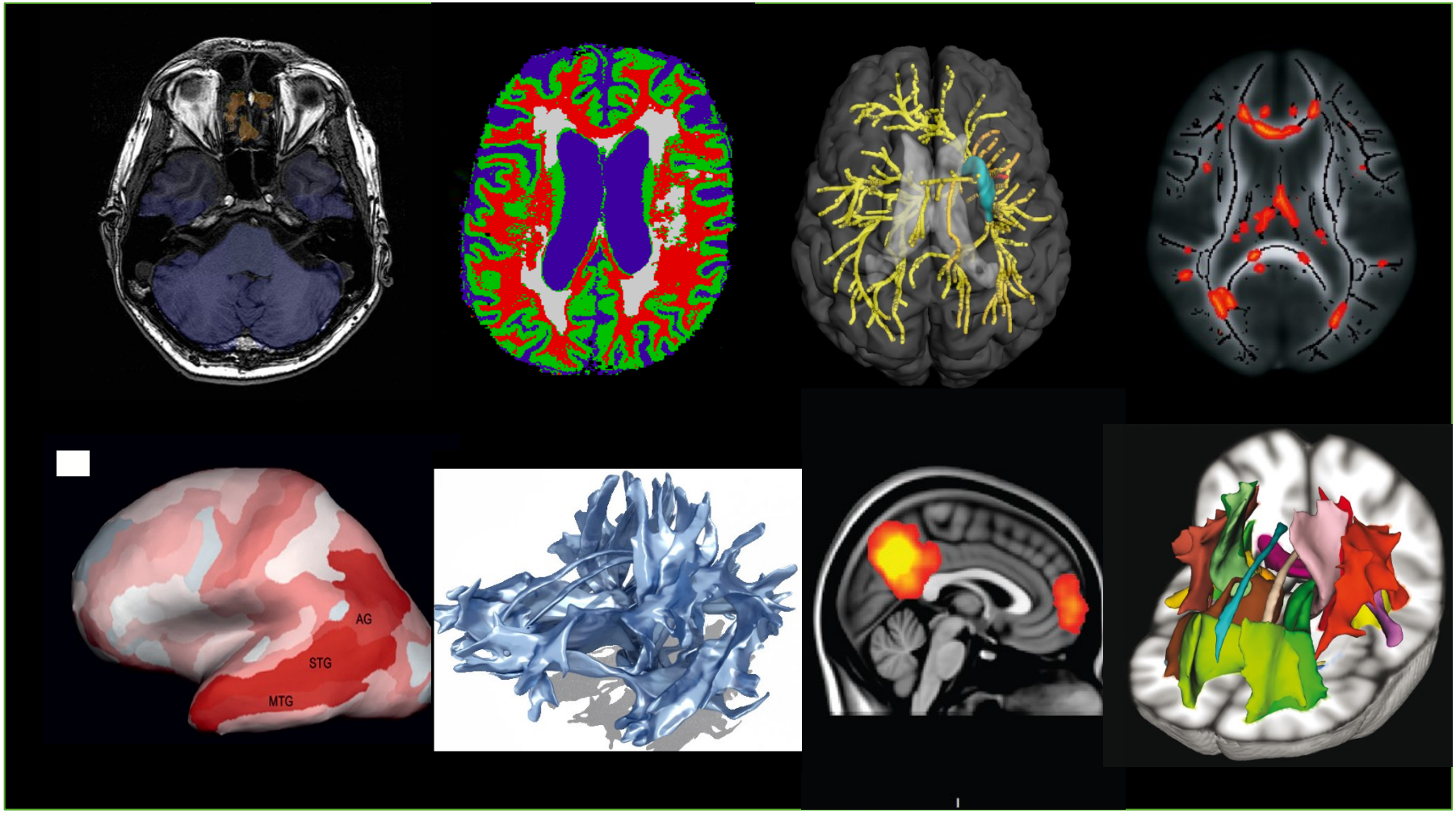
Google Deepmind is able to process hundreds of thousands of medical information within minutes. Google is cooperating with the Moorfields Eye Hospital NHS Foundation Trust to improve eye treatment.

IBM Watson :

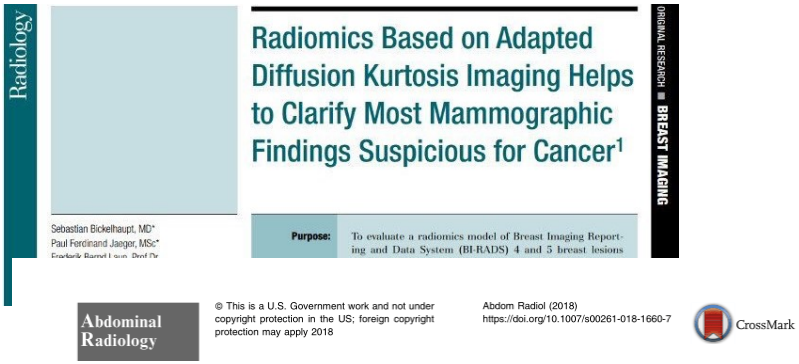
IBM Watson Health offer a suite of products and services which help physicians to make more informed and accurate decisions faster and to cull new insights from electronic medical records (EMR).

AI in Clinical Applications

Extraction of “Invisible” Biomarkers



AI in Clinical Applications: Radiology



Radiology

Radiomics Based on Adapted Diffusion Kurtosis Imaging Helps to Clarify Most Mammographic Findings Suspicious for Cancer[1]

ORIGINAL RESEARCH ■ BREAST IMAGING

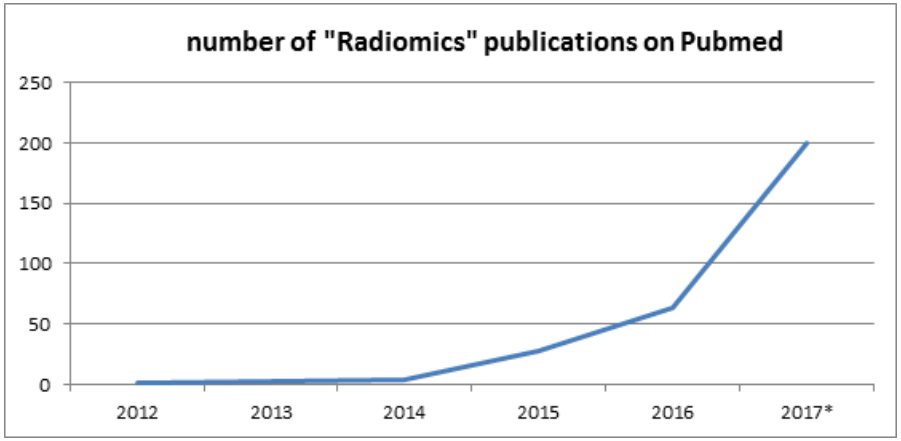
Sebastian Bickelhaupt, MD*
Paul Ferdinand Jaeger, MSc*

Purpose: To evaluate a radiomics model of Breast Imaging Reporting and Data System (BI-RADS) 4 and 5 breast lesions

Abdominal Radiology

Abdom Radiol (2018)
https://doi.org/10.1007/s00261-018-1660-7

CrossMark



Radiomics and radiogenomics of prostate cancer

Clayton P. Smith,[1,2] Marcin Czarniecki,[1] Sherif Mehralivand,[1,3,4] Radka Stoyanova,[5] Peter L. Choyke,[1] Stephanie Harmon,[6] and Baris Turkbey[1]

npj | Breast Cancer

www.nature.com/npjbcancer

ARTICLE OPEN

Quantitative MRI radiomics in the prediction of molecular classifications of breast cancer subtypes in the TCGA/TCIA data set

Hui Li[1,12], Yitan Zhu[2,12], Elizabeth S Burnside[3], Erich Huang[4], Karen Drukker[1], Katherine A Hoadley[5], Cheng Fan[5], Suzanne D Conzen[6], Margarita Zuley[7], Jose M Net[8], Elizabeth Sutton[9], Gary J Whitman[10], Elizabeth Morris[9], Charles M Perou[5], Yuan Ji[2,11] and Maryellen L Giger[1]

SCIENTIFIC REPORTS

OPEN

Precision Radiology: Predicting longevity using feature engineering and deep learning methods in a radiomics framework

Received: 8 December 2016
Accepted: 6 April 2017
Published online: 10 May 2017

Luke Oakden-Rayner[1,2], Gustavo Carneiro[3], Taryn Bessen[1], Jacinto C. Nascimento[4], Andrew P. Bradley[5] & Lyle J. Palmer[2]

IEEE Access

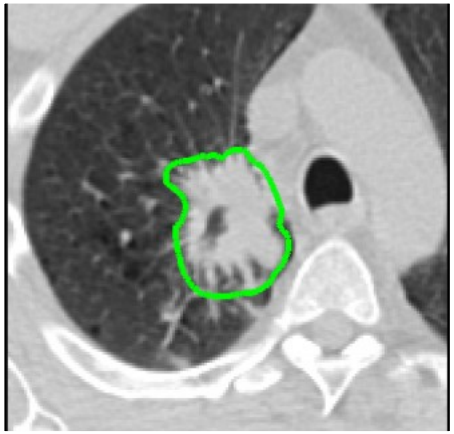
Date of publication xxxx 00, 0000, date of current version xxxx 00, 0000.
Digital Object Identifier 10.1109/ACCESS.2017.DOI

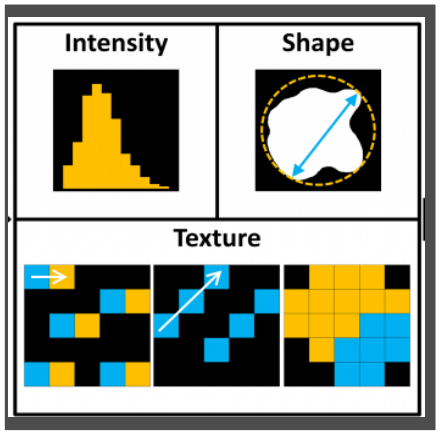
Deep radiomic analysis of MRI related to Alzheimer's disease

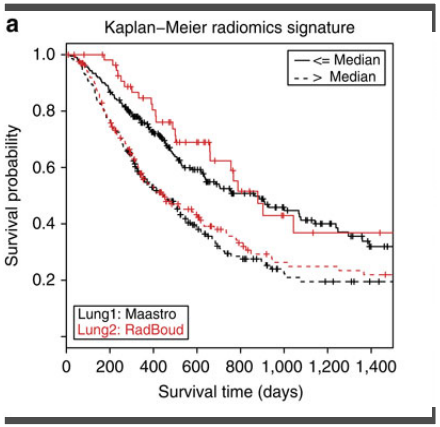
AHMAD CHADDAD[1,3], CHRISTIAN DESROSIERS[2], TAMIM NIAZI[3]
[1]Department of Automated Manufacturing Engineering, Ecole de technologie supérieure, Montreal, QC, Canada
[2]Department of Software and IT Engineering, Ecole de technologie supérieure, Montreal, QC, Canada
[3]Department of Radiation Oncology, McGill University, Montreal, QC, Canada

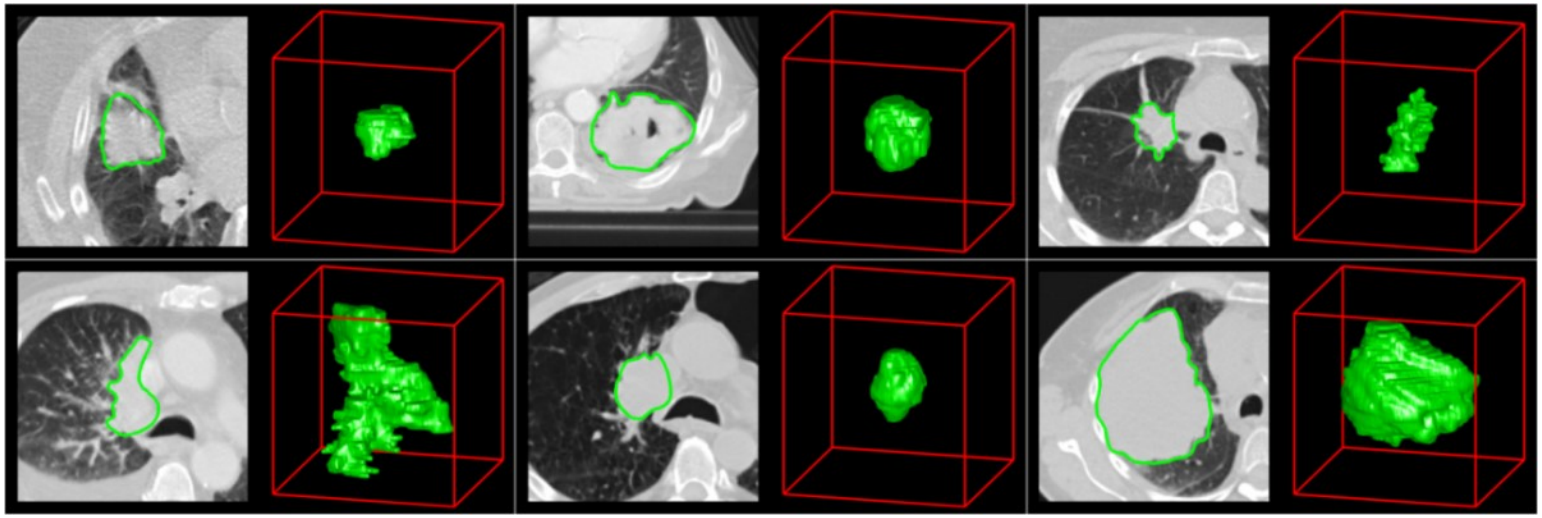
A.I. + Radiology = Radiomics

Quantification of Imaging Phenotype



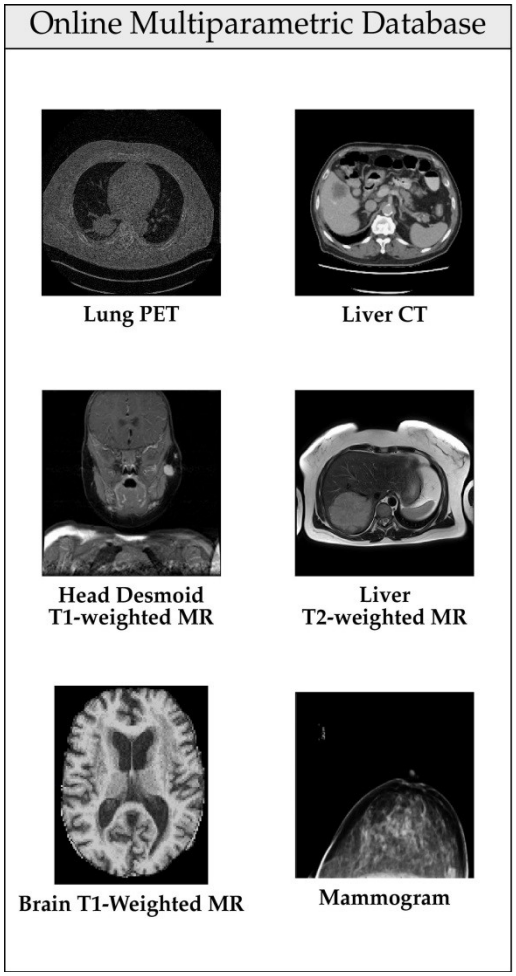


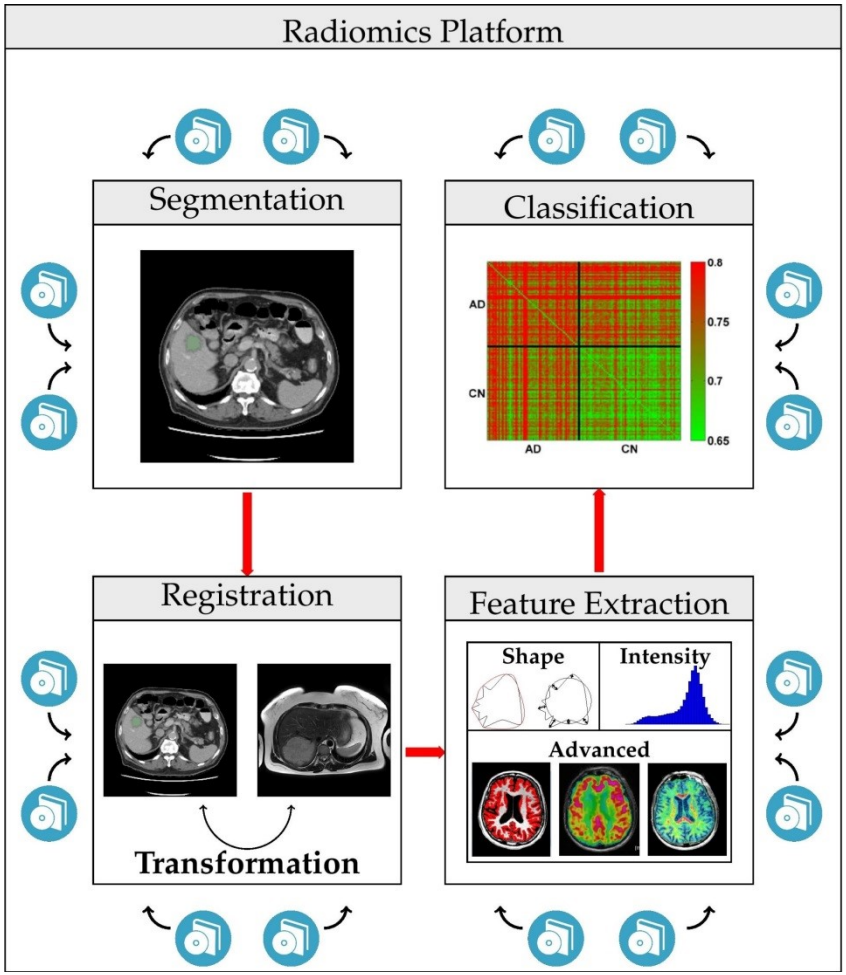


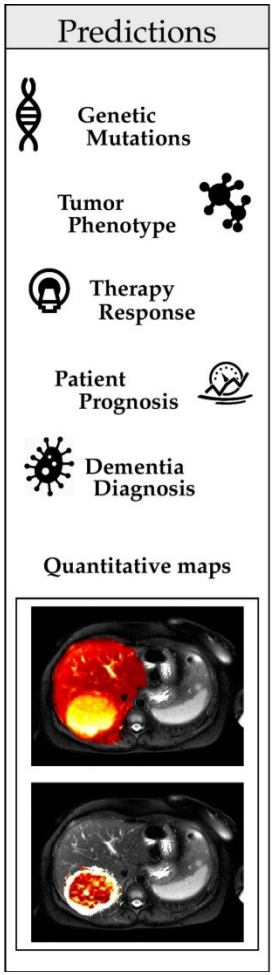


Aerts HJWL, et al. Nature Com. 2014

Multiparametric Radiomics Platform







AI today in Bracco/CDI

IEEE International Conference on Bioinformatics and Biomedicine
3-6 December 2018, Madrid

Radiomics for Predicting CyberKnife response in acoustic neuroma: a pilot study

Natascha Claudia D'Amico*‡, Rosa Sicilia†‡, Ermanno Cordelli†
Isa Bossi Zanetti§‡ Giancarlo Beltramo§, Deborah Fazzini*‡, Giusep
*Imaging Department, Centro Diagnostico Italian
†Unit of Computer Systems and Bioinformatics, Department of Engineeri
‡Joint Laboratory on Precision Medicine and E
Università Campus Bio-Medico di Roma - Centro Diagnosti
§Cyberknife Department, Centro Diagnostico Italia
¶Bracco Imaging S.p.A., Milan,

Grossi *Immunity & Ageing* 2010, **7**(Suppl 1):S3
http://www.immunityageing.com/content/7/S1/S3

IMMUNITY & AGEING

PROCEEDINGS **Open Access**

Artificial Adaptive Systems and predictive medicine: a revolutionary paradigm shift

Enzo Grossi

CDI

ECR 2018 DIVERSE UNITED

A new radiomics approach to predict the evolution of PI-RADS score 3/5 prostate areas in multiparametric MR

N.C. D'Amico, E. Grossi, G. Valbusa, A. Malasevschi, G. Cardone, S. Papa

CDI

Centro Diagnostico Italiano, Milan, Italy.
Bracco Imaging S.p.A

Conclusion

Many fear that robots, A.I., and automation, in general, will take their jobs without alternatives. The same anxieties emerged in healthcare about artificial intelligence taking the place of radiologists, robots surpassing the skills of surgeons, or taking jobs in pharma.

That is not true !!!

Physicians should accept technology understanding and using it continuing to take the final decision about their patients

Physicians will work more efficiently at the interface with patients, supporting and guiding them towards the fighting against their own disease.