From Technologies to Markets

Artificial Intelligence for Medical Imaging 2020

Market and Technology Report 2020

YOLE Développement

Sample

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REPORT OBJECTIVES

- Provide an overview of the market of AI in the field of medical imaging in terms of number of algorithms deployed and the value they generate for every player involved, at medical device level, AI platform level, and algorithm development level along with the understanding of the ecosystem, technologies used, strategic positioning, and how these will evolve in the coming years.

- Present the current market data and forecasts depending on the modality studied such as MRI and CT scans, and its application in the patient diagnostic process, such as noise reduction, screening or diagnostics, in dollar value and volume of images analyzed.

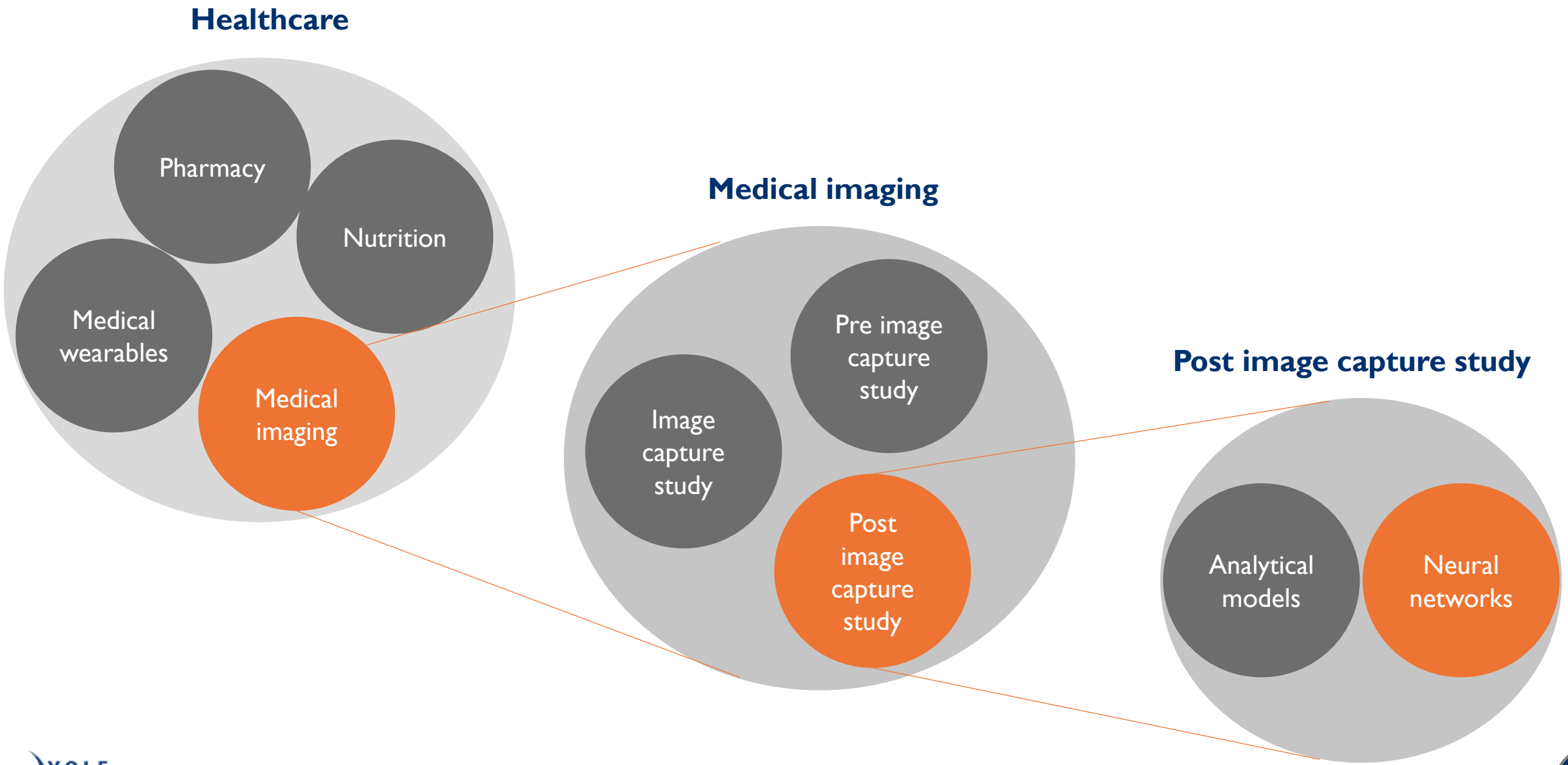
- Identify where the opportunities lie for each type of player along with a detailed description of the regulations and constraints of this field. In addition to the current overview, an introduction of the evolution of those regulations in the coming years is presented.

- Discuss the different technologies currently used, the business models and technical constraints inherent to the medical imaging field as well as trends for the integration of AI in fields other than radiology.

COMPANIES CITED IN THIS REPORT

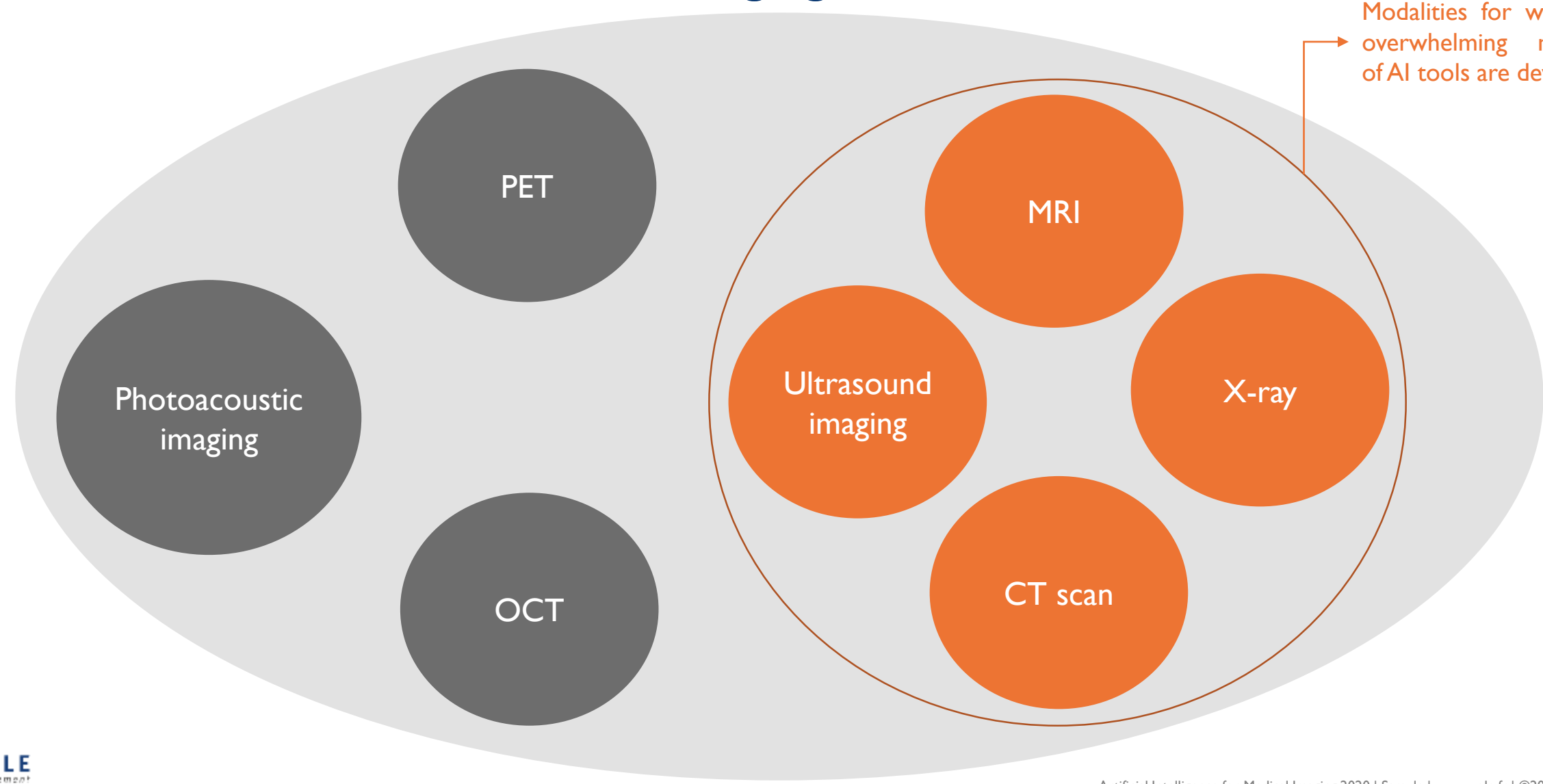
4quant, 16bit, Advantis, ai analysis inc, Aidence, Aidoc, Amazon, Aquila medical innovation, Arterys, Ascension, Avalon AI, Azmed, Balzano, Behold.ai, Blackford analysis, Brainminer, BrainScan, Butterfly network, Canon, Caption health, Carestream, Cercare medical, Circle cardiovascular imaging, Contextflow, Corindus Vascular robotics, Curacloud, Curemetrix, Deepcare, DeepMind, Deepnoid, Deepradiology, Deepwise, Densitas, Deski, Dia imaging analysis, Dr CADx, eko.ai, Enlitic, Fujifilm, GE healthcare, Gleamer, Google, Healthmyne, Hearthflow, IBM, Icometrix, Idx, Image biopsy lab, Imbio, Incepto, Infervision, Infinitt healthcare, Innovationdx, Intel, Johnson & Johnson, Kheiron medical technologies, Koios, LPixel, Lunit, maxQ, Mazor robotics, MD.ai, Medtronic, Mellanox technologies, Methinks, Microsoft, Neuropsycad, Nuance, NVidia, Optellum, Oracle, Oxipit, Perceiv.ai, Peredoc, Perspectum, Philips, Pixyl, Predible, Qmenta, Quantib, Quantitative insights, Quibim, Qure.ai, Samsung, Screenpoint, Siemens, Terarecon, Therapanacea, Therapixel, Ultromics, Verb surgical, Vida, Viz.ai, Volpara solutions, Voxelcloud, Vuno, Yitu, Zebra medical vision, and more.

REPORT SCOPE



REPORT SCOPE: MODALITIES

Medical imaging modalities

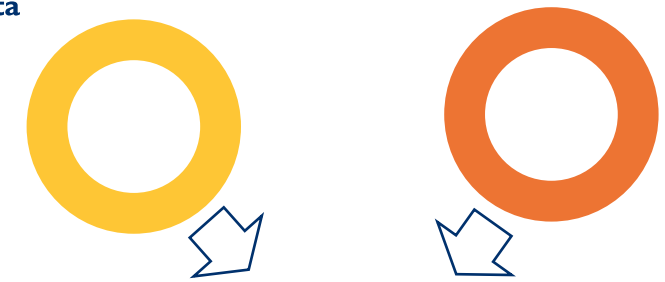


METHODOLOGIES & DEFINITIONS

Yole Développement's market forecast model is based on the matching of several sources:

Comparison with existing data
Monitoring of corporate communication
Using other market research data
Yole analysis (consensus or not)

Comparison with prior Yole reports
Recursive improvement of dataset
Customer feedback



Preexisting information

Top-to-bottom approach
Aggregate of market forecasts
@ System level

Bottom-up approach
Ecosystem analysis
Aggregate of all players' revenue
@ System level

Market
Volume (in Munits)
ASP (in $)
Revenue (in $M)

Primary data
- Reverse costing
- Patent analysis
- Annual reports
- Direct interviews

Secondary data
- Press releases
- Industry organization reports
- Conferences

Top-to-bottom approach
Aggregate of market forecast
@ Semiconductor device level

Bottom-up approach
Ecosystem analysis
Aggregate of key players' revenues
@ Semiconductor device level

Semiconductor foundry activity
Capacity investments and equipment needs

Information Aggregation

WHO SHOULD BE INTERESTED IN THIS REPORT?

Regulation agencies:

- Evaluate the market potential of future technologies and products for new applicative markets
- Identify new expectations of every player of the ecosystem
- Evaluate the growth rate of specific market

AI algorithm producer companies:

- Spot new technologies and define diversification strategies
- Position your company in the ecosystem

Insurance and medical companies:

- Understand the strategies of big players and start-ups

Marketplaces and PACS companies:

- Comprehend ecosystem dynamics
- Realize the differentiated value of your products and technologies in this market
- Identify new business opportunities and prospects

Medical device manufacturers and OEMs:

- Analyze the benefits of using these new technologies in your end-system
- Filter and select new suppliers

Financial and strategic investors:

- Grasp the potential of technologies and markets
- Acquaint yourself with key emerging companies and start-ups

ON THE ROAD TO AUTONOMOUS TREATMENT PLANNING

DATA CAPTURING

Electronical clinical report

Clinical report in paper form

DICOM files

Data management

PROCESSING

Snakes segmentation

Analytic approach

COMPUTING

Segmentation using deep learning

High speed execution

Autonomous diagnostic of the lesions

High quality/complex diagnostic

Automatization

ANALYZING

Augmented hospitals

Autonomous treatment planning

Digitalization	Standardization	Image analysis	Screening	Diagnostics	Treatment planning	Augmented hospitals and surgeons
1980	1993 DICOM standard	2000 Fast and stable snakes algorithms	2018 First deep learning products to reach the market (Idx)	TODAY 2021 Adoption of AI in standard medical analysis	>2030	

AI OVERVIEW

Machine learning is used to build a mathematical model to make predictions without any explicit conditions.

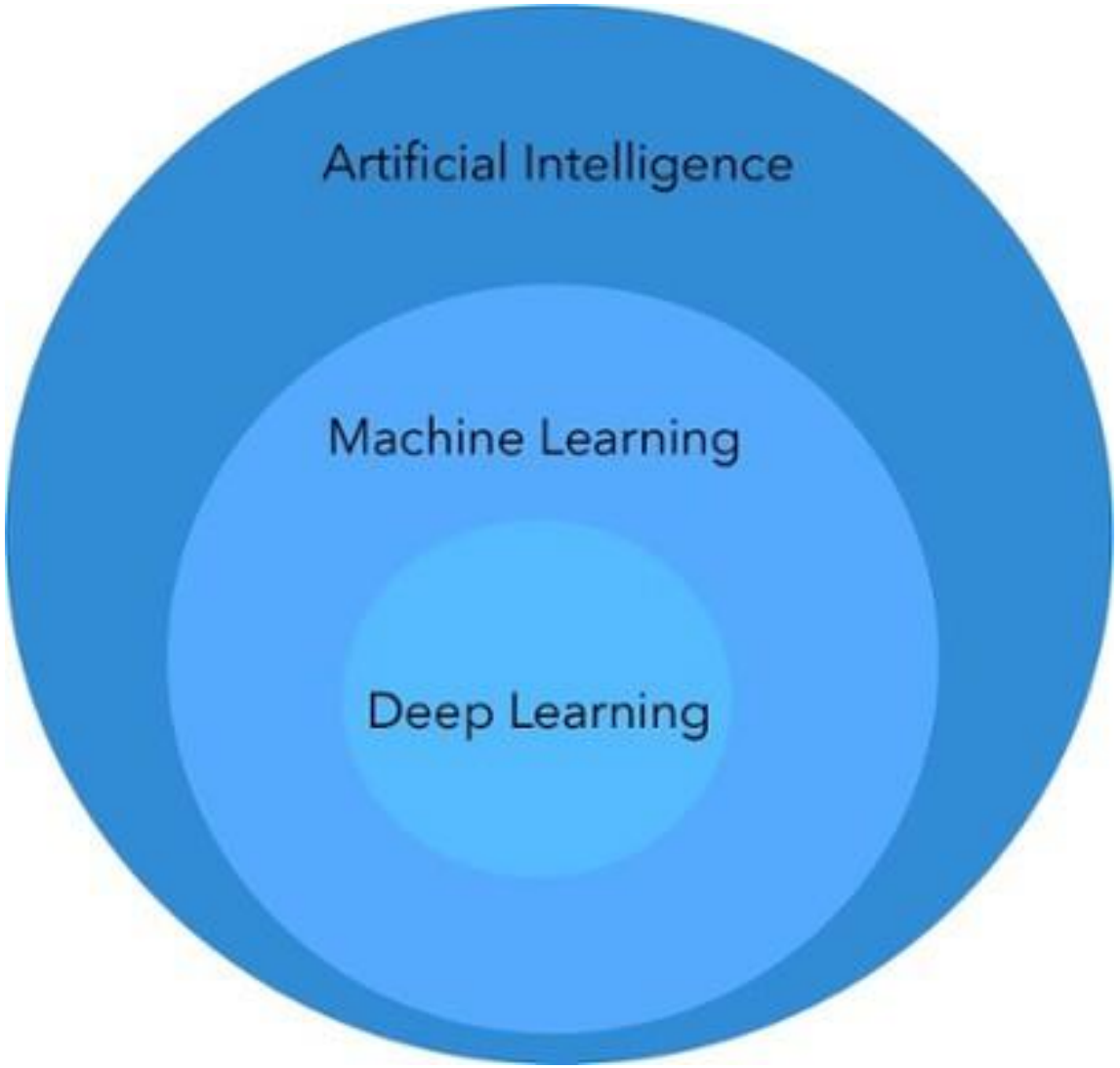
Machine learning is a **statistical model**.

Deep learning is a branch of machine learning and is based on **deep neural networks**.

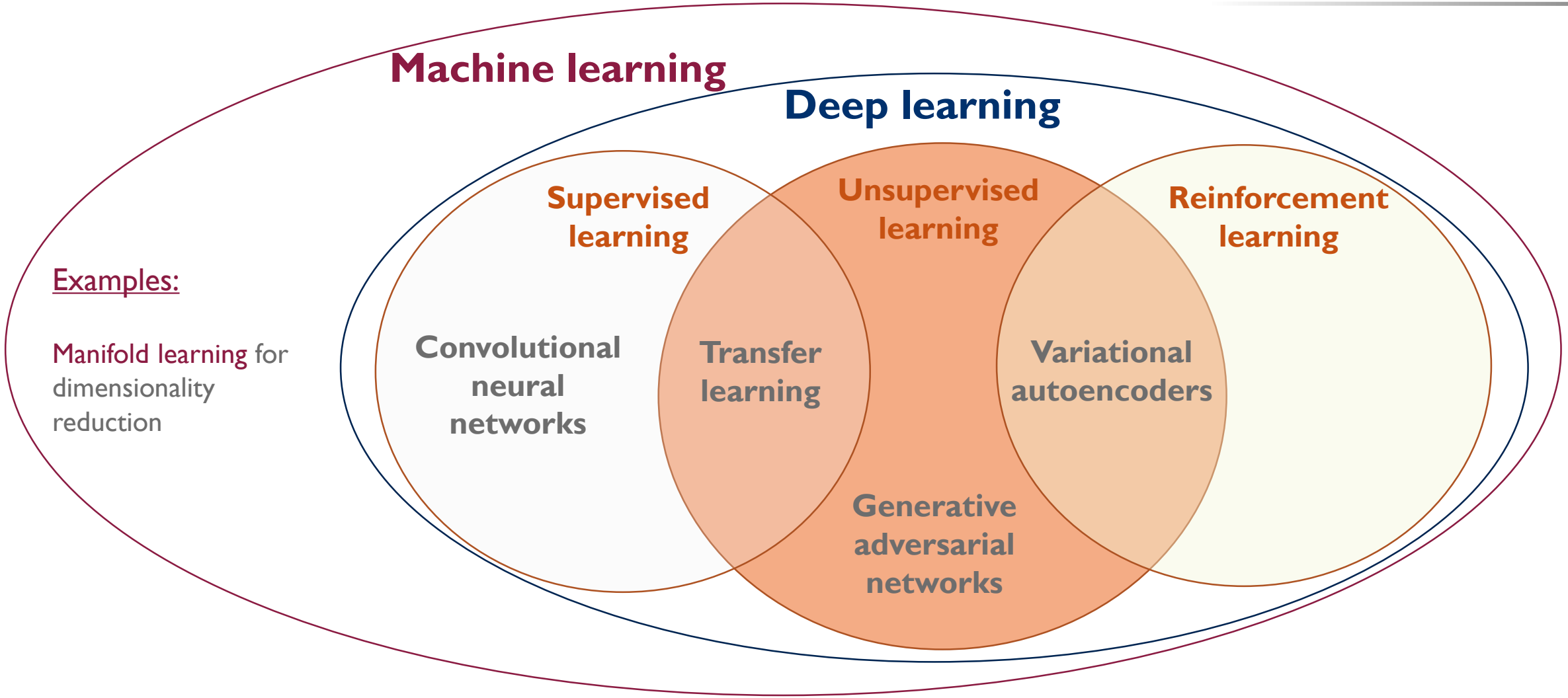
This model is mainly used in computer vision or in audio recognition.

Deep learning models get the best accuracy when applied on recognition which explains why it is used in all algorithms applied to medical imaging.

The report is focused on medical imaging. Hence to analyze companies using deep learning algorithms.



MACHINE LEARNING & DEEP LEARNING OVERVIEW



Those algorithms presented are a small part of all the developed models. Even though, in the field of medical imaging, it represents the most accurate ones.

IMAGES ACQUIRED WORLDWIDE AND APPLICATIONS FOR AI

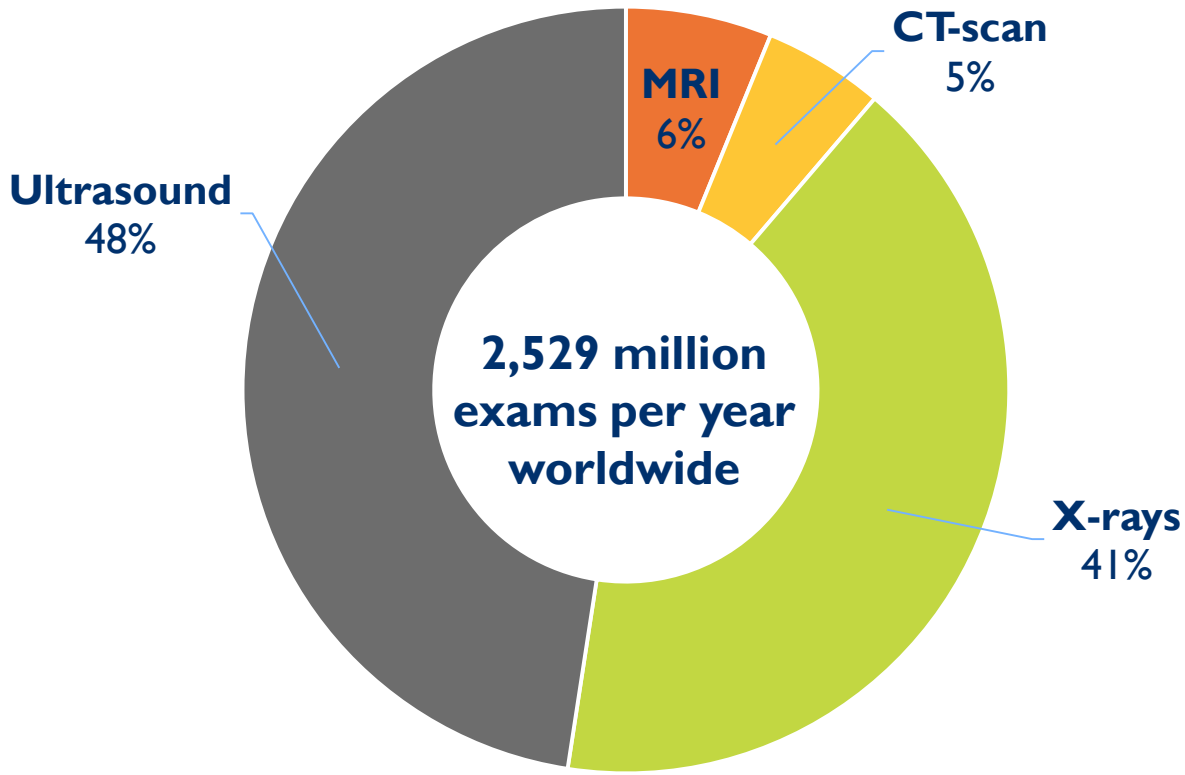
Equivalent to the acquisition of

360* **medical exams**

every second worldwide.

- Ultrasound images, even though are the most acquired ones, but are not well suited for AI analysis;
- X-rays: Highly accurate deep learning models currently limited by the difficult analysis of low contrast images;
- Deep learning technics are well adapted to MRI and CT-scan corresponding to 11% of total images acquired worldwide in 2018.

Number of exams acquired WW in million units in 2018 Per modality

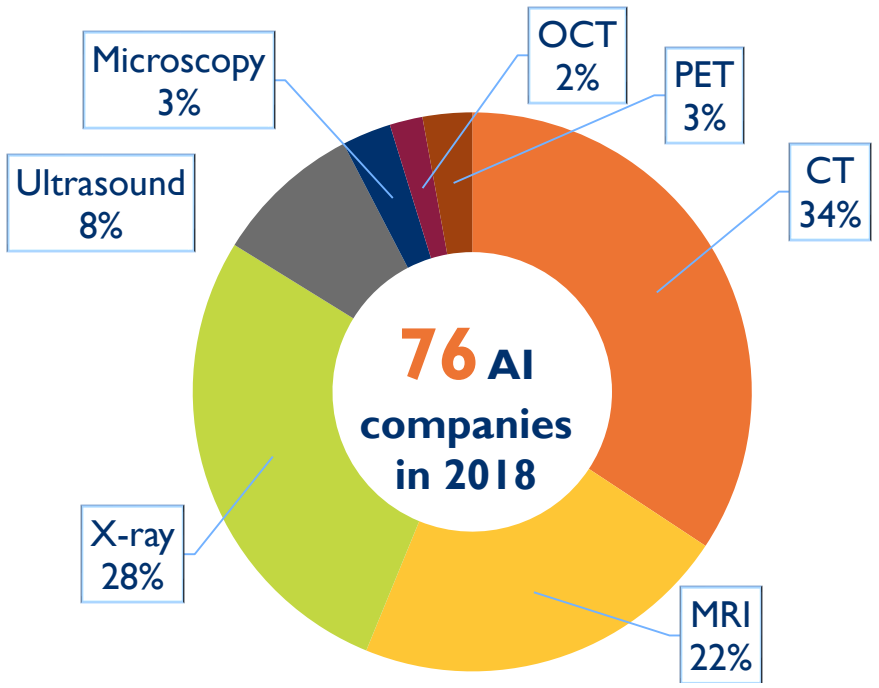


* Based on the average number of working days per year.

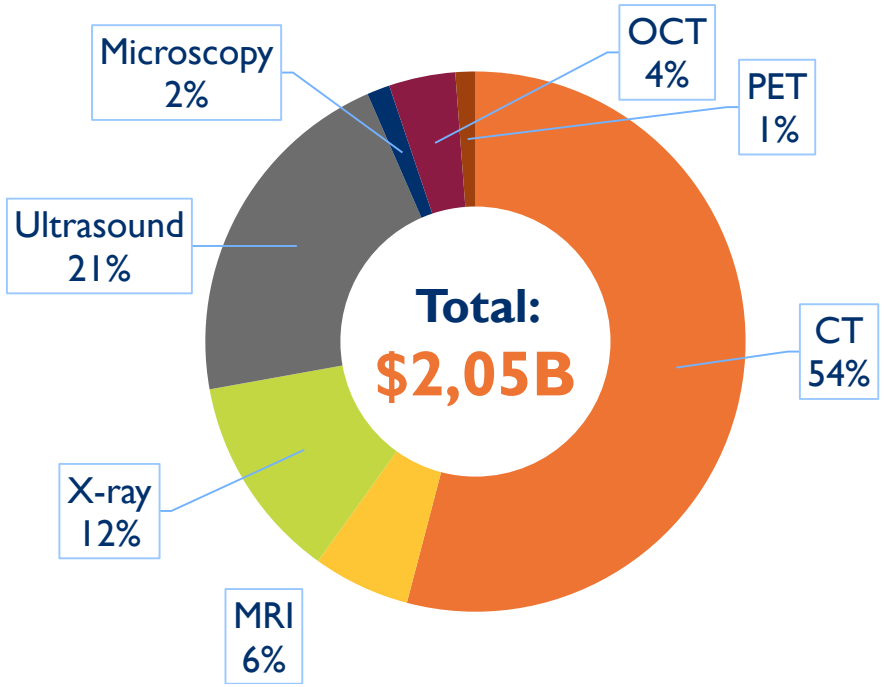
AI COMPANIES: STRONG INVESTMENTS

Where to find the investments?

Percentage of AI company per modality

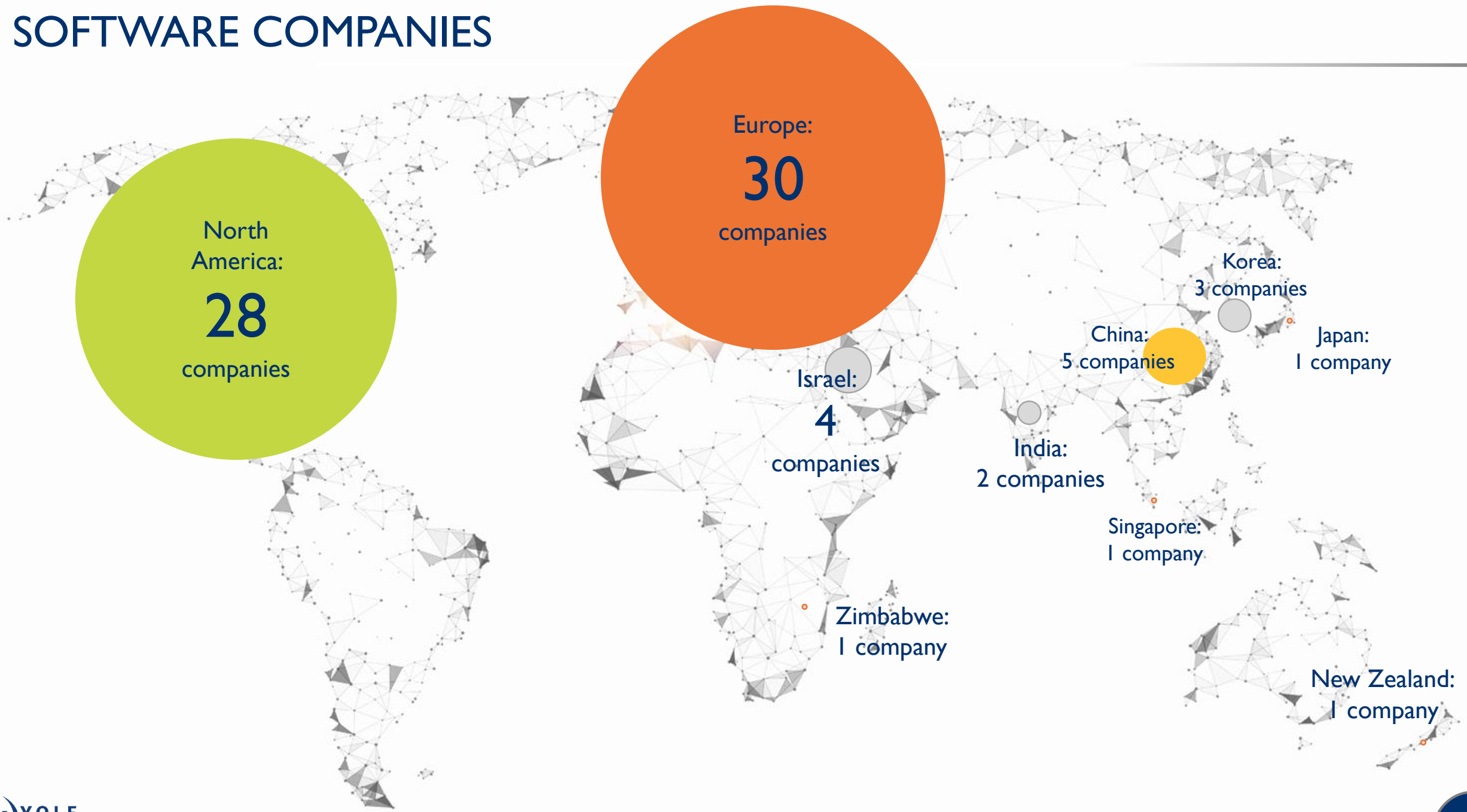


Percentage of investment per modality in AI between 2010 and 2019

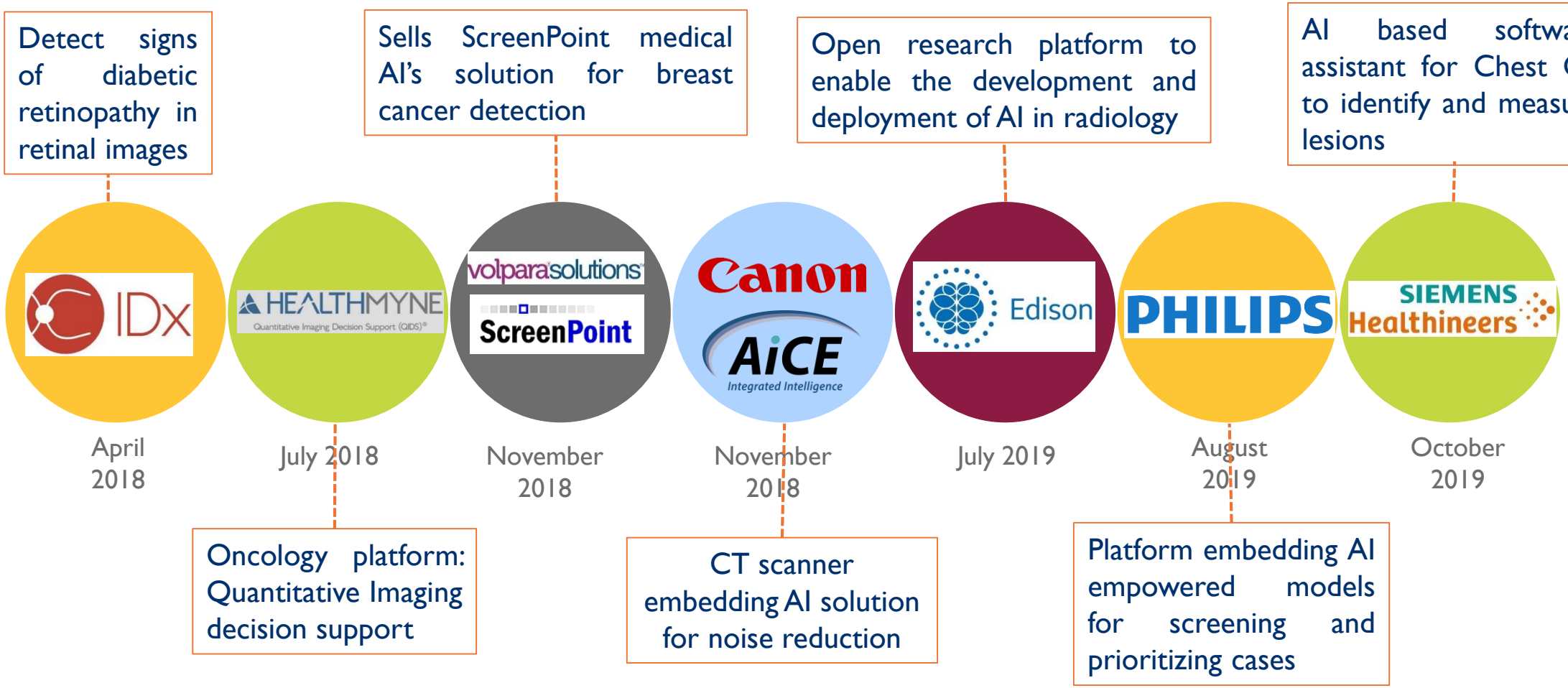


Venture capitals and medical field companies invested in new software companies developing deep learning models. This huge amount of investment highlights the enormous potential of this technology in this particular sector.

SOFTWARE COMPANIES



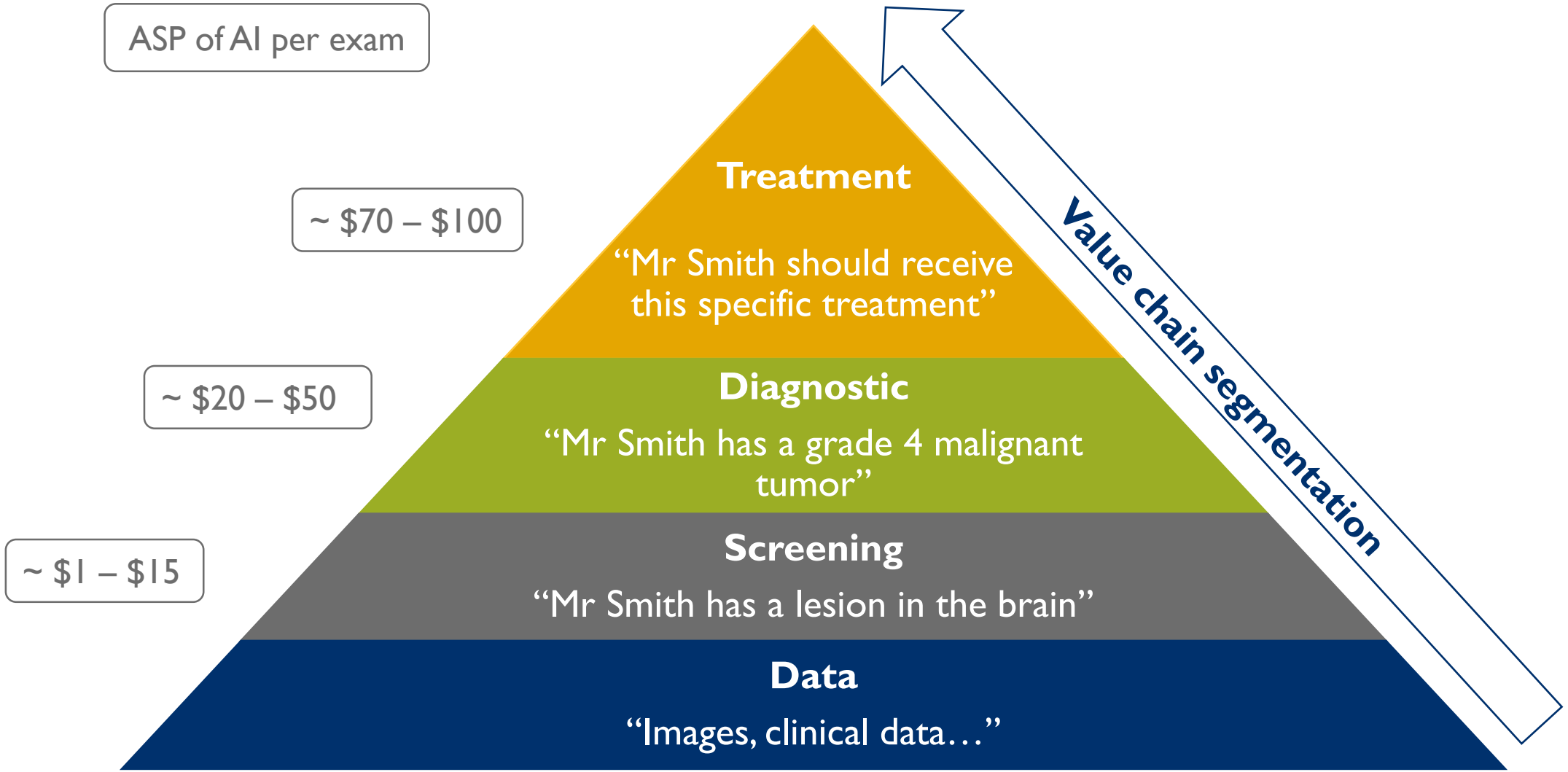
MAIN RELEASES OF AI PRODUCTS ON THE MARKET IN 2018-2019



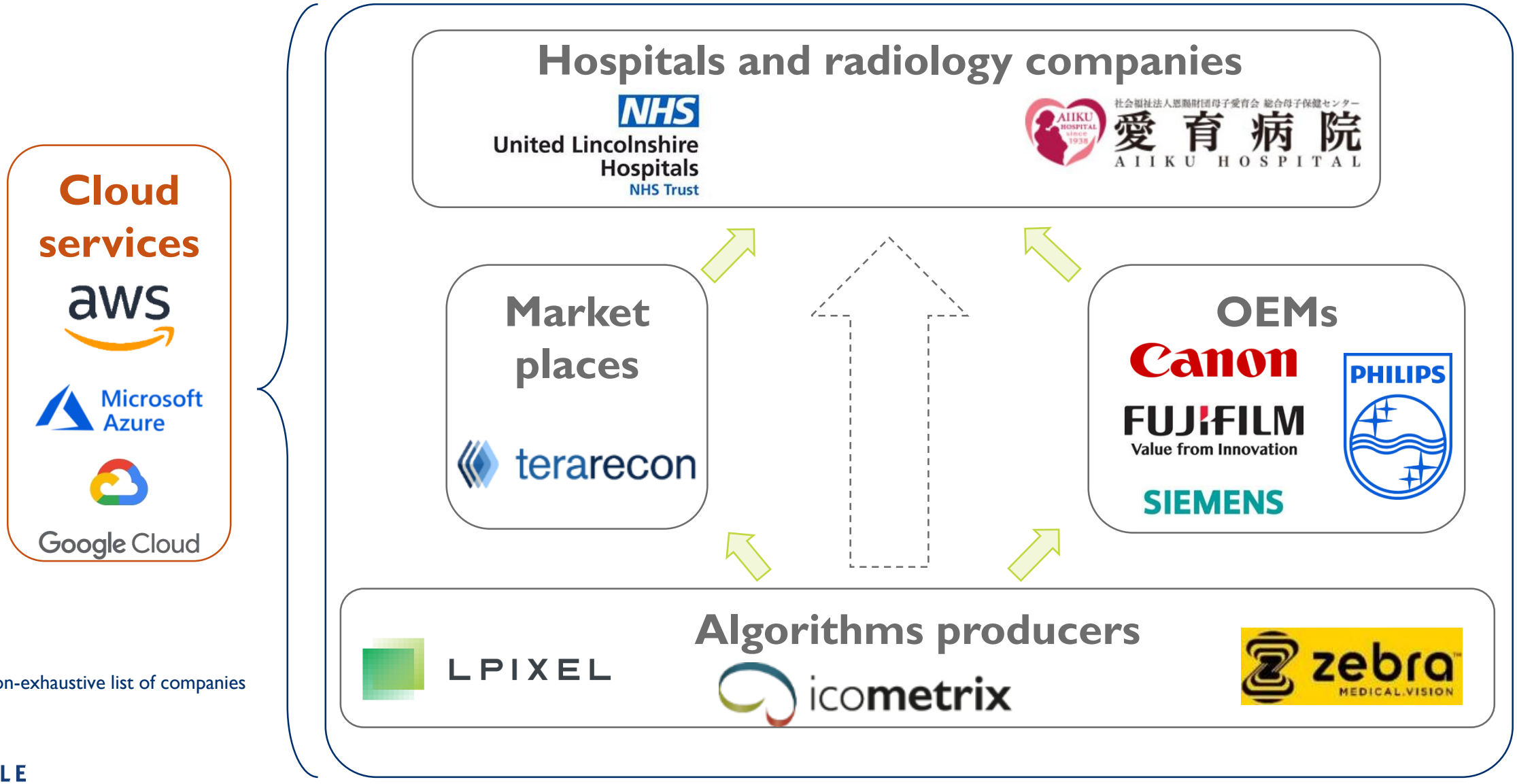
The arrival of OEMs on the AI market will boost the introduction of new tools based on deep learning.

DATA IN HEALTHCARE

The AI algorithm value chain



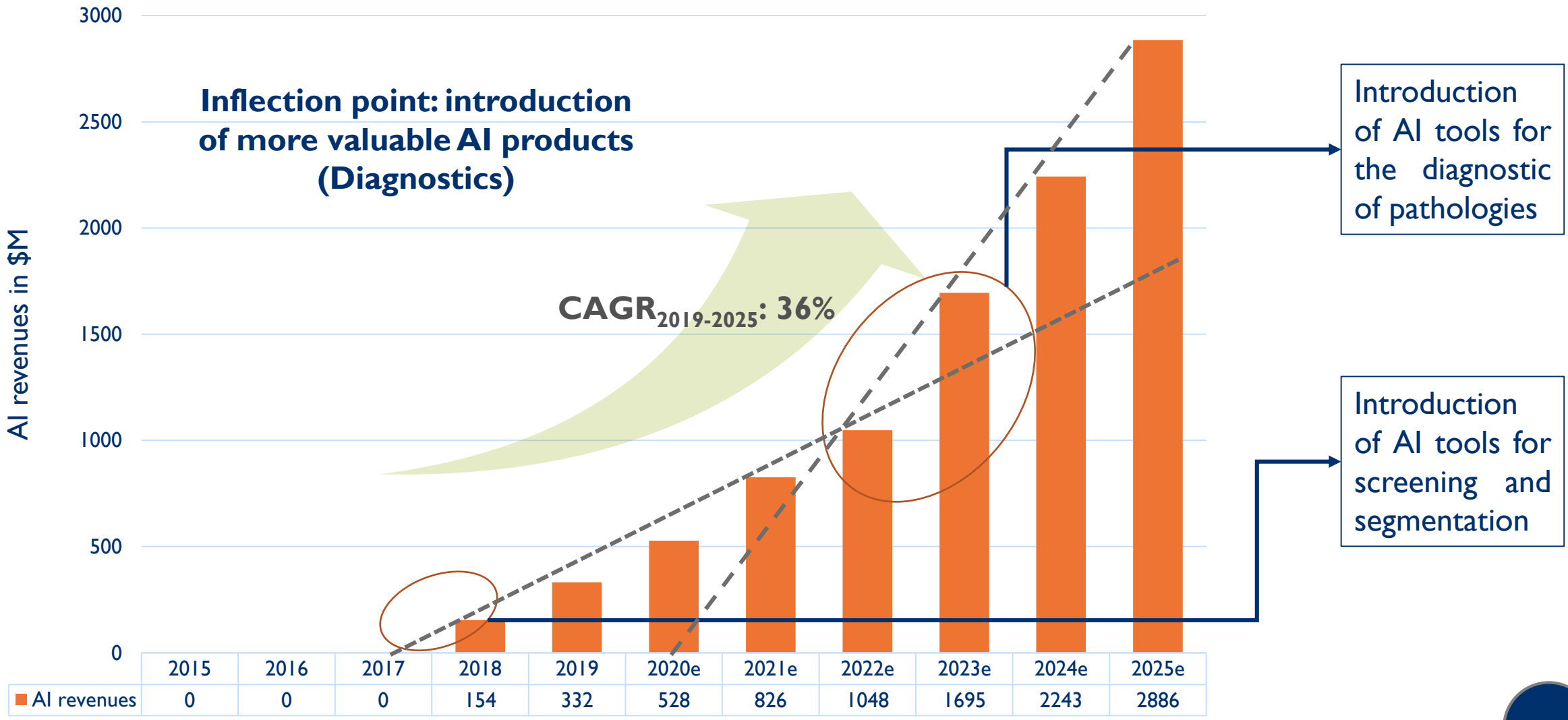
SIMPLIFIED ECOSYSTEM OF PLAYERS ENABLING THE ADOPTION OF AI IN THE MEDICAL FIELD



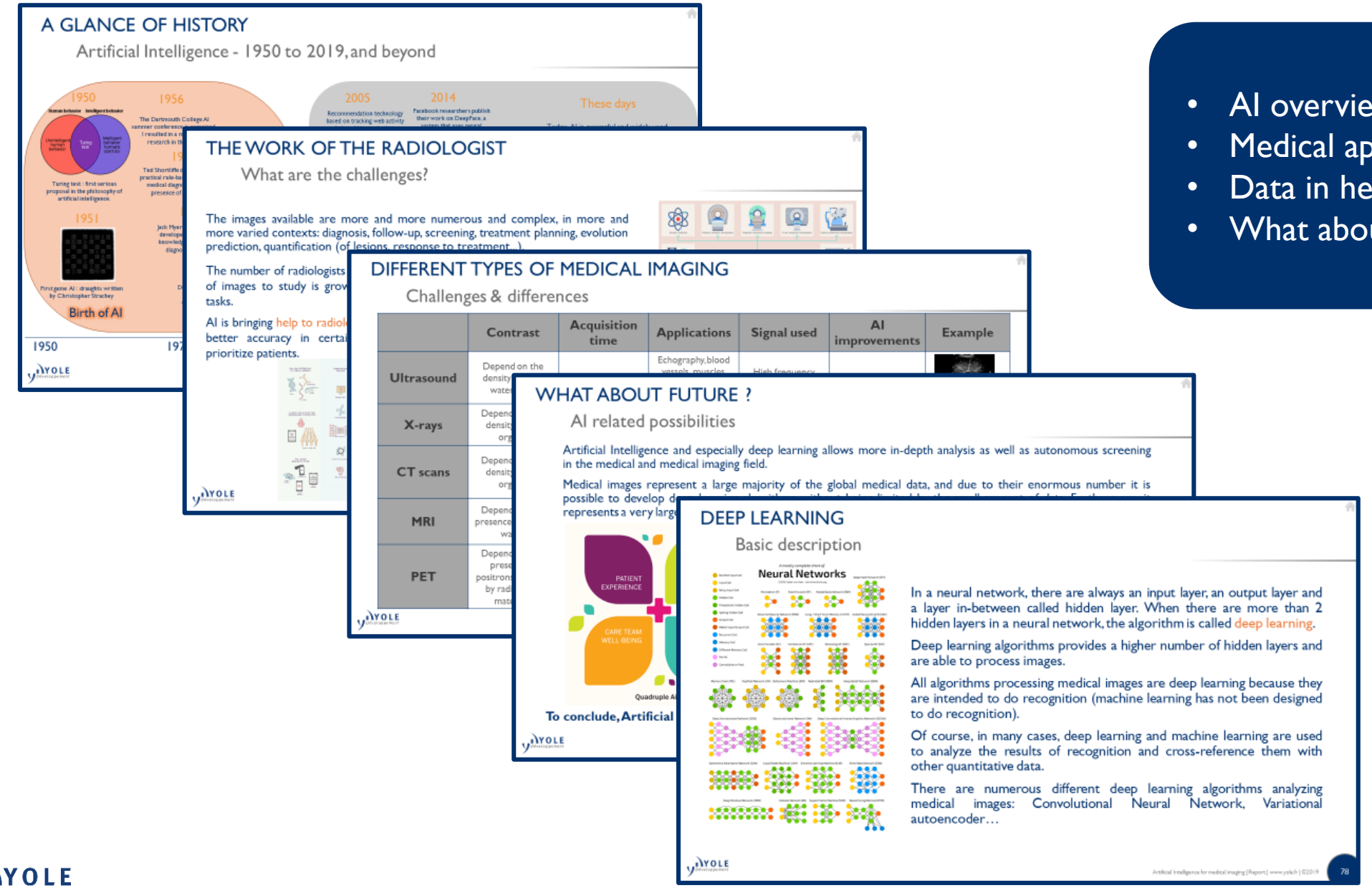
*Non-exhaustive list of companies

TOTAL AI REVENUES OF AI COMPANIES IN THE MEDICAL IMAGING FIELD

The global evolution forecasts of AI revenues for medical imaging 2015-2025

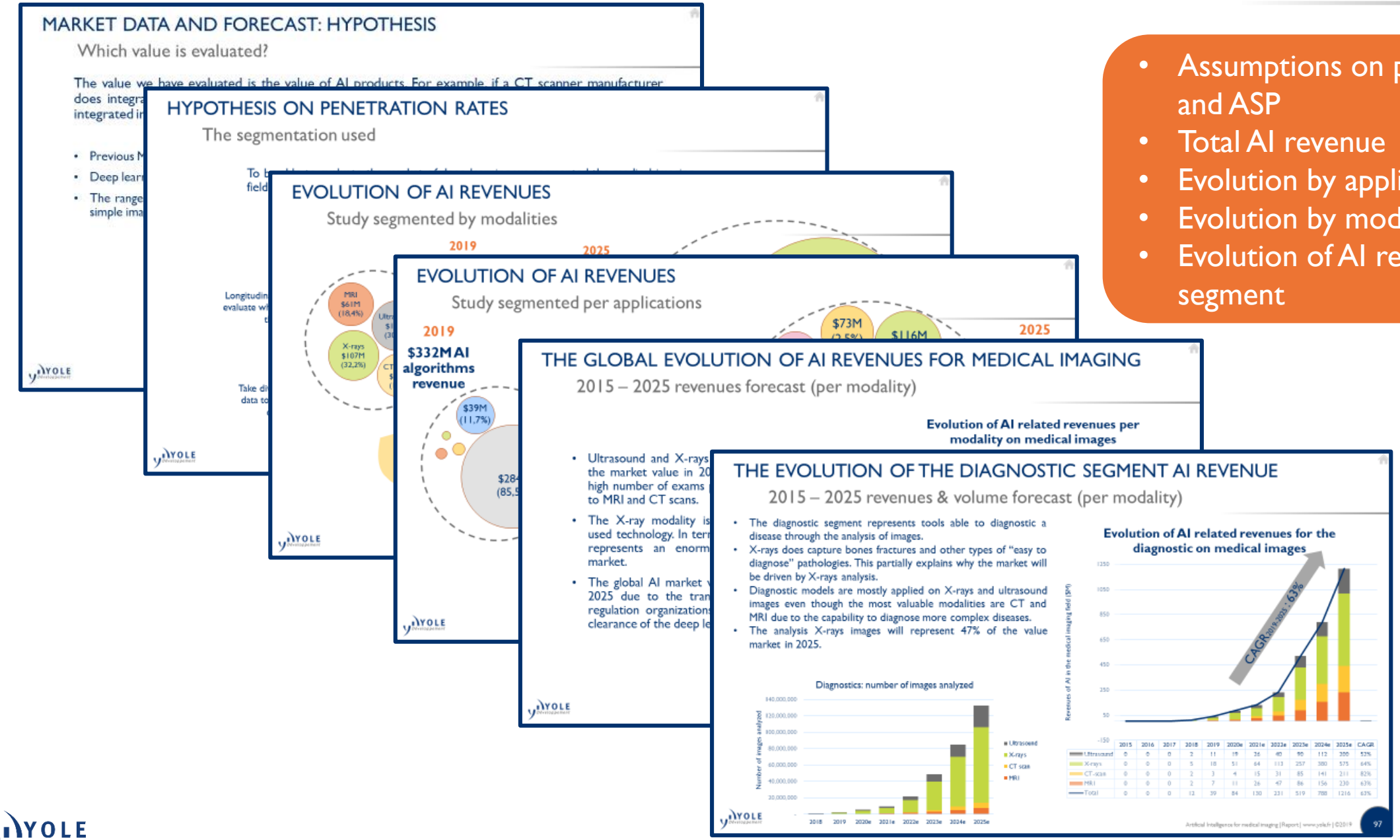


CONTEXT



- AI overview
- Medical applications
- Data in healthcare
- What about future?

MARKET FORECASTS



- Assumptions on penetration rates and ASP
- Total AI revenue
- Evolution by application
- Evolution by modality
- Evolution of AI revenues per segment

MARKET TRENDS

- AI for medical imaging: a software business
- Insurance benefits
- The regulations and constraints
- What's next

THE DATA MARKET
The strategy of major players to get data

Medical data are still interesting for marketing use.

BUSINESS MODELS OF SOFTWARE PRODUCER: A COMPLEX STRATEGY
The need for visibility

The market is not mature enough to evaluate the most profitable business models.

THE DATA MANAGEMENT FOR HOMOGENEOUS DATABASE
Teleradiology

Teleradiology is an interesting solution to manage medical data.

PACS (PICTURE ARCHIVING AND COMMUNICATION SYSTEM)
The integration of AI modules.

The integration of AI can easily be perform when using cloud technologies

THE EXAMPLE OF AN MRI EXAM
Proportion of the technical and intellectual package

Additional
Intellectual
22%
Technical fixe
78%

WHICH REGULATIONS ARE CONSTRAINTS FOR AI AND WHICH ARE NOT ?
A supervised introduction of AI on the market

Ethic

INSURANCE COMPANIES
The integration of AI into the reimbursement system

OEMs will benefit a lot from AI in 10 years by using enhanced low quality sensors.

IMPACT OF AI: ROAD TO LOW COSTS/LOW QUALITY SENSORS
How AI is changing the way data is processed?

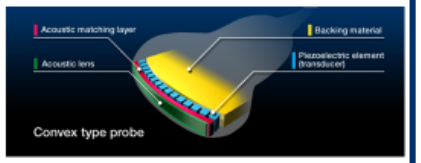
Different types of AI algorithms improve images: Preprocessing tools and post processing tools.

Preprocessing: Algorithms applied on the row data (not applied on images) → currently at a research phase.

Post processing: Algorithms applied on images. The noise reduction represents a large part of the enhancement AI could bring to medical devices → this is the case on CT scanner and Ultrasound imaging device.

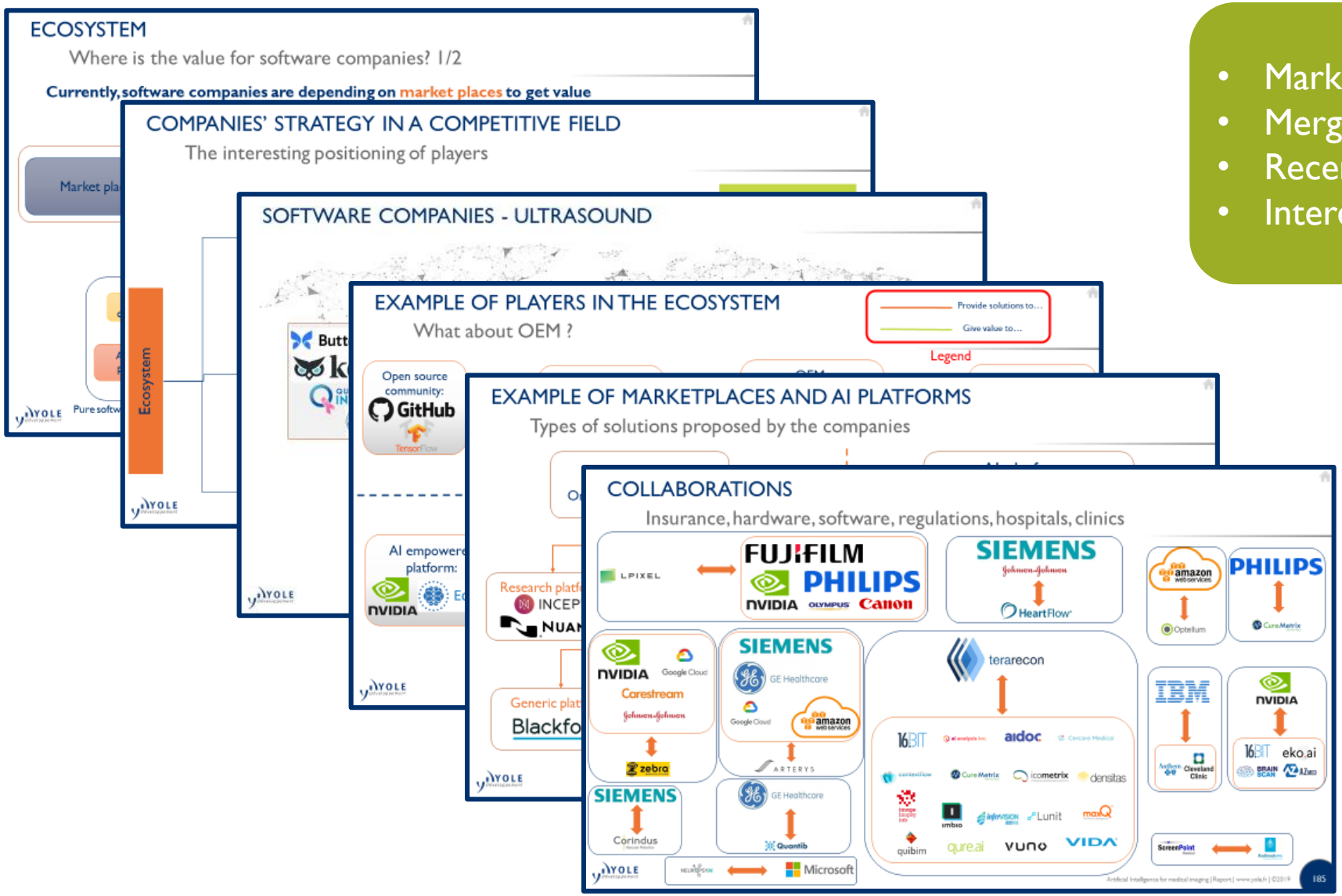
The possibility to improve the resolution, the noise presence and the sensitivity of an image enable medical device manufacturers to use low quality sensors acquiring low quality images greatly enhanced by AI tools.

Such models are currently at a research phase due to difficult implementation of reconstruction models → can we trust fully AI-reconstructed images ?



Ultrasound probe based on PZT
source: NDK

ECOSYSTEM



- Market shares
- Mergers and acquisitions
- Recent product launch
- Interesting start-ups

TECHNOLOGY TRENDS

- Why using AI
- Modality specifics
- Software development
- IT infrastructure

MRI IMAGING: HIGH QUALITY IMAGING

MRI images are the most accurate ones on the market allowing the training and the deployment of the most accurate deep learning models.

The post acqu
treatment planni
though, other app

- Faster acquisitio
- Use of lower e
- This would all
(currently distu

Currently existin

- Stabilization a
patient slight
widespread in

CT SCANS IMAGING: THE CURRENT FOCUS OF OEM

The most targeted modality for the use of AI models is currently the CT scanner.

Indeed, in the US
the development

It allows the dev
models.

Nevertheless, sor

- Possibility to pe
- Develop radi
reconstruction
- A faster acquisi
- CT spectral sc
allowing more

Current product

- AiCE Canon
radiation dose

ULTRASOUND: THE AI INTEGRATION FOR NOISE REDUCTION

The most valuable modality

- Siemens has filed numero
- The number of ultrasoun
for AI.
- Different uses of AI:
  - Row data analysis:
sensitivity of this m
  - Post acquisition: Im
pathologies.
- By combining those 2 ap
analyses in the case of a p
- A low price device will th

In terms of value
perform fast an

DEVELOPMENT RESOURCES / PARAMETRIZATION RESOURCES

Current development trends

Differe

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The AI models are relying on the quality of the images and annotations.

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ON PREMISE COMPUTING

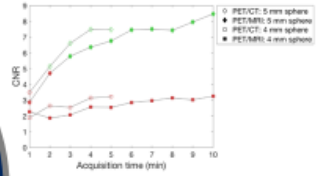
An interesting solution for hospitals

The new solutions proposed by cloud companies are improving data security.

Embedded AI could become more common in some specific situations.

MEDICAL IMAGING: CLOUD OR ON THE EDGE?

The future of medical imaging 2/2



Current cloud infrastructure:

- Execution speed does not slow the radiologist's workflow in most of the cases.
- The security of the data has been fairly regulated by the global community.
- CT, MRI does not require very high speed diagnosis since the machine captures patient's images throughout a long period.

In the following years:

- Development of cloud structures
- Use of edge solutions for data security reasons.
- Embedded AI algorithms will be developed for very high speed modalities such as ultrasound.

Cloud and on premise computing are preferred by hospitals to embedded hardware for costs reasons.

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YOLE GROUP OF COMPANIES RELATED REPORTS

Yole Développement

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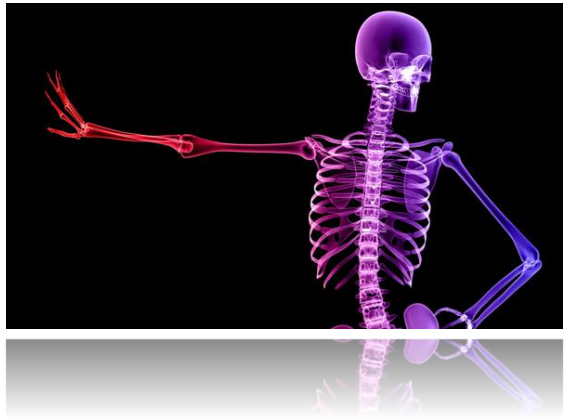
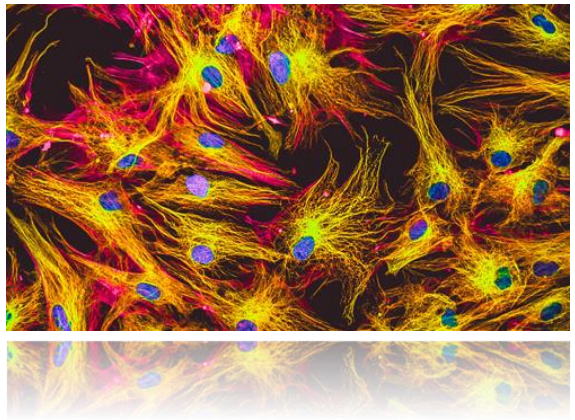
X-Ray Detectors for Medical, Industrial and Security Applications 2019



Cameras for Microscopy and Next-Generation Sequencing 2019



Artificial Intelligence Computing for Consumer 2019

Artificial Intelligence Computing for Automotive 2019

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Artificial Intelligence in Medical Diagnostics – Patent landscape analysis 2019

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