Use cases of AI in Medical Imaging

The Startup

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Outline

- Introduction – what is different in a Start Up
- Use cases
- Wrap-up
What is different in Starting-Up: MISSION

- Mission defines a culture in the organization and a field of development
- Not to overlook or consider an unnecessary marketing ploy
- Mission and vision are very different, do not use interchangeably
- Lay language, atemporal, showing the impact in the end-beneficiary
- Frequent temptations to work ‘out of mission’ because of revenue

**QUIBIM’s mission**: “Improve humans health by applying advanced and innovative medical image processing techniques to radiological images in order to detect the alterations produced by diseases and drugs in the body.”
Introduction

Medical Imaging AI Startups

**General Imaging**
- 4Quant
- 12Sigma
- 16NT
- Advenio
- Aidoc
- Aidence
- Artery
- Balzano
- Behold.ai
- Blackford
- CeraCloud
- Contextflow
- DeepCare
- DeepRadiology
- Enlitic
- Ilumina
- Imagia
- ImageAnalysis
- Innovationex
- Imagen
- Lunit
- LPixel
- Oxipit
- PereDoc
- Perspectum
- Predible
- Qubim
- Qure.ai
- VoleCloud
- Vuno
- Zebra

**Cardiovascular Imaging**
- BayLabs
- CORSTEM
- Circle
- Diligent
- Elsner
- HeartFlow
- Ultromics

**Lung Imaging**
- Diascan
- Dr CADx
- HealthMyne
- Imbio
- Optellum
- RadLogics
- Thirona
- Vida

**Neurological Imaging**
- Advantis
- AI Analysis Inc.
- Avalon
- Brainminer
- Brainomix
- Cercare Medical
- Combinotics
- CorticoMetrix
- Cometrix
- RAPID
- Schemax
- Qmenta
- Quantib
- Viz

**Breast Imaging**
- CureMetrix
- Densitas
- Koios
- ScreenPoint Medical
- Volarisolutions

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Most Funded Medical Imaging AI Startups

- Infervision
- Deepwise
- Zebra Medical Vision
- Artery
- 12 SIGMA
- VoxelCloud
- Viz.ai
- HealthMyne
- Imagen
- Circle Cardiovascular
- Brainomix
- Huiyi Hui Ying
- MaxD-AI
- Bay Labs
- Vuno
- Enlitic
- Aidoc
- Lpixel
- ScreenPoint Medical
- Qvii Medical
- Blackford Analysis
- SigTuple
- Lunit
- Image Analysis
- DIA Image Analysis

Total Amount Raised ($m)
Introduction

Start-up funding strategies

• Focused on revenues and break-event: Independent and organic growth company.
  
  Risk of being a services company

• Focused on value generation: Dependent on fundraising and exponential growth.

  Risk of bubble

• Focused on revenues + break-event while increasing value: Combined model relying on initial fundraising till break event.

  Minimum risk zone for AI companies
Introduction

Market Evolution

- The market is in the innovator/early adopter phase and several barriers need to be overcome (see slide 9) before the transition to the mainstream market.
- The market is heterogeneous in nature, comprising many clinical applications with individual requirements.
- Partnerships are essential to create end-to-end solutions for the mainstream market that meet the needs of most radiologists. No company can do it alone.

* Some non-AI quantitative imaging tools, e.g., perfusion analysis, have transitioned to mainstream.
** Breast CAE has transitioned to mainstream in the US, but not in other regions.
Pains in which QUIBIM is focused:

- **Lack of standardized process**: No consensus on acquisition methods and image processing steps for the extraction of quantitative data.

- **Lack of use of quantitative imaging and AI**: There are lots of research in medical image processing and AI but still there has been no impact in radiological workflow.

- **Chicken & egg problem**: Clinicians not trusting quantitative radiology and radiomics because lack of validation results in large datasets (precision and accuracy). Quantitative imaging vs clinical endpoints.

- **Lack of recognition**: Patients don’t understand the radiology reports and don’t know what a radiologist exactly is.
Introduction

Pains in which QUIBIM is focused:

• **Lack of standardized process:** Use of stepwise methodology for new imaging biomarkers development and qualification.

• **Lack of use of quantitative imaging and AI:** propose a multi-vendor, multi-purpose seamless solution

• **Chicken & egg problem:** intuitive generation of analysis results, linking them to clinical endpoints and patient outcome

• **Lack of recognition:** simplifying and standardizing radiology output (beyond images) interpretation for clinicians and patients (inspired by blood tests)
• Can we do it now?

**Challenge 1:** Sort chest X-rays to be reported by the degree of abnormal findings, provided by an AI algorithm embedded in PACS/RIS

**Challenge 2:** Open a MR prostate cancer case for reporting and already having the target lesion segmented with all features extracted (Diffusion, Perfusion and textures), generating a draft PI-RADSv2 report

**Challenge 3:** Search in our PACS or IT system for cases with a CT-derived emphysema percentage higher than 10% to include them in a clinical trial for COPD
Use cases

• **Lack of reproducibility**: Different quantitative results in workstations from different vendors using the same case

• **Lack of knowledge**: For most imaging biomarkers, we still do not know the relationship with clinical endpoints at a large scale (diagnostic, prognostic, treatment response)

• **Lack of IT integration**: Lots of research, AI algorithms and start-up companies but few real embedded in radiology workflow
Use cases
Use cases

• ‘Seamless’ integration:

1. Cases are retrieved from the PACS automatically by pre-defined rules (i.e. StudyDescription) at specific times (i.e. night?)

2. Pre-computing: A.I. models or automated image analysis ‘pipelines’ start execution upon reception if there is a positive match

3. Results are generated and sent back to PACS in order to be ready before radiological reading

4. Although all the process is completely automated, technicians or radiologists can also launch new analysis manually at any time
Bottlenecks of conventional image analysis:

1. Need for manual delineation of regions of interest (ROI)
2. Lack of help in data interpretation (lack of decision support)
Use case I: Automated region segmentation
**Use case I:** Automated region segmentation in prostate cancer workflow

### Source images
- **T2w**
- **DWI**
- **DCE-MRI**

### Segmentation
- **Organ extraction**
- **Clustering**
- **Nosological image**

### Feature
- **Volume/Shape features**
- **Histogram features**
- **Texture Features**

### Data integration
- **Clinical**
- **Genomic**
- **Metabolomic**

### Data mining
- **Radiogenomics**
- **Predictive/prognostic models**
- **Diagnostic models**
Use case I: Automated region segmentation in prostate cancer workflow

AI deep supervision segmentation (real time video)

Human segmentation (x10 accelerated)
Use case I: Automated region segmentation in prostate cancer workflow

• Non-supervised AI clustering
Use case I: Automated region segmentation in prostate cancer workflow

- Pathology
- PI-RADS
- Nosologic map

Nosologic map
(No human involved)
Use case I: Automated region segmentation in other regions

• MR liver segmentation in diffuse liver diseases
Use case I: Automated region segmentation in other regions

- Automated vertebra detection and bone analysis
Use case II: classification and decision support

Chest X-ray abnormality (own data and NIH database)

Abnormal Probability: 0.87

CNN Classifiers

Weighing
Fully Connected
Network

Abnormal Probability: 0.53
Use case II: classification and decision support

Chest X-ray pneumonia detection (RSNA challenge)

- Blue Boxes → Ground Truth (Segmented by an expert radiologist)
- Red Boxes → Artificial Intelligence Predictions
It is possible to overcome the lack of integration with innovative platforms provided by start-ups covering the requirements for management of AI algorithms and quantitative data.

This is the key to increase our knowledge in:

- Relationship between quantitative imaging biomarkers and Clinical Endpoints
- Precision and accuracy of algorithms and software from vendors
SYMBIOSIS of RADIOLGY & AI

MACHINE LEARNING SHOWCASE
North Level 3 - 7367G