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Milano

17 GIUGNO 2024

Conversations with an AI gynecologist: design of an explainable medical decision support tool

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It’s me, hi!

Former neuroscientist 🐭
Former ML specialist
Former R&D in Computer Vision
Current CTO @ SynDiag

I like:

- Ops (any ops!)
- Cloud
- Iterations

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A few facts about SynDiag:

Launched in 2018
3 founders
9 people
PoliTO Spin Off
5 IPs protected in 5+ countries
2 products
1.7M raised in 2023

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AI in Healthcare:

Imaging and Diagnostics
Predictive Analytics
Personalized Medicine
Virtual Health Assistants
Administrative Workflow
Remote Monitoring
Clinical Decision Support
…

Goals:

Efficacy and accuracy
Efficiency and costs reduction
Personalized care
Discovering new patterns
…

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Types of AI in Healthcare

Machine Learning (ML)
Deep Learning (DL)
The new wave: foundation models/ large language models/ generative AI for fully anonymized data

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SynDiag
United against ovarian cancer.

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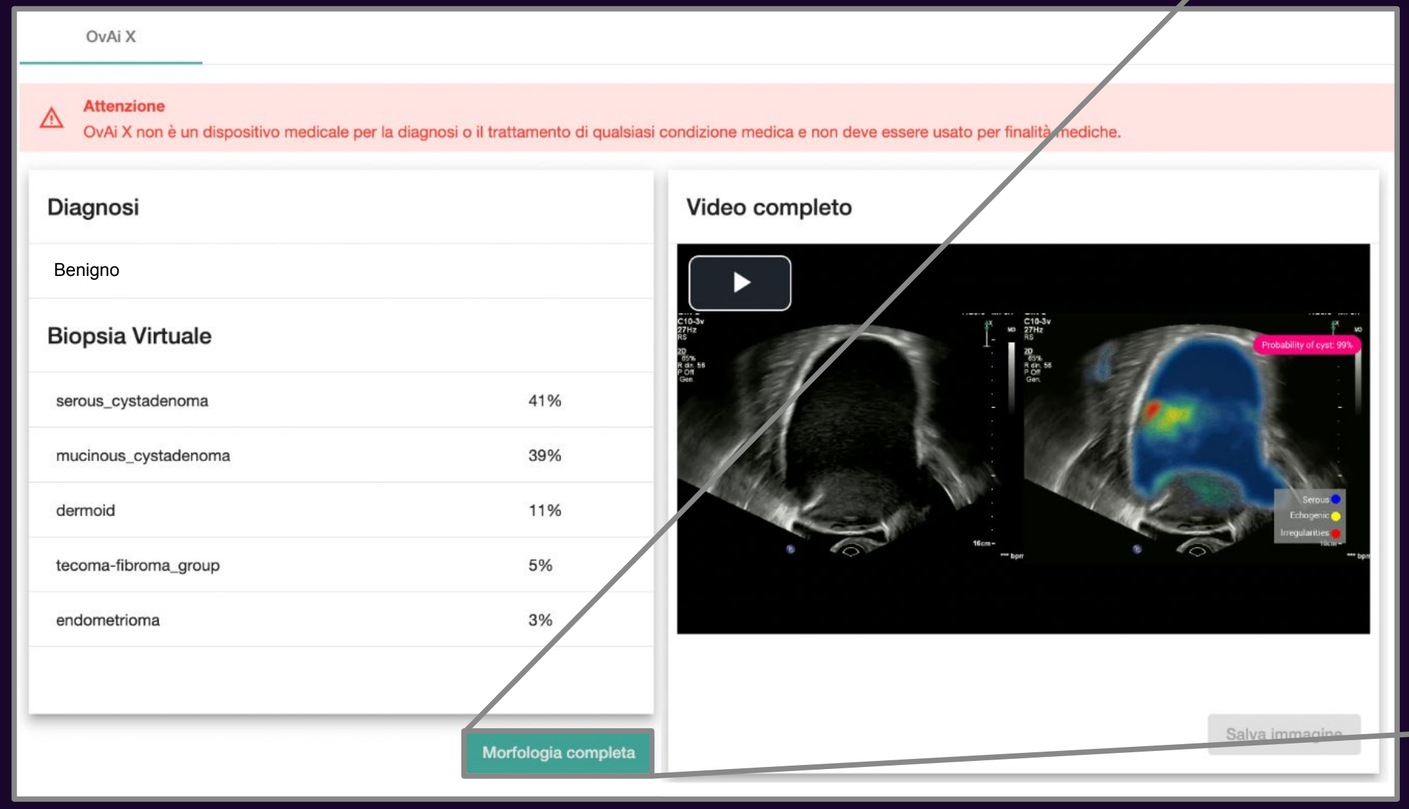
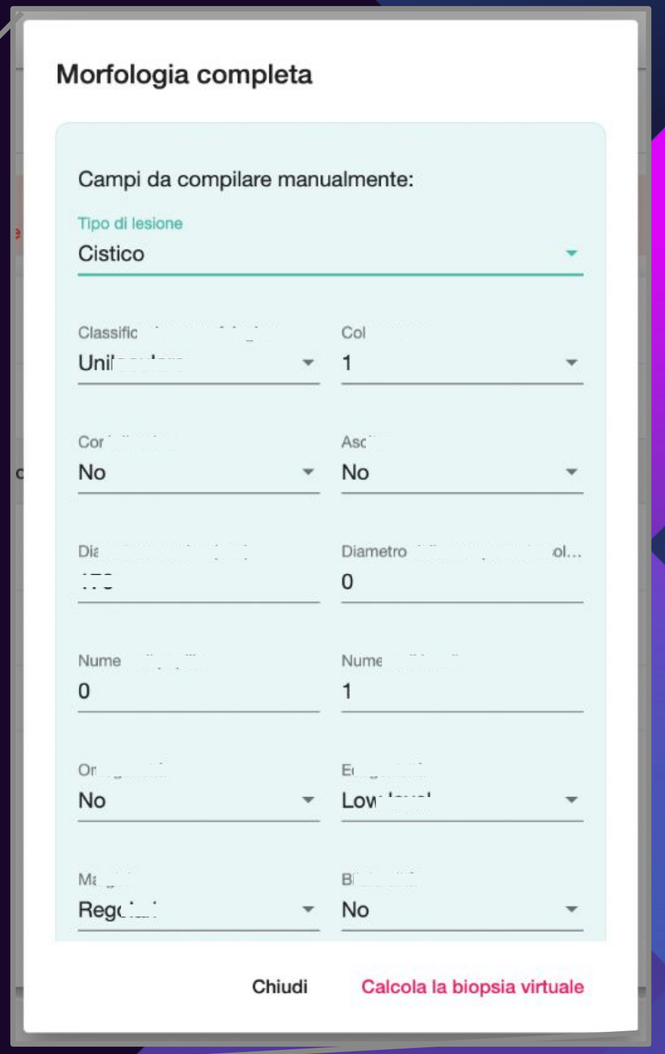
OvAi case study





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OvAi case study:

Diagnostic support for gynecological tumors

Visual tumor description

Diagnostic suggestion

Printable ultrasound report

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OvAi case study

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Main features of OvAi:

Transparency
Modularity

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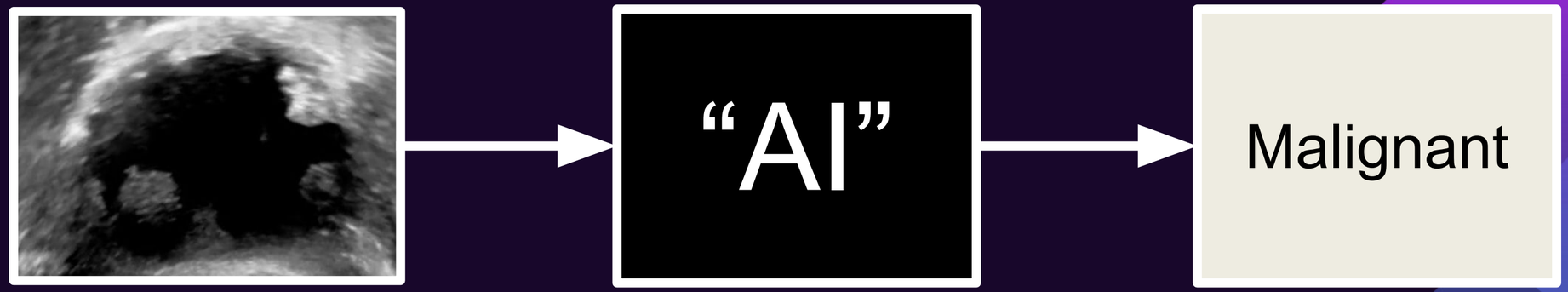
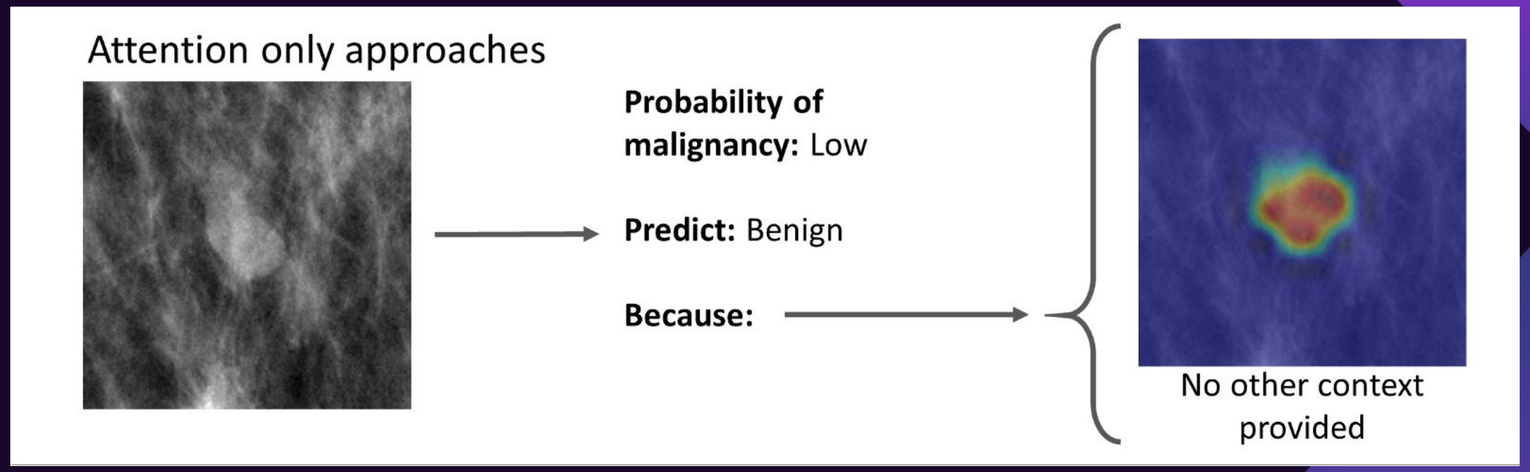
Transparency by design



Transparency by design

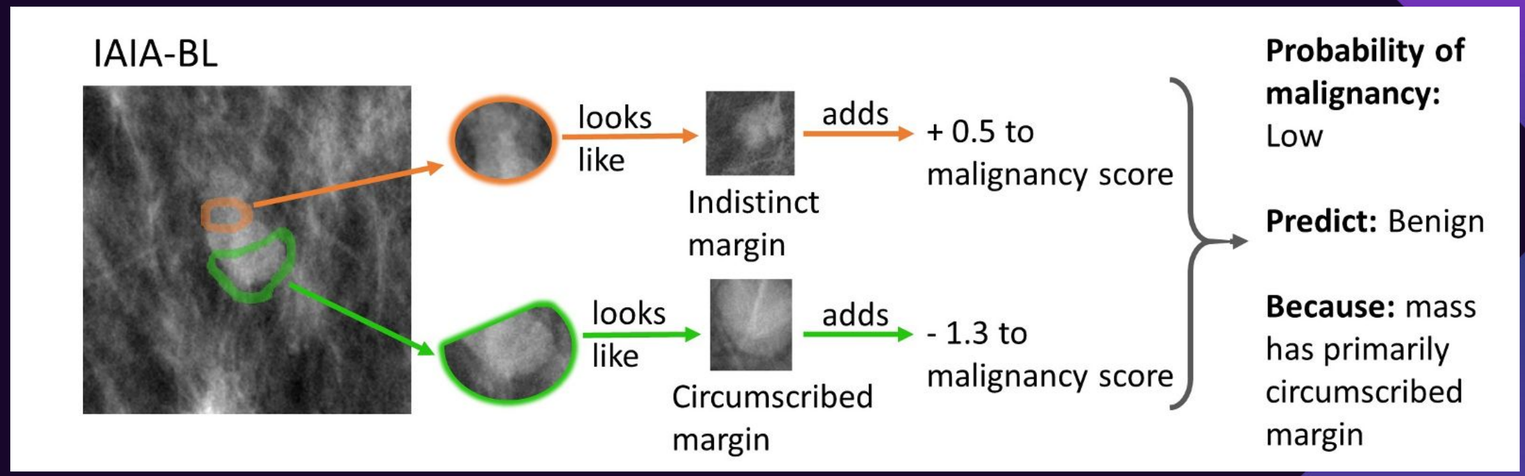
Limits of XAI (es. GradCam)



Citation

Transparency by design

The importance of domain knowledge



Citation

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Transparency by design

Real Data

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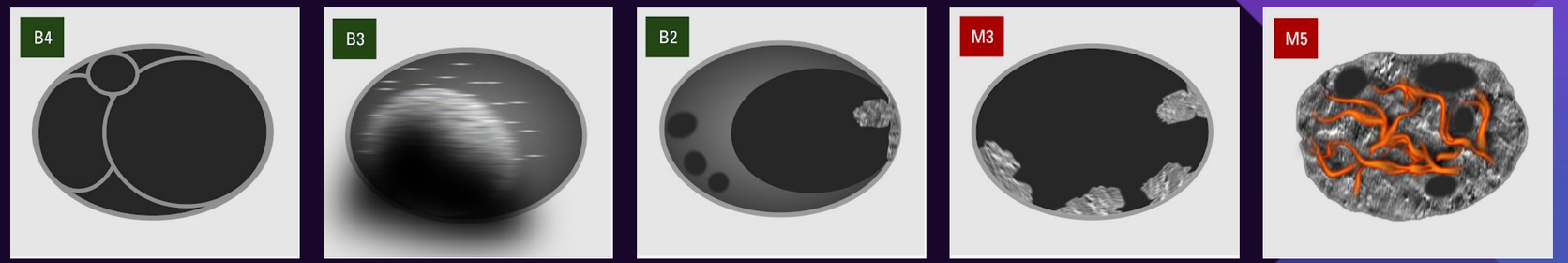
Transparency by design

Real Data

Official diagnostic guidelines



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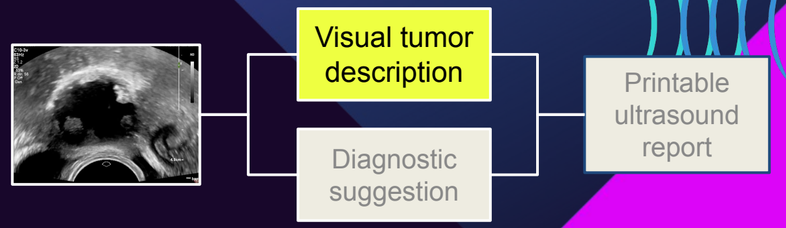
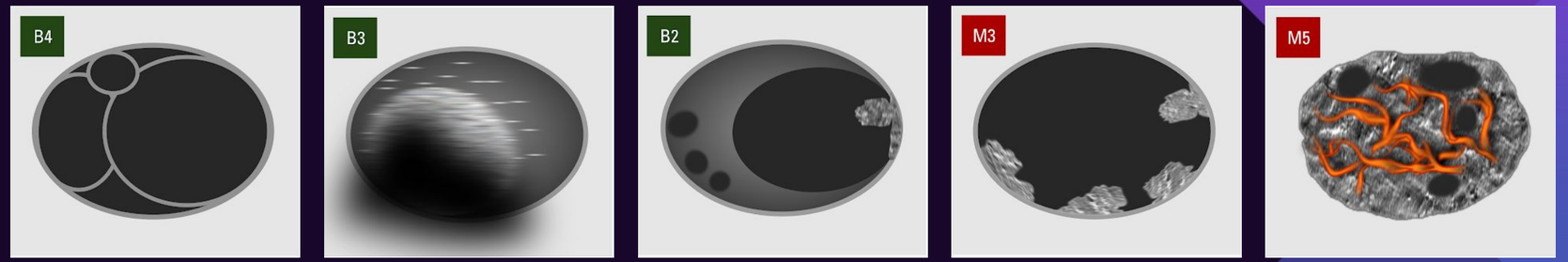


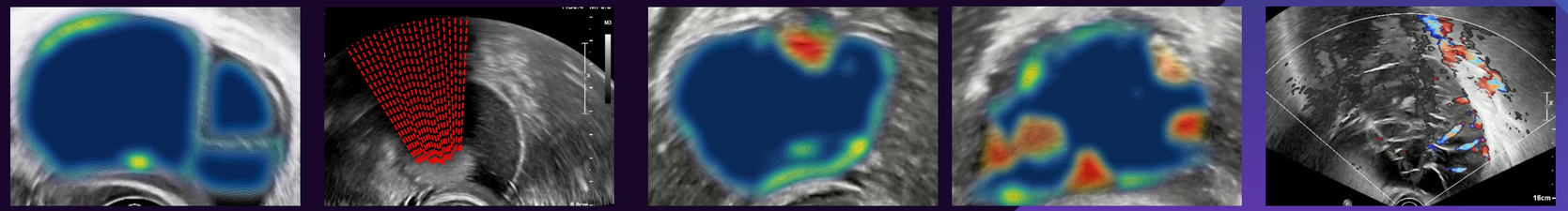
Transparency by design

Real Data

Official diagnostic guidelines



OvAi Explainable output



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Pillars of responsible AI

- Privacy and security
- Fairness and inclusion
- Robustness and safety
- Transparency and control
- Accountability and governance

Summary from Meta, Microsoft, Google, IBM, OpenAI, AWS resources

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Modularity in OvAi

ROI detection	Diagnostic class suggestion
Visual description	Tumor identification

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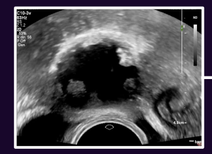
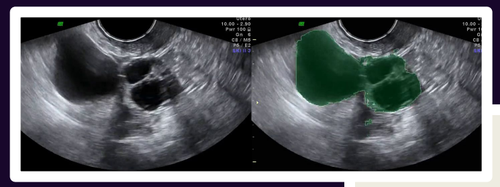


Visual tumor description

Diagnostic suggestion

Printable ultrasound report

Modularity in OvAi

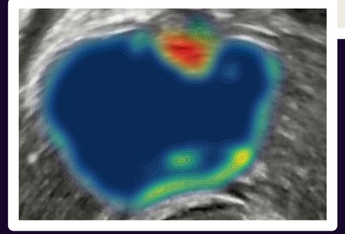


ROI detection

Diagnostic class suggestion

Benign vs Malignant

Visual description



Tumor identification

Mucinous Cystadenoma

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Modularity in OvAi

Pros:

- Specific tasks and technologies
- Work with limited resources
- Reuse modules
- Regulatory requirements

Cons:

- Integration
- Overall performance
- Maintenance
- Coupling

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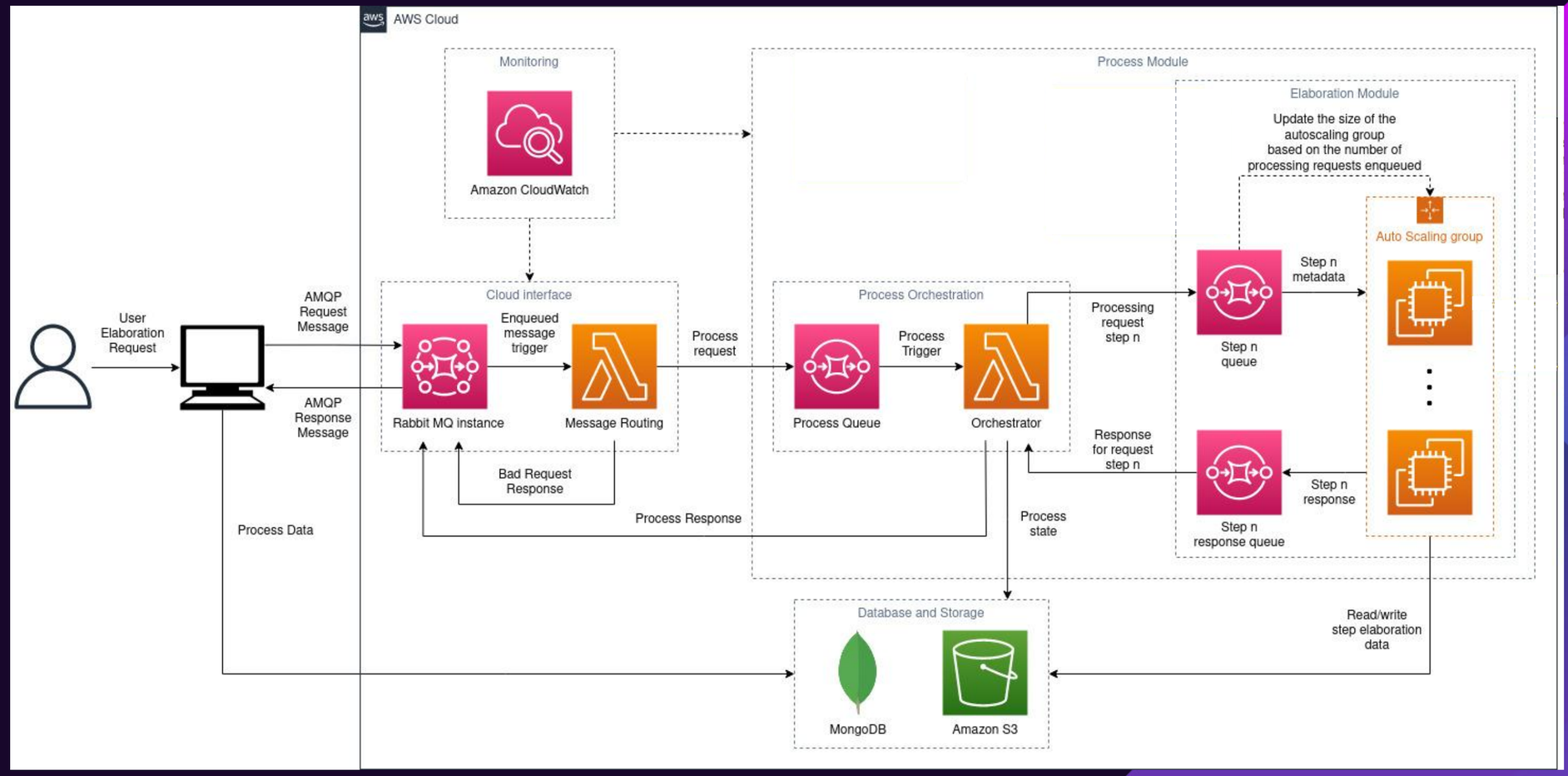
Product architecture



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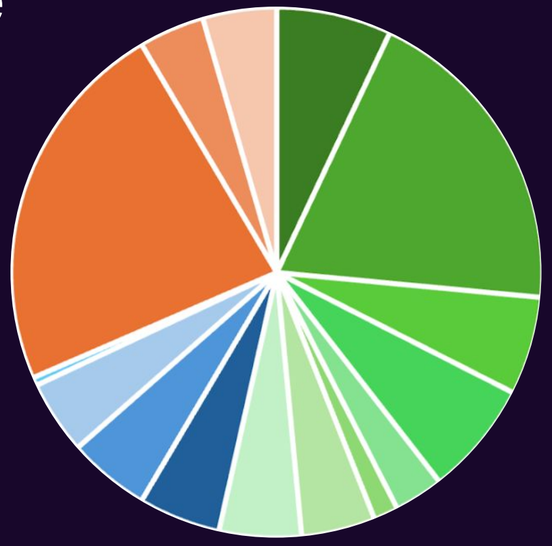
Used dataset:

~800 clinical cases from 7 hospital partners
55% benign, 33% malignant, 12% BOT cases
~5 videos, ~6 images per case
15 histotypes



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Solution development

- Python/ TensorFlow, PyTorch, Scikit-learn
- Algorithms: UNet, CNN, random forest, …
- Cross validation on AWS batch
- Gitlab, Weight&Biases

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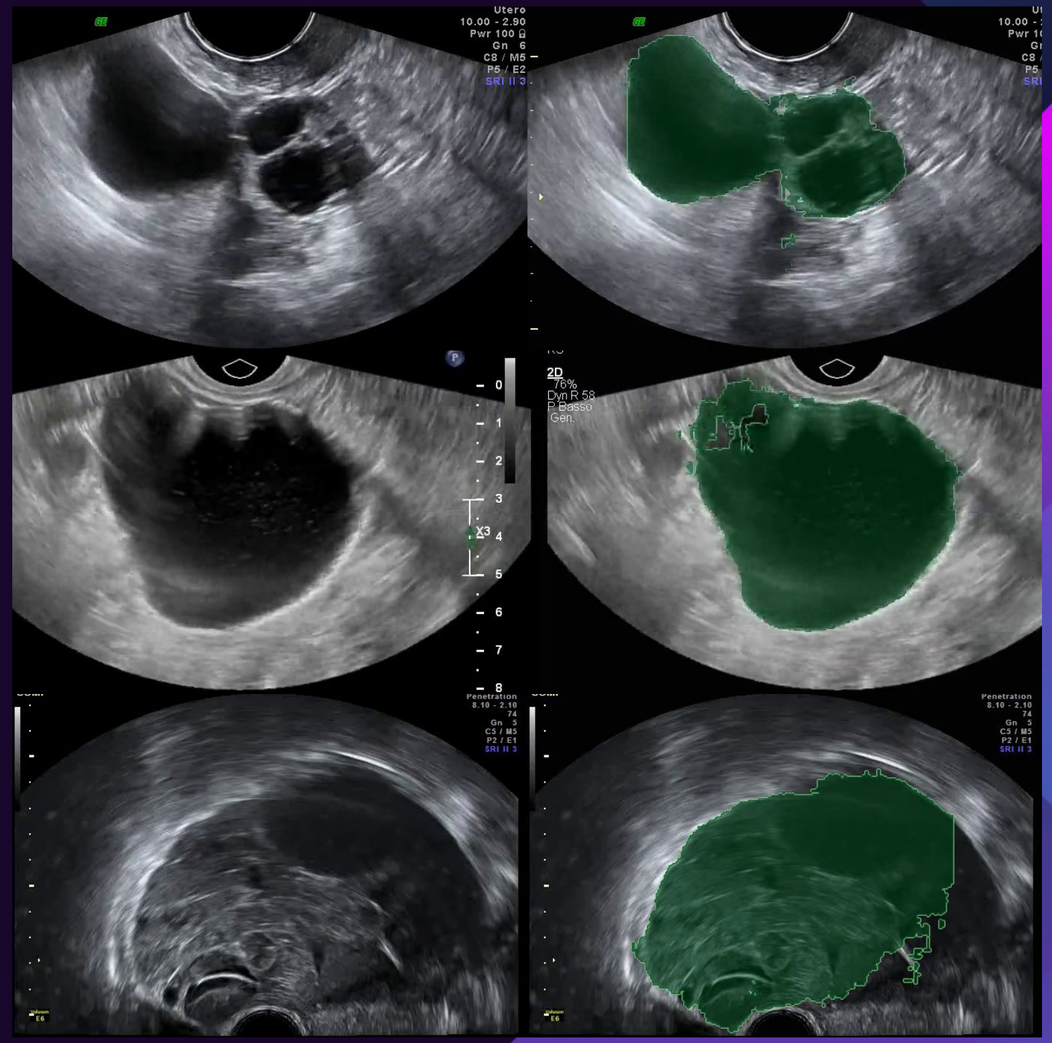
Modules performance

ROI detection

Detection of lesion:
sensitivity 80%, specificity 97%

Segmentation of lesion
DICE: 88%



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Modules performance

Tumor identification

Accuracy: 77%
Sensitivity: 88%
Specificity: 95%

Table 2. Accuracy, sensitivity, specificity, positive and negative LR with regard to malignancy of subjective evaluation of static ultrasound images by observers with varying levels of ultrasound experience

Sonologist	AUC	Accuracy n (%)	95% CI	p	Sensitivity n (%)	95% CI	p	Specificity n (%)	95% CI	p	LR+ (95% CI)	LR– (95% CI)
Experts												
A	0.92247	89 (147/166)	83–93		86 (60/70)	76–92		91 (87/96)	83–95		9.14 (5.03–17.25)	0.16 (0.09–0.27)
B	0.86109	82 (136/166)	75–87		86 (60/70)	76–92		79 (76/96)	70–86		4.11 (2.81–6.23)	0.18 (0.10–0.31)
C	0.88199	83 (138/166)	77–88		80 (56/70)	69–88		85 (82/96)	77–91		5.49 (3.41–9.12)	0.23 (0.14–0.36)
Consensus opinion		85 (141/166)	79–90		83 (58/70)	72–90		86 (83/96)	78–92		6.12 (3.74–10.36)	0.20 (0.12–0.32)
Senior trainees												
D	0.84189	80 (133/166)	73–85	0.1441	84 (59/70)	74–91	0.7630	77 (74/96)	[illegible]8–84	0.0389	3.68 (2.56–5.45)	0.20 (0.12–0.34)
E	0.85506	81 (134/166)	74–86	0.1779	70 (49/70)	58–79	0.0201	89 (85/96)	[illegible]1–93	0.5637	6.11 (3.52–10.95)	0.34 (0.23–0.47)
Junior trainees												
F	0.78586	78 (129/166)	71–83	0.0455	70 (49/70)	58–79	0.0290	83 (80/96)	75–89	0.4913	4.20 (2.67–6.81)	0.36 (0.24–0.51)
G	0.72560	72 (120/166)	65–79	0.0014	74 (52/70)	63–83	0.1336	71 (68/96)	61–79	0.0039	2.55 (1.83–3.62)	0.36 (0.23–0.54)
H	0.72664	70 (117/166)	63–77	0.0004	86 (60/70)	76–92	0.6171	59 (57/96)	49–69	<0.0001	2.11 (1.65–2.77)	0.24 (0.12–0.47)
I	0.79464	75 (125/166)	68–81	0.0114	73 (51/70)	61–82	0.0896	77 (74/96)	68–84	0.0606	3.18 (2.18–4.77)	0.35 (0.23–0.51)

p value refers to the comparison with the consensus opinion. Consensus opinion is defined as the diagnosis suggested by at least 2 of the 3 experts.

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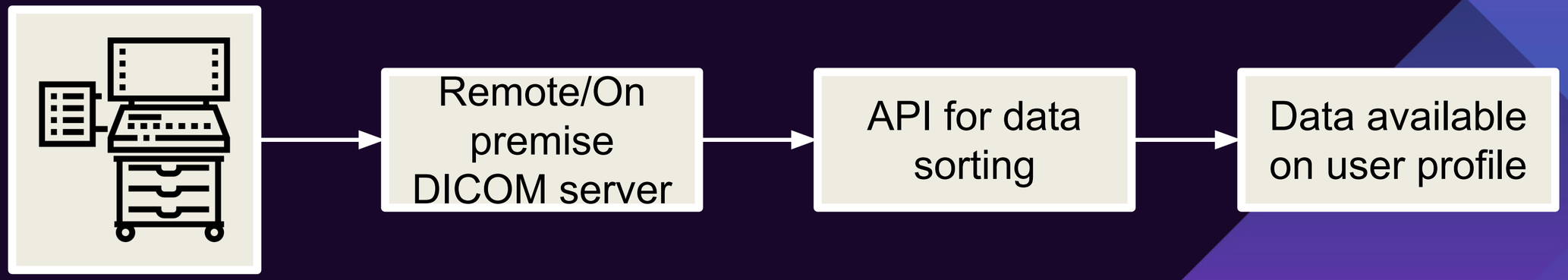
Deployment in clinical environment

- Access through a webapp
- Data can be dragged and drop or sent from the ultrasound machine



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Challenges in AI in Healthcare:

Data quality and availability
Model biases
GDPR and data management
Regulatory requirements
Cost and resource requirements
Integration into existing systems (e.g. where will it be deployed)

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Cloud Champions

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