Improving Mammography Malignancy Segmentation by Designing the Training Process

Short paper #137 @ MIDL 2020

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What we are looking on?

Mammography imaging is usually the initial imaging exam for breast cancer screening

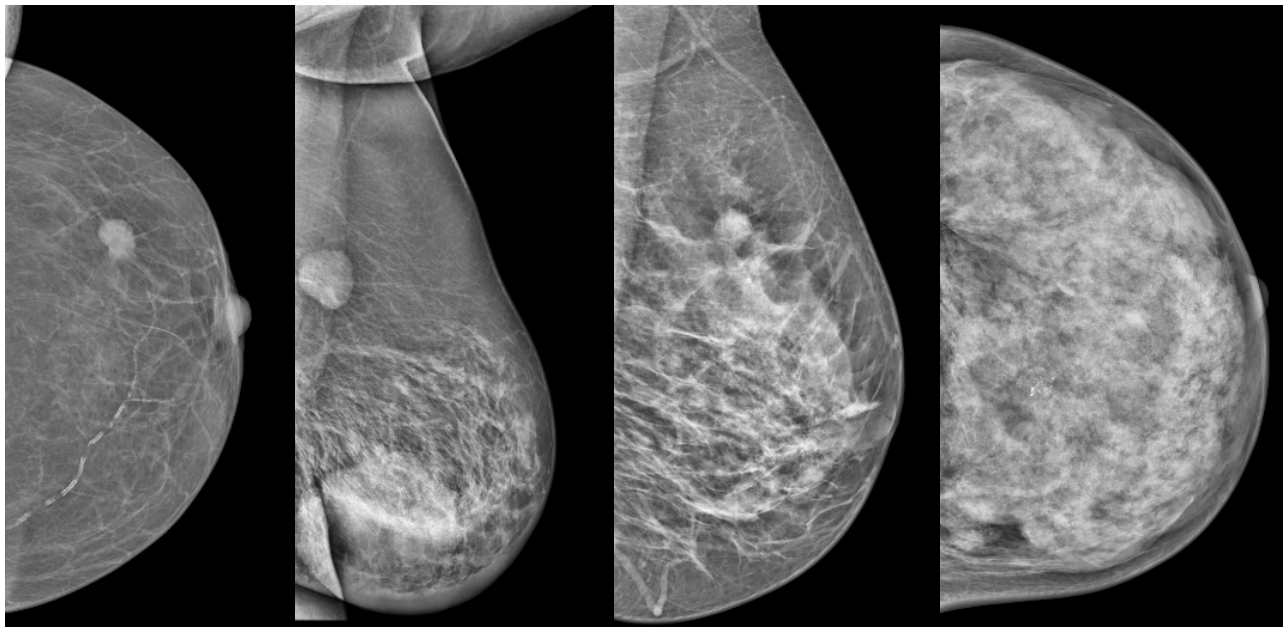


Figure 1: Samples from INBreast database[1]

[1] Inês C. Moreira et al. "INbreast: Toward a Full-field Digital Mammographic Database.". In: *Academic Radiology* 19.2 (2012), pp. 236–248. ISSN: 10766332. DOI: 10.1016/j.acra.2011.09.014. URL: http://www.ncbi.nlm.nih.gov/pubmed/22078258.

What are we trying to do?

Our aim: Find and segment malignant regions on mammograms

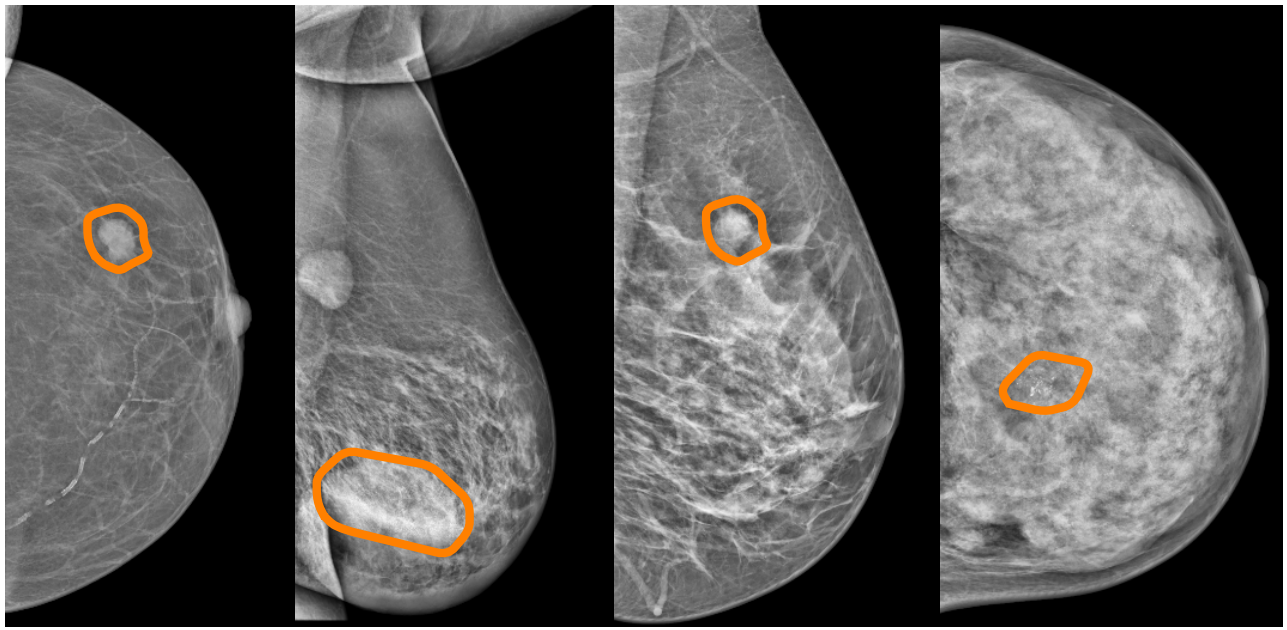


Figure 2: Same samples with contoured malignancies (INBreast[2])

[2] Inês C. Moreira et al. "INbreast: Toward a Full-field Digital Mammographic Database.". In: *Academic Radiology* 19.2 (2012), pp. 236–248. ISSN: 10766332. DOI: 10.1016/j.acra.2011.09.014. URL: http://www.ncbi.nlm.nih.gov/pubmed/22078258.

What are the challenges?

- High resolution of images: $\approx 4000 \times 3000$ pixels and more (depends on pixel spacing)
- Small findings to segment $\approx 5 - 10mm^2$, i.e. $< 100^2$ *pixels*

What do we propose?

Two-step training

1. Self-supervised reconstruction for an knowledge initialization[3]
2. Malignancy extraction instead of segmentation probability

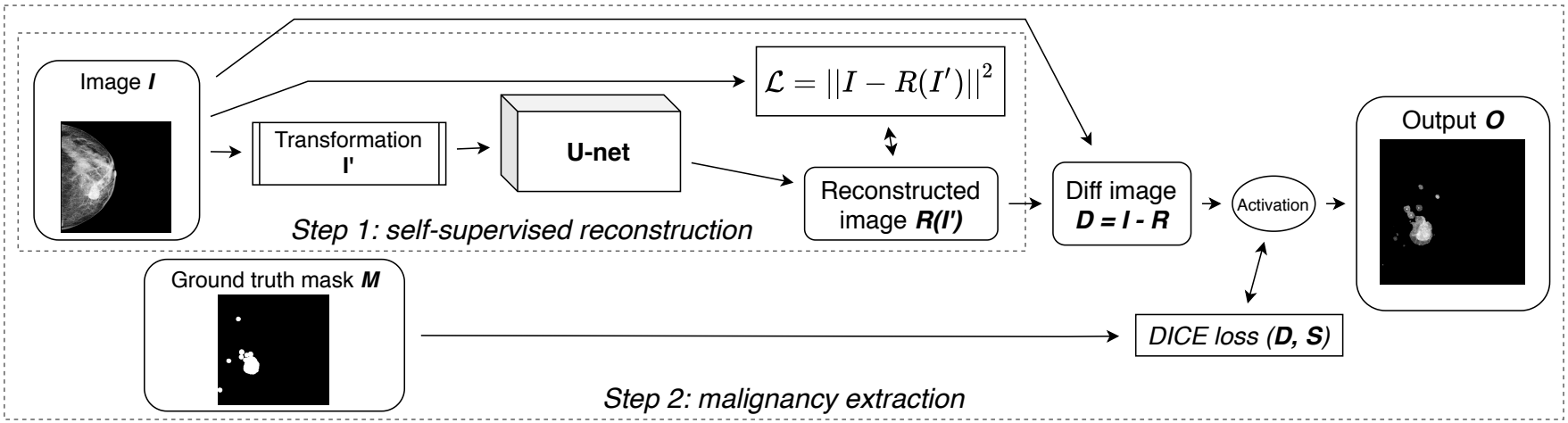
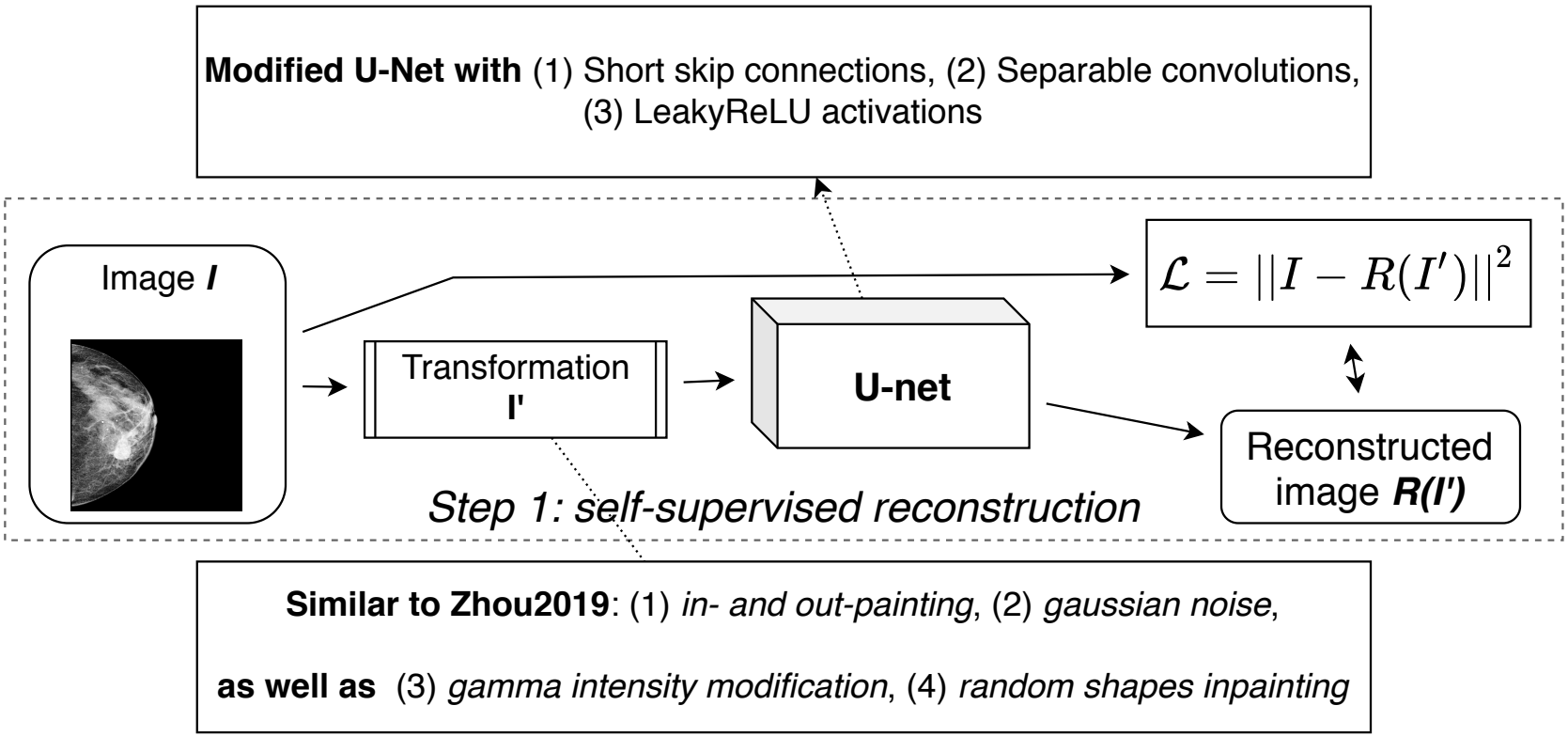


Figure 3: Proposed configuration of a U-Net

[3] Zongwei Zhou et al. "Models genesis: generic autodidactic models for 3d medical image analysis". In: *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. Vol. 11767 LNCS. Springer, 2019, pp. 384–393. ISBN: 9783030322502. DOI: 10.1007/978-3-030-32251-9_42. arXiv: 1908.06912.

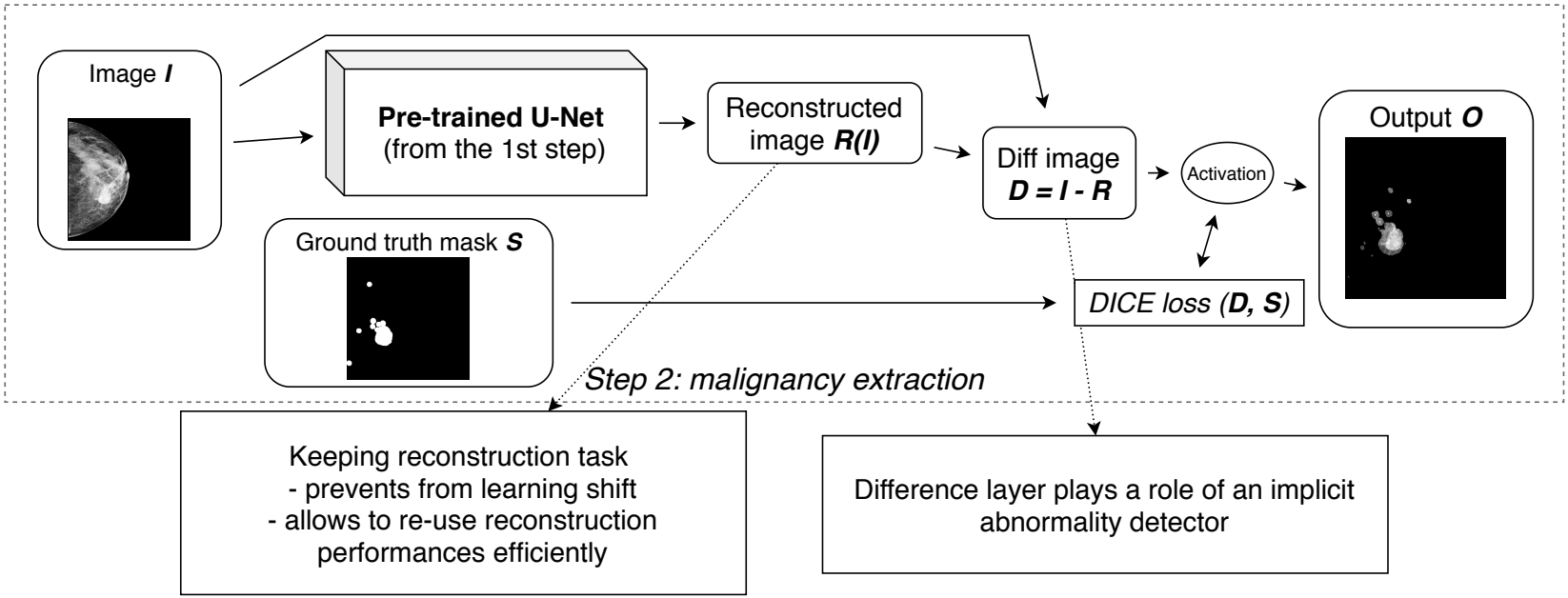
Method details

1st step: Reconstruction training with a U-Net[4]-like architecture



[4]Olaf Ronneberger, Philipp Fischer, and Thomas Brox. *U-net: Convolutional networks for biomedical image segmentation.* Tech. rep. 2015, pp. 234–241. DOI: 10.1007/978-3-319-24574-4_28. arXiv: 1505.04597. URL: http://lmb.informatik.uni-freiburg.de/.

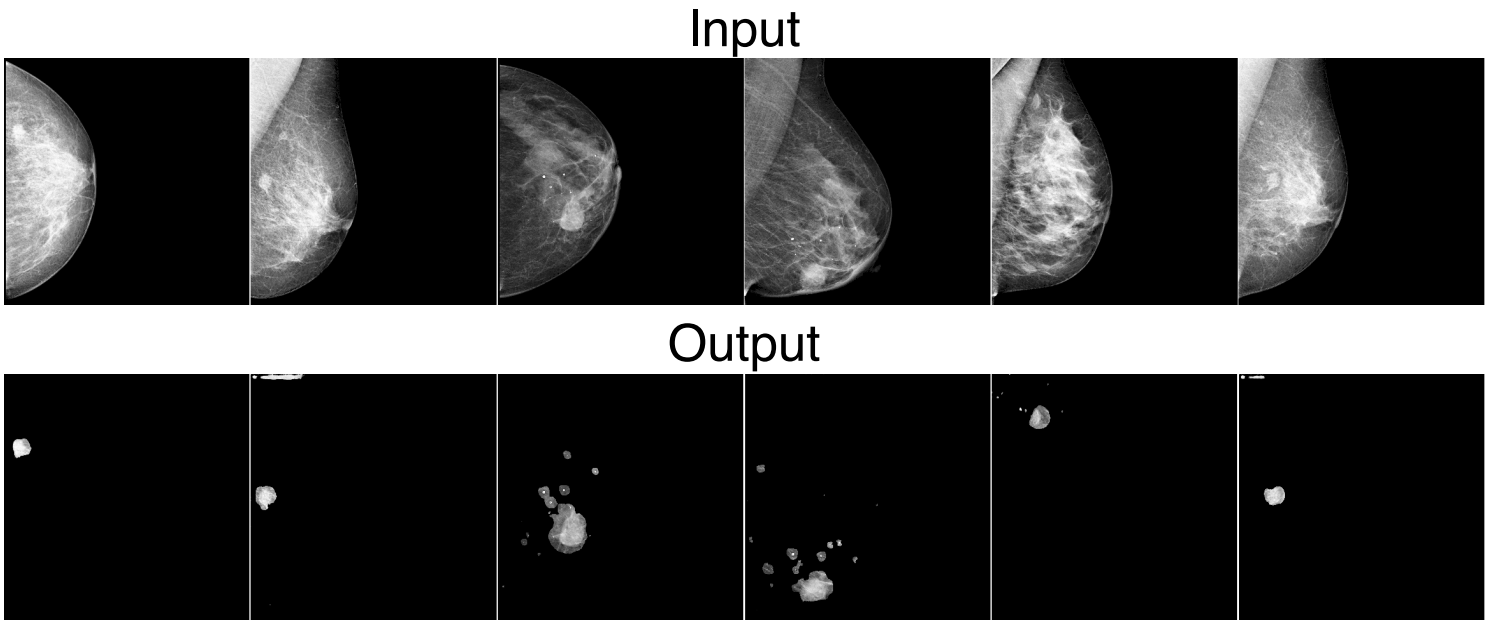
2nd step: Malignancy extraction using a difference layer



What do we get?

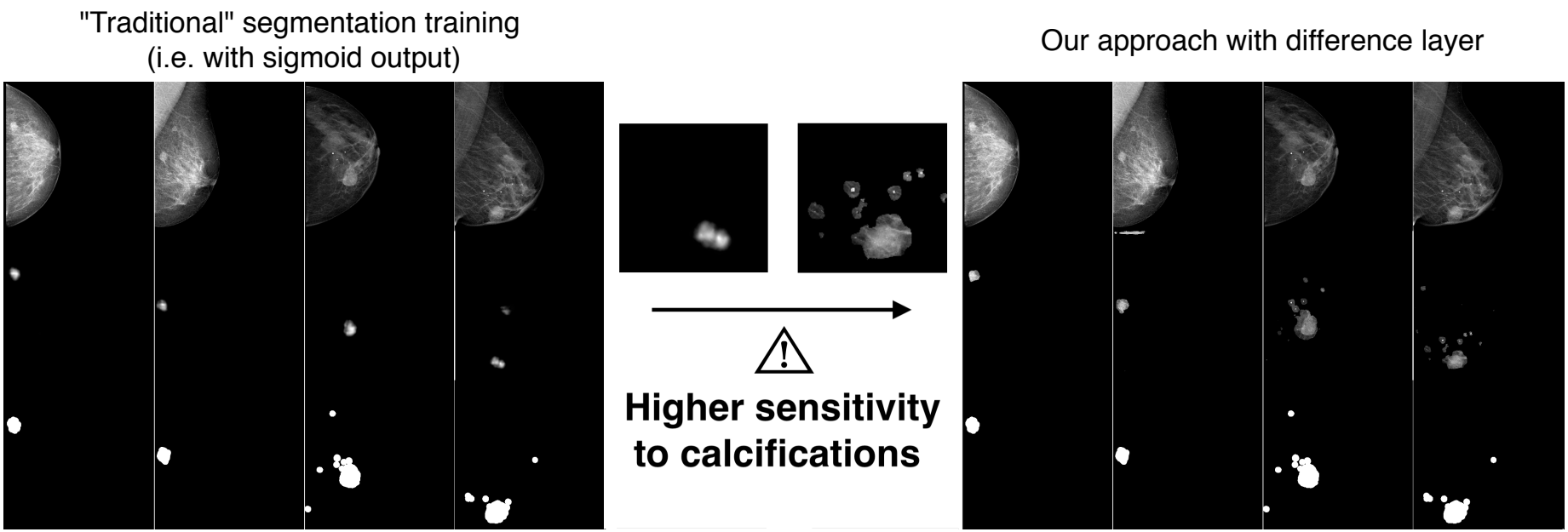
Network output

1. More sensitive
2. More interpretable



What do we get?

Network output compared to the traditional segmentation training



What do we get?

- Best score on INBreast: $DICE = 0.61$
  (comparable to SOTA segmentation performances)
- Less variability in training: on 10 epochs our approach yields
  $DICE_{avg} = 0.59$ vs. $DICE_{avg} = 0.52$ with probability-based training
- Sensible to masses and calcifications
- Images of 1536x1536 (pixel spacing $\approx 0.15mm$)
  acceptable with regards to findings (i.e. $\approx 10mm^2$, $> \approx 65pixels^2$)

Thank you
See you in the Q&A session

References i

Inês C. Moreira et al. “INbreast: Toward a Full-field Digital Mammographic Database.”. In: *Academic Radiology* 19.2 (2012), pp. 236–248. ISSN: 10766332. DOI: 10.1016/j.acra.2011.09.014. URL: http://www.ncbi.nlm.nih.gov/pubmed/22078258.

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