Improved Breast Computer-Aided Detection (CAD) with use of advanced analytics including deep learning

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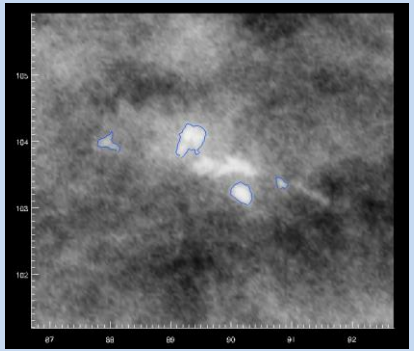
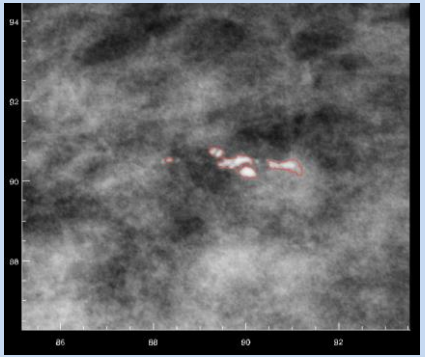
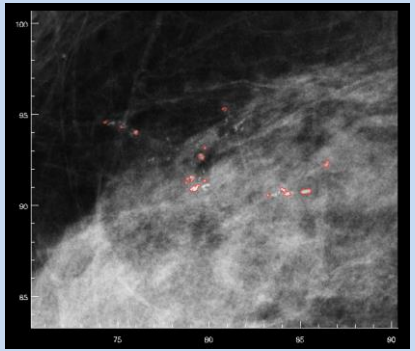




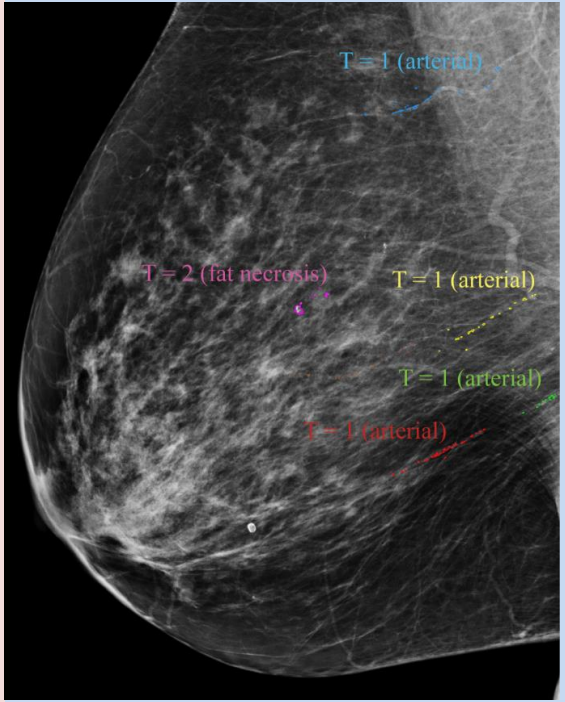


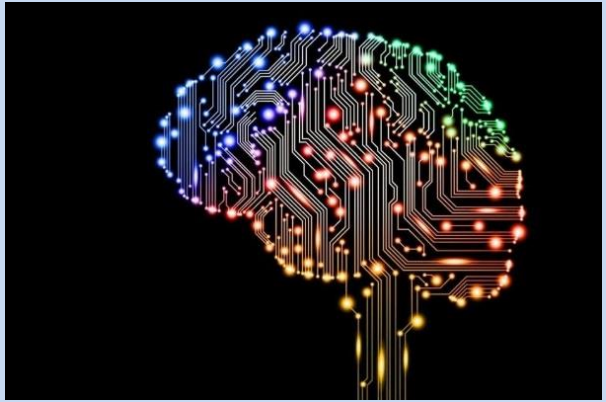
Disclosures

Dr. Watanabe is a consultant for CureMetrix
Dr. Bradley is Chief Medical Officer at CureMetrix
Dr. Vu, Mr. Weise are employees of CureMetrix

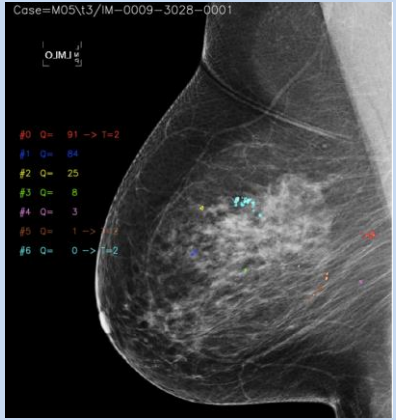
CureMetrix®

The CureMetrix technology described in this paper is in the research stage of development and is not available for clinical use. The product has not been reviewed bythe Food and Drug Administration or any other regulatory body. Additional review may be necessary before a product can be offered commercially. CureMetrix is currently evaluating the regulatory requirements for its products in development.





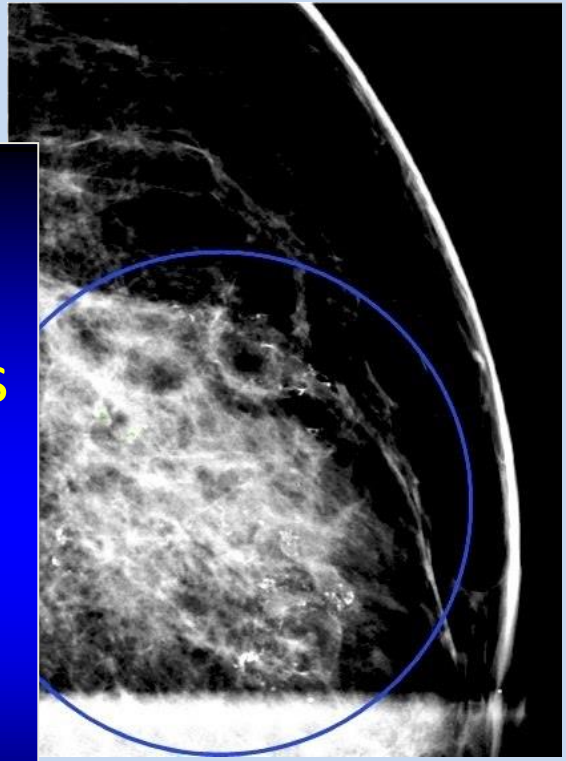
PURPOSE



Purpose: Deep learning, also known as machine learning, is a technology being applied to many areas outside of medicine. There is potential for deep learning in medical imaging to assist in diagnostic imaging

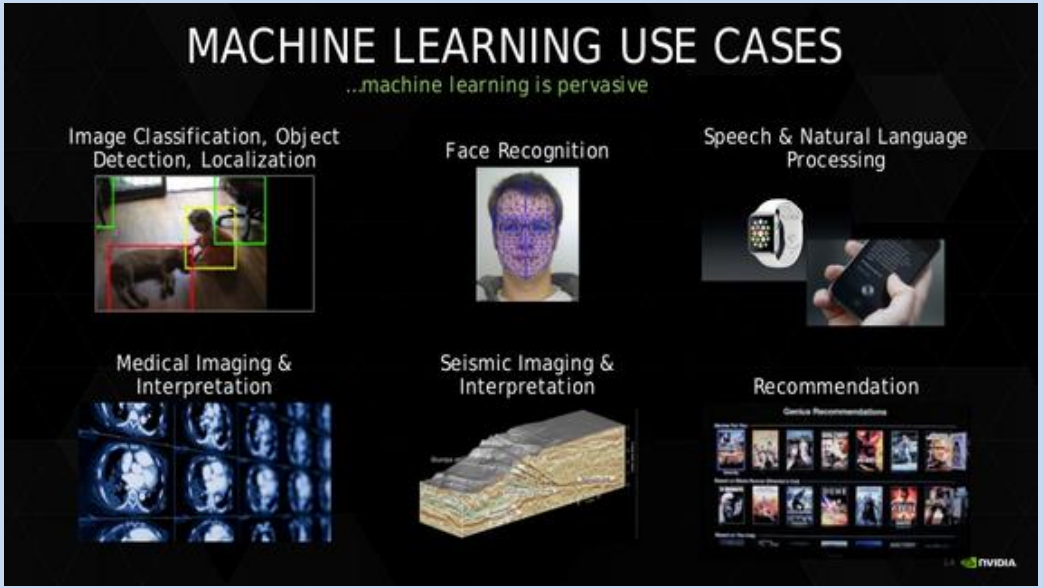
Purpose

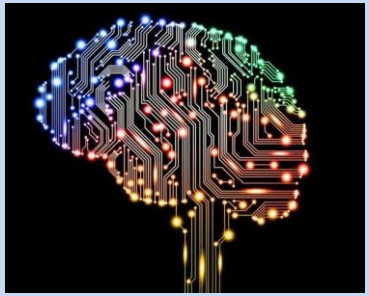
The goal of this study is to assess the enhanced accuracy of a mammography CAD (Curemetrix cmAssist) which employs a deep learning algorithm along with physics based advanced analytics in identifying malignant calcifications, using an image database of "ground truth" comprised of biopsy confirmed cases.



Benign fat necrosis

Deep learning is a form of machine learning
It is a subset of Artificial Intelligence which is widely used in many industries…
Machines that perceive

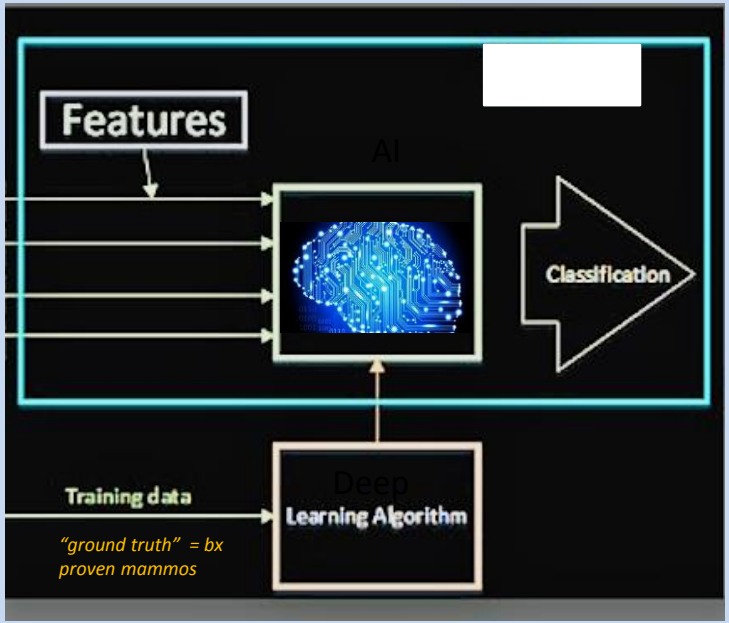


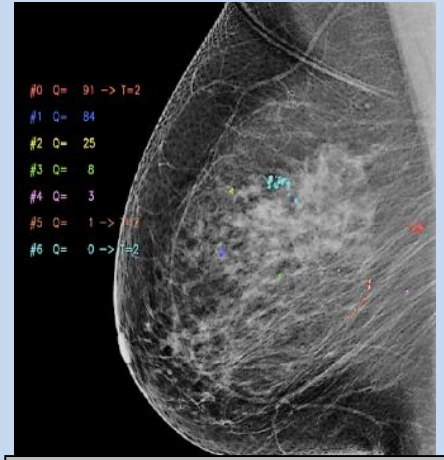


MACHINE LEARNING – Artificial Intelligence

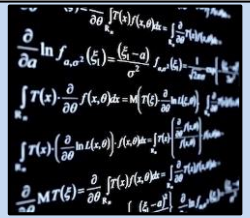
Lesions are also classified with a probability for malignancy using deep learning

Training cases





Mathematical predictions summarized as a numerical value called Q score

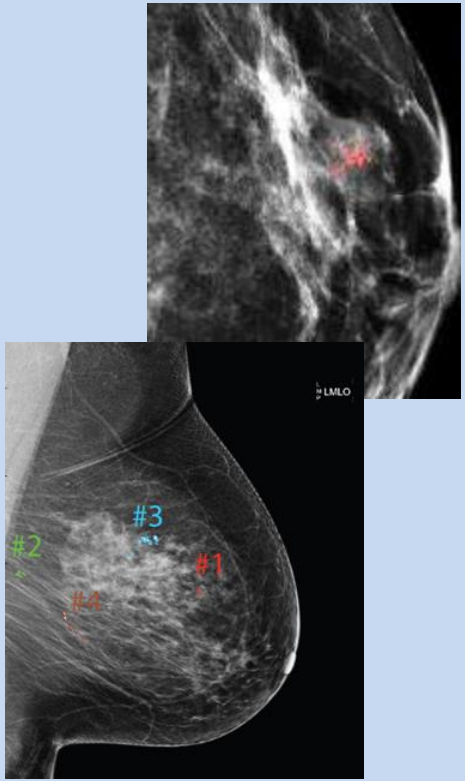


Deep learning is a form of machine learning = the newest and most popular approach to Artificial Intelligence –
Higher Q score = higher likelihood for malignancy

Materials and Methods

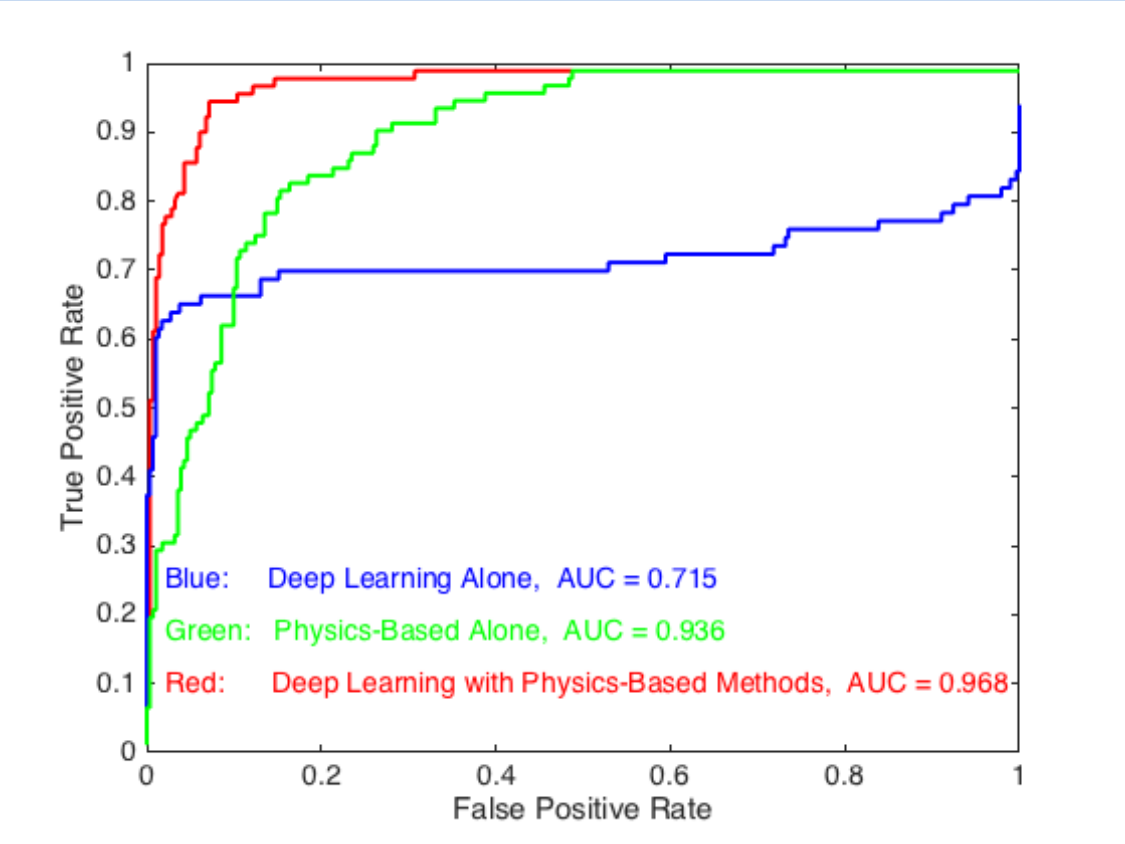
- The data set consists of 292 biopsy-proven cancer cases (90 for testing and 202 for training) and 933 BI-RADS 1&2 cases (280 for testing and 653 for training). The first study here was limited to evaluation of benign and malignant breast calcifications.
- 2D digital mammograms were used.

- Receiver operator curves (ROC) were obtained to compare performance as follows: Physics based CAD, deep learning CAD and the combination of physics based and deep learning (DL).

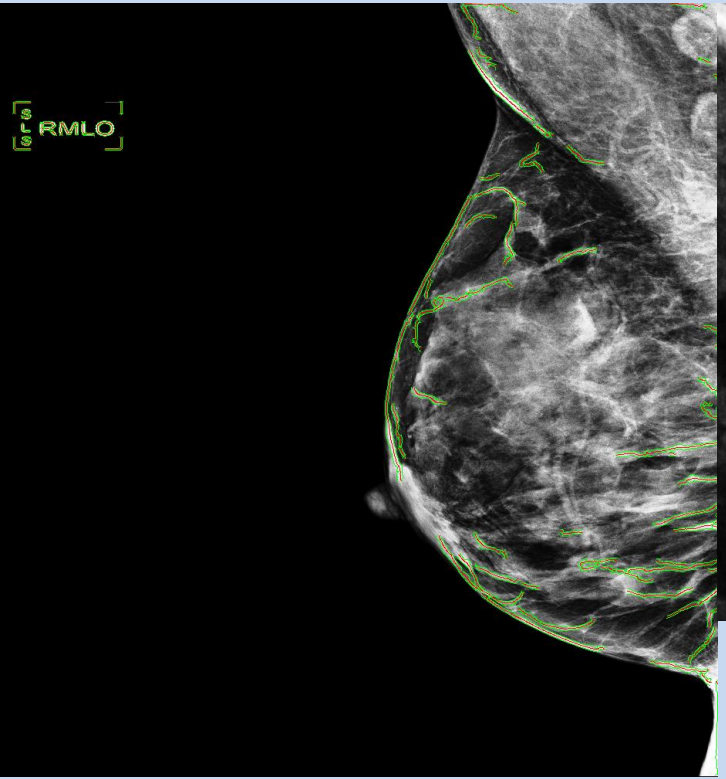


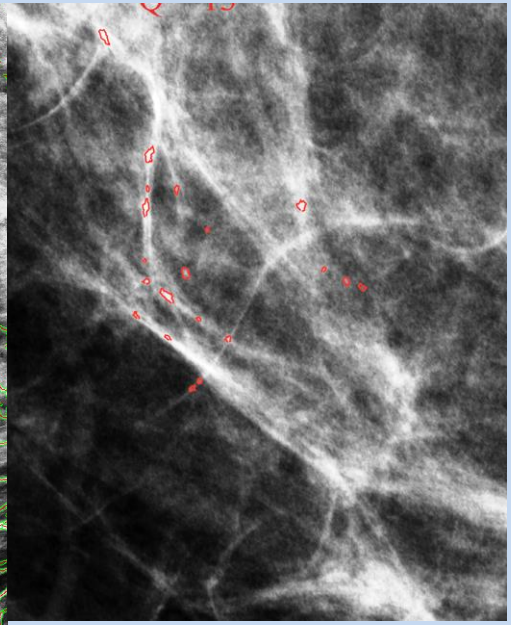
RESULTS

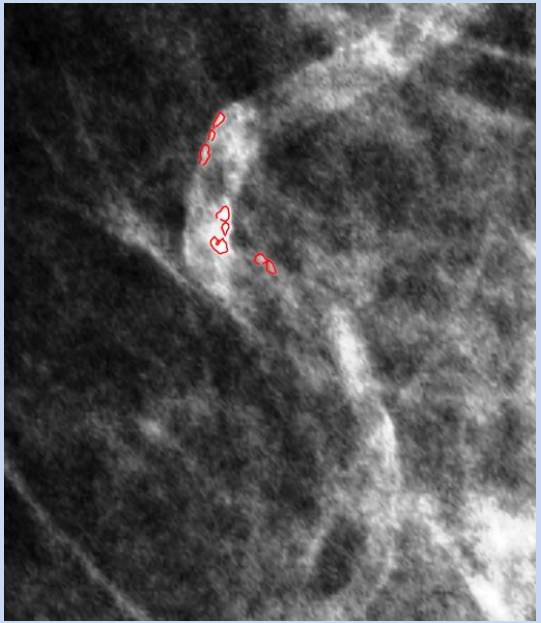
- The results show improved accuracy of CAD with the addition of the deep learning algorithm (red curve)
- Two different models are evaluated: 1. deep learning alone (blue curve, AUC = 0.715), and 2. deep learning, augmented by novel physics-based methods (red curve, AUC = 0.968). The results show that specialized combination of techniques yield a marked improvement in the accuracy of CAD. At 93% sensitivity, the false-positive per image (FPPI) corresponding to Model 2 (red curve) is 0.0257, compared to industry standards of 0.23 (FPPI) at the same sensitivity.



The algorithm maps and excludes benign arterial calcifications through use of deep learning



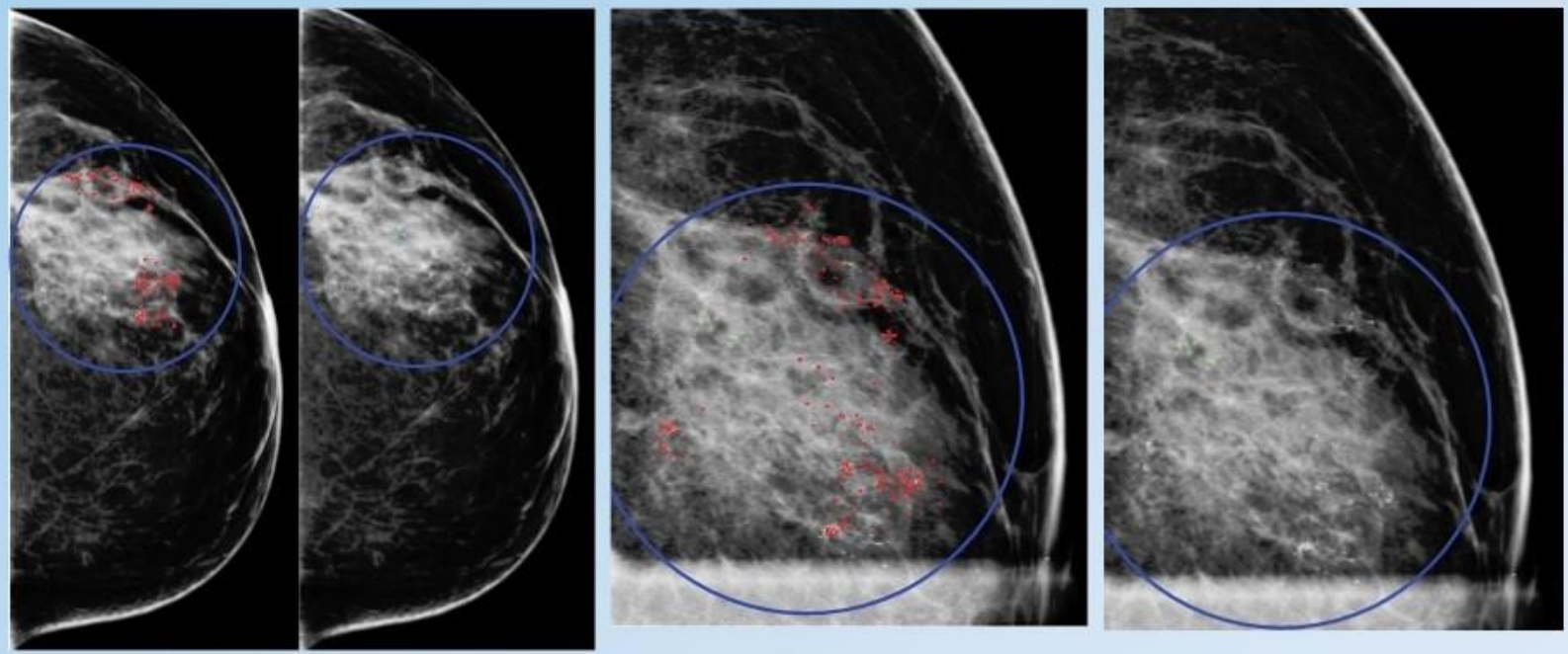




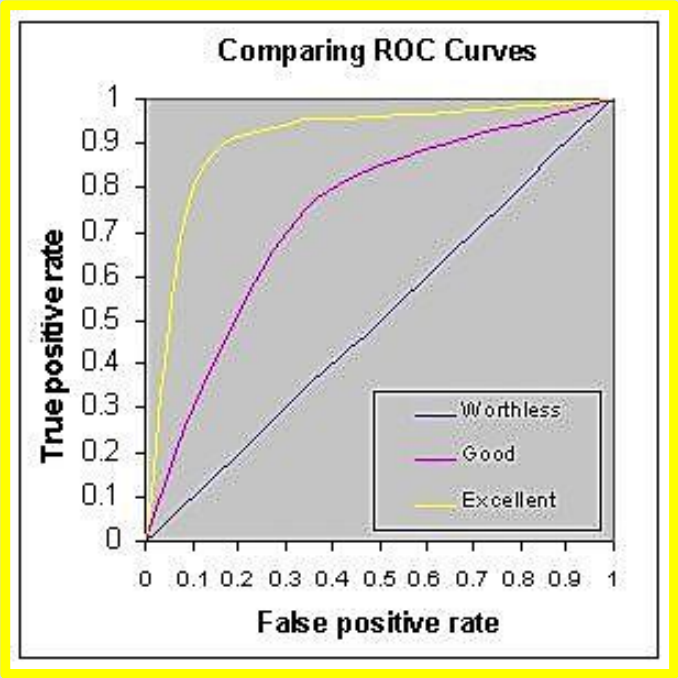
Example of difficult benign arterial calcifications that are excluded by the quantitative CAD through deep learning training

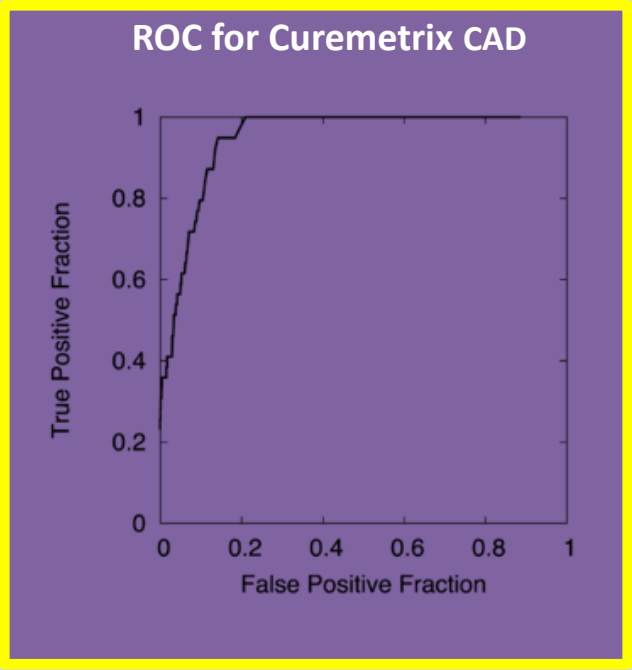
Type 1 - benign arterial calcifications

False Positive for radiologist and
True Negative for qCAD
Fine linear branching and rim calcifications measuring 7 cm with regional distribution in the middle lateral region: Path proven fat necrosis



AUC OF qCAD FOR CALCIFICATIONS IN SCREENING = 0.97





A perfect ROC is a vertical line
Area Under the Curve (AUC) is a summary of the ROC between 0 to 1 where 1 = perfection

*AUC of **0.97** for calcifications in over 7,232 screening cases*

Conclusion:

The use of deep learning augments the mammography CAD in both sensitivity and specificity.

In this study, the improvement of the CAD with deep learning is quantitatively measured and shown to provide accuracy scores that exceeds published results for conventional CAD systems.

Deap learning may further improve CAD as more data is entered.
Deep learning may be useful in other medical imaging modalities besides mammography

CAD with deep learning may enhance throughput and accuracy of mammography interpretations through earlier detection and/or improved classification of breast lesions