Sample Project Topics

Note: we have provided a list of relevant papers for most topics as a starting point. You can identify additional papers for your topic(s) of interest by either going through the papers cited by some of the **review papers** posted on the course's webpage (i.e., especially the latest ones) or by **searching online**. Please note that although different teams can choose the same topic, the approaches used must be different.

1. Assessment of **breast tissue density** in mammograms
    - 2006 - Modeling and Classifying Breast Tissue Density in Mammograms
    - 2017 – Breast density classification with Deep Convolutional Neural Networks
    - 2017 - A deep learning method for classifying mammographic breast density categories
    - 2019-Determination of mammographic breast density using a deep convolutional neural network
    - 2021 -Multi-View_Mammographic_Density_Classification_by_Dilated_and_Attention-Guided_Residual_Learning

2. **Pectoral muscle removal** in mammograms
    - 2016 - Review of recent advances in segmentation of the breast boundary and the pectoral muscle in mammograms
    - 2020 - A review of breast boundary and pectoral muscle segmentation methods in computer-aided detection/diagnosis of breast mammography

3. Mass/Calcifications/Architectural Distortion **segmentation** in mammograms
    - 2020 - Deep Learning Computer-Aided Diagnosis for Breast Lesion in Digital Mammogram
    - 2021 - Breast Cancer Segmentation Methods Current Status and Future Potentials
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4. Detection and classification of **masses** in mammograms
    - 2015 - An Efficient Approach for Automated Mass Segmentation and Classification in Mammograms
    - 2017 - Detecting and classifying lesions in mammograms with Deep Learning
    - 2018 - A fully integrated computer-aided diagnosis system for digital X-ray mammograms via deep learning detection, segmentation, and classification
    - 2018 - Automated soft tissue lesion detection and segmentation in digital mammography using a u-net deep learning network
    - 2018 - Detection of masses in mammograms using a one-stage object detector based on a deep convolutional neural network
    - 2018 - Simultaneous detection and classification of breast masses in digital mammograms via a deep learning YOLO-based CAD system

- 2019 - Automatic mass detection in mammograms using deep convolutional neural networks
- 2019 - Breast cancer detection using synthetic mammograms from generative adversarial networks in convolutional neural networks
- 2020 - Classification of breast mass in two-view mammograms via deep learning
- 2020 - Joint 2D-3D Breast Cancer Classification
- 2021 - Connected-UNets a deep learning architecture for breast mass segmentation
- 2021 - Breast Lesions Detection and Classification via YOLO-Based Fusion Models

5. Detection and classification of **micro-calcifications** in mammograms
    - 2009 - CADx of mammographic masses and clustered microcalcifications - a review
    - 2016 - Transferring Learned Microcalcification Group Detection from 2D Mammography to 3D Digital Breast Tomosynthesis Using a Hierarchical
    - 2018 - A context-sensitive deep learning approach for microcalcification detection in mammograms
    - 2019 - Breast Microcalcification Diagnosis Using Deep Convolutional Neural Network from Digital Mammograms
    - 2019 - Breast Microcalcification Diagnosis Using Deep Convolutional Neural Network from Digital Mammograms

6. Detection of **architectural distortions** in mammograms
    - 2019 - Context-based ensemble classification for the detection of architectural distortion in a digitized mammogram
    - 2020 – A State of the Art Survey on Deep Learning Methods for the Detection of Architectural Distortion from Digital Mammography
    - 2021 - A deep learning model using data augmentation for detection of architectural distortion in whole and patches of images

7. **Image enhancement** of mammograms
    - 2019 - A Multiscale Contrast Enhancement for Mammogram Using Dynamic Unsharp Masking in Laplacian Pyramid
    - 2021 - RICE A method for quantitative mammographic image enhancement

8. Analysis of **bilateral asymmetry** in mammograms
    - 2011Bilateral_asymmetry_identification_for_the_early_detection_of_breast_cancer
    - 2020 - Detecting Asymmetric Patterns and Localizing Cancers on Mammograms

- 2020 - Cross-View_Attention_Network_for_Breast_Cancer_Screening_from_Multi-View_Mammograms

9. Breast cancer **risk assessment**
    - 2017 - Deep learning in breast cancer risk assessment evaluation of convolutional neural networks on a clinical dataset of full-field digital mammograms
    - 2019 - Deep learning modeling using normal mammograms for predicting breast cancer risk
    - 2021 - Breast Cancer Risk Assessment A Review on Mammography-Based Approaches

10. **Super resolution** in mammography
    - 2017 - Super-Resolution Imaging of Mammograms Based on the Super-Resolution Convolutional Neural Network
    - 2021 - Super-resolution of mammograms

11. **Early detection** of breast cancer (Ductal Carcinoma In Situ (DCIS) or Stage 0)
    - 2017 - Non-calcified ductal carcinoma in situ of the breast comparison of diagnostic accuracy of digital breast tomosynthesis, digital mammography, and ultrasonography
    - 2021 - Imaging of Noncalcified Ductal Carcinoma In Situ
    - 2020A_Review_on_Recent_Progress_in_Thermal_Imaging_and_Deep_Learning_Approaches_for_Breast_Cancer_Detection

12. **Data augmentation** for training DL models
    - 2020 - Segmentation of Masses on Mammograms Using Data Augmentation and Deep Learning
    - 2020 - Medical Image Synthesis via Deep Learning
    - 2021- A deep learning model using data augmentation for detection of architectural distortion in whole and patches of images
    - 2019 - Evaluation of data augmentation via synthetic images for improved breast mass detection on mammograms using deep learning
    - 2018 - Conditional Infilling GANs for Data Augmentation in Mammogram Classification
    - 2020 - Using Convolutional Neural Network with Cheat Sheet and Data Augmentation to Detect Breast Cancer in Mammograms

13. **Content-Based Mammogram Retrieval** (using **perceptual** similarity)
    - 2009Learning_of_Perceptual_Similarity_From_Expert_Readers_for_Mammogram_Retrieval

14. **Transfer learning** in mammography
    - 2016 - Mass detection in digital breast tomosynthesis deep convolutional neural network with transfer learning from mammography

15. **Fusion of multiple mammogram views** for improved mass detection and classification (or micro-calcifications or architectural distortions).
    - 2016 - A MULTI-VIEW DEEP LEARNING ARCHITECTURE FOR CLASSIFICATION OF BREAST MICROCALCIFICATIONS
    - 2017 - Automated Analysis of Unregistered Multi-View Mammograms with Deep Learning
    - 2018 - High-Resolution Breast Cancer Screening with Multi-View Deep Convolutional Neural Networks
    - 2019 - Multi-View Convolutional Neural Networks for Mammographic Image Classification

16. **Fusion of different modalities** (like MRI, Ultrasound, Mammograms) for improved mass detection and classification (or micro-calcifications or architectural distortions).

Some **cool** ideas from the paper "2017 - Why CAD Failed in Mammography" (section "Future Applications")

Only 84% of breast cancers are detected by interpreting radiologists. The 16% of cancers that are missed by radiologists likely reflect limitations in image perception by the human eye [21]. **AI can help if we focus on the unique features of the missed cancers**.

CAD failed, in no small part, because it was recruited to do what radiologists already do well—pick up the 84% of cancers. In screening for breast cancer, **AI should function not as a second pair of eyes, but as a Hubble telescope, to see what we cannot see**.

Rather than replicate large-scale maps, CAD 2.0 should **zoom into the areas of blindness**. Radiologists know their blind spots. One example is the **dense breast**, which is known to reduce the sensitivity of the mammogram to dangerously low levels [22].

A radiologist's largest blind spot is **what imaging cannot see**, and this includes information from the **"-omics" such as proteomics and genomics**.

The major shift, owing to more powerful graphical processing units, is the change from supervised learning to **unsupervised learning**. **AI will no longer be bound to radiologists for determination of the truth**, but may, through its own pattern-learning abilities **teach radiologists what they are liable to miss.**

The lesions can be compared with and clustered with similar lesions that have known pathology. Then, **using content-based image retrieval**, these lesions can then be presented to the radiologist with **a set of images that share similar features and have known pathology** [23].

As computer power doubles in short periods of time [24], CAD 2.0 could be applied to not just one view of the same image, but also into **different views**, **prior images**, and even non-imaging data, such as **pathology images**.

Newer technologies can use "**transfer learning**" where algorithms developed on a certain data set—for example, one image-view mammograms—are applied to different data sets [Perhaps the biggest application for this technology will be in breast tomosynthesis [26]. Deep learning has been used in tomosynthesis with success [25].