Using Eye-Gazing Data to Predict Radiologists' Cognitive Behavior during Breast Cancer Screening

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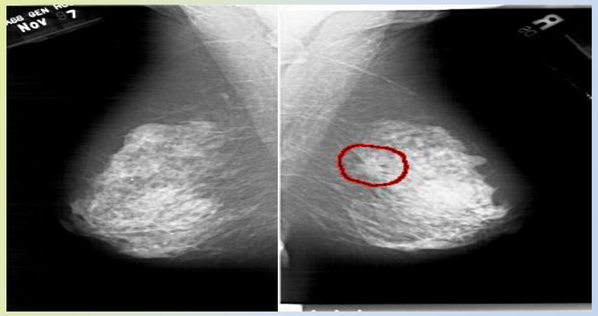
Introduction

Breast cancer is second leading cause of cancer death in U.S women

- Earlier diagnosis = greater chance of survival
- Mammography most widely used screening method
- **10%-30% of cancers overlooked due to human error[1]**
- Two types of human error[2]
  - Perceptual (failure to fixate on cancer)
  - Cognitive (failure to report a perceived cancer)



Images from case studies complied from University of South Florida

Objectives

- Determine whether or not eye tracking data can be used
  - to predict radiologists' cognitive behavior
  - to differentiate perceptual and cognitive errors
- Compare predictive modeling at individual vs. group level

Methodology

Data Collection: gaze data of 6 radiologists (3 experts and 3 residents) reviewing 20 cases

Predictive modeling using WEKA software package

- Regression (LOGISTIC)
- Artificial neural networks (ANN)

Leave-one-out cross validation scheme

Trend analysis for all radiologists (GLOBAL), depending on experience level (GROUP), and per INDIVIDUAL

Results

Predicting cognitive behavior: Will the radiologist report a lesion?

Models	% ACCURACY LOGISTIC	% ACCURACY ANN
GLOBAL	79.33	81.64
GROUP		
Trainees	80.00	77.14
Experts	78.65	75.73
INDIVIDUAL		
1	79.00	77.14
2	75.00	75.73
3	72.22	72.22
4	75.68	67.66
5	82.86	82.86
6	35.49	45.16

Results

Predicting perceptual and cognitive error: Will the radiologist make a diagnostic error?

Models	% ACCURACY LOGISTIC	% ACCURACY ANN
GLOBAL	74.40	75.36
GROUP		
Trainees	73.34	70.48
Experts	75.30	78.65
INDIVIDUAL		
1	72.73	72.73
2	69.44	63.89
3	75.00	75.00
4	72.93	70.27
5	80.00	82.86
6	51.62	41.94

Conclusions

- Eye tracking data can be used to predict radiologist
  - cognitive behavior
  - makes a diagnostic error
- Individual level Predictive modeling more accurate depending on the sample size
- Overall predictive modeling >70% accuracy rate
- Enables preliminary studies for more individualized breast cancer screening methods

1. Mello-Thoms, C., Dunn, S. M., Nodine, C. F., & Kundel, H. L. (2003; 22). The Perception of Breast Cancer-A Spatial Frequency Analysis of What Differentiates Missed From Reported Cancers. *IEEE Transactions on Medical Imaging*, 1297-1305.

2. Mello-Thoms, C., Dunn, S., Nodine, C. F., Kundel, H. L., & Weinstein, S. P. (2002;179). The Perception of Breast Cancer: What Differentiates Missed From Reported Cancers in Mammography? *Academic Radiology*, 1004-1012.

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