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

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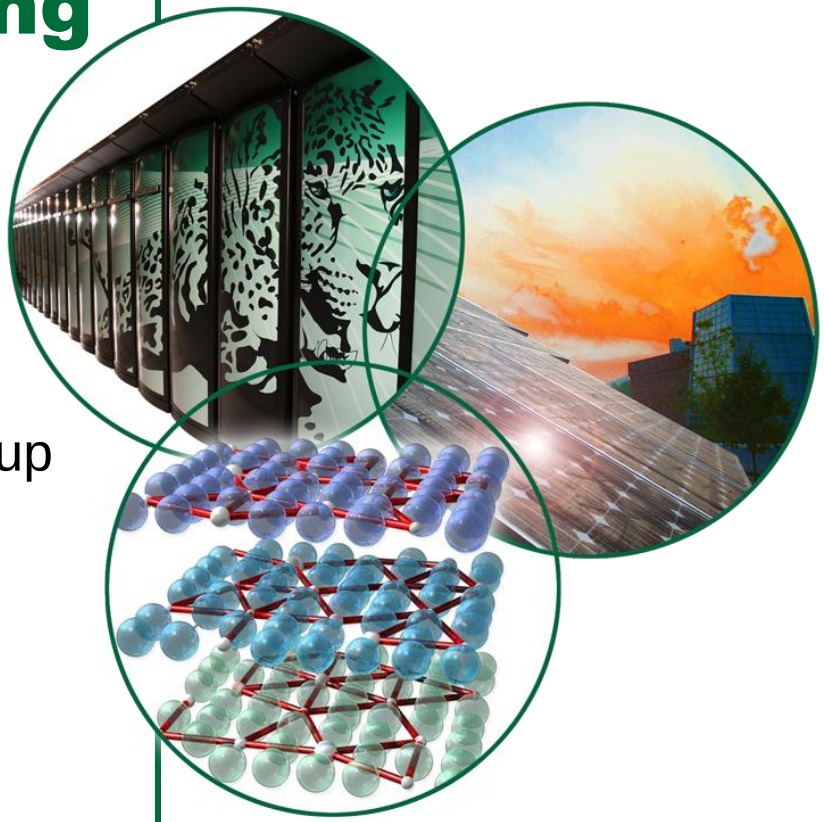

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Overview

Introduction

Objectives

Methodology

Conclusions

Future work

Breast Cancer

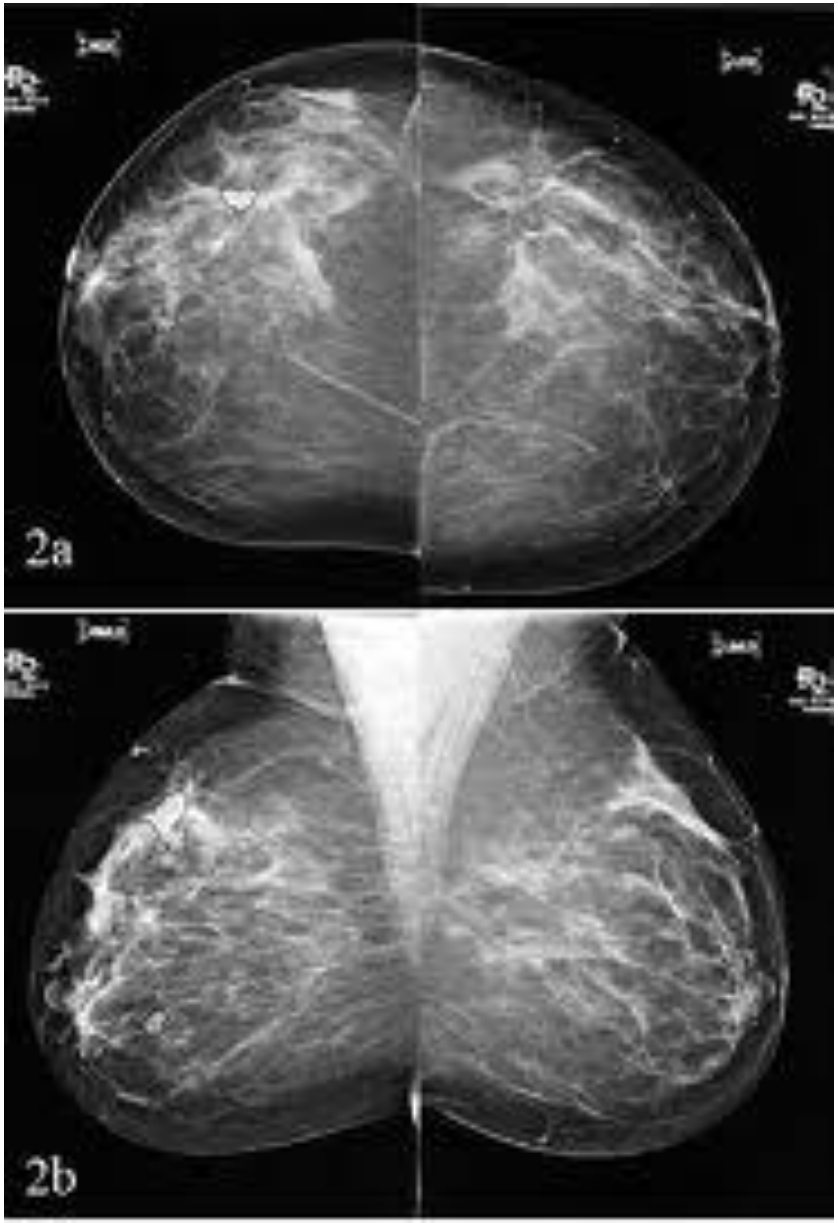
Breast cancer second leading cause of death in women

Introduction

Early diagnosis = greater chance of survival

Mammography most widely used screening method

Mammography



Challenges with Mammography Screening

Low cancer prevalence: ~1/250

Volume burden: ~40,000,000 studies /yr

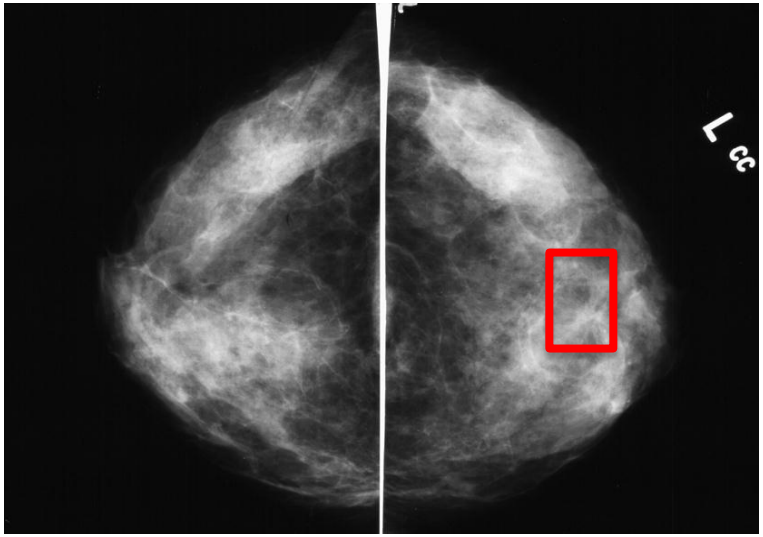
Rapid reading + Shortage of experts

Legal burden: #1 malpractice

The Challenge

How do we prevent human error in mammographic diagnosis?

Mammography Diagnostic Errors



Diagnostic error in breast cancer detection

Perceptual

(failure to see true lesions)

Cognitive

(failure to report visually perceived lesions OR falsely perceiving normal parenchyma as cancerous lesion)

Objectives

1. determine whether or not eye tracking data can be used to:

predict radiologists' cognitive behavior	differentiate radiologists' perceptual and cognitive errors

2. determine whether predictive modeling is more effective at individual rather than group level

Methodology

Data collection: eye-tracking data from 6 radiologists (3 experienced and 3 radiology residents)

Predictive modeling: WEKA software package to build a Regression (LOGISTIC) and an Artificial Neural Network (ANN)

Cross-validation: Leave one-out cross validation scheme

Trend analysis: Compare predictive models built for all radiologists, based on their experience level, and individually

Data collection

Gaze data collected from 20 cases

- 10 malignant, 5 benign, and 5 normal
- Cancer and benign cases were biopsy-proven
- Normal cases confirmed with a 2-year follow up

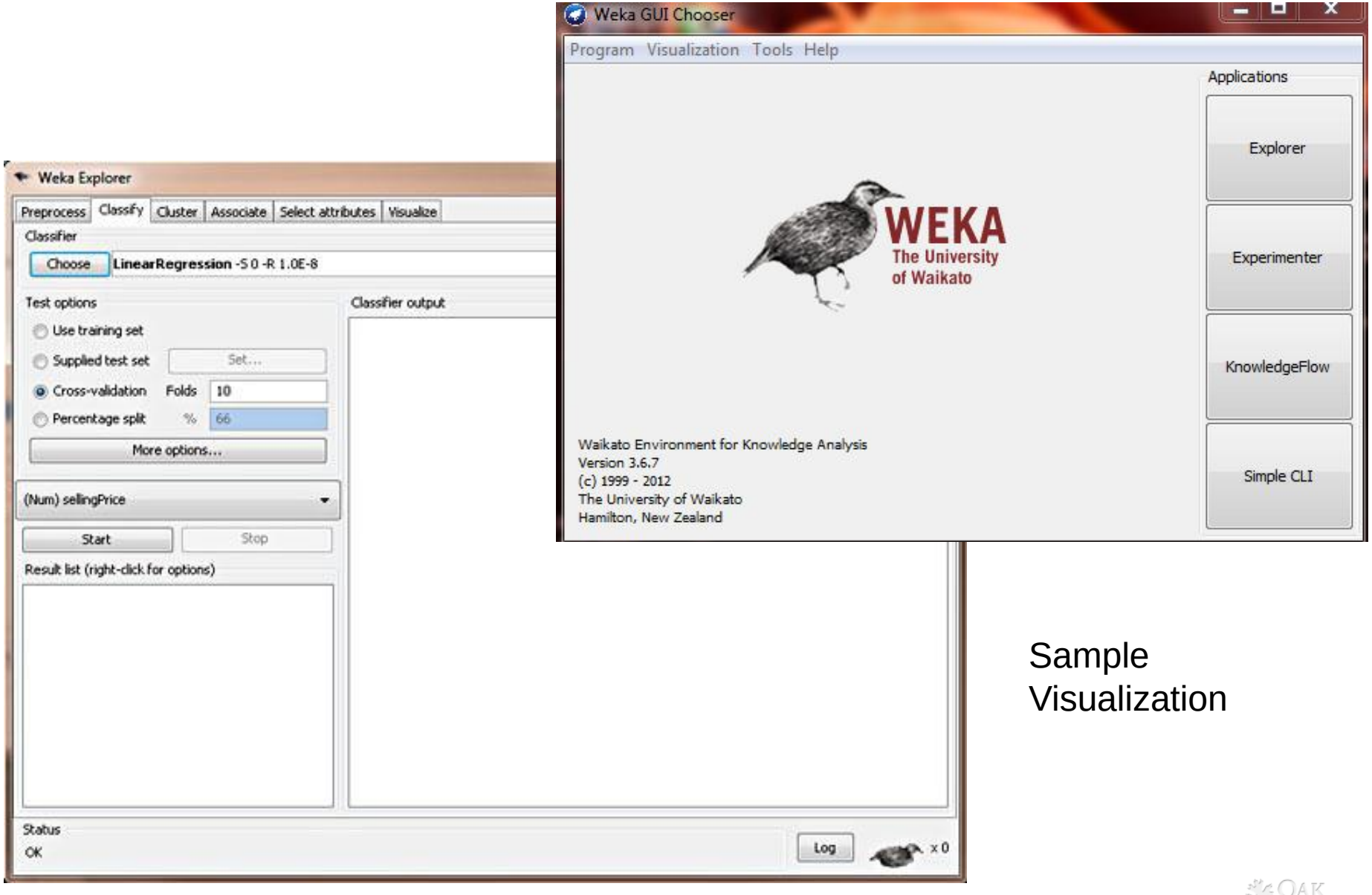
Gaze variables using head tracker

- Total dwell
- Time to initial fixation
- Number of returns

Clinical decisions

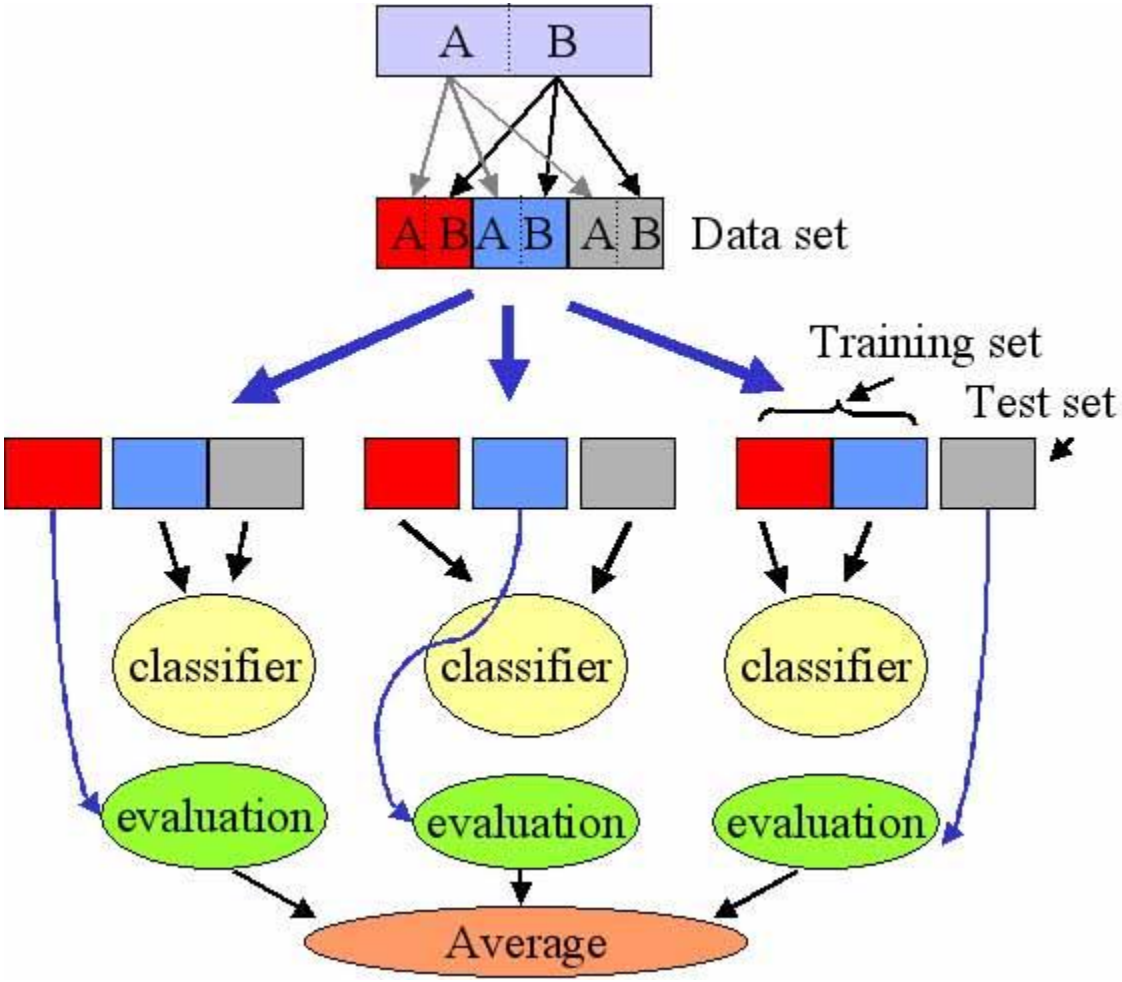
- CORRECT
  - TP – correctly marked true lesions
  - TN – correctly unmarked normal regions
- ERROR
  - FP – normal regions falsely marked as cancer
  - FN – missed true lesions
- FN-falsely labeled as normal

Predictive Modeling: WEKA



Sample Visualization

Cross-Validation: Leave one-out



Can we predict if a radiologist will mark a location?

	% ACCURACY LOGISTIC	% ACCURACY ANN
GLOBAL	79.33	81.64
GROUP		
Residents	80.00	77.14
Experts	78.65	75.73
INDIVIDUAL		
1	79.00	81.82
2	75.00	83.33
3	72.22	72.22
4	75.68	65.66
5	82.86	82.86
6	35.49	45.16

Higher accuracy

Large range, variable

exception

Results: Can we predict if radiologist will make a diagnostic error?

	% ACCURACY LOGISTIC	% ACCURACY ANN
GLOBAL	74.40	75.36
GROUP		
Residents	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

The radiologist's gaze pattern can be used to predict diagnostic error

Predictive accuracy was >70% using only 3 gaze parameters

Individualized modeling appears to be better approach

Future Work

Increase the dataset

Include more eye-gazing parameters

Investigate more elaborate predictive models

Develop a computerized decision support system that is user-adaptive.

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ANY QUESTIONS?