

A General End-to-End Method for Characterizing Neuropsychiatric Disorders using Free-Viewing Visual Scanning Tasks

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Introduction

Background and Motivation

- Eye-gaze tracking technology is used by researchers to find metrics from human visual scanning behaviour (VSB) for objective diagnosis and monitoring of neuropsychiatric disorders
- Current techniques in this field are non-generalizable and rely on domain expertise and study-specific assumptions

Our Contributions

- We present a general, data-driven, end-to-end method that:
 - extracts relevant features of attention from biases in VSB
 - uses these features to classify between subject groups with vanilla MLPs
- Results on two study datasets show that our general method exceeds the performance of state-of-the-art study-specific analysis models

Visual Scanning Tests

Technology

- Visual Attention Scanning Technology (VAST, EL-MAR Inc. Toronto, Ontario, CA)
- Subjects sit ~65cm away from a 23-inch LCD monitor (1920x1080 pixels) with an integrated eye-tracking system

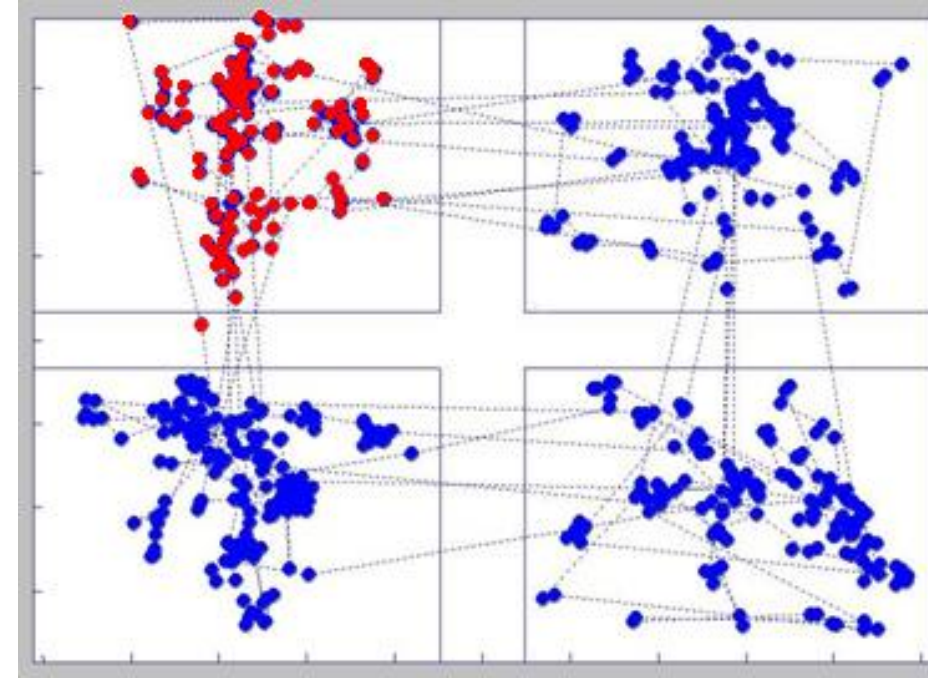
Eye-tracking Paradigm – Eizenman et al. (2003)

M. Eizenman, H. Y. Lawrence, L. Grupp, E. Eizenman, M. Ellenbogen, M. Gemar and R. D. Levitan, "A naturalistic visual scanning approach to assess selective attention in major depressive disorder," *Psychiatry research*, vol. 118, p. 117–128, 2003.

- Naturally view sets of slides (no task) for around 10 seconds each
- Each slide 4 discrete images of different themes in 2x2 grid format
- Images compete for patients' attention



Example of a slide containing 4 discrete images of happy and sad themes



Example of possible fixations and saccades for a subject viewing a slide

Data

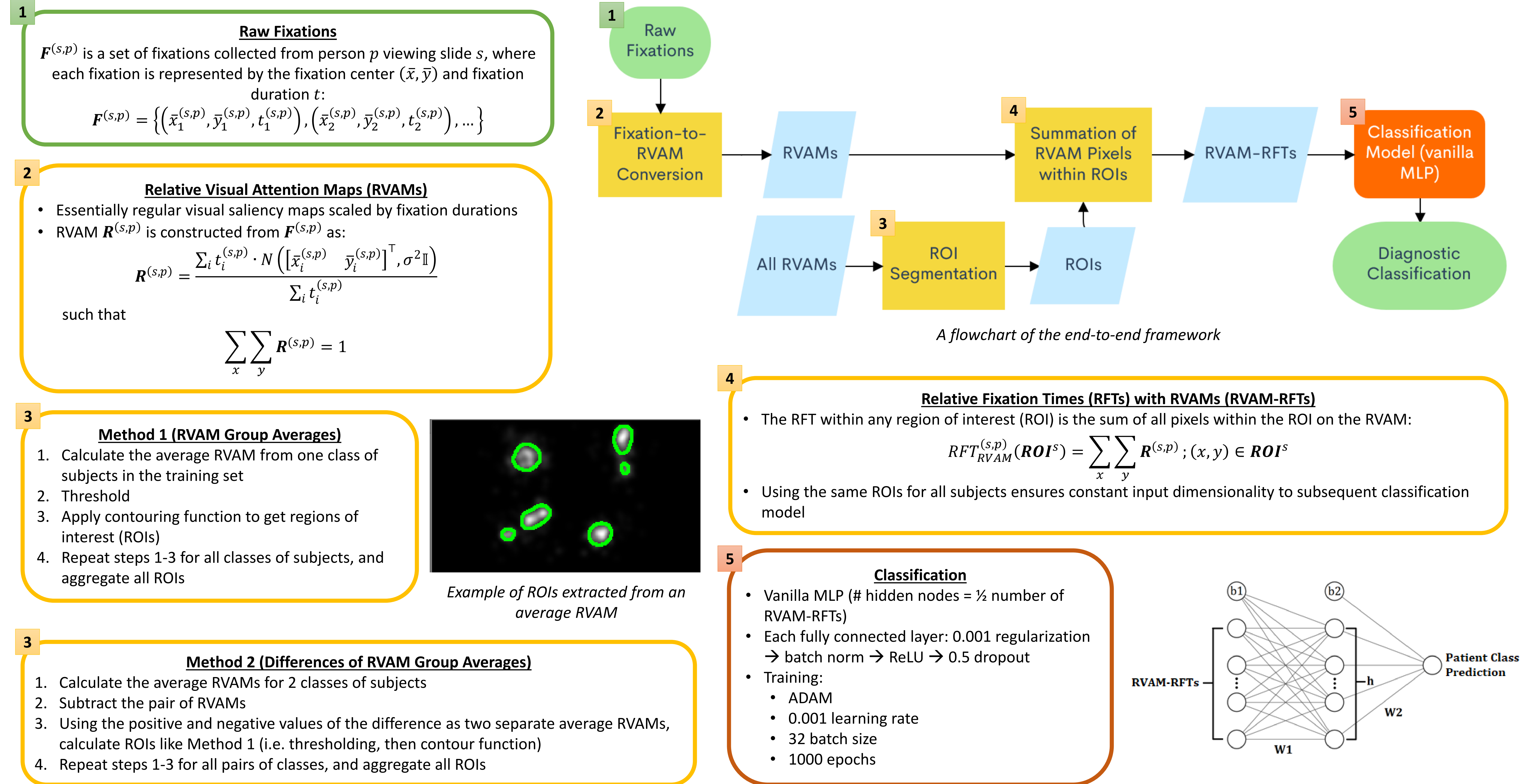
Anorexia Nervosa study (AN study)

- 37 total participants
 - 14 patients with AN
 - 23 control subjects
- 78 slides
 - 30 filler slides
 - 3 experimental sets of 16 slides each investigating attentional biases to body shapes

Depression study (BD/MDD study)

- 73 total participants
 - 26 depressed patients with bipolar disorder (BD)
 - 47 depressed patients with unipolar/major depressive disorder (MDD)
- 50 slides
 - 35 filler slides
 - 15 experimental set of slides with emotional faces

Methodology



Results

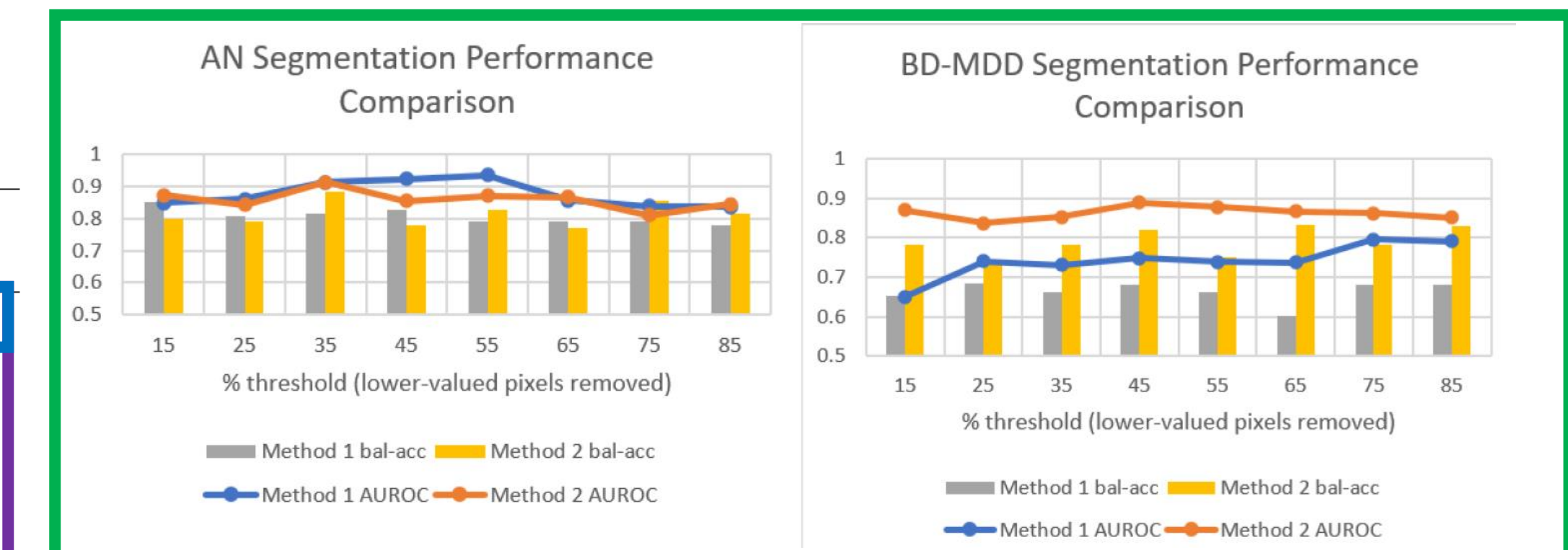
- General method can reliably segment granular ROIs, which are not manually predefined by study-specific domain knowledge (i.e. image-level boundaries corresponding to image themes)

- General method using Method 2 for ROI segmentation achieved results better than state-of-the-art study-specific methods

- General method using Method 2 for ROI segmentation is stable and robust to threshold variance

TABLE I
CLASSIFICATION RESULTS AND COMPARISONS

Techniques		AN			BD-MDD		
ROI	RFT	AUROC	Brier Score	Balanced Accuracy	AUROC	Brier Score	Balanced Accuracy
Method 2	RFT_{RVAM}	0.9130	0.1005	0.8851	0.8879	0.1753	0.8187
Method 1	RFT_{RVAM}	0.9348	0.1064	0.7919	0.7954	0.2394	0.6821
Manually defined (4 image boundaries)	RFT_{RVAM}	0.9596	0.0996	0.8137	0.5900	0.3275	0.5753
Baseline							
Manually defined (4 image boundaries)	RFT_{raw}	0.9130	0.1069	0.8571	0.6522	0.2831	0.5859
Past Work [7]							
LRCN					0.879		0.801
RNN w/ 3-by-3 per-image grid ROI					0.823		0.744



Acknowledgements

We acknowledge the support by the Natural Sciences and Engineering Research Council (NSERC) of Canada and the Vision Science Research Program (VSRP) at the University of Toronto and Toronto Western Hospital