Classification of Eye Tracking Data Using Saliency Map

Shafin Rahman[2], Sejuti Rahman[1], Omar Shahid[1], Md Tahmeed Abdullah[1] and Jubair Ahmed Shourov[1]
[1]University of Dhaka, [2]North South University
Dhaka, Bangladesh

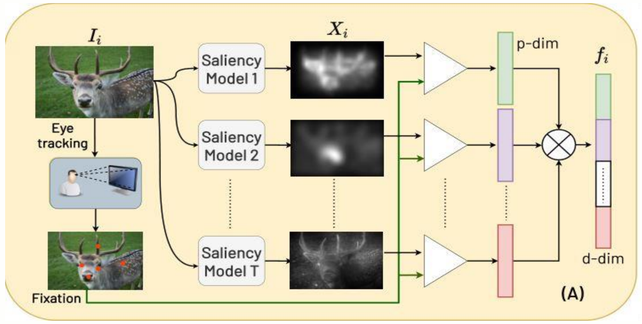
Problem Definition:

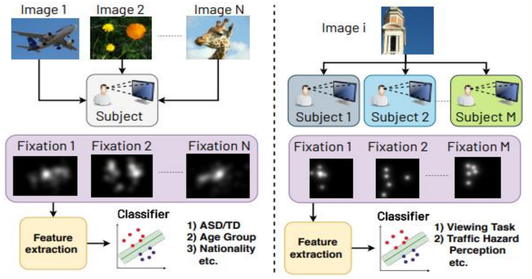
Classifying subject group (e.g. age, autism syndrome etc) and perceptual viewing task (e.g. free viewing, saliency viewing etc) using fixation data in an image.

Contributions:

- Novel Feature Extraction method for task agnostic eye-tracking data.
- Use Saliency maps to extract discriminative features for fixation data.
- State-of-the-art performance on three tasks, ASD screening, Toddler age prediction and Visual perceptual task prediction.

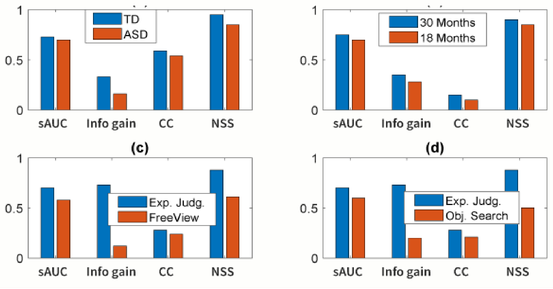
Proposed Method



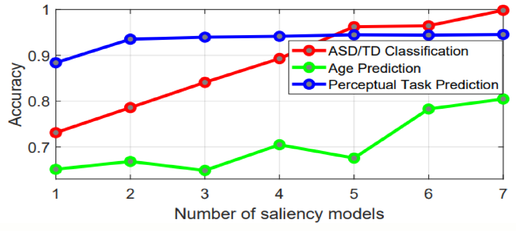


Why Saliency Maps?

Considering saliency maps as a standard prediction and comparing other fixation maps of different classes with this standard, one can distinguish fixation data. For comparison popular saliency evaluation metrices such as AUC Judd, AUC Borji, Shuffled AUC, Correlation Coefficient, KL Divergence, Info Gain and NSS.



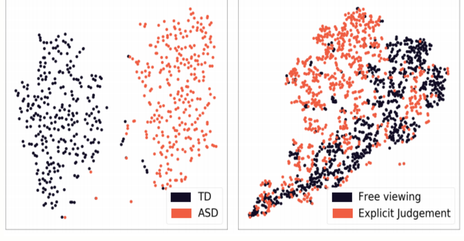
Ablation Study



Issues with Existing Methods

- Lack of a general task agnostic solution
- HoGs, Gist, Spatial density, LM filters, CNN feature (VGG,ResNet)
  - Same feature set does not consistently work across problems
- Different problems require to find different aspects of fixation data as distinguishing information
- The learning model cannot get enough supervision from a small amount of fixation data

Feature Visualization



Limitations

A notable limitation of this line of investigation is the unavailability of the large scale and public dataset. All the datasets used in this study are small scale containing the number of images and subjects at best 800 and 45, respectively. Moreover, datasets for such problems (ASD screening, Toddler age perdition etc.) are publicly unavailable. In future, one can collect large scale data and open it for researches to further investigate the applicability of eye-tracking data in real-life applications.

Experiments & Results

ASD/TD Classification

ASD/TD Classification Results

	Accuracy	Sensitivity	Specificity	AUC
Chen'19 (Independent) [4]	89.00	86.00	93.00	92.00
Chen'19 (Full) [4]	93.00	93.00	93.00	98.00
Ours (SVM)	99.50	96.70	99.30	99.50
Ours (XGBoost)	**99.80**	**1.00**	**99.70**	**99.80**

Toddler's age Classification

Toddler Age Classification Results

	Accuracy	Sensitivity	Specificity	AUC
Dalrymple'19 [2]	**83.00**	**90.00**	81.00	**84.00**
Ours (SVM)	75.60	78.90	72.70	75.80
Ours (XGBoost)	**83.00**	84.20	**81.80**	83.00

Perceptual Task Classification

	Free/obj	Free/Sal	Free/Exp	Obj/Sal	Obj/Exp	Sal/Exp
All images and subjects						
Boisvert'16 [5]	84.38	66.13	89.75	89.88	97.75	90.00
Ours (SVM)	**86.35**	**78.57**	95.33	**94.70**	**97.80**	**96.20**
Ours (XGBoost)	84.20	74.30	**96.50**	84.25	97.70	96.10
50% images but all subjects						
Boisvert'16 [5]	73.41	59.59	-	71.01	-	-
Ours (SVM)	**79.54**	**71.70**	**86.21**	82.31	**90.20**	**91.56**
Ours (XGBoost)	78.80	69.60	86.13	**82.51**	88.60	90.36
All images but 50% subjects						
Boisvert'16 [5]	79.98	60.16	-	77.85	-	-
Ours (SVM)	**82.30**	**66.25**	**78.77**	**81.33**	**84.57**	**83.18**
Ours (XGBoost)	77.20	64.32	75.13	80.23	79.00	81.50

Summary

- Existing eye tracking classification methods are not generalized across tasks
- Employ popular Saliency models for feature extraction from fixation data
- Shows significant performance boosts in comparison to similar investigations