GridFix: A Python toolbox to facilitate fixation analysis and evaluation of saliency algorithms using Generalized linear mixed models (GLMM)

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Introduction

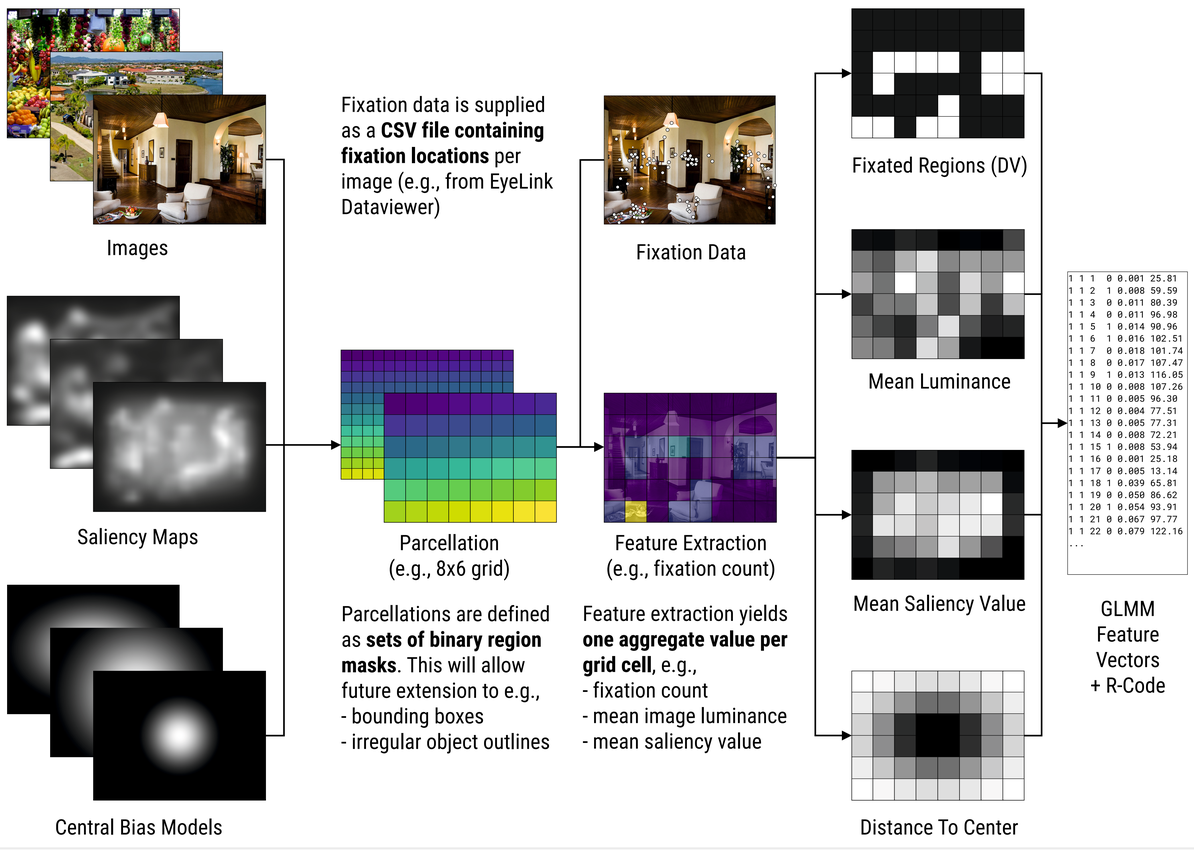
Recently, we proposed a method of fixation analysis in visual scenes based on Generalized Linear Mixed Models (GLMM) [1]. This new approach uses a-priori image parcellation using e.g., a regular grid of image regions.

Here, we present a Python toolbox [2] to facilitate the necessary data pre-processing. As an example application, we compare three different saliency models and how well they predict fixations above and beyond the contribution of the central fixation bias (CB).

Dataset

- N=42 student participants (8M / 34F; 18-29 years of age; mean age 22.1 years)
- 150 photographs of indoor/outdoor real-world scenes (800x600 pixels)
- Memorization task, each scene viewed for 6 s in random order
- Binocular gaze recording using EyeLink 1000 at 1000 Hz per eye

GridFix Toolbox Workflow



Example Analysis

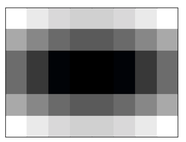
Example Research Question: how well does a given saliency model predict image fixations, above and beyond a central fixation bias?

Input Image

Classic Saliency
Itti, Koch & Niebur, 1998
r_{CB} = -0.50

AWS
Garcia-Diaz et al., 2012
r_{CB} = -0.37

GBVS
Harel, Koch & Perona, 2007
r_{CB} = -0.83



Anisotropic Euclidean Distance (v=0.45)

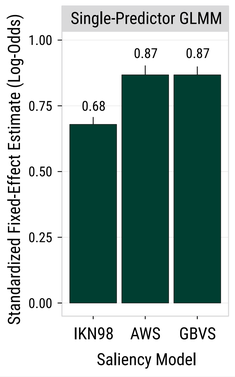
- Single-predictor GLMM: fixed effect of local saliency (i.e., mean saliency per cell)
- Two-predictor GLMM: local saliency predictor + CB distance predictor

Example Code

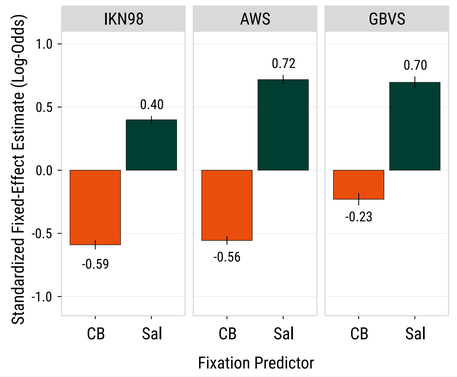
```
from gridfix import *

# Load saliency maps and define grid parcellation
maps = ImageSet('/path/to/saliency_maps')
grid = GridRegionSet(maps.size, gridsize=(8,6))

# Define features of interest
ff_sal = MapFeature(maps, grid, stat=mean())
ff_cb = CentralBiasFeature(maps, grid, measure='gaussian')

fix = Fixations('fixation_data.csv')

# Define the model. update() will start preprocessing data
glmm = FixationModel(fix, grid, features=[ff_sal, ff_cb])
glmm.update()
glmm.save('output_file')
```

- Object-oriented toolbox, suitable for both interactive and script use
- Outputs feature values and R source code, to be adapted to each study
- Parcellations and features can be easily combined into different GLMM factor structures as needed

Results



- Both CB and saliency can independently predict fixations
- GLMM estimates allow for saliency model comparison
- Saliency models incorporating a central bias (e.g., GBVS) yield lower independent CB effect



Ref.

[1] Nuthmann, A., & Einhäuser, W. (2015). A new approach to modeling the influence of image features on fixation selection in scenes. *Annals of the New York Academy of Sciences*, 1339(1), 82-96.

[2] https://github.com/ischtz/gridfix (see QR code)

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European Conference on Visual Perception (ECVP) 2016 • Aug 28th - Sep 1st • Barcelona

Funding: data collection was funded by a BA/Leverhulme Small Grant to AN (grant number SG142521).