Mimicking Face Pareidolia with CNNs

A trial and error expedition...

by Roman Kessler

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on July 9, 2020

Mimicking Face Pareidolia with CNNs

* what is face pareidolia?
* experiment for "measuring" face pareidolia
* current research question
* transfer learning with MobileNet_v1
* predicting faces in random noise
* revealing "internal face templates"
* conclusion & limitations

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» examples of face pareidolia

https://imgur.com/r/pics/zESfT

» examples of face pareidolia

M. J. Carlotto, “Digital imagery analysis of unusual martian surface features”, Applied Optics,vol. 27, no. 10, pp. 1926–1933, 1988

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» example stimulus

Random noise stimulus.

* 12 subjects
* each rated 1000-3300 random noise images

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» research question

* Can we build a machine, that mimics the subjects' face pareidolia?
* more explicitly: Can this machine find any correlate of a face in the stimuli, the subject labelled as "face" vs. the stimuli, the subject labelled as "non-face"?

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» training classes


face

"non-face"

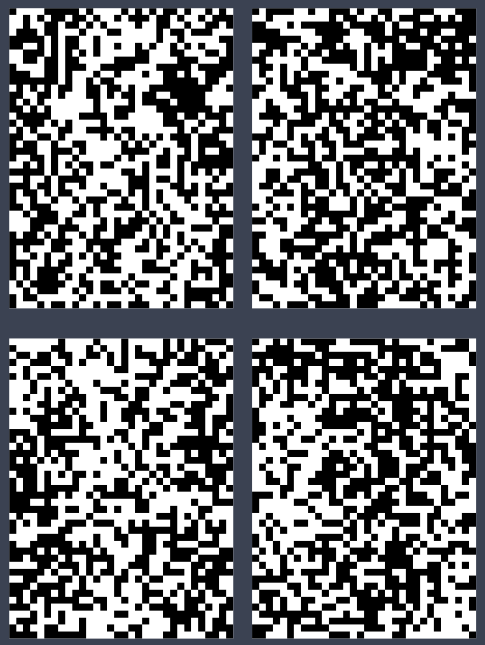
Example training images.

* https://www.kaggle.com/chetankv/dogs-cats-image
* S. Yang, P. Luo, C.-C. Loy, and X. Tang, "From facial parts responses to face detection: A deep learning approach", in Proceedings of the IEEE international conference on ComputerVision, pp. 3676–3684, 2015.

» image preprocessing pipeline

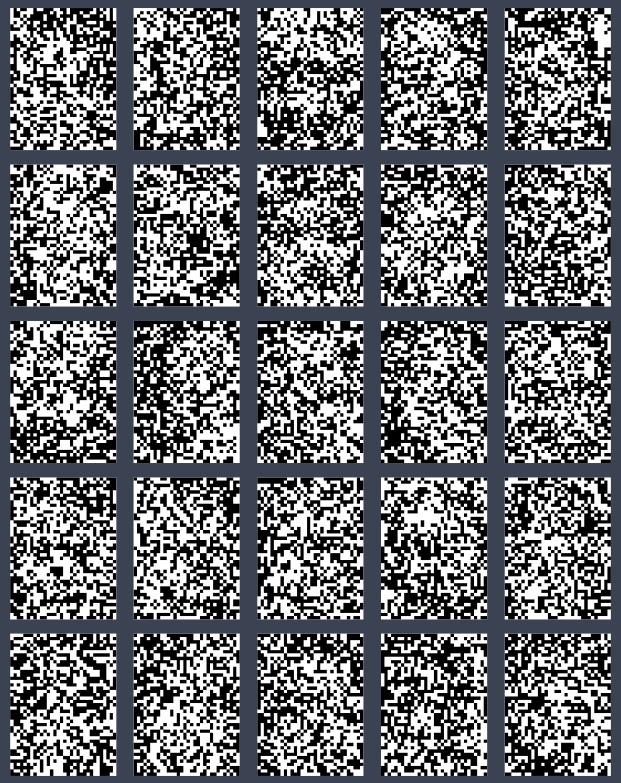
1. convert to grayscale
2. cropping the borders
3. rescale to 43x32
4. determine median pixel value
5. binarizing image (threshold: median)
6. pseudo-convert to RGB
7. augmentation of non-face class
    * mirroring
    * inverting
8. add artificial noise (p=0.4)

» processed & augmented non-face examples



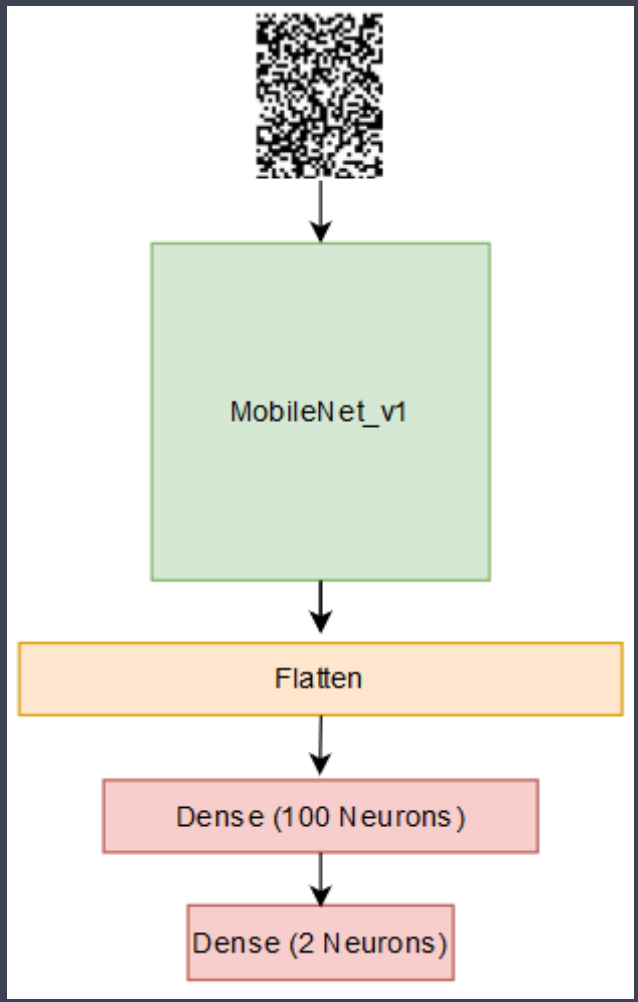
artificial noise: 80%

» processed face examples



artificial noise: 80%

» model architecture



- train stimuli per class: 19.000
- test stimuli per class: 5.000
- no frozen layers
- optimizer: Adam
- loss: Binary Crossentropy
- epochs: 20
- batch size: 25
- train accuracy: 97%, test accuracy: 86%

Layer 1 is the MobileNet_v1,Layers 2-end are custom.

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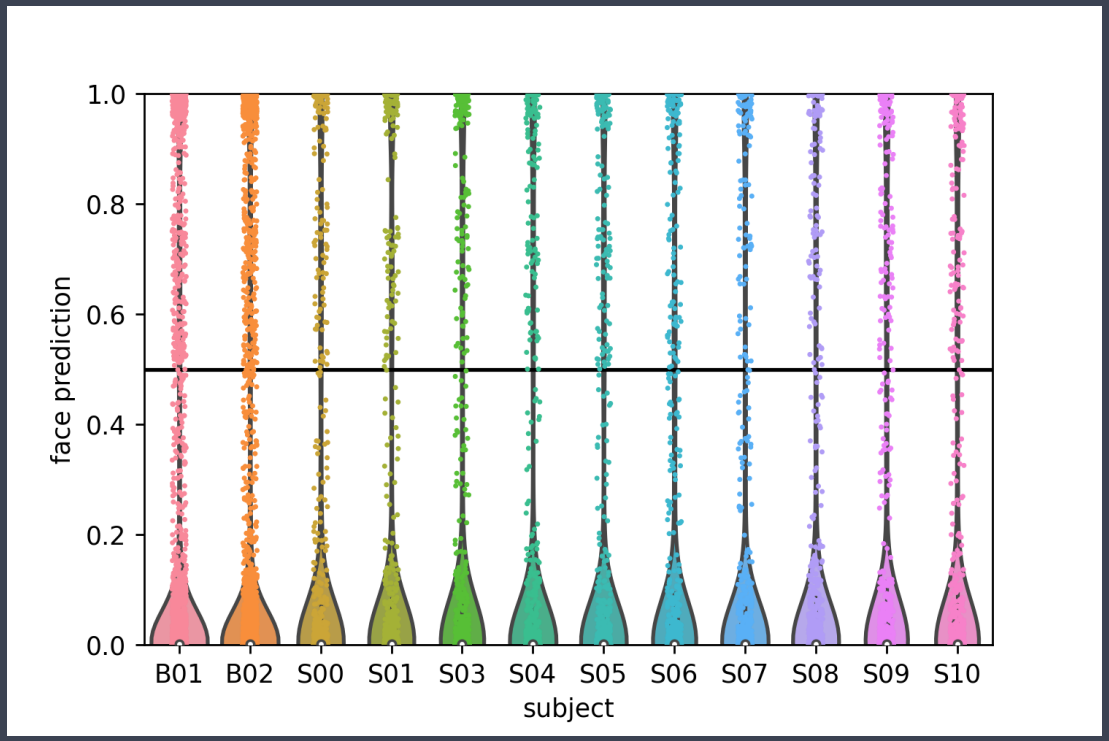
» face predictions by the model



face probabilities (predicted by model) in pure noise stimuli of each subject

* no significant overlap between model prediction and subject labeling (all p > 0.05, Bonferroni corrected)

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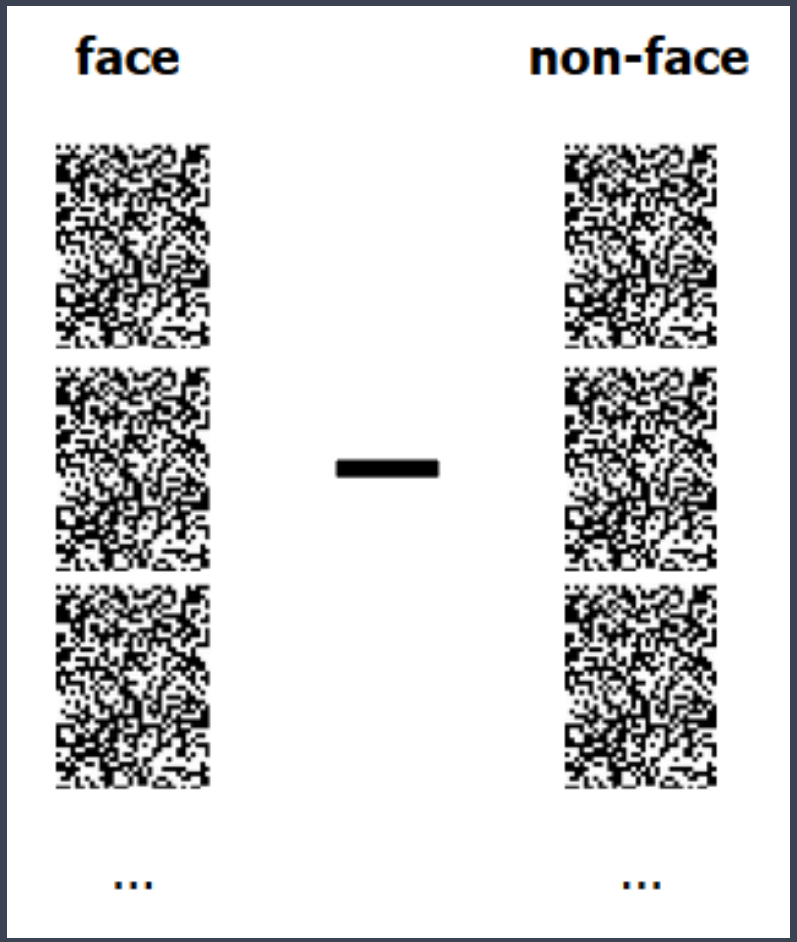
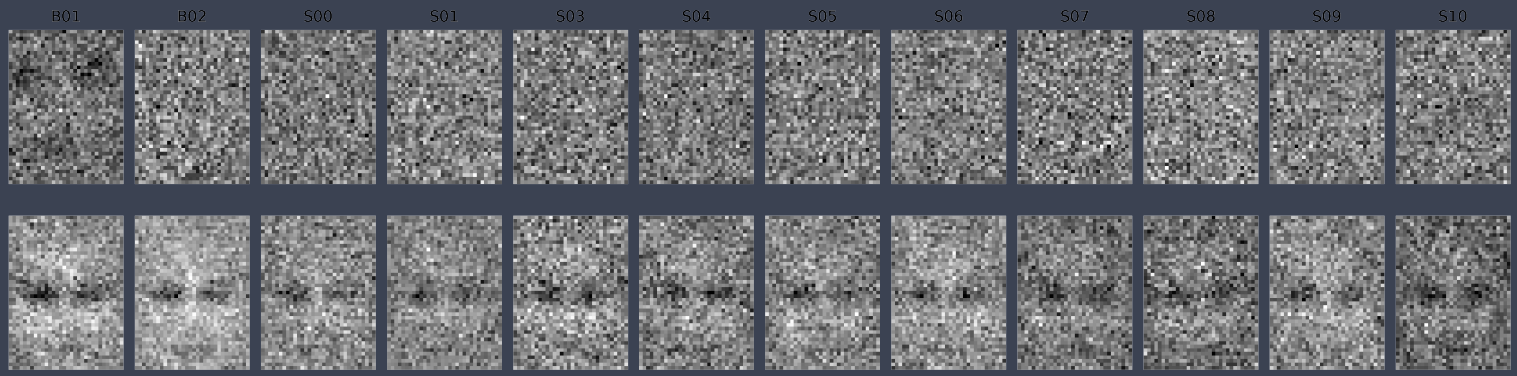
» face vs. non-face noise stimuli



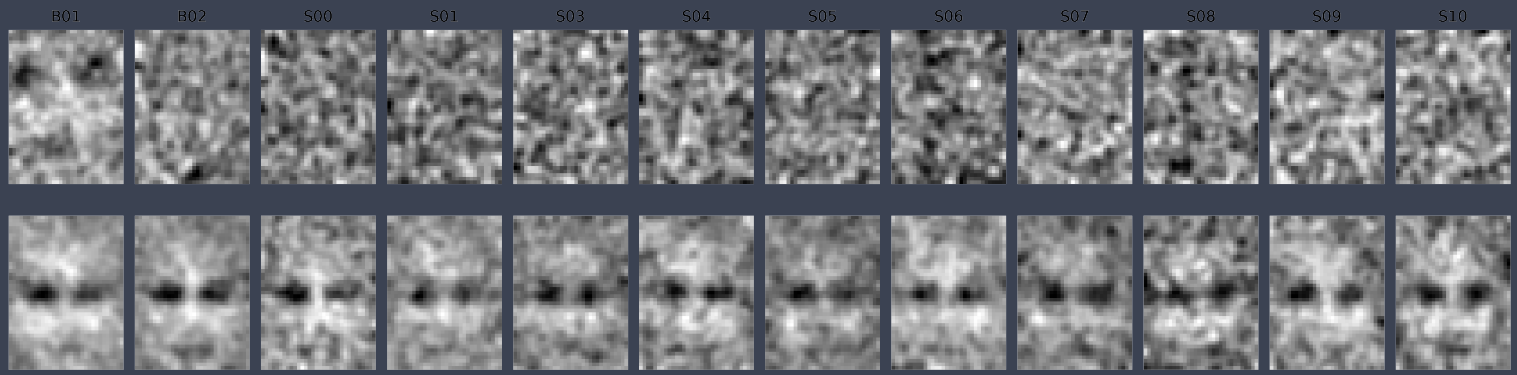
$$\frac{1}{n} \cdot \sum_{i=1}^{n} \text{Image}_i - \frac{1}{m} \cdot \sum_{j=1}^{m} \text{Image}_j$$

» face vs. non-face noise stimuli



top: subjects' internal face templates,bottom: model's internal face templates

» face vs. non-face noise stimuli



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gaussian smooth on template with $\sigma = 1$

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» conclusion

* development of binary face-classifier on noisy input images works
* however, no significant agreement between face classifier's predictions and subjects' classifications
* internal template of face classifier seems consistent across different data sets

» limitations

- suitable train classes?
- face-class to homogeneous?
- different network architecture?
- no measure of (un)certainty of subjects' classifications (include reaction time?)

Dead ends:

- using already existing face detectors or face classifiers
- viola jones / haar cascades ...
- train with "pure noise" stimuli, labelled by subject
  - without augmentation: overfitting
  - with augmentation: no learning

» Data availability statement

All used data, analysis pipelines, and further experiments can be retrieved from my GitHub repository

https://github.com/kesslerr/facepareidolia

Please feel free to experiment by yourself. Please cite Thome et al., 2020 (in press) when use.

I want to thank Ina Thome for the stimulus material, which was kindly provided.

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