

Learning where to look: A foveated visuomotor control model

Emmanuel Daucé, Pierre Albigès & Laurent Perrinet



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Acknowledgements:

- Rick Adams and Karl Friston @ UCL - Wellcome Trust Centre for Neuroimaging
- Jean-Bernard Damasse and Laurent Madelain - ANR REM
- Frédéric Chavane - INT



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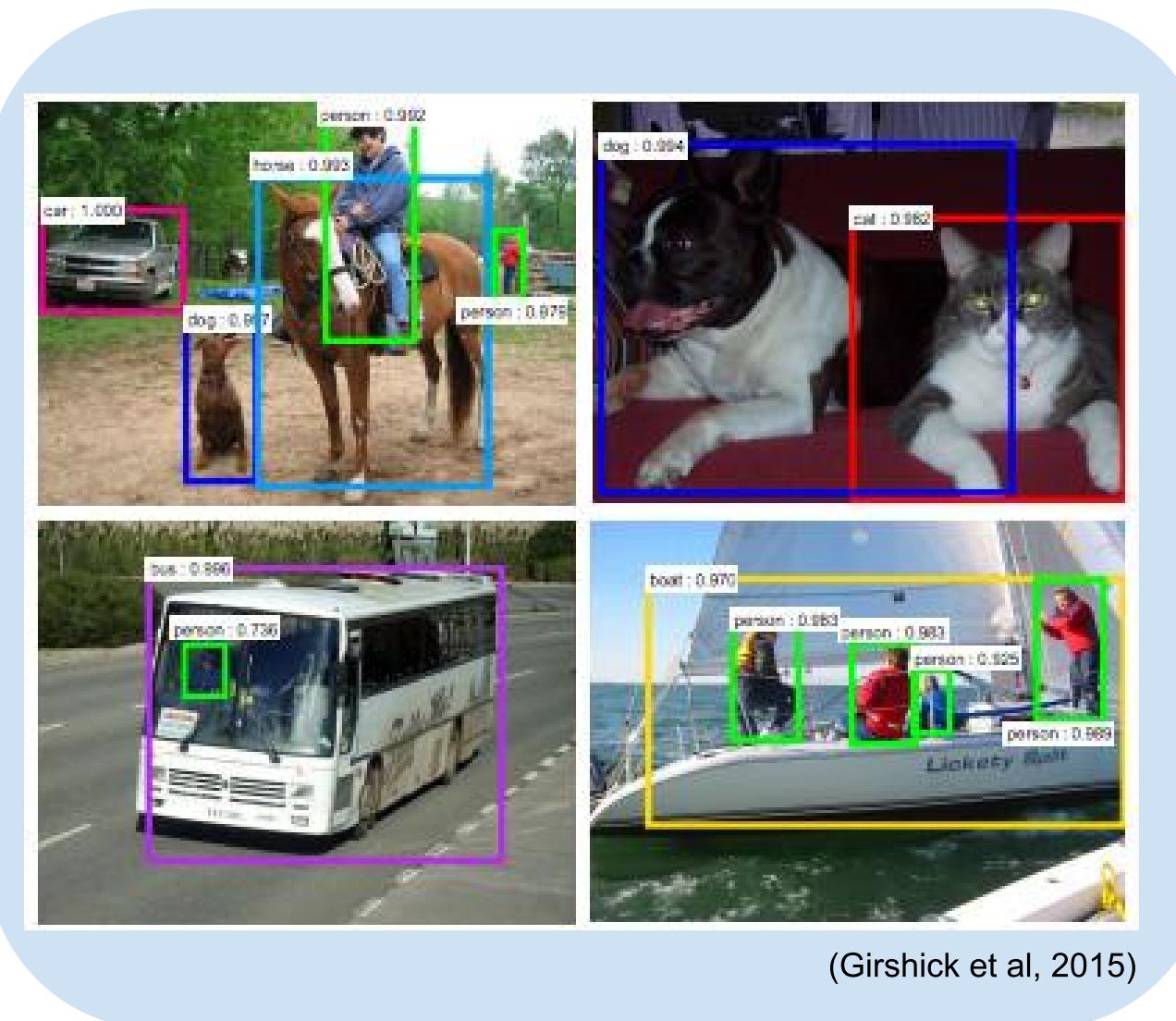
Outline

1. Motivation
2. Methods
3. Results
4. Conclusion

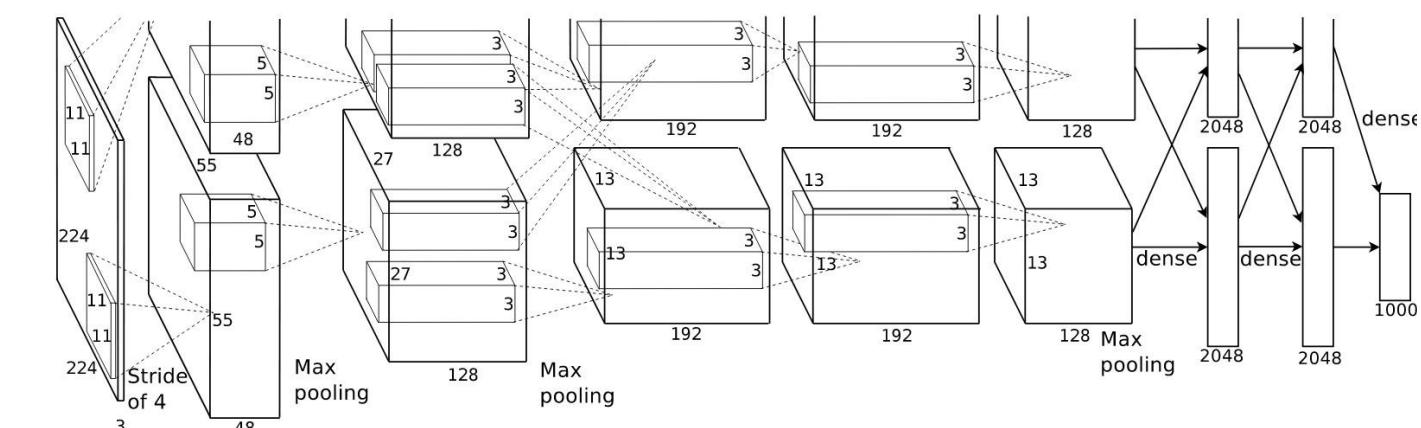
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Computer vision

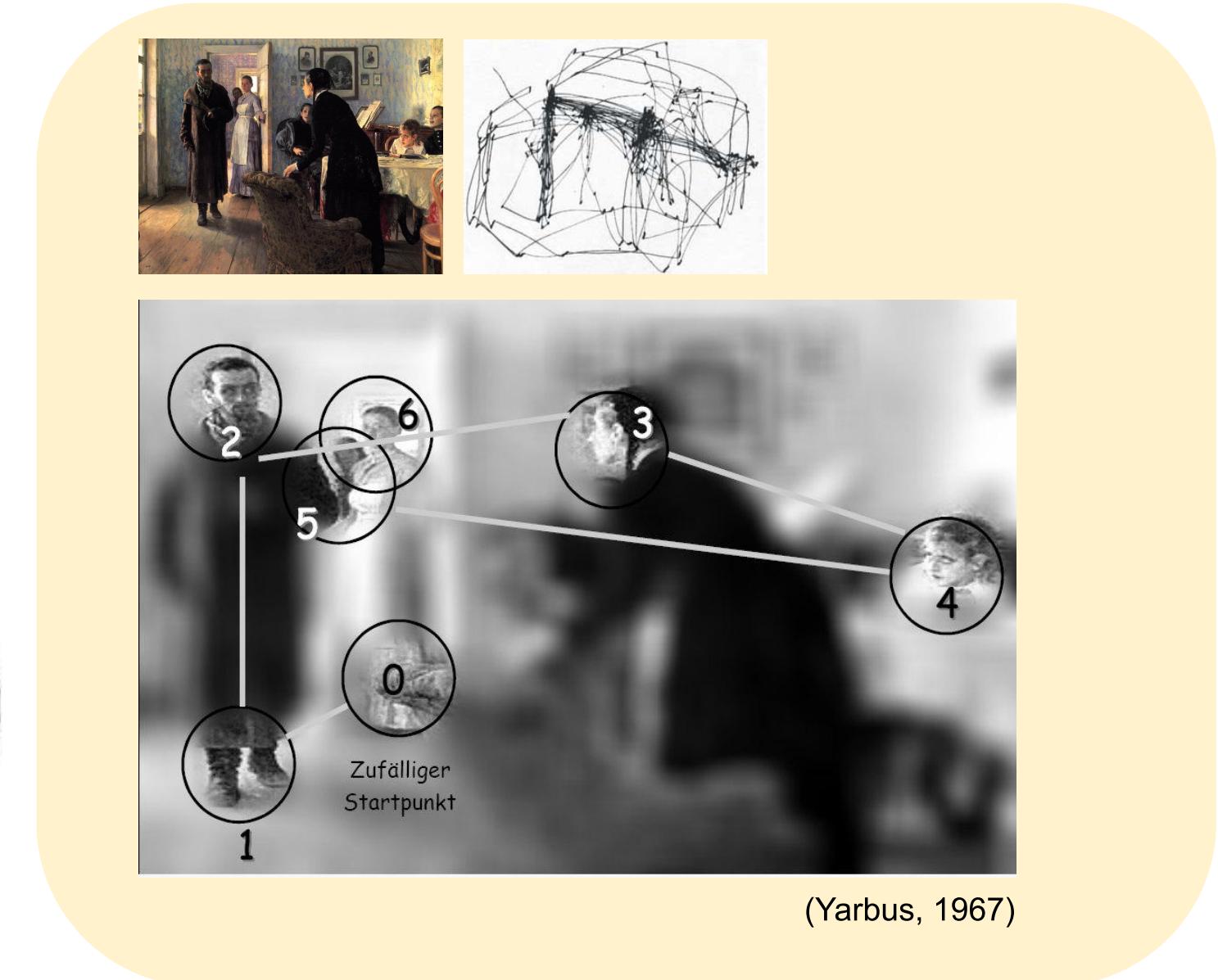
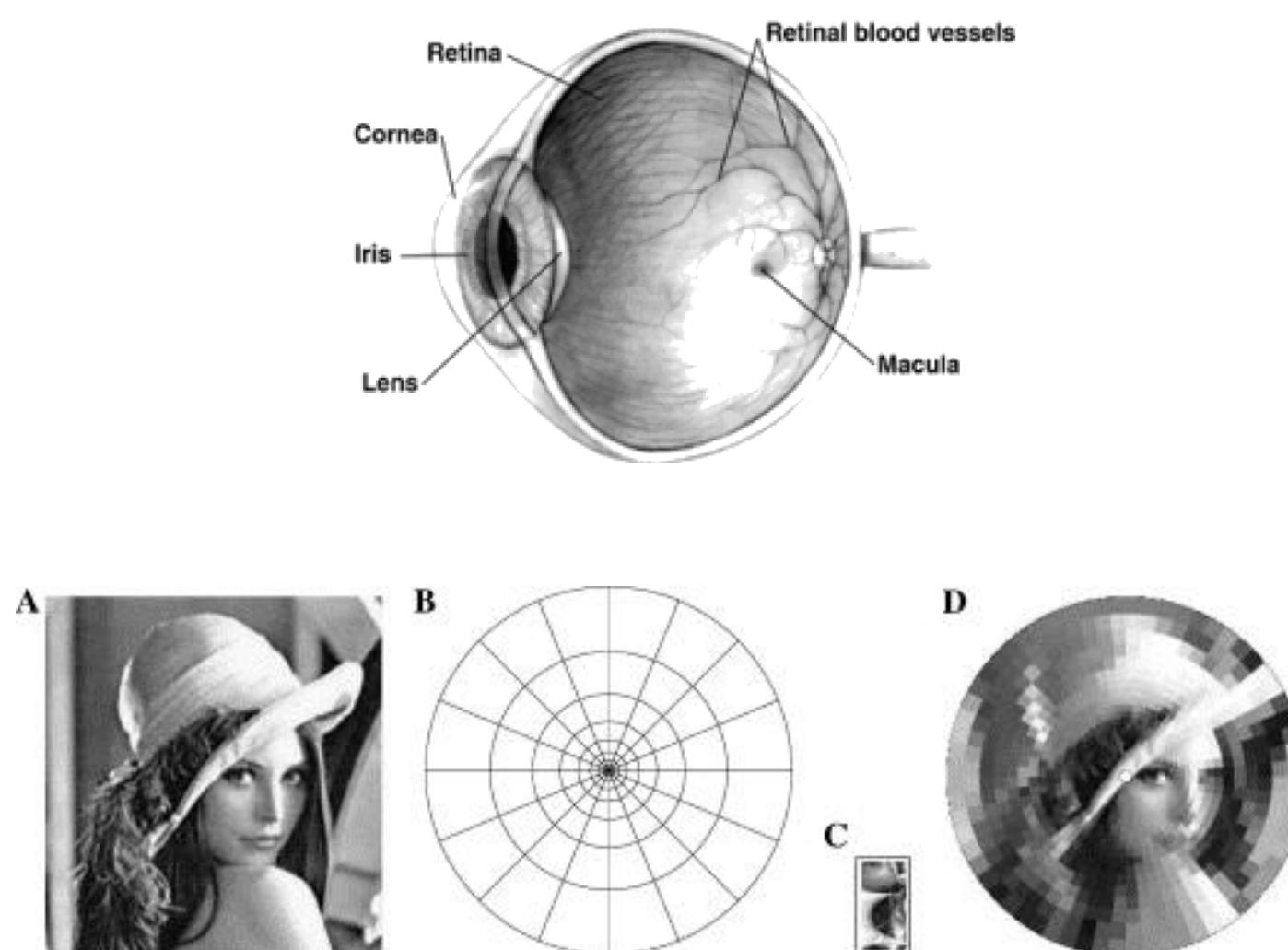


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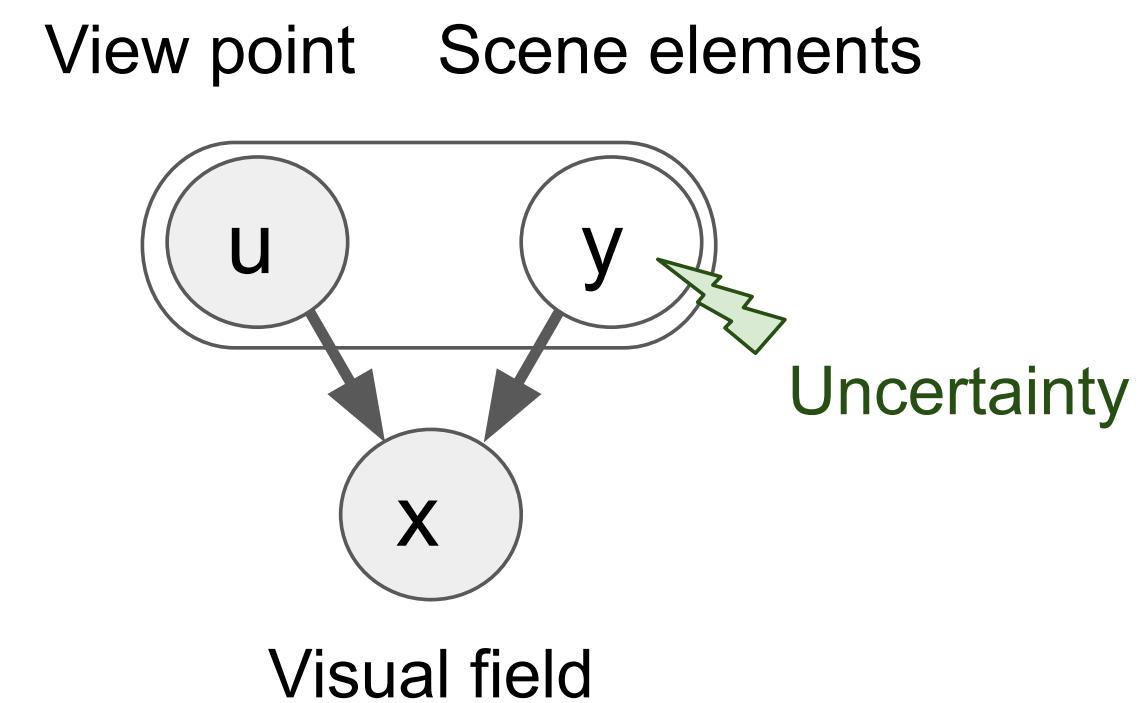
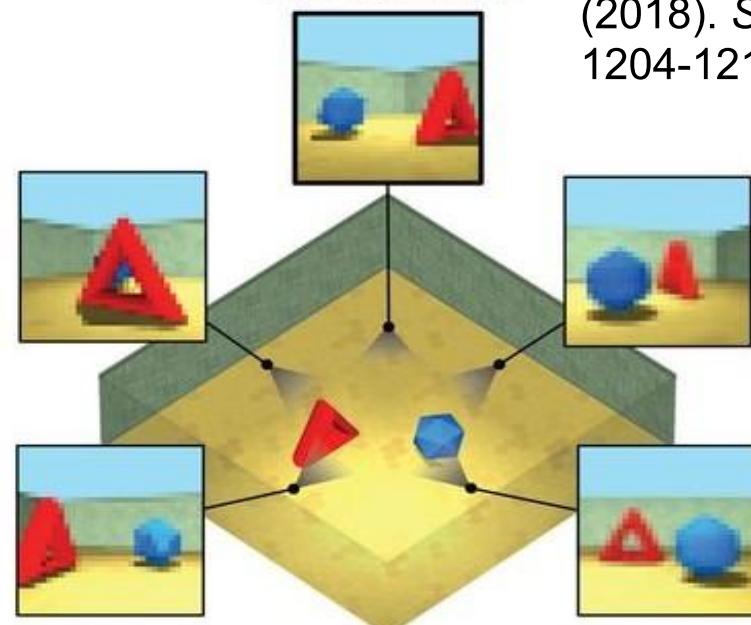
(Hinton et al, 2012)

Human vision



Statistical Viewpoint

Eslami, S. A., Rezende, et al.
(2018). *Science*, 360(6394),
1204-1210.



Attention vs. Scene Understanding

Bayesian surprise (Information Gain)	$E_y [\log P(Y x, u) - \log P(Y)]$
(Itti & Baldi, 2009)	

B O T T O M - U P

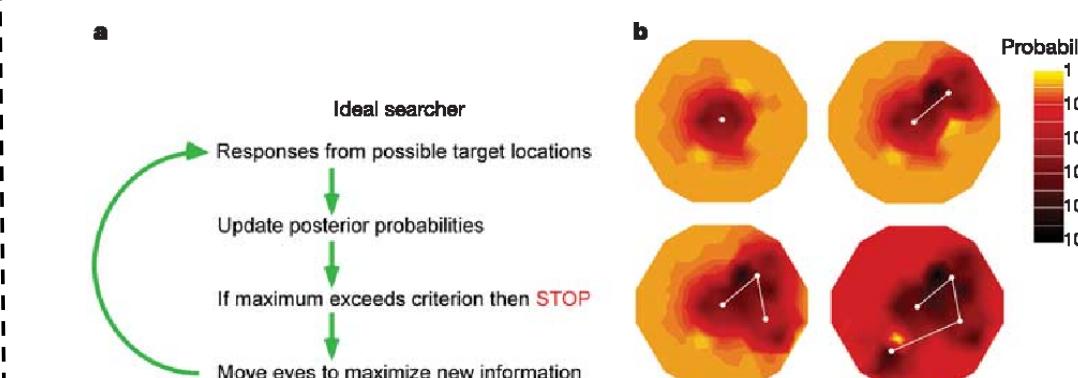
Visual attention
Saliency Maps



Itti and Koch (2000)
Kümmerer et al (2015)

T O P - D O W N

Active Inference
Recurrent Attention



Najemnik, J., & Geisler, W. S. (2005)
Butko & Movellan (2010)
Fu et al (2017)

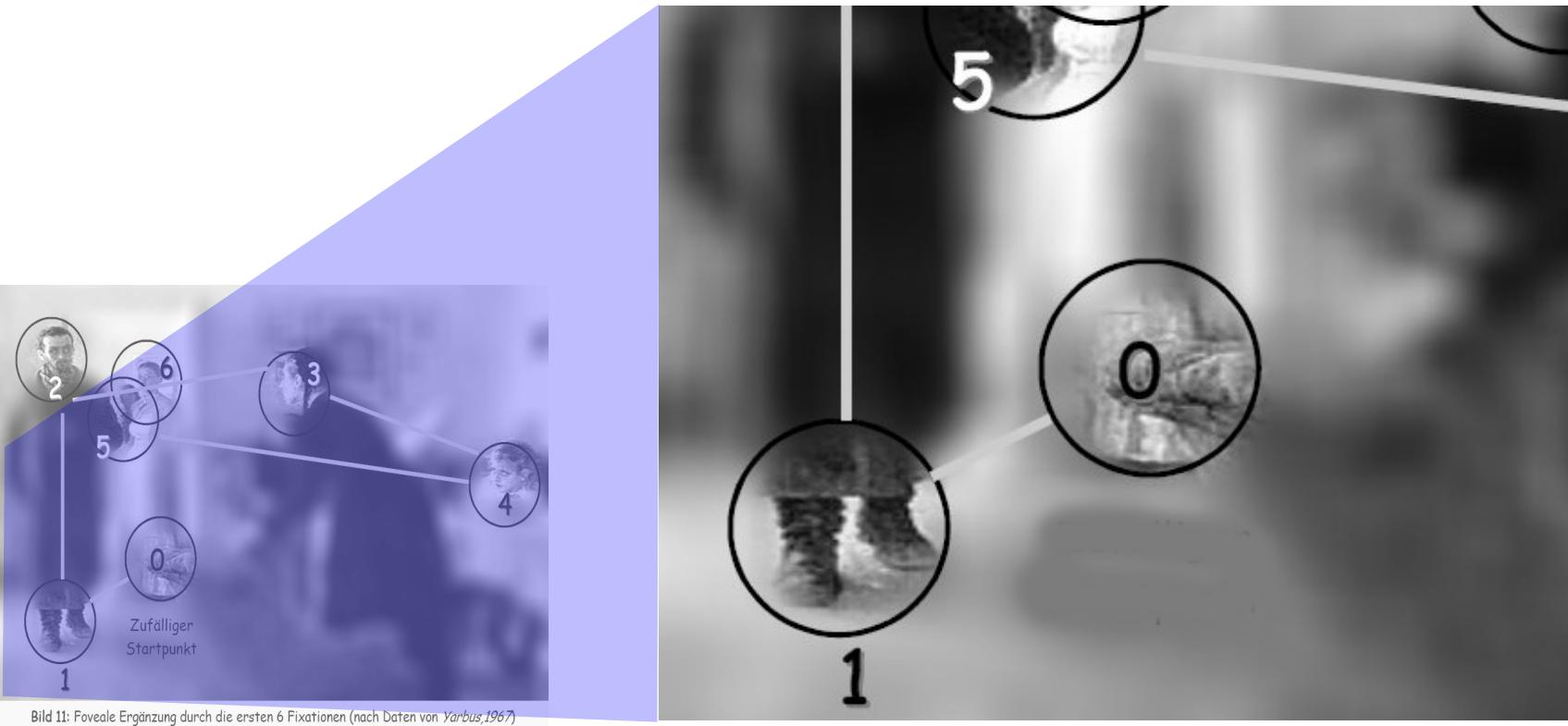
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Principles for central and peripheric vision



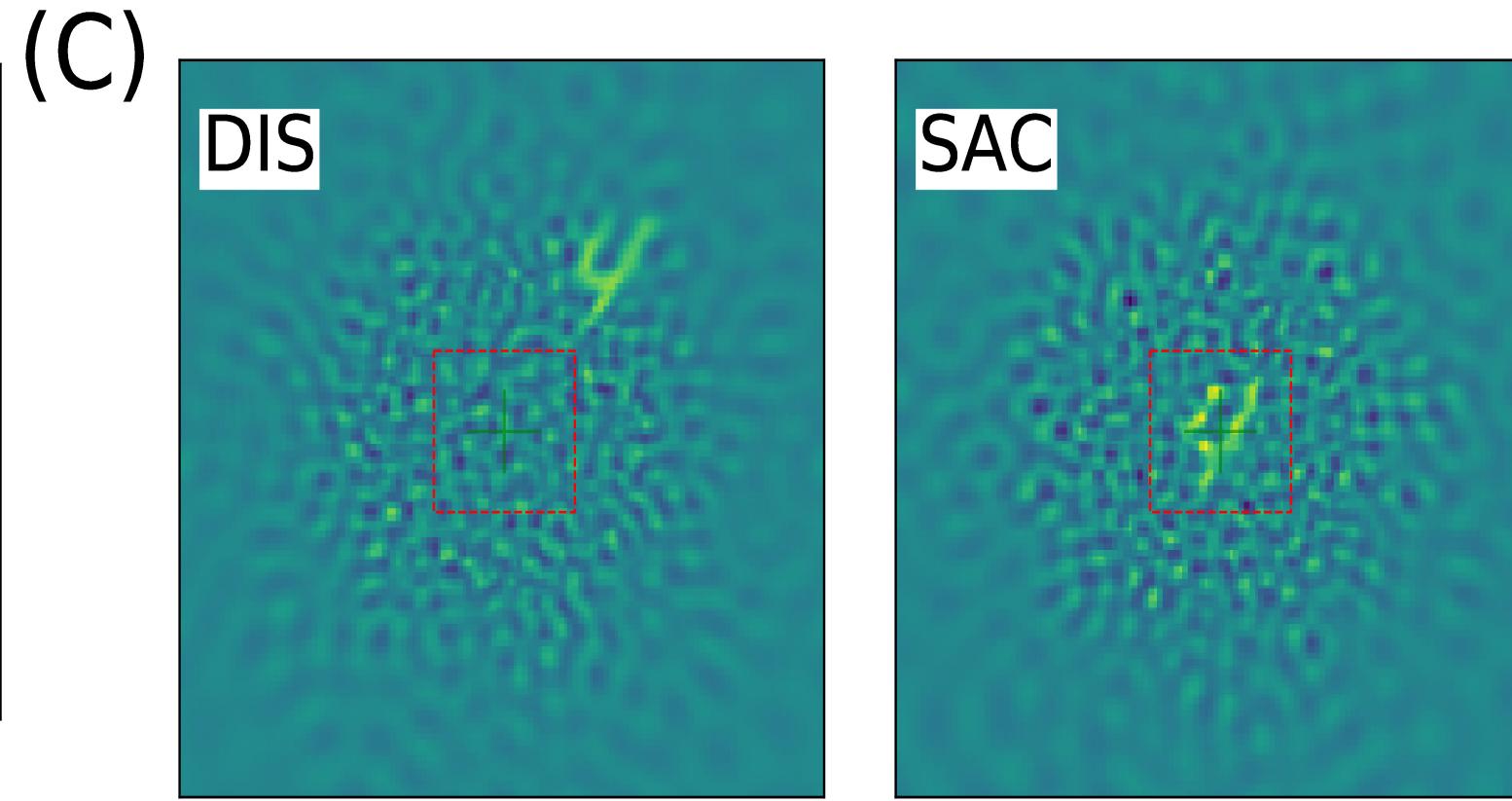
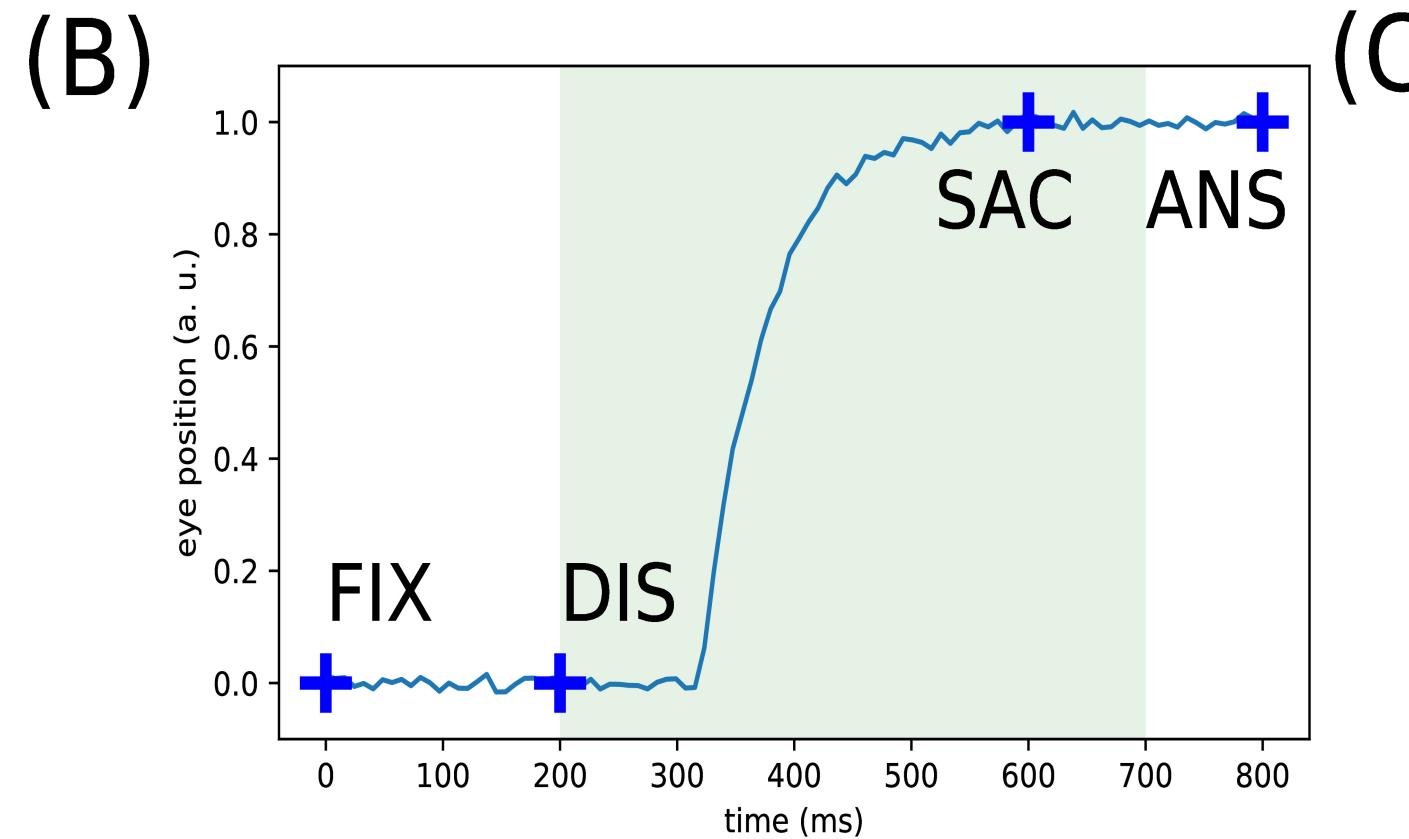
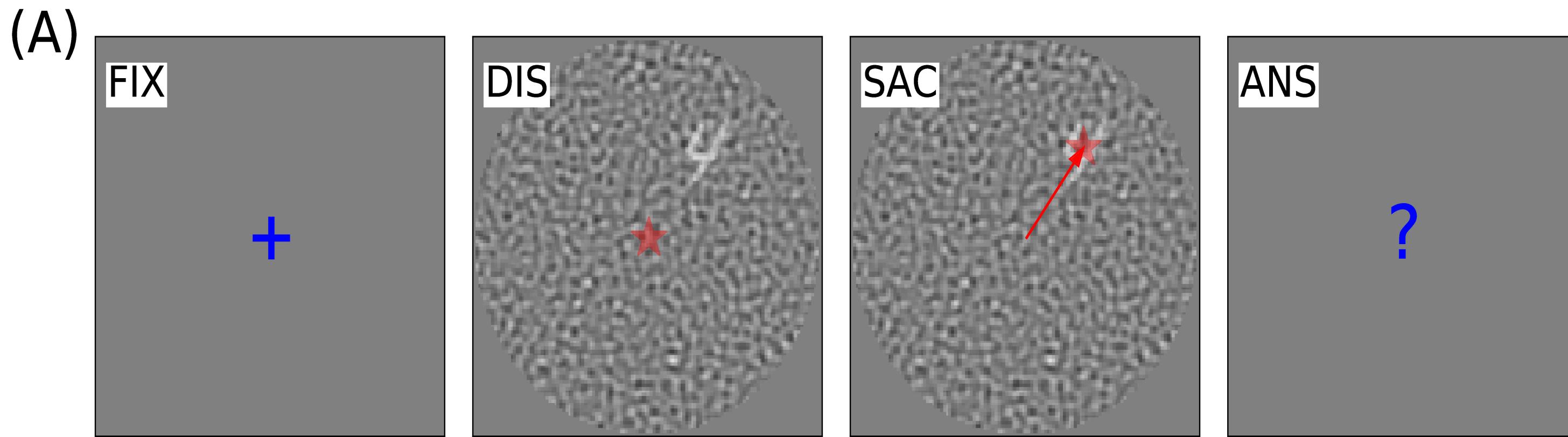
Information Gain :

$$E_y [\log P(Y|x, u) - \log P(Y)]$$

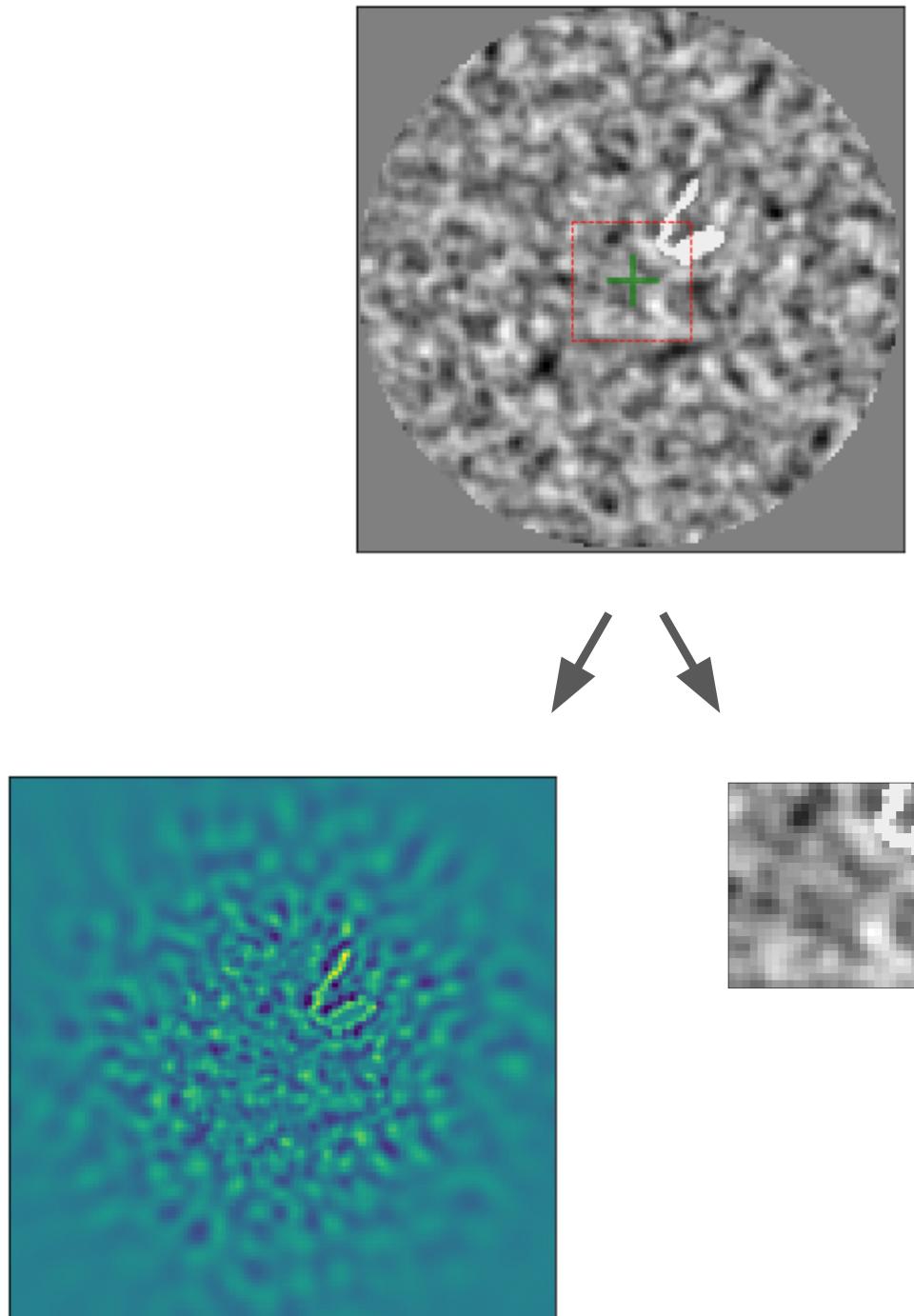
Peripheral processing

Central processing

Methods - "Experimental" setup



Methods: What/Where separation



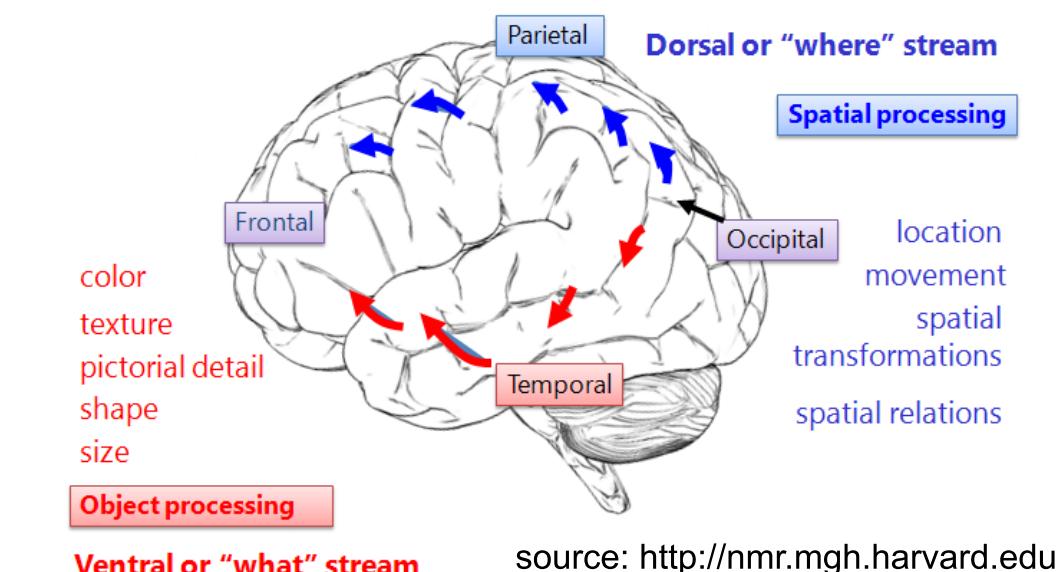
Approximate Information Gain :

$$E_y [\log P(Y|x, u) - \log P(Y)] \approx \log P(\hat{y}|x, u) - \log P(\hat{y})$$

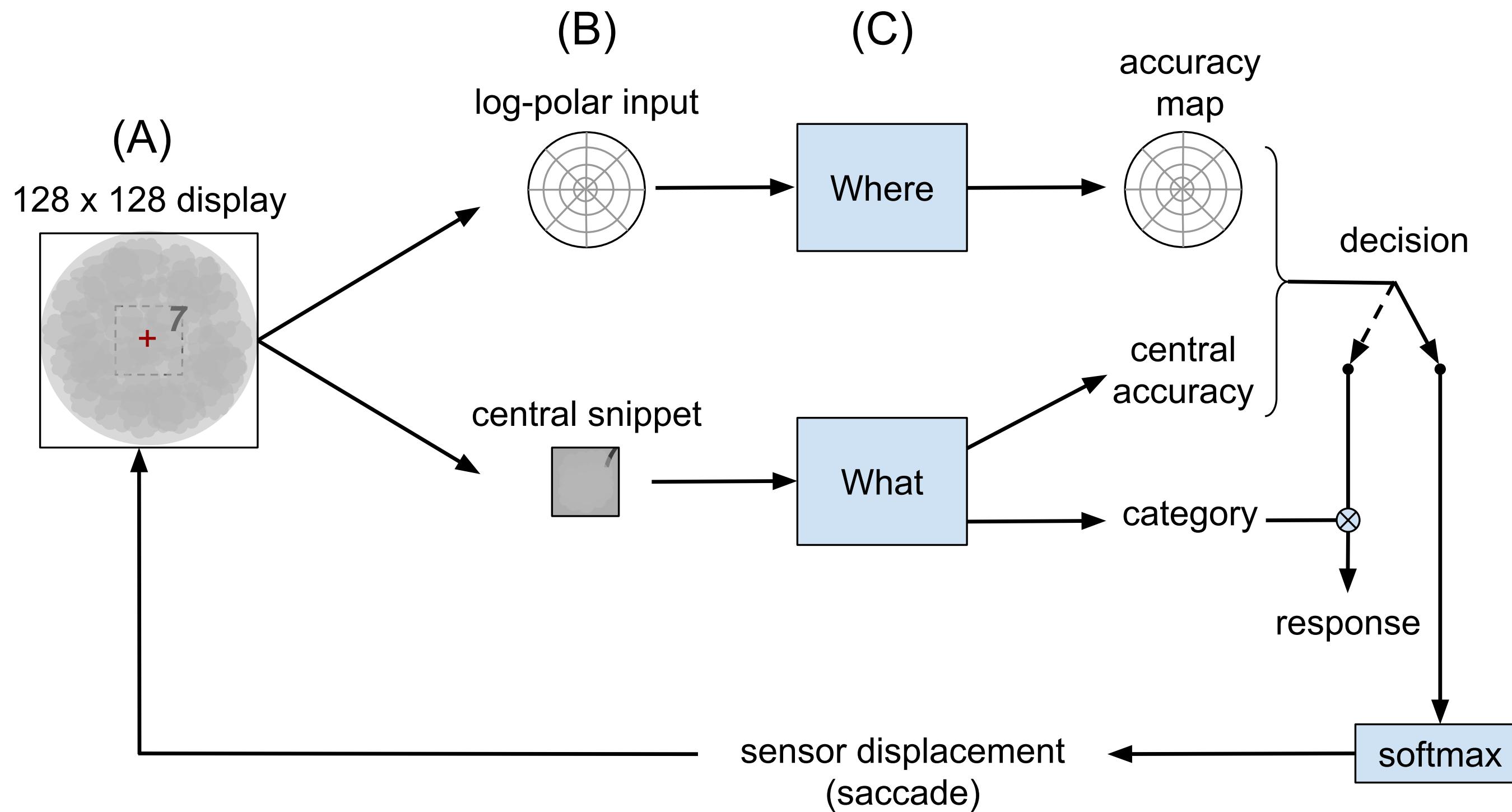
Future Central Accuracy
(after saccade)

Central Accuracy

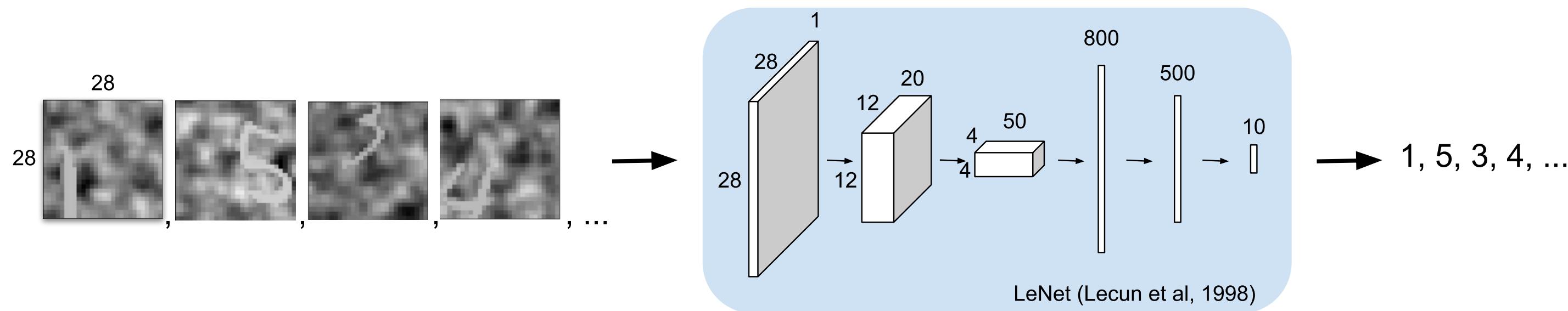
What/where pathways in visual processing
Mishkin, M., Ungerleider, L. G., & Macko, K. A. (1983).



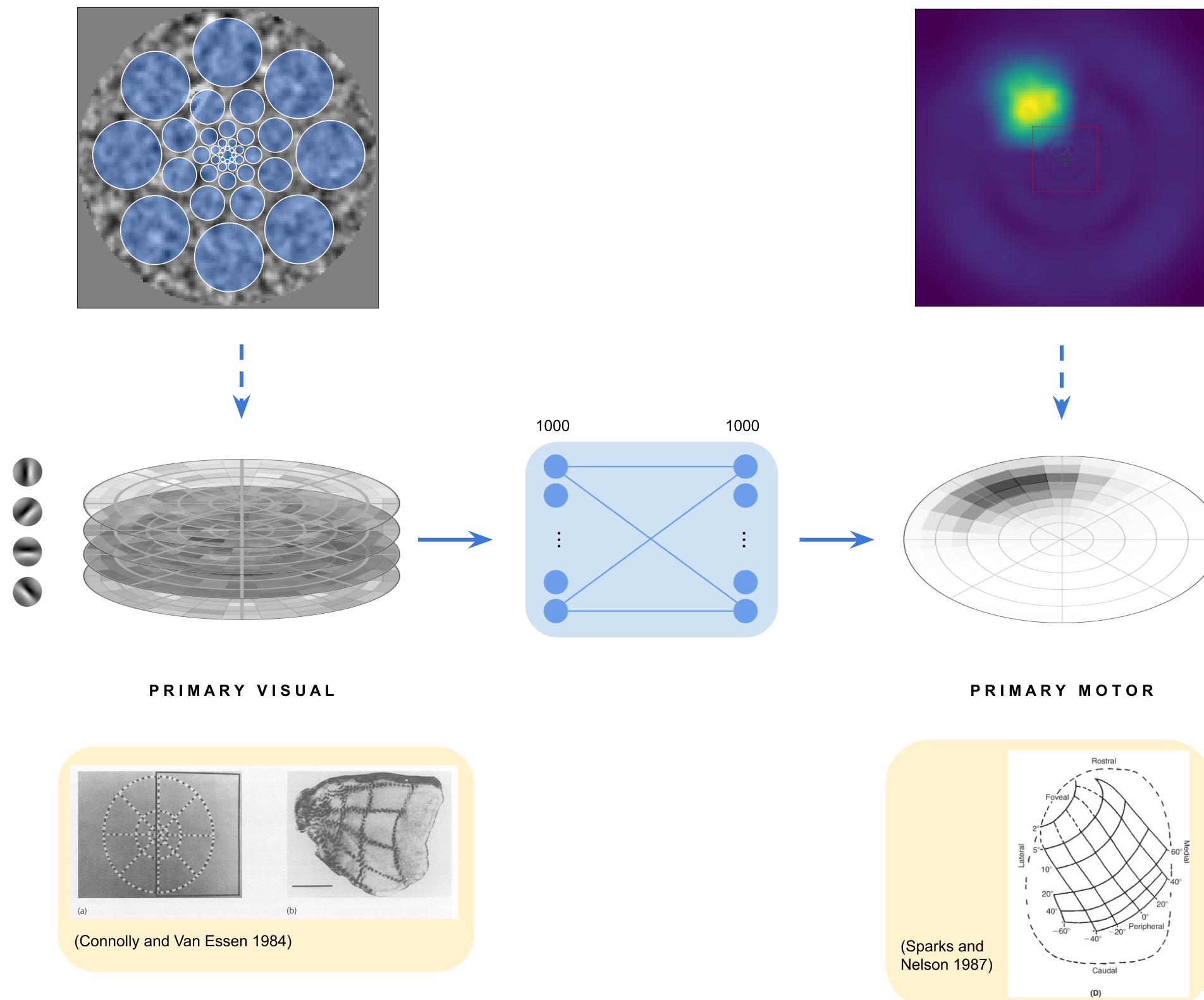
Methods: Computational Graph



Methods: What



Methods: Where



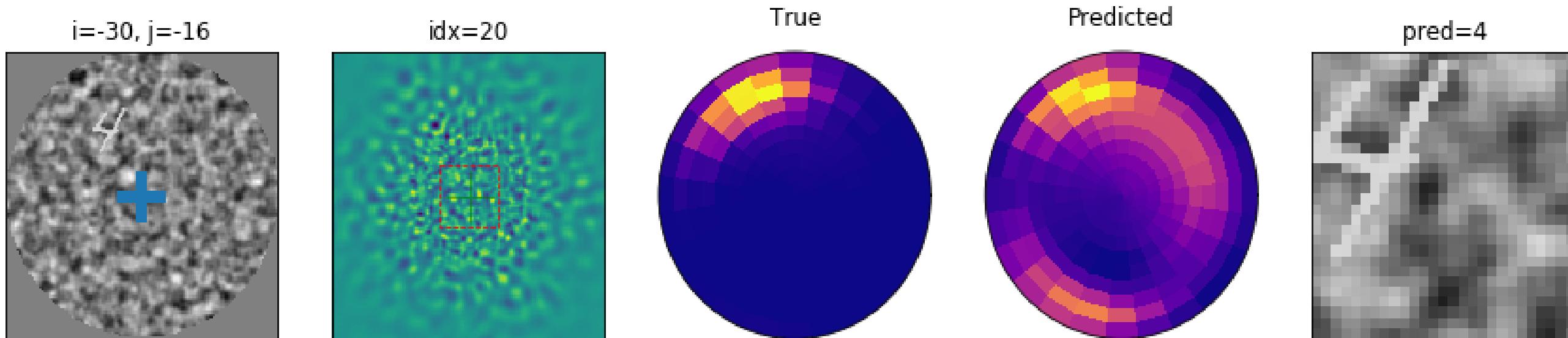
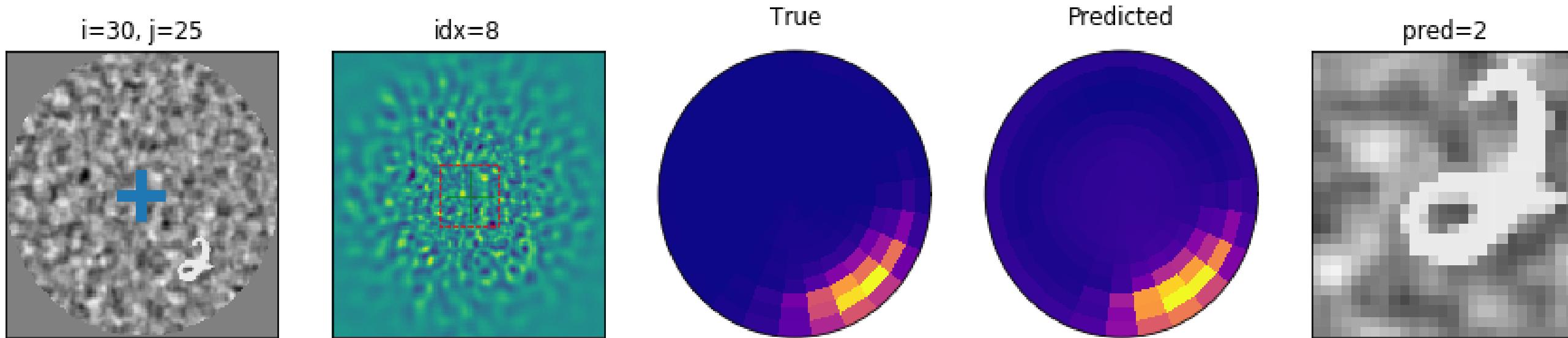
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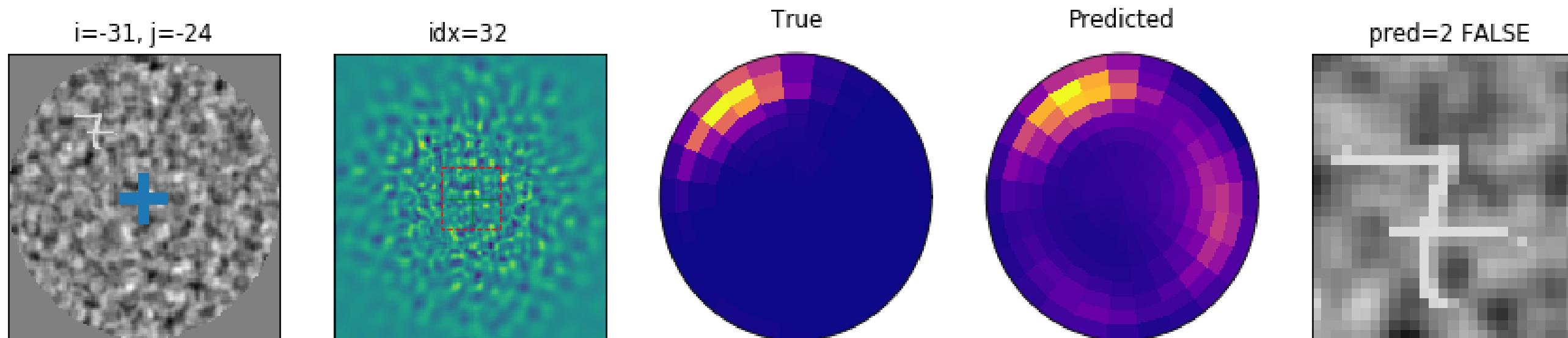
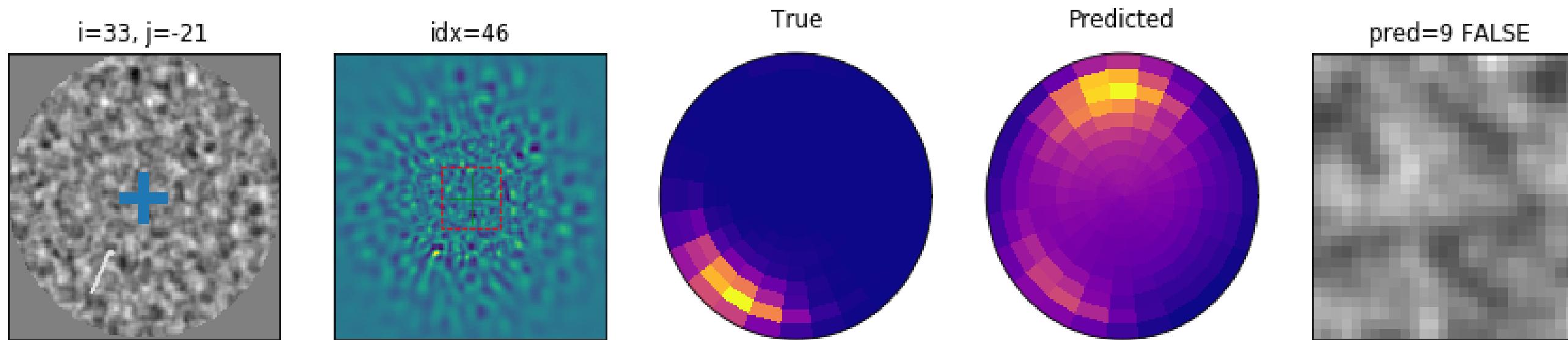
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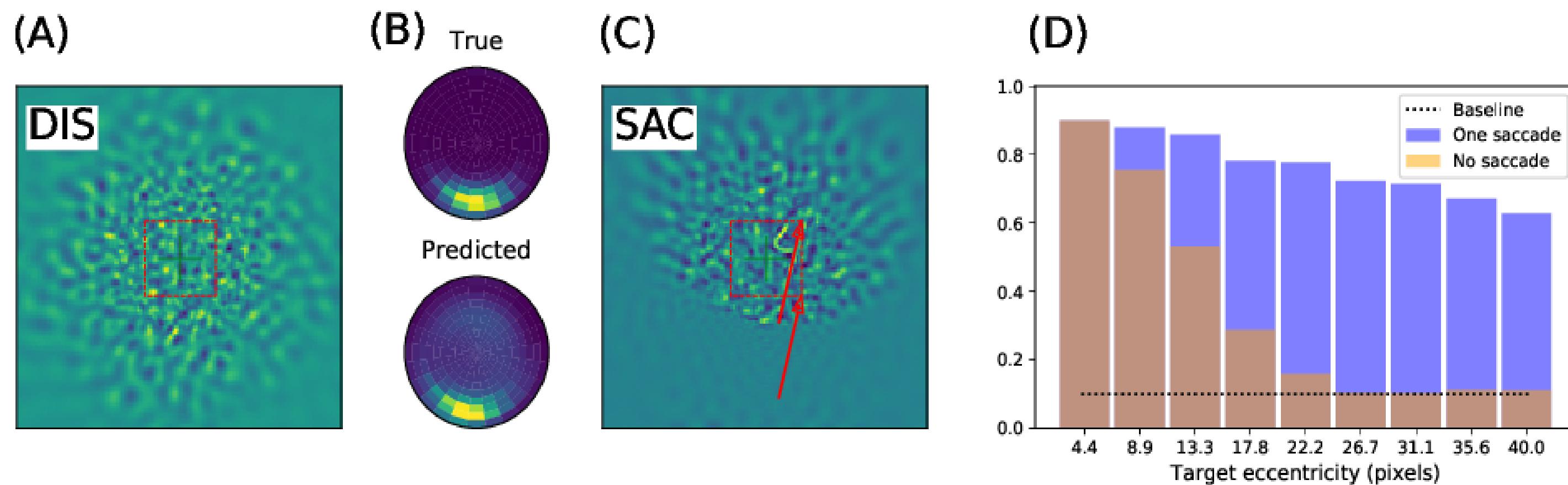
Results: success



Results: failure

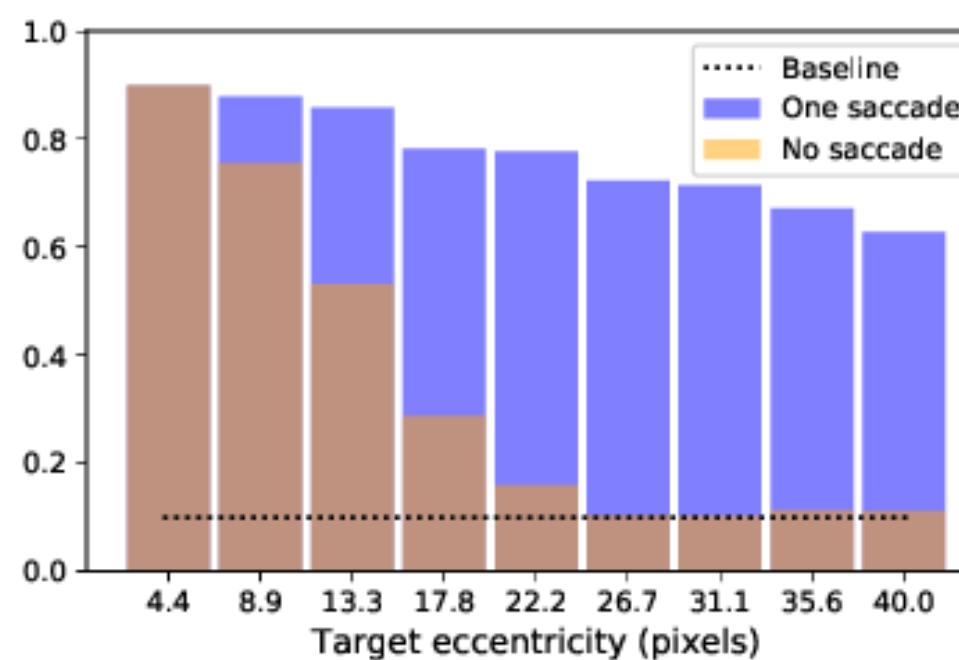


Results

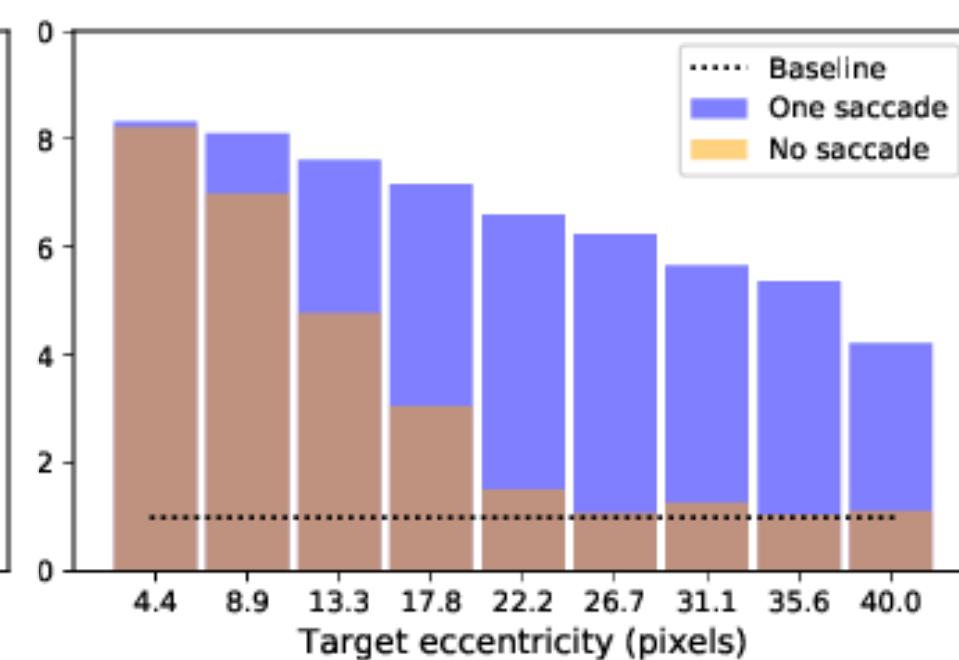


Results

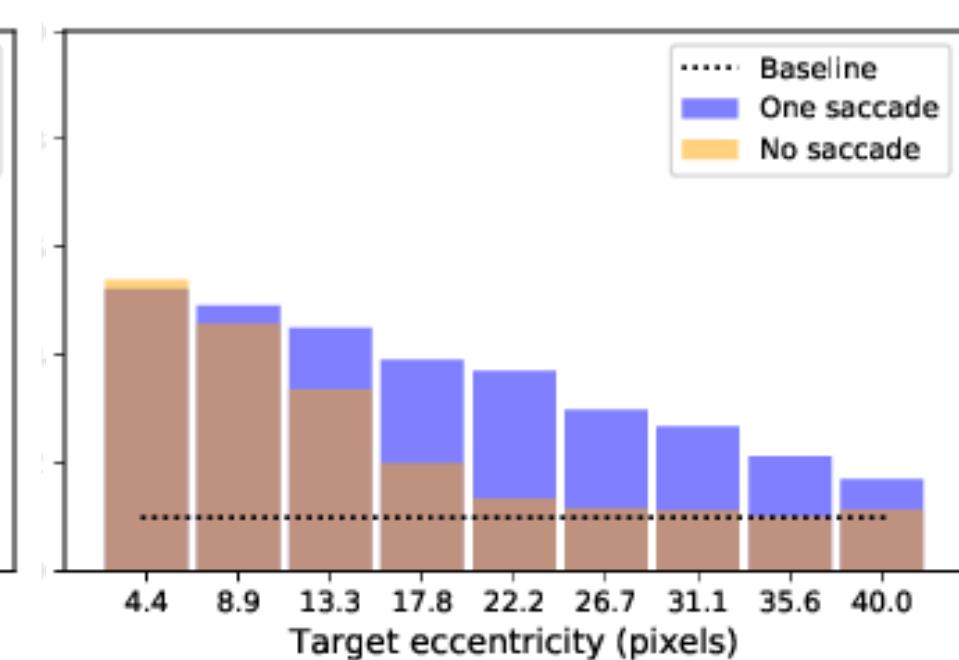
Contrast = 0.7



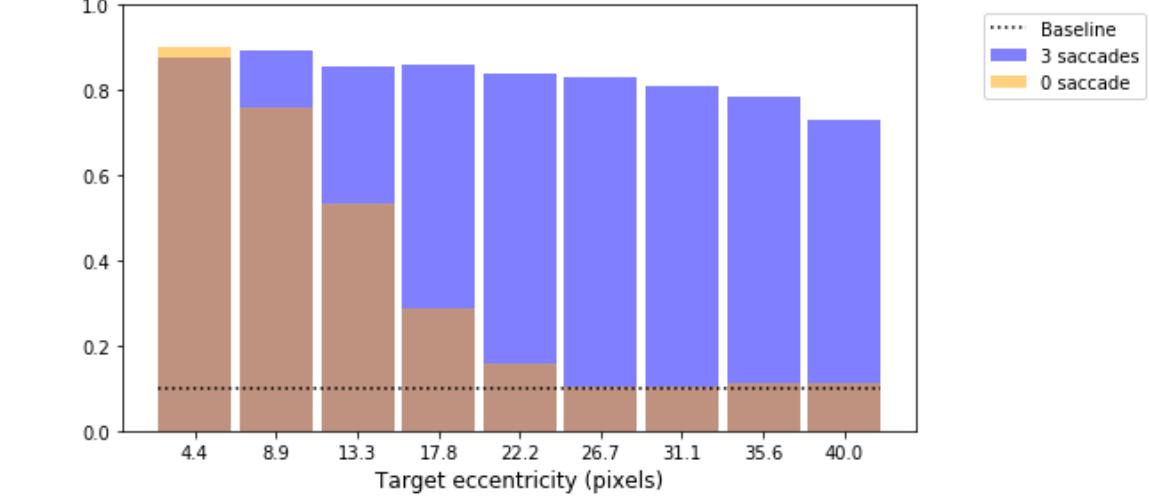
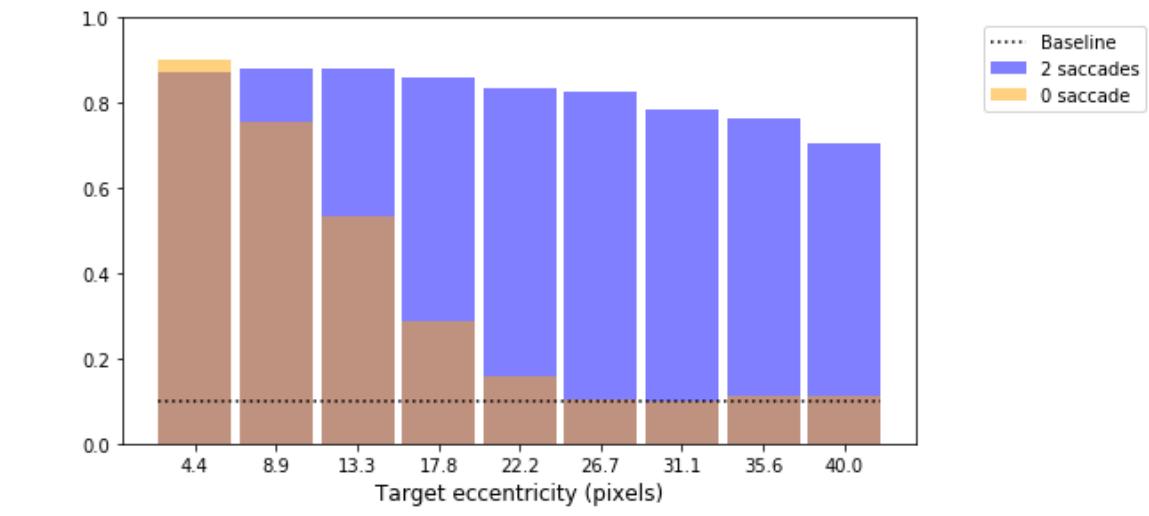
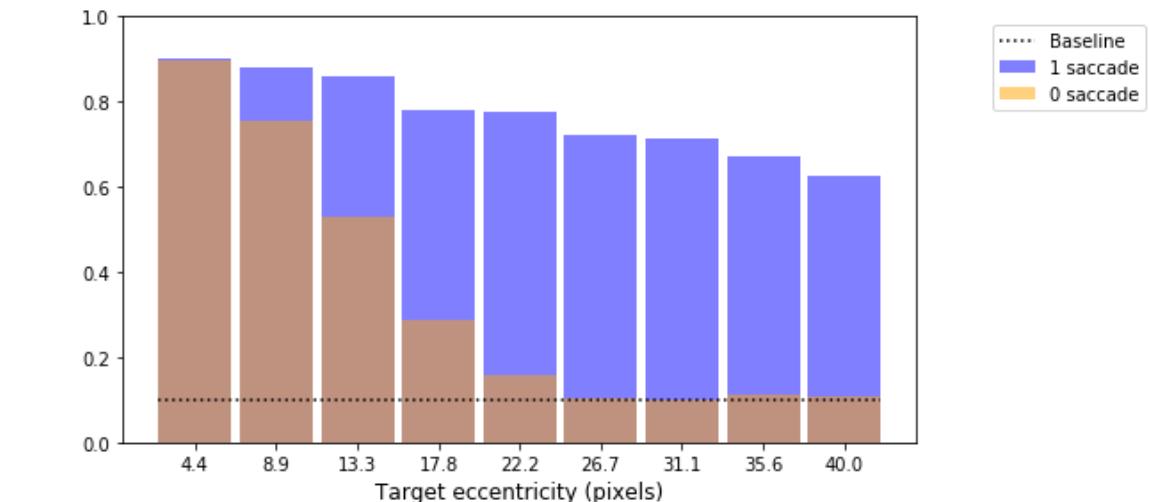
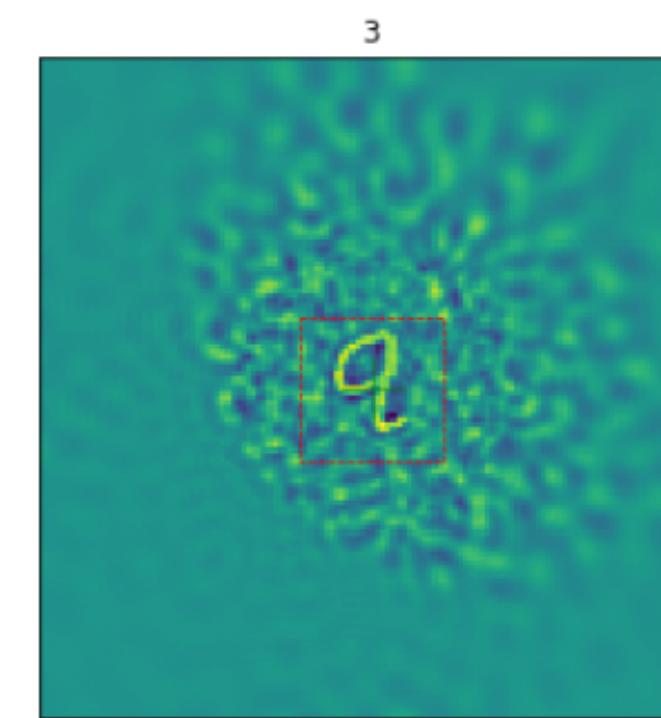
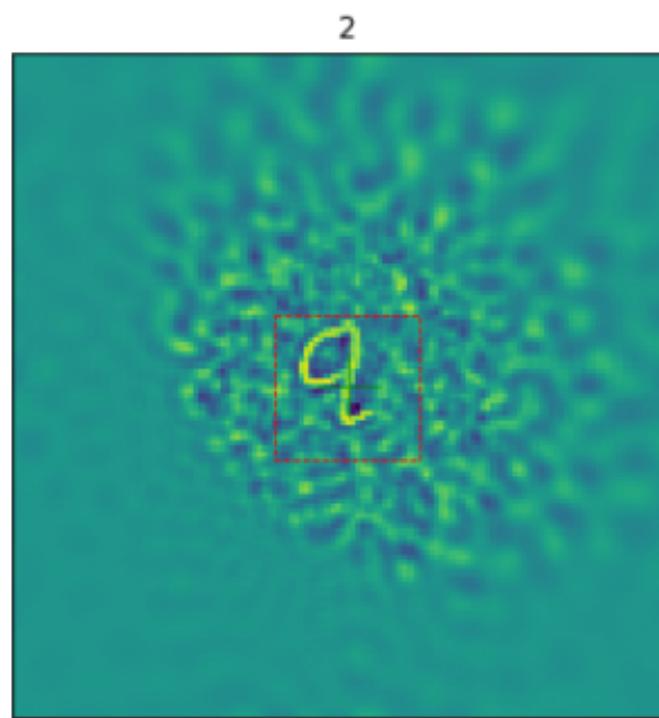
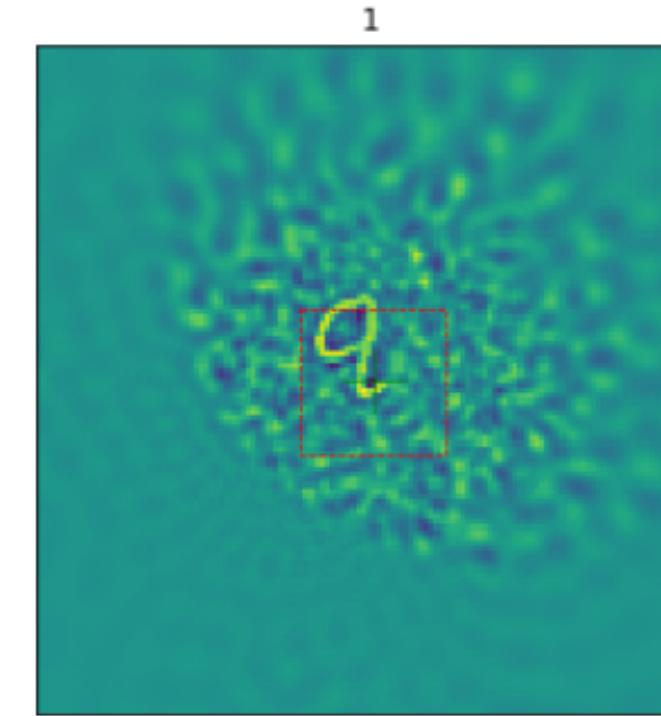
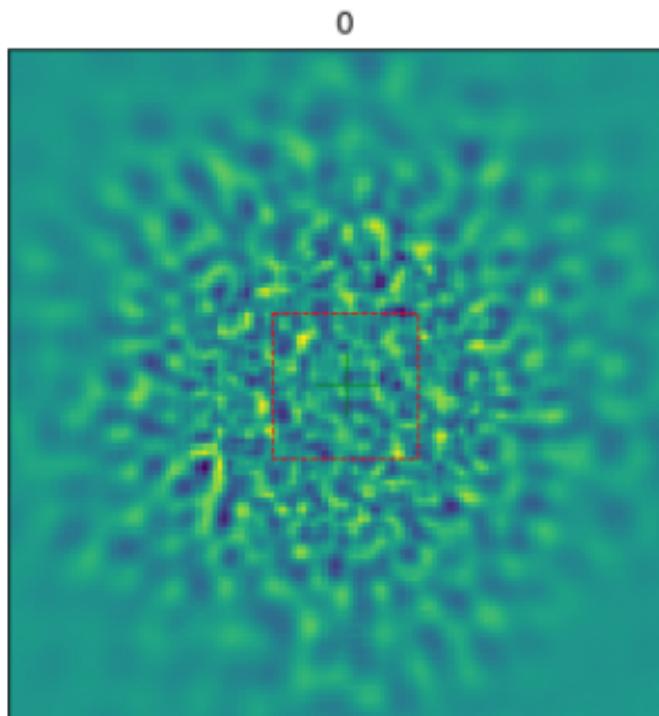
Contrast = 0.5



Contrast = 0.3



Results



Bayesian Online Changepoint Detector

- an implementation of Adams & MacKay 2007 "Bayesian Online Changepoint Detection" in Python.

```
@TECHREPORT{ adams-mackay-2007,  
  AUTHOR = "Ryan Prescott Adams and David J.C. MacKay",  
  TITLE  = "Bayesian Online Changepoint Detection",  
  INSTITUTION = "University of Cambridge",  
  ADDRESS = "Cambridge, UK",  
  YEAR = "2007",  
  NOTE = "arXiv:0710.3742v1 [stat.ML]",  
  URL = "http://arxiv.org/abs/0710.3742"  
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This work was supported by the PACE-ITN Project.



<https://laurentperrinet.github.io/talk/2019-07-15-cns>