

Edge statistics in natural versus laboratory images

Implications for understanding lateral connectivity in primary visual cortex with respect to animal environments

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3 - Max Planck Florida Institute, Jupiter, Florida

4 - Institute for Adaptive and Neural Computation, University of Edinburgh

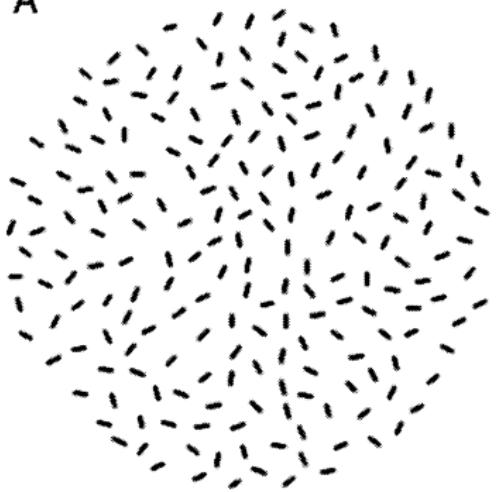
Thursday, May 10th, 2012

iTWIST '12, Marseille, France.

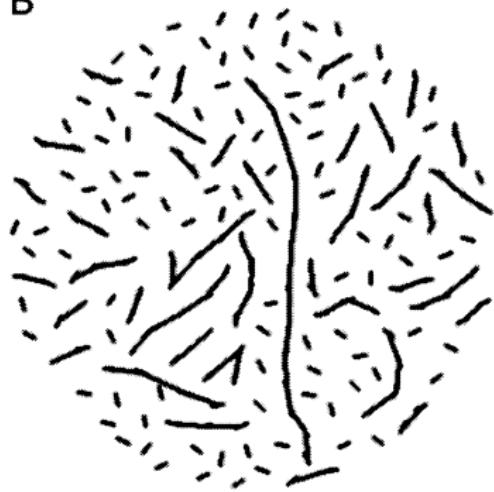
This work was supported from the European Community's Seventh Framework Program FP7/2007-2013 under grant agreement number 214728-2, "CODDE".



A

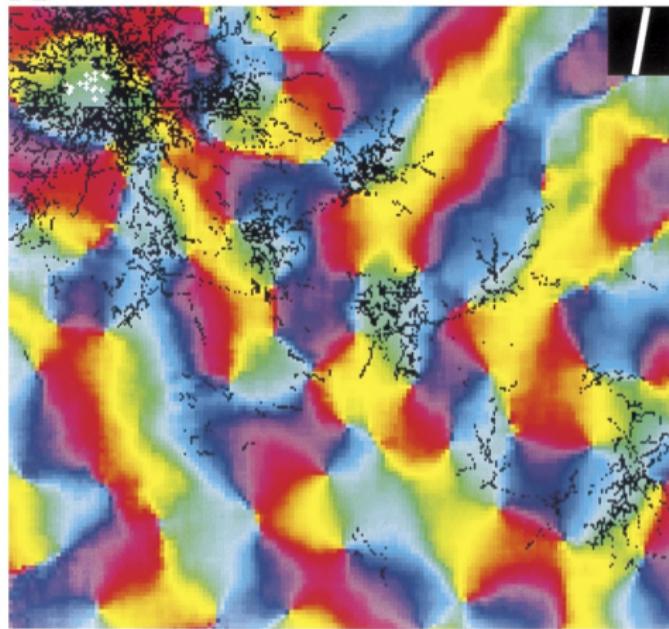


B

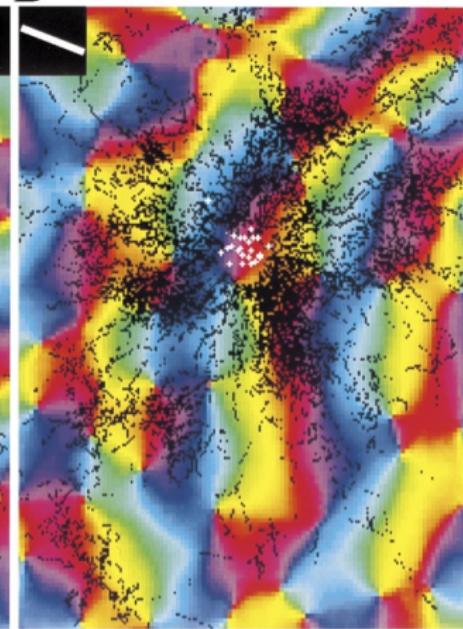


(Geisler et al., 2001, Vision Research)

A



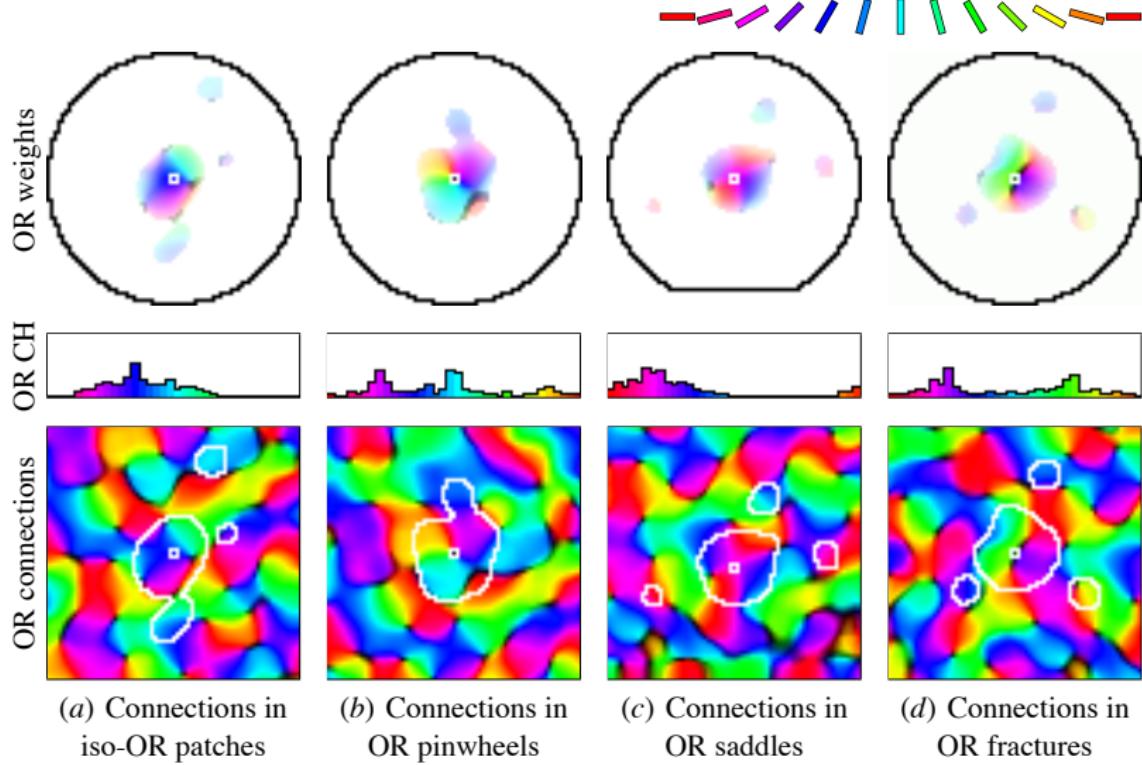
B



500 μm

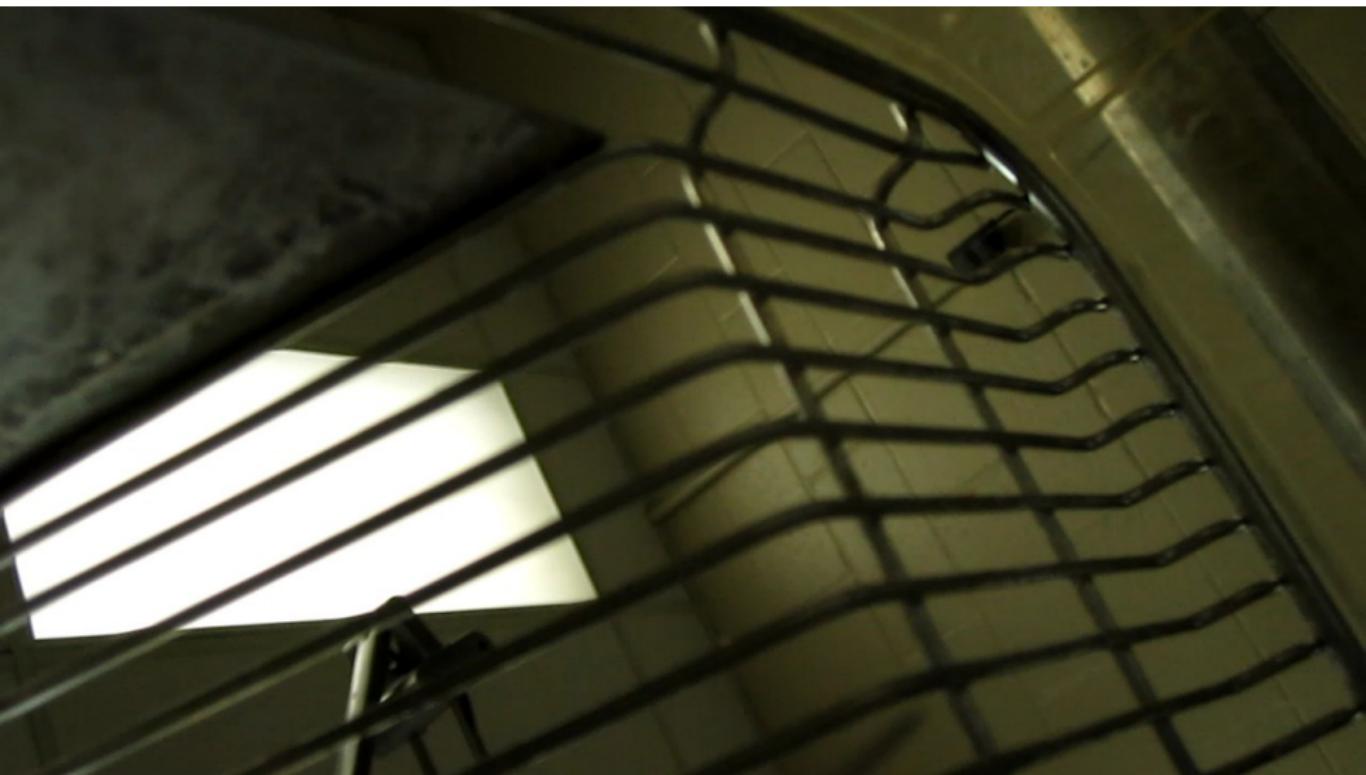


(Bosking et al, 1997, Journal of Neuroscience)



(Choe et al. 2004; Miikkulainen et al., 2005)





Outline: Edge statistics in natural versus laboratory images

Introduction: linking neural structure to natural scenes

Geisler et al, 2001

Bosking et al, 1997

Problem statement

Method: detection of edges

Geisler et al, 2001

Log Gabor representation / Sparse coding

Results: natural vs. laboratory images

Some examples of edge extraction

Second-order statistics

Quantitative difference using classification

Take-home message

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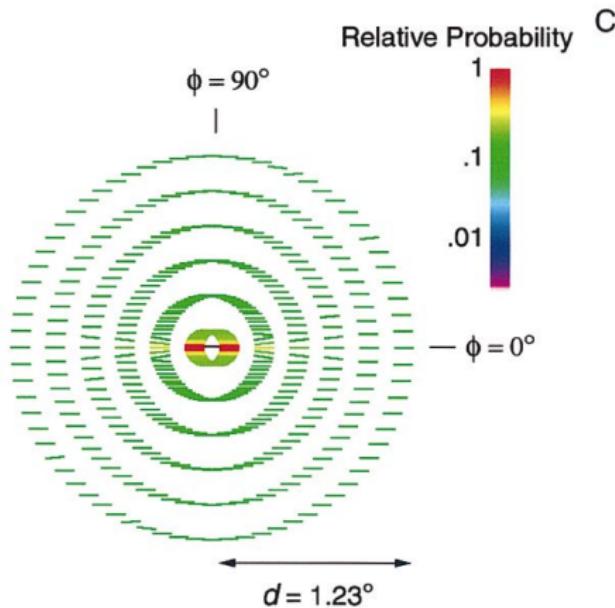
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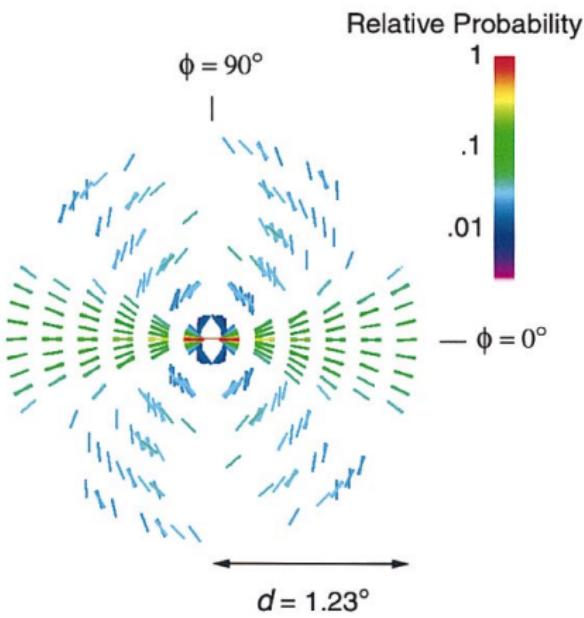
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Take-home message

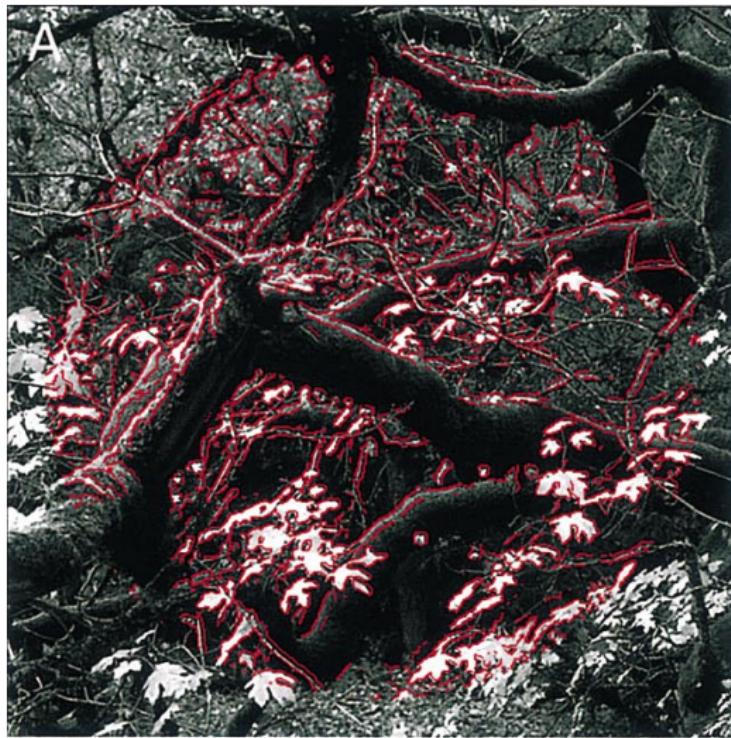
B



C

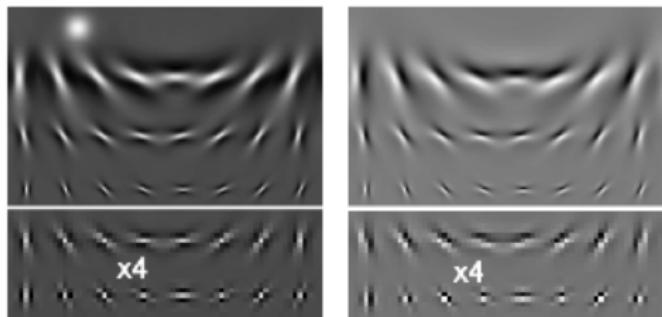
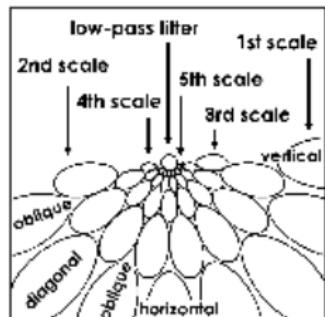


Geisler et al, 2001

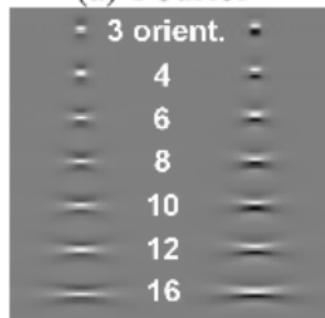


(Geisler et al., 2001, Vision Research)

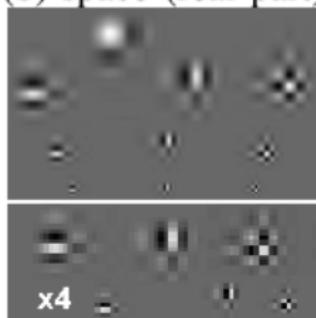
Log Gabor representation / Sparse coding



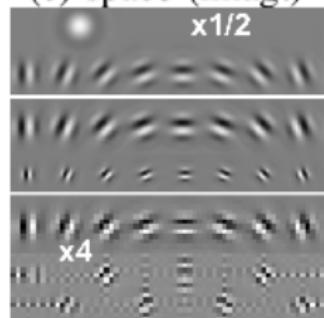
(a) Fourier



(b) space (real part)



(c) space (imag.)



(d) log-Gabor

(e) 'Db4' wavelets

(f) Steerable pyramid

(Fischer et al, 2007, International Journal of Computer Vision)

(Perrinet, 2010, Neural Computation)

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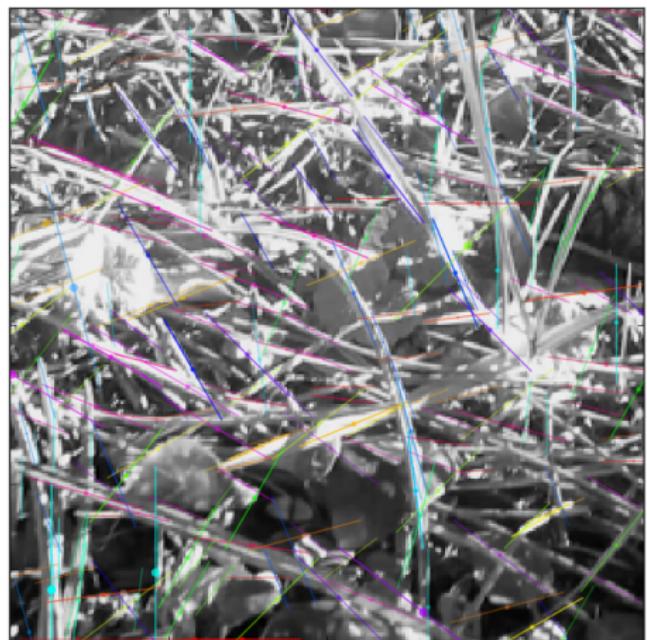
Some examples of edge extraction

Second-order statistics

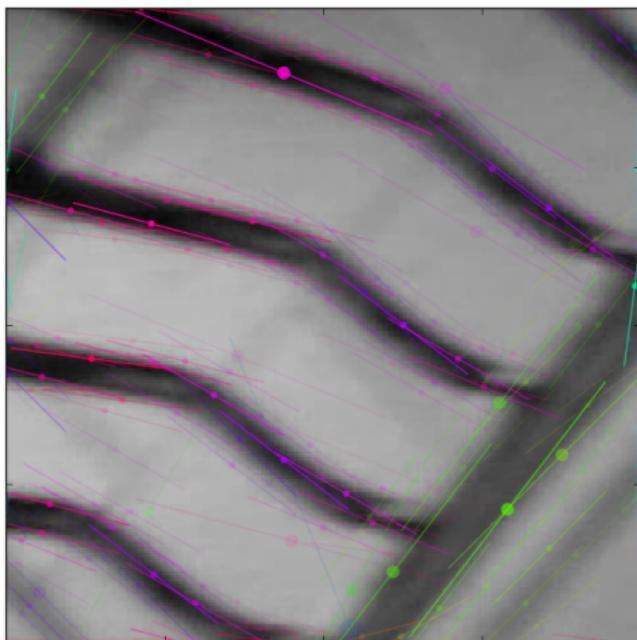
Quantitative difference using classification

Take-home message

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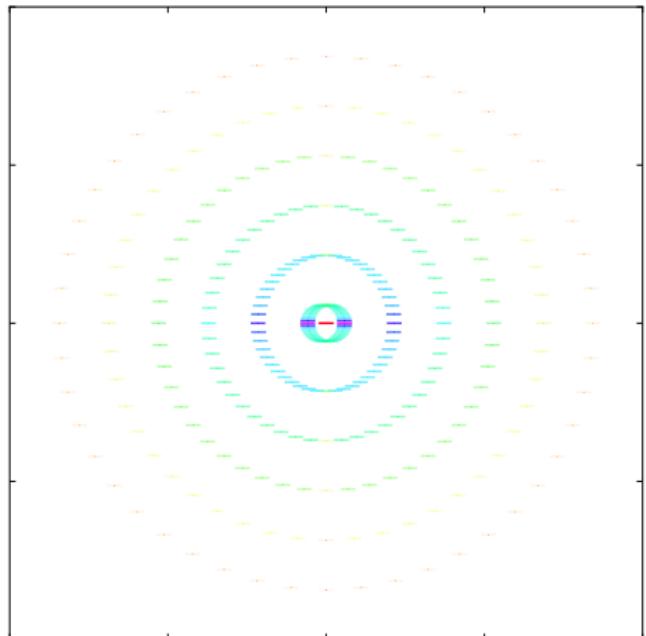
Natural



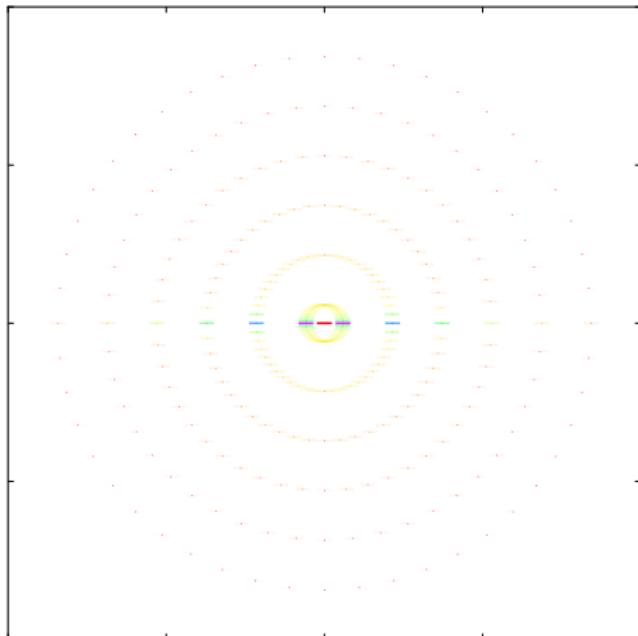
Laboratory

Second-order statistics

$$\arg \max_{\theta} p(\theta | d, \phi, \sigma, \pi_0)$$



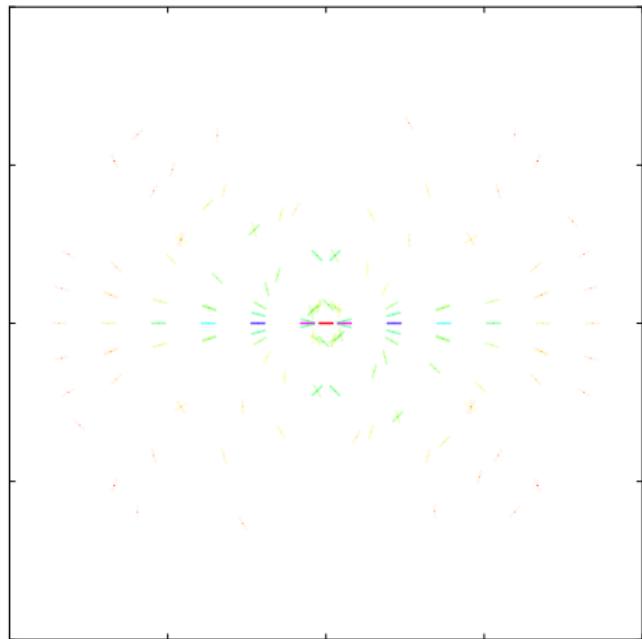
Natural



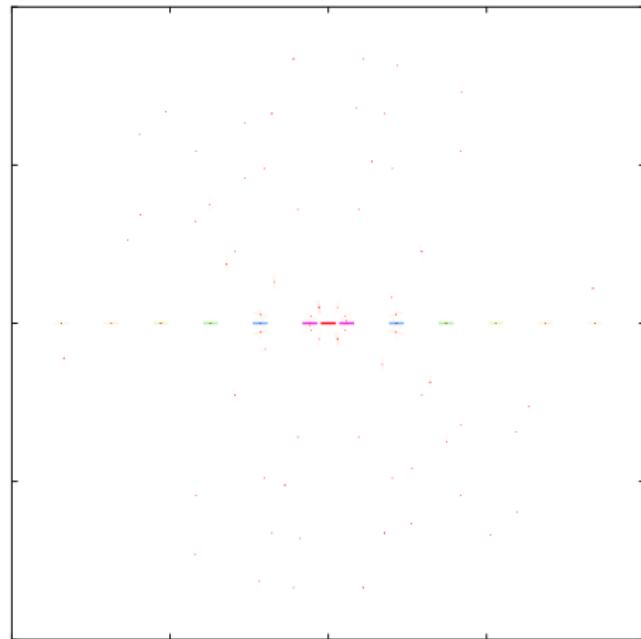
Laboratory

Second-order statistics

$$\arg \max_{\phi} p(\phi | d, \theta, \sigma, \pi_0)$$



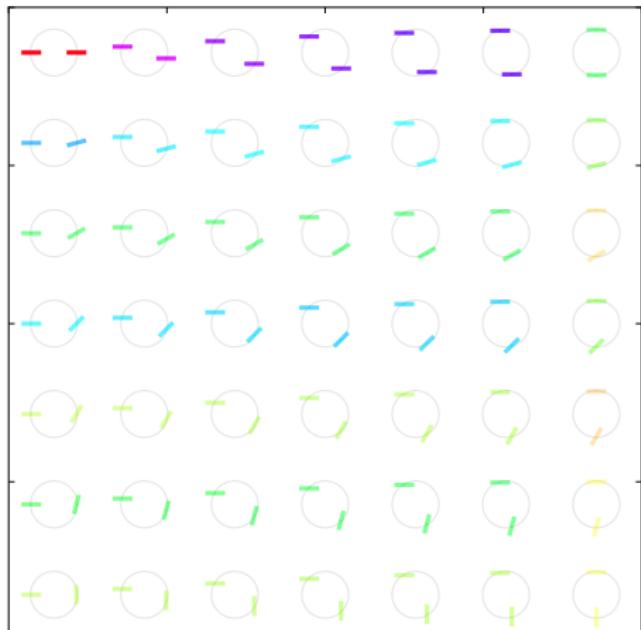
Natural



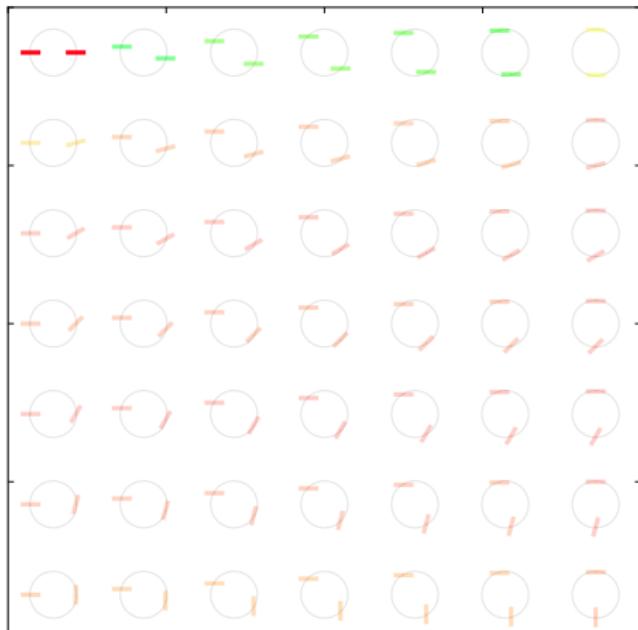
Laboratory

Second-order statistics

$$p(d, \phi, \theta, \sigma | \pi_0) \approx p(d, \sigma | \pi_0) p(\theta, \phi | \pi_0)$$

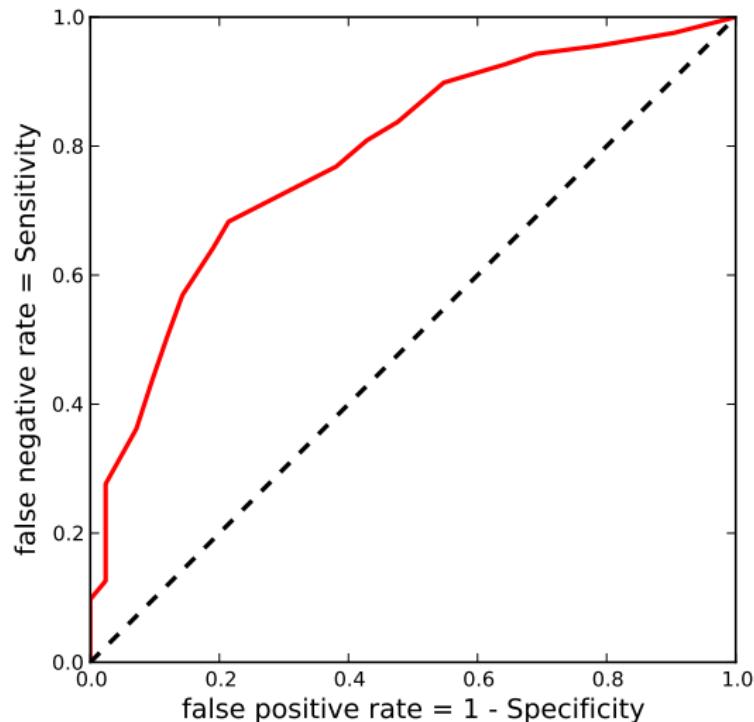


Natural

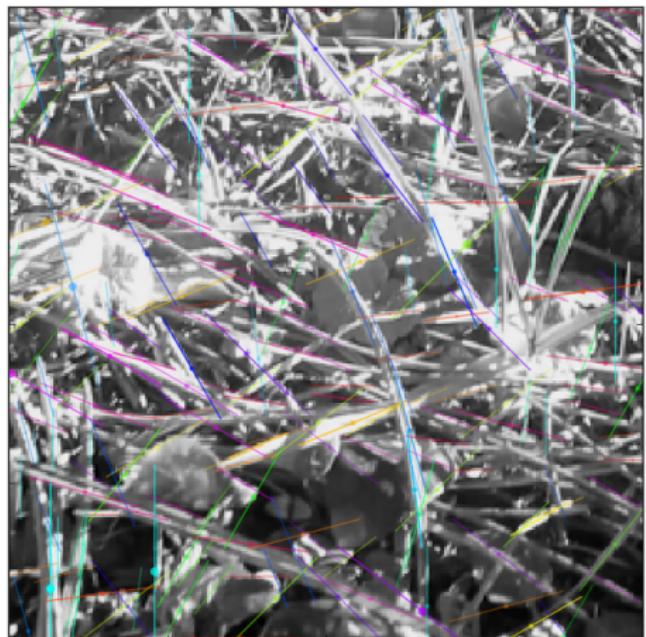


Laboratory

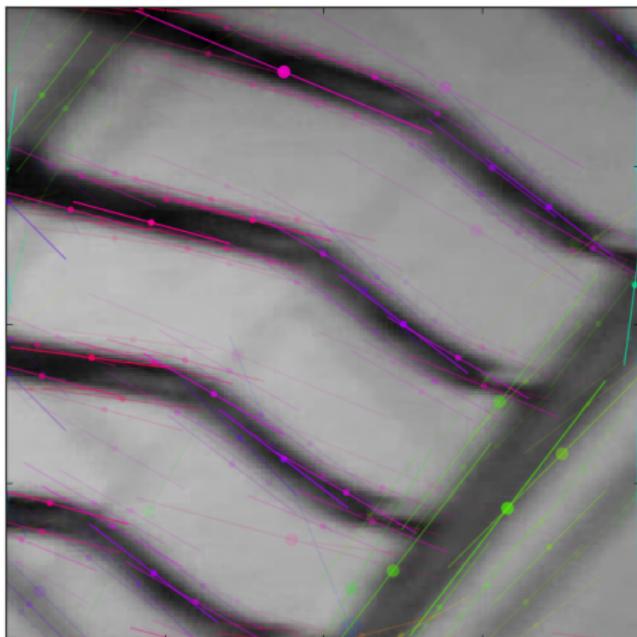
Quantitative difference using classification



Summary



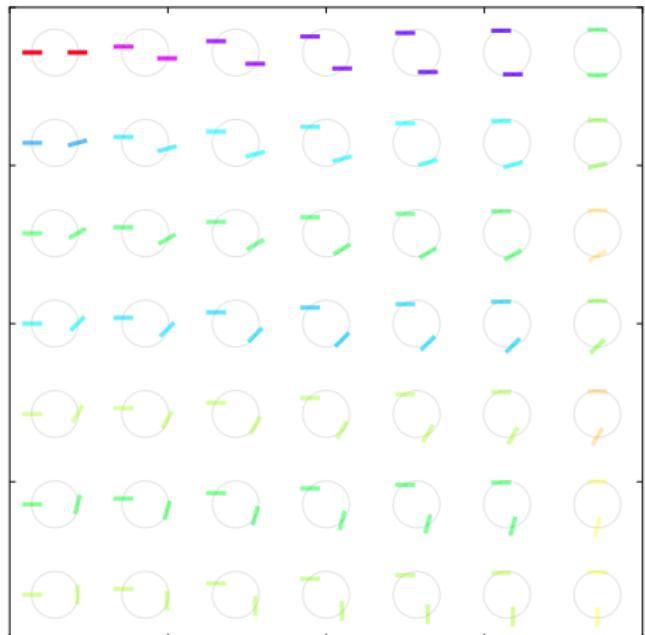
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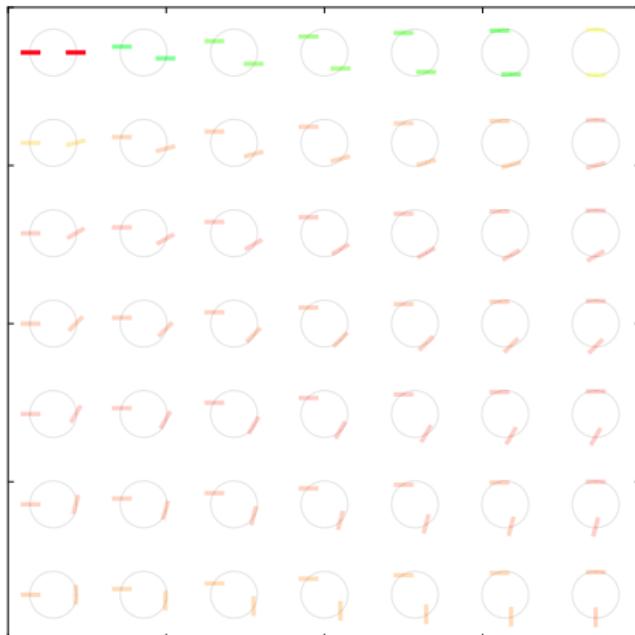
Laboratory

Summary

$$p(d, \phi, \theta, \sigma | \pi_0) \approx p(d, \sigma | \pi_0) p(\theta, \phi | \pi_0)$$



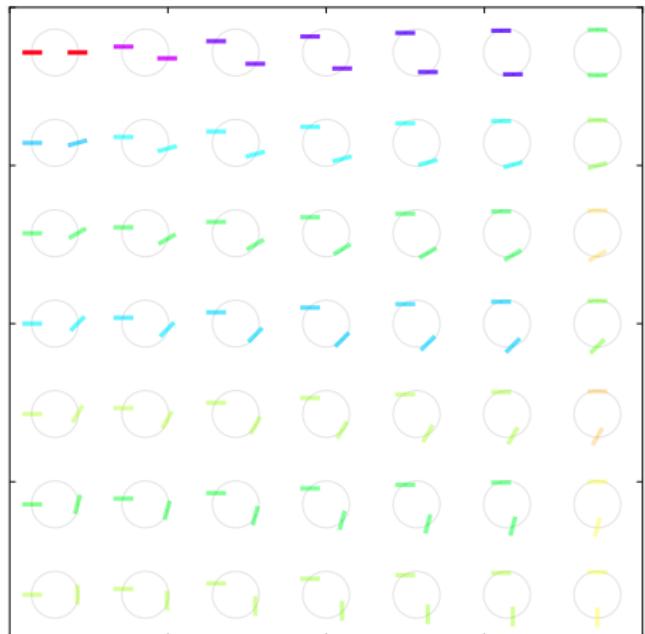
Natural



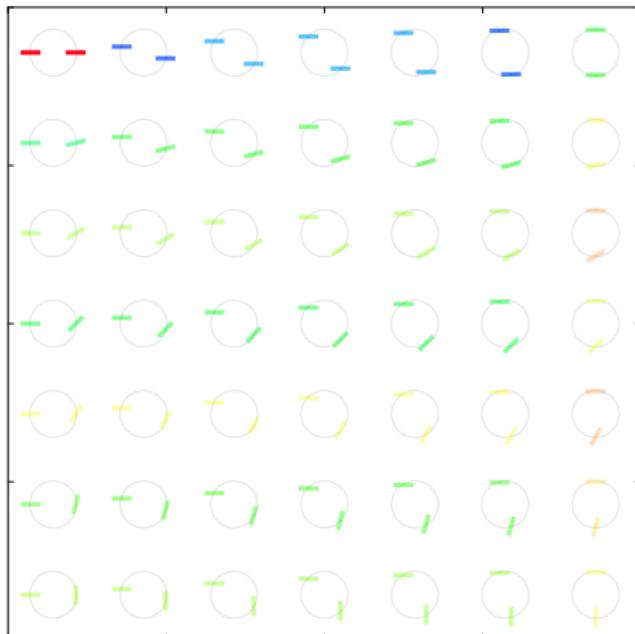
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Summary

$$p(d, \phi, \theta, \sigma | \pi_0) \approx p(d, \sigma | \pi_0) p(\theta, \phi | \pi_0)$$



Natural



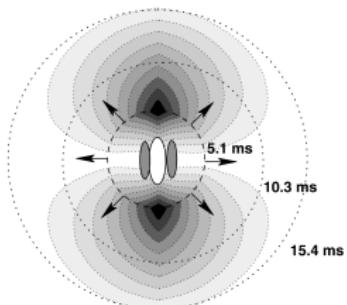
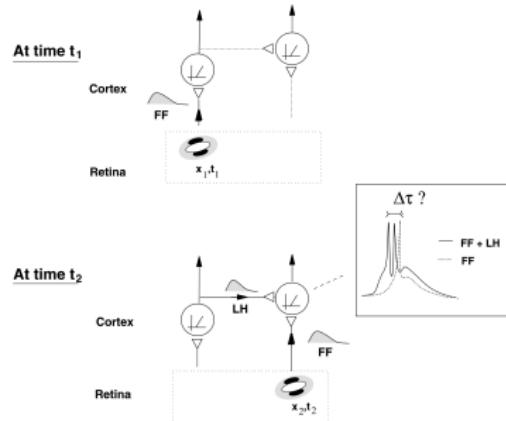
Laboratory

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URL http://invibe.net/LaurentPerrinet/Presentations/12-01-24_Edinburgh
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Neuromorphic implementation

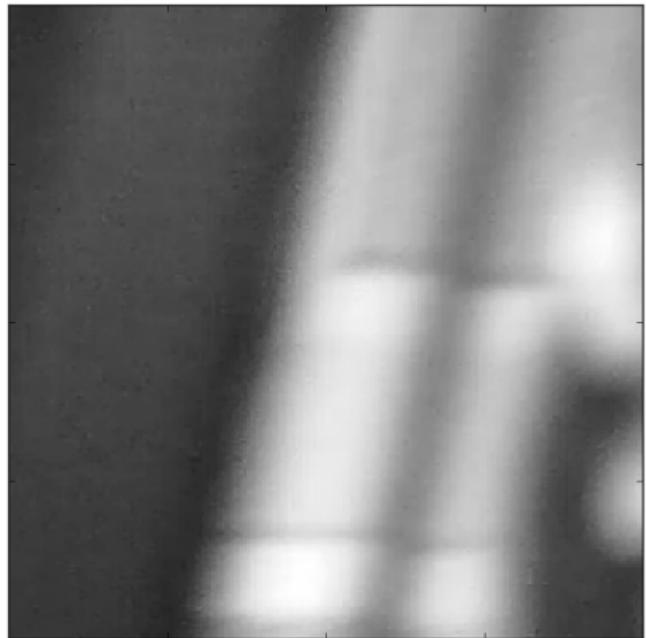
P. Series et al. / Vision Research 42 (2002) 2781–2797



(Series et al., 2002)

Fig. 1. Cartoon of the V1 model, which represents an array of cortical units

Matching Pursuit

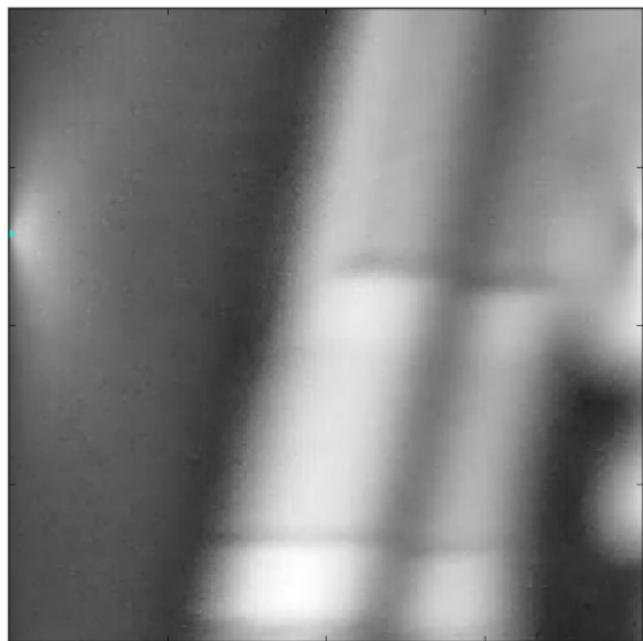


Residual

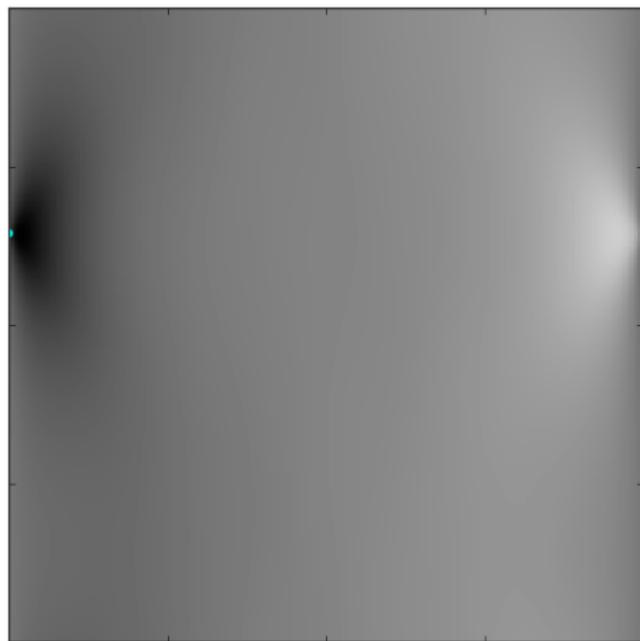


Edges

Matching Pursuit

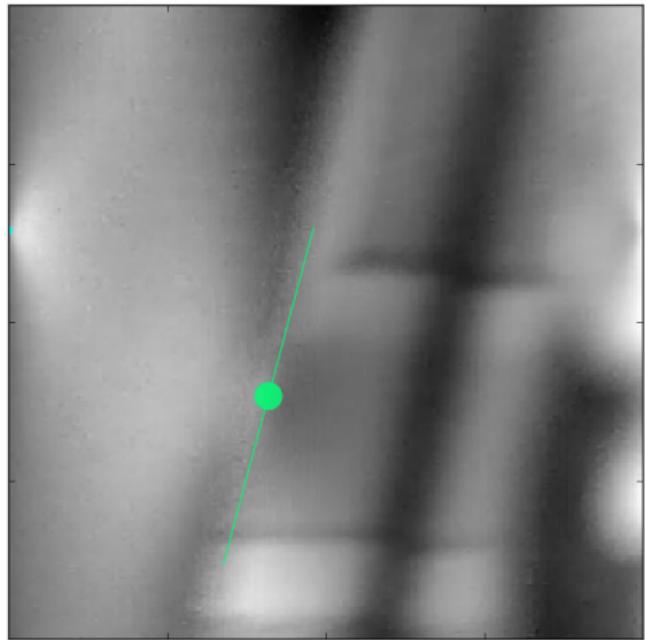


Residual

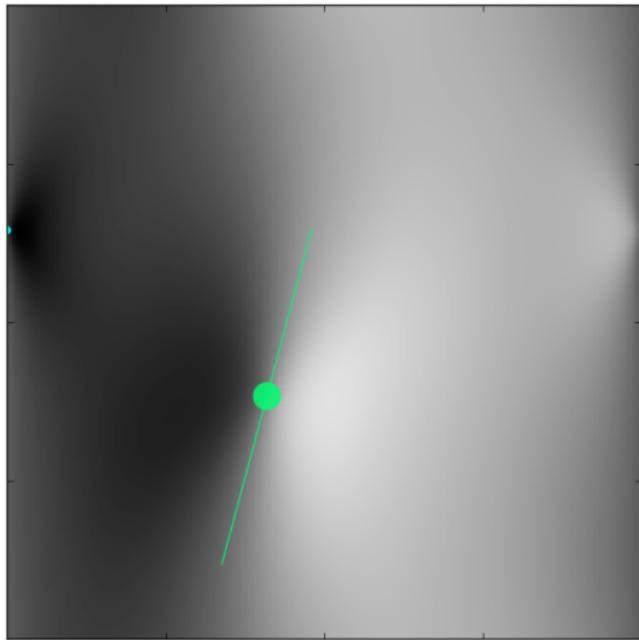


Edges

Matching Pursuit

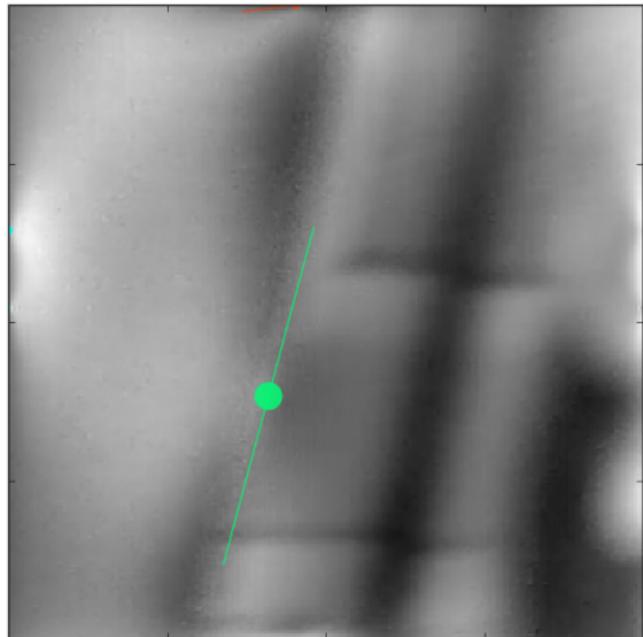


Residual

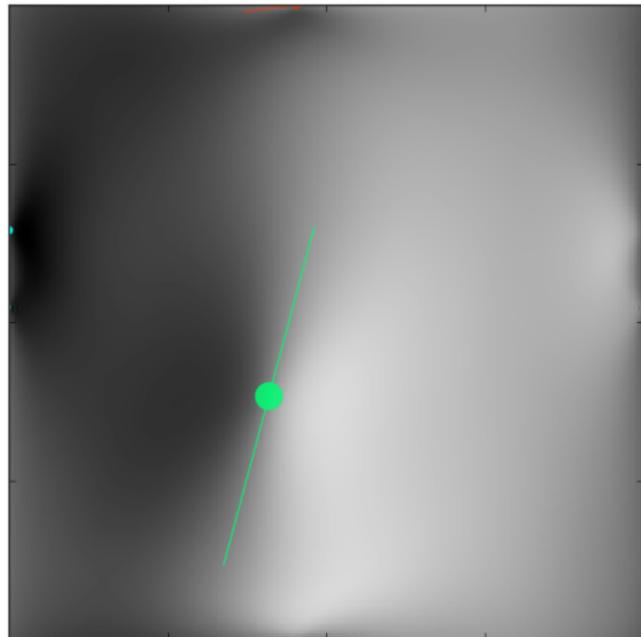


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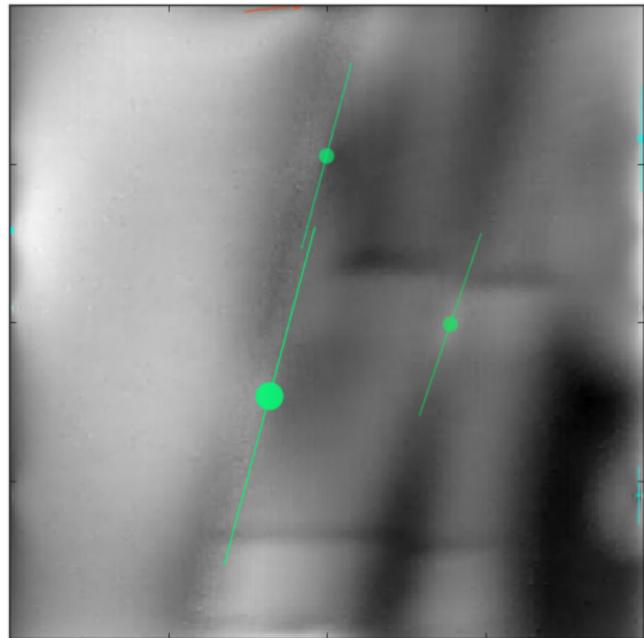


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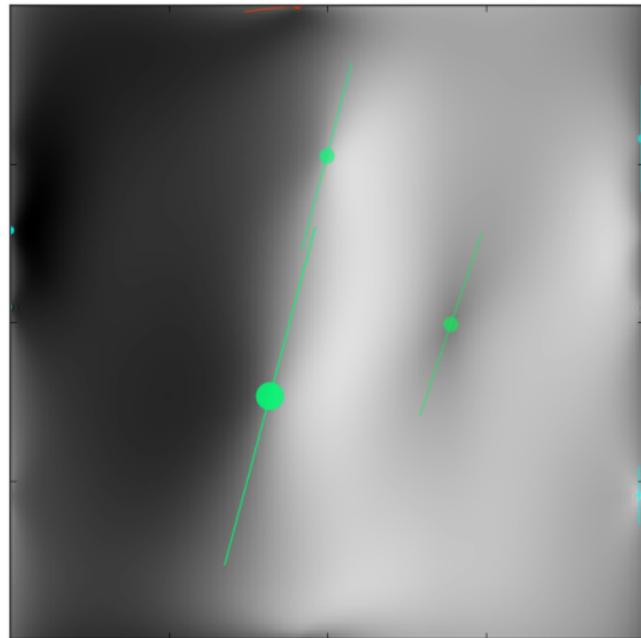


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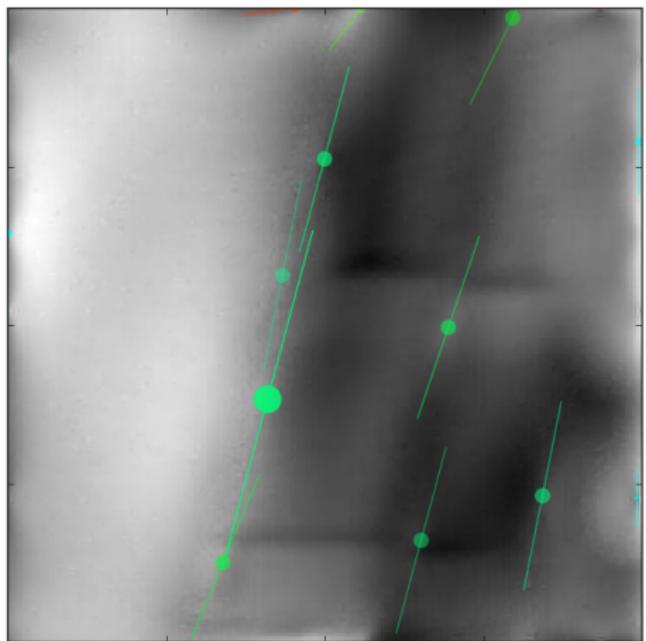


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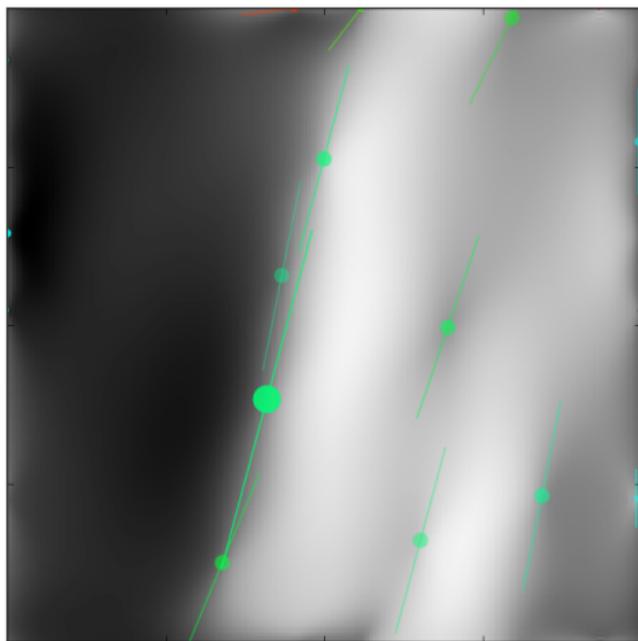


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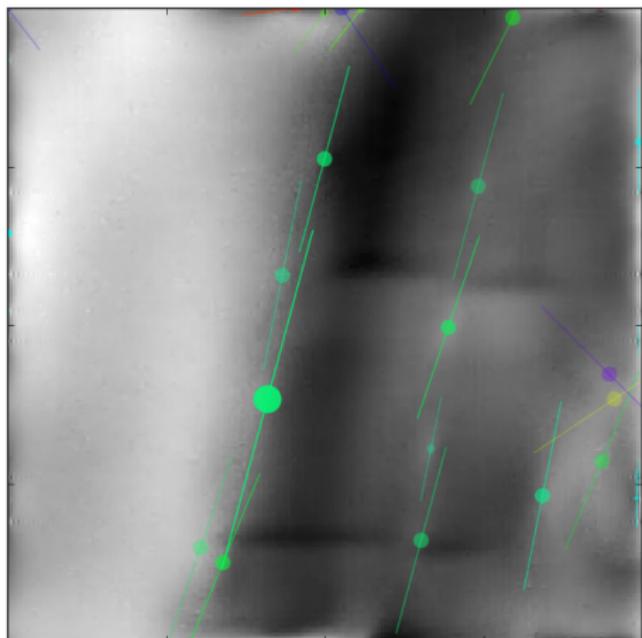


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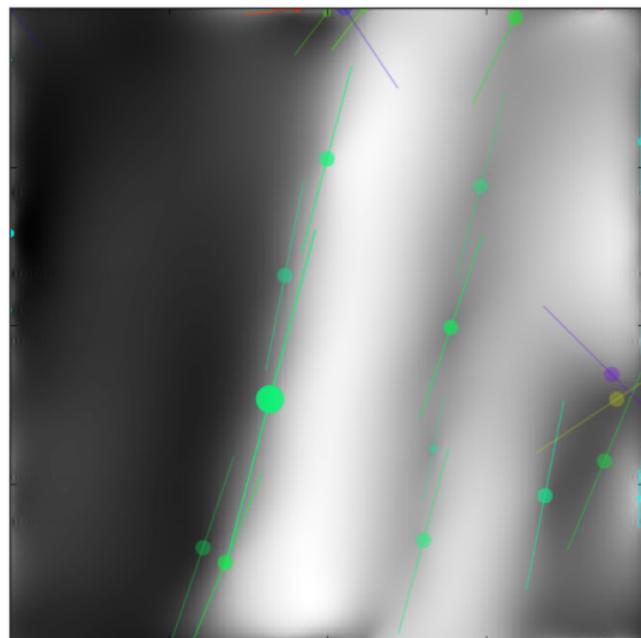


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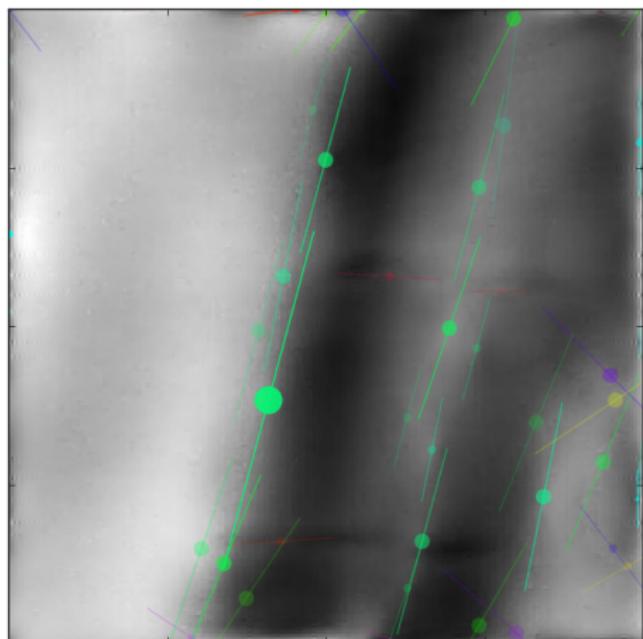


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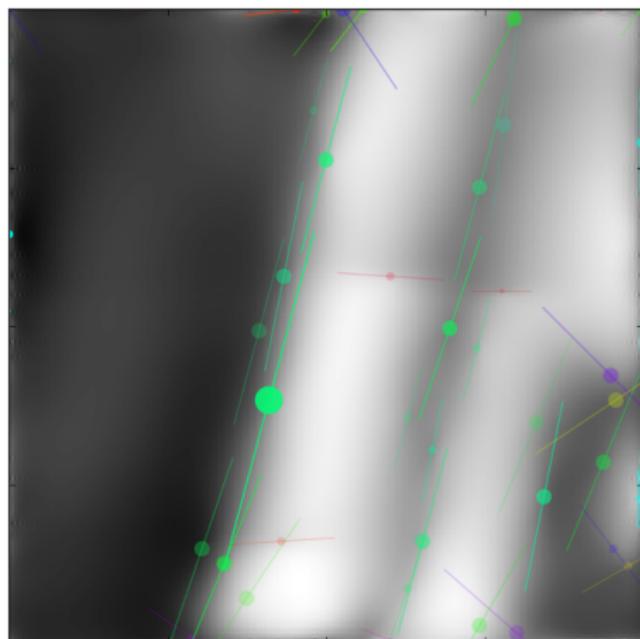


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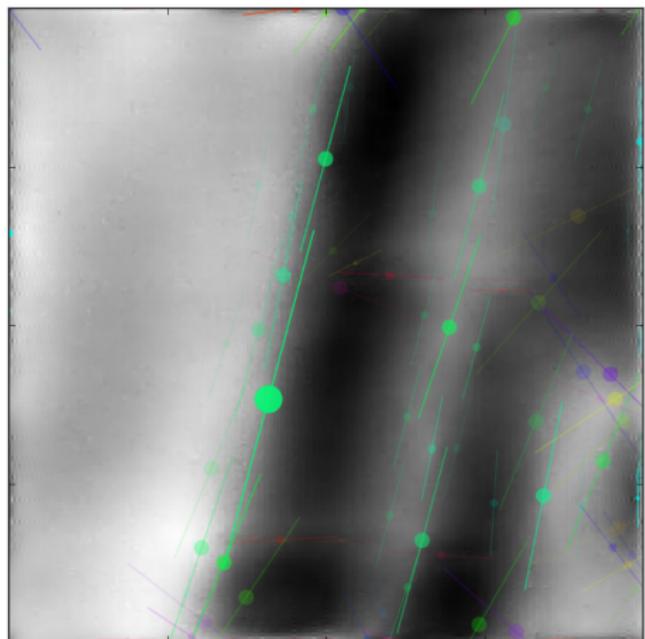


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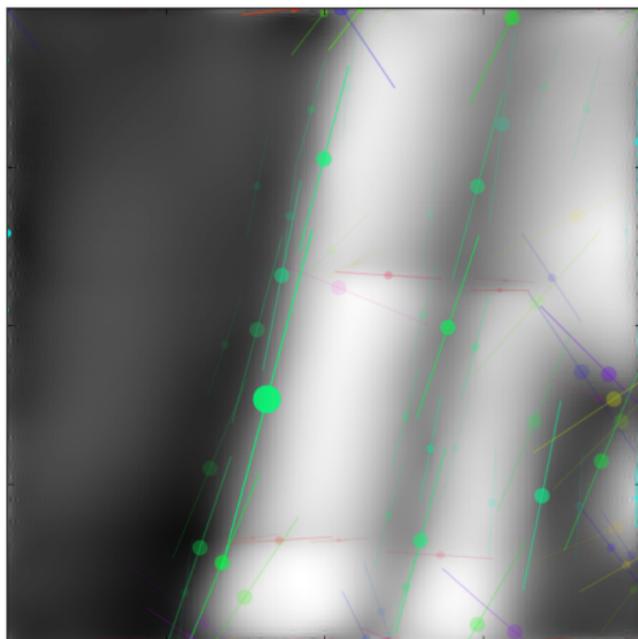


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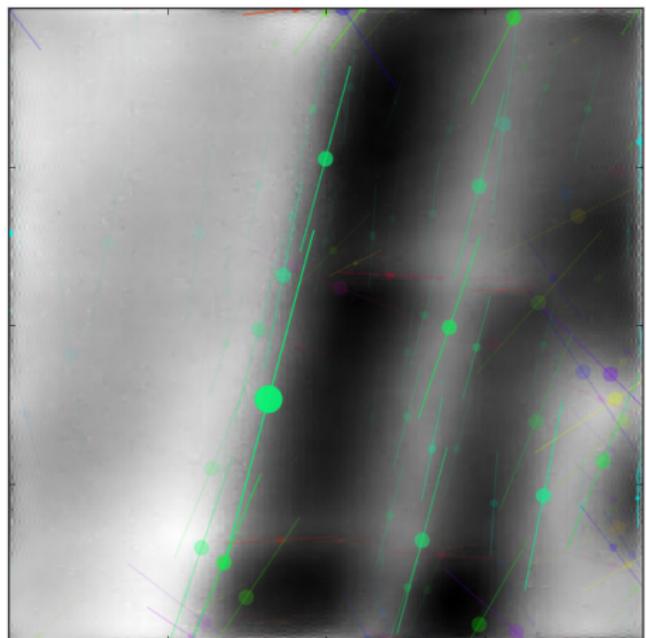


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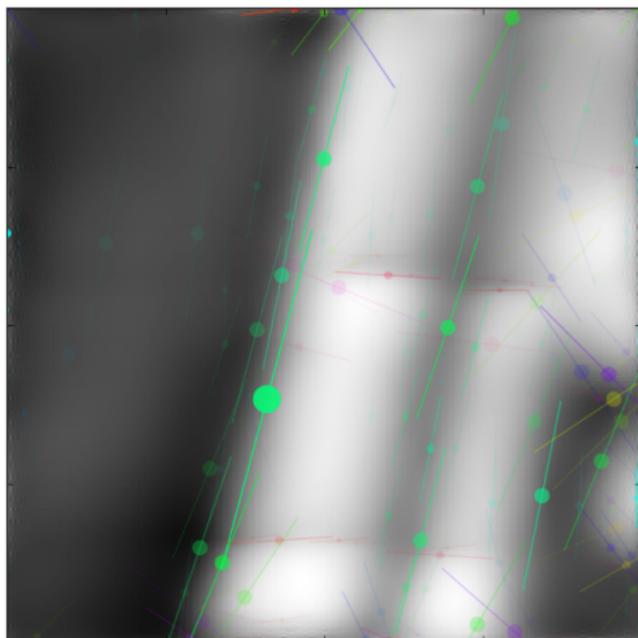


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