

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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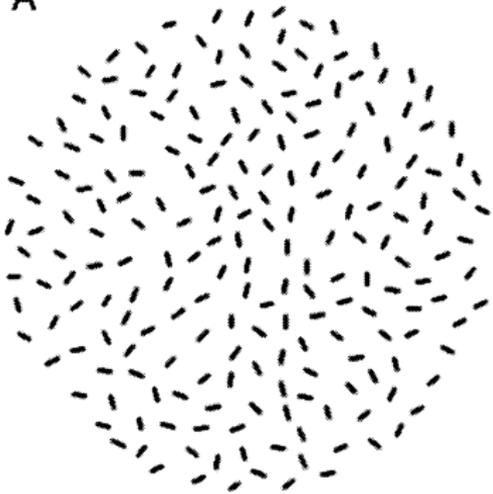
Thursday, May 10th, 2012

iTWIST '12, Marseille, France.

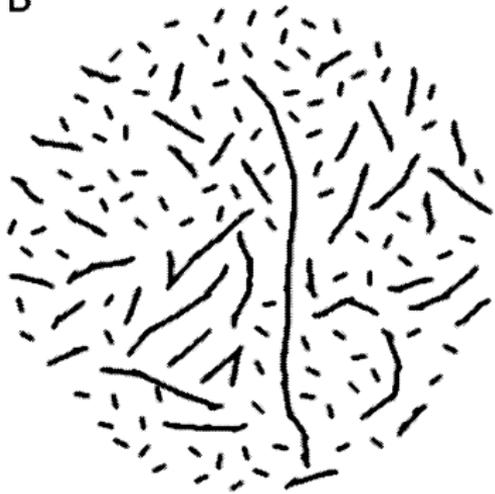
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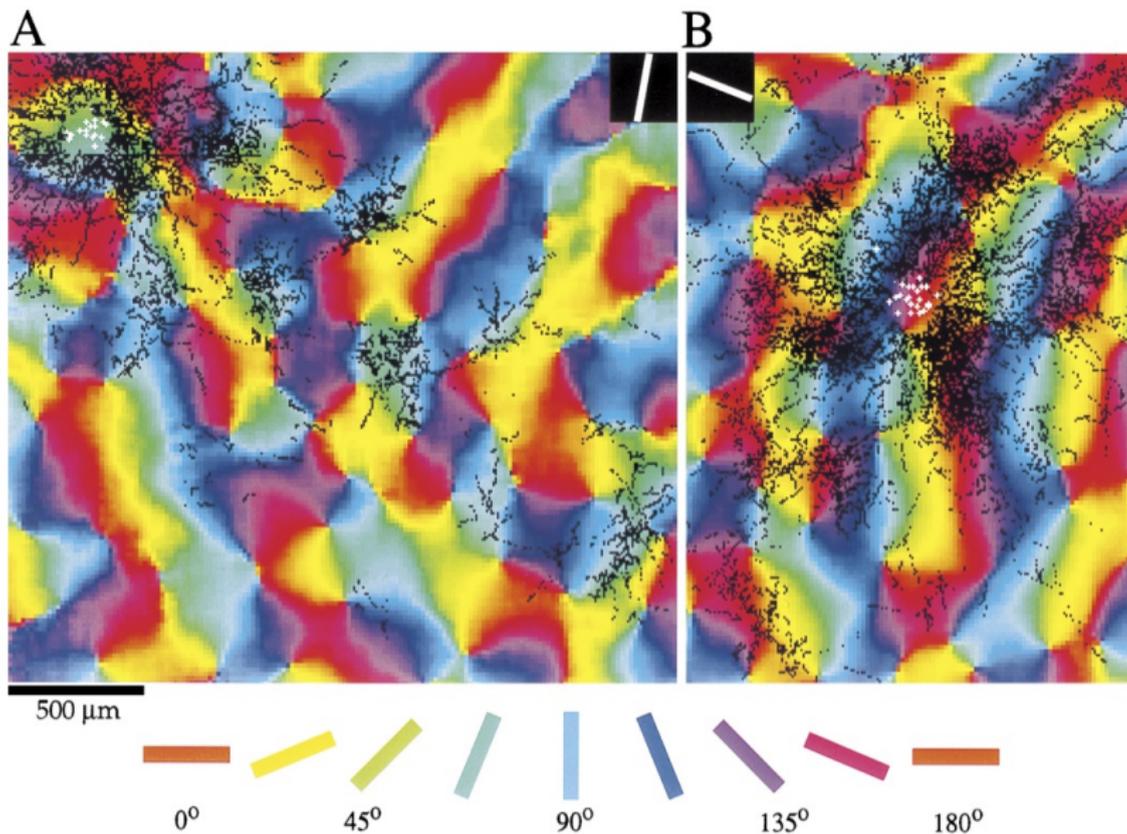
A



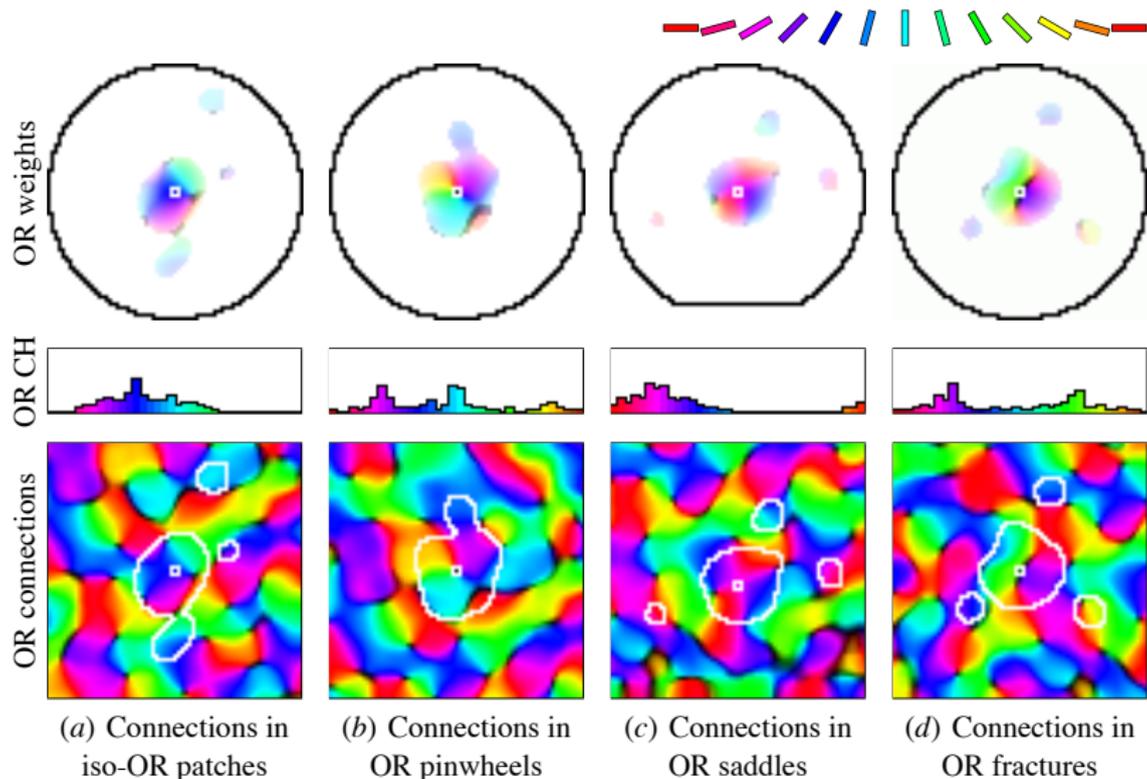
B



(Geisler et al., 2001, Vision Research)

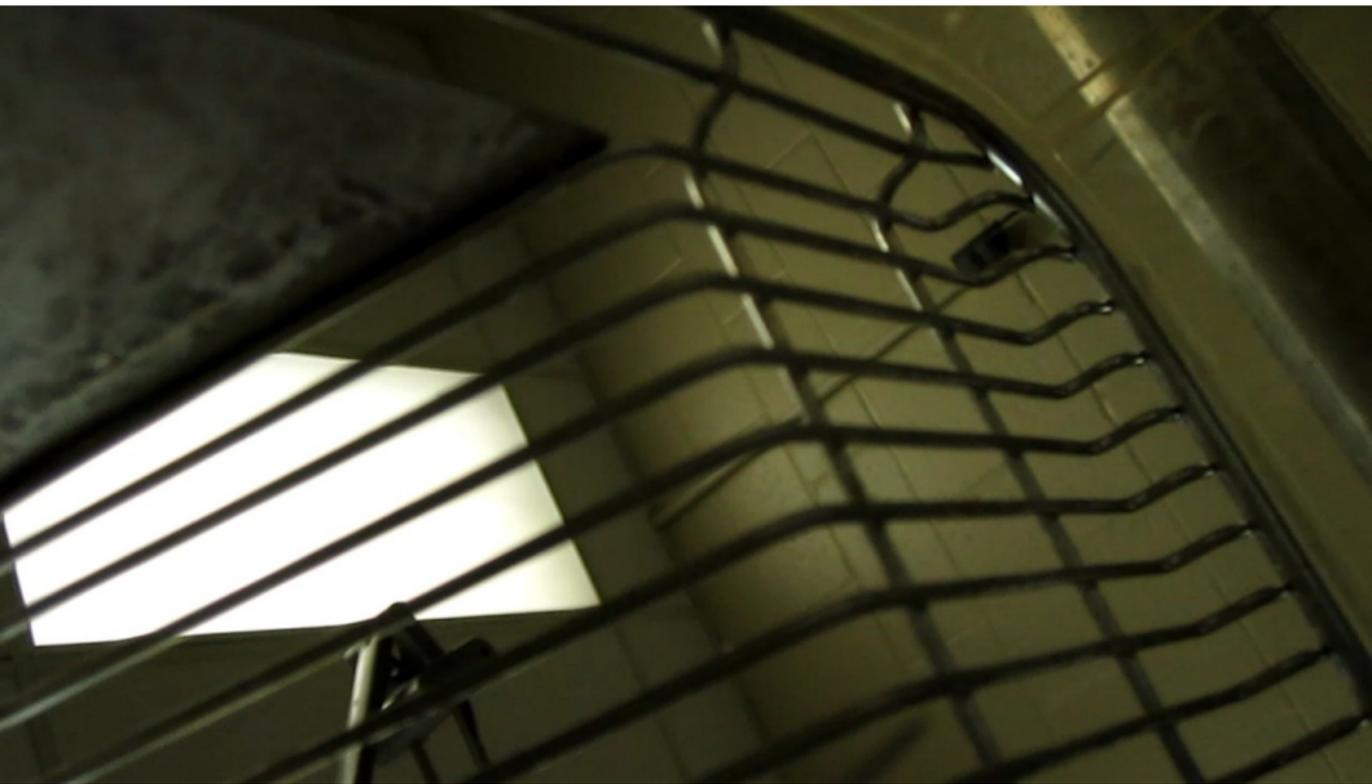


(Bosking et al, 1997, Journal of Neuroscience)



(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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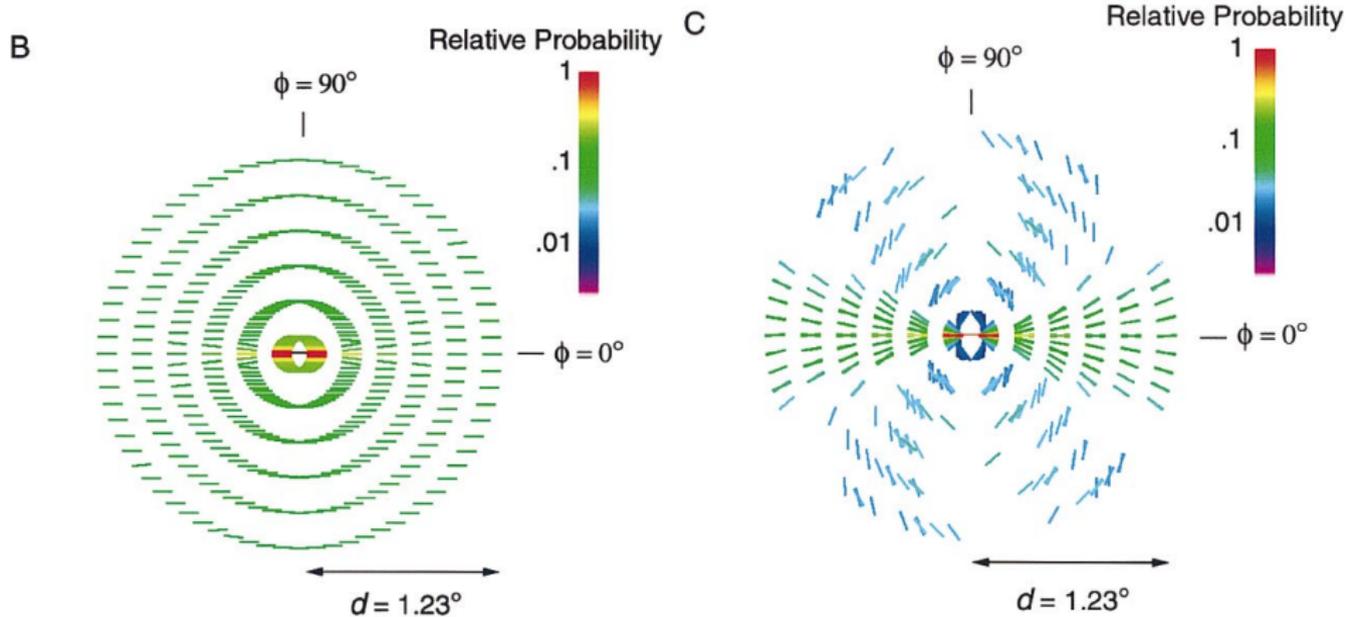
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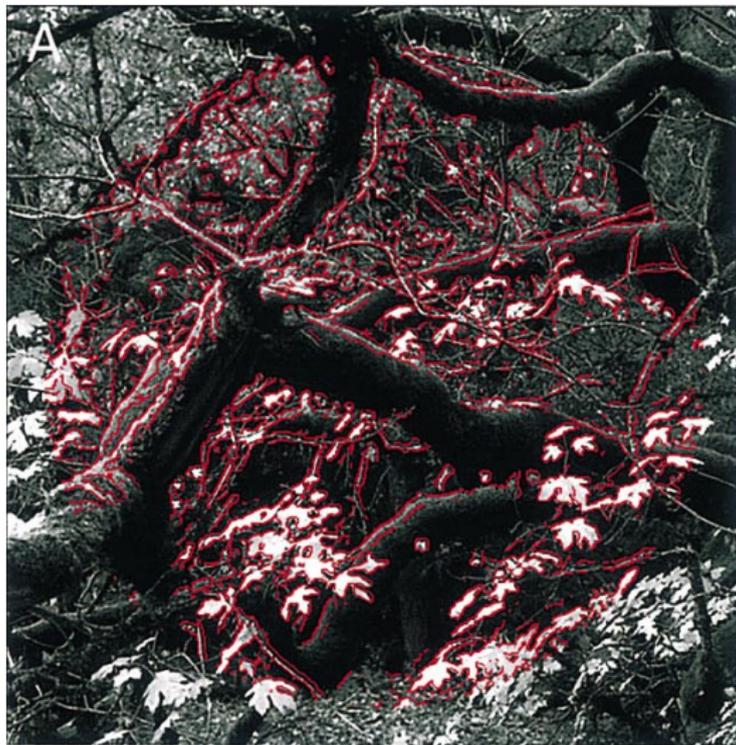
Second-order statistics

Quantitative difference using classification

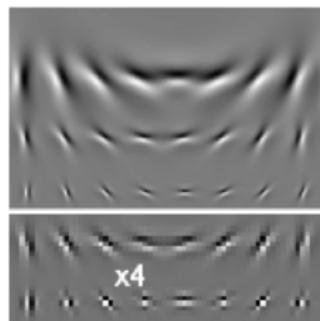
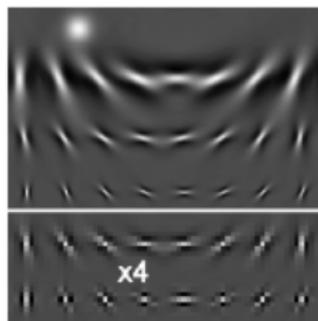
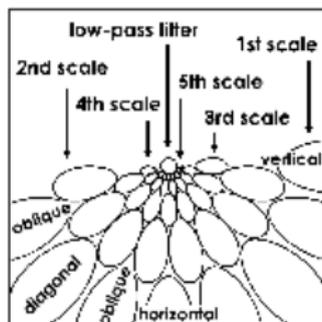
Take-home message



(Geisler et al., 2001, Vision Research)



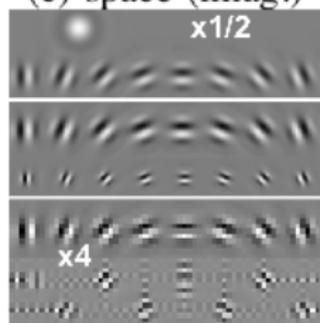
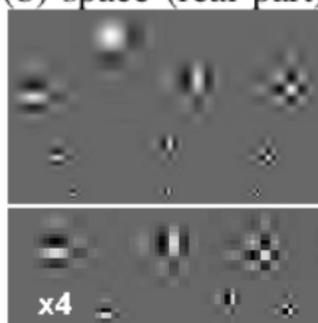
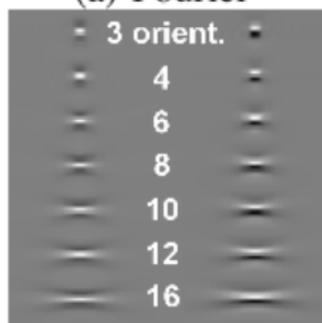
Log Gabor representation / Sparse coding



(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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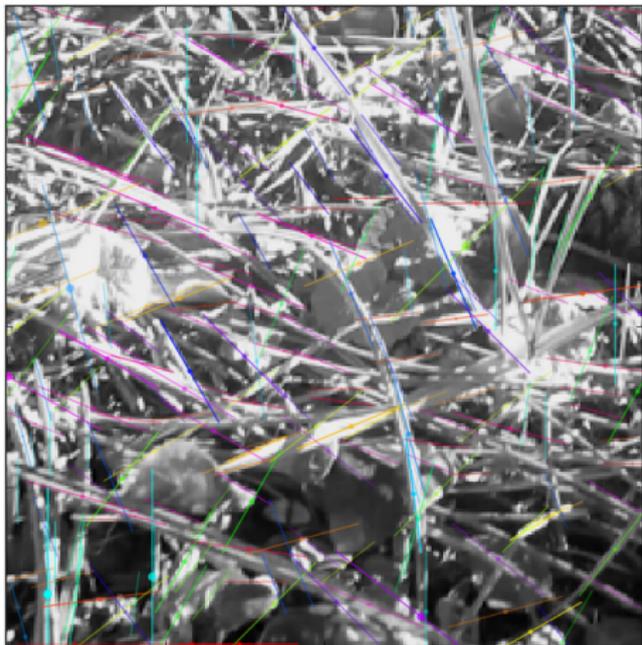
Some examples of edge extraction

Second-order statistics

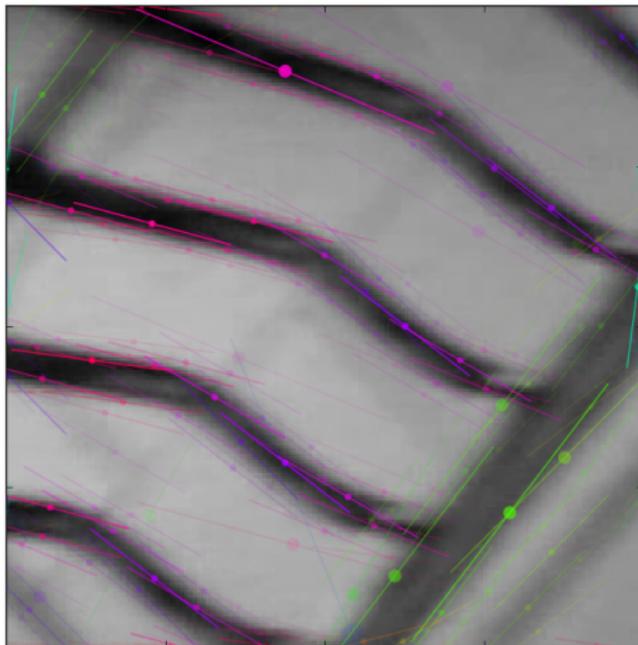
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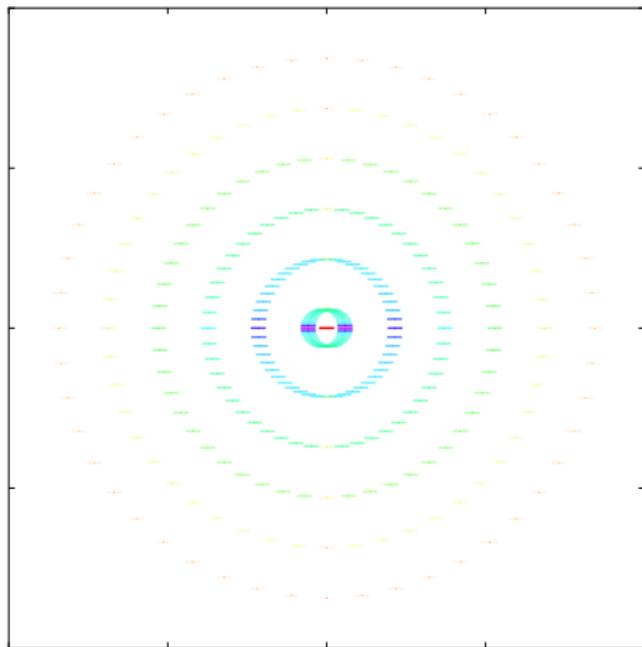
Natural



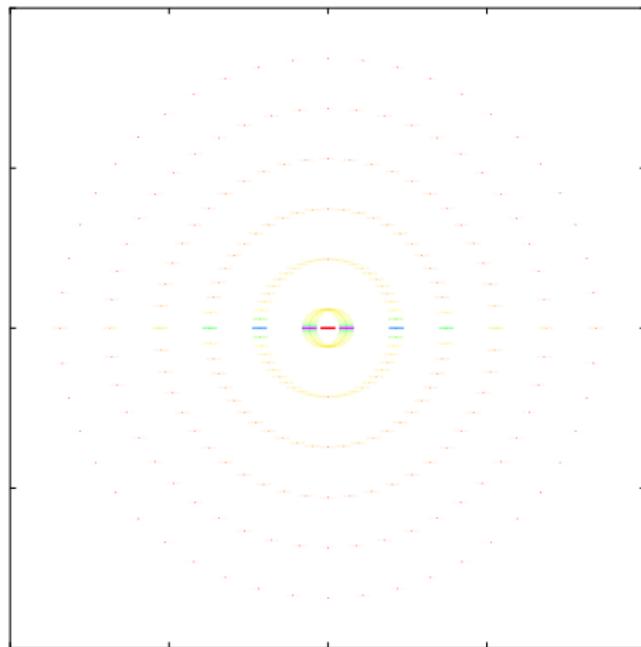
Laboratory

Second-order statistics

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



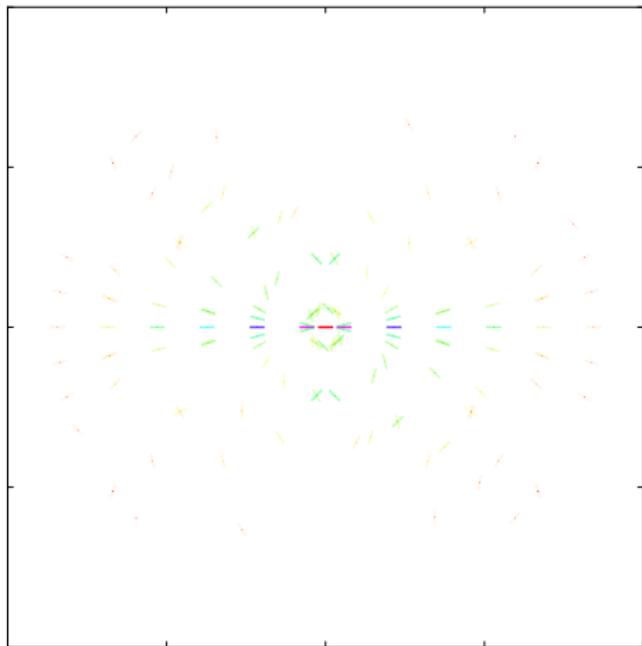
Natural



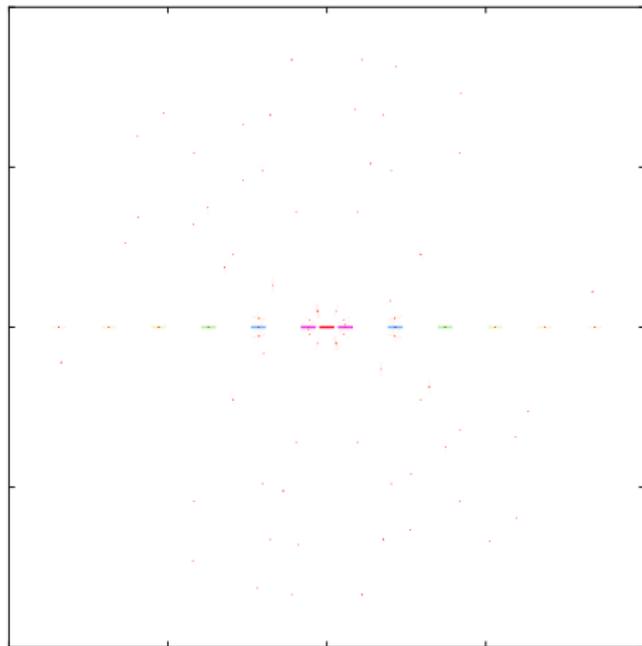
Laboratory

Second-order statistics

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



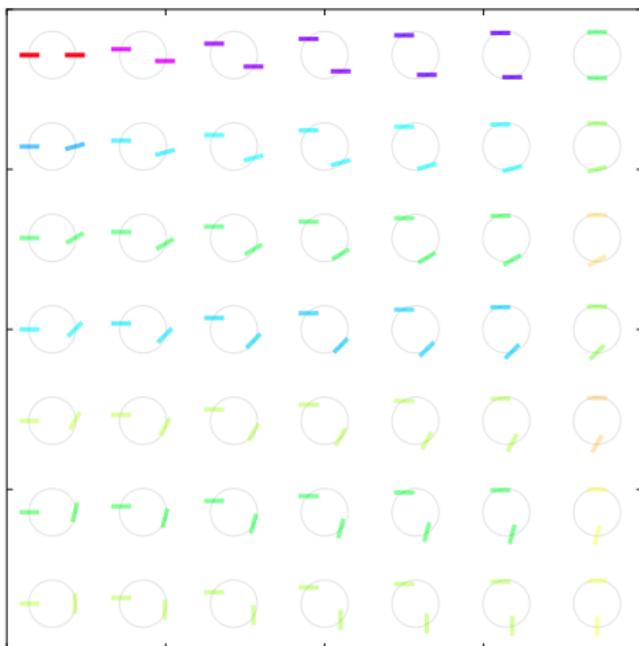
Natural



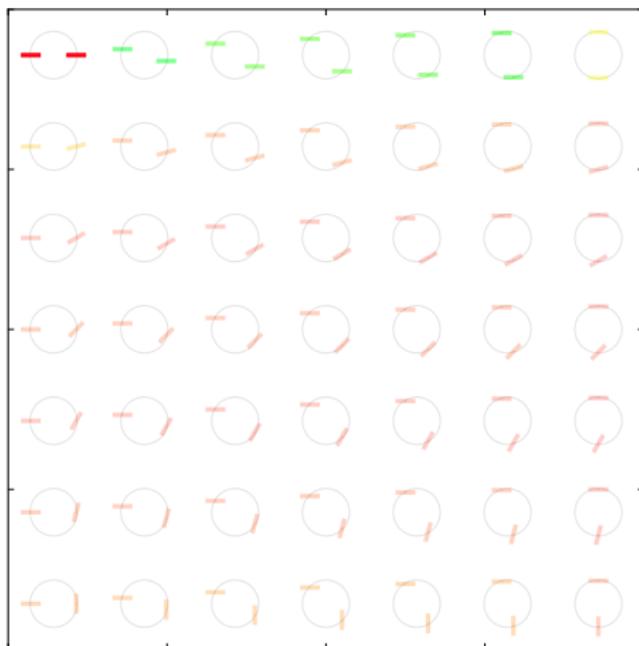
Laboratory

Second-order statistics

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

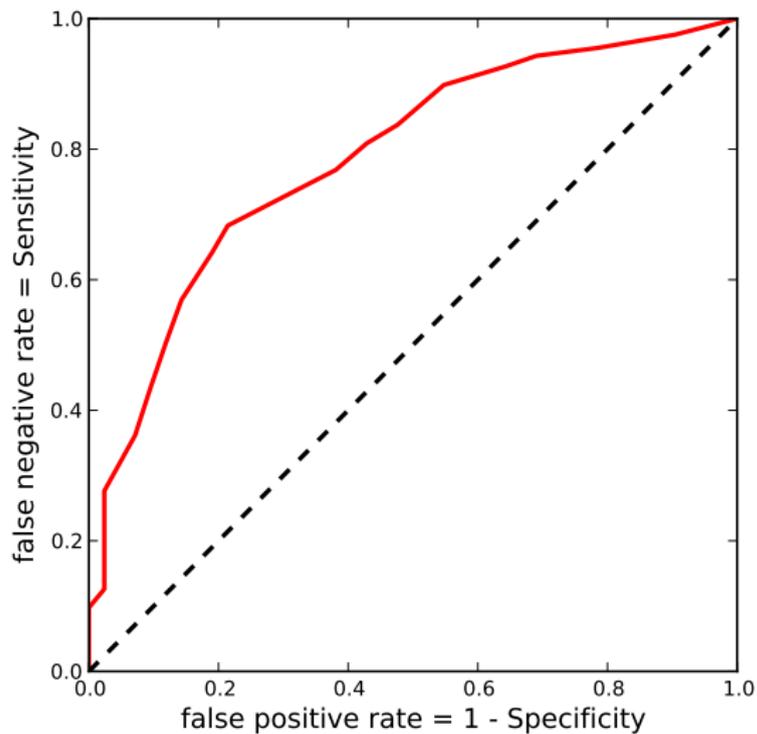


Natural

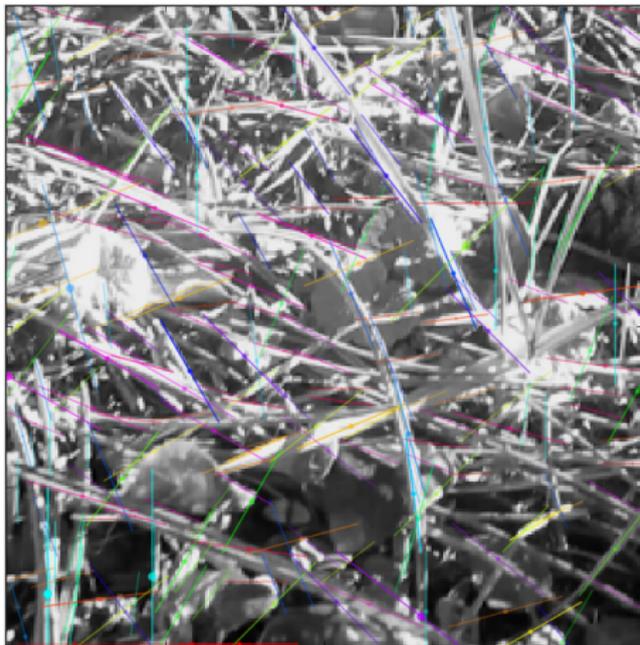


Laboratory

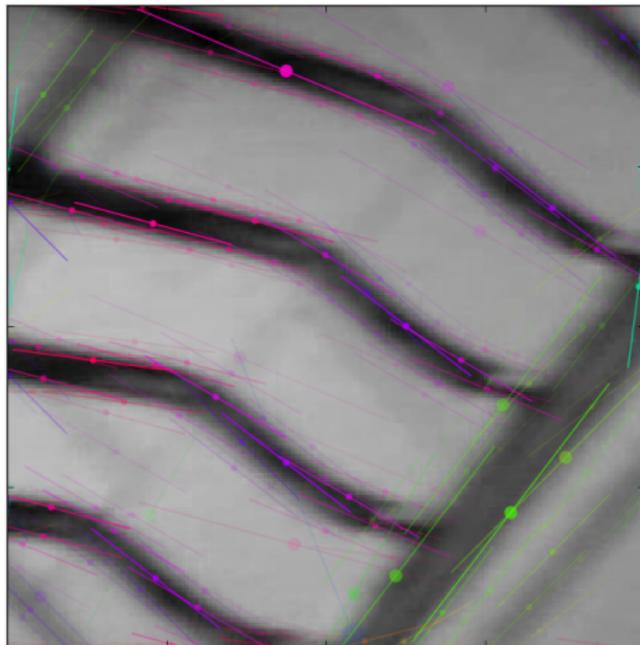
Quantitative difference using classification



Summary



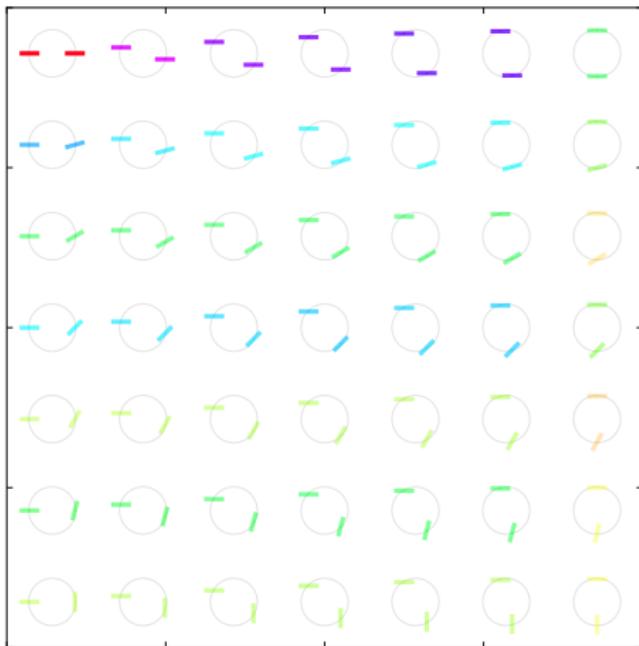
Natural



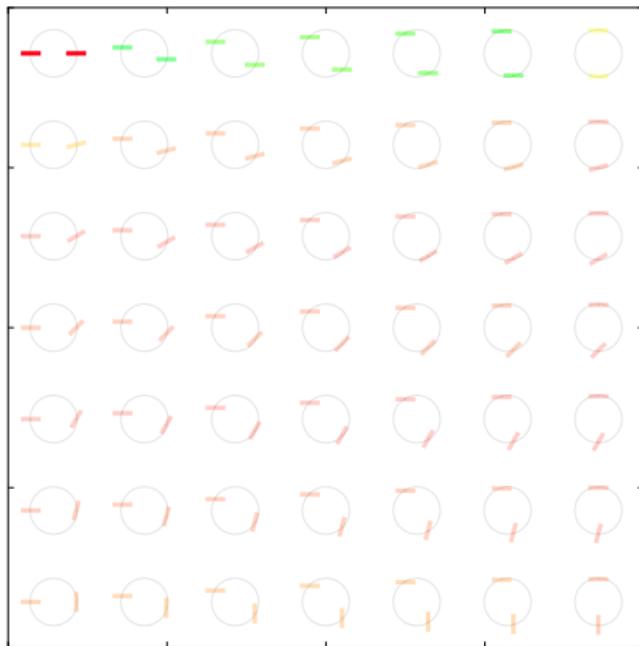
Laboratory

Summary

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



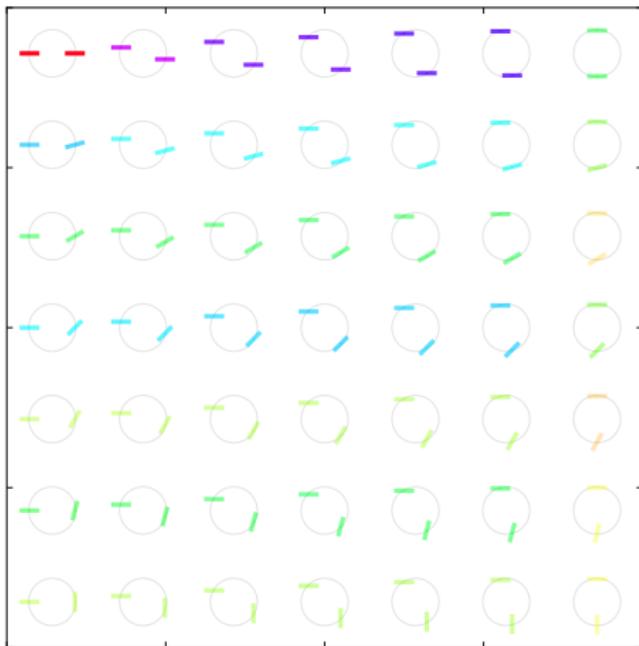
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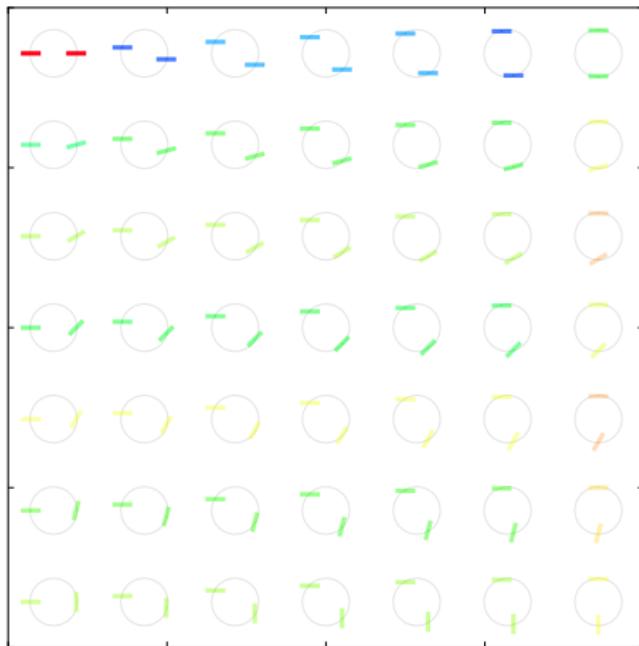
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Summary

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



Natural



Laboratory

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Neuromorphic implementation

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

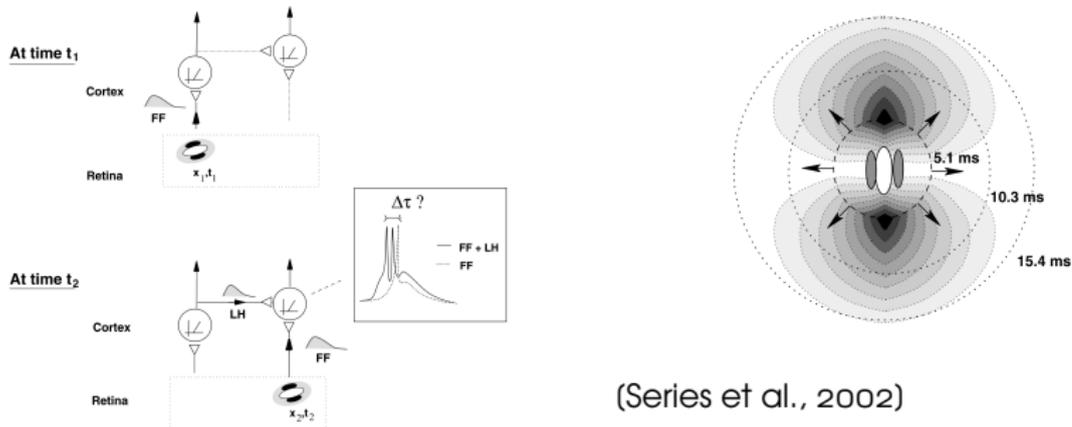


Fig. 1. Cartoon of the V1 model, which represents an array of cortical units

(Series et al., 2002)

Matching Pursuit

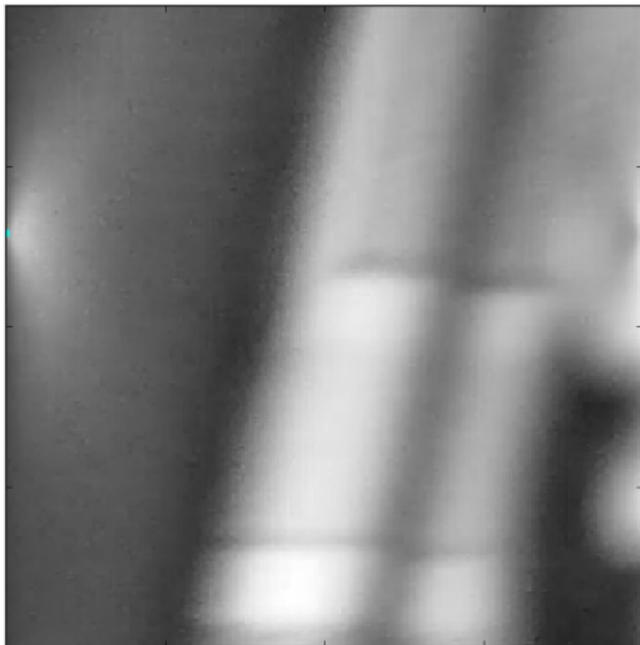


Residual

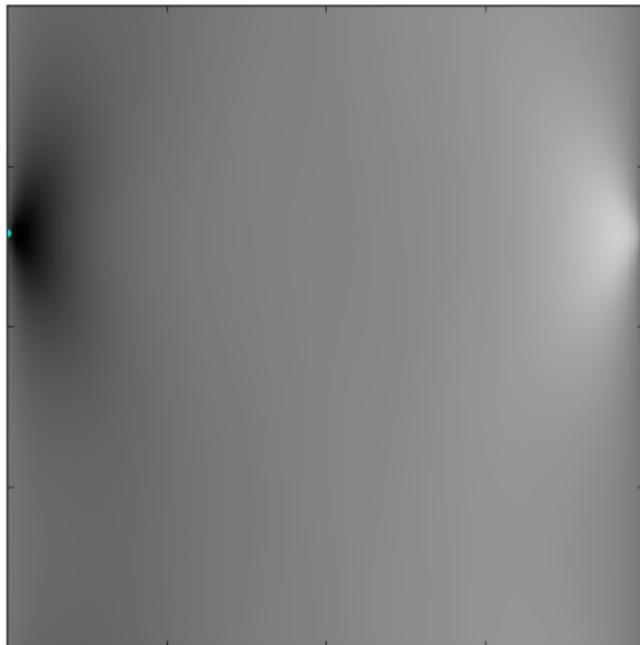


Edges

Matching Pursuit

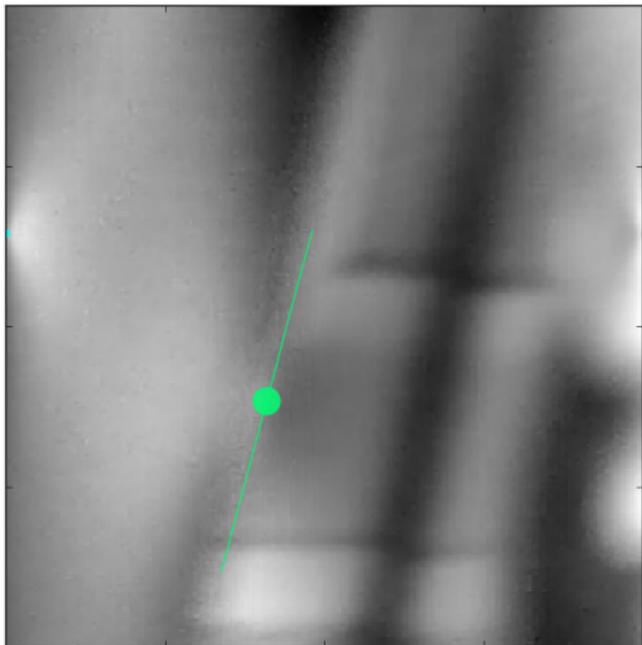


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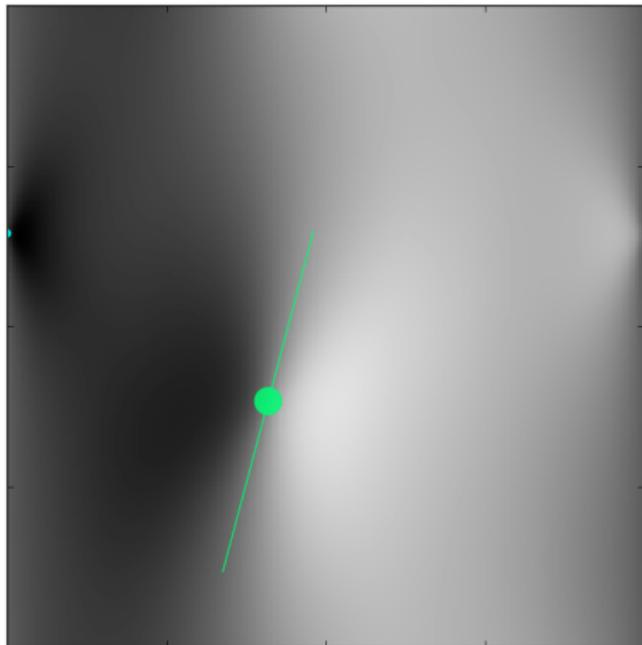


Edges

Matching Pursuit

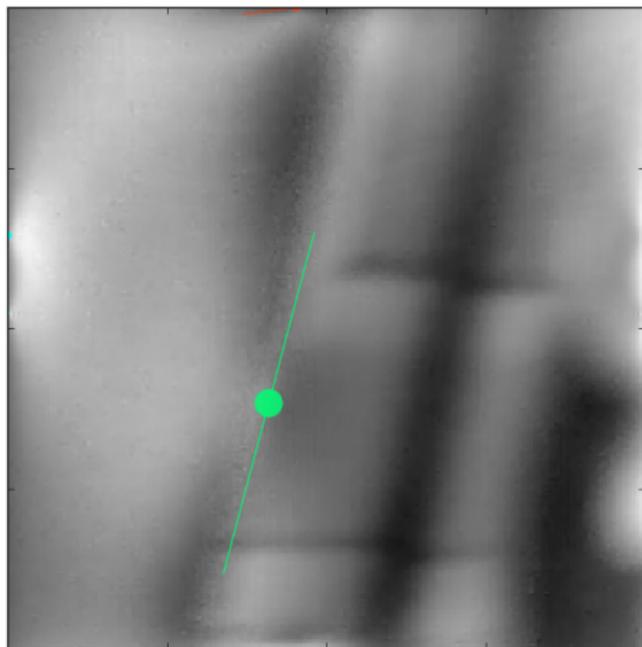


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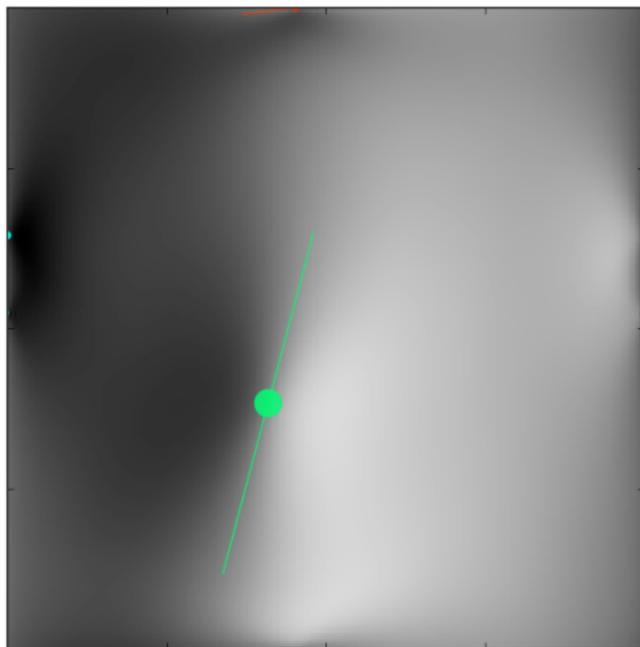


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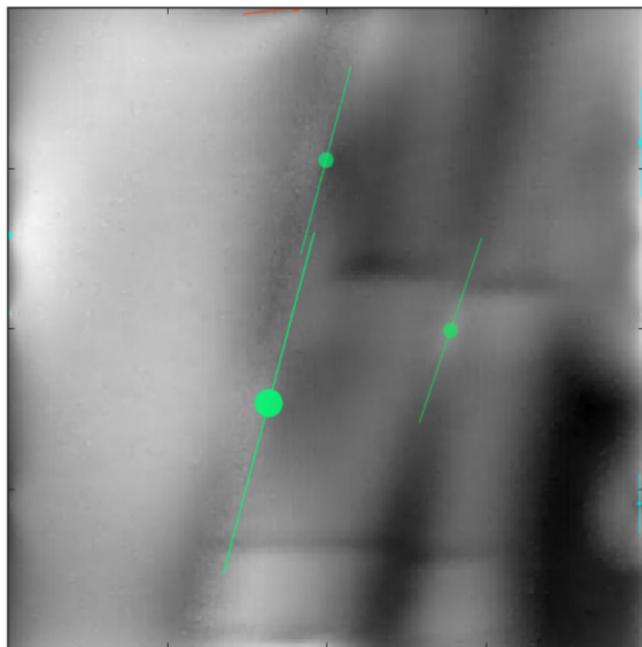


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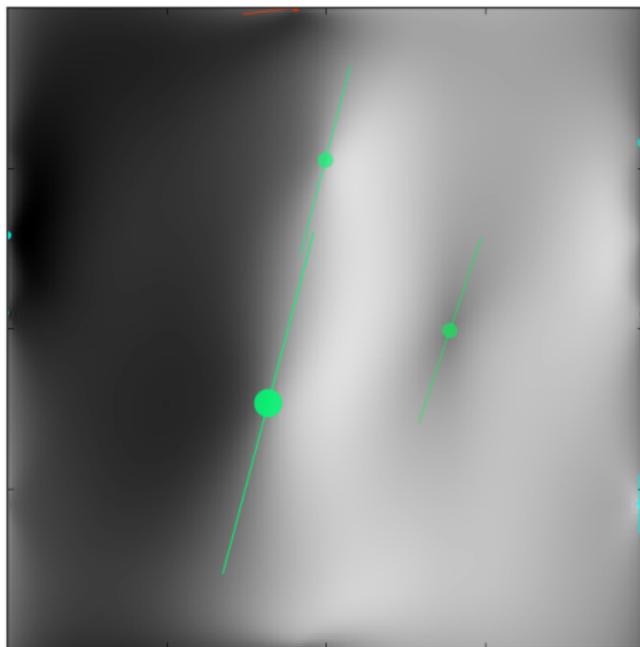


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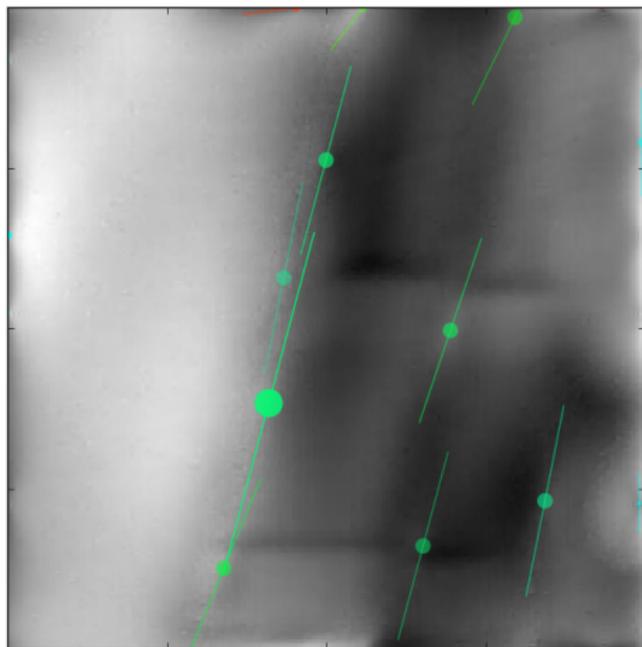


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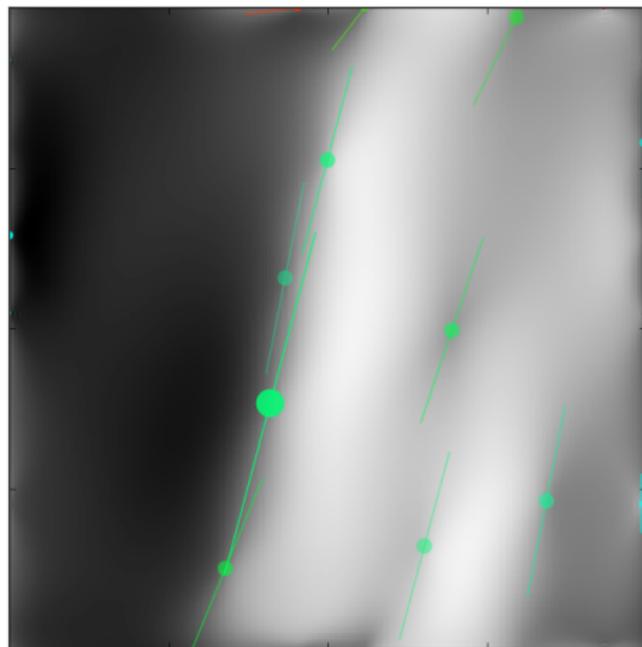


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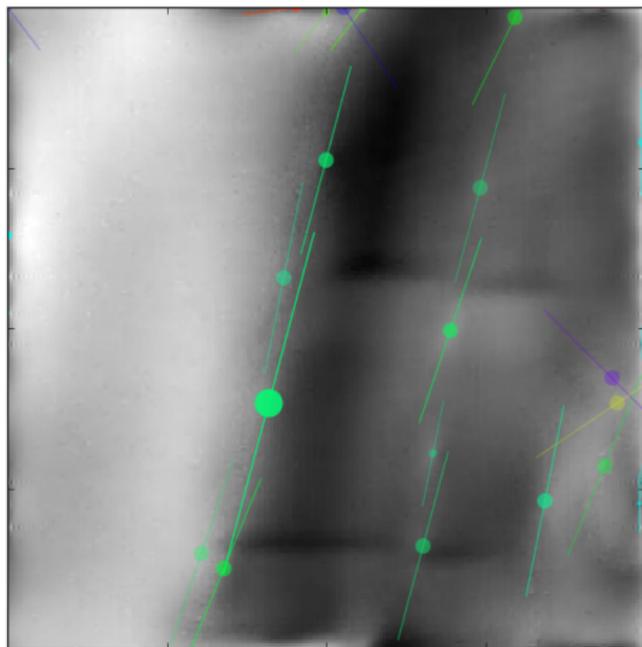


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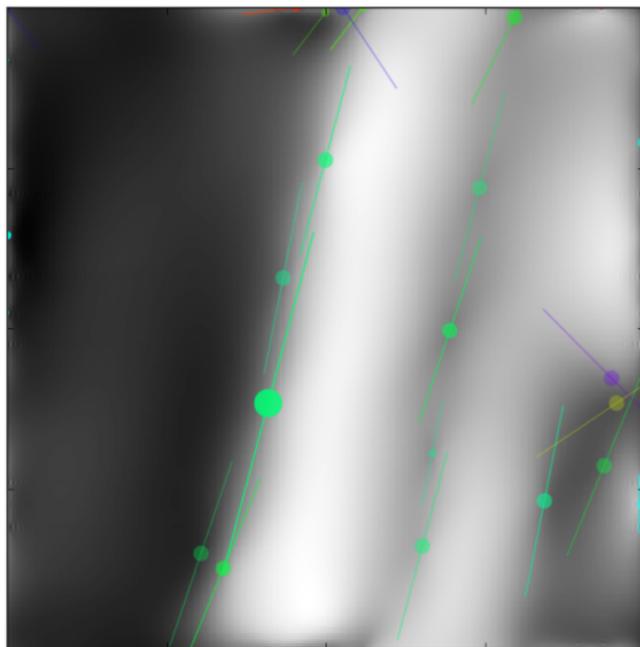


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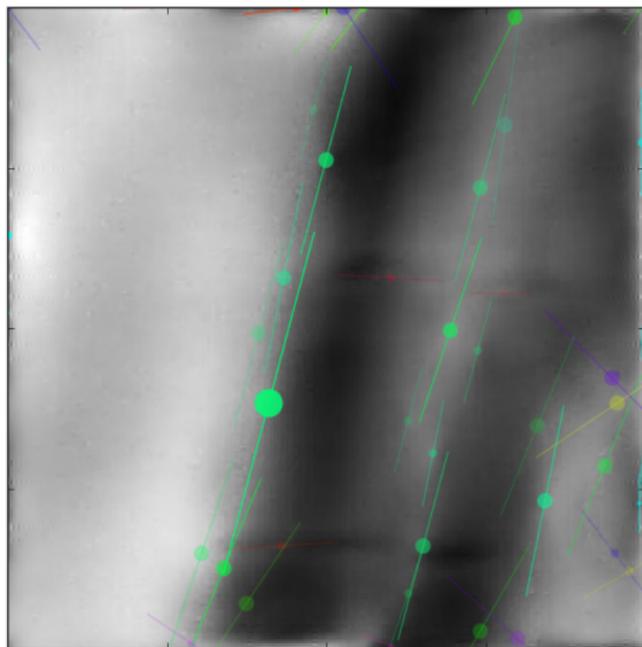


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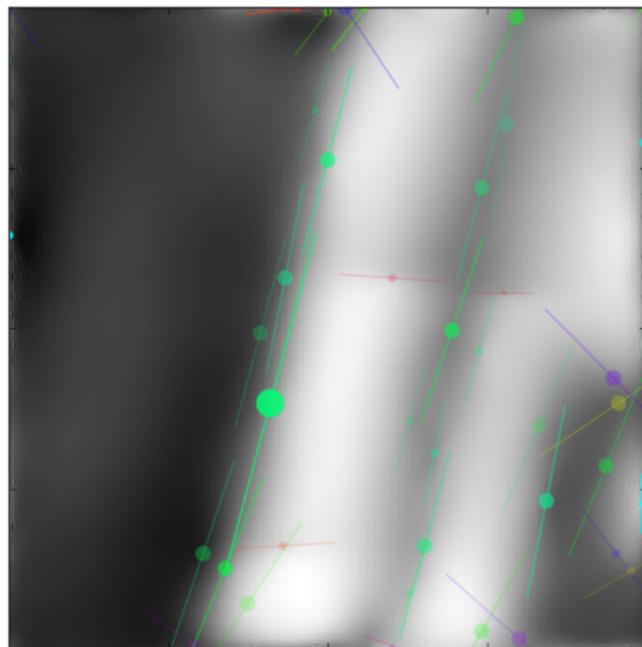


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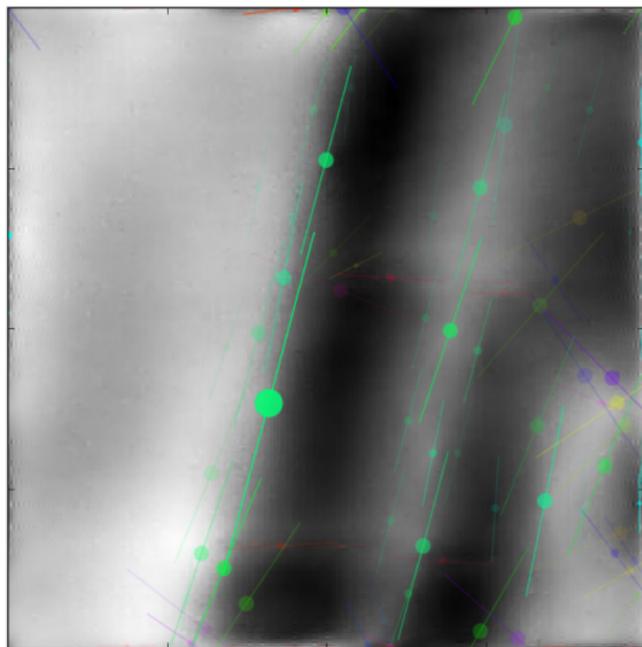


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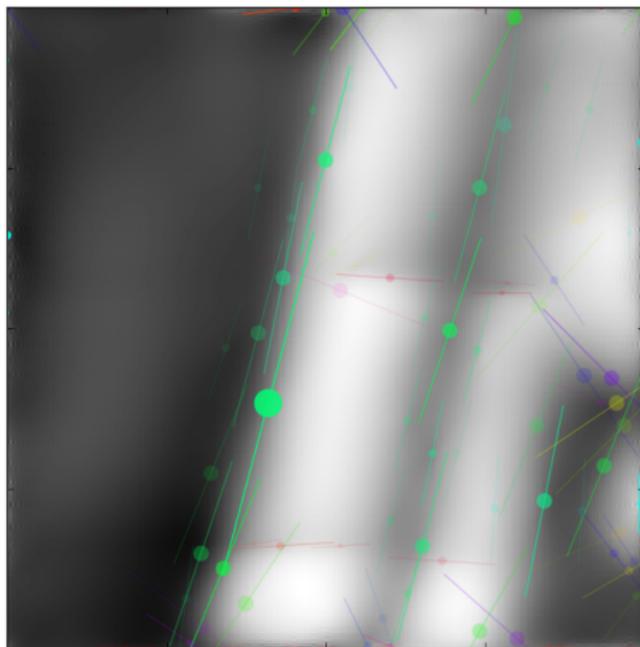


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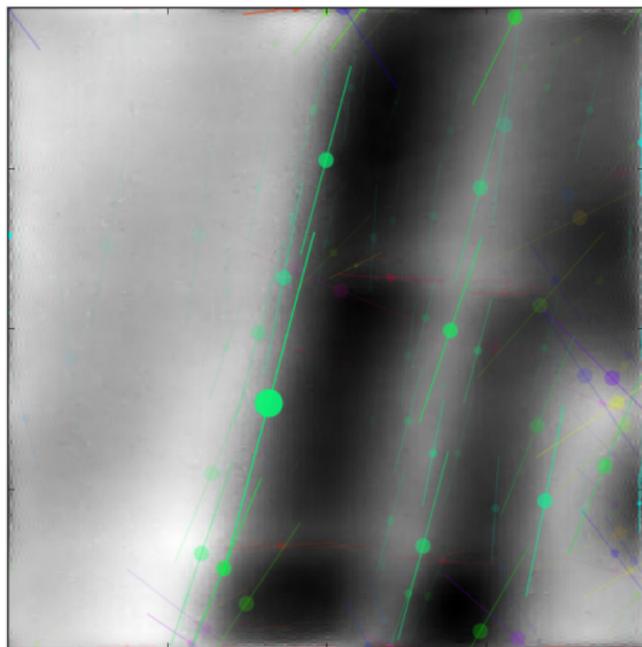


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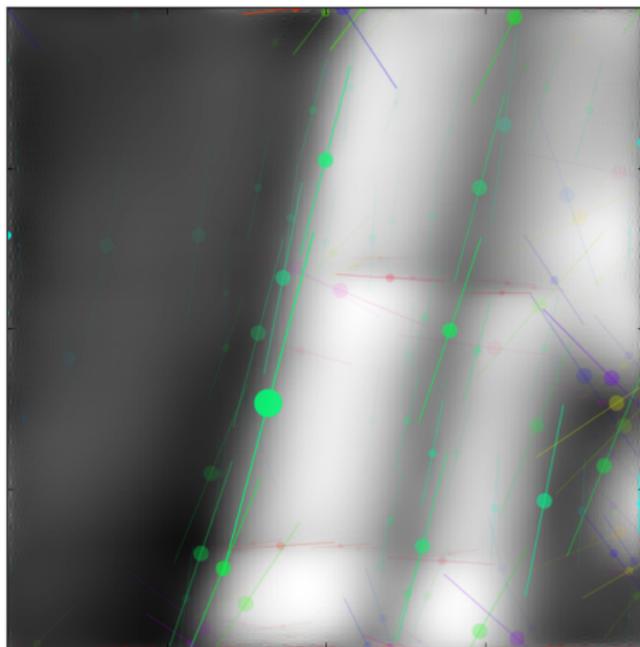


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Matching Pursuit



Residual



Edges