

Edge co-occurrences and categorizing images

Implications for understanding adaptation of the function of V1 with respect to the environment

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University College London, UK.

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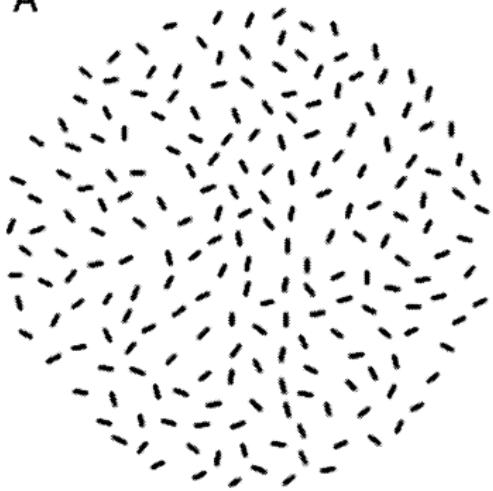
Tuesday, 3rd of December, 2013

Motion Clouds network meeting.

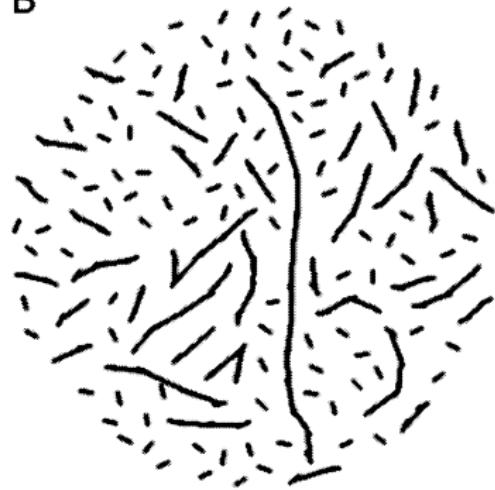
This work is supported by projects “BrainScaleS” (EU funding, grant number FP7-269921).



A

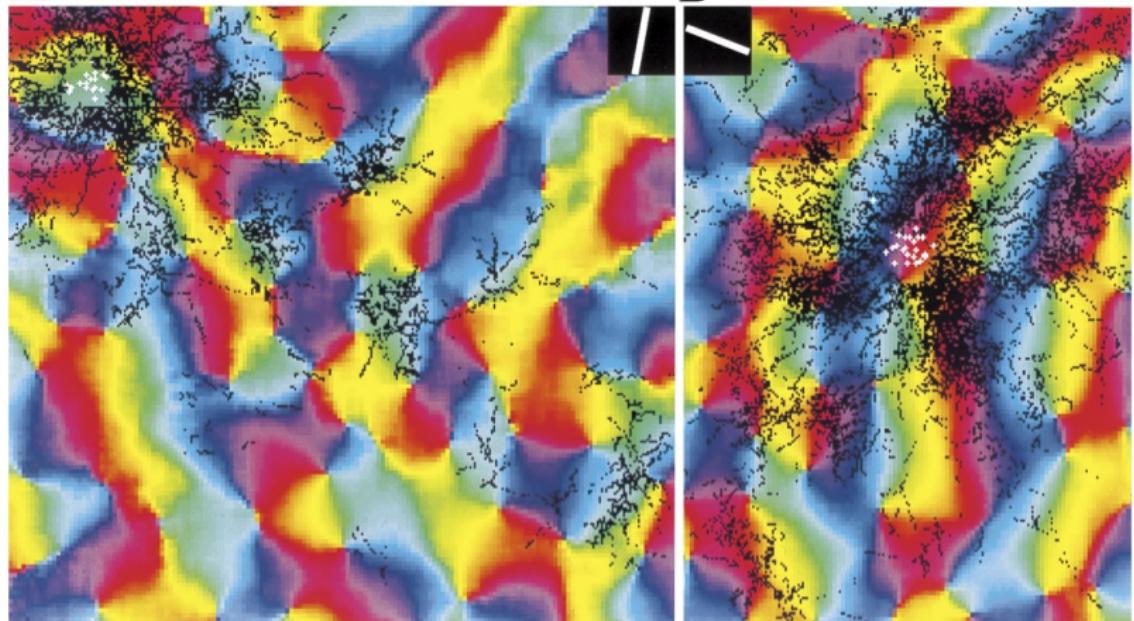


B



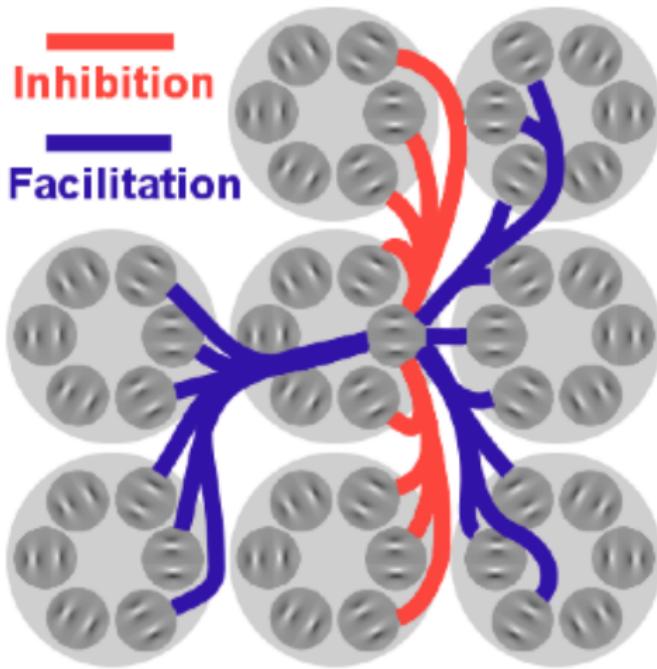
[Geisler et al., 2001, Vision Research]

A

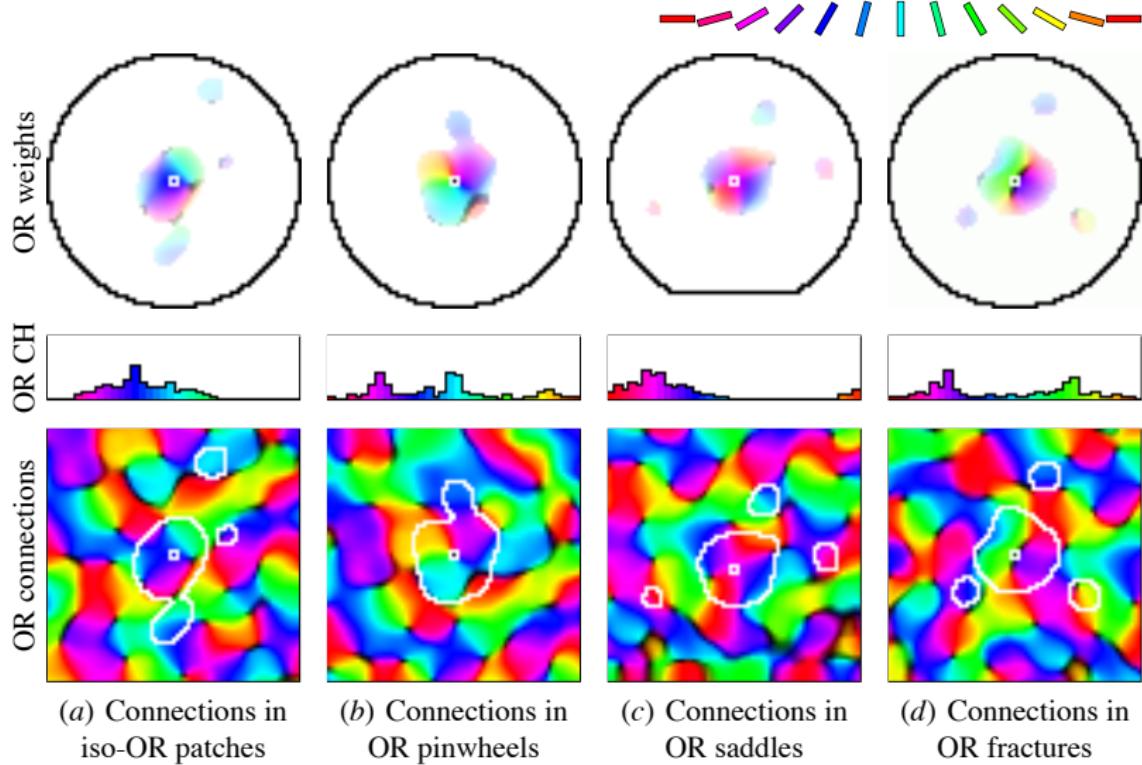


B

[Bosking et al, 1997, Journal of Neuroscience]

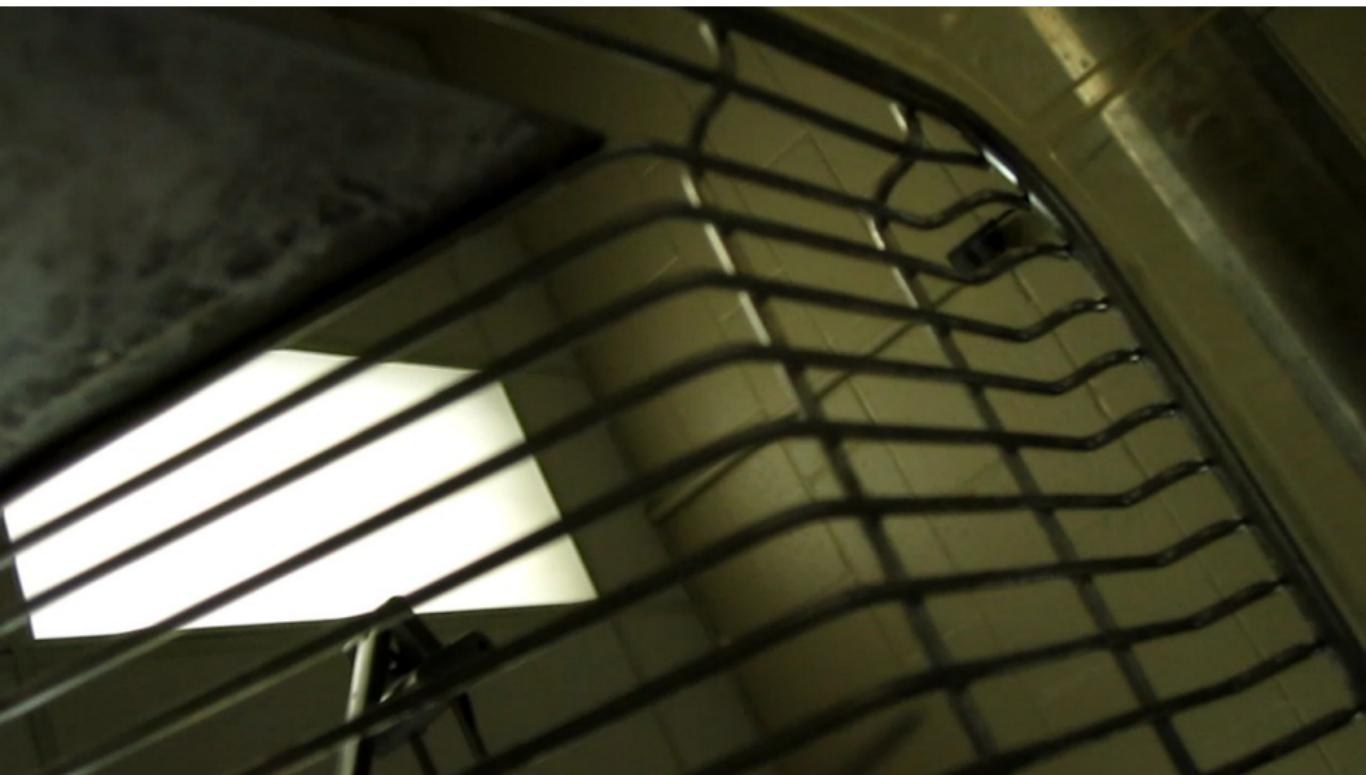


[Fischer et al., 2007]



[Choe et al. 2004; Miikkulainen et al., 2005]





Outline: Edge co-occurrences and categorizing 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

Categorizing animals vs animals

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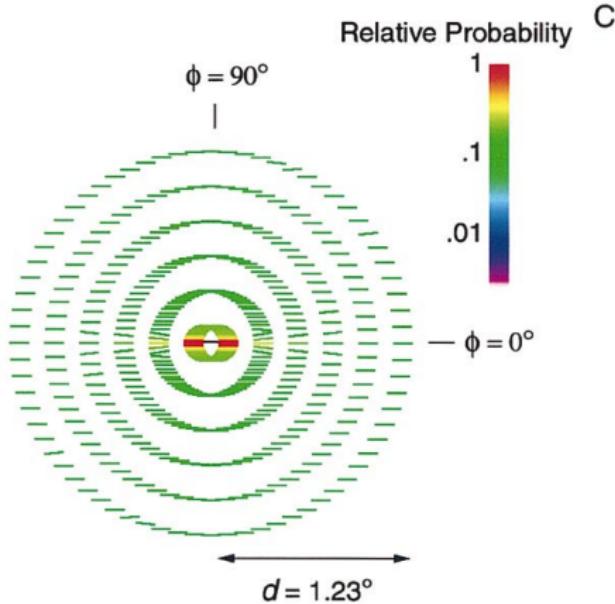
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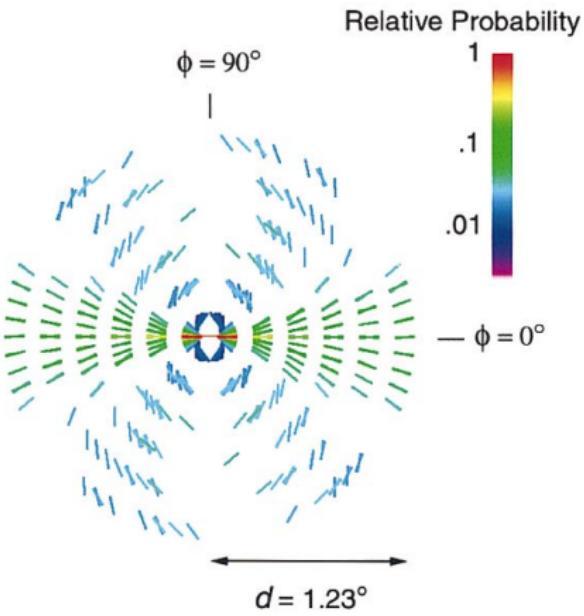
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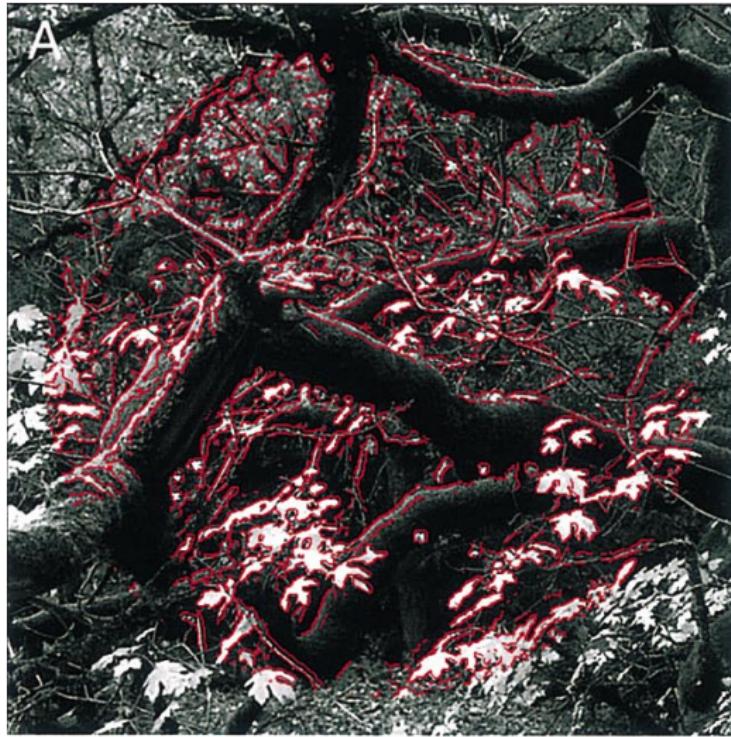
B



C

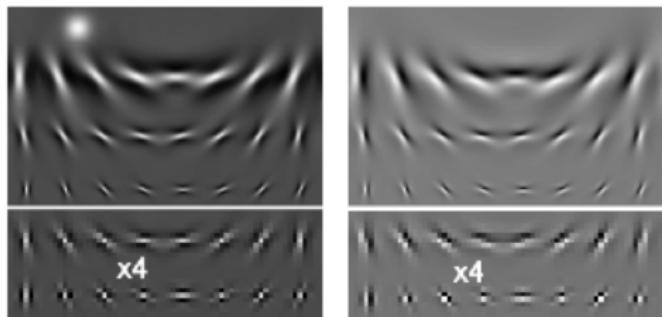
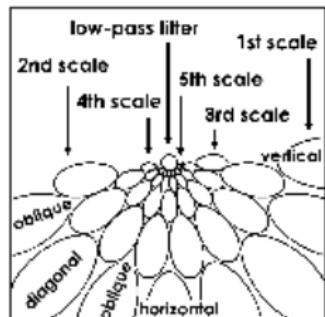


Geisler et al, 2001

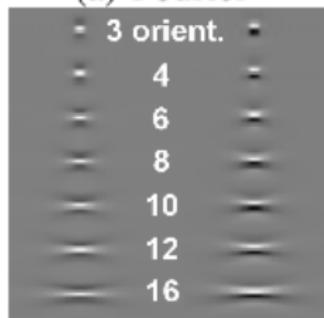


[Geisler et al., 2001, Vision Research]

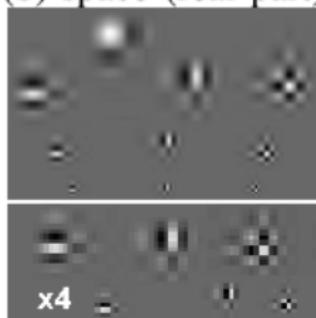
Log Gabor representation / Sparse coding



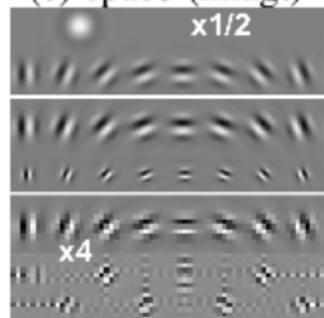
(a) Fourier



(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

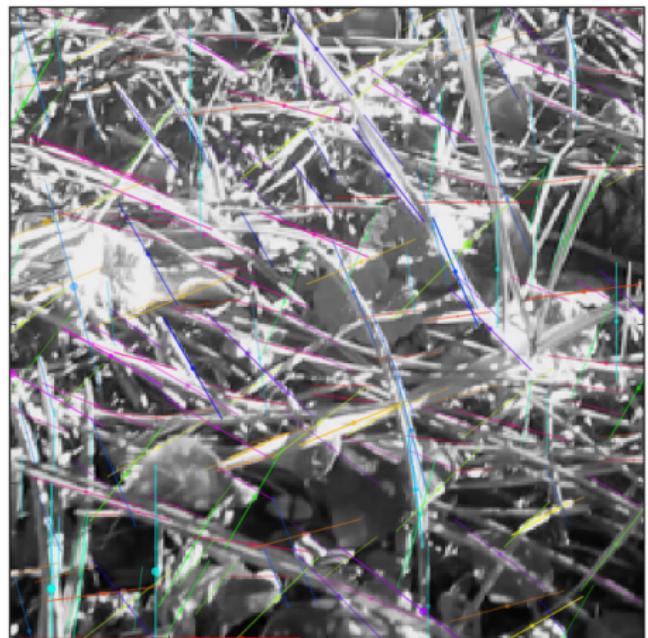
Second-order statistics

Quantitative difference using classification

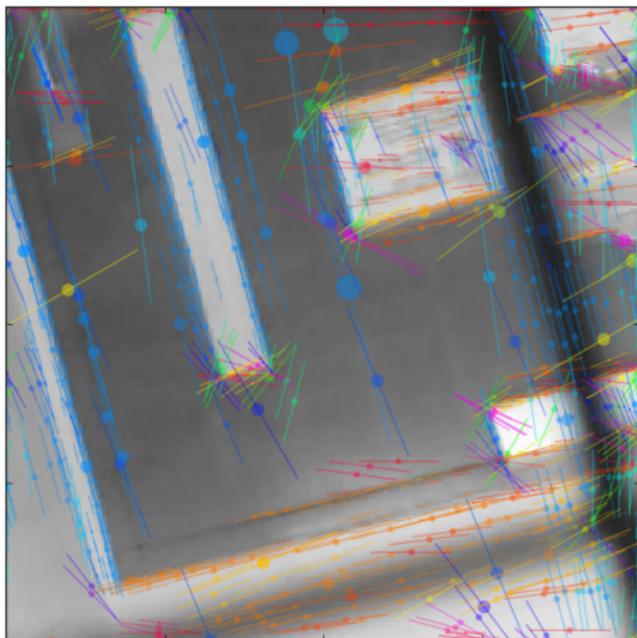
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Categorizing animals vs animals

Some examples of edge extraction



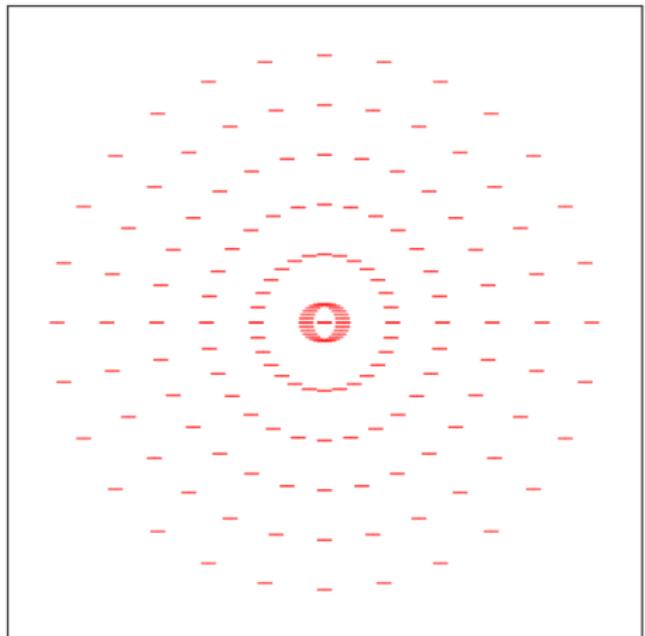
Natural



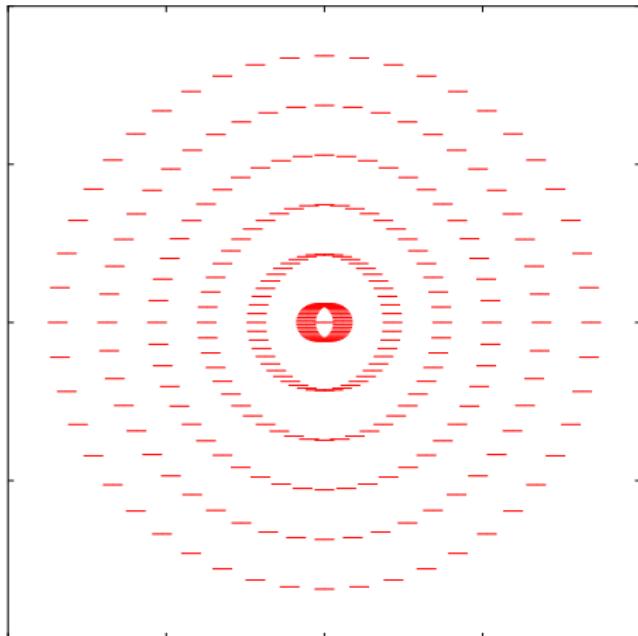
Laboratory

Second-order statistics

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



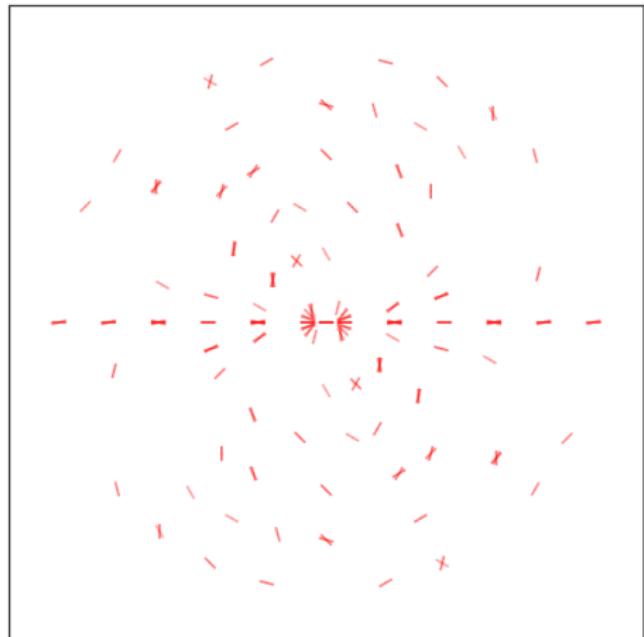
Natural



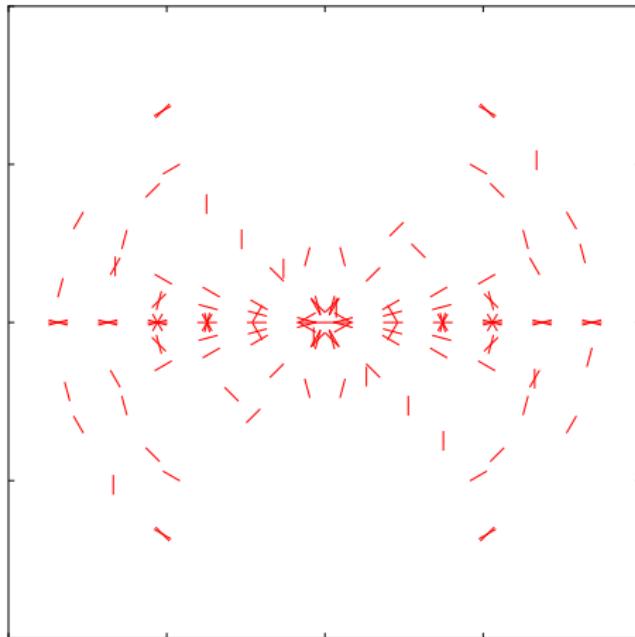
Laboratory

Second-order statistics

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



Natural

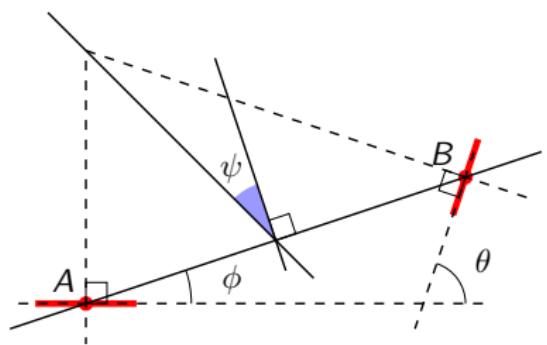
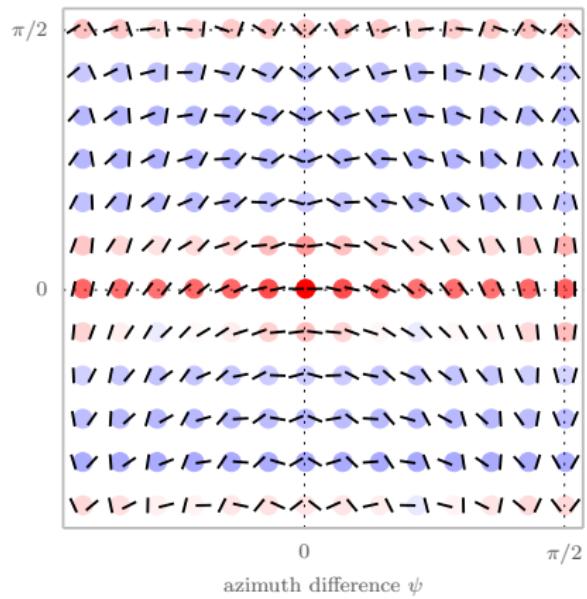


Laboratory

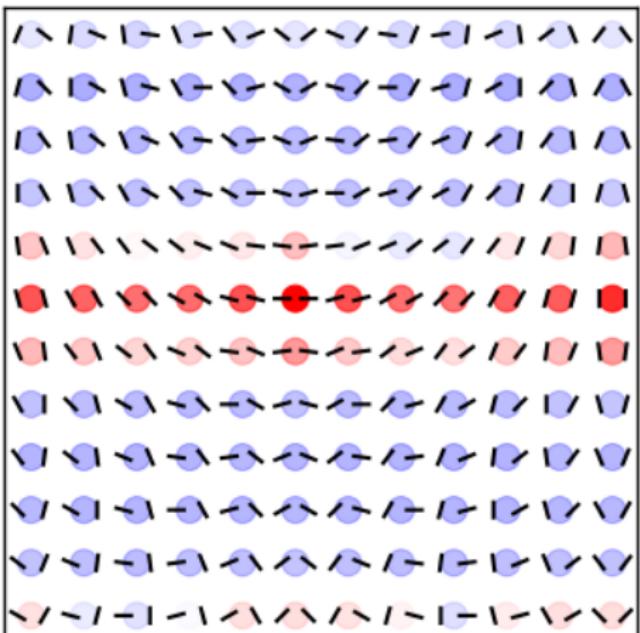
Second-order statistics

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

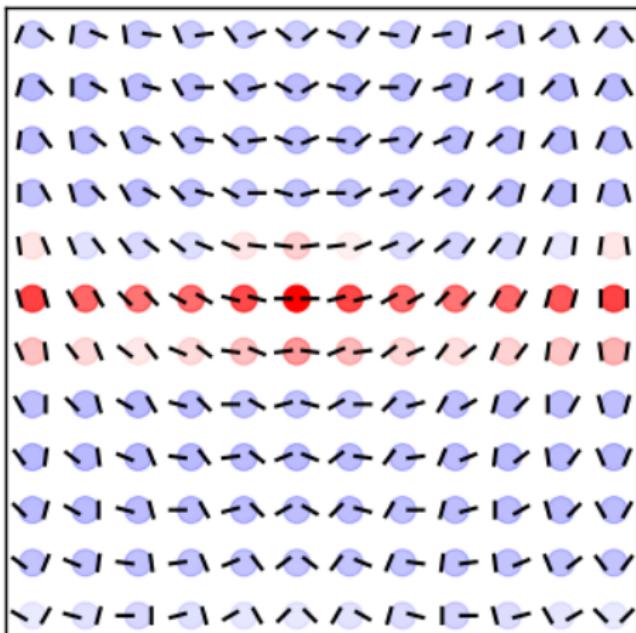
orientation difference θ



Second-order statistics

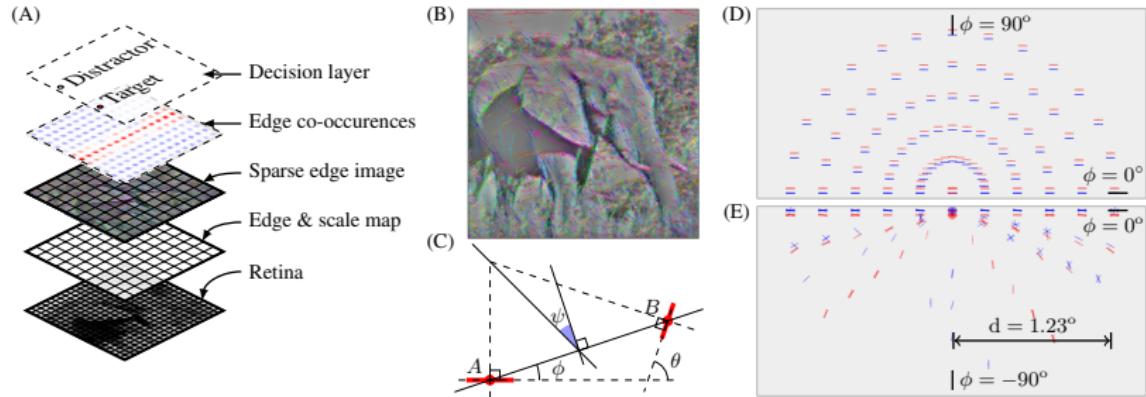


Natural



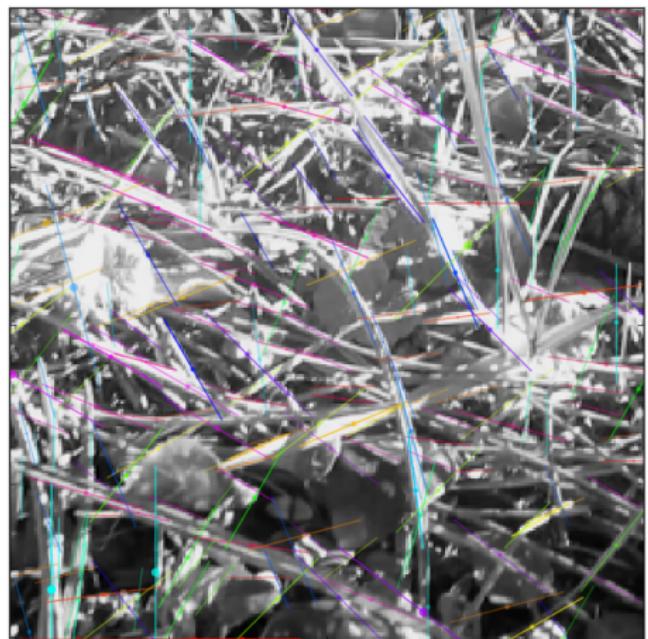
Laboratory

Quantitative difference using classification

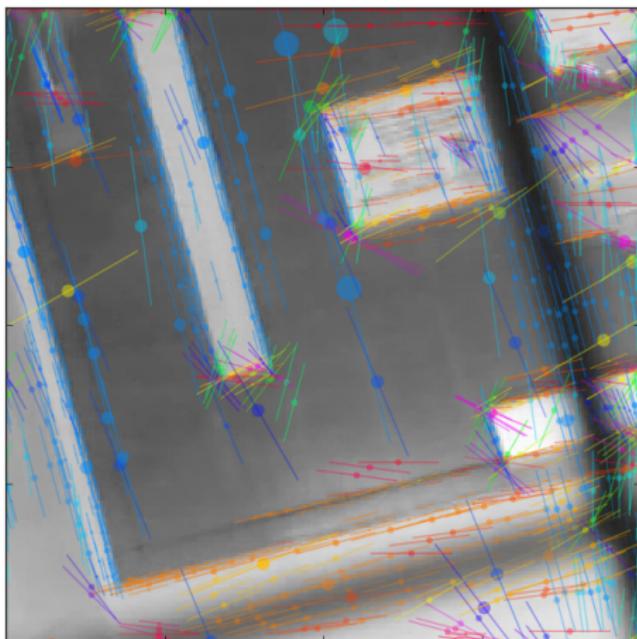


Database 1	Database 2	2-means	SVM 1	SVM 2	SVM C
Natural	Artificial	98%	88%	99%	98%

Summary



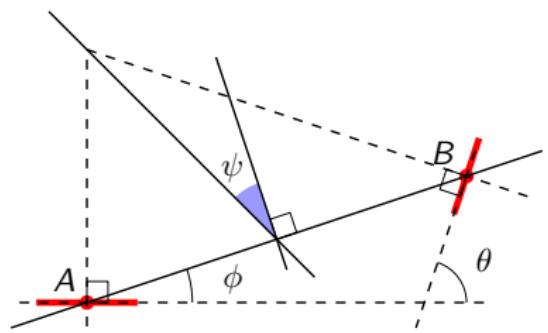
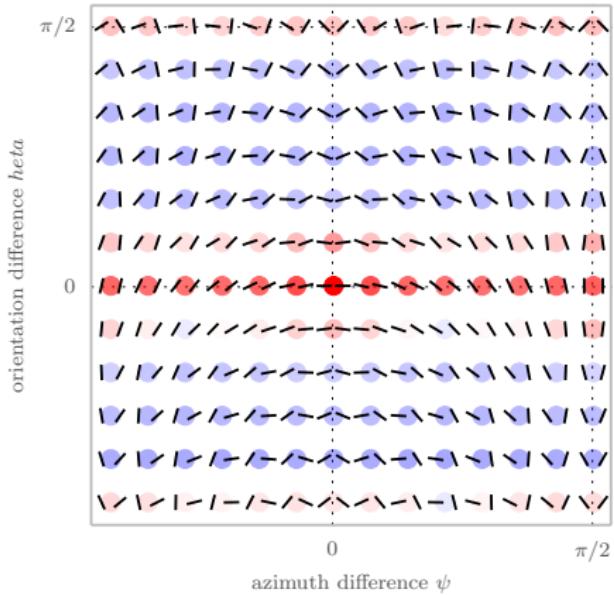
Natural



Laboratory

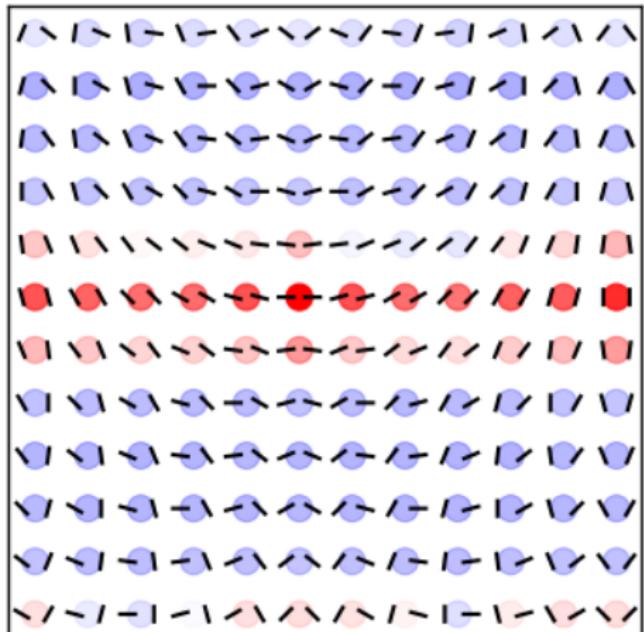
Summary

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

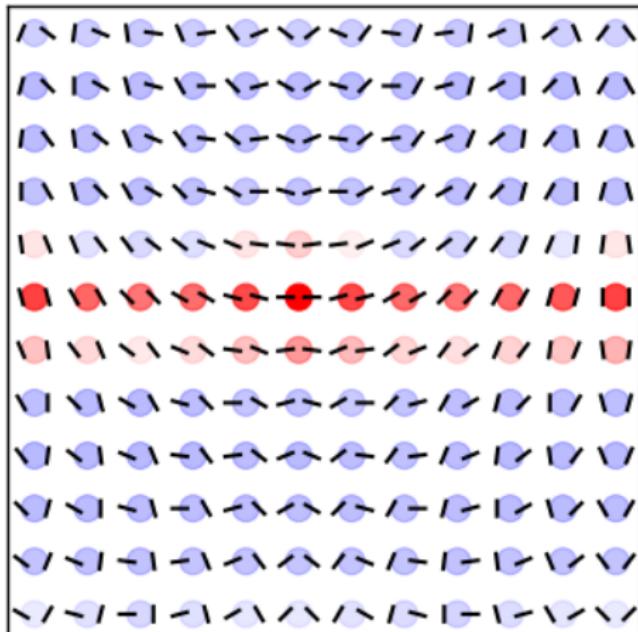


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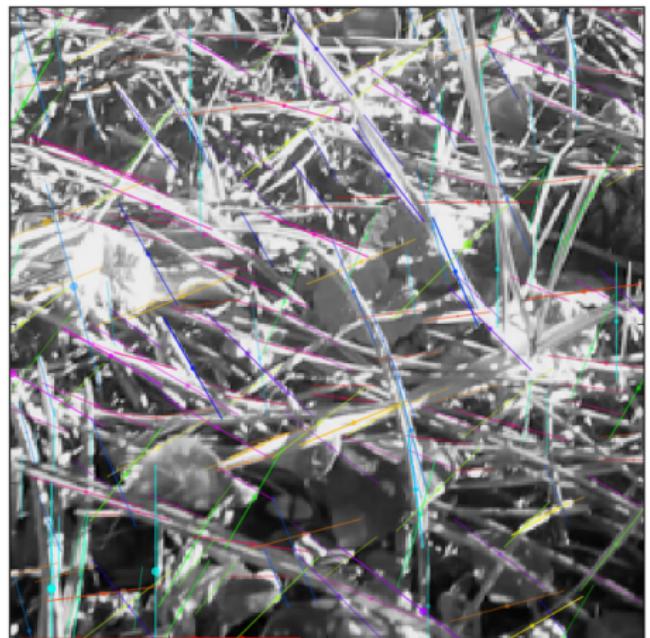


Natural

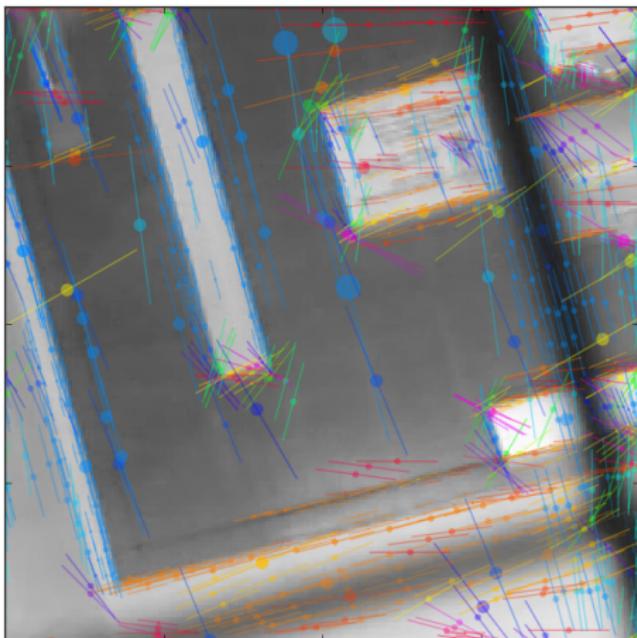


Laboratory

Categorizing animals vs animals

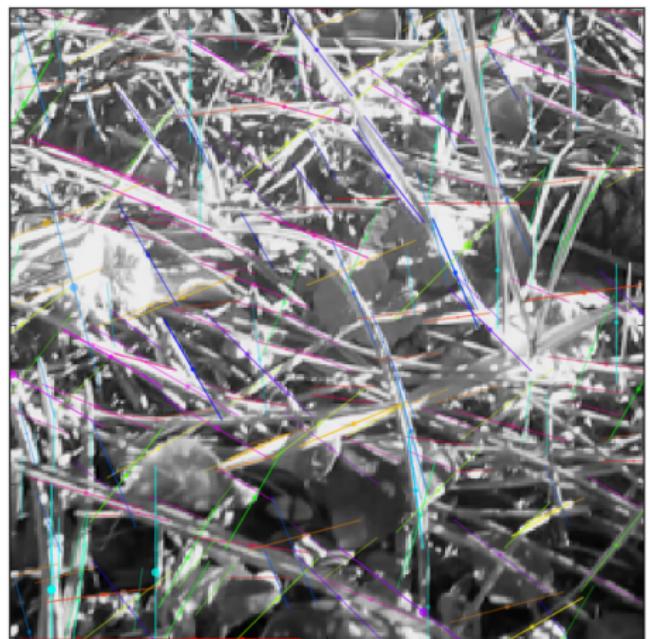


Natural

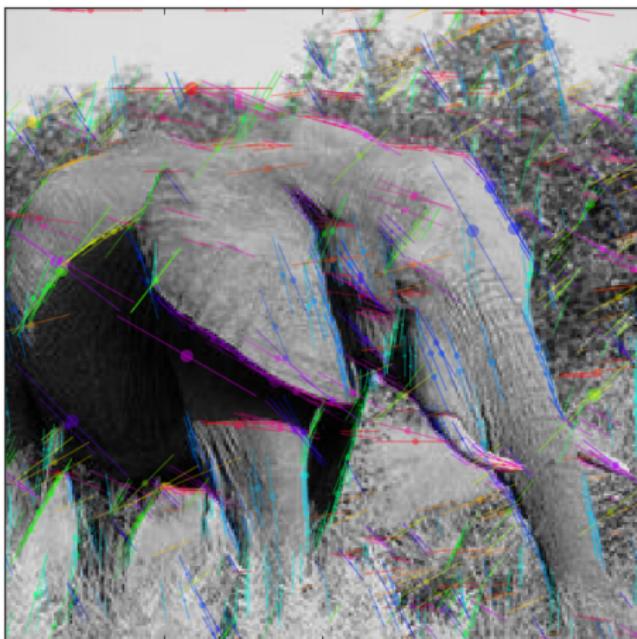


Laboratory

Categorizing animals vs animals

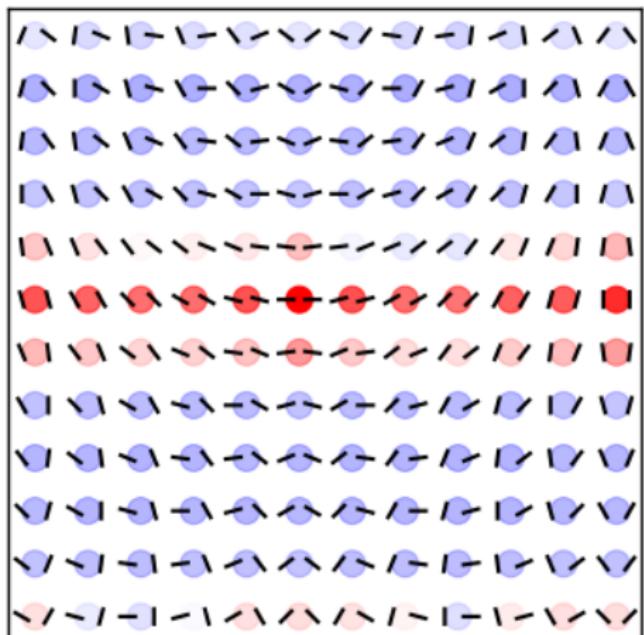


Natural

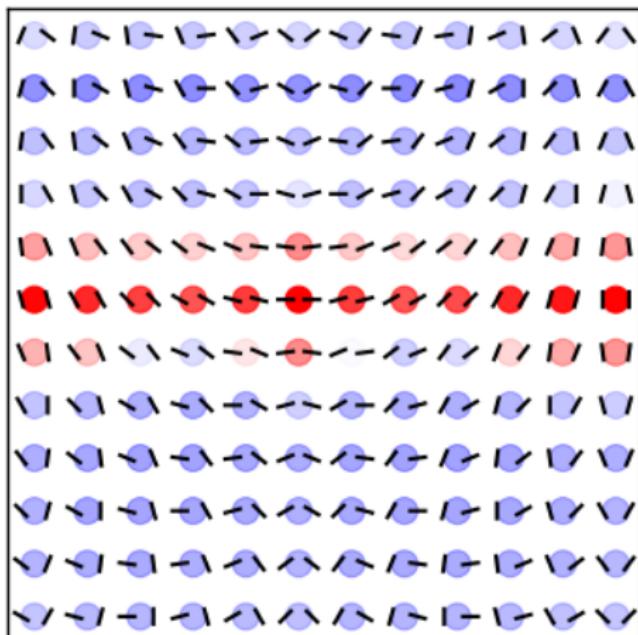


Animal

Categorizing animals vs. animals



Natural



Animal

Categorizing animals vs animals

Database 1	Database 2	2-means	SVM 1	SVM 2	SVM C
Natural	Natural	50%	50%	50%	50%
Natural (noise)	Animal (noise)	64%	71%	77%	77%
Natural	Animal	65%	68%	82%	81%
Natural	Artificial	98%	88%	99%	98%

Categorizing animals vs animals

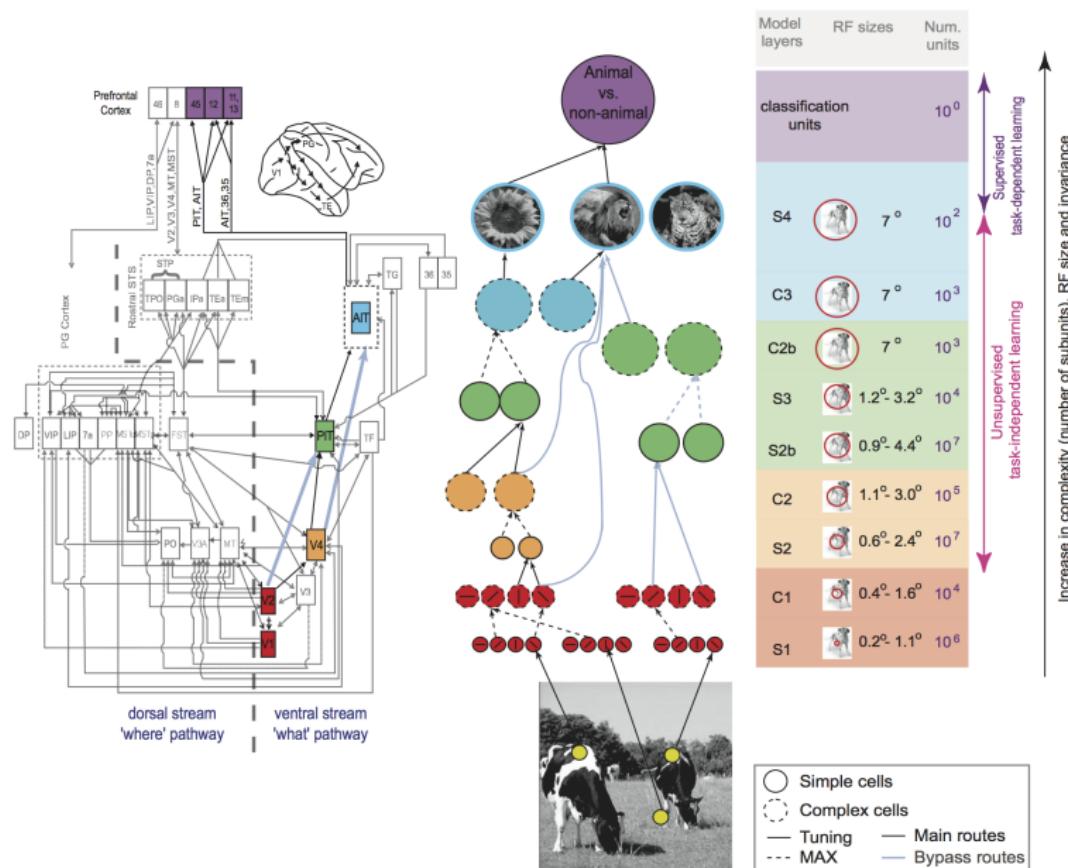


Best



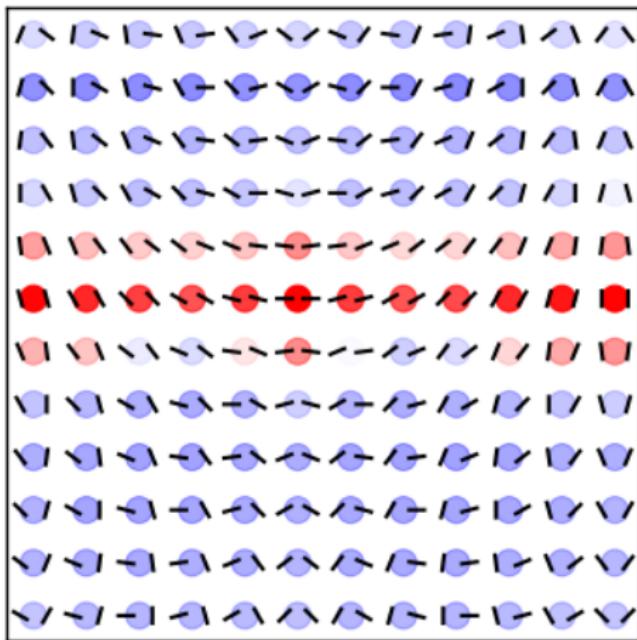
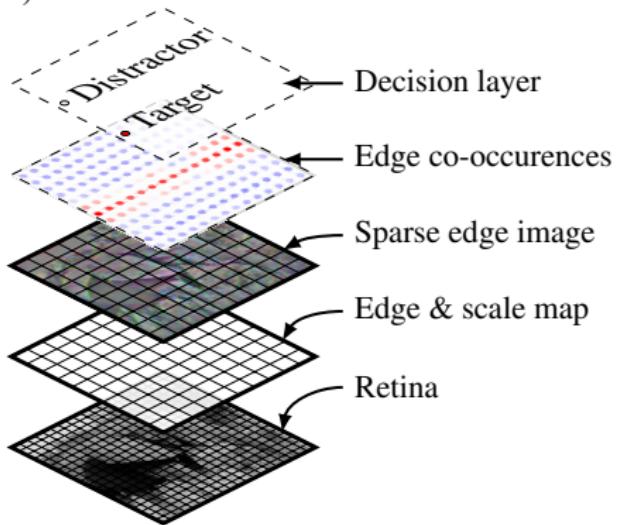
Worst

Categorizing animals vs. non-animals



Categorizing animals vs animals

(A)



References

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-  P. Seriès, S. Georges, J. Lorenceau, and Y. Frégnac.
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Neuromorphic implementation

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

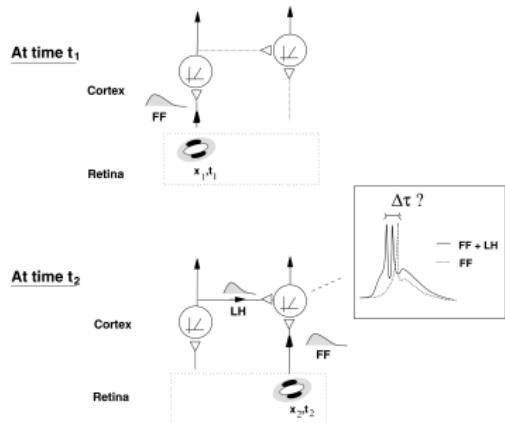
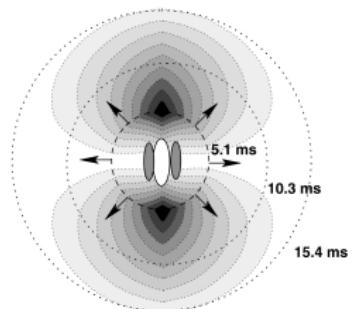


Fig. 1. Cartoon of the V1 model, which represents an array of cortical units



[Series et al., 2002]

Matching Pursuit



Residual

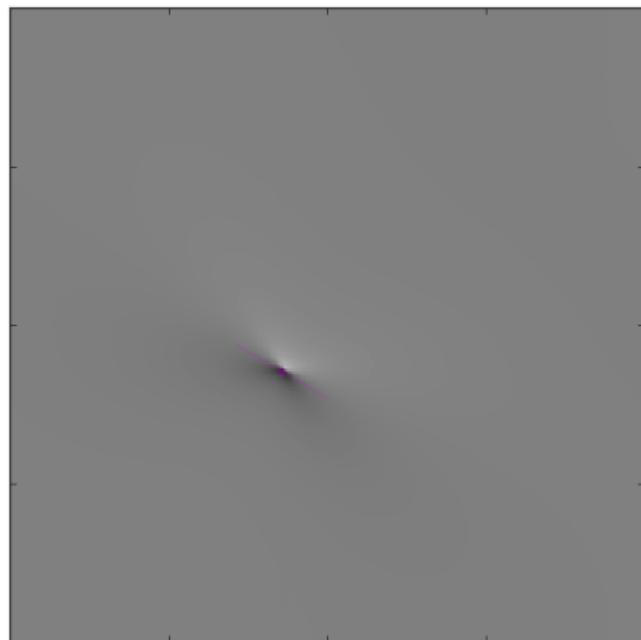


Edges

Matching Pursuit



Residual

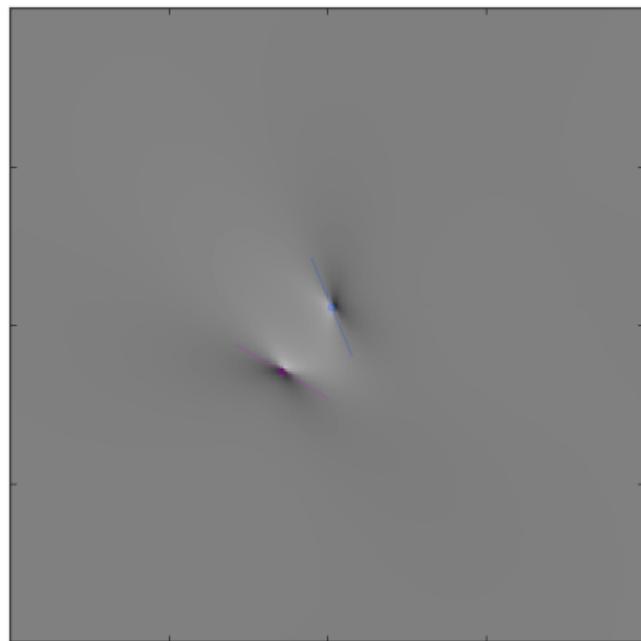


Edges

Matching Pursuit



Residual

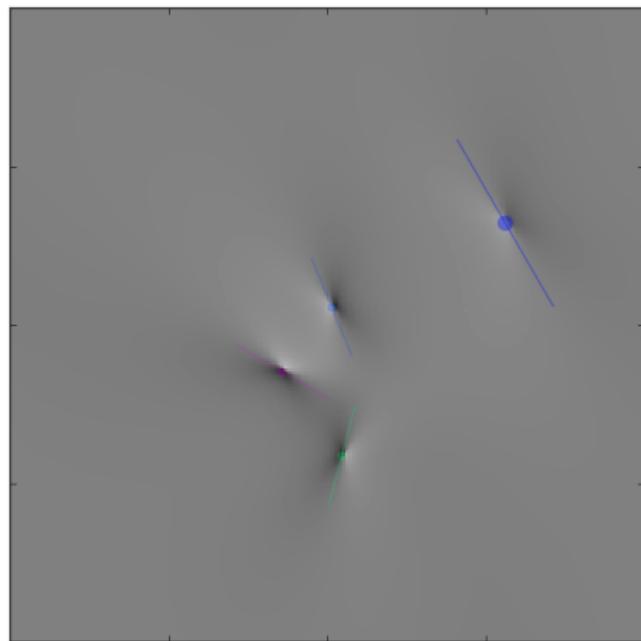


Edges

Matching Pursuit



Residual

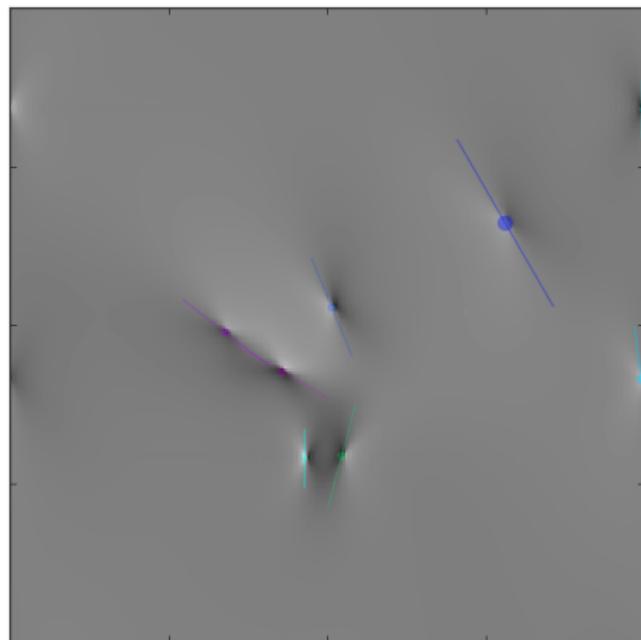


Edges

Matching Pursuit



Residual

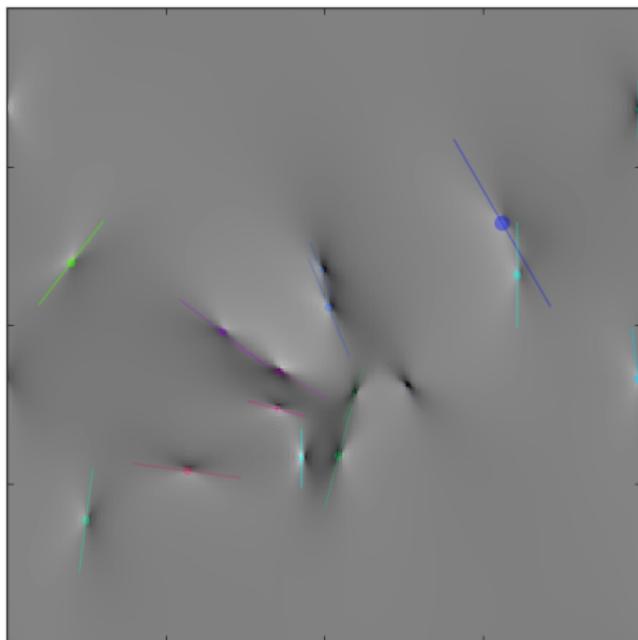


Edges

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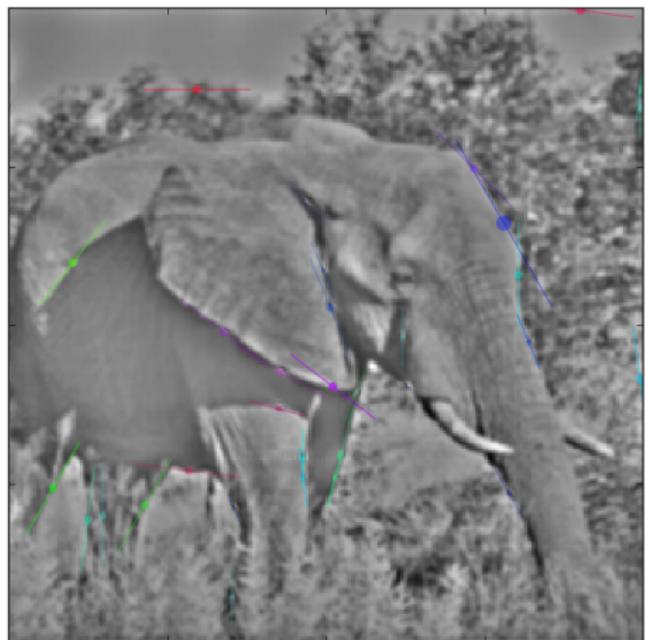


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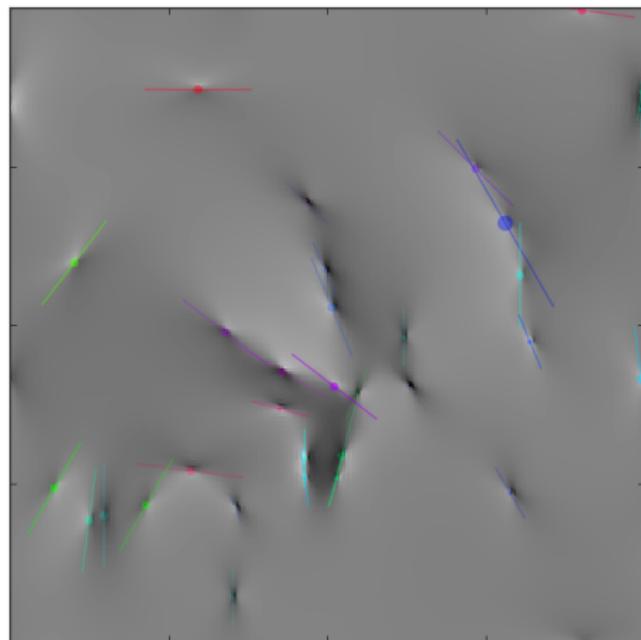


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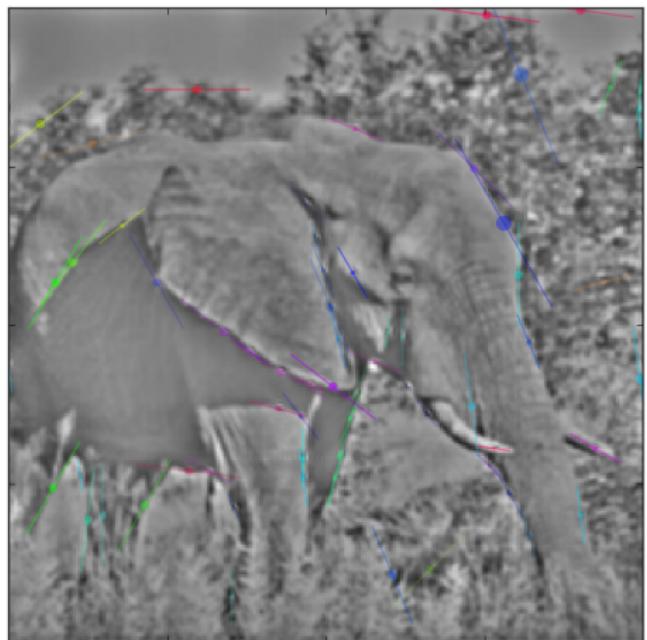


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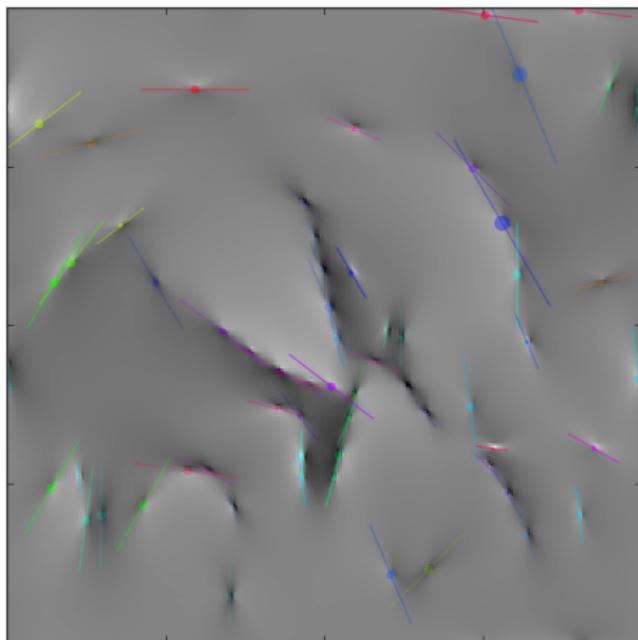


Edges

Matching Pursuit

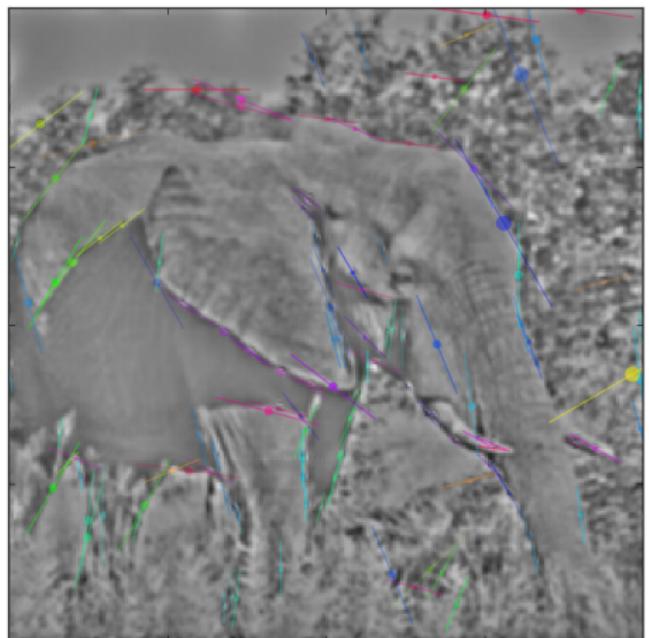


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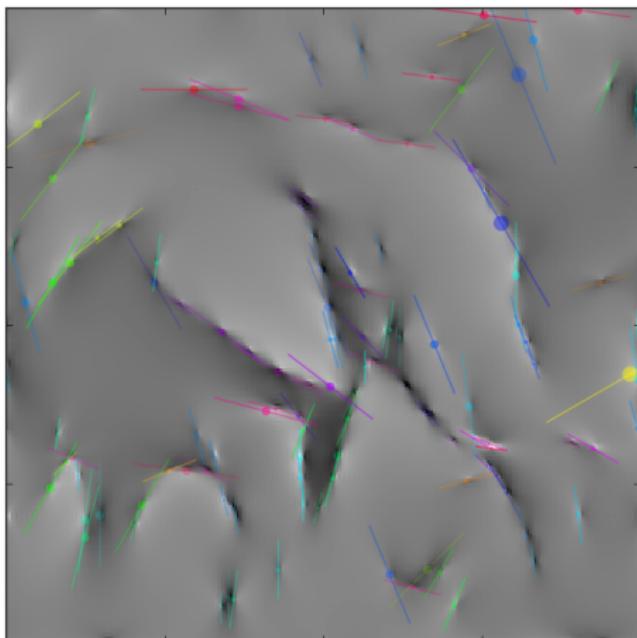


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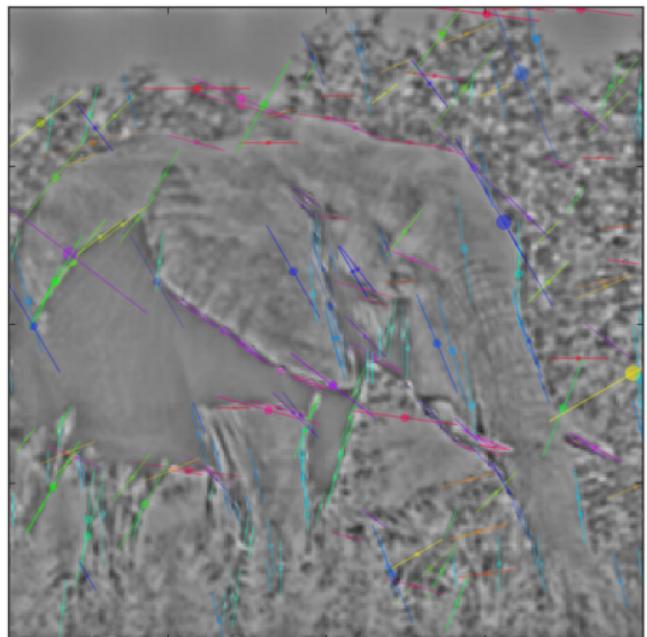


Residual

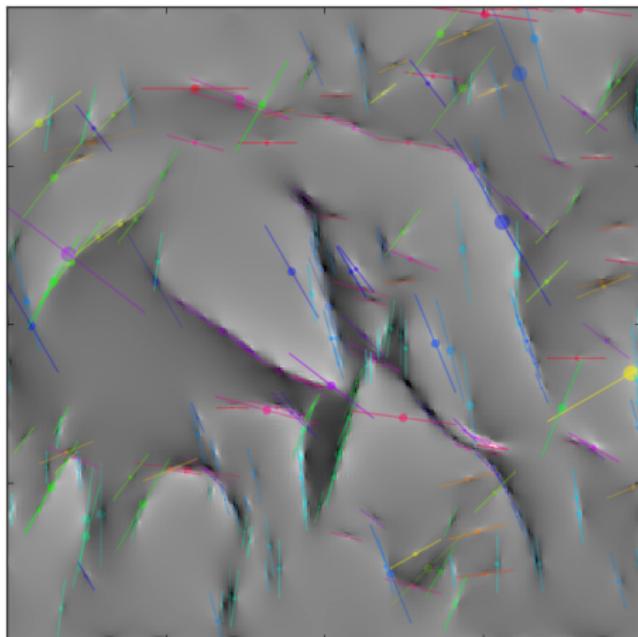


Edges

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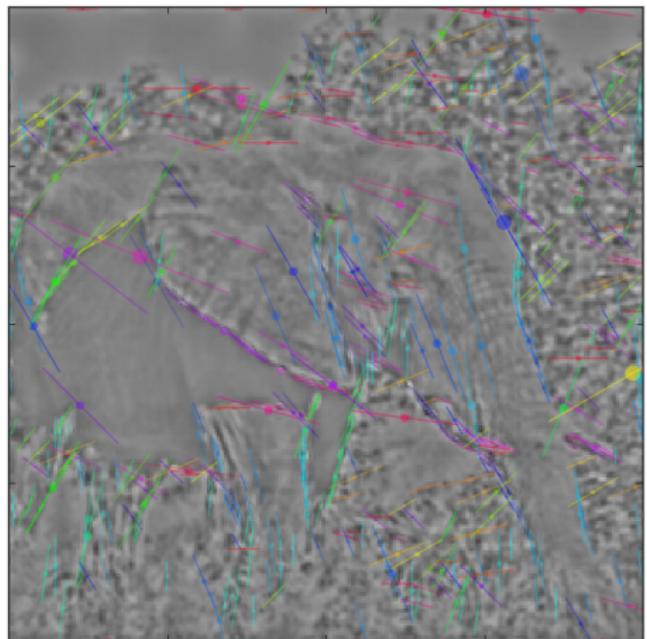


Residual

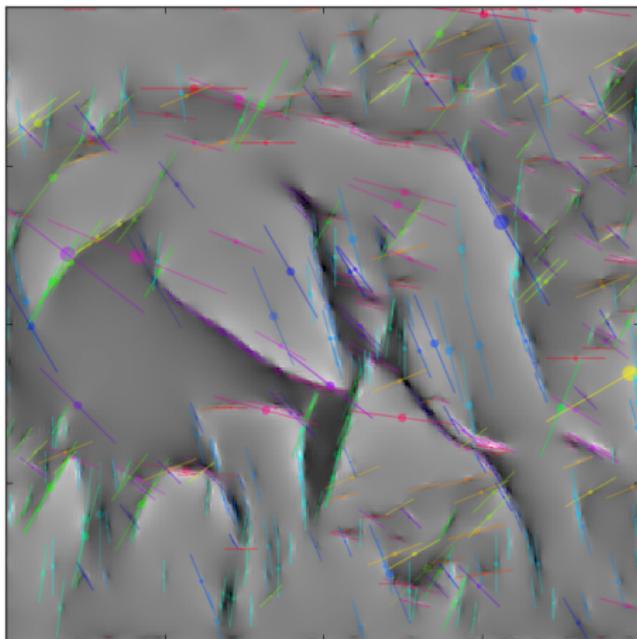


Edges

Matching Pursuit

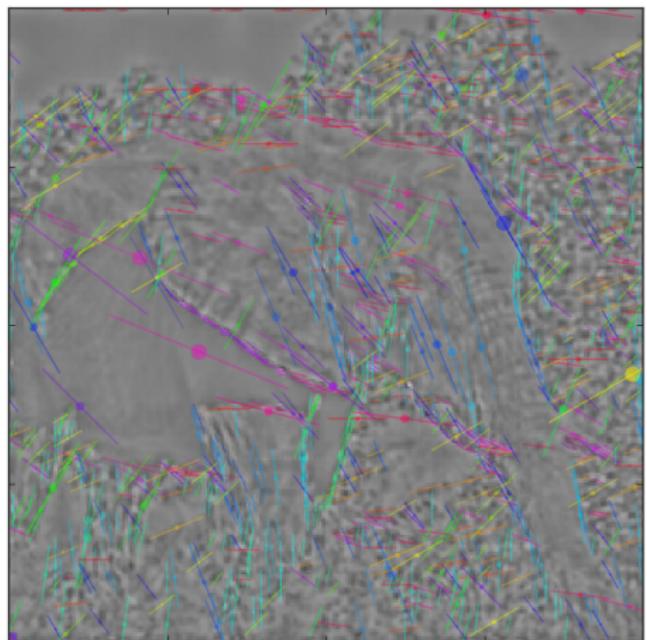


Residual

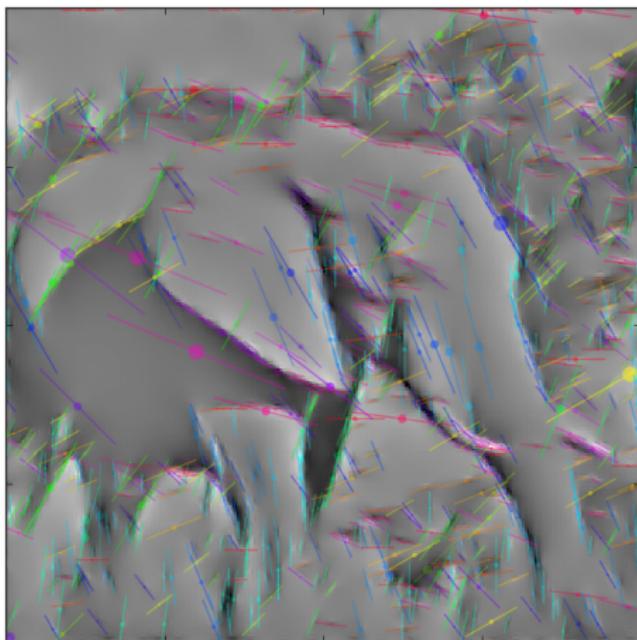


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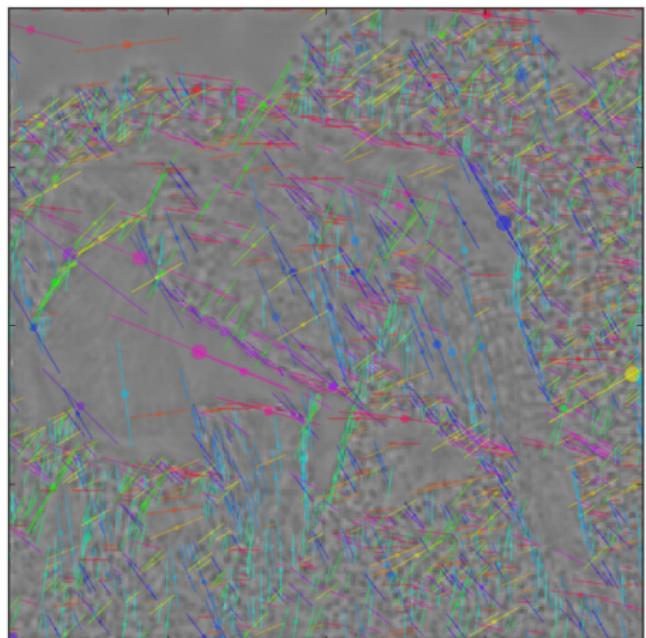


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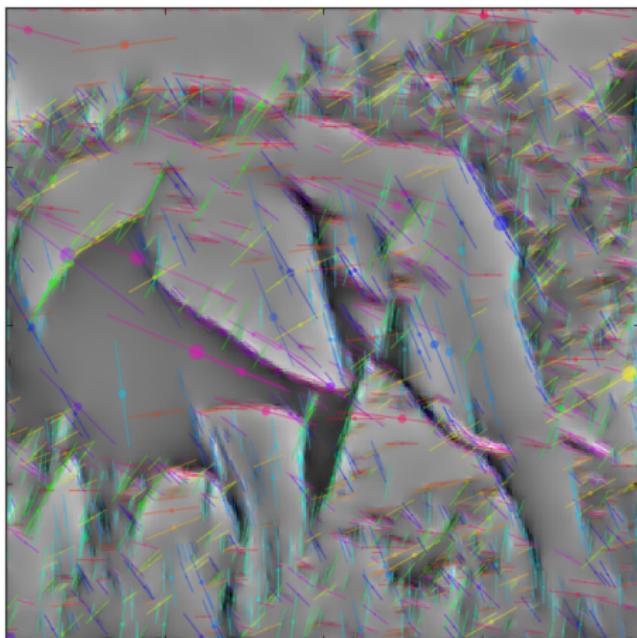


Edges

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Residual



Edges