

A CORF Computational Model of a Simple Cell

with application to Contour Detection

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Contribution

- CORF is a **computational model of a simple cell**.
- The proposed CORF model **shares more properties** with a simple cell than the Gabor Function (GF) model.

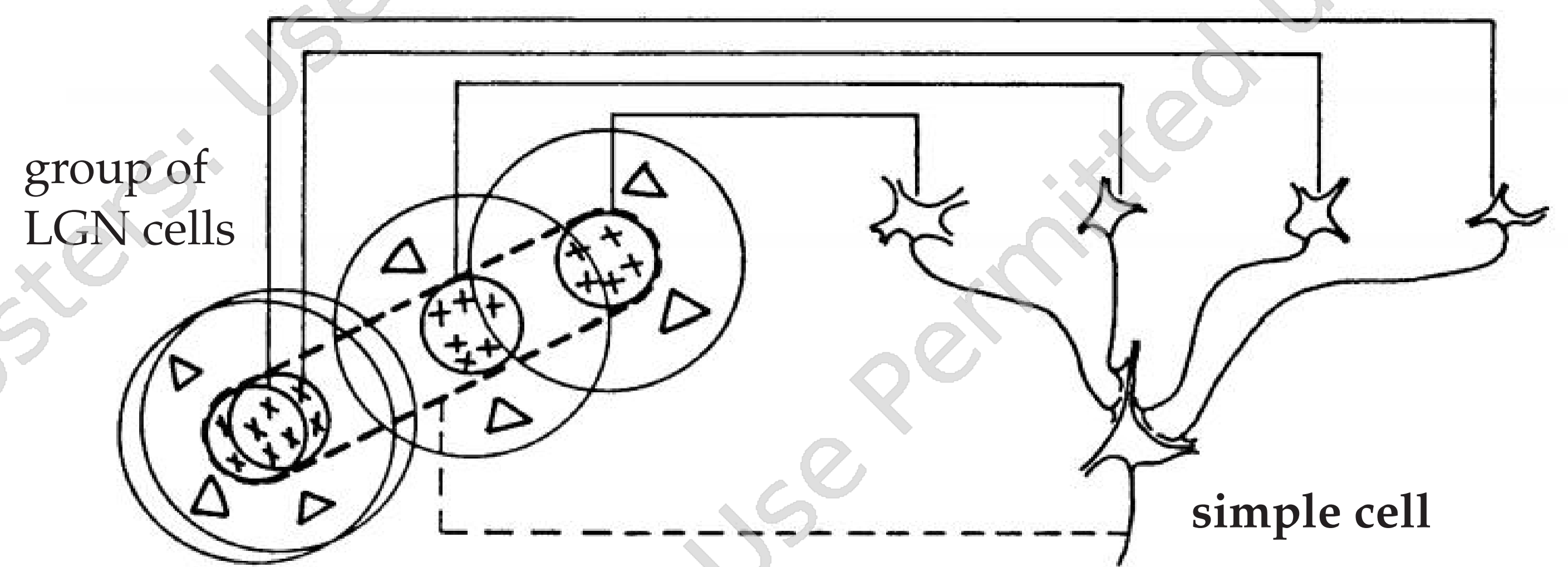
Some **properties of a real simple cell**

Some properties of a real simple cell	CORF [1]	GF [2]
1. Orientation selectivity	✓	✓
2. Cross orientation suppression	✓	✗
3. Contrast invariant orientation tuning	✓	✗
4. Response saturation	✓	✗

- CORF is **more effective** than GF in **contour detection**, which is assumed to be the primary biological role of simple cells.

Motivation

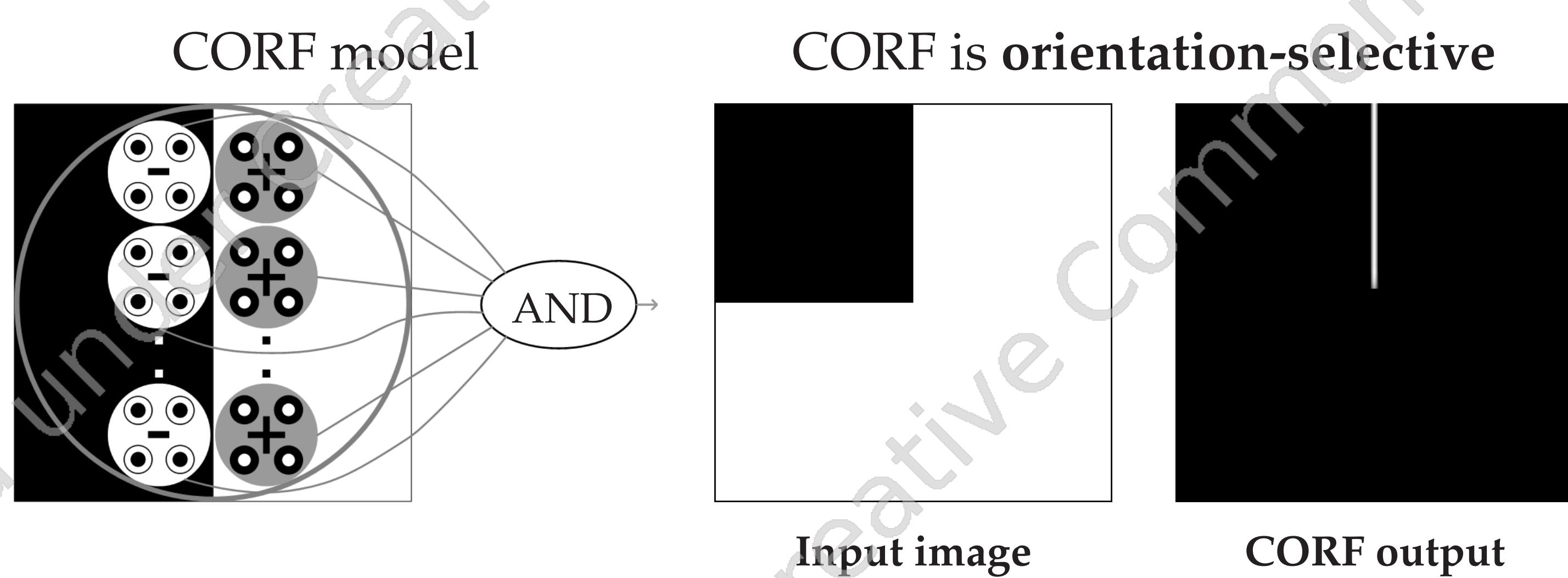
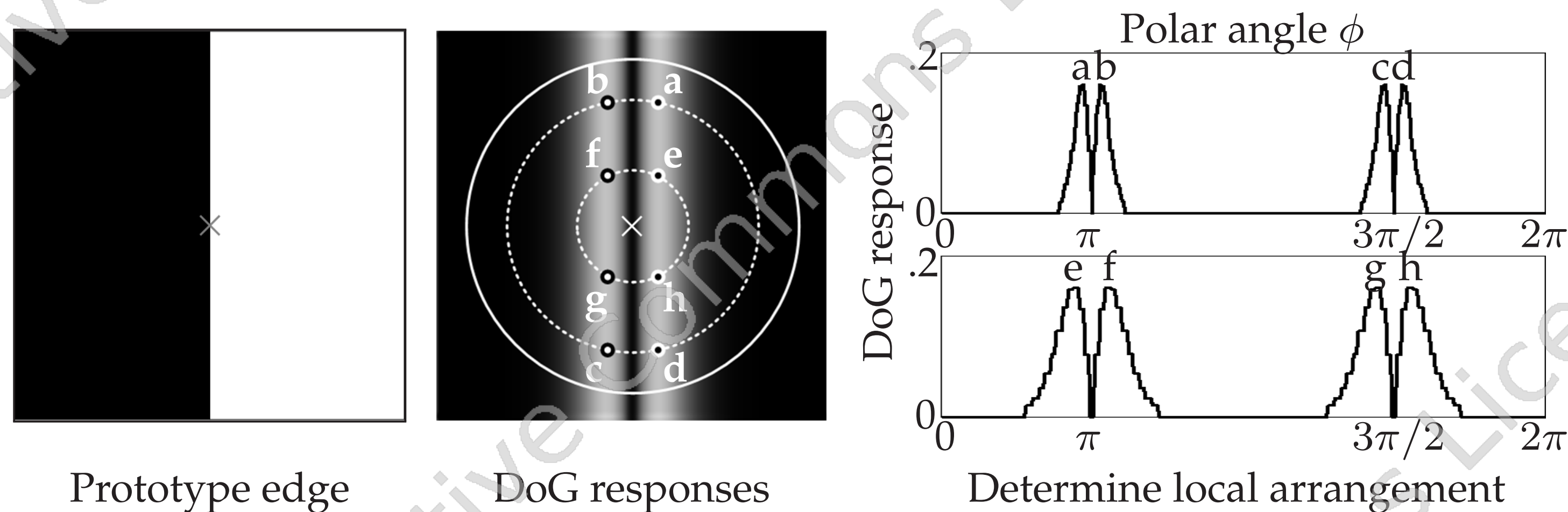
CORF = Combination Of Receptive Fields



Hubel and Wiesel (1962) [3]

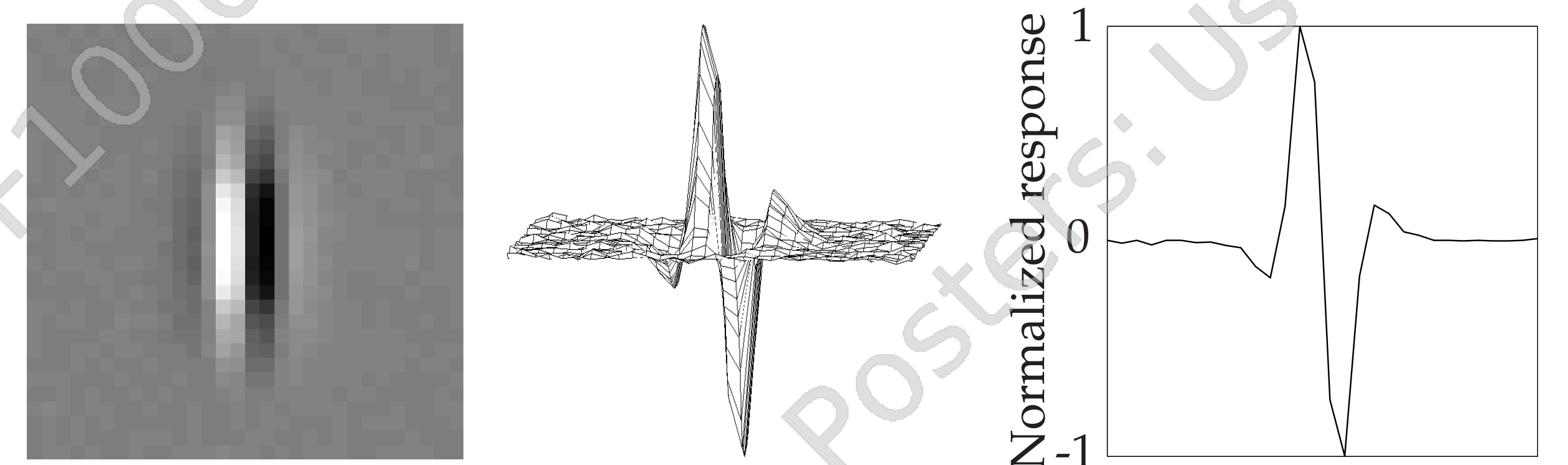
CORF model

The local LGN activity determines which LGN receptive fields are used in the CORF model.

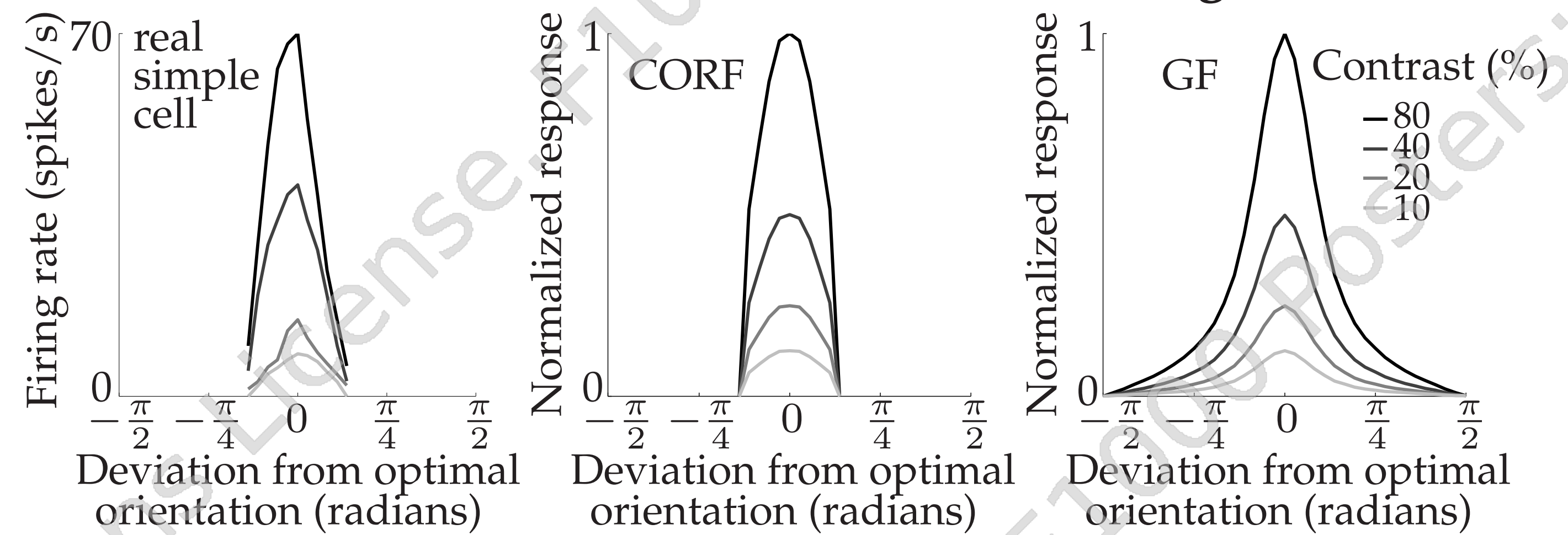


CORF properties

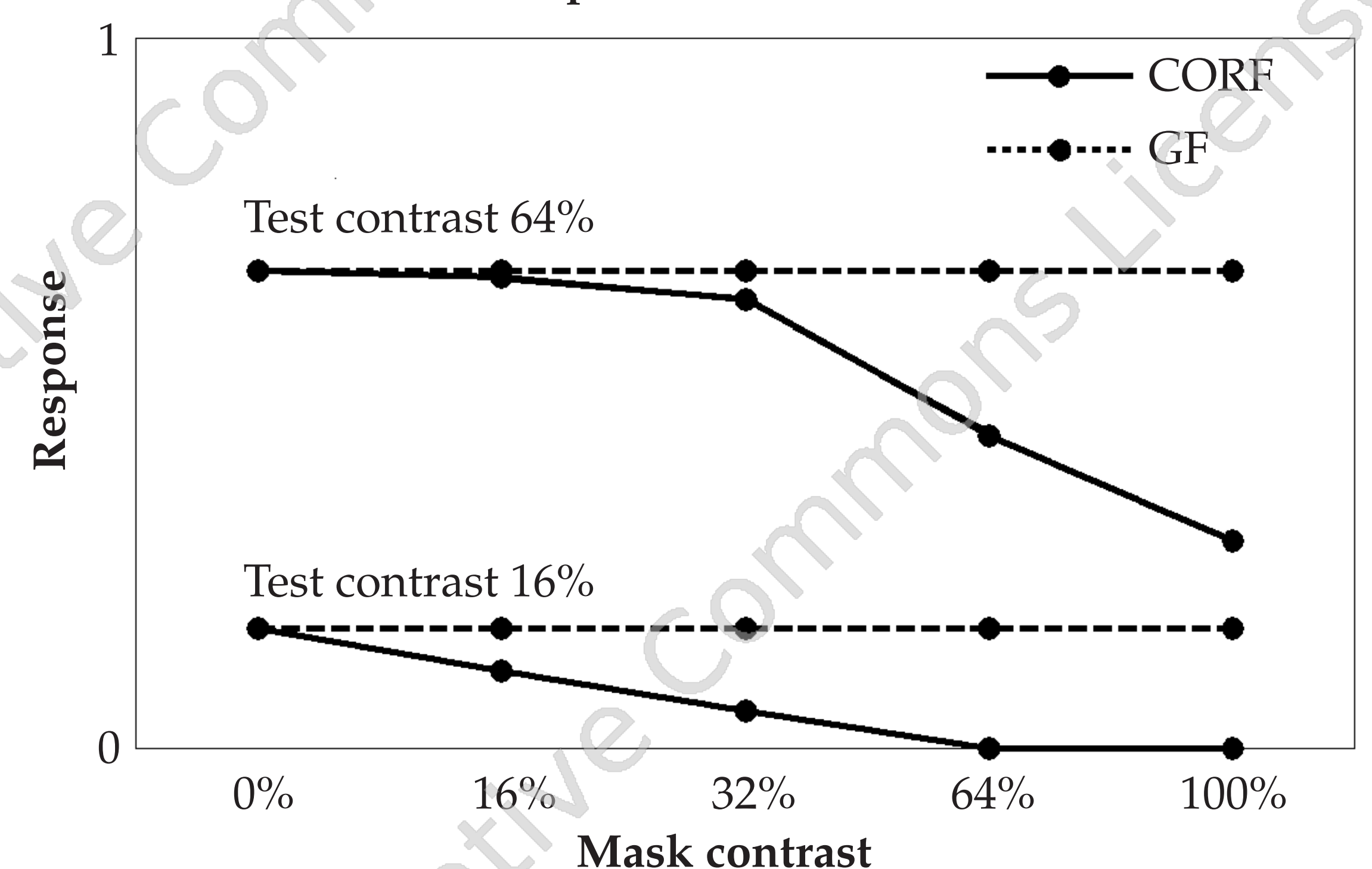
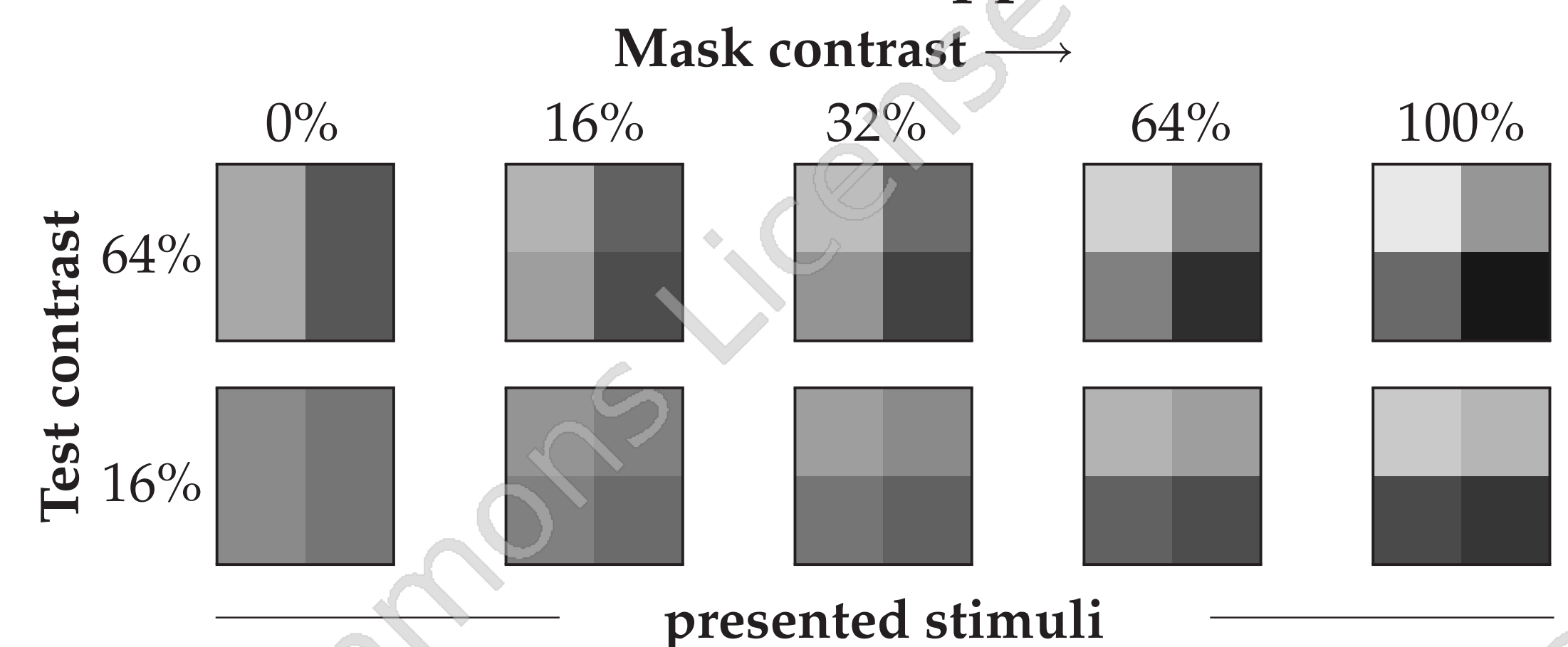
Receptive field determined by **simulated reverse correlation**



Contrast invariant orientation tuning



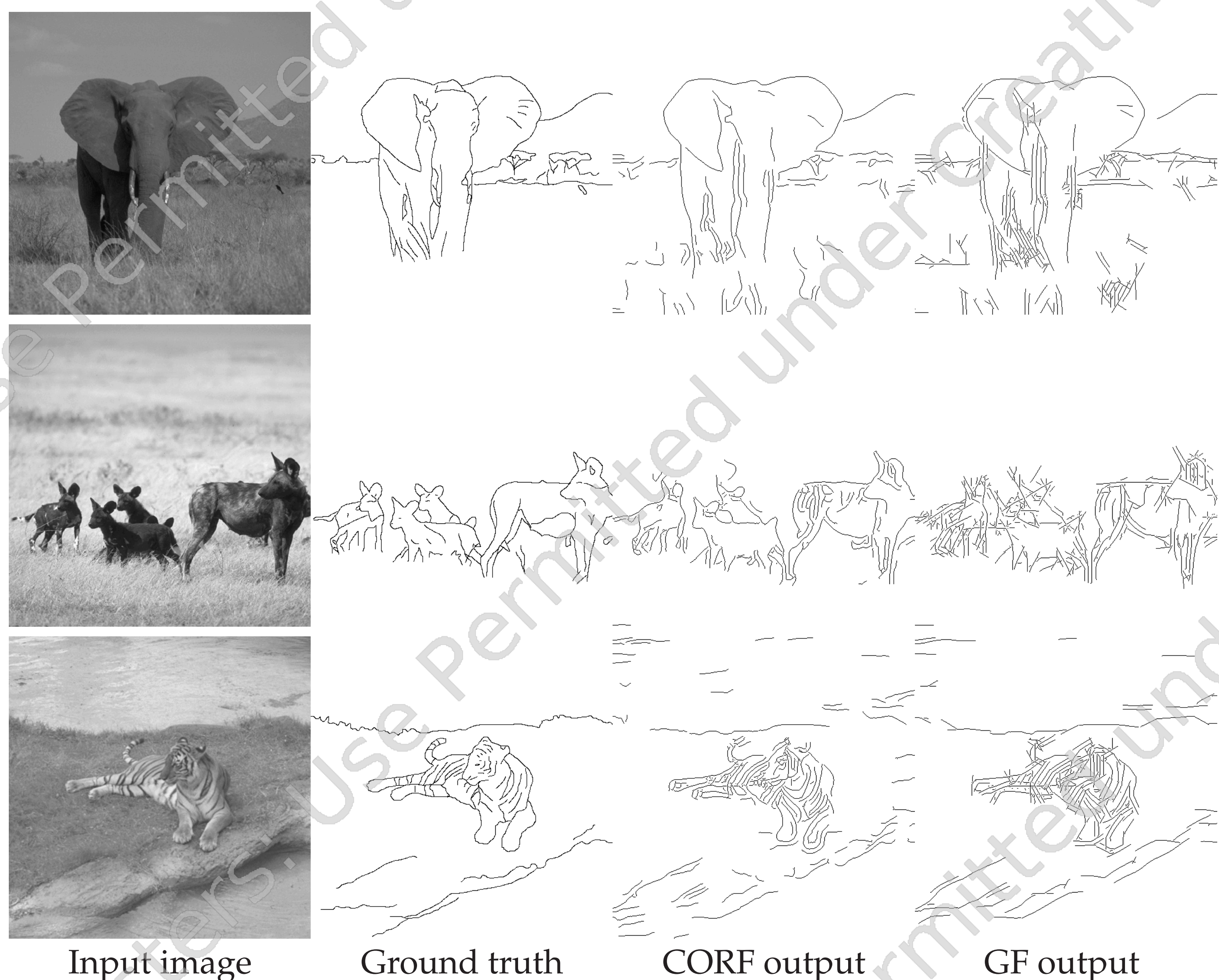
Cross orientation suppression



Results of contour detection

Examples of images from the RuG data set

http://www.cs.rug.nl/~imaging/databases/contour_database/contour_database.html



Matlab script of the CORF operator: <http://matlabserver.cs.rug.nl/>

Paired *t*-test statistic $\left\{ \begin{array}{l} \text{RuG data set: } t(39) = 4.39, p < 10^{-4} \\ \text{Berkeley data set: } t(299) = 3.88, p < 10^{-4} \end{array} \right.$
CORF **outperforms** GF

References

- [1] Azzopardi, G., Petkov, N., A CORF computational model of a simple cell outperforms the Gabor function model, *Biol Cybern*, vol. 106(3), pp. 177-189, 2012.
- [2] Daugman, J. G., Uncertainty Relation for Resolution in Space, Spatial-Frequency, and Orientation Optimized by Two-Dimensional Visual Cortical Filters, *J Opt Soc Am A*, vol. 2(7), pp. 1160-1169, 1985.
- [3] Hubel, D. H. and Wiesel, T. N., Receptive Fields, Binocular Interaction and Functional Architecture in Cats Visual Cortex, *J Physiol-London*, vol. 160(1), pp. 106-154, 1962.