A Computational Model of the Anterior Intraparietal Area

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Introduction

Context The macaque anterior intraparietal area (AIP) receives a variety of visual input and encodes 3D object shape. It has dense connections with frontal hand area F5. Lesions impair preshaping of the hand for grasping.

Goals We want to understand more clearly how AIP visual-dominant neurons parameterizes shapes. This is challenging because electrophysiological data are sparse.

Approach 1) Fit different shape parameterizations to AIP data; 2) See how well they can be mapped from signals in the caudal intraparietal area (CIP), a major source of information about surface orientation and curvature; 3) Test shape parameterizations in a robotic grasp controller. This poster is about (1) and (2).

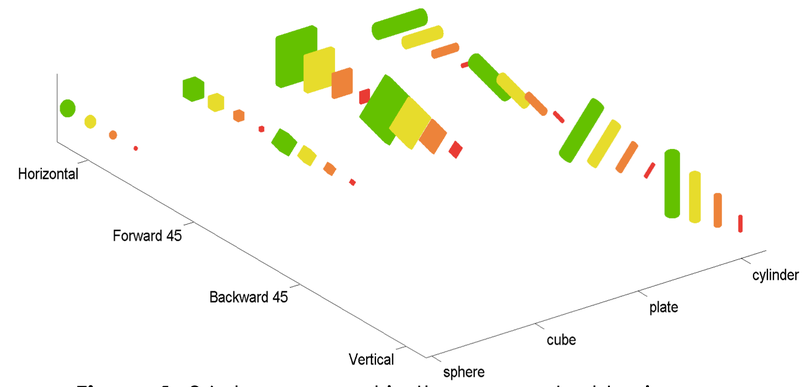


Figure 1: 36 shapes used in the aumented tuning curves

CIP

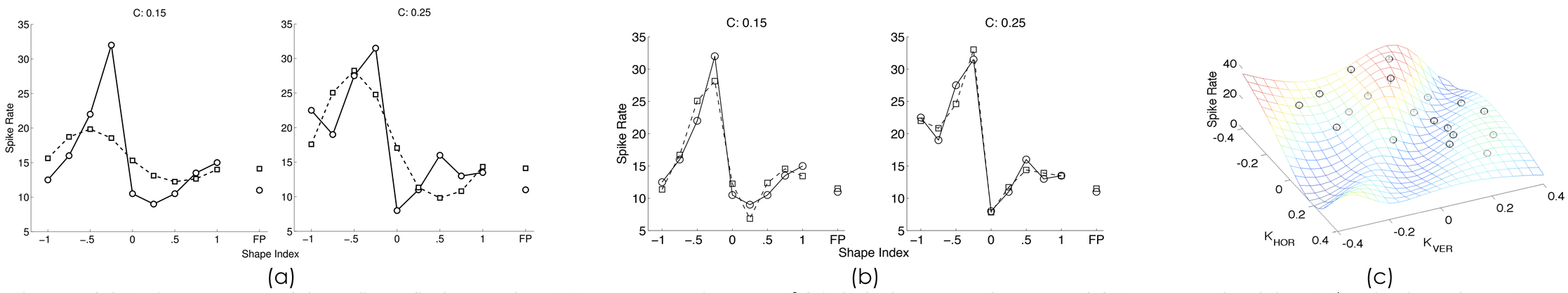
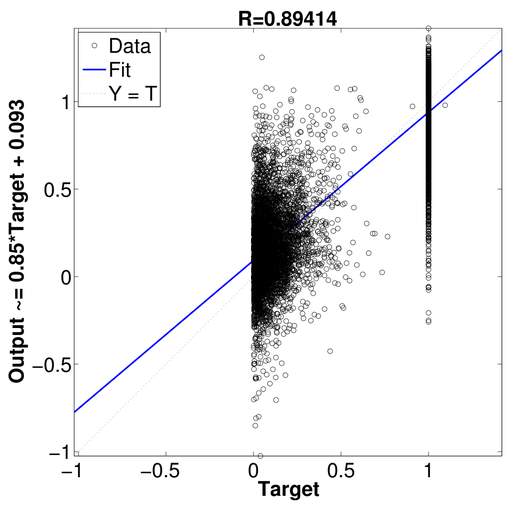


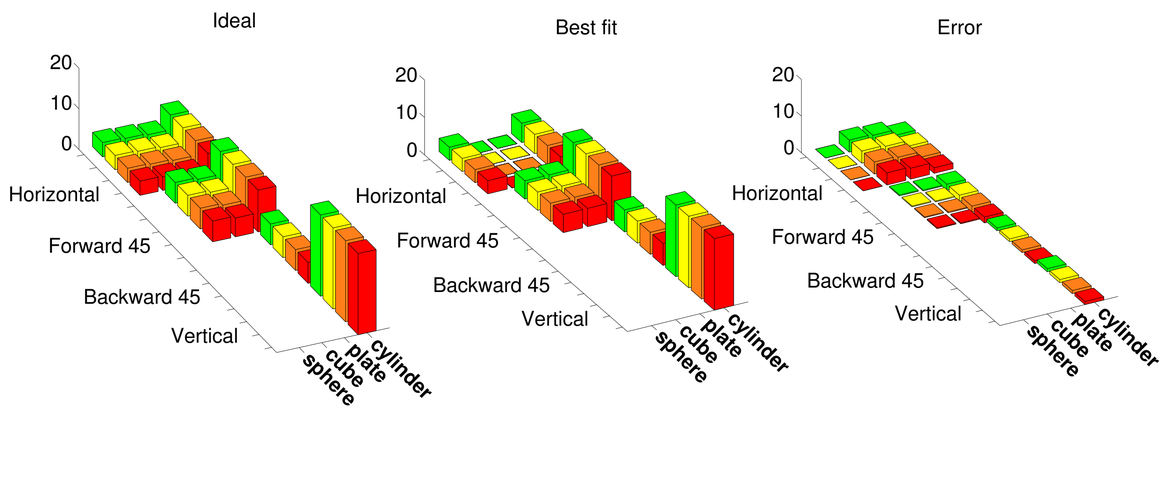
Figure 2: (a) Cosine-tuned and (b) non-linear fits (squares) to CIP curvature tuning curves[3] (circles) of an example neuron. (c) Same model as (b) vs. 2nd derivatives of depth.

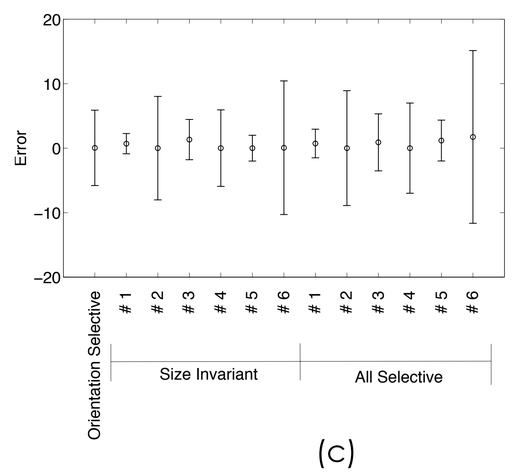
Superquadrics

CIP to AIP

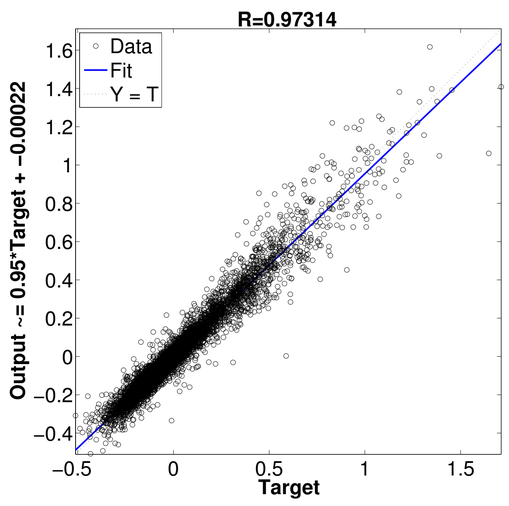


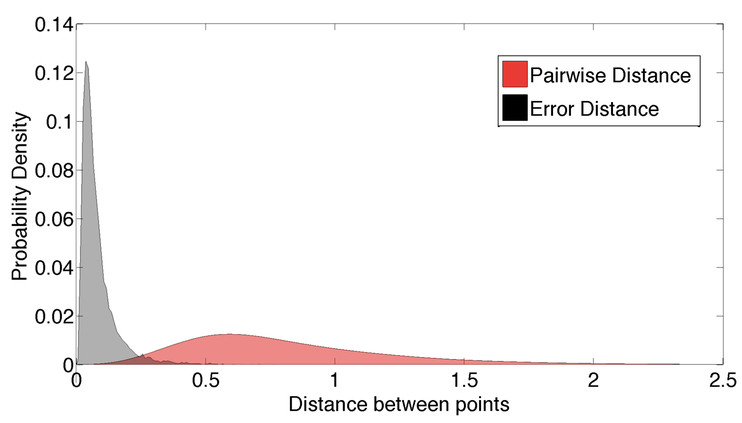
AIP

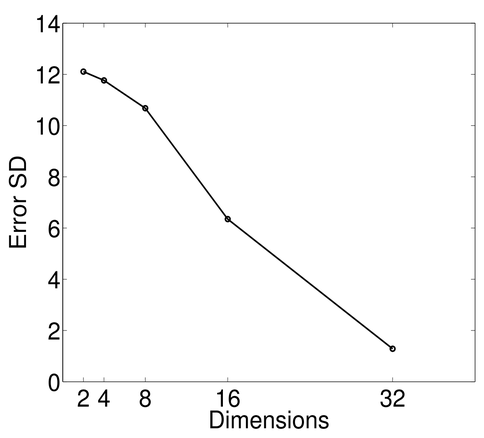




Isomap







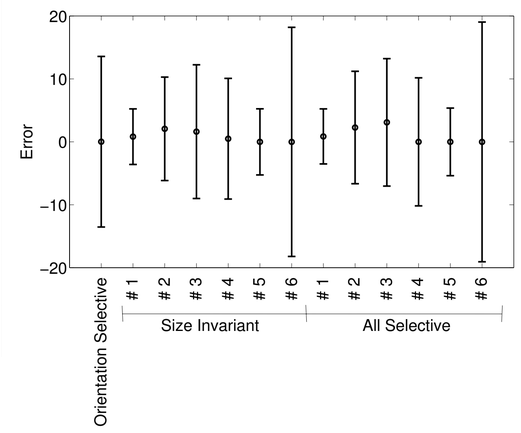


Figure 3: Regression plot comparison between neural network approximations of superquadrics (a) and Isomap (d) parameters. (b) Best fit of a model neuron that is cosine-tuned over superquadric parameters. The fit is to an "augmented" tuning curve that includes data points from a specific neuron[4] and additional points estimated from population data. Quality of AIP tuning curve fits with cosine tuning over 8 superquadric (c) and 8 isomap (g) parameters. (e) Comparison of the distance between points in the isomap and the error of the neural network approximations. (f) Error over tuning curves vs. the dimension of the isomap.

Next Steps

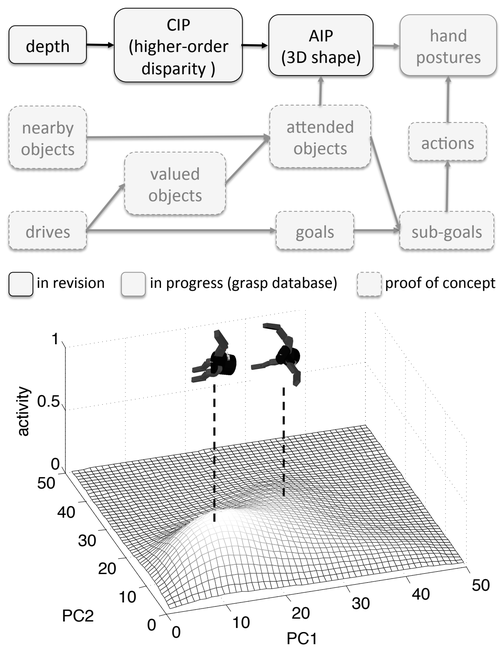
In robotics, superquadric fits play a role in grasping that is similar to AIP neurons: they are a low-dimensional shape charactierization that facilitates grasp planning. However, our results suggest that superquadric parameters are probably not similar to the variables encoded by AIP. In contrast, the parameters of a nonlinear dimension reduction of depth map features fit AIP data more closely and are more consistent with visual input from CIP.

Testing on a Robot

(with Benjamin Rosman & Renaud Detry)

Cognitive Influences

(with Serge Thill & Renaud Detry)



References

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[4] Murata et al. (2000) J Neurophysiol 83, 2580-2601.

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