The role of feedback projections in a biologically realistic, high performance model of object recognition

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Introduction

Previous models of object recognition to date have focused on leveraging the invariance properties of forward projections to in the ventral visual stream to explain the brain's ability to solve the problem of visual object recognition. The present model of object recognition embodies a general theory of object recognition: [CU3D 100] The feedback projections can establish attractor states that constrain the response properties of forward projections.

Although feedback projections are as numerous as forward projections in the ventral pathway, their role in object recognition is not yet well understood. The present model shows how feedback projections can produce considerably robust recognition performance in the face of uncertainty due to visual noise.

The Leabra model of object recognition

The present model of object recognition embodies a general theory of object recognition. Leabra [1,2,3], that shows how a small set of biologically plausible rules can lead to the development of a powerful object recognition system. The Leabra model of object recognition is described below.

Evaluating recognition: CU3D 100

We developed our own image database (CU3D-July) to address recent concerns that other widely-used datasets fail to index the challenge of object recognition. [CU3D 100]

- 100 unique object categories
- 40-45 models per category

- Models normalized for position, scale, and lighting
- Full sets of rendering parameters for testing object-invariance

Rendering parameters used in the present simulations:

- 90° depth rotation about z-axis / horizontal flip
- 20° right rotation about x-axis
- 80° overhead lighting rotation
- 30° planar translation
- 25° scaling
- 14° planar rotation

A role of feedback projections: Robustness to visual uncertainty

To test the potential role of feedback projections in resolving visual uncertainty, we embedded our objects in visual noise. [CU3D 100]

- Spatially correlated noise built on learned visual knowledge
- 1D noise based on feedback projections
- 2D noise based on feedback projections

The noise was drawn using each object's power spectrum and a random phase. This result is visualized using a simple weighted sum. For t = signal, k = 0, .2, .4, .6, 1.

Conclusions & Predictions

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References


Further information

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