Patients with pulvinar lesions exhibit localization deficits and more severe attentional modulations. Stimuli surrounding the field of attention (FOA) are suppressed, and object-centred reference frame in top most layer. At each layer, minimize the loss of information from the FOA.

Problems with existing models:
- Lack details of neuronal representations, transformations and operations
- Weight matrices are recomputed for each focus of attention
- Implausible number of pulvinar neurons (e.g. 2^3)

Existing models of visuospatial attention typically assume a single process that determines where to direct attention. With this location selected, how does attention affect the processing of visual information through cortex?

Dynamic Routing Model for Visuospatial Attention

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Introduction

- Existing models of visuospatial attention typically deal with determining where to direct attention [1].
- With this location selected, how does attention affect the processing of visual information through cortex?
- Problems with existing models:
  - Lack details of neuronal representations, transformations and dynamics
  - Weight matrices are recomputed for each focus of attention
  - Implausible number of pulvinar neurons (e.g. 2^3)

Patterns of neuronal activations are known to vary due to the location of the attended stimulus within the receptive field (RF). Determining where to direct attention is a complex process that involves multiple brain regions and levels of processing.

Neural Implementation

- Implemented using the Neural Engineering Framework [2]
  - 7 input and 3 output columns – 150 LIF neurons per population
  - Intermediate neurons compute a non-linear combination of control and feedforward visual signals
- Control signal indicates where to sample within column's RF
- When control signal is outside of neuron's RF, default routing is used (i.e. entire visual field is resampled at each layer)

Results

- Detailed spiking LIF implementation of attentional routing
- Requires a plausible number of pulvinar neurons
- Static synaptic weights and low dimensional control signal
- Consistent with timing of attentional modulation of neural activity
- Scales well (tested up to 40,000 neurons)
- Accounts for empirical observations

Predictions

- Case 1 – Linear dendrites
  - Intermediate cortical neurons that are responsive to both cortical afferents and indirect pulvinar signals
  - Non-linear dendrites are not required, however intermediate neurons are required
- Case 2 – Non-linear dendrites
  - Far fewer neurons would be needed
  - In either case, cortical neurons in lamina 4 receiving direct pulvinar projections need not be sensitive to visual stimuli

References: