Feature-Dependent Cross-Connections in Multi-Path Neural Networks

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Rich Layer-wise Feature Extraction by Multi-paths

- Neural network deepening is well established
- Powerful feature extraction within layers?
- Conventional Widening $\rightarrow$ Parallel computations in a layer
- No context-dependent allocation of resources in a layer

- Image context is distributed along the depth of NN
- In a multi-path network, the nature of resource allocation may change with the depth
- It is intuitive to learn the resource allocation separately, layer-wise.

a) Hummingbird  b) Hummingbird  c) Electric Eel
Feature-Dependent Cross-Connections

- Given layer, group homogenous feature maps to parallel paths
- Route the input, layer-wise, end-to-end through such paths
- $X \rightarrow$ Global Average Pooling $\rightarrow$ non-linear computation $\rightarrow$ gates for $X$
- Cross-weight the connections and add to output $Y$
Image Recognition Domain

- ResNet-X → ResNet with X paths and cross-connections
- Our multi-path nets surpass
  - Conventional widening
  - Existing adaptive feature extraction methods
  - Deeper networks
- With similar or less complexity
Routing Visualization

- Input-output activation strengths (red intensities)
- Gate strengths (blue intensities and connection thickness)
- White boxes show the layer stack where no cross-connections are inserted
- Slightly different soft dynamic routing can be observed
Gating Patterns

**Img a**

Maximized for b and c

**Shallow Gate**

Maximally activated images

**Img b**

Maximized for a and b

**Deeper Gate**

Synthesized image to maximize gate

**Img c**
Gate Histograms of Parallel Paths

- A single layer (one graph) consists of two histograms (two paths)
- Thanks to the adaptive cross-connection based routing, the parallel computations learn distinct features.
Thank You

More Info:
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