2-min introduction of ‘Geometric Graph Convolutional Neural Networks’

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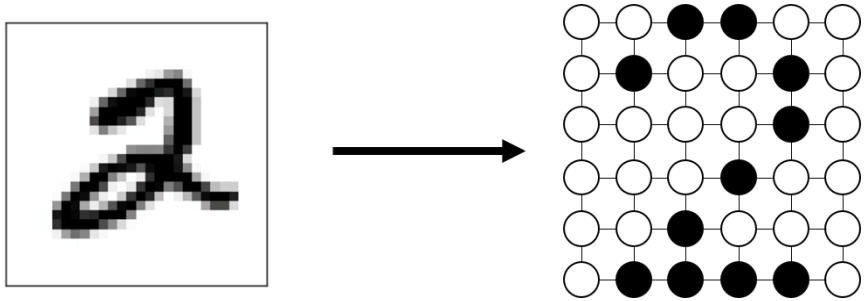
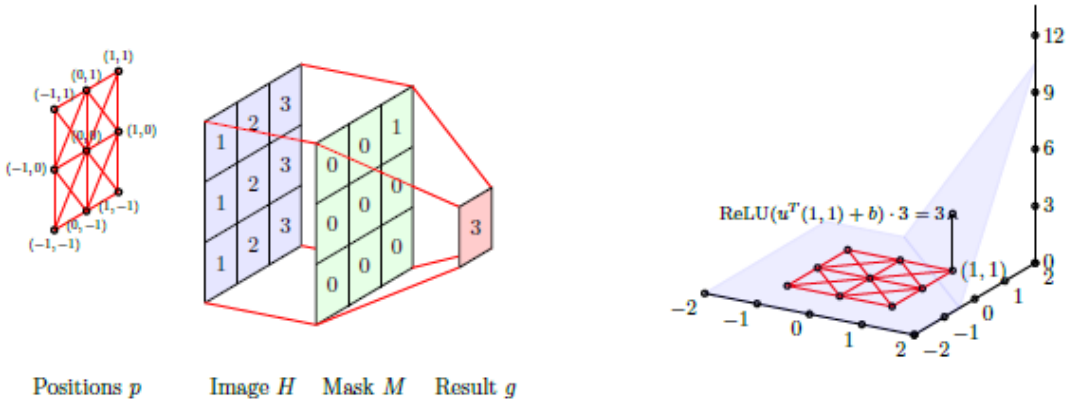
Key idea of geo-GCN

- How to use geometric features (spatial coordinates) in GCNs
- A proper generalization of GCNs and CNNs



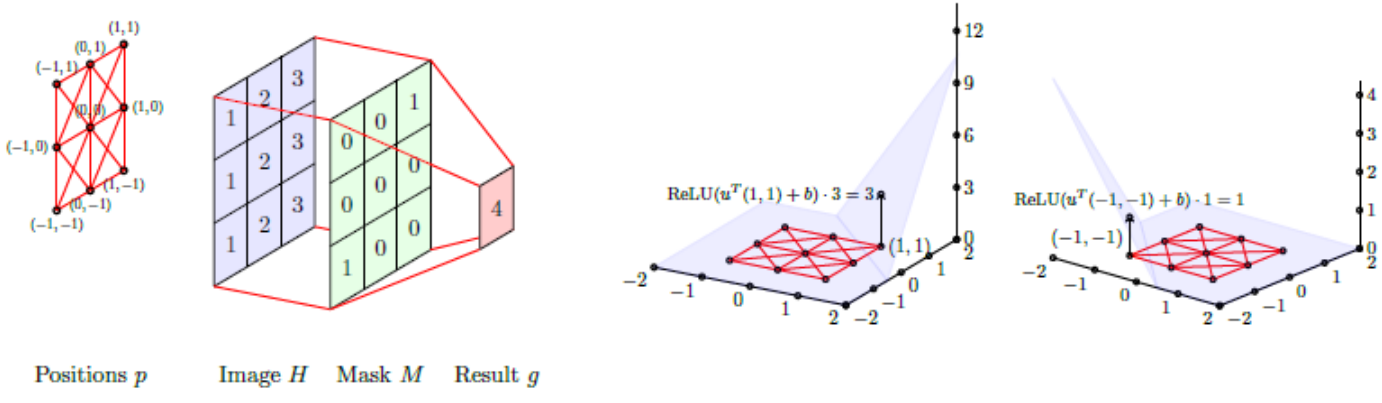
Intuition behind geo-GCN



$$M = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\left.\begin{aligned} p &= (p_x, p_y)^T \\ q &= (q_x, q_y)^T \end{aligned}\right\} \; q - p \in \{-1, 0, 1\}^2$$

$$g_p = \bar{h}_p(u, b) = \sum_{q \in N_p} \mathrm{ReLU}(u^T(q-p) + b) h_q$$



$$M = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

$$\bar{h}_p(u_k, b_k) = \sum_{q \in N_p} \mathrm{ReLU}(u_k(q-p) + b_k) h_q$$

$$\bar{h}_p(u_1, b_1) = 1 \cdot h_{p+\mathbb{1}} \; and \; \bar{h}_p(u_2, b_2) = 1 \cdot h_{p-\mathbb{1}}$$

$$\bar{h}_p = \begin{bmatrix} \bar{h}_p(u_1, b_1) \\ \bar{h}_p(u_2, b_2) \end{bmatrix} = \begin{bmatrix} h_{p+\mathbb{1}} \\ h_{p-\mathbb{1}} \end{bmatrix}$$

$$g_p = w_p^T \bar{h}_p = 1 \cdot h_{p+\mathbb{1}} + 1 \cdot h_{p-\mathbb{1}}$$

Experiment Results

- Image graph classification
- Incomplete image classification

Table 1: Classification accuracy on two graph representations of MNIST.

Method	Grid	Superpixels
ChebNet	99.14%	75.62%
MoNet	99.19%	91.11%
SplineCNN	99.22%	95.22%
geo-GCN	**99.36%**	**95.95%**

Table 2: Classification accuracy of graph representations of incomplete MNIST images.

Method	Accuracy
FCNet + mean	87.59%
FCNet + k-NN	87.10%
FCNet + mice	88.59%
ConvNet + mean	90.95%
ConvNet + k-NN	90.67%
ConvNet + mice	92.10%
geo-GCN	**92.40%**