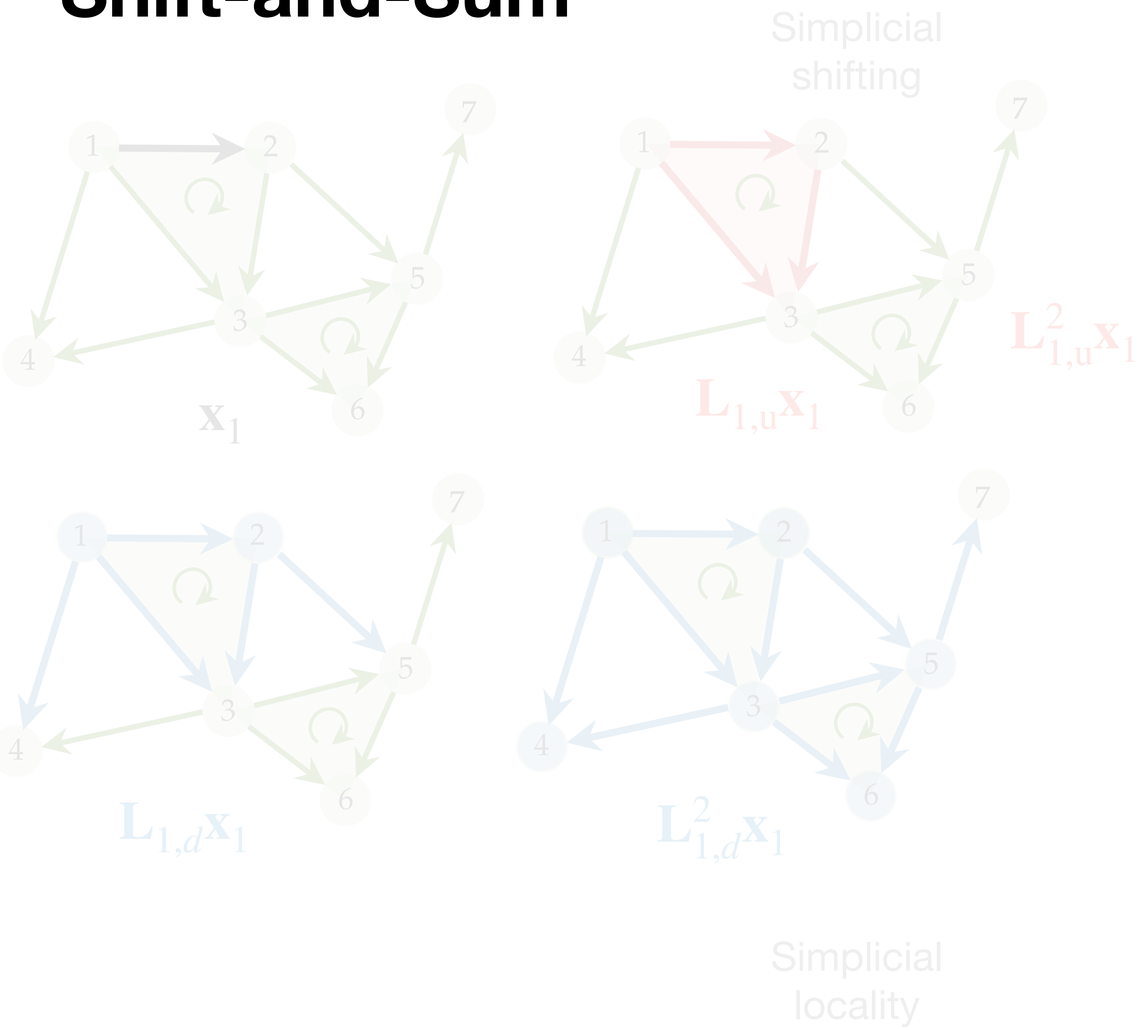
Edge Convolution

Shift-and-Sum

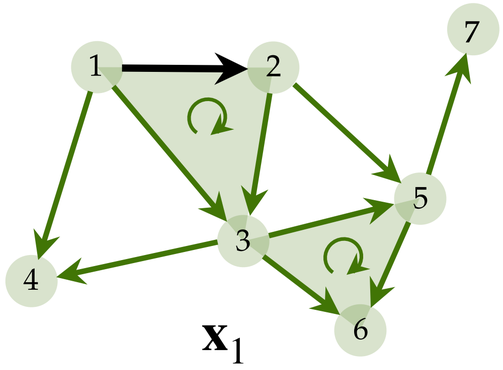


Simplicial Convolutional Filter

$$\mathbf{H} := \mathbf{H}(\mathbf{L}_{\mathrm{d}}, \mathbf{L}_{\mathrm{u}}; \boldsymbol{\alpha}, \boldsymbol{\beta}) = \sum_{k=0}^{K_{\mathrm{d}}} \alpha_k \mathbf{L}_{\mathrm{d}}^k + \sum_{k=0}^{K_{\mathrm{u}}} \beta_k \mathbf{L}_{\mathrm{u}}^k$$

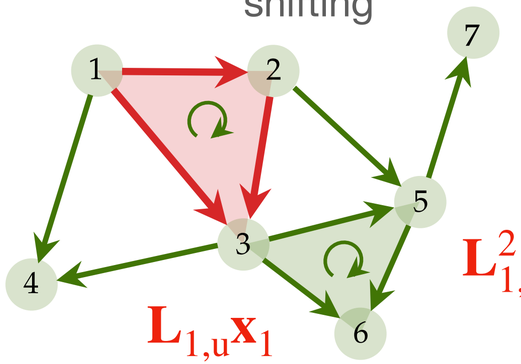
Edge Convolution

Shift-and-Sum



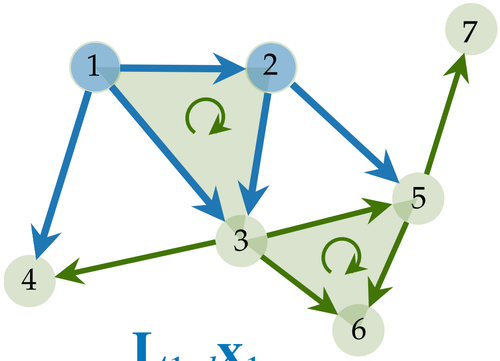
$\mathbf{x}_1$

Simplicial shifting

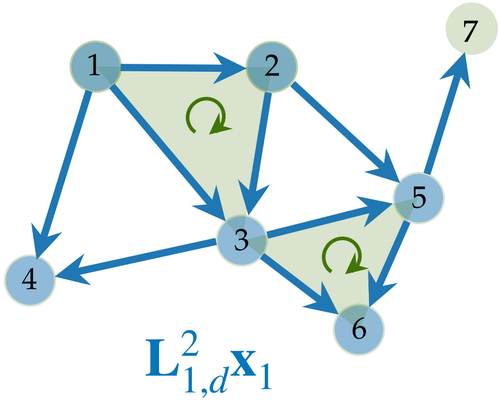


$\mathbf{L}_{1,\mathrm{u}}\mathbf{x}_1$

$\mathbf{L}^2_{1,\mathrm{u}}\mathbf{x}_1$



$\mathbf{L}_{1,d}\mathbf{x}_1$



$\mathbf{L}^2_{1,d}\mathbf{x}_1$

$$[\mathbf{L}_{1,d}\mathbf{f}]_i = \sum_{j \in \{\mathcal{N}_{1,i} \cup i\}} [\mathbf{L}_{1,d}]_{ij}[\mathbf{f}]_j$$

Simplicial locality

Simplicial Convolutional Filter

$$\mathbf{H} := \mathbf{H}(\mathbf{L}_{\mathrm{d}}, \mathbf{L}_{\mathrm{u}}; \boldsymbol{\alpha}, \boldsymbol{\beta}) = \sum_{k=0}^{K_{\mathrm{d}}} \alpha_k \mathbf{L}_{\mathrm{d}}^k + \sum_{k=0}^{K_{\mathrm{u}}} \beta_k \mathbf{L}_{\mathrm{u}}^k$$