GCN $$\mathbf{X}' = \hat{\mathbf{D}}^{-1/2}\hat{\mathbf{A}}\hat{\mathbf{D}}^{-1/2}\mathbf{X}\mathbf{\Theta},$$

Euclidean

$$h_i^l = W^l x_i^{l-1}$$

$$p_i^l = \sum_{j \in \mathcal{N}(i)} k_{i,j} h_j^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = M^l \circledcirc Z_i^{l-1}$$

$$P_i^l = \exp\Big(\sum_{j \in \mathcal{N}(i)} k_{i,j} \log(Q_j^l) \Big)$$

$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$

GAT

$$\mathbf{x}_i' = \alpha_{i,i}\mathbf{\Theta}\mathbf{x}_i + \sum_{j \in \mathcal{N}(i)} \alpha_{i,j}\mathbf{\Theta}\mathbf{x}_j,$$

Euclidean

$$h_i^l = W^l x_i^{l-1}$$

$$p_i^l = \alpha_{i,i} h_i^l + \sum_{j \in \mathcal{N}(i)} \alpha_{i,j} h_j^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = M^l \circledcirc Z_i^{l-1}$$

$$P_i^l = \exp(\alpha_{i,i} \log(Q_i) + \sum_{j \in \mathcal{N}(i)} \alpha_{i,j} \log(Q_j^l))$$

$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$

SGC

$$\mathbf{X}' = \left(\hat{\mathbf{D}}^{-1/2}\hat{\mathbf{A}}\hat{\mathbf{D}}^{-1/2}\right)^{K}\mathbf{X}\mathbf{\Theta},$$

Euclidean

$$h_i^l = \sum_{j \in \mathcal{N}(i)} k_{i,j} \cdots \sum_{z \in \mathcal{N}(j)} k_{j,z} x_z^{l-1}$$

$$p_i^l = W^l h_i^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = \exp\left(\sum_{j \in \mathcal{N}(i)} k_{i,j} \cdots \sum_{z \in \mathcal{N}(j)} k_{j,z} \log Z_z^{l-1} \right)$$

$$P_i^l = M^l \circledcirc Q_i^{l-1}$$

$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$

GIN

$$\mathbf{x}_i' = h_{\mathbf{\Theta}}\left((1+\epsilon)\cdot \mathbf{x}_i + \sum_{j\in\mathcal{N}(i)} \mathbf{x}_j\right)$$

Euclidean

$$h_i^l = (1+\epsilon)x_i^{l-1} + \sum_{j\in\mathcal{N}(i)} k_{i,j}x_j^{l-1}$$

$$p_i^l = W^l h_i^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = \exp((1+\epsilon)\log Z_i^{l-1} + \sum_{j\in\mathcal{N}(i)} k_{i,j}\log Z_j^{l-1})$$

$$P_i^l = M^l \odot Q_i^{l-1}$$

$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$

ChebConv

$$\mathbf{X}' = \sum_{k=1}^{K} \mathbf{Z}^{(k)} \cdot \mathbf{\Theta}^{(k)}$$

$$\mathbf{Z}^{(1)} = \mathbf{X}$$
$$\mathbf{Z}^{(2)} = \hat{\mathbf{L}} \cdot \mathbf{X}$$
$$\mathbf{Z}^{(k)} = 2 \cdot \hat{\mathbf{L}} \cdot \mathbf{Z}^{(k-1)} - \mathbf{Z}^{(k-2)}$$

Euclidean

$$h_i^l = W^l x_i^{l-1}$$

$$p_i^l = h_i^l + W^l \sum_{j \in \mathcal{N}(i)} k_{i,j} h_j^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = M^l \circledcirc Z_i^{l-1}$$

$$P_i^l = Q_i^l \oplus (M^l \circledcirc \exp(\sum_{j \in \mathcal{N}(i)} k_{i,j} \log Z_j^{l-1}))$$

$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$

ChebConv

$$\mathbf{X}' = \sum_{k=1}^{K} \mathbf{Z}^{(k)} \cdot \mathbf{\Theta}^{(k)}$$

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$$\mathbf{Z}^{(k)} = 2 \cdot \hat{\mathbf{L}} \cdot \mathbf{Z}^{(k-1)} - \mathbf{Z}^{(k-2)}$$

Euclidean

$$h_i^l = W^l x_i^{l-1}$$

$$p_i^l = h_i^l + W^l \sum_{j \in \mathcal{N}(i)} k_{i,j} h_j^l$$

$$x_i^l = \varphi(p_i^l + b^l)$$

SPD / Hyperbolic

$$Q_i^l = M^l \circledcirc Z_i^{l-1}$$

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$$Z_i^l = \varphi^{spd}(P_i^l \oplus B^l)$$