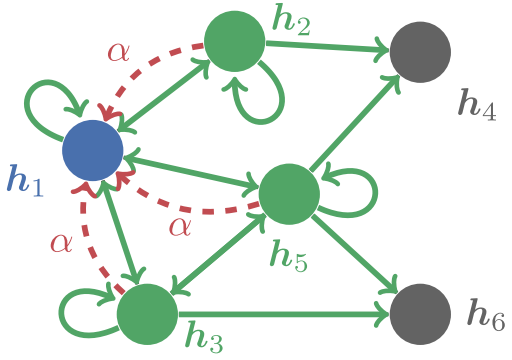
It's PageRank All the Way Down

Simplifying Deep Graph Neural Networks

dom.jack@unimelb.edu.au sarah.erfani@unimelb.edu.au jeffrey.chan@rmit.edu.au sutharshan.rajasegarar@deakin.edu.au calecki@unimelb.edu.au

PageRank

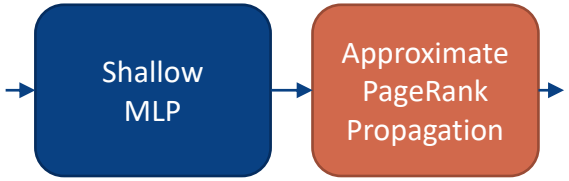


$$\mathbf{x}^{(k+1)} = \alpha\mathbf{x}^{(0)} + (1-\alpha)\hat{A}\mathbf{x}^{(k)}$$

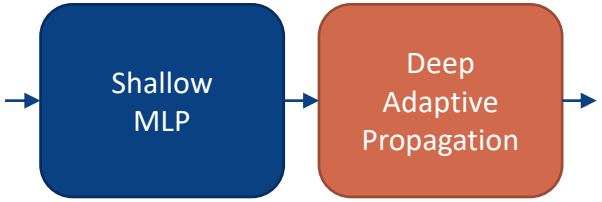
$$\lim_{i\to\infty} \mathbf{x}^{(k)} = \alpha[1 - (1-\alpha)\hat{A}]^{-1}\mathbf{x}^{(0)}$$

$$T_{PR} = \alpha[1 - (1-\alpha)\hat{A}]^{-1}$$

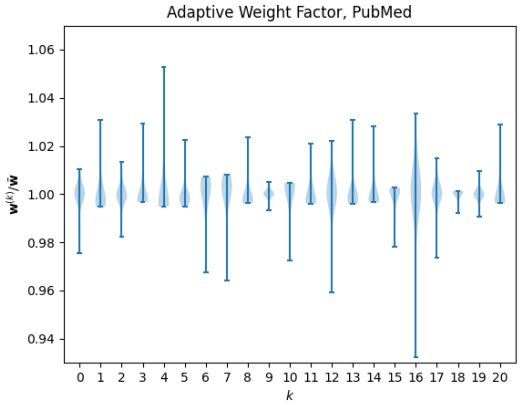
APPNP



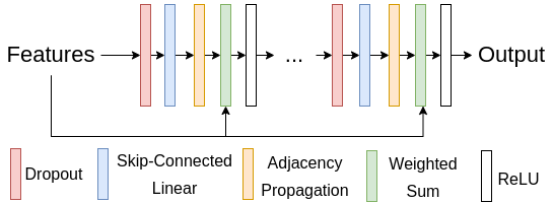
Deep Adaptive GNN



$$\text{logits} = \sum_{k=0}^{K} \text{diag}(\mathbf{w}^{(k)})\hat{A}^k Z, \quad \mathbf{w}^{(k)} = \hat{A}^k Z\mathbf{s}$$



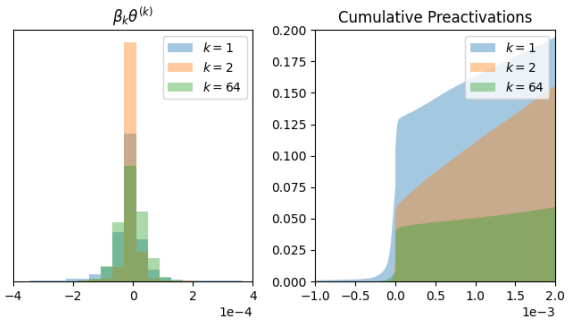
Simple and Deep GCNs (GCN2)



$$X^{(k+1)} = \sigma\left(\left[\alpha X^{(0)} + (1-\alpha)\hat{A}X^{(k)}\right]\varphi^{(k)}\right),$$

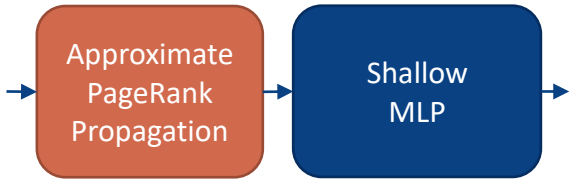
$$\varphi^{(k)} = (1-\beta_k)I + \beta_k\theta_k,$$

$$\sigma(x) = \text{Relu}(x) = \max(x, 0)$$



	APPNP	DAGNN	SS-DAGNN	MLP-PPR (DAGNN)	GCN2	SS-GCN2	MLP-PPR (GCN2)
Cora	82.84 ± 0.50	84.15 ± 0.56	84.32 ± 0.64	84.71 ± 0.31	85.23 ± 0.57	85.15 ± 0.43	85.05 ± 0.29
CiteSeer	69.41 ± 0.63	73.18 ± 0.50	73.08 ± 0.51	73.49 ± 0.75	73.14 ± 0.40	72.61 ± 1.17	72.86 ± 0.59
PubMed	80.34 ± 0.08	80.62 ± 0.49	80.59 ± 0.47	80.47 ± 0.17	80.32 ± 0.51	80.03 ± 0.33	79.84 ± 0.25

PPR-MLP



Model	Cora-Full	PubMed	Reddit	MAG-Scholar
APPNP	62.8	**76.9**	-	-
PPR-GO	61.0	75.2	**26.6**	69.3
PPR-MLP	**62.97 ± 0.86**	76.00 ± 2.27	26.28 ± 1.49	**73.94 ± 1.90**

Model	ogbn-arxiv
SIGN	65.68 ± 0.06
PPR-MLP	**66.21 ± 0.19**
SIGN XL	66.06 ± 0.19
PPR-MLP XL	**66.55 ± 0.28**