Summary Questions of the lecture

- Describe the key idea of APPNP: Approximated Personalized Propagation of Neural Prediction.

→ APPNP predicts (extracts) the node features using a shared neural network, then iteratively propagates the features(predictions) for K steps. The propagation is done by the random walk with the personalized teleport to the initial predictions, where the Chebyshev filter, which is also column stochastic, is used for random transition probability matrix.

$P = D^{-1}A$ ← *Ra.Walk*

$$\hat{\tilde{A}} = \tilde{D}^{-1/2}\tilde{A}\tilde{D}^{-1/2}$$ ← *ChevNet*

$$Z^{(0)} = H = f_\theta(X),$$

$$Z^{(k+1)} = (1-\alpha)\hat{\tilde{A}}Z^{(k)} + \alpha H, k = 0, \ldots, K-2$$

$$Z^{(K)} = \mathrm{softmax}\left((1-\alpha)\hat{\tilde{A}}Z^{(K-1)} + \alpha H\right),$$

Summary Questions of the lecture

- What are the benefits of APPNP: Approximated Personalized Propagation of Neural Prediction.

→ After K steps of propagation, $Z^{(K)}$ becomes a weighted sum of $K, K-1, K-2, \cdots, 1$ –hop aggregations and the original node features H. The multiplicity of the Chebyshev filter makes the feature converge to the equilibrium point leads but can enlarge the smoothing region and so cause a over-smoothing. However, APPNP can prevent over-smoothing by the teleport to the original node features H and the attenuation of the propagation coefficients of high-order hops.

$$Z^{(K)} = (1-\alpha)\hat{\tilde{A}}Z^{(K-1)} + \alpha H$$

$$Z^{(K)} = (1-\alpha)\hat{\tilde{A}}\left((1-\alpha)\hat{\tilde{A}}Z^{(K-2)} + \alpha H\right) + \alpha H$$

$$Z^{(K)} = (1-\alpha)^2\hat{\tilde{A}}^2Z^{(K-2)} + (1-\alpha)\alpha\hat{\tilde{A}}H + \alpha H$$

$$Z^{(K)} = (1-\alpha)^K\hat{\tilde{A}}^K H + \cdots + (1-\alpha)\alpha\hat{\tilde{A}}H + \alpha H$$

Summary Questions of the lecture

- Discuss the difference among personalized PageRank, ShevNet, and APPNP.

→ The central differences lie in the type of filters (or transition matrices in random walk-sense) used, and whether explicitly retaining original features (or random teleports in random walk-sense) is allowed. Personalized PageRank uses the vanilla normalized adjacency matrix and allows teleports to a random query node. The simplified ChebNet uses the Chebyshev filter for the transition matrix, and does not allow the original features to be explicitly included. APPNP also uses the Chebyshev filter, but allows random teleports to the original features.