GeniePath: Graph Neural Networks with Adaptive Receptive Paths

KDD 2018

Introduction

- This paper presents, GeniePath, a scalable approach for learning adaptive receptive fields of neural networks defined on permutation invariant(排列不变性) graph data.

Deformable Convolutional Networks(ECCV 2017)

- 可变性卷积核

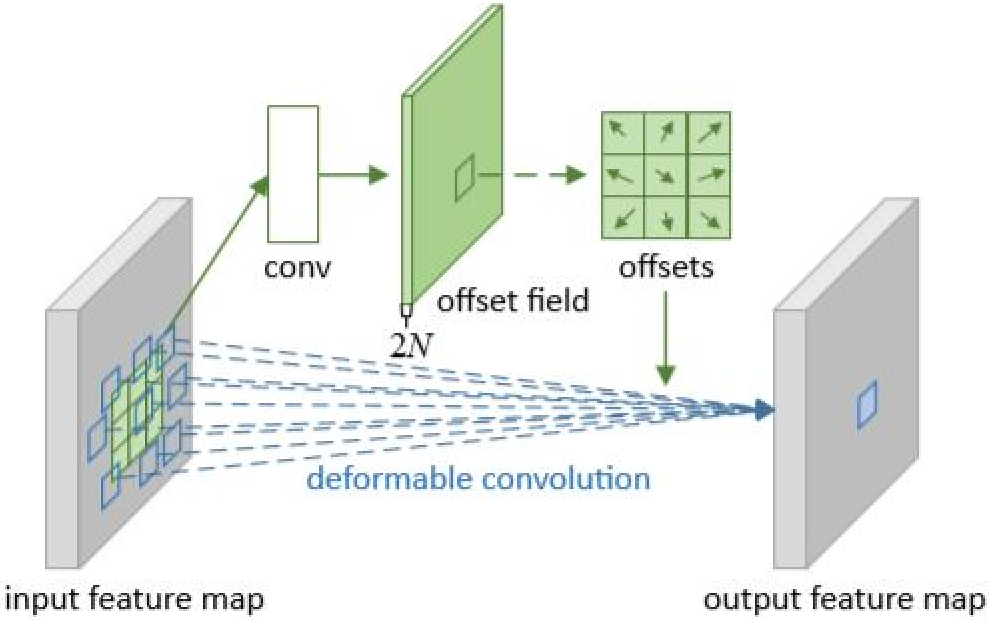


Figure 2: Illustration of 3 × 3 deformable convolution.

Permutation Invariant

$$\begin{aligned} f(\{h_1, ..., h_j, ...\} | j \in \mathcal{N}(i)) \\ = f(\{h_{\sigma(1)}, ..., h_{\sigma(j)}, ...\} | j \in \mathcal{N}(i)) \end{aligned} \tag{4}$$

定义：输入参数顺序不影响输出结果的函数，如 $f(x, y, z) = f(y, x, z) = f(z, y, x)$

定理： 若 f, g 是对于邻居 $N(\cdot)$ 是排序不变量，那么 $g \circ f$ (复合函数， 等价 $g(f(x))$)也仍然是排序不变量，这允许以层叠方式堆叠函数。

Adaptive Path Layer

- Adaptive Breadth + Adaptive Depth
- Breadth

$$\alpha(x,y) = \mathrm{softmax}_y\big(v^\top \tanh(W_s^\top x + W_d^\top y)\big), \qquad (7)$$

where $\mathrm{softmax}_y f(\cdot, y) = \frac{\exp f(\cdot,y)}{\sum_{y'} \exp f(\cdot,y')}$.

$$h_i^{(\mathbf{tmp})} = \tanh\Big({W^{(t)}}^\top \sum_{j \in \mathcal{N}(i) \cup \{i\}} \alpha(h_i^{(t)}, h_j^{(t)}) \cdot h_j^{(t)}\Big)$$

Adaptive Path Layer

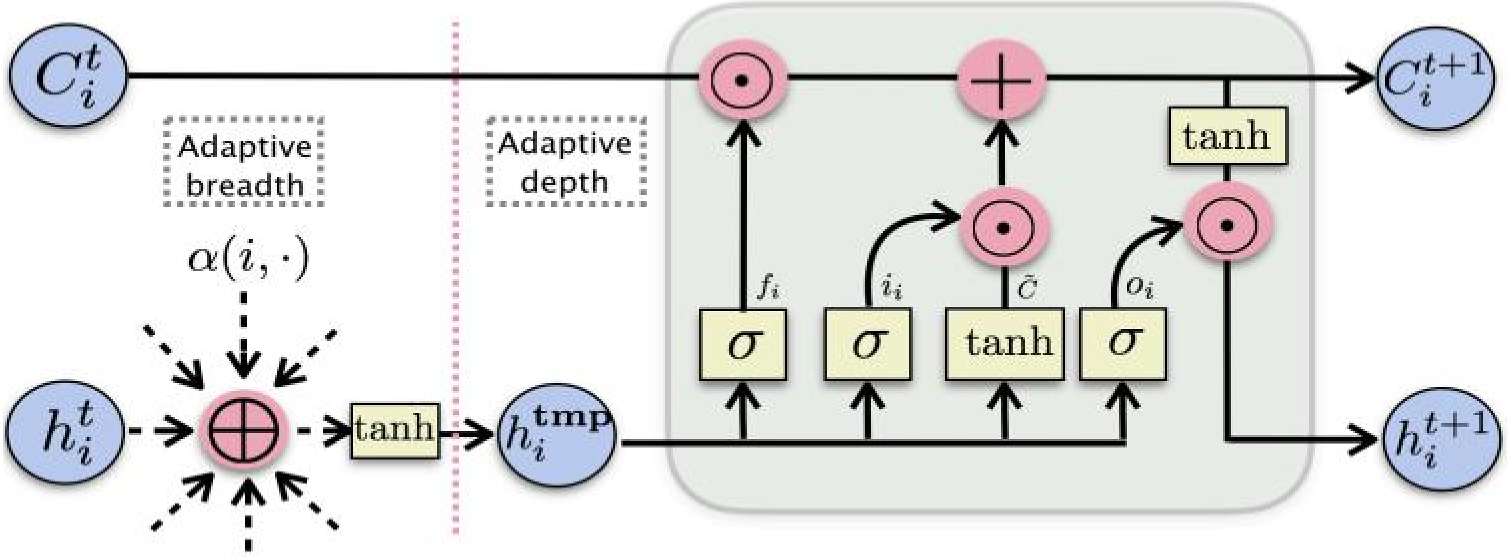
- Adaptive Breadth + Adaptive Depth
- Depth

$$i_i = \sigma({W_i^{(t)}}^\top h_i^{(\mathbf{tmp})}), \qquad f_i = \sigma({W_f^{(t)}}^\top h_i^{(\mathbf{tmp})})$$

$$o_i = \sigma({W_o^{(t)}}^\top h_i^{(\mathbf{tmp})}), \qquad \tilde{C} = \tanh({W_c^{(t)}}^\top h_i^{(\mathbf{tmp})})$$

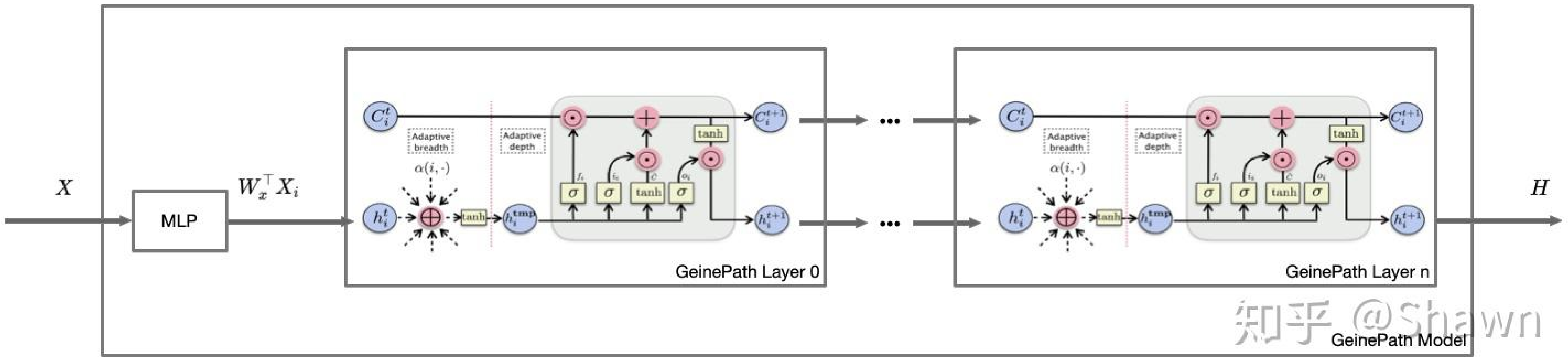
$$C_i^{(t+1)} = f_i \odot C_i^{(t)} + i_i \odot \tilde{C},$$

Model



C_i^t
Adaptive breadth
Adaptive depth
$\alpha(i, \cdot)$
h_i^t
tanh
$h_i^{\mathbf{tmp}}$
f_i
i_i
$\tilde{C}$
o_i
σ
σ
tanh
σ
tanh
C_i^{t+1}
h_i^{t+1}

Application



Application