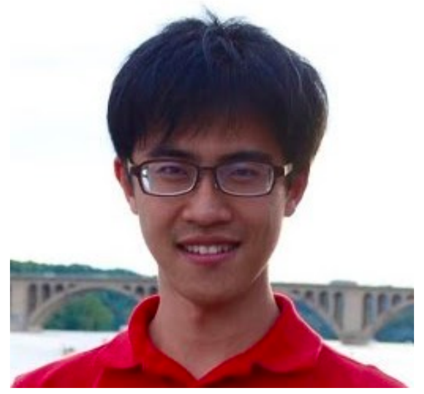
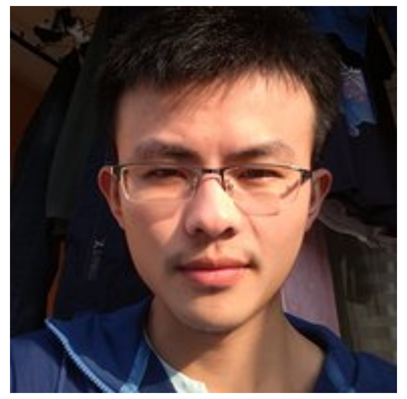
Simplifying Graph Convolutional Networks








Felix Wu* | Tianyi Zhang* | Amauri Holanda de Souza Júnior* | Christopher Fifty | Tao Yu | Kilian Q. Weinberger

*: Equal contribution

Graph Convolutional Networks Applications
(Kipf and Welling, ICLR 2017)

- Social Networks & Citation Networks
- Applied Chemistry
- Natural Language Processing
- Computer Vision
- …

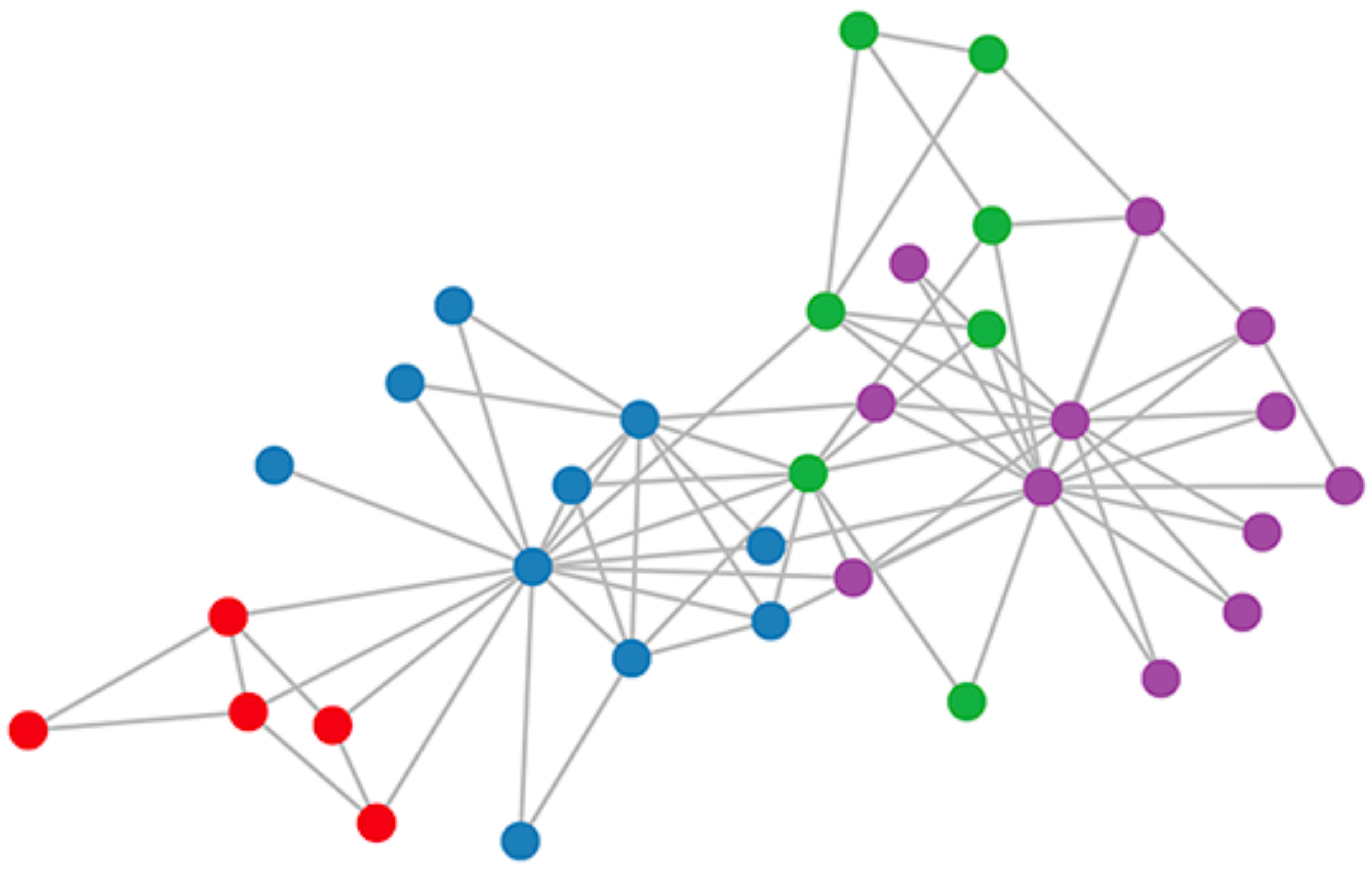
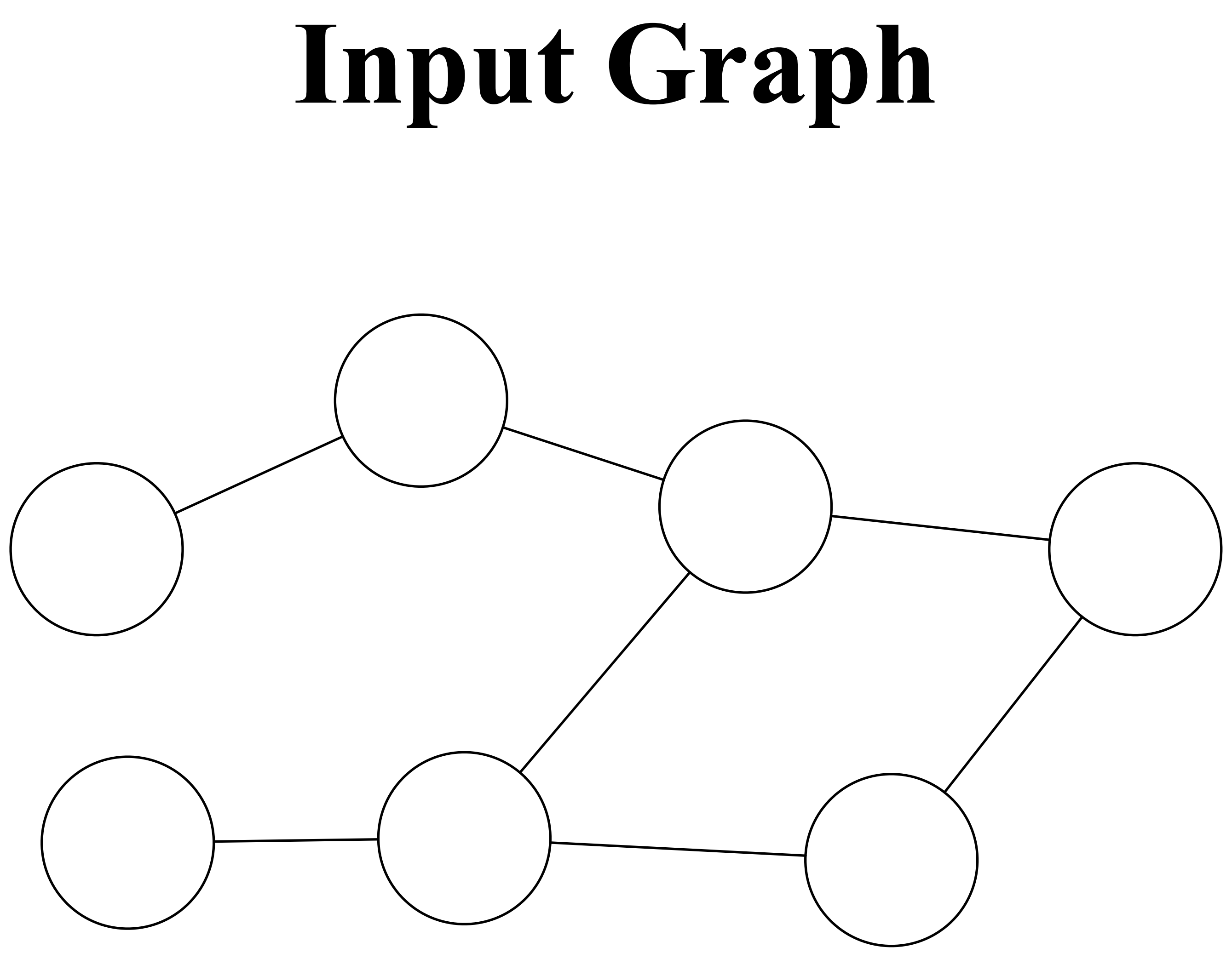


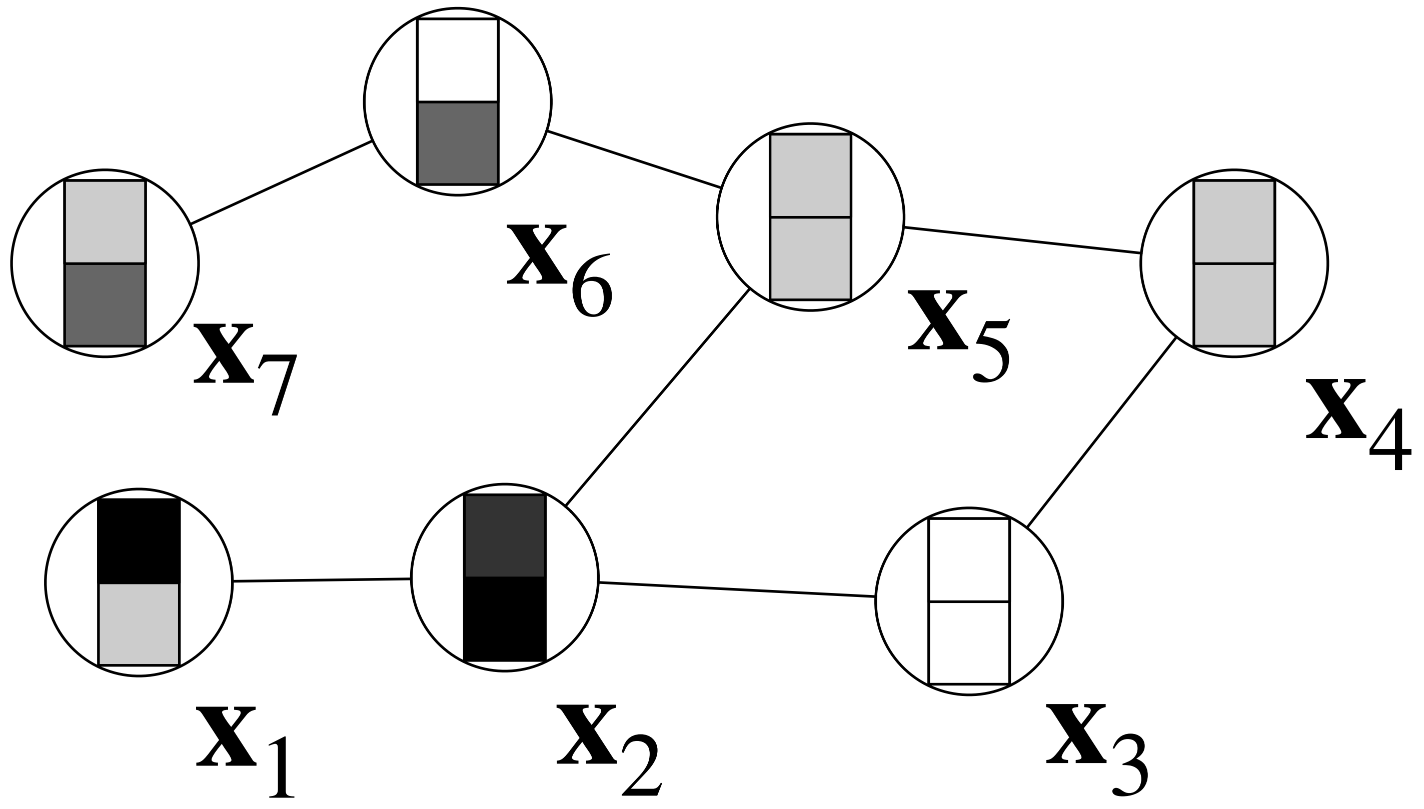
Image source: https://tkipf.github.io/graph-convolutional-networks/images/karate.png

Node Classification



Node Classification

Input Graph

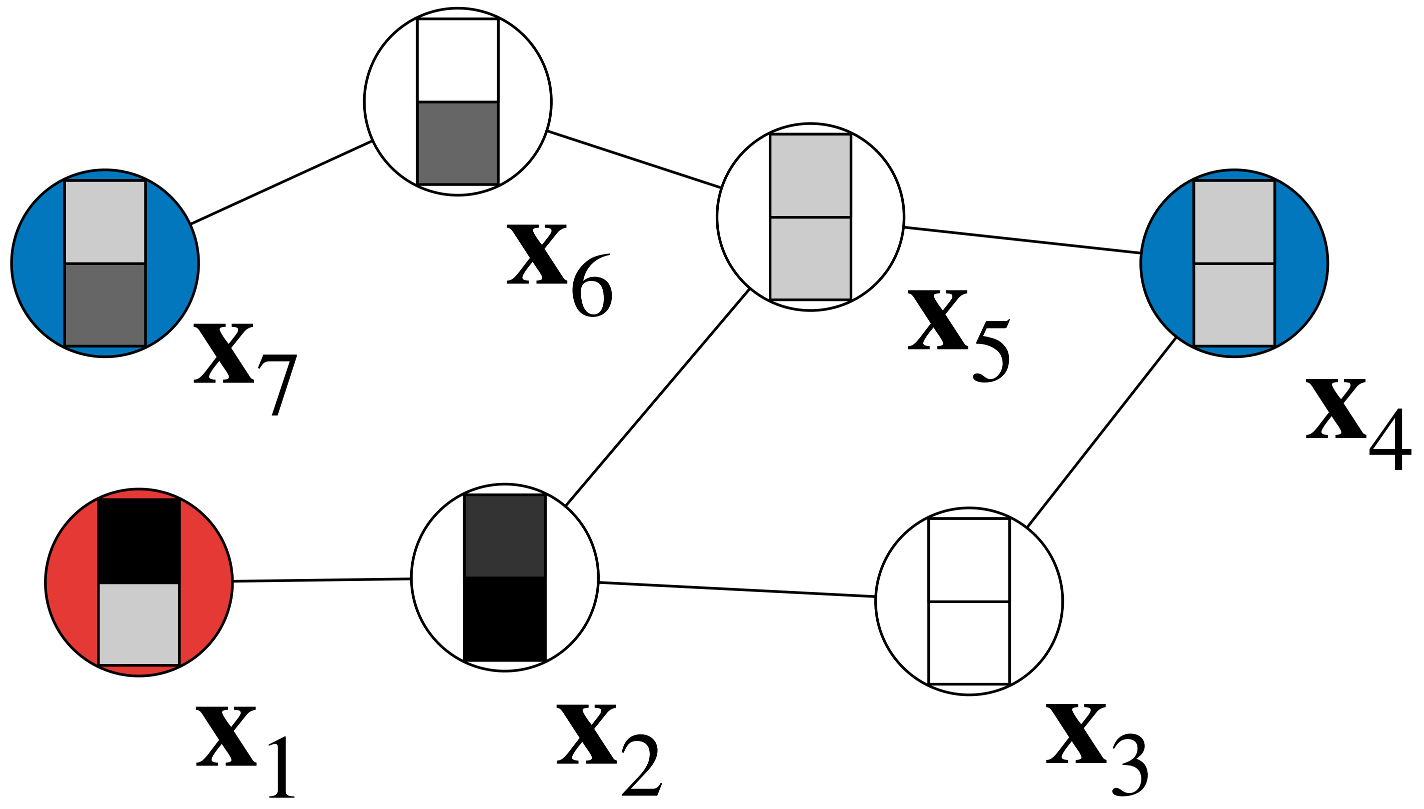


Features: $\mathbf{X} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]^\top$

Class +1: Class -1: Feature Vector: Feature Value: -1 0 +1

Node Classification

Input Graph



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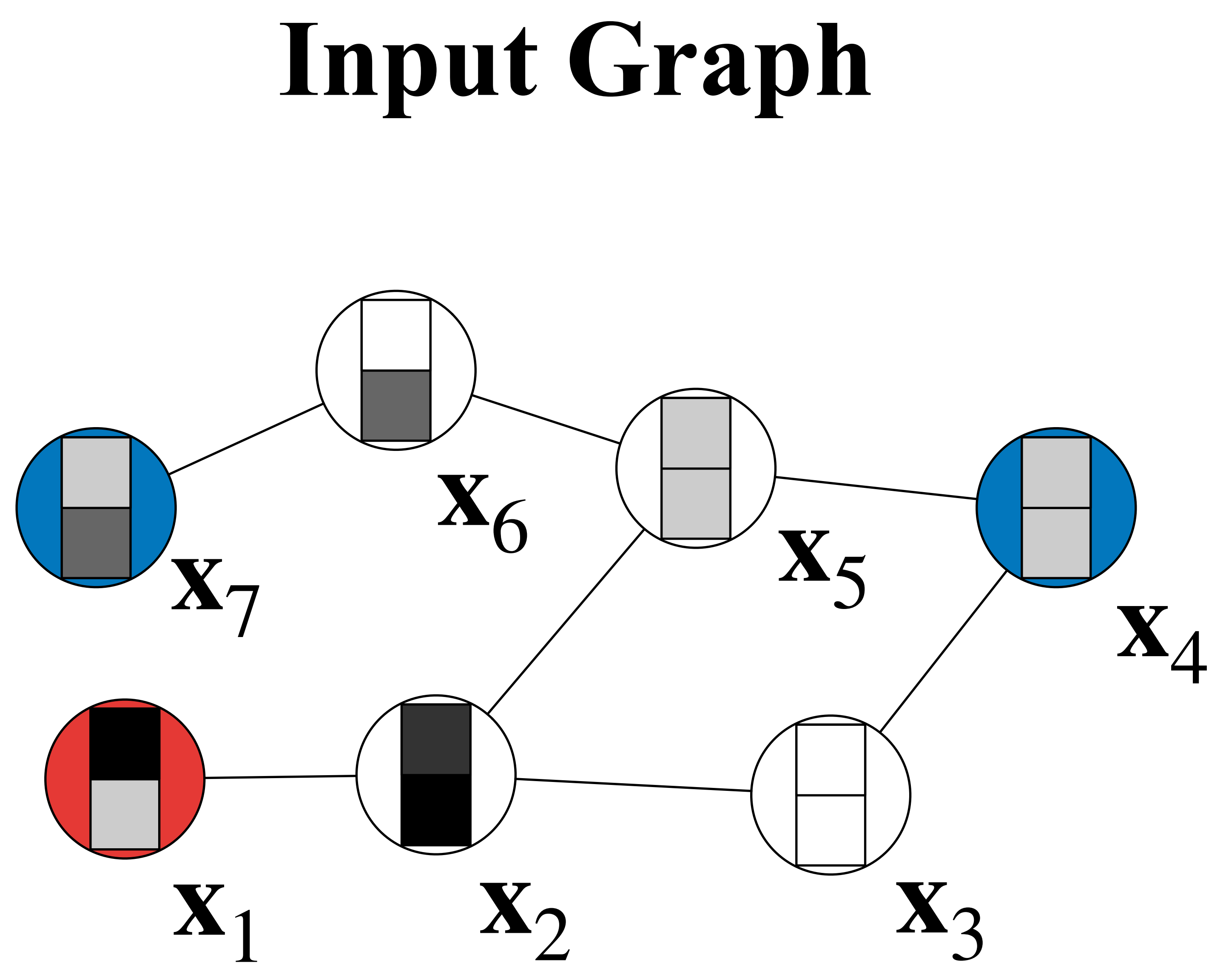
(Partially labelled)

Node Classification



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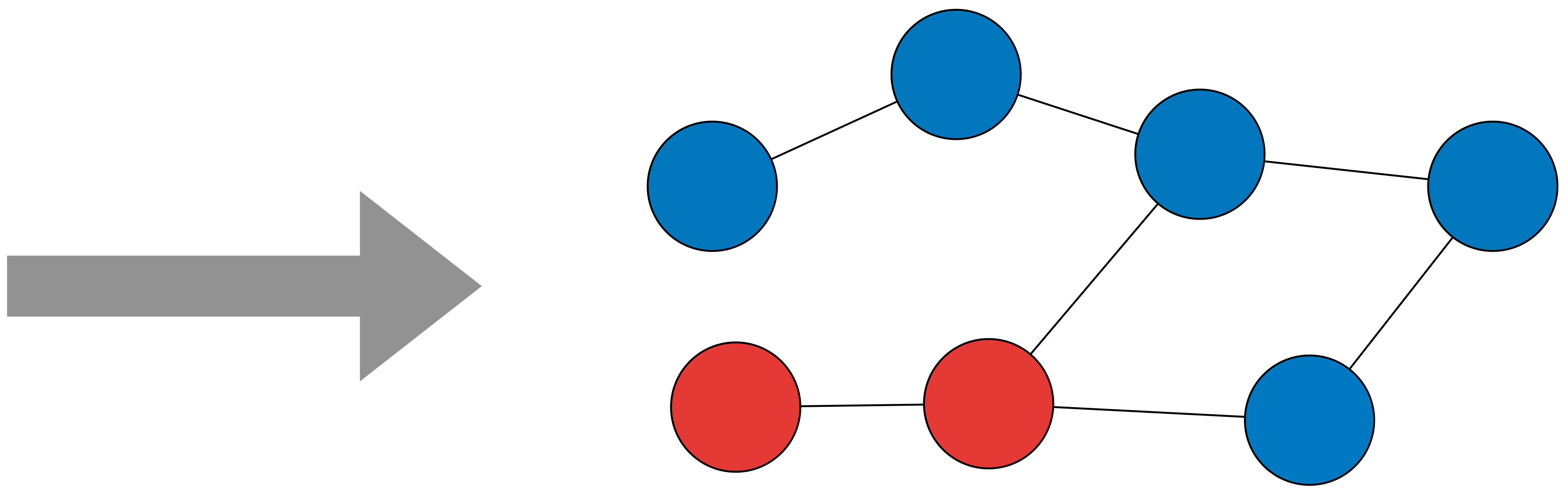
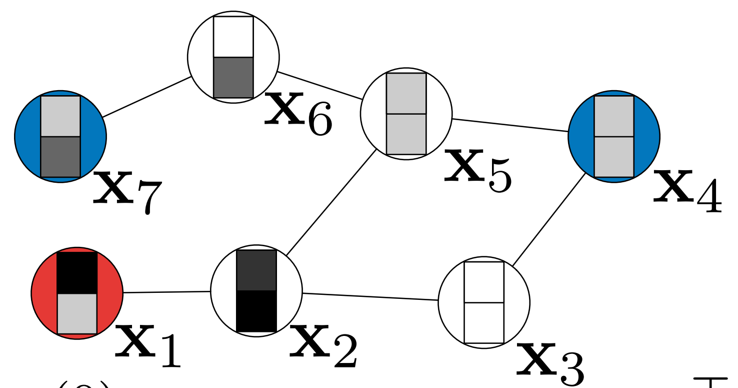


Graph Convolutional Network (GCN)

Input Graph

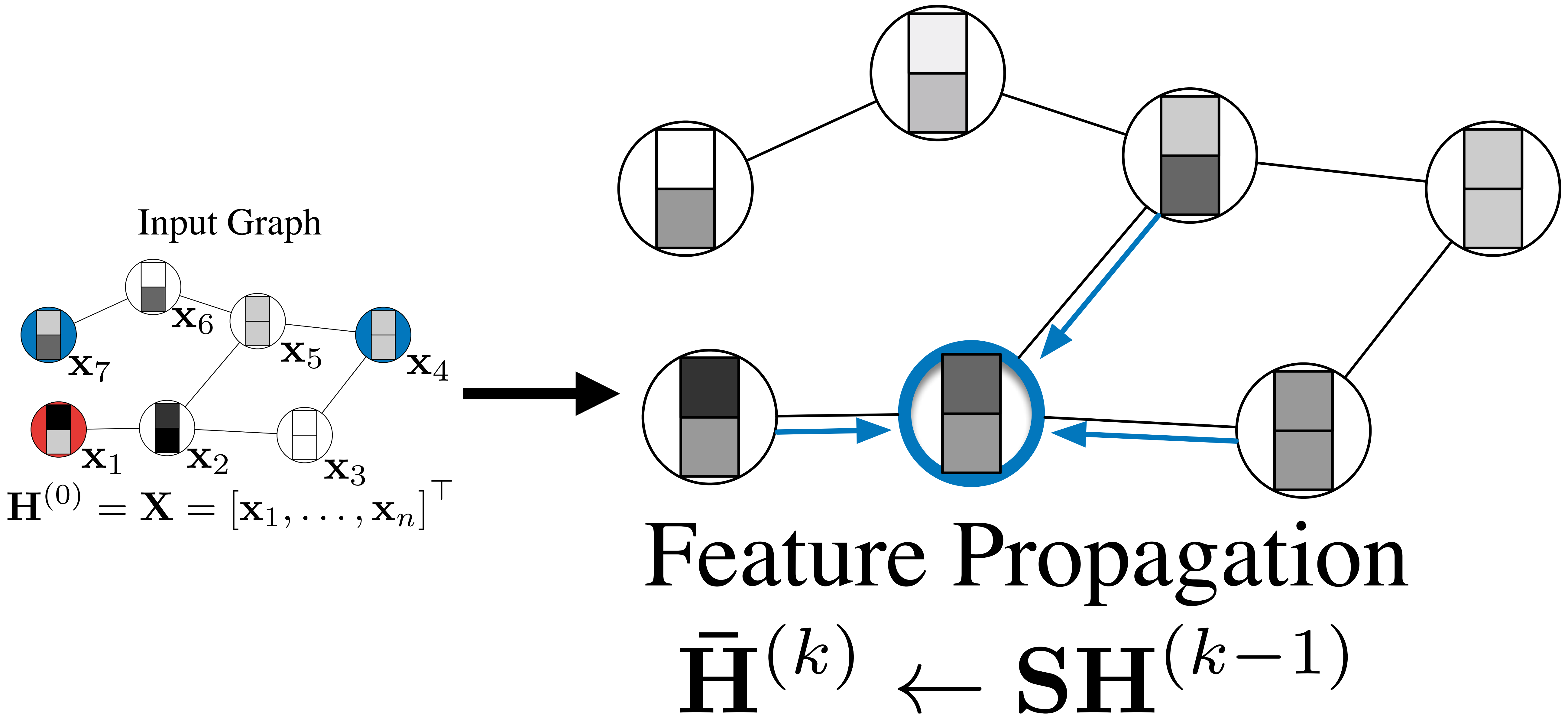


$$\mathbf{H}^{(0)} = \mathbf{X} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]^\top$$

Class +1: Class -1: Feature Vector:

Feature Value: -1 0 +1

Graph Convolutional Network (GCN)



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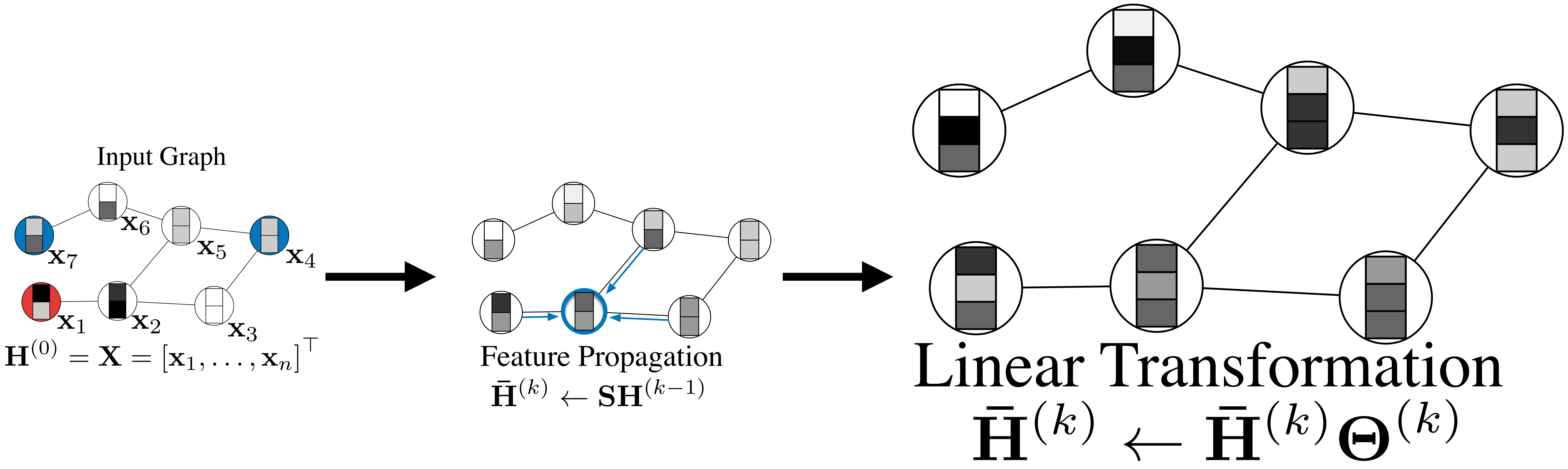

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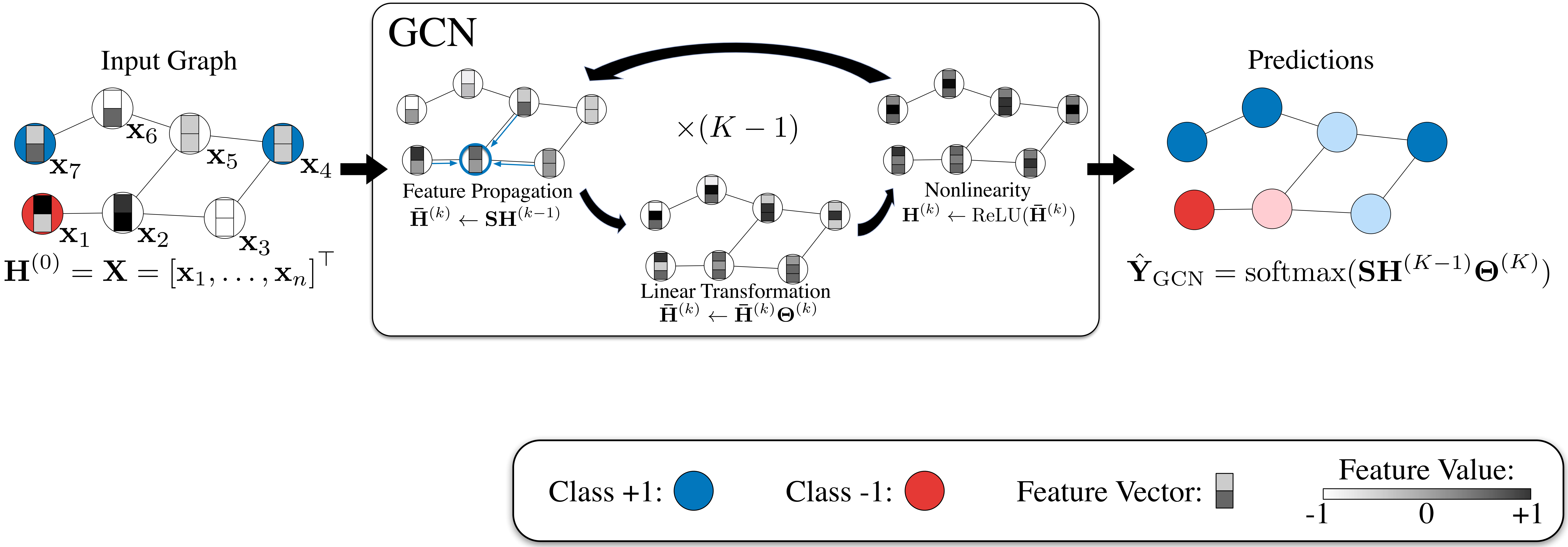
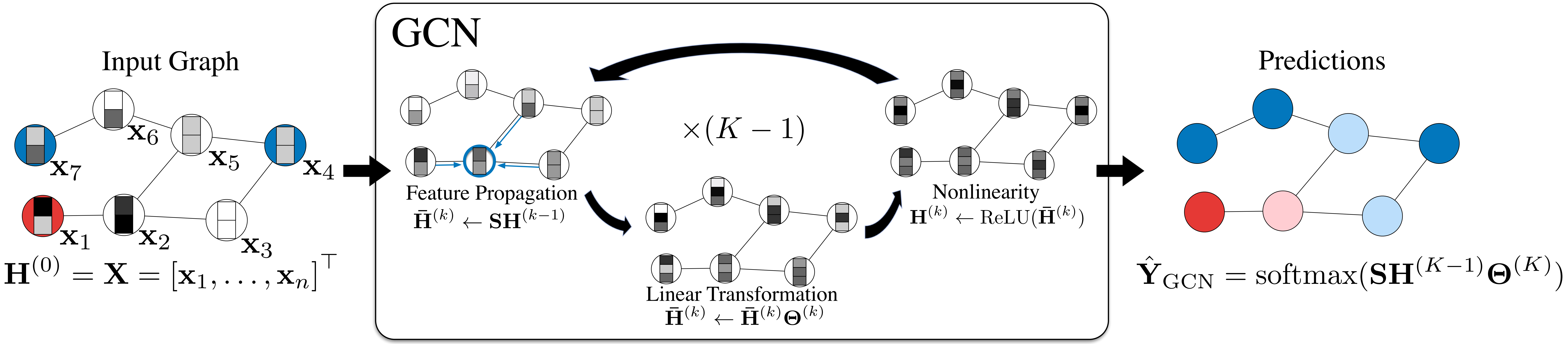


Graph Convolutional Network (GCN)

Is the nonlinearity necessary?



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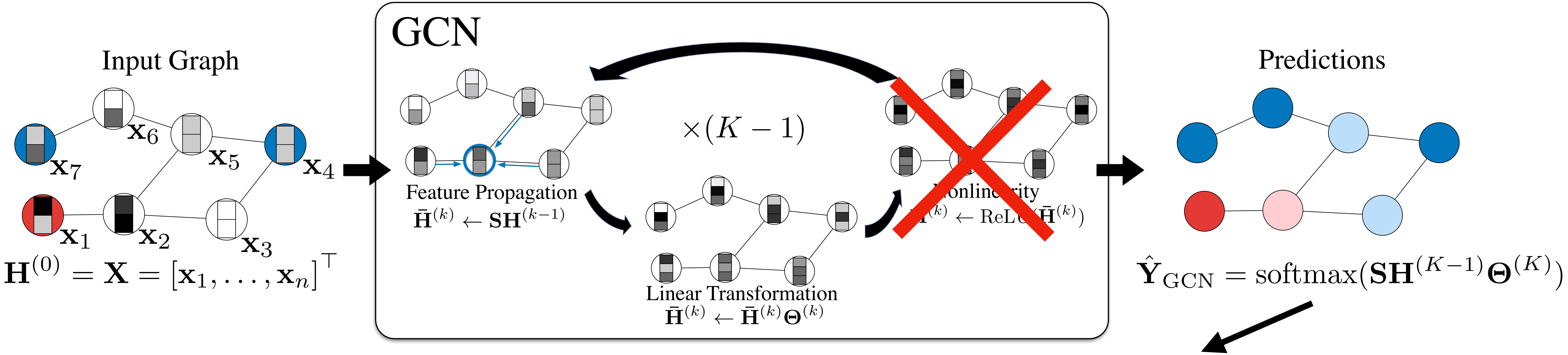

$$\hat{\mathbf{Y}} = \mathrm{softmax}\left(\mathbf{S}\ldots\mathbf{S}\mathbf{S}\mathbf{X}\mathbf{\Theta}^{(1)}\mathbf{\Theta}^{(2)}\ldots\mathbf{\Theta}^{(K)}\right)$$

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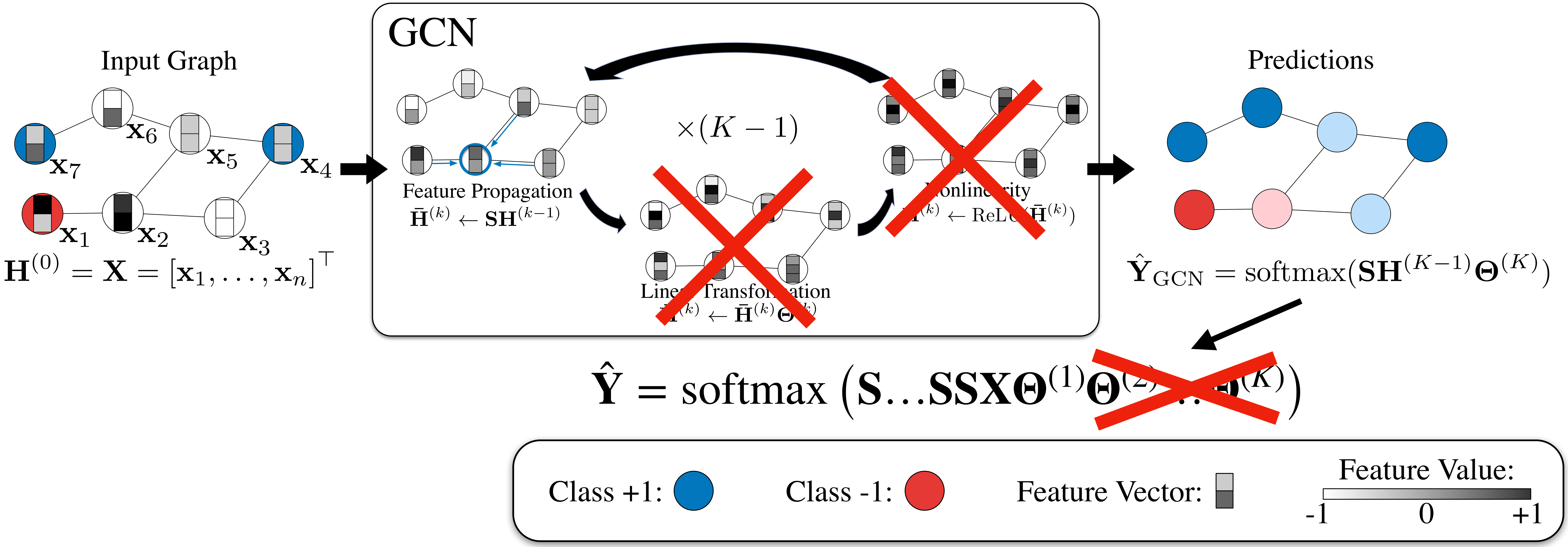

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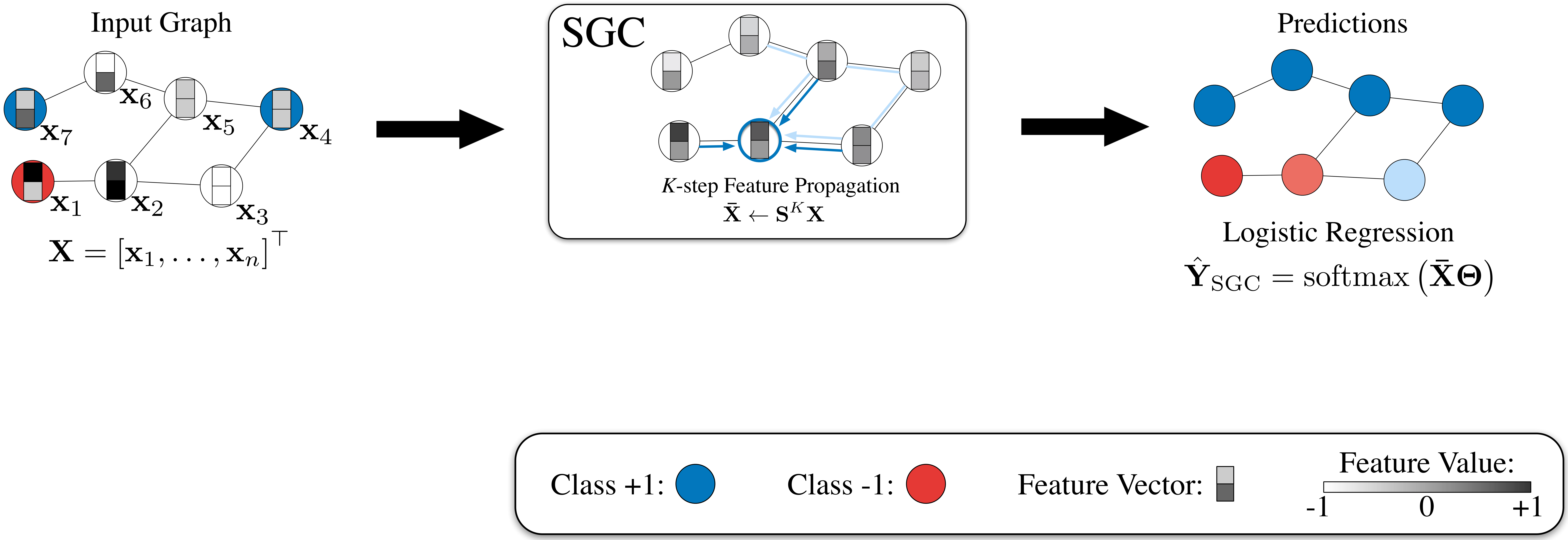
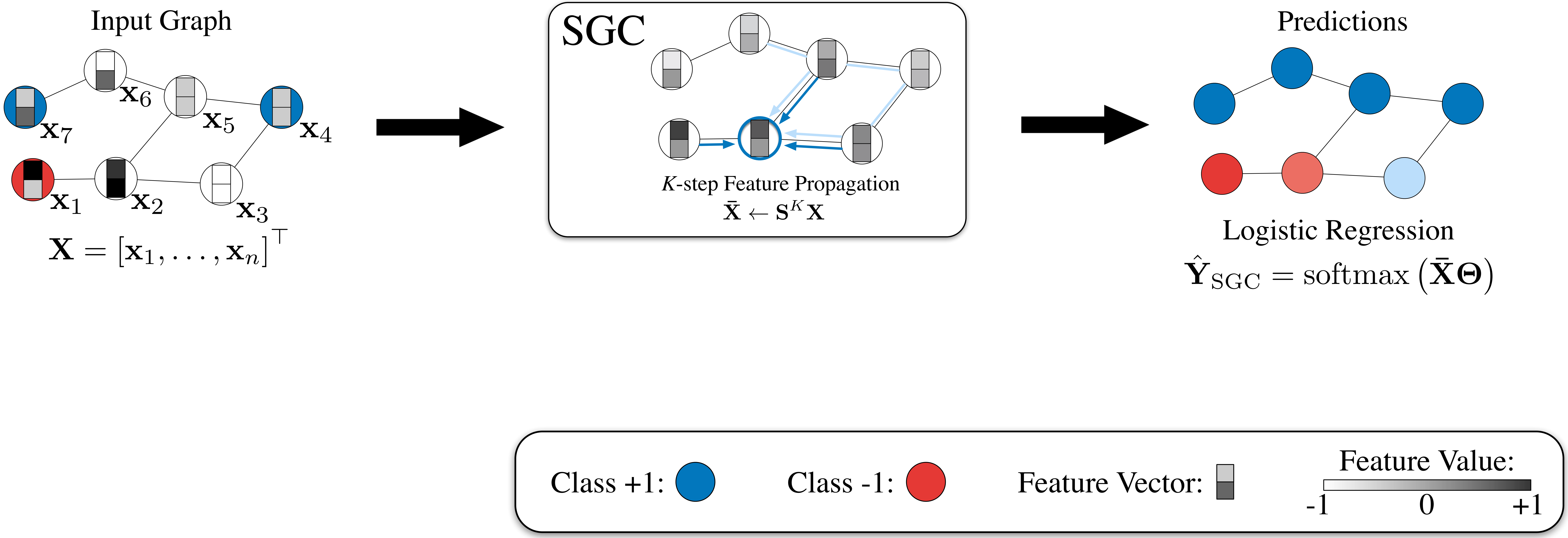
Simple Graph Convolution (SGC)



Simple Graph Convolution (SGC)

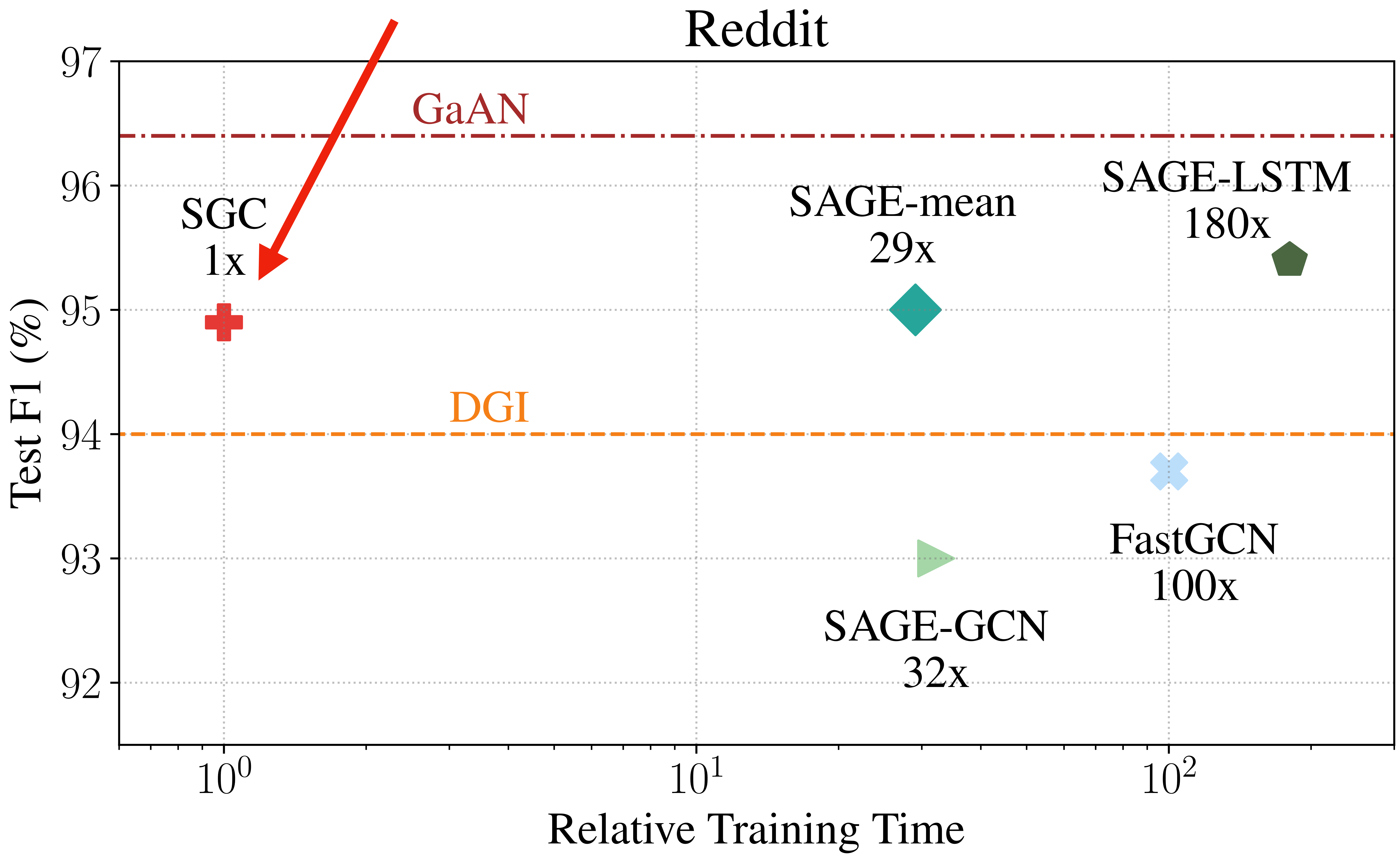
1. Interpretability
2. Mini-batch training on large graphs
3. Second-order opimization methods



Performance vs. Training Time on Reddit Dataset

(Hamilton *et al.*, NeurIPS 2017)

Within 2.7 seconds.



Reddit dataset contains 233K nodes and 11.6M edges

Comparable or Better Results

- SGC performs on par with or better than GCN across **5 tasks** including **14 datasets.**
  - Graph classification on citation and social networks: Cora, Citeseer, Pubmed, and Reddit datasets
  - Text classification: 20NG, R8, R52, Ohsumed, MR
  - Semi-supervised user geolocation: GEOTEXT, TWITTER-US, TWITTER-WORLD
  - Relation extraction: TACRED
  - Zero-shot image classification: ImageNet

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But not on **graph classification** task! (Nonlinearity is still beneficial on this task)

Thank You!

- A linear model (SGC) is sufficient on many graph tasks.
- Our official code is available at: https://github.com/Tiiiger/SGC
- We thank *Deep Graph Library*, *PyTorch Geometric*, *Spektral,* and *StellarGraph* for including SGC in their library.
- Please feel free to come by our poster section if you have questions:

Tonight 06:30~09:00 PM @ **Pacific Ballroom #267**