

Graph Mamba: Rethinking Graph Neural Networks Through Selective State Spaces

A minimalist approach to node classification that replaces traditional message passing with sequence modeling

The Quiet Crisis in Graph Learning

The fundamental limitations of today's GNNs and Transformers

The Depth Problems

Each hop requires another layer, leading to **oversmoothing**

Long-range information is forced through few edges, causing **Over-Squashing**

The Cost

State-of-the-art accuracy demands **excessive depth, parameters, and sacrifices stability**

The Core Question

So... What if we stop treating graphs as graphs? (Can we capture **multi-hop context** without stacking graph convolutions?)

Our Answer

Inspired by “*Graph Mamba: Towards Learning on Graphs with State Space Models*” – Ali Behrouz, Farnoosh Hashemi

Represent each node as a **short, ordered sequence** of its neighborhoods, then let a **selective state-space model** decide what to remember.

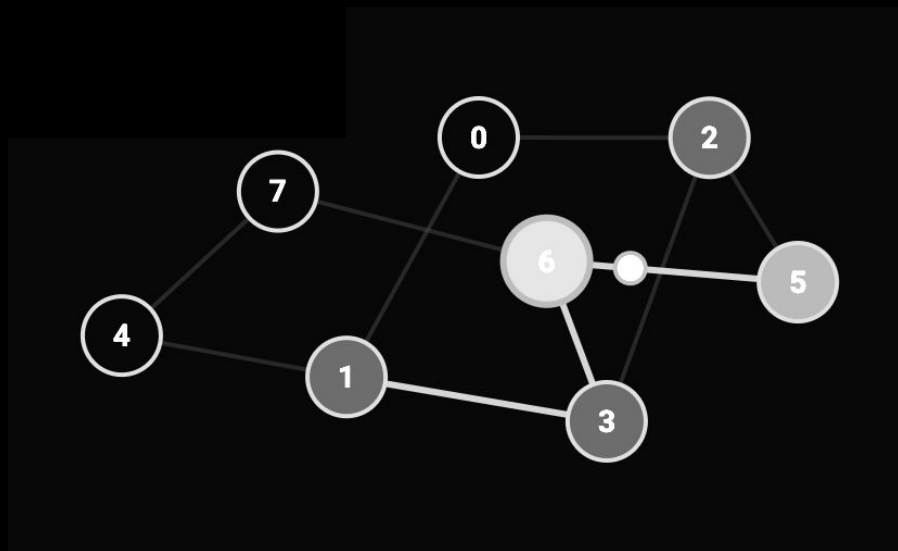
Stage 1 – Graph Tokenization

Converting graph structure into processable sequences

Method: Multi-walk random sampling

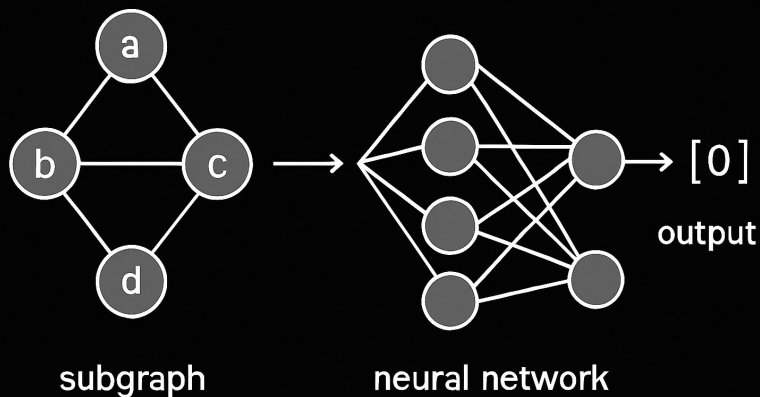
Process: Union of visited nodes \rightarrow induced subgraph

Advantage: Achieves **coverage** and **stochasticity** without exhaustive expansion



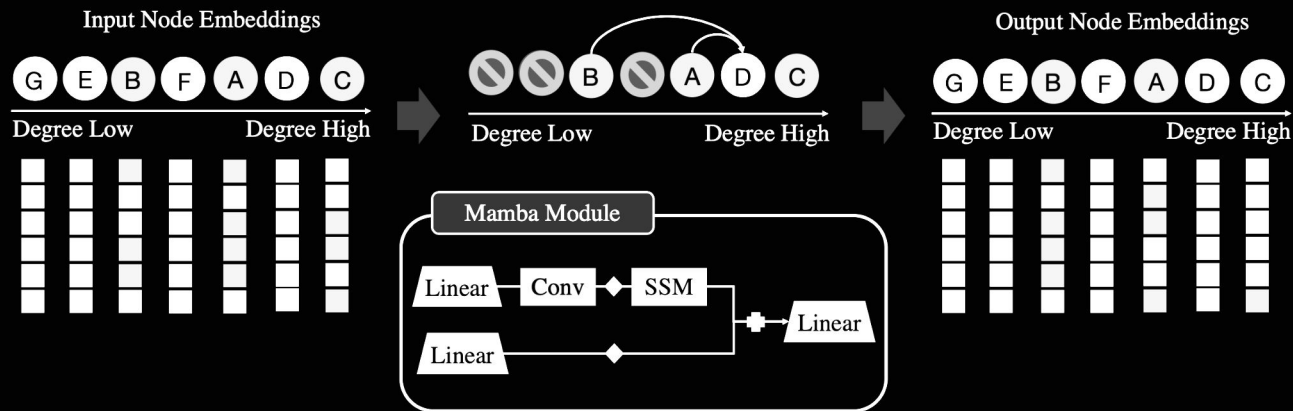
Stage 2 – Local Encoder: Mini-GCN Compressor

Turning each subgraph into **64-dimensional vector**



Stage 3 – Sequence Processor: Bidirectional Selective SSM

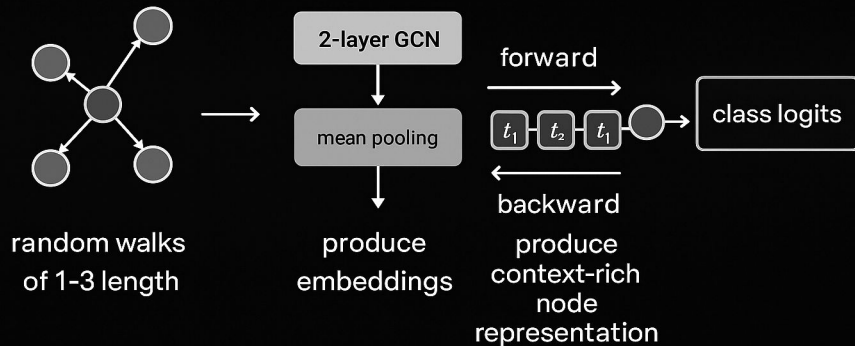
Efficient long-range context modeling



We run this scan **forward and backward** so each token sees context from both its local and distant neighborhoods

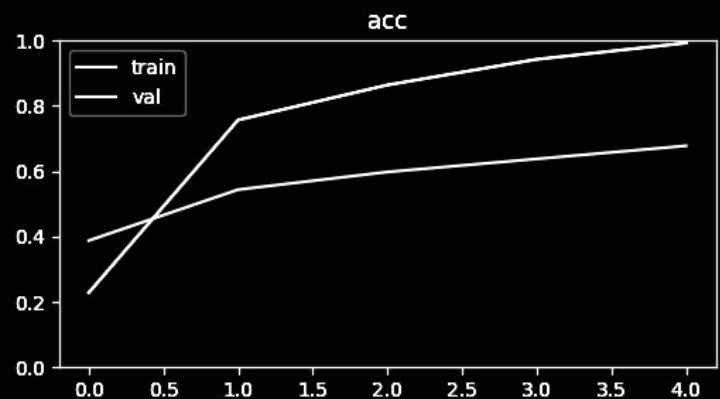
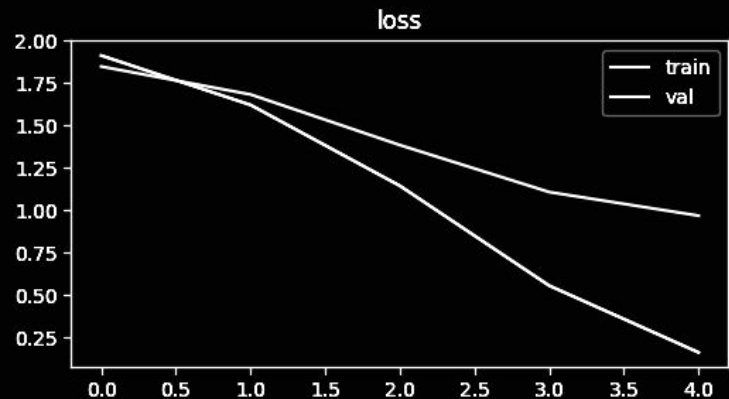
End-to-End Architecture

Graph \rightarrow Tokeniser \rightarrow Mini-GCN \rightarrow Bi-SSM \rightarrow Linear Classifier



Total trainable layers is just 4 (2 GCN + 1 SSM + 1 Linear).
No Attention, no deep stacks, no complex tricks.

Empirical Snapshot



acc: 0.6780,
precision: 0.6945,
recall: 0.6737,
f1: 0.6839

Conclusion

Graphs and sequences are not opposing formalisms.
With careful sampling, a sequence model of three tokens can rival
deep message passing.