

PROBLEM 3.1. Graph Convolutional Networks

This task deals with classification using *Graph Convolutional Networks (GCN)*. The data we will use is Zachary's karate club¹, a social network documenting interactions between members of a karate club. The data we wish to predict is the persons/nodes affiliations after the club split into two.

- a) Implement a python class for representing weighted graphs. Do not use matrices, as the support for sparse matrices is not mature in `jax`.
- b) Write a function that takes a graph, a graph signal and a parameter set and performs one layer of a GCN. Verify your implementation by applying it to Zachary's graph, the dummy graph signal and layer parameters and comparing the output to the given one.
- c) Read up on Flax NNX² and wrap the GCN layer as Flax Module. Add the option for specifying an output nonlinearity.
- d) Build a two-layered GCN that classifies nodes the of network binary. Since the whole information lies in the graph structure itself we have no input features. It is a proven strategy to have the identity matrix as input signal in such scenarios. Use the binary cross entropy as loss taking into account only the first and last node. Train the network and use the remaining nodes for estimating the accuracy.

¹https://en.wikipedia.org/wiki/Zachary%27s_karate_club

²https://flax.readthedocs.io/en/latest/nnx_basics.html should be a sufficient resource.