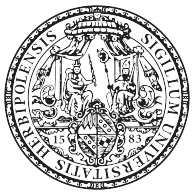

Deep Learning
SoSe 2024

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Exercise Sheet 10

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Total points: 2

Please upload your solutions to WueCampus as a scanned document (image format or pdf), a typesetted PDF document, and/or as a `jupyter` notebook.

1. Graph Convolutional Network

(a) Given the following neighborhood aggregation formula of GCN: 1P

$$h_v^{l+1} = \sigma\big(W_l \sum_{u \in N(v)} \frac{h_u^{(l)}}{|N(v)|} + B_l h_v^l\big), \forall l \in \{0, \ldots, L-1\}$$

derive the matrix formulation of $\sum_{u \in N(v)} \frac{h_u^{(l)}}{|N(v)|}$.

(b) 1P

a) Generate a network of 150 nodes with 2 visible class distinctions. Create a GCN model with 2 conv layers, use softmax function to output the probabilities of classes. As a feature matrix for nodes generate:
   i) A feature matrix of zeros,
   ii) the identity matrix as a feature matrix,
   iii) random features sampled from a normal distribution,
   iv) use node2vec with $p = 1$ and $q = 4$ to get the node embeddings, and use the node embeddins as feature matrix.

b) Train the model for 1000 epochs and plot the loss functions for each model in one plot. Comment on the differences of these models by checking the convergence of the loss function.

c) Use the latent space representation of the nodes from the second layer from one of the models mentioned above to visualise the feature maps.

Hint: Check out the Notebooks (Week 11) shown in the practice sessions of the lecture for additional guidance.