**Question 1**

Graph Density:

As you increase the number of nodes N, the graph density tends to decrease. This is because for the same number of edges (2 \* N in this case), as you add more nodes, the graph becomes less dense because the ratio of edges to possible edges (combinations of nodes) decreases.

Degree Distribution:

The degree distribution becomes more spread out and tends to resemble a power-law distribution as N increases. This means that a few nodes have significantly higher degrees compared to most nodes. As N increases, the degree distribution becomes more heterogeneous, with a few nodes having very high degrees, while most nodes have relatively lower degrees.

**Question 2**

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| --- | --- | --- |
| **Learning Method** | **Description** | **Use Cases** |
| Supervised Learning | Learns from labeled data; input features and labels | Classification, Regression |
| Self-Supervised Learning | Learns from data by creating surrogate tasks | Pre-training for transfer learning |
| Semi-Supervised Learning | Uses both labeled and unlabeled data for training | Scarce labeled data, improved model performance |

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| --- | --- | --- |
| **Learning Method** | **Description** | **Use Cases** |
| Transductive Learning | Builds a model for specific data points within the dataset | Specific predictions within the dataset |
| Inductive Learning | Builds a model that generalizes to unseen data | Generalization to new, unseen data points |

**Question 3**

By increasing number of epochs to 500 the accuracy went from 64% to 82.35%

|  |  |
| --- | --- |
| **Model** | **Accuracy Data** |
| Normal GCN |  |
| GCN Without self loops |  |
| GCN With more layers |  |
| GCN With skip connections |  |

**Question 4**

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| --- | --- | --- | --- | --- |
| **Feature** | **Message Passing GNN** | **Graph Convolution Network (GCN)** | **Graph Attention Network (GAT)** | **GraphSAGE** |
| Framework | General framework | Specialized architecture | Specialized architecture | Specialized architecture |
| Aggregation Mechanism | Message passing | Simple aggregation strategy | Attention mechanism | Neighborhood sampling |
| Attention Mechanism | No | No | Yes (per neighbor) | No |
| Weight Sharing | Flexible | Shared weights | Shared weights | Flexible |
| Inductive Learning | Depends on variant | No (transductive) | Yes (inductive) | Yes (inductive) |
| Handling of Neighbor Information | Customizable | Direct neighbors | Weighted neighbors | Aggregated subgraphs |
| Loss of Fine-Grained Structural Information | Depends on variant | Yes | Limited (due to smoothing) | Some due to sampling |
| Computational Efficiency | Variable | Efficient | Efficient | Efficient |
| Model Capacity | Variable | Limited | Increased with attention | Limited |