Graph Transformer Algorithm for Intrusion Detection Systems (IDS)

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# Graph Transformer Training and Evaluation Algorithm

The Graph Transformer model is trained and evaluated using the following algorithm:

: Graph representation, : Feature matrix, : Labels, : Datasets, Hyperparameters: Trained model , Evaluation metrics

**Step 1: Data Preprocessing** Normalize feature matrix . Encode labels as binary or multi-class categories.

**Step 2: Graph Construction** Represent network traffic as . Update adjacency matrix dynamically.

**Step 3 Model Initialization** Initialize Graph Transformer with: - Multi-head attention layers with heads. - Feed-forward neural networks with hidden dimensions . - Dropout layers with dropout rate .

**Step 4: Training Process** Divide into mini-batches of size . Initialize , . Forward pass: Compute predictions . Compute loss using Cross-Entropy Loss:

Backward pass: Update parameters using Adam optimizer with learning rate . Compute validation loss on . Update . Reset . Increment by 1.

**Step 5: Evaluation** Evaluate on . Compute metrics: Accuracy, Precision, Recall, F1-Score, ROC-AUC.

**Step 6: Return** Trained model and evaluation metrics.