**Use case of Graph Machine Learning Real time Applications**

**Graph ML applications**

Graph ML applications can be broadly classified into four categories based on the level at which the predictions are made:

**Diagram

Description automatically generated**

**Graph level prediction:**

These applications involve predicting properties of the entire graph, rather than individual nodes or edges.

**Edge level prediction:**

These applications involve predicting properties of individual edges in a graph, such as predicting the presence of a link between two nodes or predicting the type of relationship between them.

**Node level prediction:**

These applications involve predicting properties of individual nodes in a graph, such as predicting the category of a node or predicting its degree centrality.

**Subgraph level prediction:**

These applications involve predicting properties of subgraphs within a larger graph, such as predicting the existence of certain patterns or motifs in the graph.

These categories are not mutually exclusive, and many graph ML applications may involve predictions at multiple levels.

For example, predicting the community structure of a social network involves making graph-level predictions about the entire network, as well as node-level predictions about the category of individual users and their connections to other users.

**Chart, radar chart

Description automatically generated**

**Graph Level prediction ML applications**

Graph level prediction refers to the application of machine learning techniques to predict properties of a whole graph, rather than individual nodes or edges. Here are some examples of applications of graph-level prediction:

**Graph classification:** Graph-level prediction can be used to classify entire graphs into different categories based on their structural properties, such as social networks, chemical compounds, or protein structures.

**Generative modelling**: Graph-level prediction can be used to generate new graphs that follow a certain pattern or distribution, such as chemical compounds with specific properties or social networks with certain characteristics.

**Link prediction:** Graph-level prediction can be used to predict whether a new edge will be added to a graph based on its existing structure.

**Graph embedding:** Graph-level prediction can be used to embed a graph into a lower-dimensional space, preserving its structure and properties, and enabling efficient graph analysis and comparison.

**Graph clustering:** Graph-level prediction can be used to cluster similar graphs into groups based on their structure and properties, such as clustering of social networks or chemical compounds.

**Graph alignment:** Graph-level prediction can be used to align different graphs with similar structures, such as comparing chemical compounds or protein structures.

**Graph generation:** Graph-level prediction can be used to generate new graphs with desired properties, such as predicting the structure of new molecules or designing new materials.

**Graph regression:** Graph-level prediction can be used to predict continuous properties of graphs, such as the solubility of chemical compounds or the binding affinity of protein-ligand interactions.

**Recommendation systems:** Graph-level prediction can be used to recommend items or services to users based on their interaction with the graph, such as recommending movies or books to users based on their rating history.

**Network analysis:** Graph-level prediction can be used to analyse and compare different types of networks, such as social networks, transportation networks, or power grids.

**Node level Graph ML Applications**

Node level Graph Machine Learning (ML) refers to the application of ML techniques to nodes in a graph, which are the entities that are connected by edges. Here are some examples of applications of node-level graph ML:

**Node classification:** Node-level graph ML can be used to classify nodes in a graph, based on their features or properties.

**Community detection:** Node-level graph ML can be used to identify communities of nodes in a graph, based on the patterns of connections between them.

**Entity resolution:** Node-level graph ML can be used to resolve entities in a graph that refer to the same real-world object, based on their properties and connections.

**Recommendation systems:** Node-level graph ML can be used to recommend items or services to users, based on the patterns of their interactions with other nodes in a graph.

**Fraud detection:** Node-level graph ML can be used to detect fraudulent behaviour in financial transactions, by analysing the properties and connections of nodes involved in the transactions.

**Content recommendation:** Node-level graph ML can be used to recommend content to users, based on the similarity between the properties and connections of nodes associated with the content and those associated with the user.

**Sentiment analysis:** Node-level graph ML can be used to analyse the sentiment of nodes in a social network, based on their properties and connections.

**Biomedical research:** Node-level graph ML can be used to analyse the properties and connections of biological entities such as genes and proteins, to identify potential drug targets and disease mechanisms.

**Natural language processing:** Node-level graph ML can be used to analyse the properties and connections of words and phrases in a text corpus, to identify patterns and relationships between them.

**Customer segmentation:** Node-level graph ML can be used to segment customers based on their properties and connections, to identify the most valuable customer segments and target them with personalized marketing campaigns.

**Subgraph level graph ML Applications**

Subgraph level Graph Machine Learning (ML) refers to the application of ML techniques to subgraphs, which are subsets of nodes and edges within a larger graph. Here are some examples of applications of subgraph-level graph ML:

**Graph classification:** Subgraph-level graph ML can be used to classify entire graphs, based on the properties and connections of subgraphs within them.

**Network alignment:** Subgraph-level graph ML can be used to align subgraphs between two or more graphs, based on their properties and connections.

**Pattern mining:** Subgraph-level graph ML can be used to mine frequent patterns or motifs within a graph, based on the properties and connections of subgraphs.

**Knowledge graph completion:** Subgraph-level graph ML can be used to complete a knowledge graph, by predicting missing subgraphs or edges based on the properties and connections of existing subgraphs and edges.

**Graph matching:** Subgraph-level graph ML can be used to match a subgraph within a larger graph to a target subgraph, based on their properties and connections.

**Drug discovery:** Subgraph-level graph ML can be used to predict the efficacy of a drug by analysing subgraphs of chemical structures and their connections.

**Protein-protein interaction prediction:** Subgraph-level graph ML can be used to predict protein-protein interactions by analysing subgraphs of protein structures and their interactions.

**Network security:** Subgraph-level graph ML can be used to detect network intrusions by analysing subgraphs of network traffic and identifying anomalous patterns.

**Social network analysis:** Subgraph-level graph ML can be used to analyse the structure of social networks, by identifying and comparing subgraphs of communities and their connections.

**Image processing:** Subgraph-level graph ML can be used to identify and classify subgraphs of features within an image, such as edges, corners, and objects.

**Edge level Graph ML applications**

Edge level Graph Machine Learning (ML) refers to the application of ML techniques to edges, which are the connections between nodes in a graph. Here are some examples of applications of edge-level graph ML:

**Link prediction:** Edge-level graph ML can be used to predict the likelihood of a link between two nodes in a graph, based on the features of the nodes and the other edges in the graph.

**Anomaly detection:** Edge-level graph ML can be used to detect anomalous edges in a graph, based on the patterns of the other edges in the graph.

**Fraud detection:** Edge-level graph ML can be used to detect fraudulent behaviour in financial transactions, by analysing the connections between the parties involved in the transactions.

**Recommender systems:** Edge-level graph ML can be used to predict which products or services a user might be interested in, based on the connections between users and products in a graph.

**Traffic prediction:** Edge-level graph ML can be used to predict traffic patterns in a city, by analysing the connections between roads and historical traffic data.

**Social network analysis:** Edge-level graph ML can be used to identify influential individuals in a social network, based on the connections between individuals and the content they share.

**Cybersecurity:** Edge-level graph ML can be used to detect and prevent cyber-attacks, by analysing the connections between devices on a network and the patterns of data traffic.

**Image and video processing:** Edge-level graph ML can be used to detect and track objects in images and videos, by analysing the connections between pixels or frames.

**Natural language processing:** Edge-level graph ML can be used to analyse the connections between words and phrases in a text corpus, to identify patterns and relationships between them.

**Supply chain optimization:** Edge-level graph ML can be used to optimize supply chain networks, by analysing the connections between suppliers, manufacturers, and customers, and identifying the most efficient routes and processes.