Synergy between Networks and Machine Learning

We can use networks and machine learning to tackle a wide variety of challenges:
• Predict future links
• Predict vertex’s attributes
• Create recommendations
• Identify fake profiles/bots
• Identify anomalies
Link Prediction

We can use the network’s topological structure to predict missing/future links. This can be useful for a variety of tasks:
- Recommend other users/items that may be interesting to a user
- Predict future interactions (for example if user A will send message to user B)
- Identify missing parts of data
- Getting a job at Facebook
Link Features

\[ \Gamma(v) := \{ u | (u, v) \in E \text{ or } (v, u) \in E \} \]

\[ \text{Friends-measure}(u, v) = \sum_{x \in \Gamma(u)} \sum_{y \in \Gamma(v)} \delta(x, y), \]

\[ \text{common-friends}(u, v) = |\Gamma(v) \cap \Gamma(u)|, \]

\[ d(v) = |\Gamma(v)| \]

\[ \text{total-friends}(u, v) = |\Gamma(u) \cup \Gamma(v)|, \]

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\[ \text{jaccard's-coefficient}(u, v) = \frac{|\Gamma(u) \cap \Gamma(v)|}{|\Gamma(u) \cup \Gamma(v)|}, \]

\[ \text{preferential-attachment-score}(u, v) = |\Gamma(u)| \cdot |\Gamma(v)|. \]

Adamic-Adar index of \( u \) and \( v \) is defined as

\[ \sum_{w \in \Gamma(u) \cap \Gamma(v)} \frac{1}{\log |\Gamma(w)|} \]
Attribute Prediction

We can use networks and supervised learning to predict a vertex’s attribute. For example, in the student’s graph below, we are able to predict a student’s test score based on his or her friends’ test scores.
Network Embedding

Network embedding encompasses a variety of methods for learning feature representations of vertices, links, and subgraphs in a network. Typically, embedding methods are based on the assumption that the similarity between objects in the network should be reflected in the learned feature representations.
Recommended Read:

- Primož Godec, Graph Embeddings — The Summary