Graph Learning for Network Data

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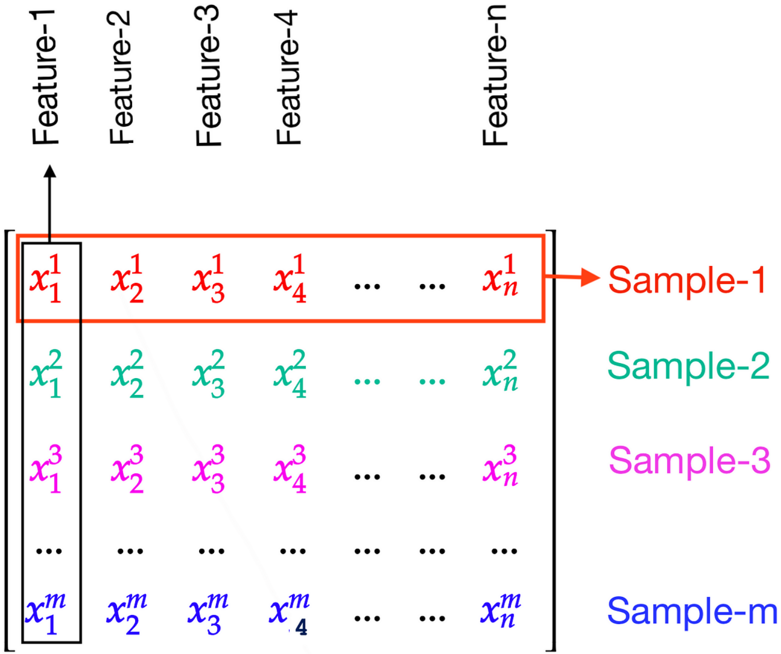
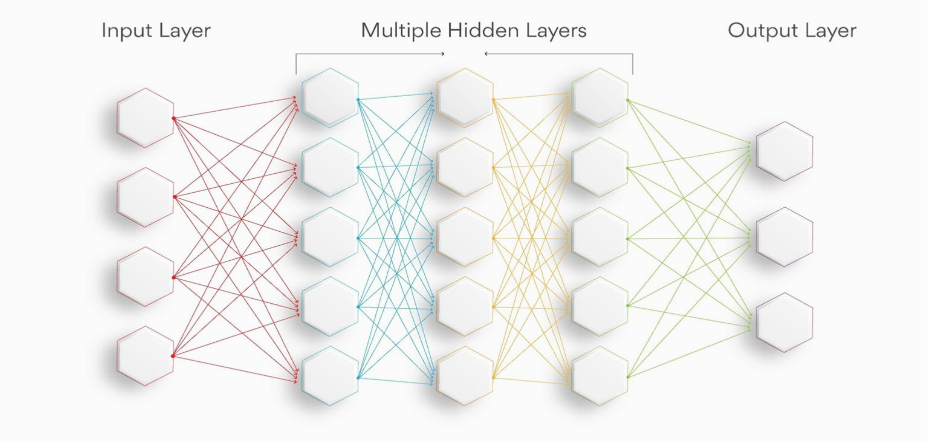
Significance

- About 1 in 18 of American patients are misdiagnosed, 1 in 50 suffer an adverse event because of misdiagnosis, and 1 in 350 suffer permanent disability or death as a result.[1]
- Development of novel drugs takes an average of 10-15 years.[2]
- Drowsy driving is responsible for an estimated 6,000 fatal crashes in the US each year, while drunk driving is responsible for around 10,000 deaths per year.[3]
- 119 billion pounds of food is wasted in the US annually. That's around 40% of the food in America, or an astounding 130 billion meals.[4]

Neural Networks

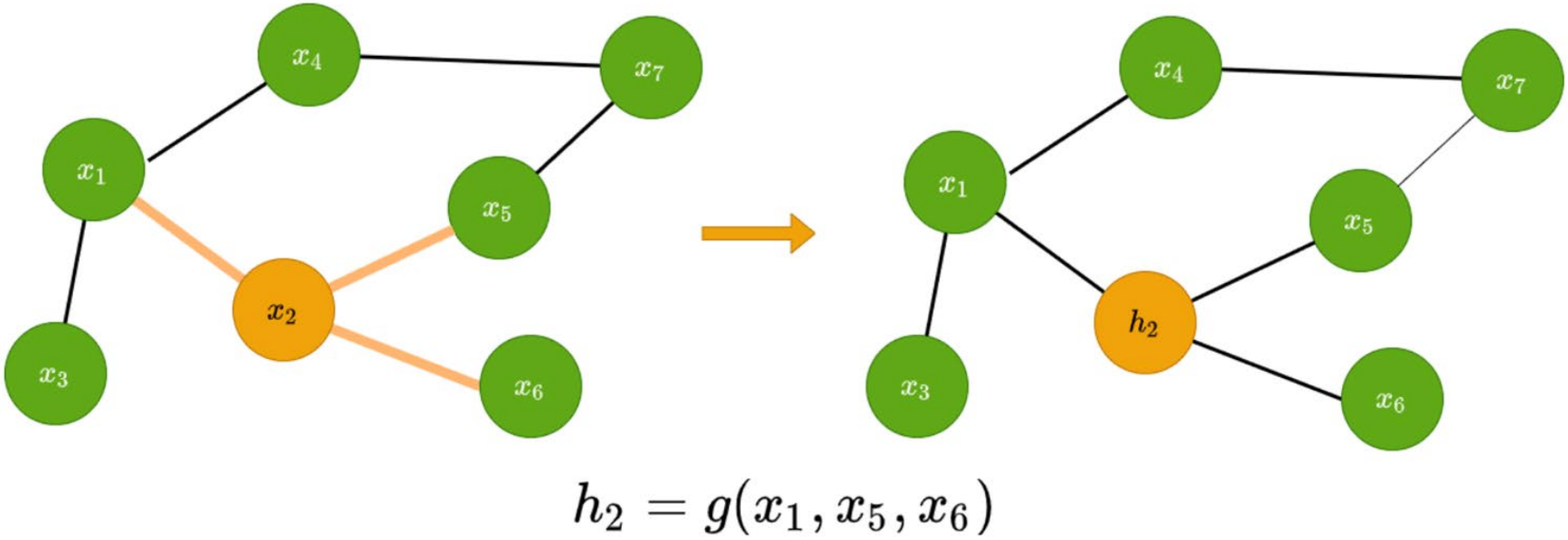


Deep Learning: Deep Guide for All Your Matrix Dimensions and Calculations!, Medium, 24 Aug. 2018, https://medium.com/from-the-scratch/deep-learning-deep-guide-for-all-your-matrix-dimensions-and-calculations-415012de1568. Accessed 31 July 2023.



Importance of Artificial Neural Networks in Artificial Intelligence, https://www.turing.com, Accessed 27 July 2023.

Graph Neural Networks

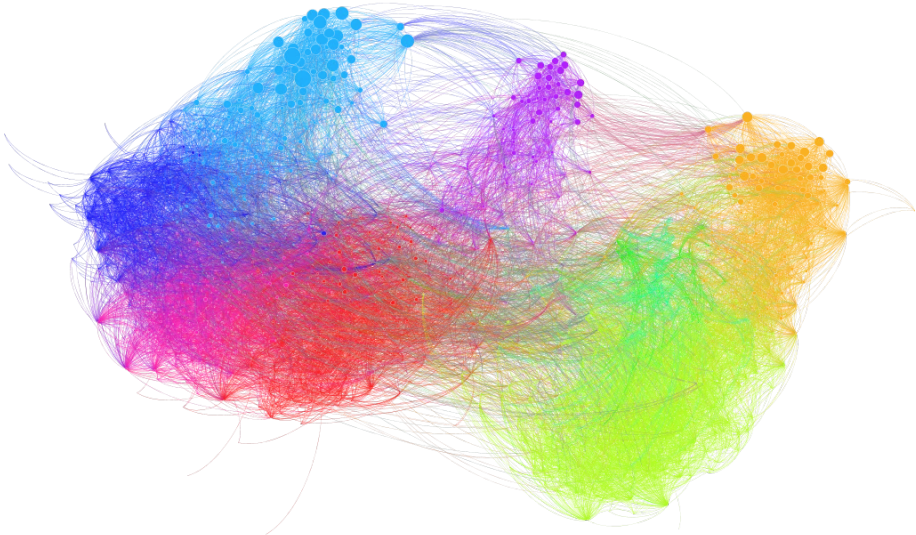


$$h_2 = g(x_1, x_5, x_6)$$

Karagiannakos, Sergios. Best Graph Neural Network Architectures: GCN, GAT, MPNN and More, 23 Sept. 2021, https://theaisummer.com/gnn-architectures/ . Accessed 27 July 2023.

Project Goals

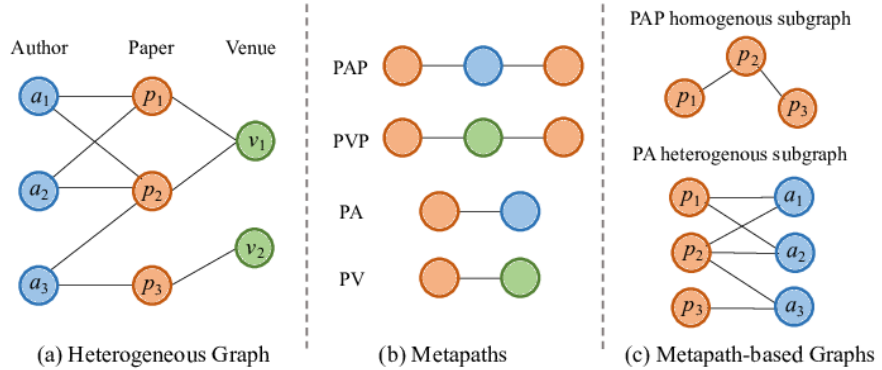
- Create a way to allow Graph Neural Networks to handle heterogeneous data
- Improve current models through novel neural network architecture



The Power of Graphs in Machine Learning and Sequential Decision Making, 3 June 2019, https://graphpower.inria.fr/schedule/. Accessed 1 Aug. 2023.

Project Goals

- establish a homogenizing pipeline for heterogeneous data
  - Allows us to label unlabeled data using the different node types
  - Allows us to easily create distribution labels



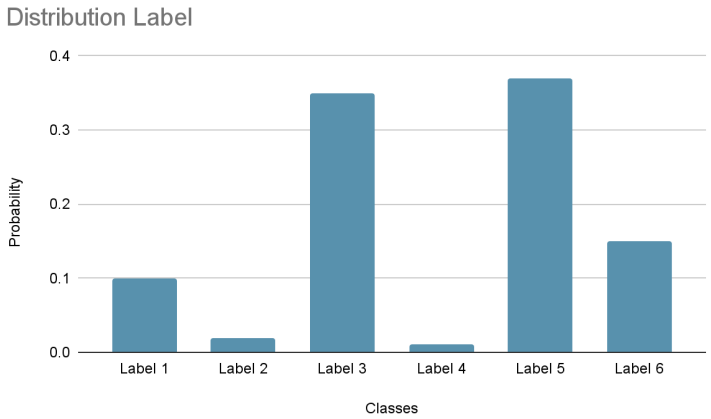
Heterogeneous Graph Neural Network Based on Metapath Subgraph Learning, Sept. 2021, Accessed 27 July 2023.

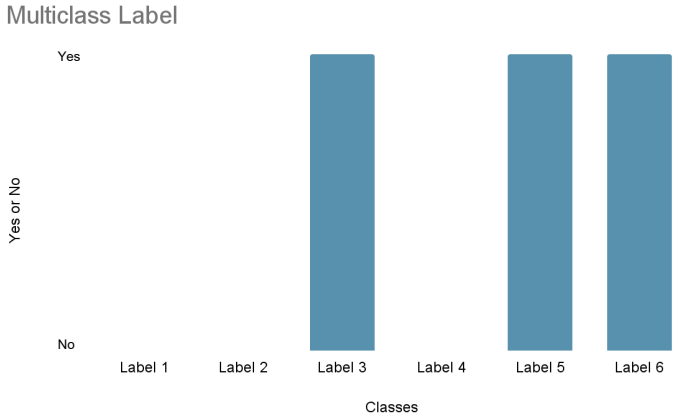
Distribution Labels

- Carries more information
- Models can easily adapt to this structure through a simple probability transformation

NEW PROBLEM:

- To train our model, we must also have distribution labels
  - Re-enter homogenizing pipeline

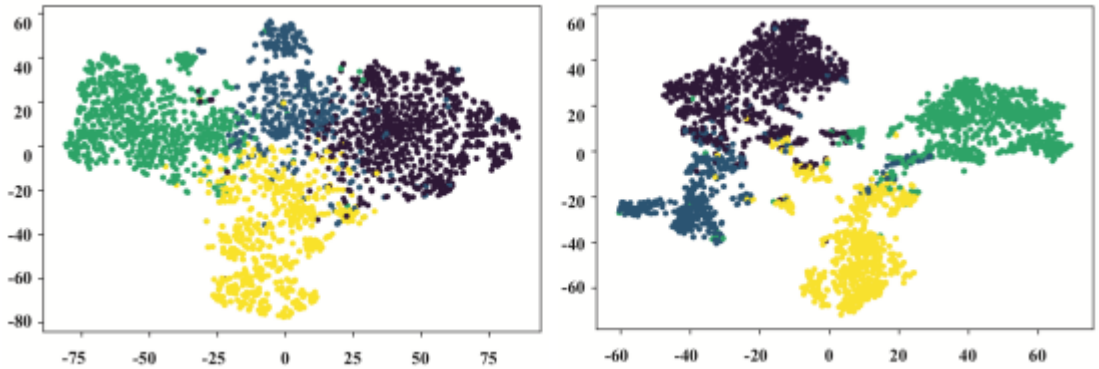




Improving Graph Neural Network Performance

Thought Process:

- Neural Networks have improved through the introduction of more information
- Extracting more information from pre-existing data
- Dynamically generating correlation information instead of using static correlation



Wang, Xiao. “Figure 6.” Heterogeneous Graph Attention Network, 20 Jan. 2021, arXiv:1903.07293. Accessed 1 Aug. 2023.

Results (On-going)

	Chebyshev Distance	Cosine Distance	Canberra Distance	Clark Distance	Intersection Distance*	KL Divergence Distance
Non-Graph LDL	0.36372	0.2401	2.7926	1.42	0.59305	N/A
GCN LDL	0.3136993139	0.1798002404	2.324628943	1.200705594	0.6427891961	0.4244690184
Static ML-GCN	0.28928456	0.16980088	2.35793181	1.22265781	0.66883566	0.38750959
Dynamic ML-GCN	0.297	0.1723	2.347	1.2186	0.6626	0.3984

***higher values are better**

LDL - Label Distribution Learning

GCN - Graph Convolutional Network

ML-GCN - Multi-layer Graph Convolutional Network

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Citations

[1] - Newman-Toker DE. Diagnostic Errors in the Emergency Department: A Systematic Review. Comparative Effectiveness Review No. 258. Agency for Healthcare Research and Quality; December 2022. DOI: 10.23970/AHRQEPCCER258

[2] - Hughes JP, Rees S, Kalindjian SB, Philpott KL. Principles of early drug discovery. Br J Pharmacol. 2011 Mar;162(6):1239-49. doi: 10.1111/j.1476-5381.2010.01127.x. PMID: 21091654; PMCID: PMC3058157.

[3] - “Drunk Driving vs. Drowsy Driving vs. Distracted Driving.” Meirowitz & Wasserberg, LLP, 20 June 2023, www.samndan.com/drunk-vs-drowsy-vs-distracted-driving/.

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Geng, Xin, and Rongzi Ji. “Label Distribution Learning.” 2013 IEEE 13th International Conference on Data Mining Workshops, 2013, https://doi.org/10.1109/icdmw.2013.19.

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Wang, Xiao, et al. Heterogeneous Graph Attention Network. arXiv:1903.07293, arXiv, 20 Jan. 2021. arXiv.org, http://arxiv.org/abs/1903.07293.