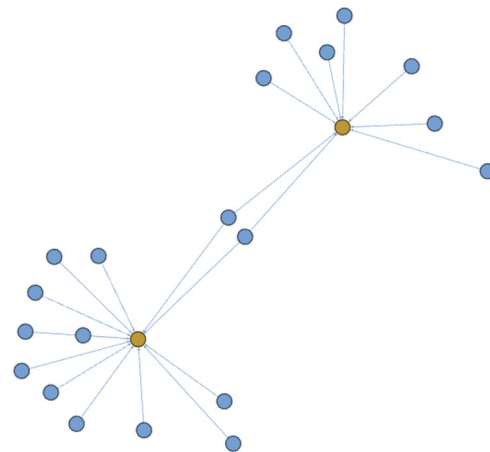


Applications of Graph Theory to Disease-Gene Networks

Participant: Jair Torres
Advisor: Dr. Hatem

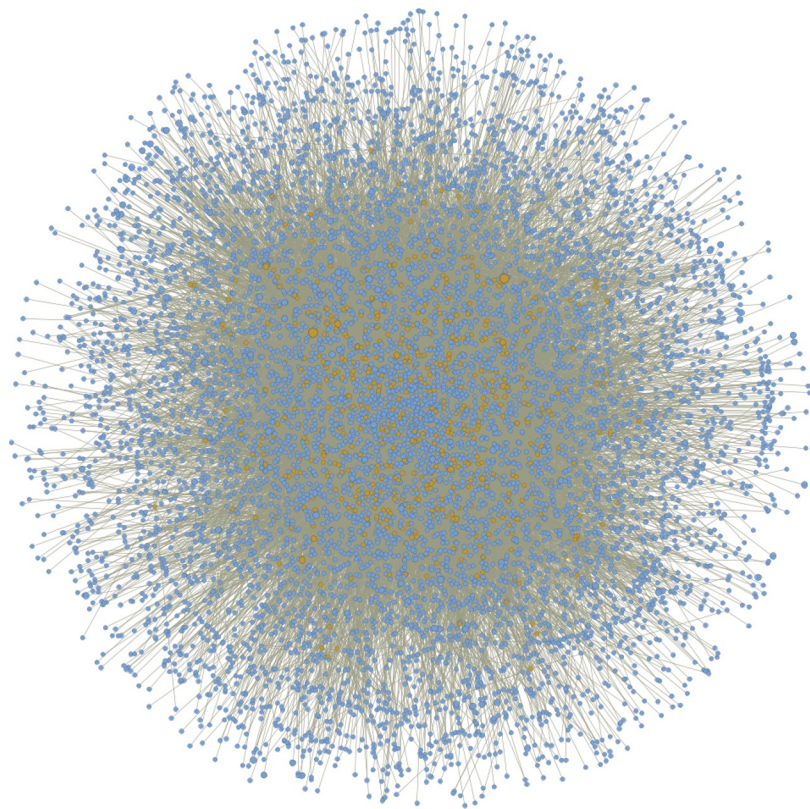
Networks

- **Networks** consist of a group of objects that are related
- Examples of biological networks:
 - Protein-Protein Interactions (PPI)
 - Food Webs
 - Gene Co-Expression
 - Disease-Gene Association



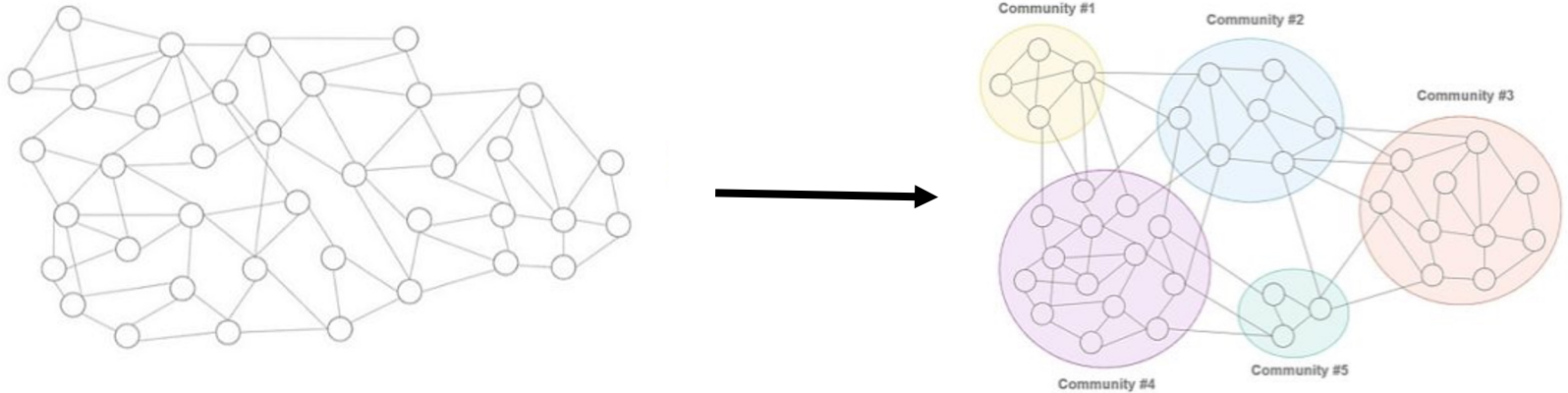
Disease-Gene Networks

- Diseases linked by genes
- Bipartite graph
- Identify molecular mechanisms underlying comorbidity

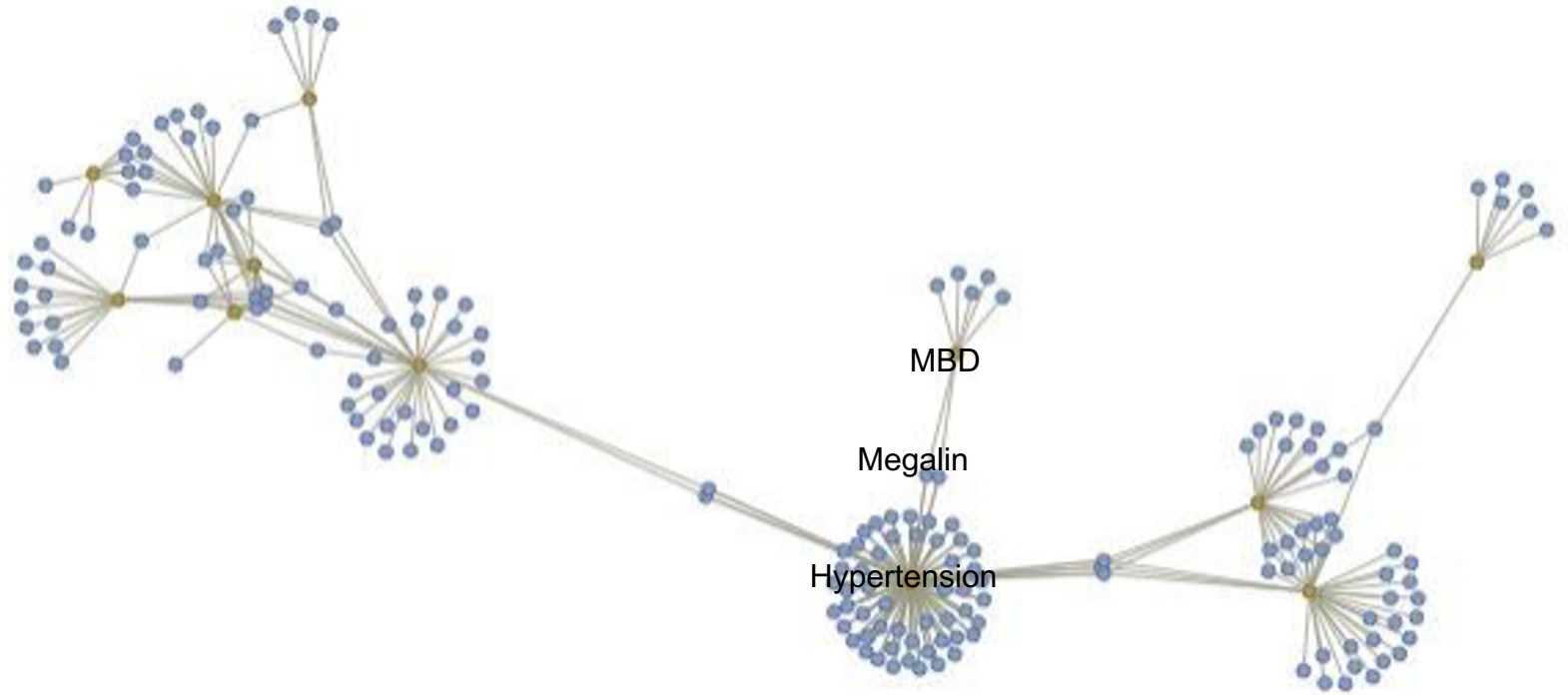


Disease-Gene Networks

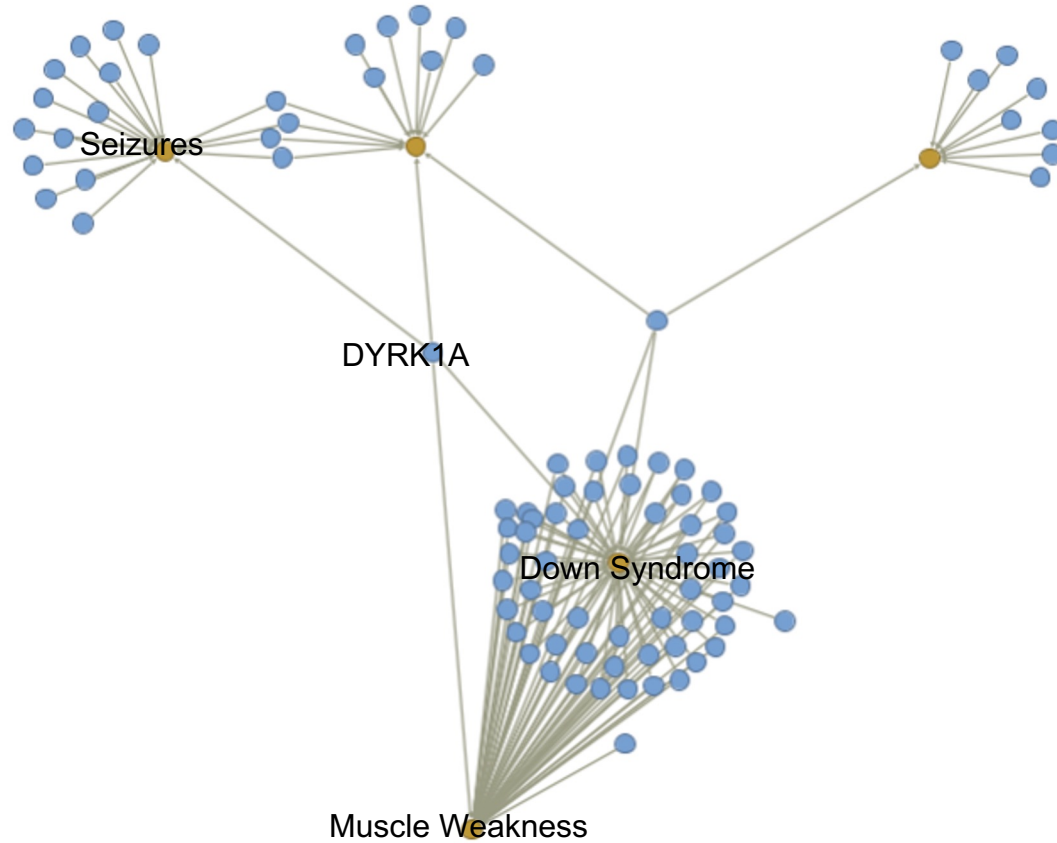
Community detection algorithm: Louvain Method



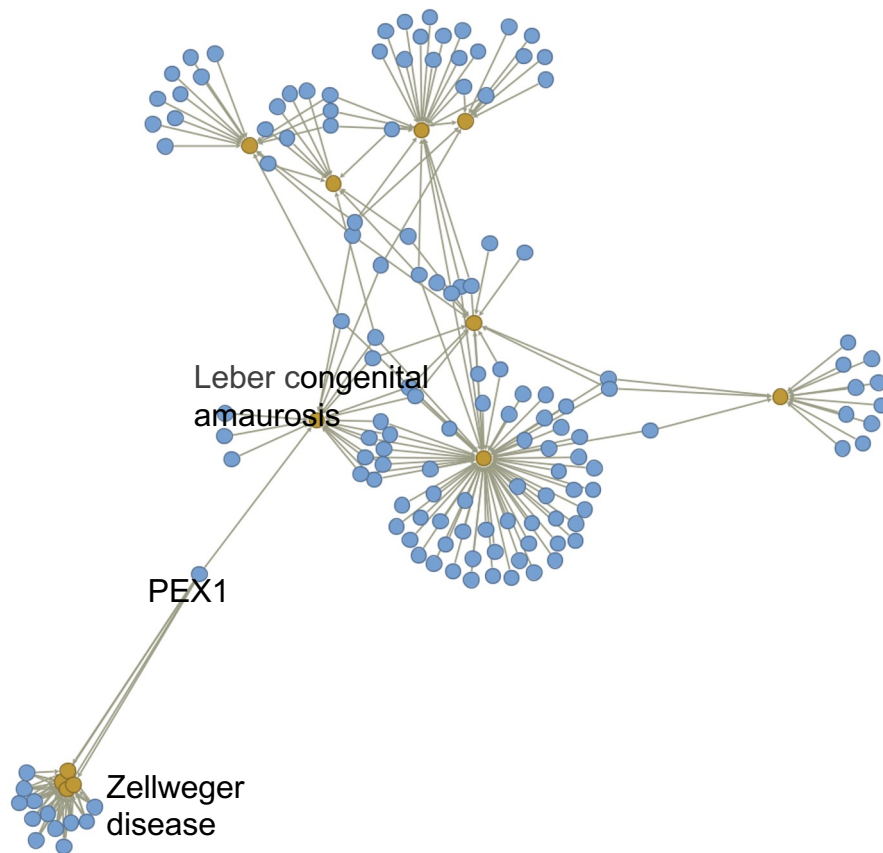
Heterogenous module linking heart diseases to metabolic bone disorder



Heterogenous module linking Down syndrome to seizures

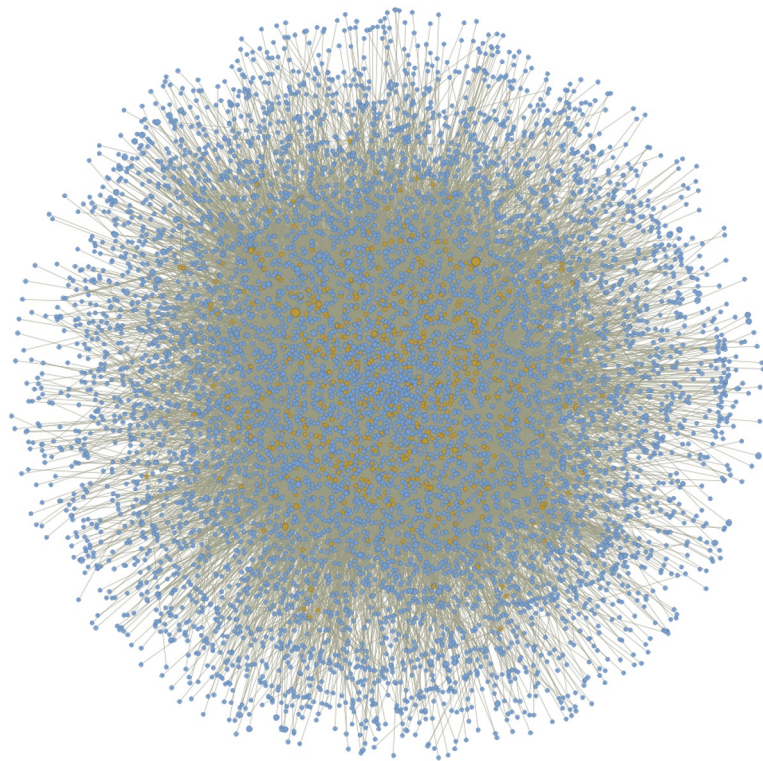


Heterogenous module linking Zellweger to eye disorders



Disease-Gene Networks

- Heart disease linked to MBD by **megalyn**
- Down syndrome linked to seizures by **DYRK1A**
- Zellweger linked to blindness by **PEX1**



References

- Altuna M, Giménez S, Fortea J. Epilepsy in Down Syndrome: A Highly Prevalent Comorbidity. *J Clin Med*. 2021 Jun 24;10(13):2776. doi: 10.3390/jcm10132776. PMID: 34202784; PMCID: PMC8268854.
- Bauer-Mehren, A., Bundschus, M., Rautschka, M., Mayer, M. A., Sanz, F., and Furlong, L. I. (2011). Gene-disease network analysis reveals functional modules in mendelian, complex and environmental diseases. *PloS one*, 6:6
- Chuang, H. Y., Lee, E., Liu, Y. T., Lee, D., and Ideker, T. (2007). Network-based classification of breast cancer metastasis. *Molecular systems biology*, 3:1
- Elumalai V, Pasrija D. Zellweger Syndrome. [Updated 2023 Feb 15]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK560676/>
- Hu, Z., Yang, K., Hu, Z., Li, M., Wei, H., Tang, Z., and Xu, J. (2021). Determining the association between hypertension and bone metabolism markers in osteoporotic patients. *Medicine*, 100:24
- Koutrouli, M., Karatzas, E., Paez-Espino, D., & Pavlopoulos, G. A. (2020). A guide to conquer the biological network era using graph theory. *Frontiers in bioengineering and biotechnology*, 8, 34.
- Pavlopoulos, G. A., Kontou, P. I., Pavlopoulou, A., Bouyioukos, C., Markou, E., and Bagos, P. G. (2018). Bipartite graphs in systems biology and medicine: a survey of methods and applications. *GigaScience*. 7:4
- Wang, C., Hu, Y. M., He, J. W., Gu, J. M., Zhang, H., Hu, W. W., ... & Zhang, Z. L. (2011). Association between low density lipoprotein receptor-related protein 2 gene polymorphisms and bone mineral density variation in Chinese population. *PloS one*, 6:12

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