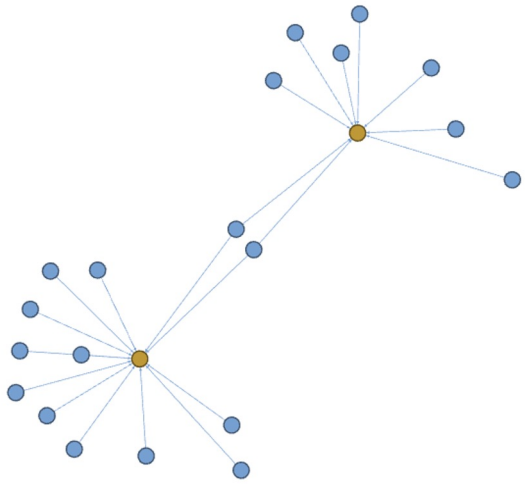
Applications of Network Analysis to Disease-Gene Networks

Participant: Jair Torres
Advisor: Dr. Ayat Hatem

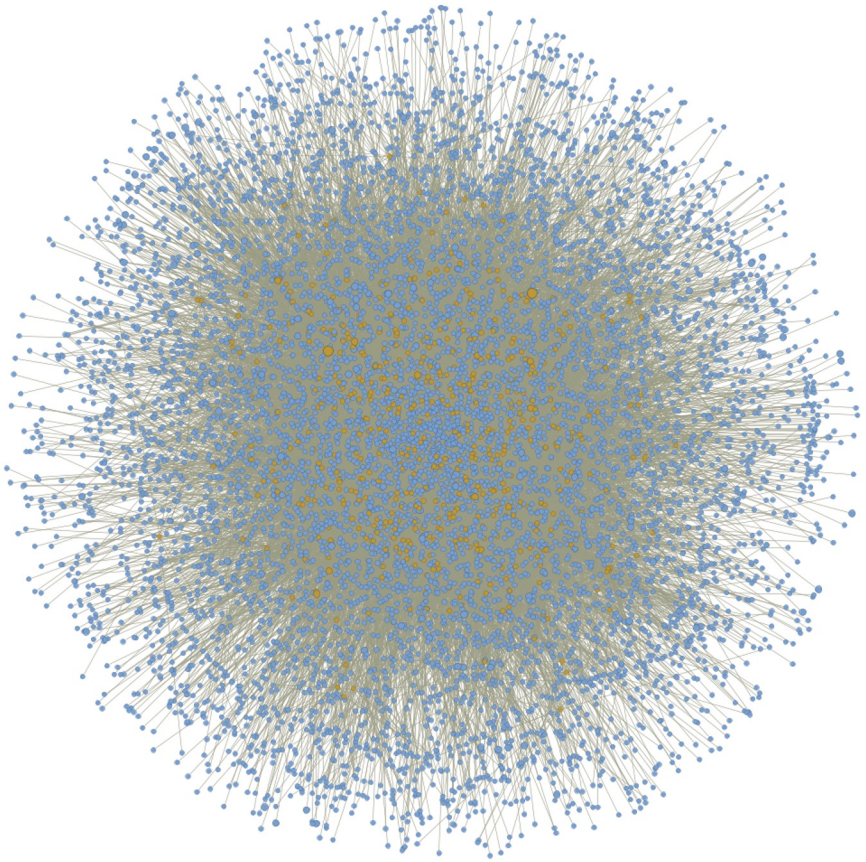
Networks

- **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



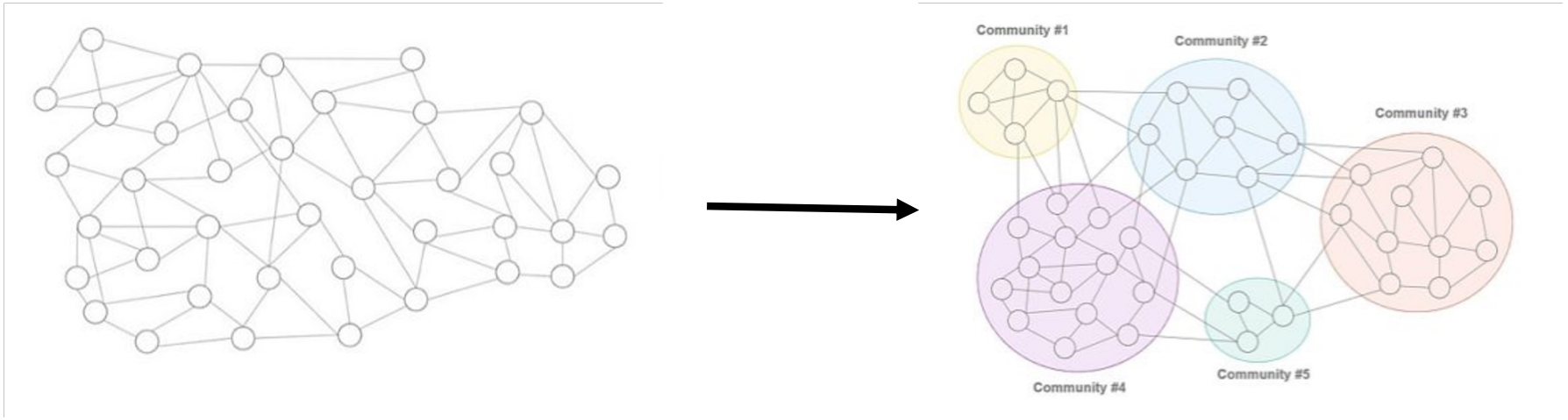
Disease-Gene Networks

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

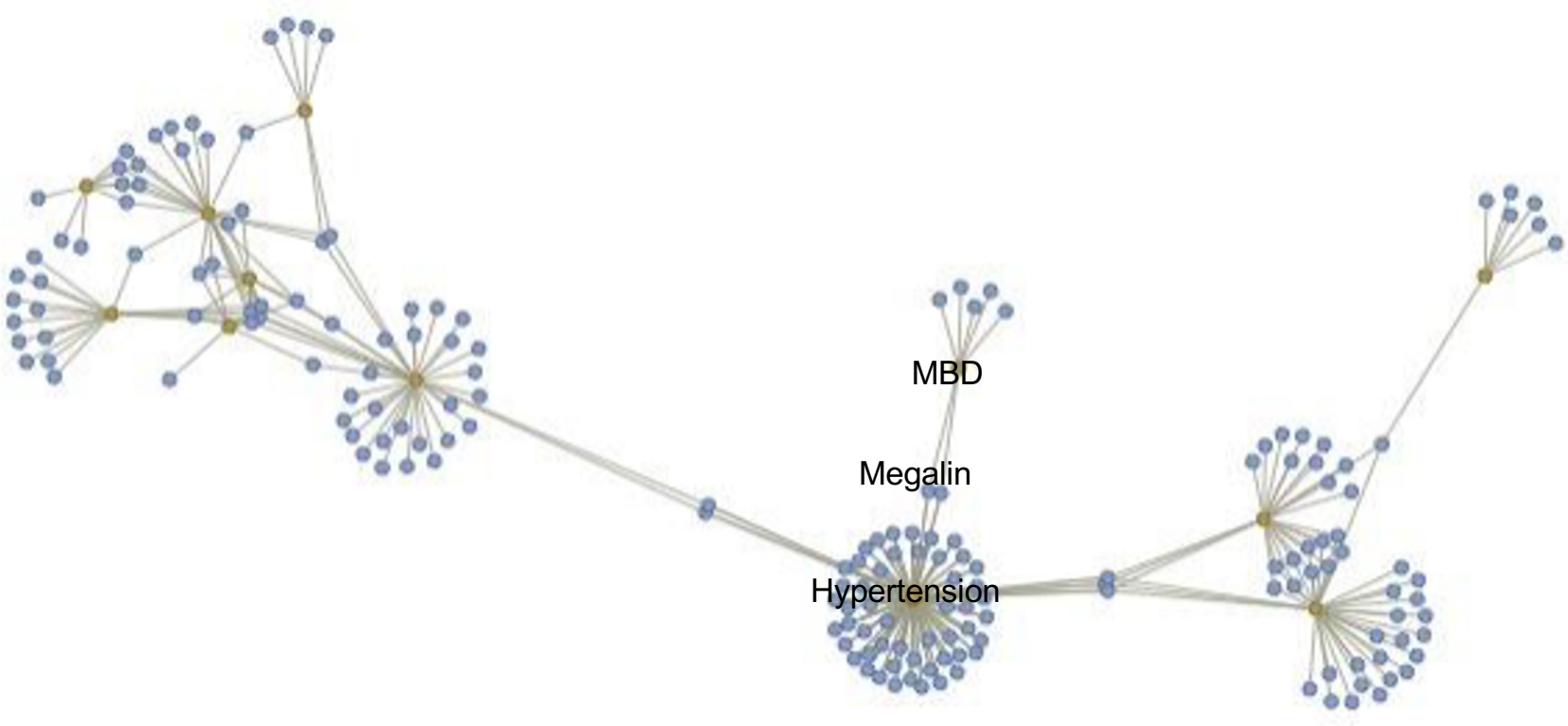


Methods

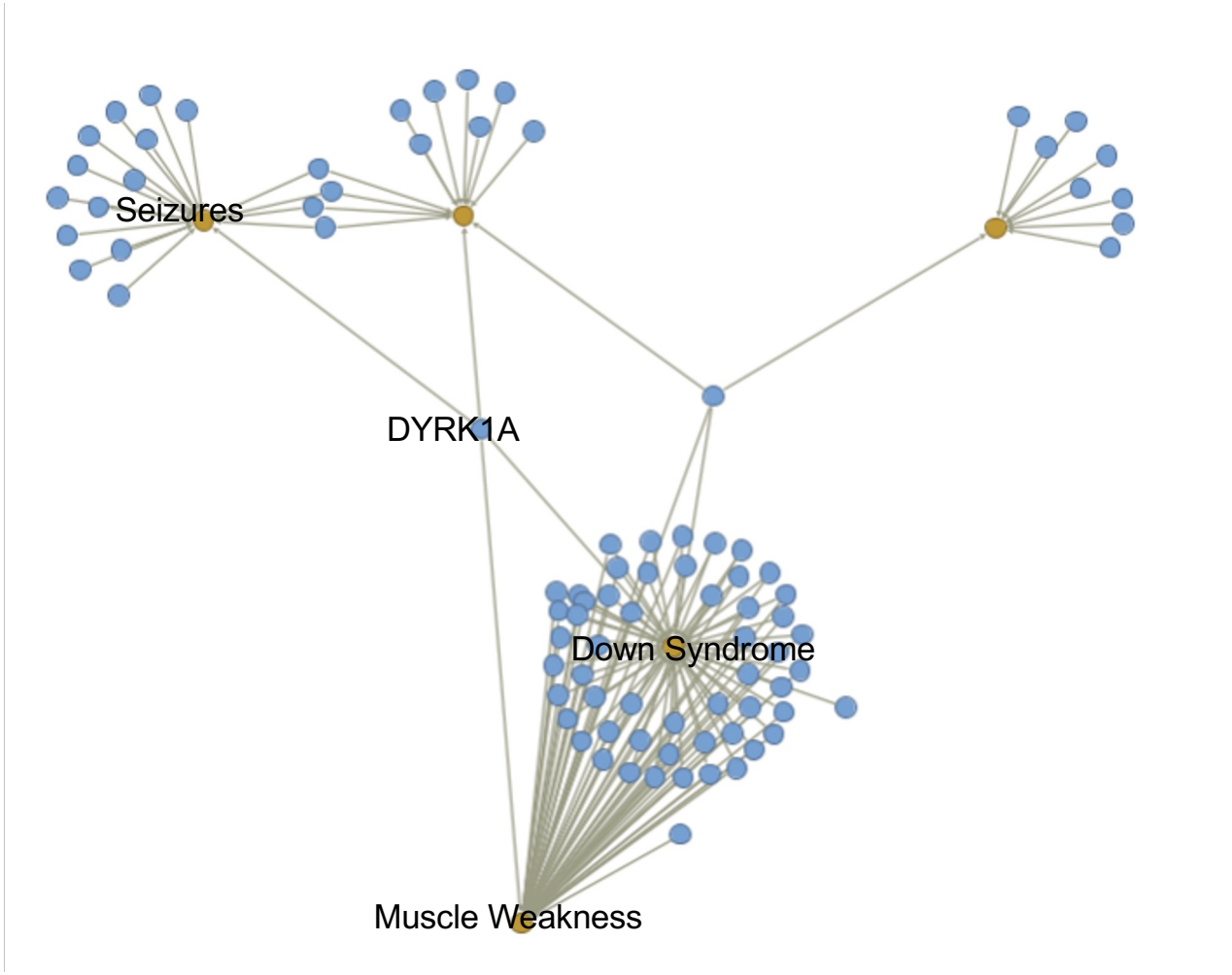
Community detection algorithm: Louvain Method (Gephi)



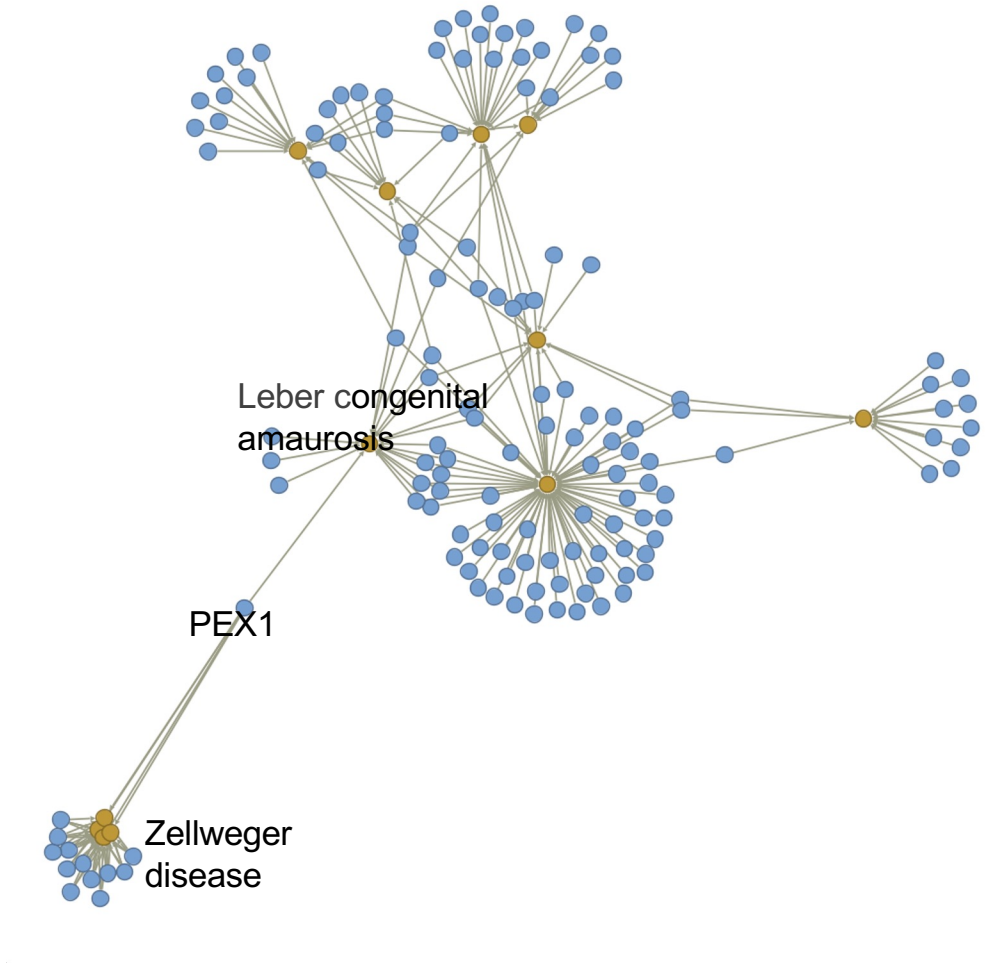
Heterogenous module linking heart diseases to metabolic bone disorder



Heterogenous module linking Down syndrome to seizures

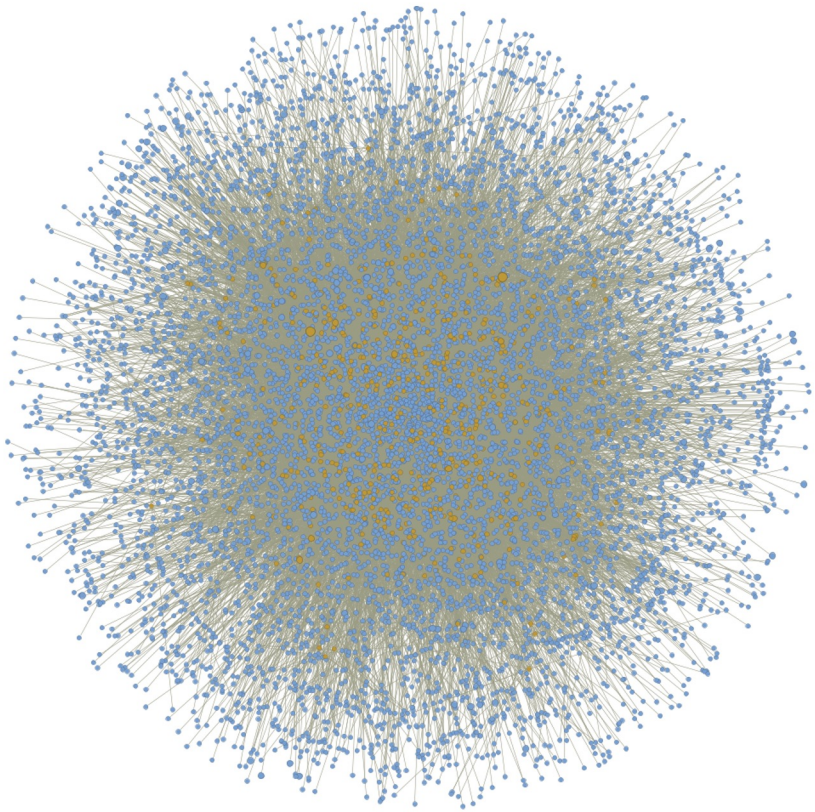


Heterogenous module linking Zellweger to eye disorders



Disease-Gene Networks

- Heart disease linked to MBD by **megalin**
- 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