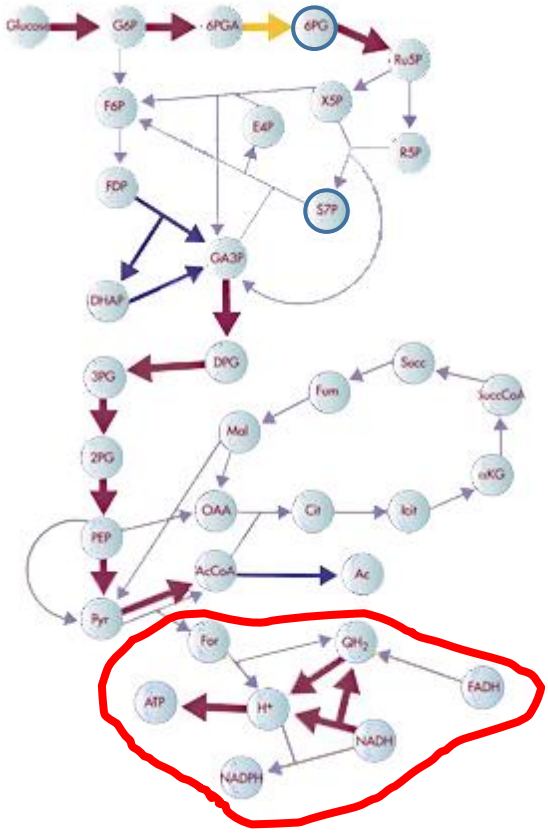
Activity – Scenario 1

1 Consider the following **metabolic network** showing some of the pathways for energy production in *Escherichia coli*, where thick arrows signify the large fluxes:

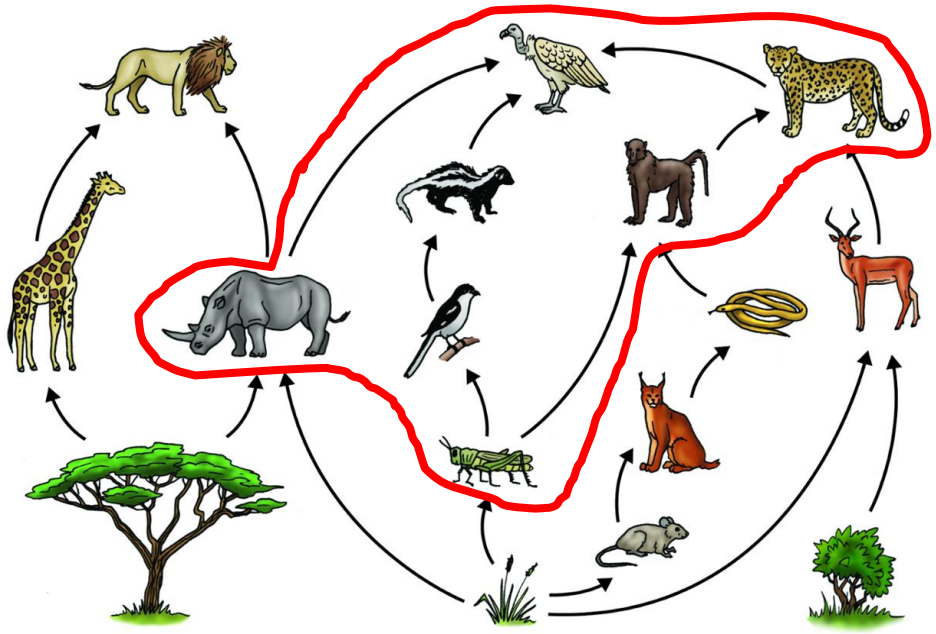


2 Answer the following questions:

- Type of graph: ☐ Undirected ☐ Directed ☐ Weighted
- What do nodes represent? _____
- What do edges represent? _____
- Build an adjacency matrix for the highlighted part of the network
- Find the node with the highest degree within the highlighted part of the network: _____
- Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly: _____
- Shortest path between *6PG* and *S7P* (highlighted): _____
- Analyze betweenness centrality for all the nodes in the shortest paths between *6PG* and *S7P* and identify the most central node accordingly: _____
- Perform a (visual) transitivity analysis in the whole network and identify hubs: _____

Activity – Scenario 2

1 Consider the following **ecological network** showing a representation of the savanna food web:

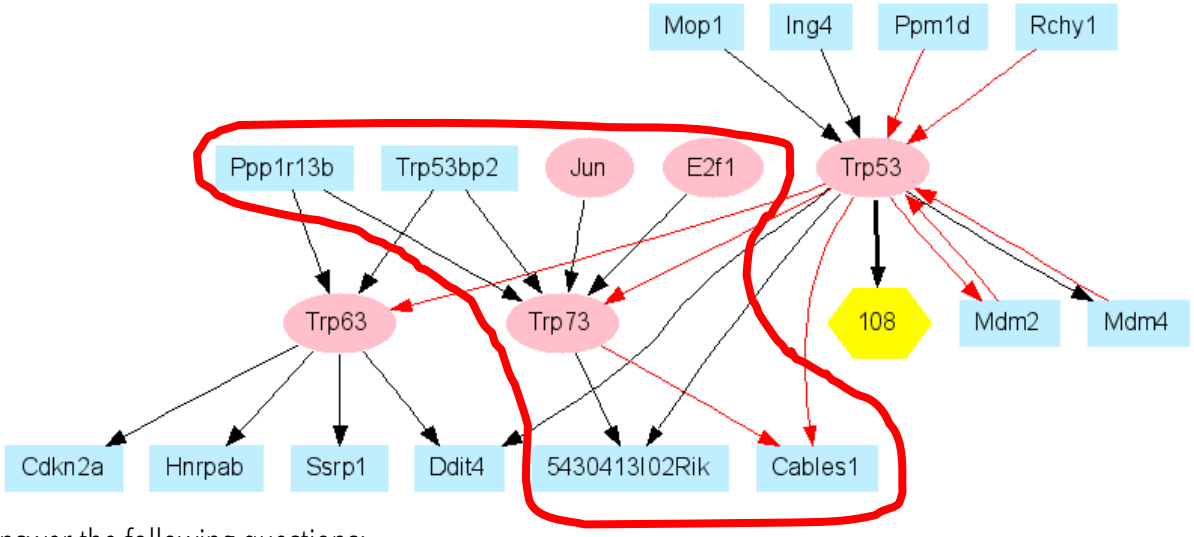


2 Answer the following questions:

- Type of graph: ☐ Undirected ☐ Directed ☐ Weighted
- What do nodes represent? _____
- What do edges represent? _____
- Build an adjacency matrix for the highlighted part of the network
- Find the node with the highest degree within the highlighted part of the network: _____
- Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly: _____
- Shortest path between *grass* and *leopard*: _____
- Analyze betweenness centrality for all the nodes in the shortest paths between *grass* and *leopard* and identify the most central node accordingly: _____
- Perform a (visual) transitivity analysis in the whole network and identify hubs: _____

Activity – Scenario 3

1 Consider the following **gene regulatory network** of the transcription factor family p53 in mouse, where pink ellipses are transcription factors, blue boxes are genes, yellow hexagons are clustered genes (the number of genes is shown inside), and red lines indicate known protein-DNA binding:

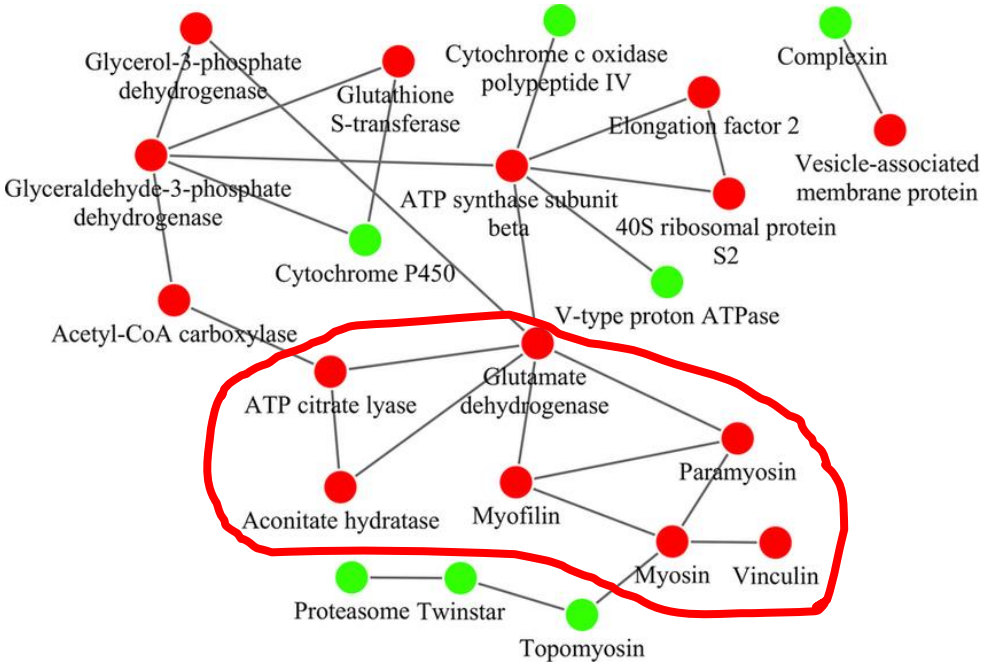


2 Answer the following questions:

- Type of graph: ☐ Undirected ☐ Directed ☐ Weighted
- What do nodes represent? _____
- What do edges represent? _____
- Build an adjacency matrix for the highlighted part of the network
- Find the node with the highest degree within the highlighted part of the network: _____
- Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly: _____
- Shortest path between *Ing4* and *Ddit4*: _____
- Analyze betweenness centrality for all the nodes in the shortest paths between *Ing4* and *Ddit4* and identify the most central node accordingly: _____
- Perform a (visual) transitivity analysis in the whole network and identify hubs: _____

Activity – Scenario 4

1 Consider the following **protein-protein interaction network** involved in the transmission mechanism of Barley yellow dwarf virus-GPV by its insect vector *Rhopalosiphum padi*:

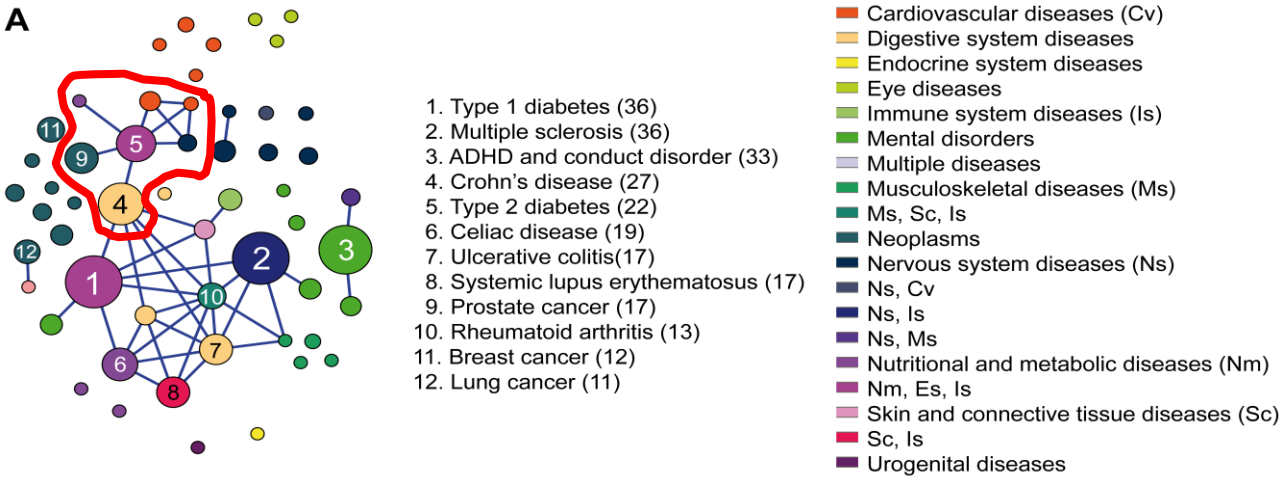


2 Answer the following questions:

- Type of graph: ☐ Undirected ☐ Directed ☐ Weighted
- What do nodes represent? _____
- What do edges represent? _____
- Build an adjacency matrix for the highlighted part of the network
- Find the node with the highest degree within the highlighted part of the network: _____
- Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly: _____
- Shortest path between *Cytochrome P450* and *Topomyosin*: _____
- Analyze betweenness centrality for all the nodes in the shortest paths between *Cytochrome P450* and *Topomyosin* and identify the most central node accordingly: _____
- Perform a (visual) transitivity analysis in the whole network and identify hubs: _____

Activity – Scenario 5

1 Consider the following **complex diseases network** in humans, where each node is a complex disease studied in GWAS, with the color of nodes corresponding to disease class as identified using MeSH, node size referring to the number of associated genes identified, and links representing sharing of disease genes:

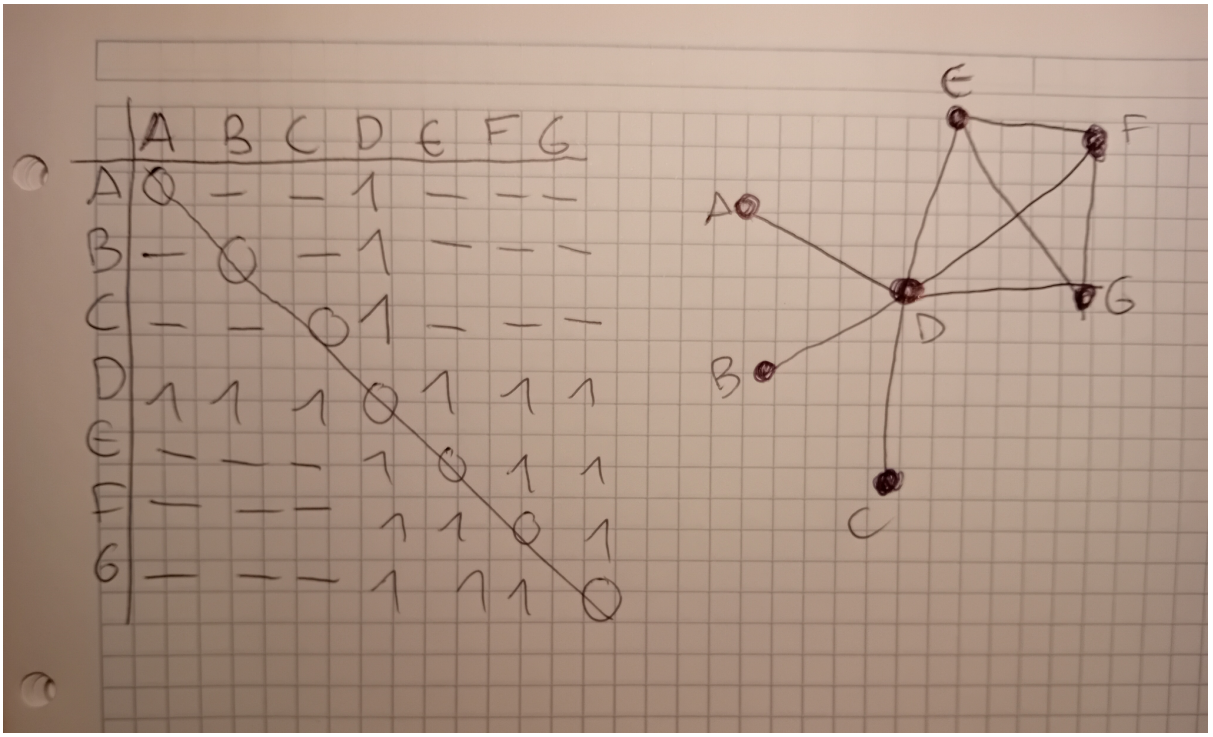


2 Answer the following questions:

- Type of graph: ☐ Undirected ☐ Directed ☐ Weighted
- What do nodes represent? _____
- What do edges represent? _____
- Build an adjacency matrix for the highlighted part of the network
- Find the node with the highest degree within the highlighted part of the network: _____
- Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly: _____
- Shortest path between *Multiple sclerosis* and *Type 2 diabetes*: _____
- Analyze betweenness centrality for all the nodes in the shortest paths between *Multiple sclerosis* and *Type 2 diabetes* and identify the most central node accordingly: _____
- Perform a (visual) transitivity analysis in the whole network and identify hubs: _____

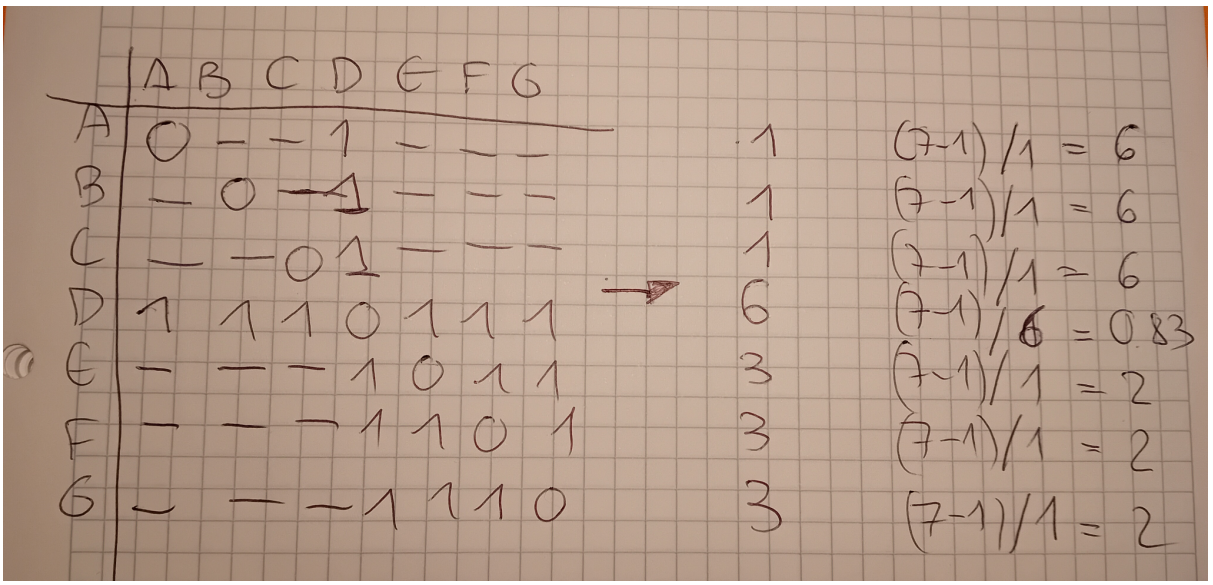
SESSION 5

2 Answer the following questions:
• Type of graph: **Undirected** Directed Weighted
• What do nodes represent? A complex disease studied in GWAS
• What do edges represent? The sharing of disease genes
• Build an adjacency matrix for the highlighted part of the network



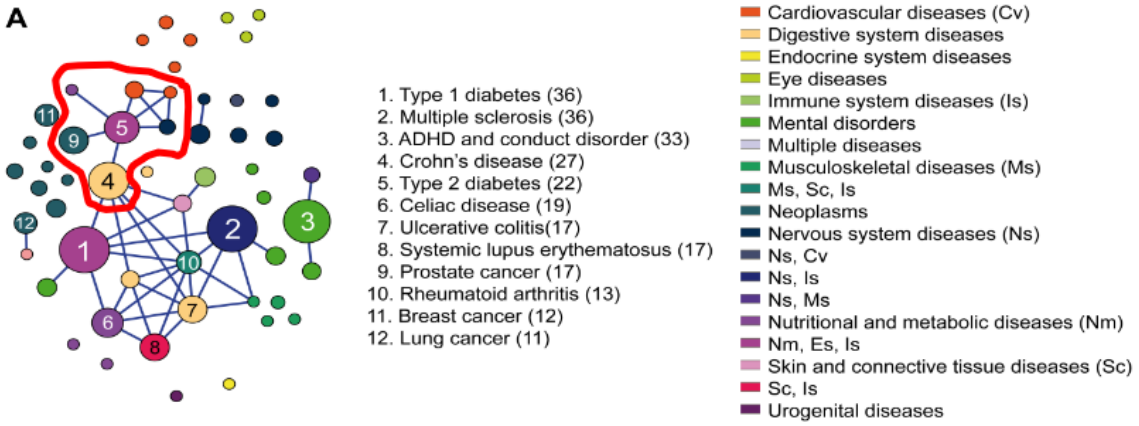
• Find the node with the highest degree within the highlighted part of the network:
Node 10: Rheumatoid arthritis
• Analyze closeness centrality within the highlighted part of the network and identify the most central node accordingly:

-Closeness centrality assesses the proximity of a node to all other nodes by considering the length of the shortest path, so:



Out of all 7 nodes, the most central one is the node D or node 5 if we use the nomenclature given by the image

• Shortest path between Multiple sclerosis and Type 2 diabetes: { “2”, “1”, “4”, “5” }
• Analyze betweenness centrality for all the nodes in the shortest paths between Multiple sclerosis and Type 2 diabetes and identify the most central node accordingly:
The values associated for those diseases are 2 and 5 meaning that we need to analyze the between centrality of 5 and 2. Being only one shortest path (2-1-4-5), the betweenness centrality corresponds to 1.
• Perform a (visual) transitivity analysis in the whole network and identify hubs:



To be able to perform a transitivity analysis in the network, we highlighted in yellow the nodes with higher connectivity and blue the lower ones. The nodes that are by themselves we didn’t highlight them. Then, by observing the nodes that have a number on them, we can say that our complex disease network is high transitivity

because it contains groups of nodes that are densely connected internally. Especially between the node with the numbers 4,2,1,10,7,8,6