Network Topology, Centrality & Community Detection — Hands-on

Learn how to treat biological interaction maps as graphs and extract actionable structure from them. This module covers network representations, centrality metrics, paths and robustness, as well as community detection so that you can identify hubs, bottlenecks and disease modules in PPI, co-expression and multi-omics networks.

Network Topology, Centrality & Community Detection

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Session Index

Session 1

Fee: Rs 8800 Apply Now

Graphs & Biological Network Representations

Graph theory basics and network types in biology

nodes, edges, degree distributions | **directed / undirected / weighted** | **bipartite and multilayer networks**

PPI, co-expression and pathway networks as graphs

sources: STRING, BioGRID, Reactome | **thresholding &**

filtering edges | projecting omics onto networks

File formats and core toolchain for network analysis

edge lists / adjacency matrices | GraphML / GML / SIF | Cytoscape, igraph, NetworkX

Session 2

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Centrality Measures, Paths & Robustness

Centrality metrics and biological interpretation

degree, betweenness, closeness | eigenvector / PageRank | hubs, bottlenecks, articulation points

Paths, distances and communication efficiency

shortest paths and geodesic distances | diameter, average path length | efficiency and small world effects

Network robustness and vulnerability analyses

random vs targeted node removal | percolation style breakdown | implications for drug targets

Session 3

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Community Detection & Network Modules

Modularity, clustering and community detection algorithms

Girvan–Newman edge betweenness | Louvain / Leiden methods | spectral clustering intuition

Overlapping communities and multi-layer networks

link communities & fuzzy clusters | multi-omics / multi-layer modules | resolution parameter effects

Biological interpretation of network modules

GO / pathway enrichment of clusters **protein complexes and pathways** **disease modules and comorbidities**

Session 4

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Mini Capstone: Disease / Function Modules from Omics

Build and annotate a biological network from public data

Theory + Practical

Run centrality and community detection on an omics integrated network

prioritise hubs and bottlenecks **identify enriched modules** **link to disease or phenotype**

Deliverables: Cytoscape session, result tables & brief report

network files & layouts **CSV of node metrics & modules** **methods & interpretation summary**