

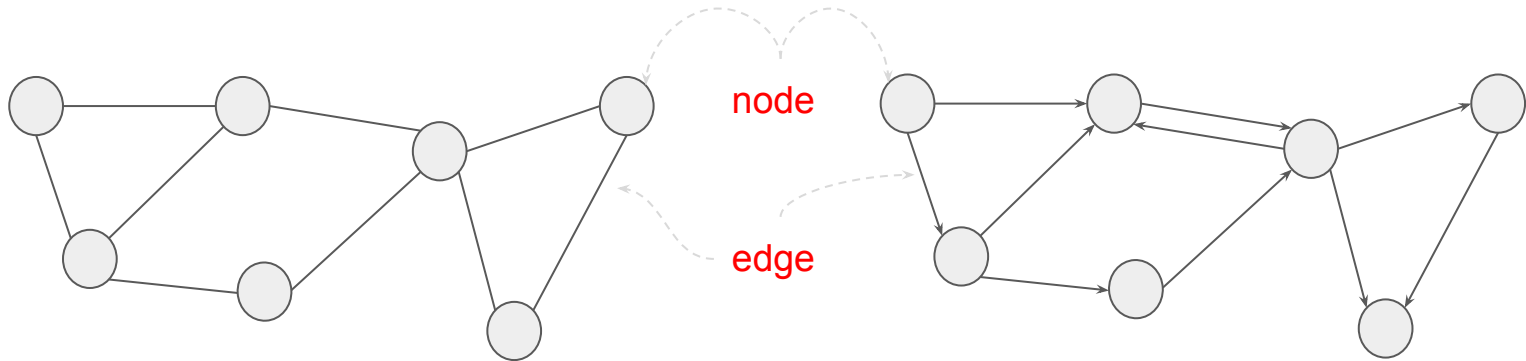
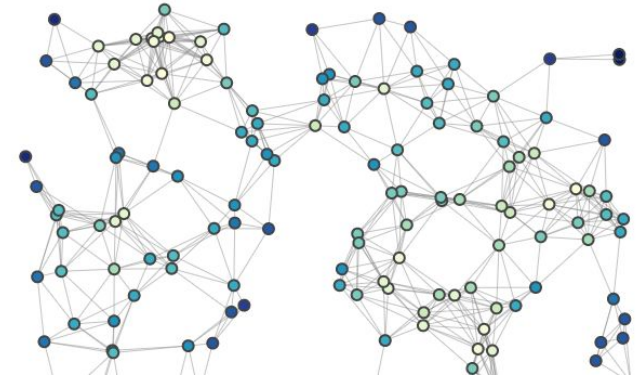


Kia Cooperative Systems Summer High School Outreach Module 2

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What is graph and why graphs are important in engineering and computer science?

Wikipedia's definition: In **mathematics**, **graph theory** is the study of **graphs**, which are mathematical structures used to model pairwise relations between objects. A graph in this context is made up of **vertices** (also called *nodes* or *points*) which are connected by **edges** (also called *links* or *lines*). A distinction is made between **undirected graphs**, where edges link two vertices symmetrically, and **directed graphs**, where edges link two vertices asymmetrically.

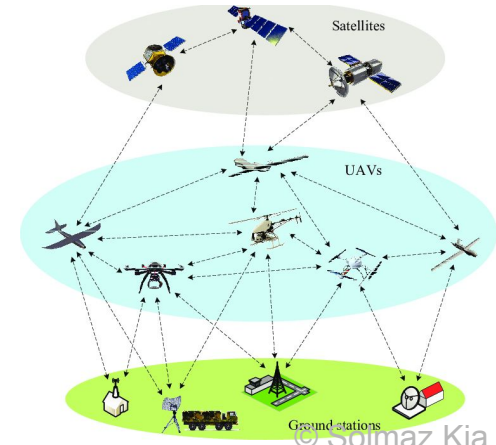
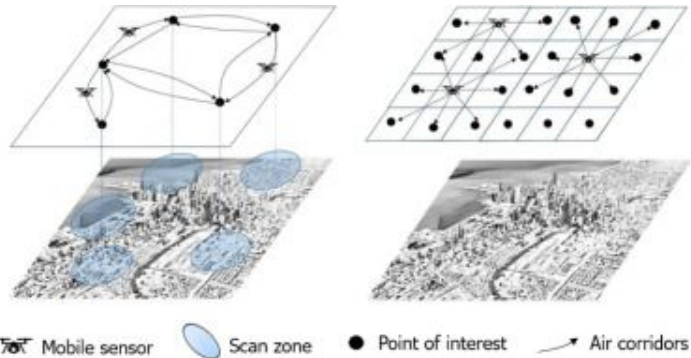
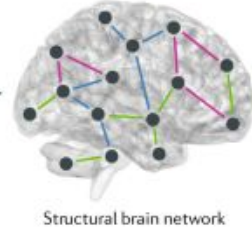
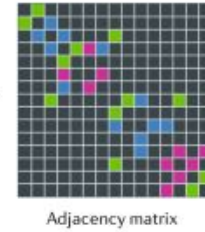
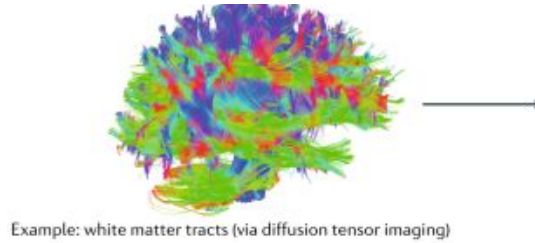
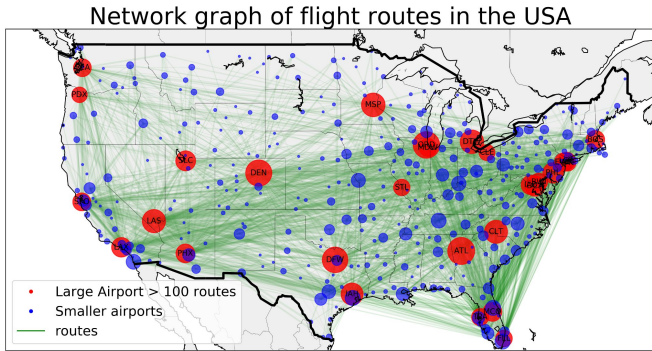


Undirected graph (think of Facebook)

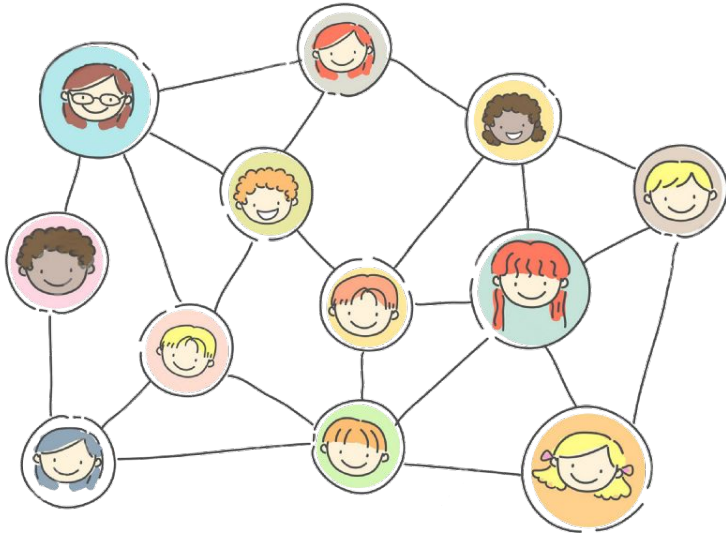
Directed graph (think of Twitter)

What is graph and why graphs are important in engineering and computer science?

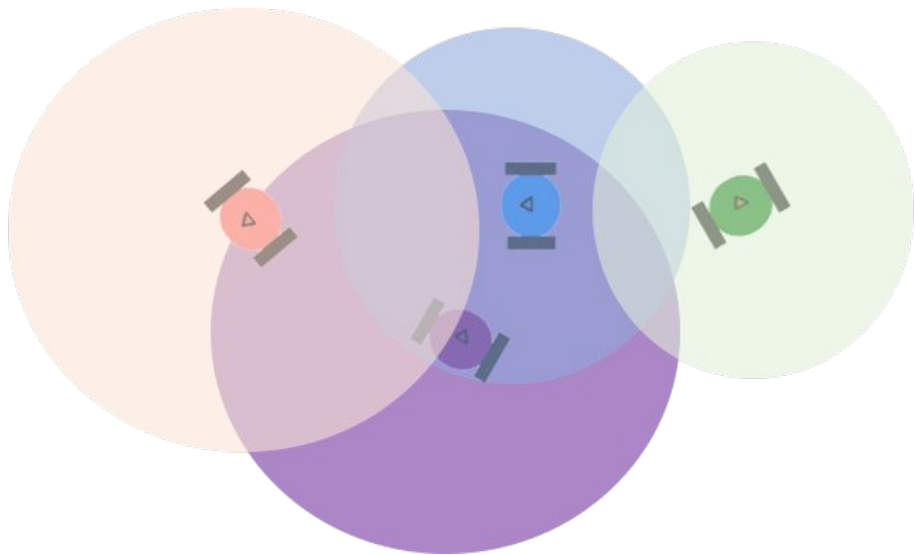
Application: Graphs are used to model **pairwise relations** between objects. Graphs provide natural abstractions for how information is shared between nodes (agents) in a network.



How to describe a graph to a computer

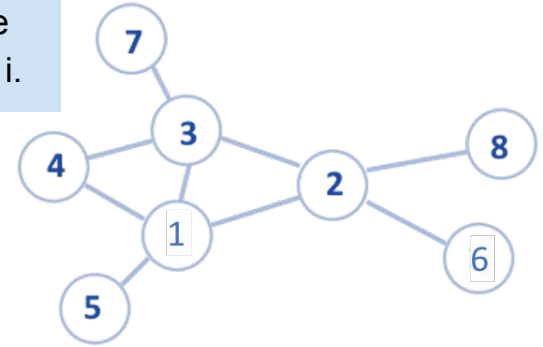


How to describe a graph to a computer



How to describe a graph to a computer

Representation #1 (Adjacency Table/List): a *lookup table*, that is, an array whose elements are lists of varying length: the i -th entry is a list of all neighbors of node i .

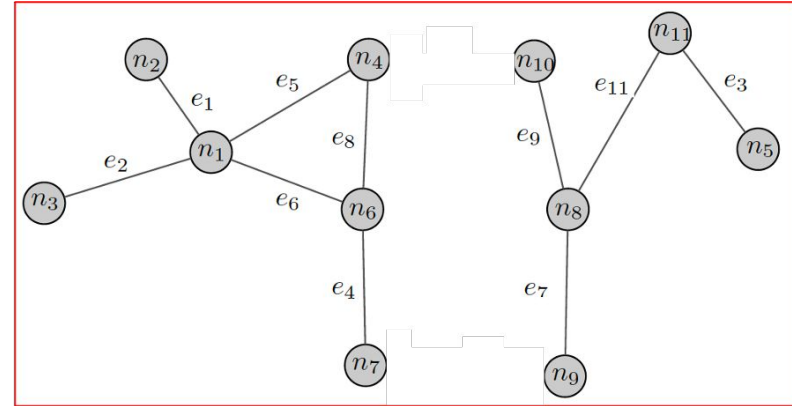


Representation #2 (Adjacency Matrix): a symmetric matrix whose (i,j) entry is equal to 1 if the graph contains the edge $\{i,j\}$ and is equal to 0 otherwise.

Representation #3 (Edge List): an array, where each entry is an edge in the graph. This representation of edges is called an *edge list*.

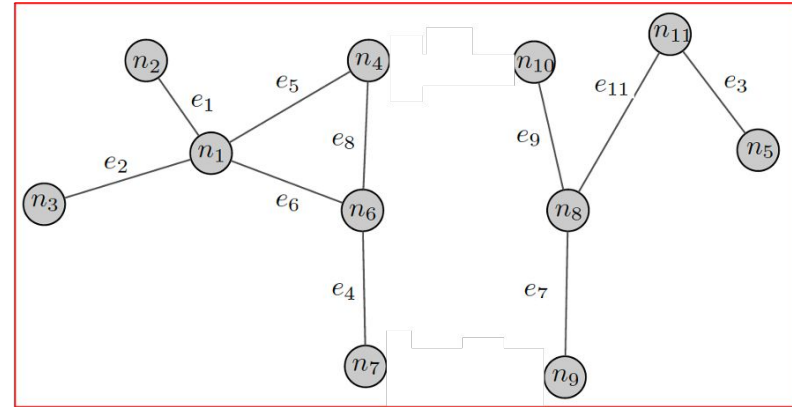
Graph terminologies

- A **path** is an ordered sequence of nodes such that from each node there is an edge to the next node in the sequence.
- The **length of a path** is the number of edges in the path from **start node** to **end node**.
- Two nodes in a graph are **path-connected** if there is a path between them.
- A graph is **connected** if every two nodes are path-connected.
- If a graph is not connected, it is said to have multiple **connected components**. More precisely, a connected component is a subgraph in which (1) any two nodes are connected to each other and (2) all nodes outside the subgraph are not connected to the subgraph.



Graph terminologies

- A **shortest path between two nodes** is a path of minimum length between the two nodes. Note that a shortest path does not need to be unique.
- The **distance between two nodes** is the length of a shortest path connecting them, i.e., the minimum number of edges required to go from one node to the other.
- A **cycle** is a path with at least three distinct nodes and with no repeating nodes, except for the first and last node which are the same. A graph that contains no cycles and is connected is called a **tree**.



Study links

<https://www.geeksforgeeks.org/comparison-between-adjacency-list-and-adjacency-matrix-representation-of-graph/>

<https://www.khanacademy.org/computing/computer-science/algorithms/graph-representation/a/representing-graphs>

<https://www.khanacademy.org/computing/computer-science/algorithms/graph-representation/a/describing-graphs>

<http://jd.hamkins.org/math-for-eight-year-olds/?fbclid=IwAR1PPFbrCzDO1nNSkzilJfoyfEAT6CEpsJowcmmQIDzXP6Bh-gymzPhboDI>

<https://courses.lumenlearning.com/wmopen-mathforliberalarts/chapter/introduction-graph-theory/>

<https://www.youtube.com/watch?v=82zIRaRUsaY>

<https://www.youtube.com/watch?v=eQA-m22wjTQ>

<https://www.analyticsvidhya.com/blog/2020/03/using-graphs-to-identify-social-media-influencers/>

<https://towardsdatascience.com/graph-theory-and-deep-learning-know-hows-6556b0e9891b>

<https://blogs.cornell.edu/info2040/2014/09/15/using-fundamental-graph-theory-analysis-to-deconstruct-the-human-brain-as-a-network/>

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