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.
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
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**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.
• 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.
• 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://jdh.hamkins.org/math-for-eight-year-olds/?fbclid=IwAR1PPFbrCzDO1nNSkzilJfoyfEAT6CEp5owcmmQ1DzXP6Bh-gymzPhboD

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

https://www.youtube.com/watch?v=82zlRaRUsaY

https://www.youtube.com/watch?v=eQA-m22wiTQ

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
