

Introduction to Graph Theory

Why Graphs?

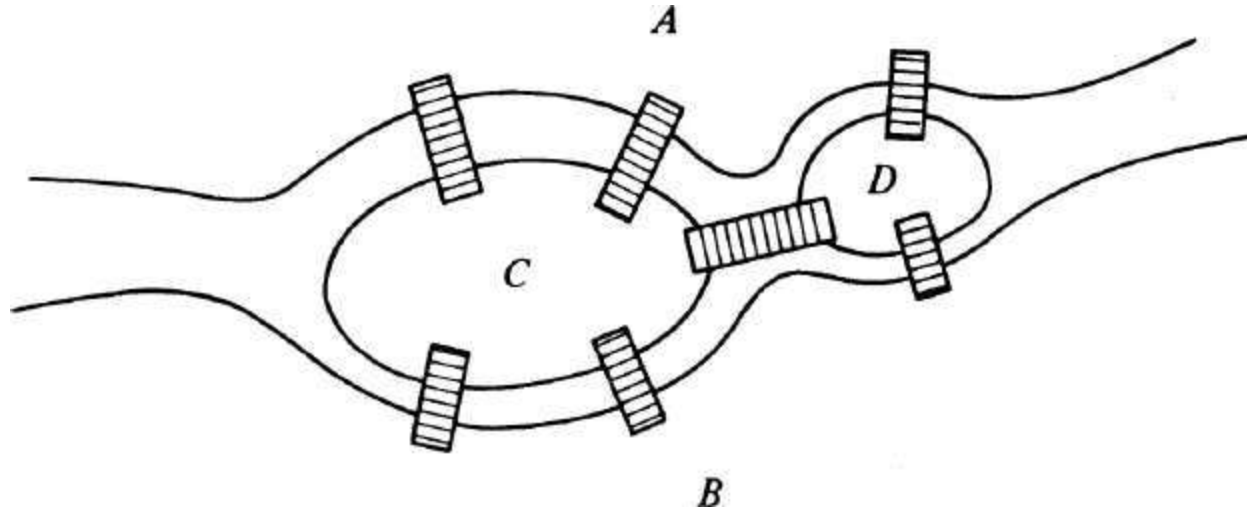
By

Hizbullah Khattak

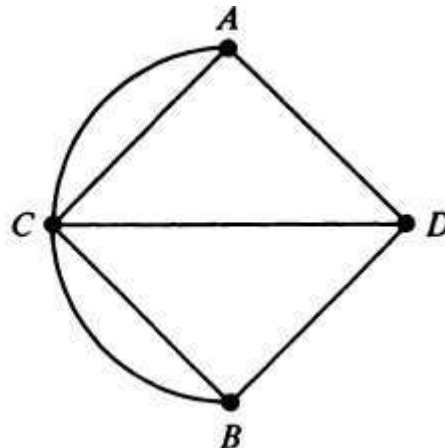
Graph Theory

- Königsberg Bridge Problem
 - Leonhard Euler (1707-1983) in 1736

Seven Bridges of Königsberg



Königsberg bridge problem



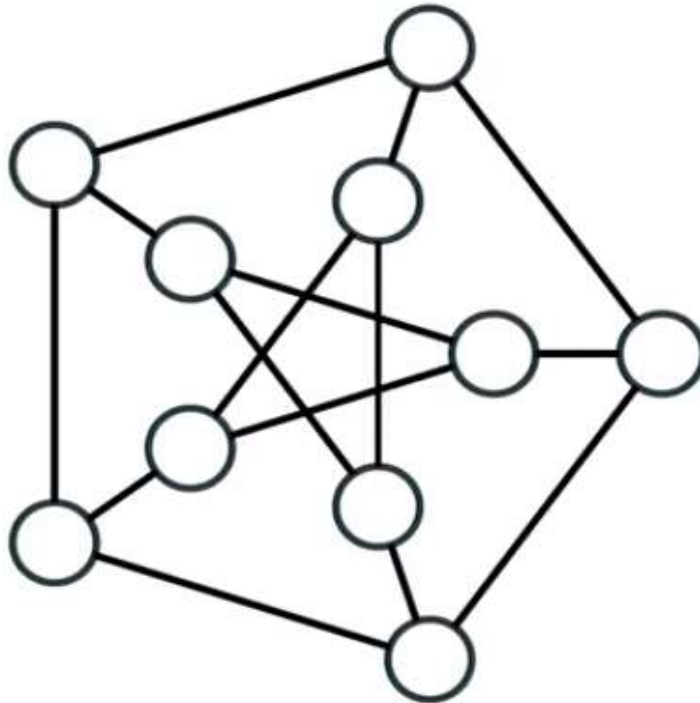
Graph of Königsberg bridge problem.

Outlines

- What is a Graph?
- Graph Examples
- Graph Applications

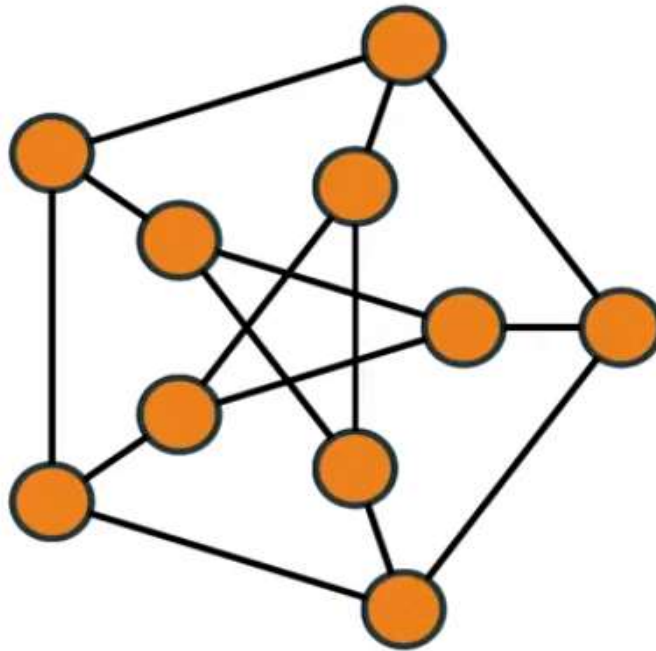
Graph

- A set of **Objects**.
- **Relations** between pairs of objects.



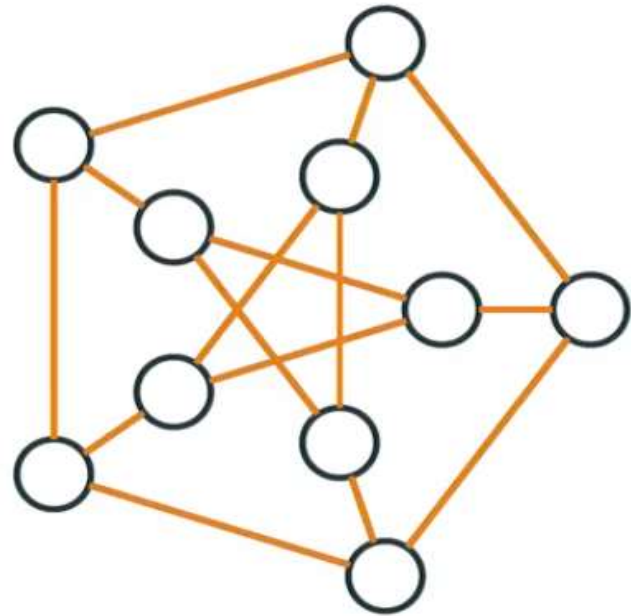
Definition

- A **Graph** $G = (V, E)$
- A set V of **Vertices/Nodes**



Definition....

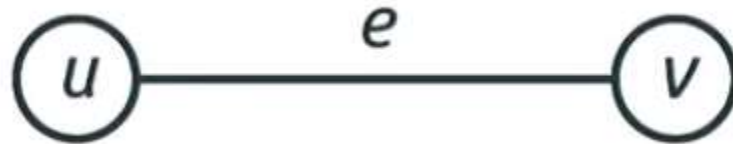
- A **Graph** $G = (V, E)$
- A set V of **Vertices/Nodes**
- A set E of **Edges**



Vocabulary



- We can name individual vertices and edges



- e **Connects** u and v .
- u and v are **End Points** of e

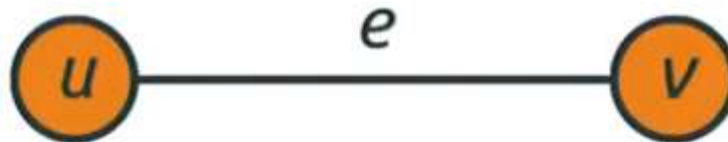


Vocabulary...

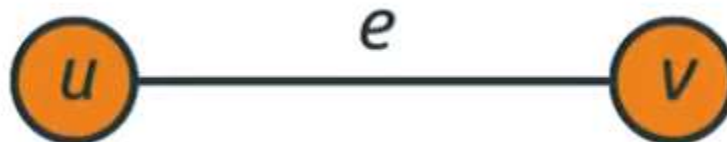
- u and e are Incident



- u and v are Adjacent



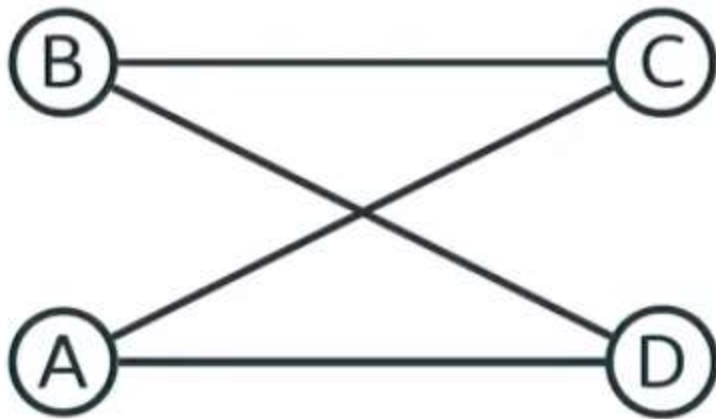
- u and v are Neighbors



Drawing a Graph

Objects: {A, B, C, D}

Relations: {{A, C},{D, A},{B, D},{C, B}}



Directed Graph



- It is often convenient to consider **Directed Edges (Arcs)**.
- They describe **asymmetric** relations.
- There is a flight from A to B, but not the other way around.
- Such a graph is called **Directed**

Drawing a Directed Graph

Objects: {A, B, C, D}

Relations: {(A, C), (D, A), (B, D), (C, B)}



Drawing a Directed Graph...

Objects: {A, B, C, D}

Relations: {(A, C), (D, A), (B, D), (C, B)}



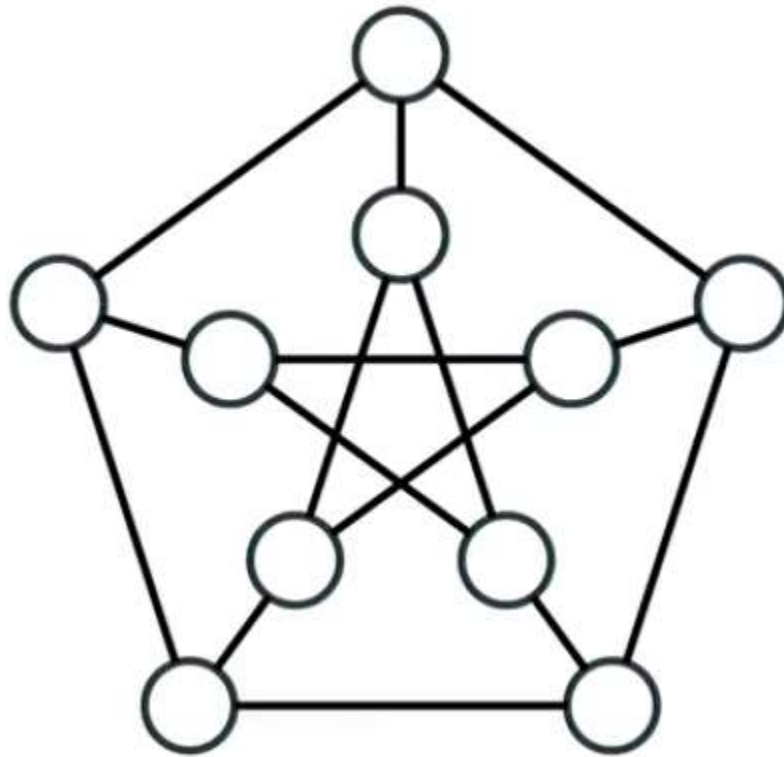
Drawing a Directed Graph...

Objects: {A, B, C, D}

Relations: $\{\{C, A\}, \{D, A\}, \{B, D\}, \{C, B\}\}$

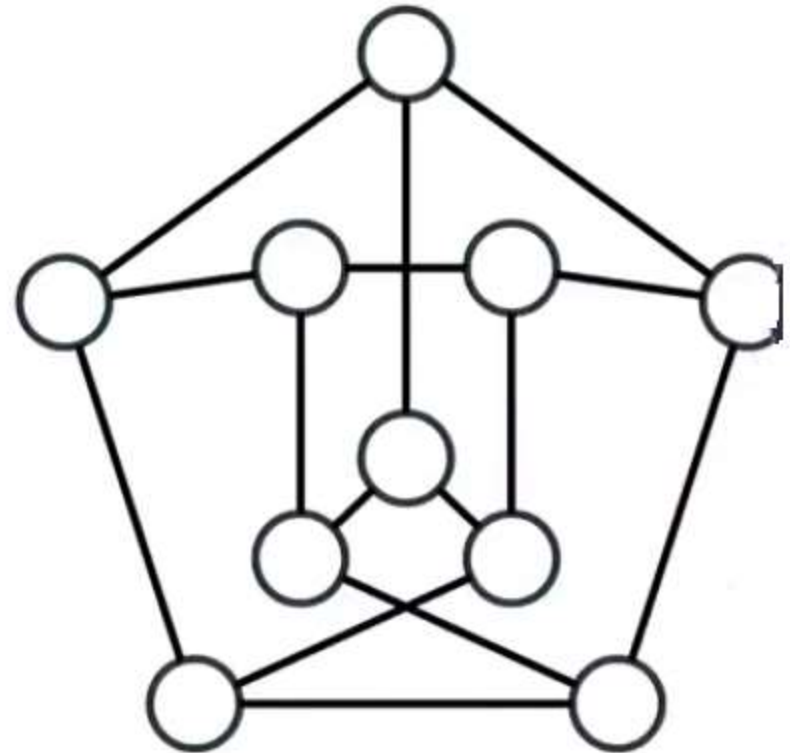
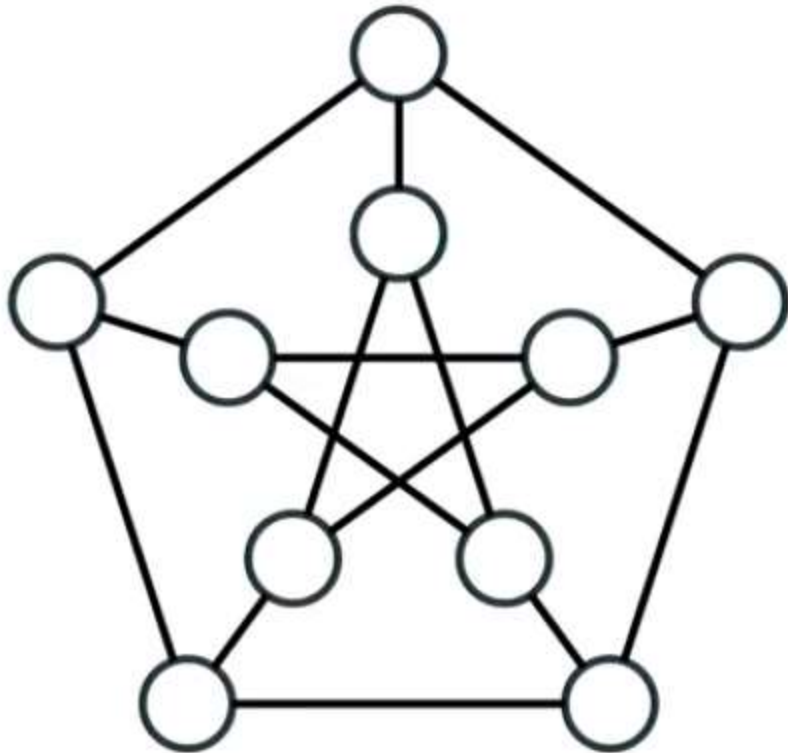


Many Ways to Draw a Graph



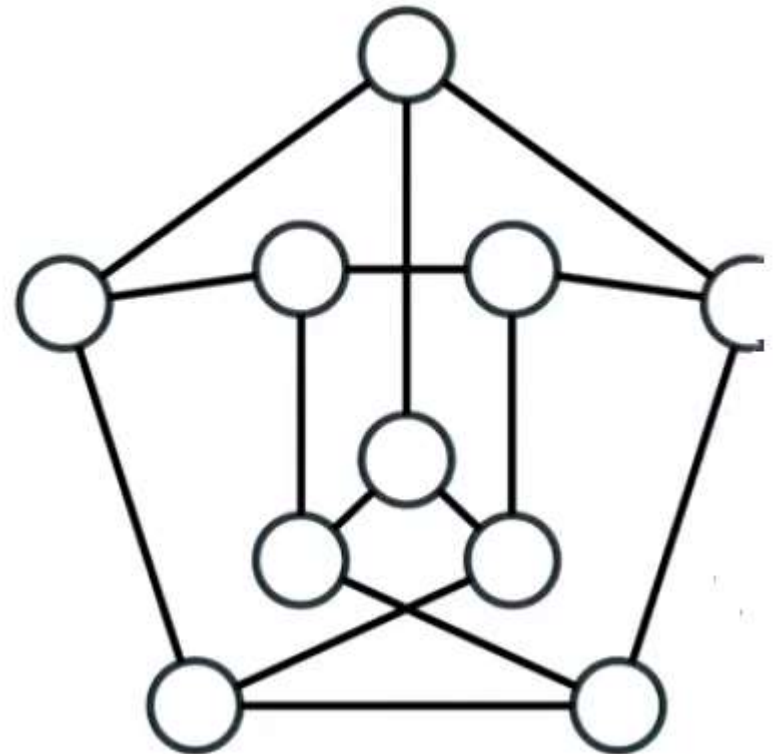
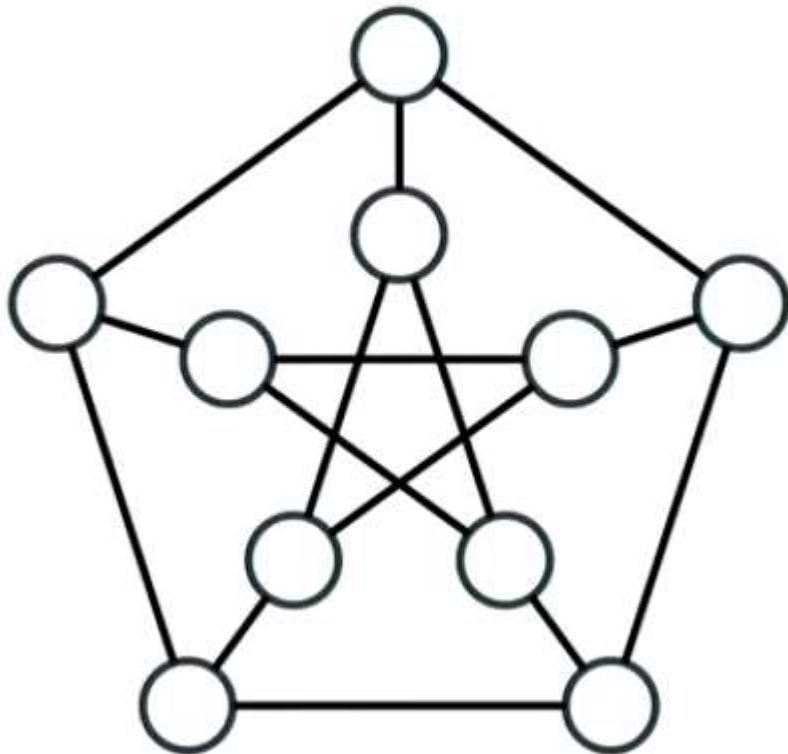
Many Ways to Draw a Graph..

- Are these graphs the same?



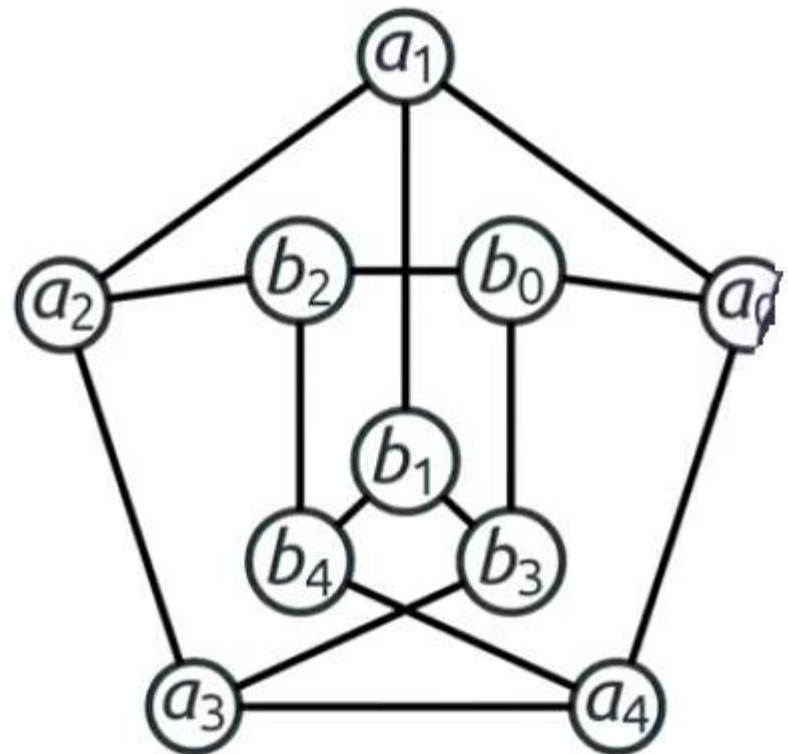
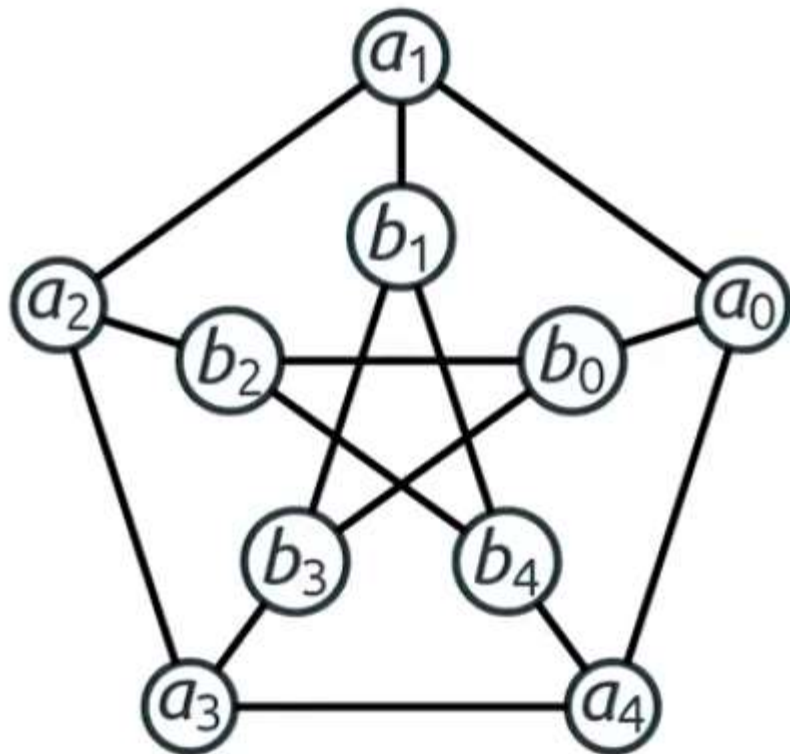
Many Ways to Draw a Graph..

- 10 vertices and 15 edges?



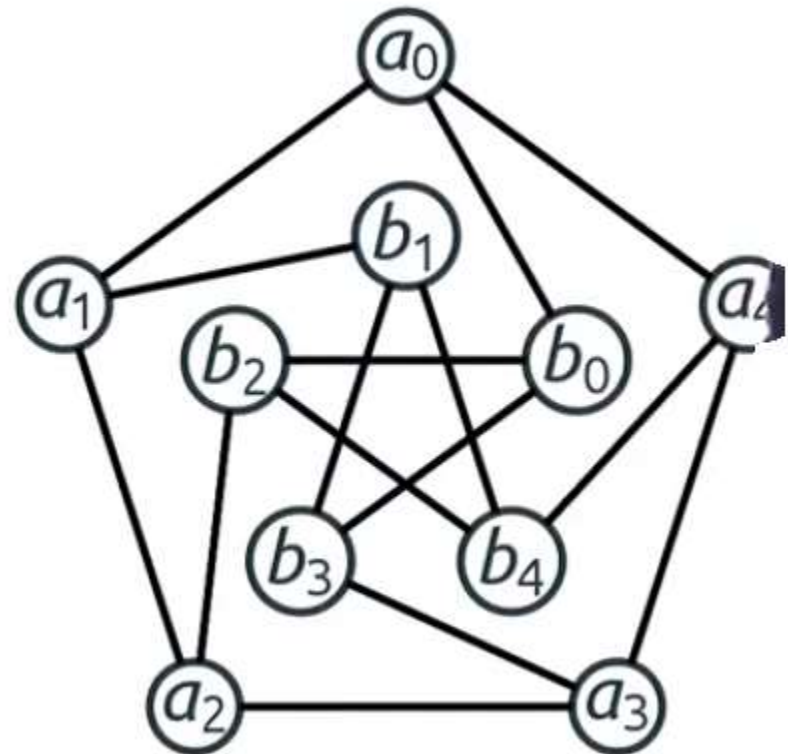
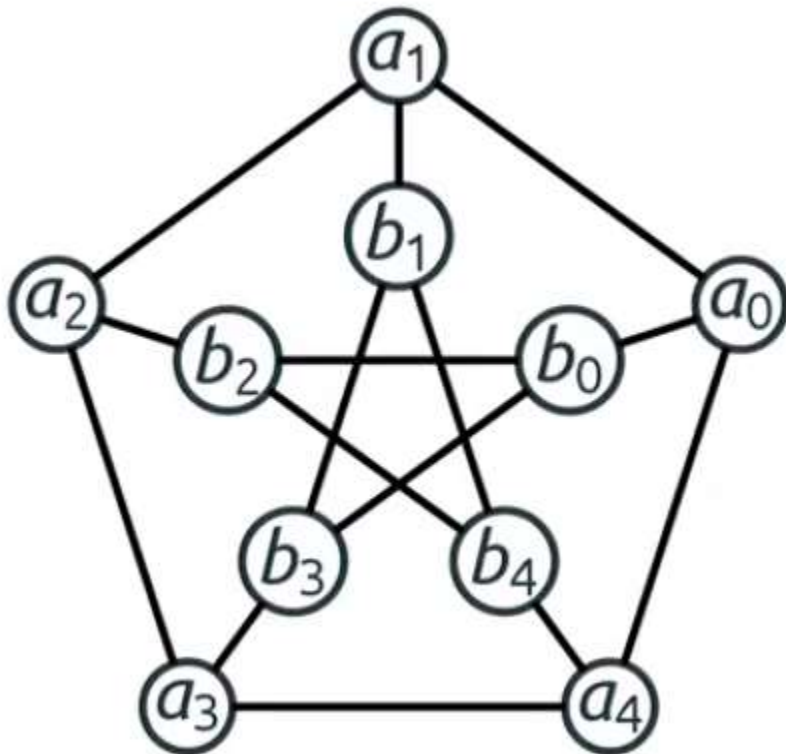
Many Ways to Draw a Graph..

- Are these graphs the same?



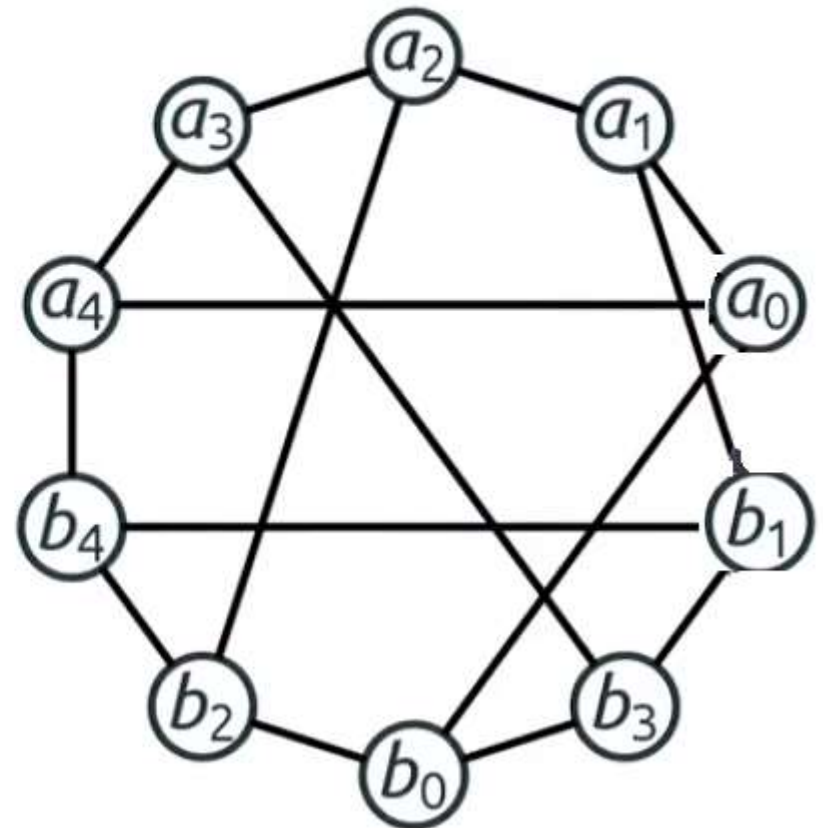
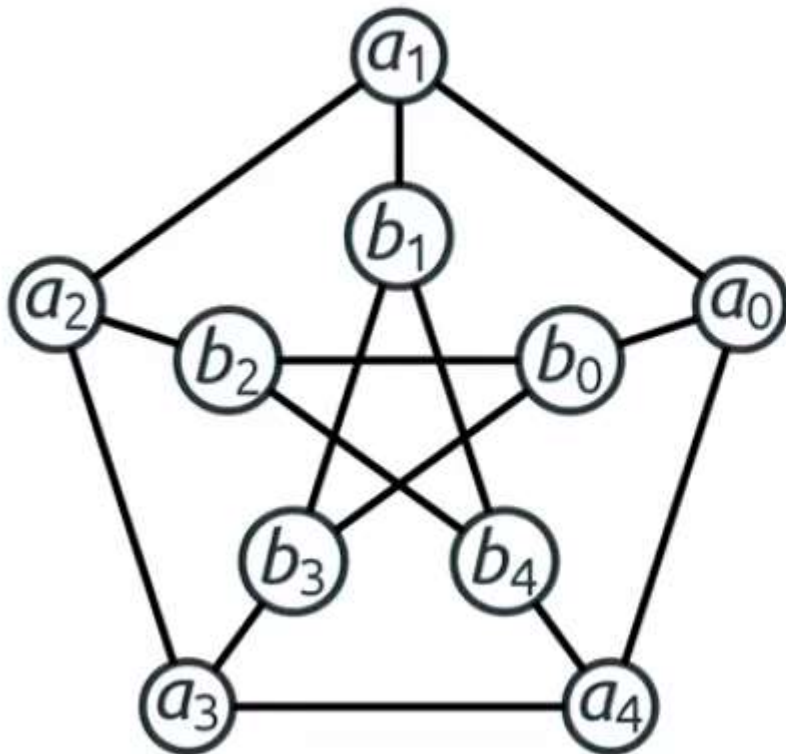
Many Ways to Draw a Graph..

- Are these graphs the same?



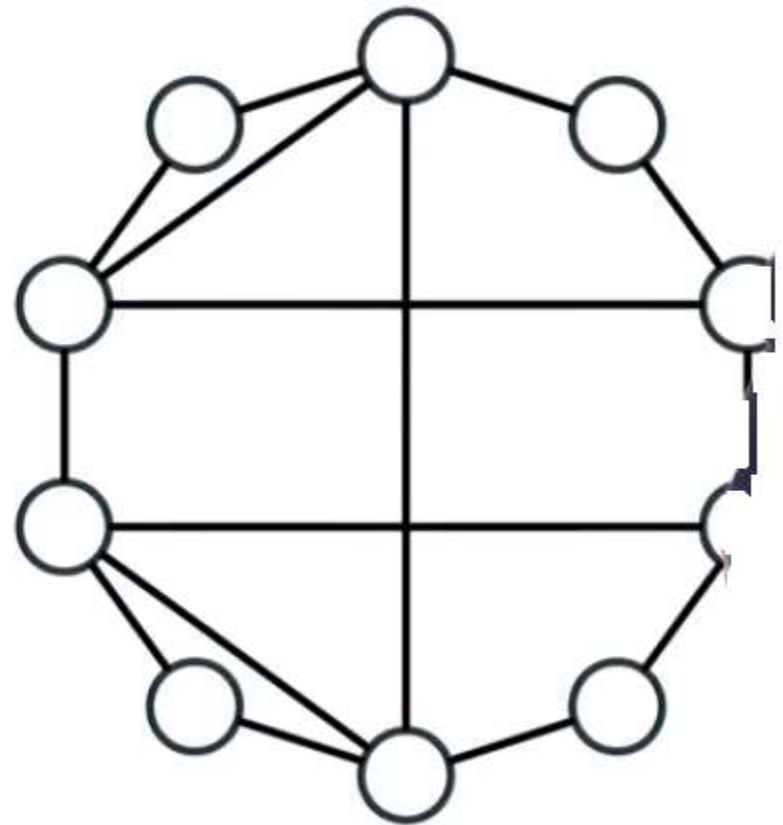
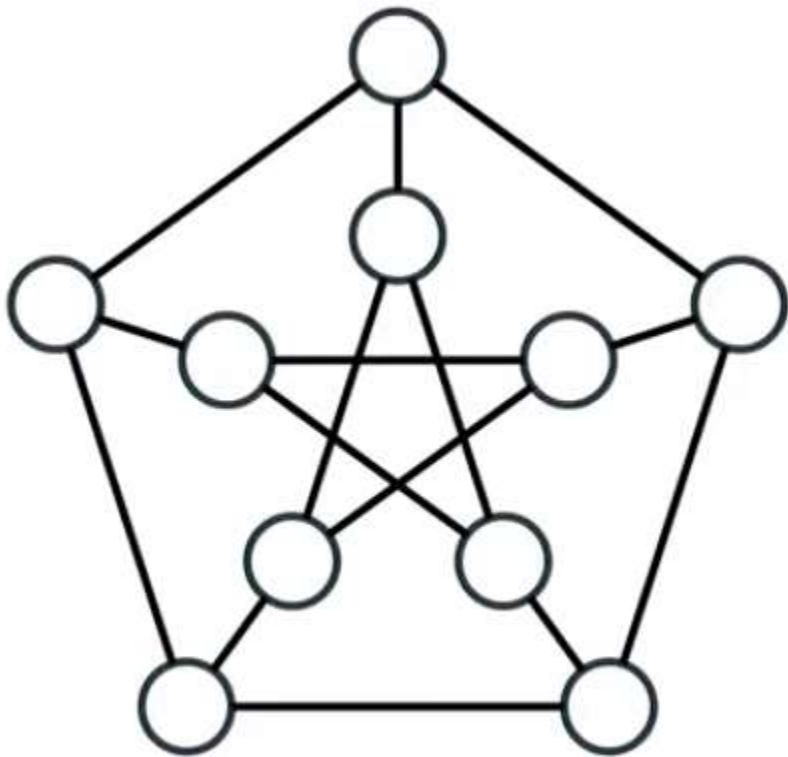
Many Ways to Draw a Graph..

Are these graphs the same?



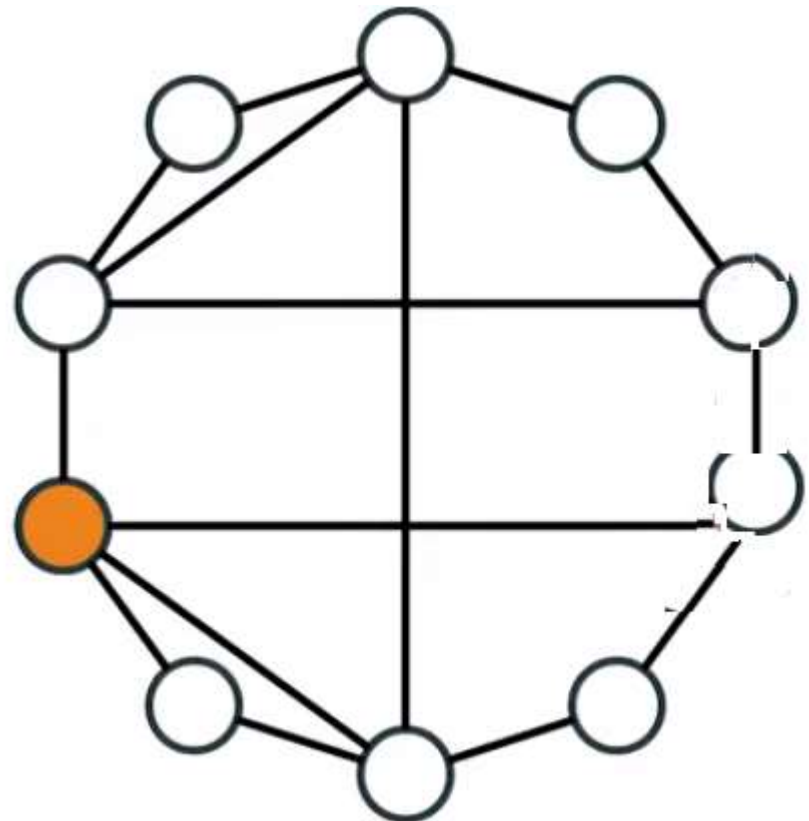
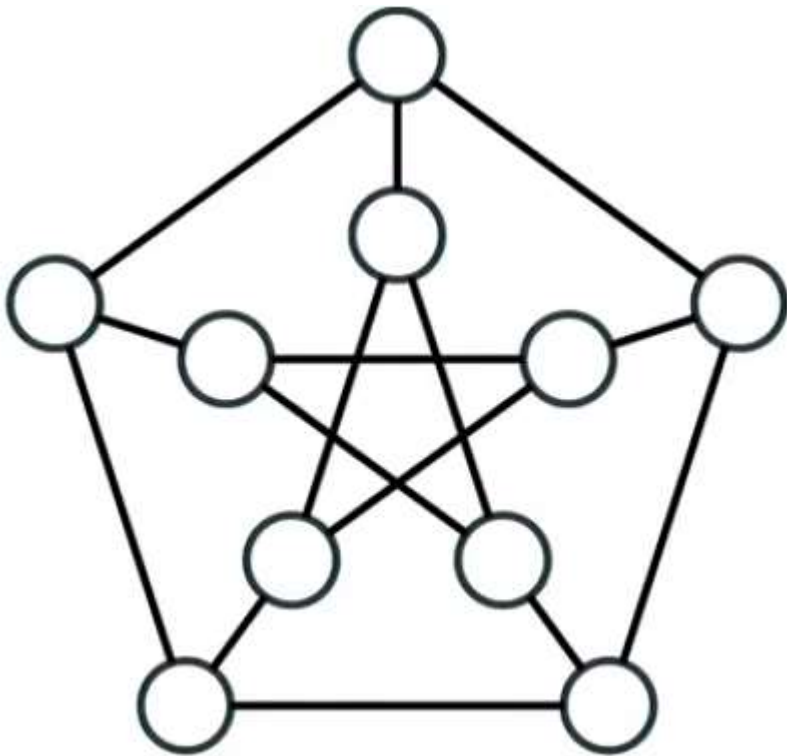
Are these Graph the same?

- 10 vertices and 15 edges?



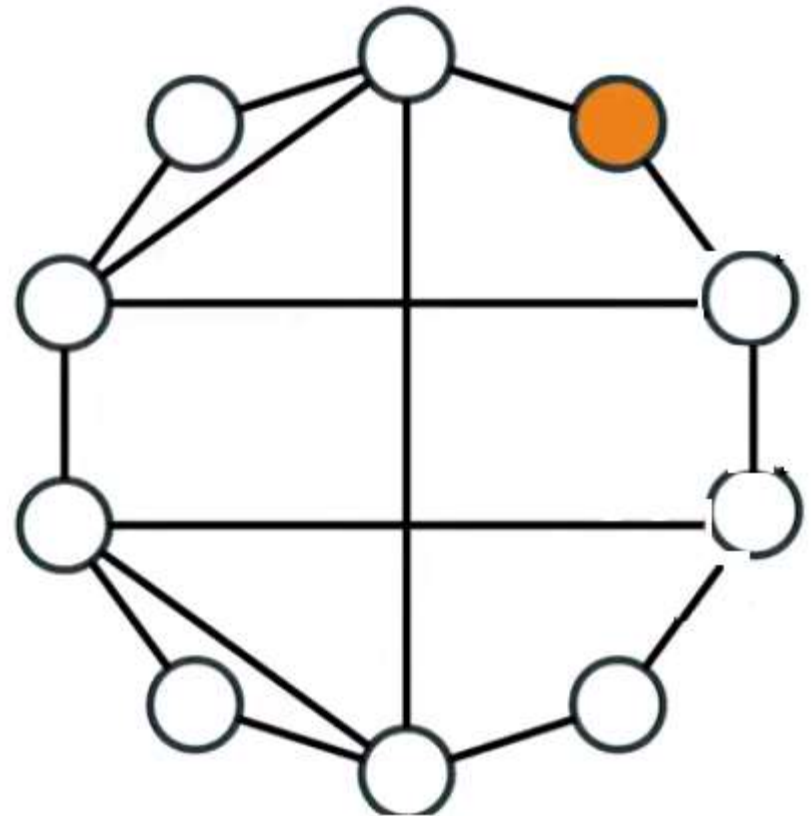
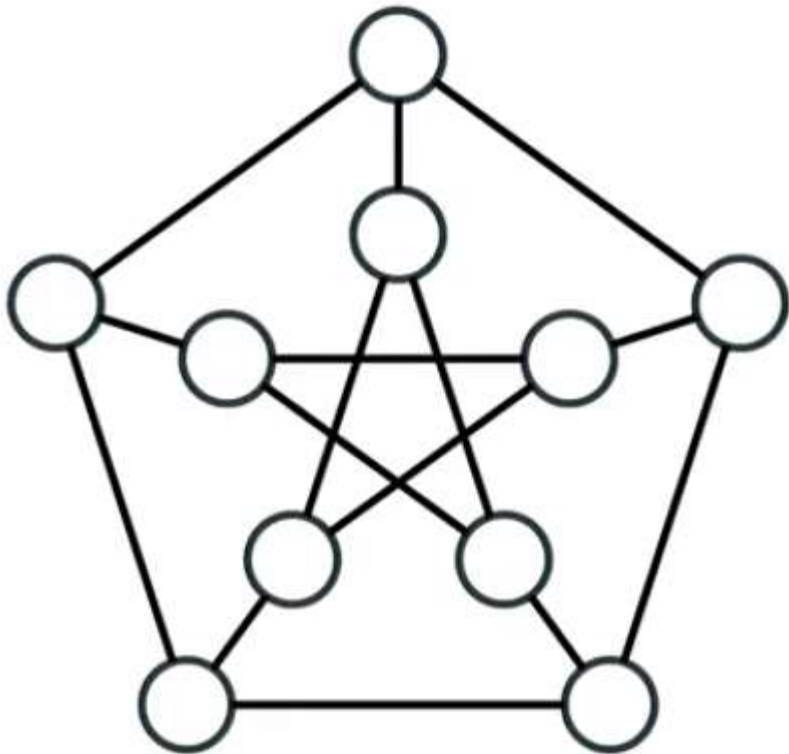
Are these Graph the same?..

- 10 **vertices** and 15 **edges**?



Are these Graph the same?..

- 10 **vertices** and 15 **edges**?



Graph Drawing is beautiful

- Graph drawing is the best possible field I can think of: It merges aesthetics, mathematical beauty and wonderful algorithms.

It therefore provides a harmonic balance between the left and right brain parts.

(Donald E. Knuth)



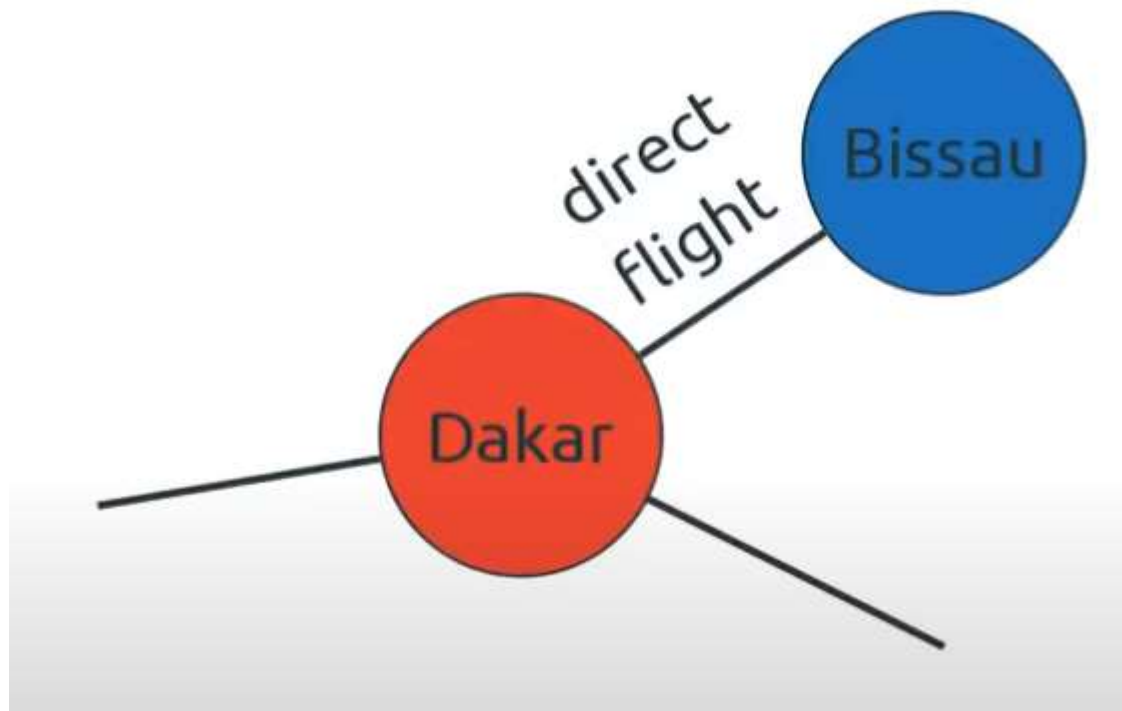
Graph Examples

Airlines Graph



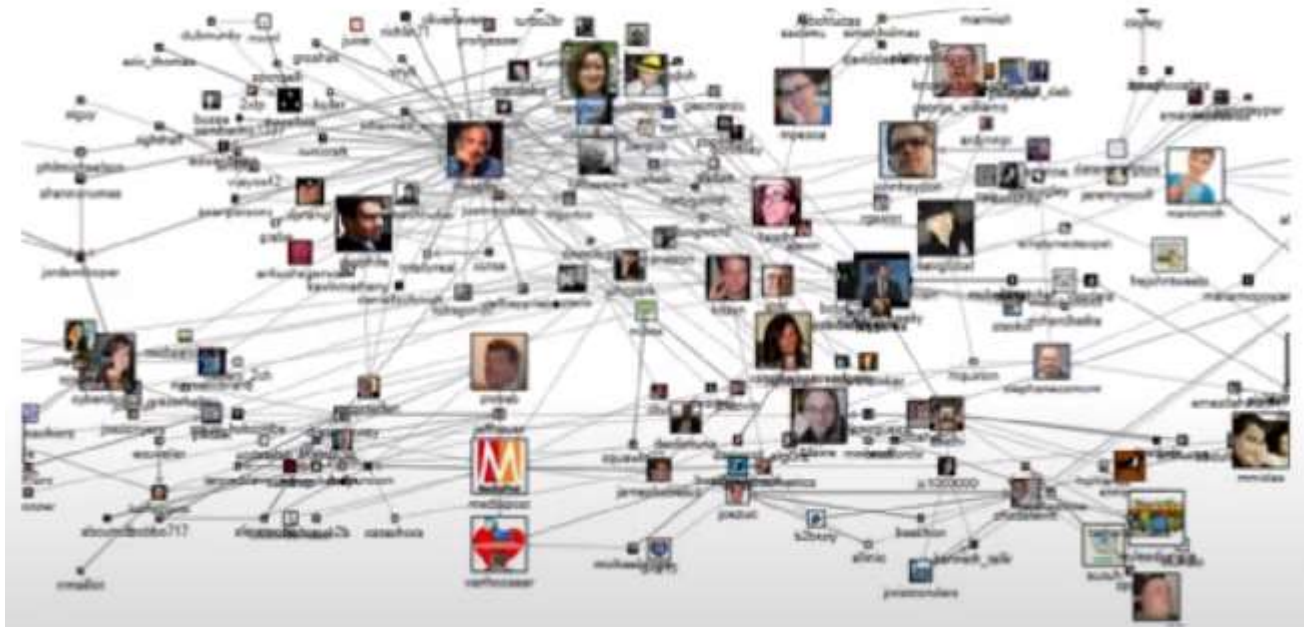
Graph Examples...

Airlines Graph



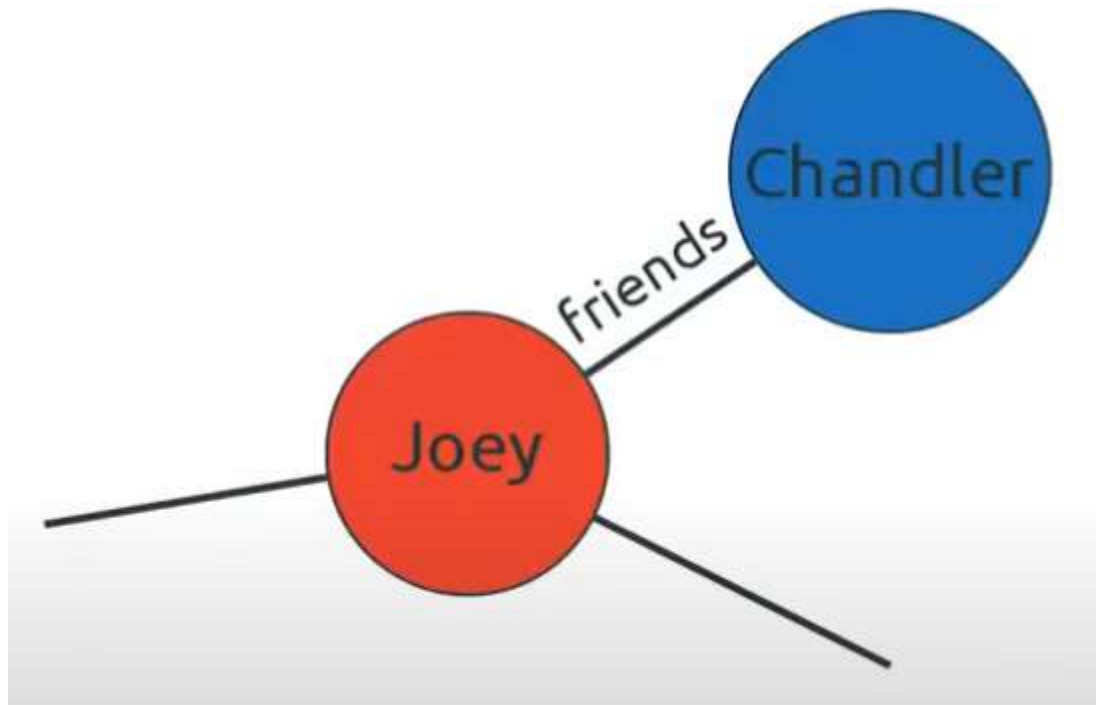
Graph Examples...

Facebook Graph



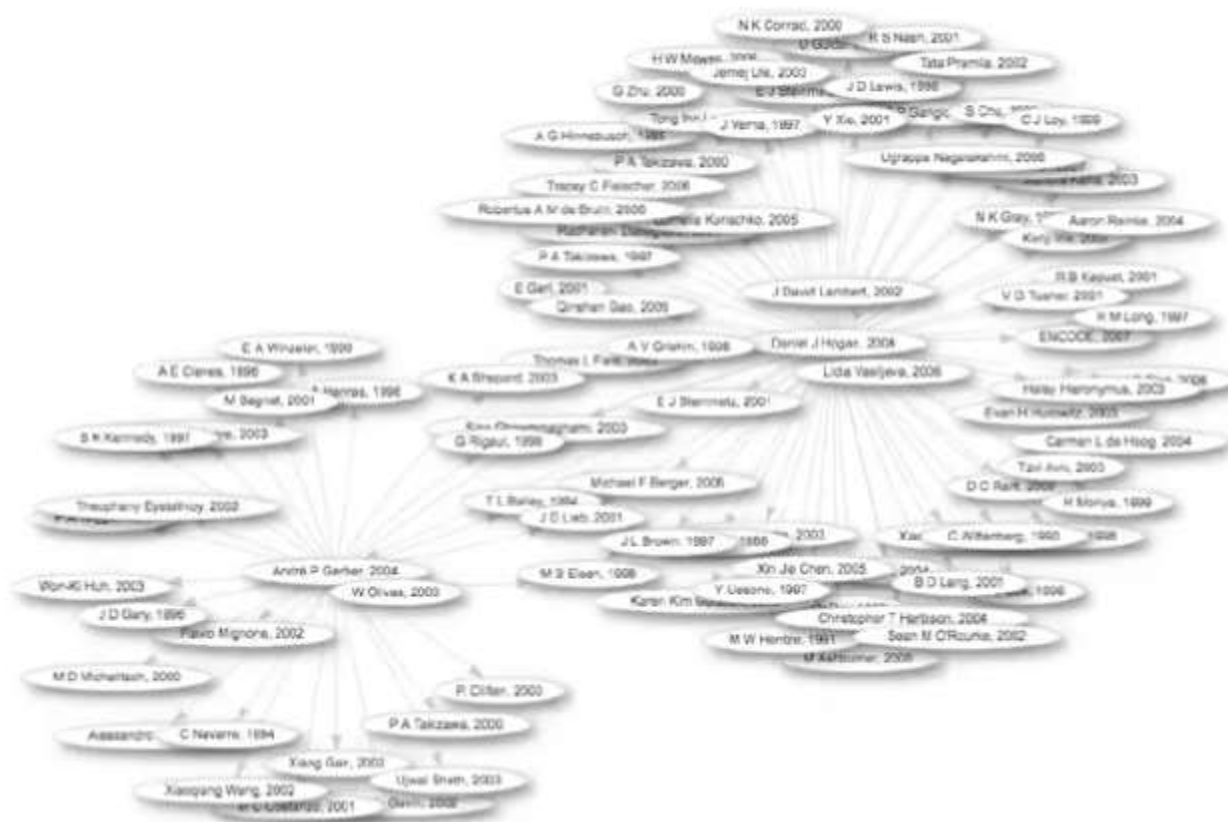
Graph Examples...

Facebook Graph



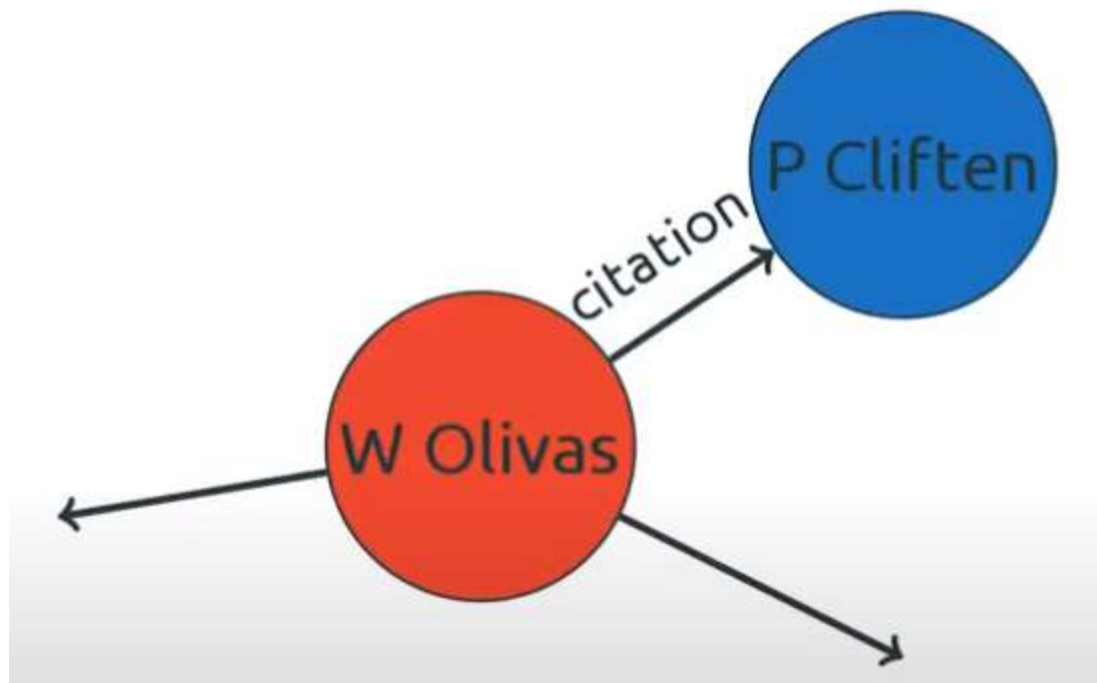
Graph Examples...

Citation Graph for a Paper



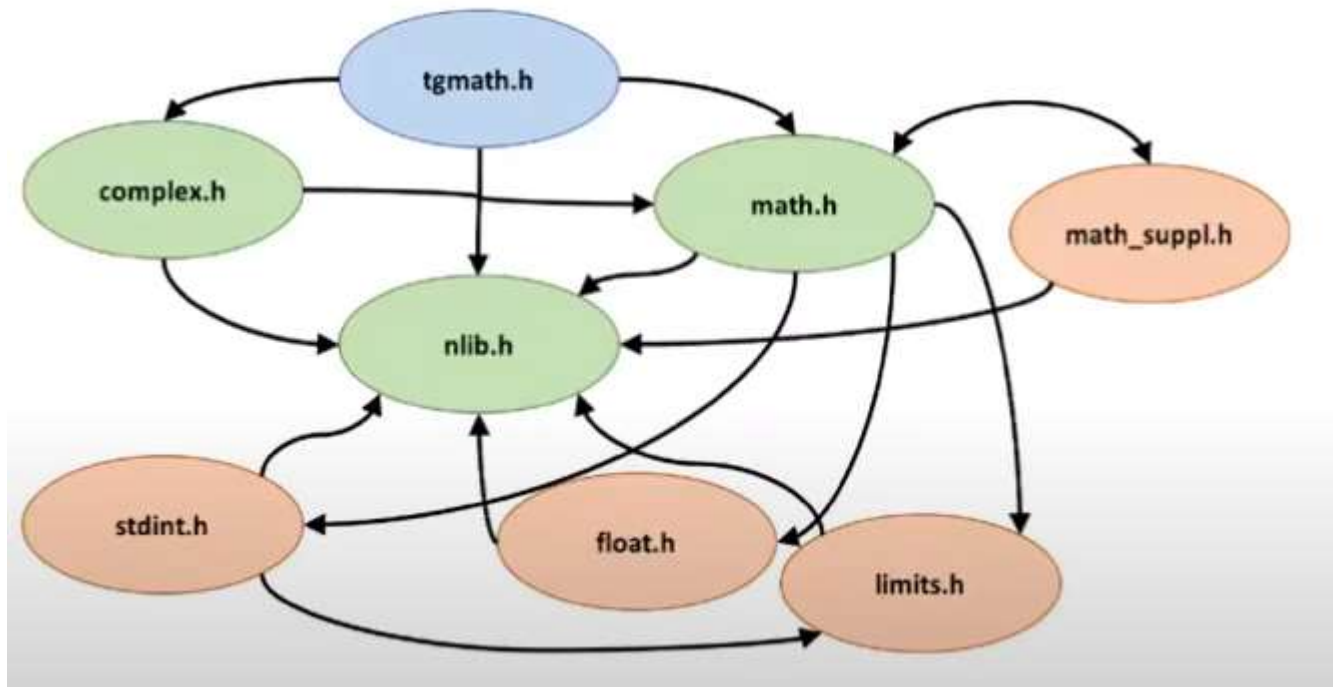
Graph Examples...

Citation Graph for a Paper



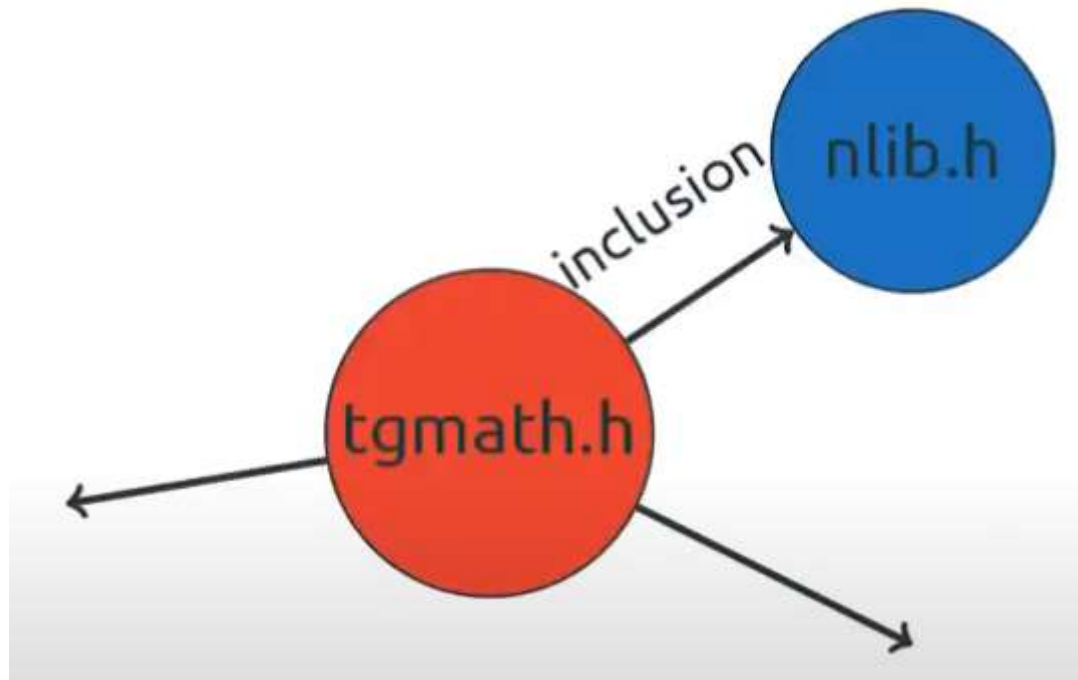
Graph Examples...

Dependency Graph



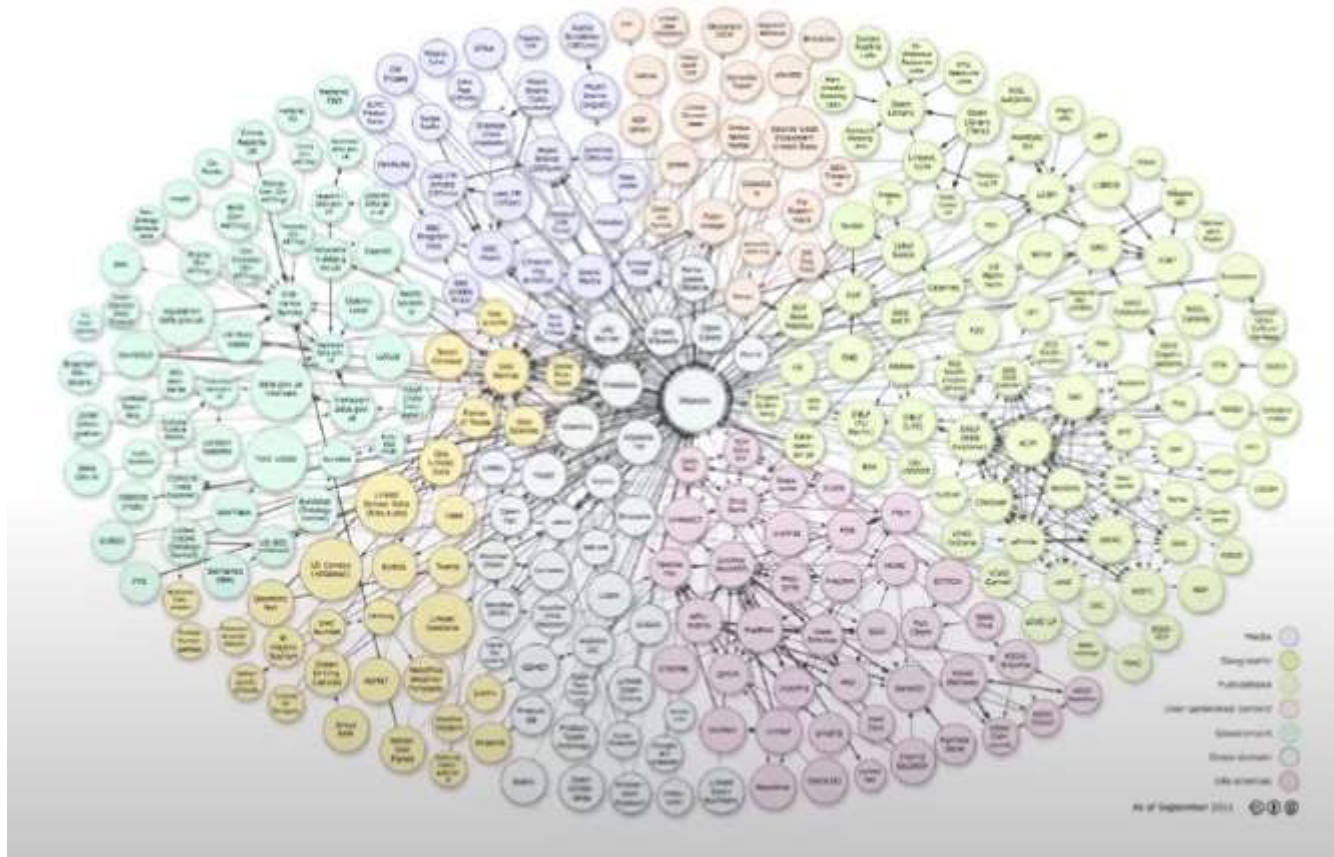
Graph Examples...

Dependency Graph



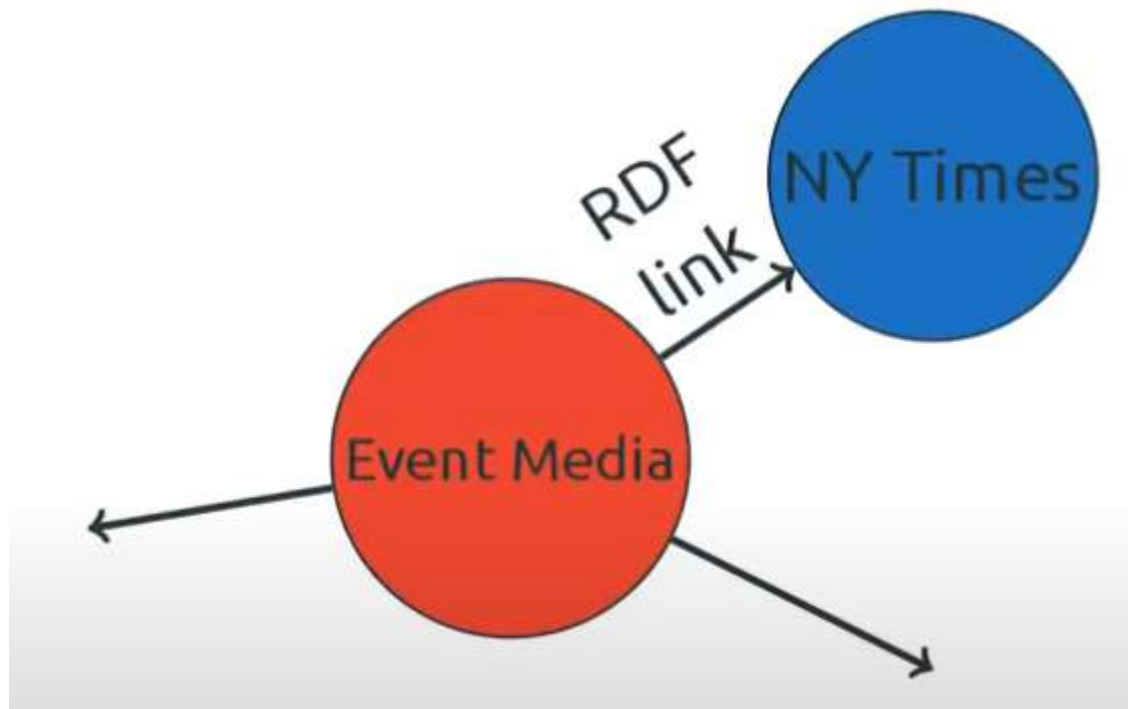
Graph Examples...

Linked Open Data diagram

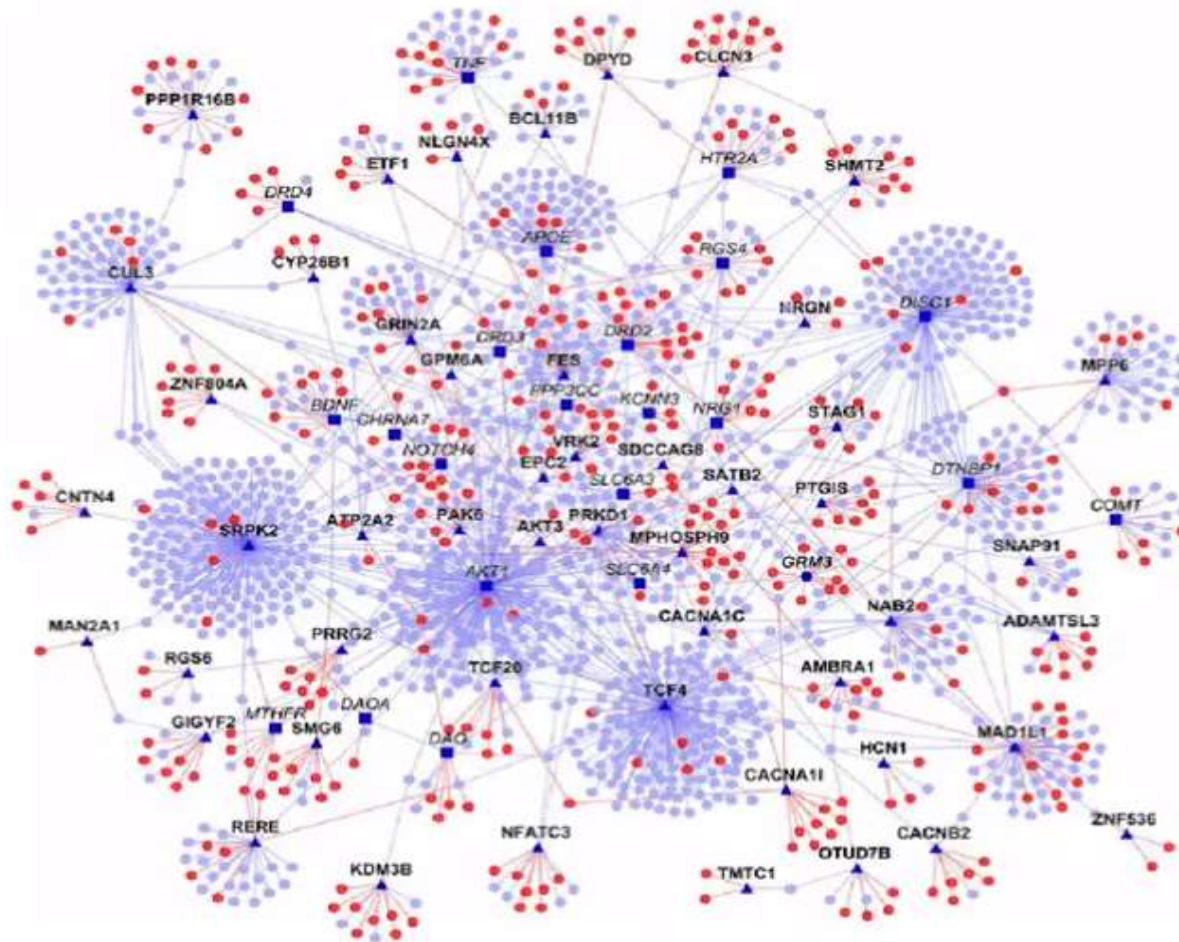


Graph Examples...

Linked Open Data diagram

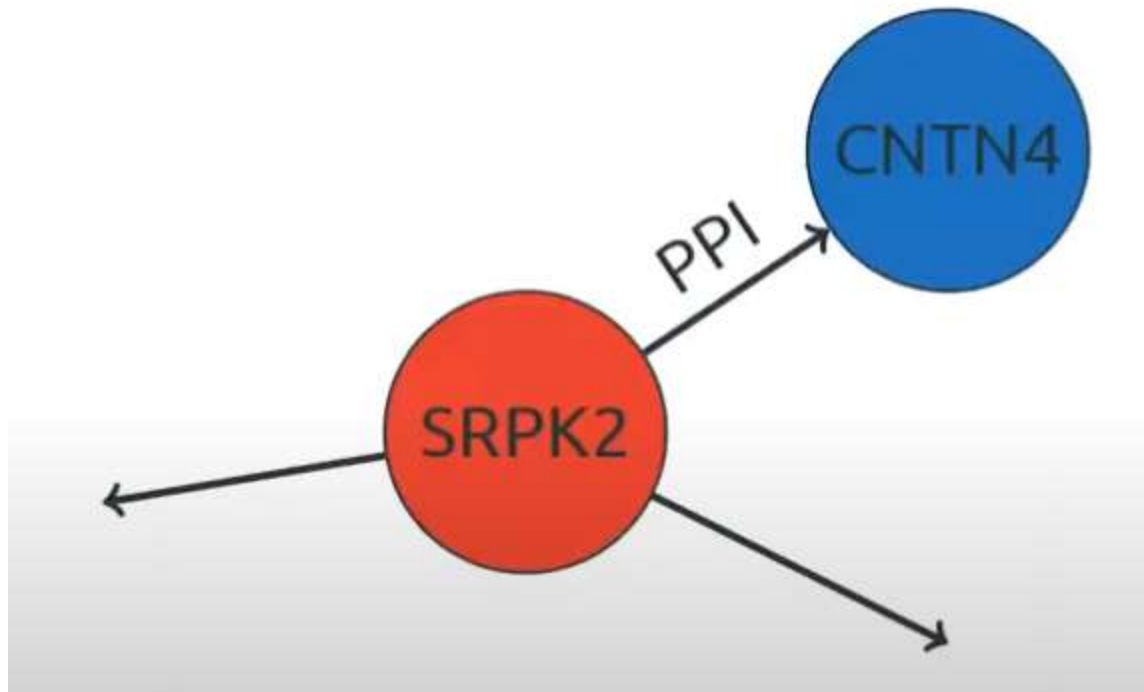


Schizophrenia Protein-Protein Interaction



Graph Examples...

Schizophrenia Protein-Protein Interaction



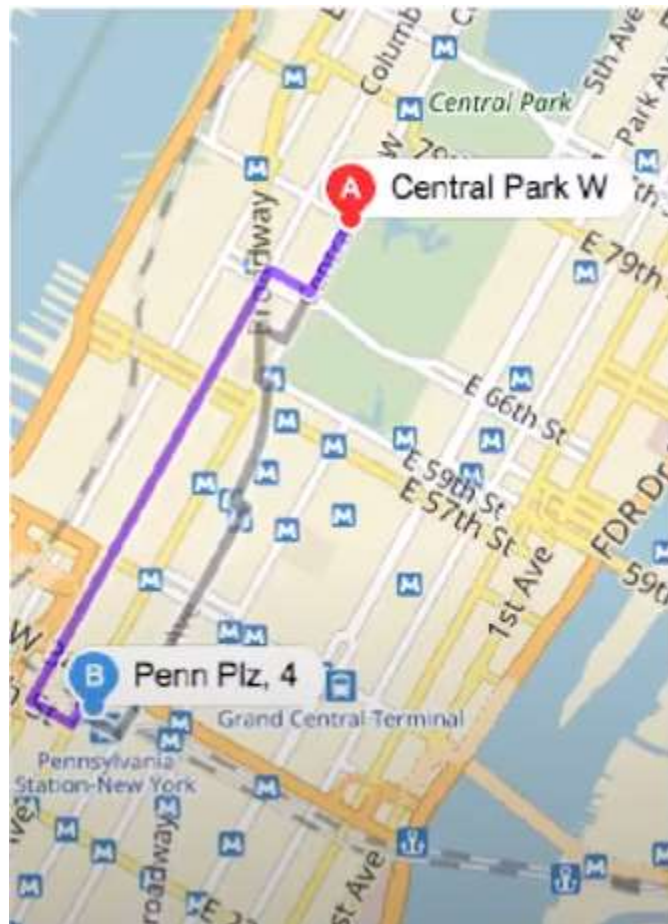
Graph Applications

Navigation



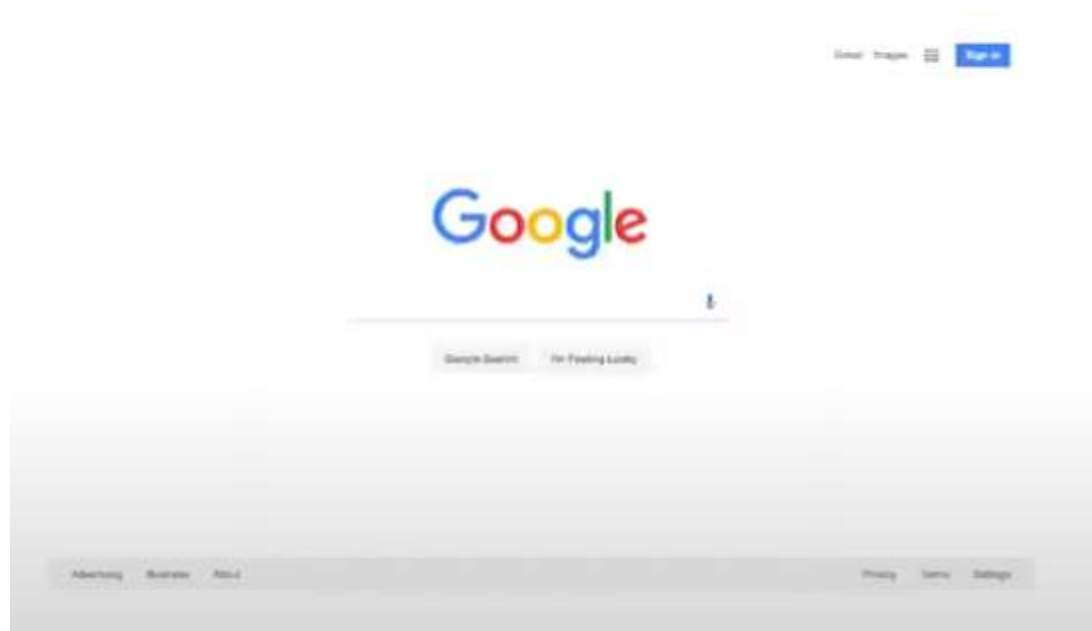
Graph Applications...

Navigation



Graph Applications...

Page Rank



Graph Applications...

Page Rank



A screenshot of a Google search interface. The search bar at the top contains the word "graph". Below the search bar, there are tabs for "All", "Images", "News", "Books", "Videos", and "More". The "All" tab is selected. Below the tabs, it says "About 333,000,000 results (1.94 seconds)". The main content area shows the definition of "graph" as a noun and a verb. Below the definitions, there is a section for "Translations, word origin, and more definitions" with a downward arrow. At the bottom, there are two Wikipedia links: "Graph - Wikipedia" and "Graph of a function - Wikipedia".

graph

About 333,000,000 results (1.94 seconds)

graph¹
/ɡrɑːf/ ⓘ

noun

1. a diagram showing the relation between variable quantities, typically of two variables, each measured along one of a pair of axes at right angles.
synonyms: chart, diagram; [More](#)

verb

1. plot or trace on a graph.
synonyms: plot, trace, draw up, delineate
"we graphed the new prices"

Translations, word origin, and more definitions

[Graph - Wikipedia](#)
<https://en.wikipedia.org/wiki/Graph> ▼
Graph (topology), a topological space resembling a graph in the sense of discrete mathematics. Graph of a function. Chart, a means of representing data (also called a graph).

[Graph of a function - Wikipedia](#)
https://en.wikipedia.org/wiki/Graph_of_a_function ▼

Graph Applications...

Page Rank

Graph TV

graphtv.kevinformatics.com/ ▼

Graph Ratings of Your Favorite TV Shows. Visualize IMDb ratings and trends of TV shows by episode.

Have you seen Mad Men, Breaking Bad, or Battlestar ...



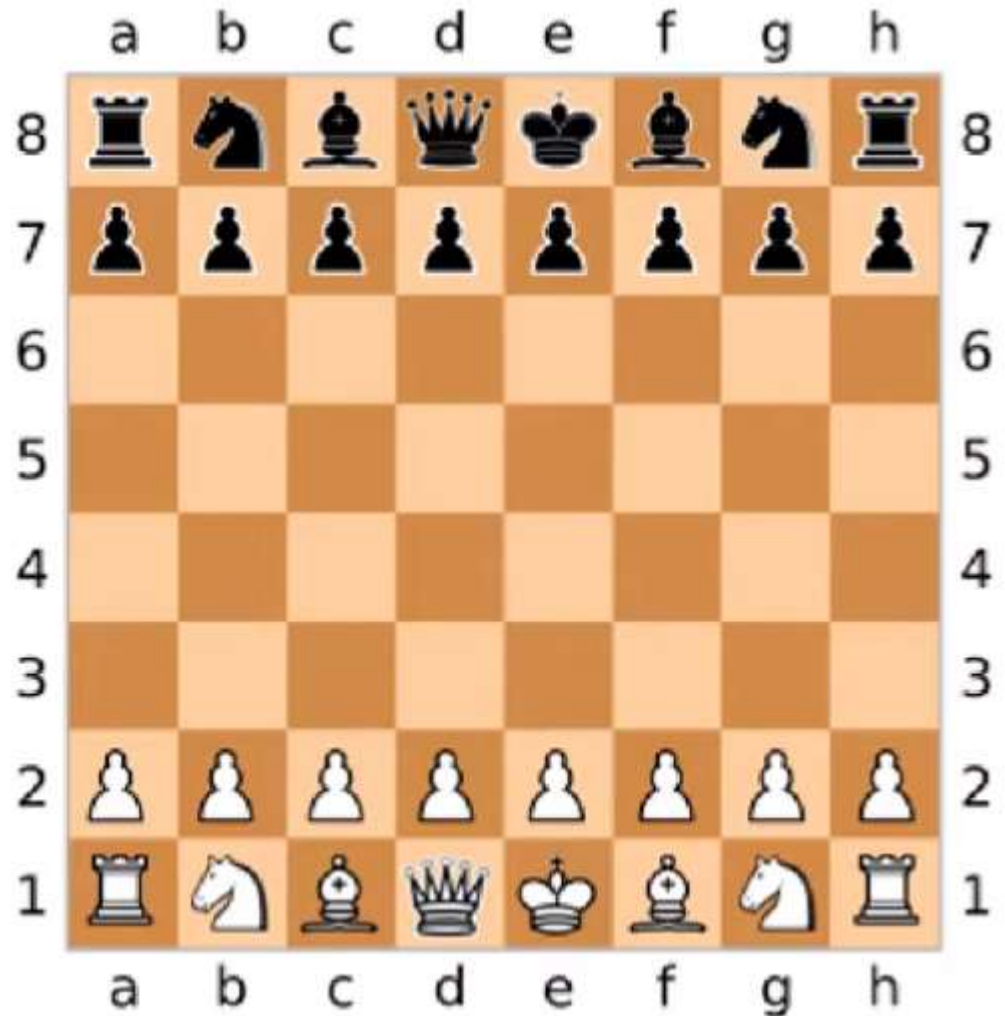
Previous

1 2 3 4 5 6 7 8 9 10

Next

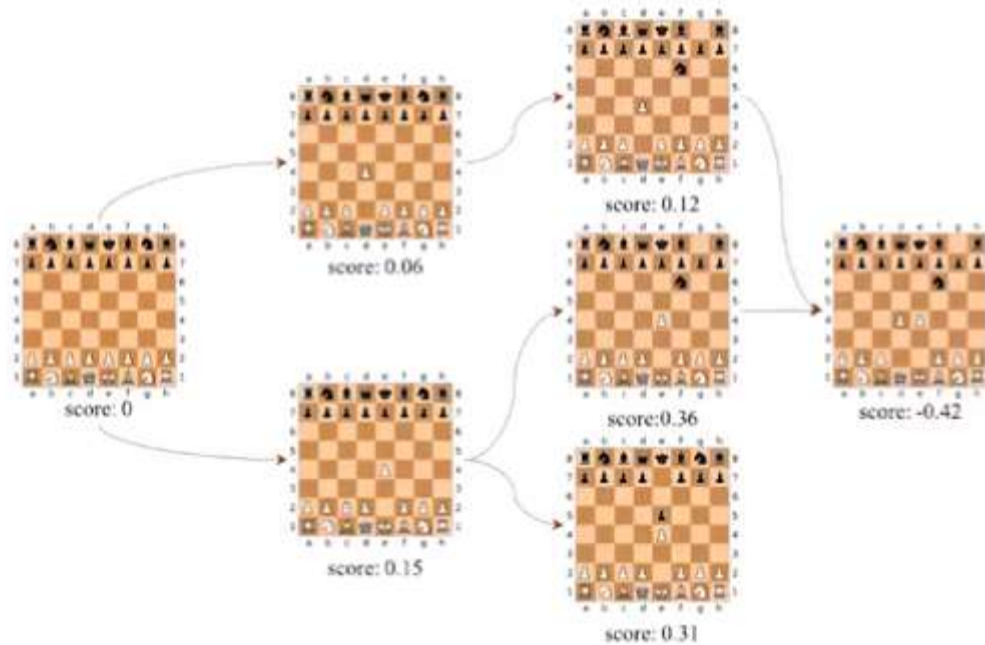
Graph Applications...

Game Strategies



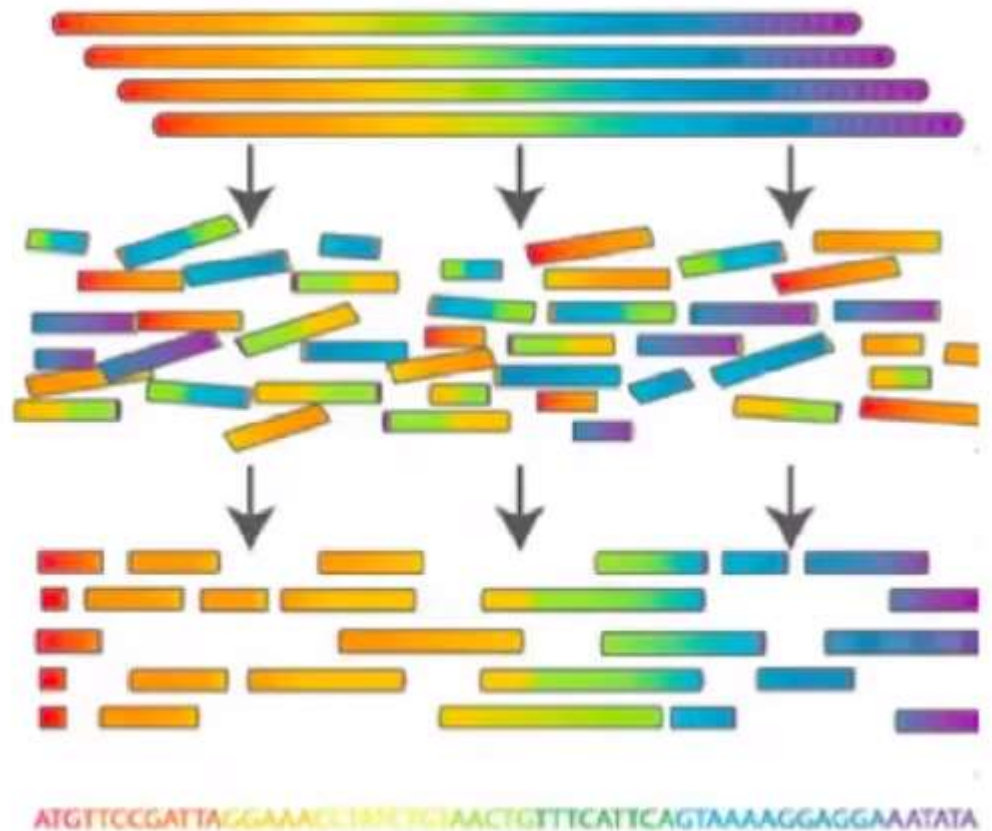
Graph Applications...

Game Strategies



Graph Applications...

Genome Assembly



Graph Applications...

GSM

4 Frequency
Ranges



Graph Applications...

GSM

4 Frequency
Ranges



Graph Applications...

Computer Chips



Graph Applications...

Computer Chips

