Basic notions

Lecture 1

Introduction

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Please, register with Gradescope ASAP.

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A graph $G = (V, E)$ is a pair consisting of a vertex set $V = V(G)$, an edge set $E = E(G)$ and a relation associating with each $e \in E(G)$ two vertices (not necessarily distinct) called its ends (or end vertices).

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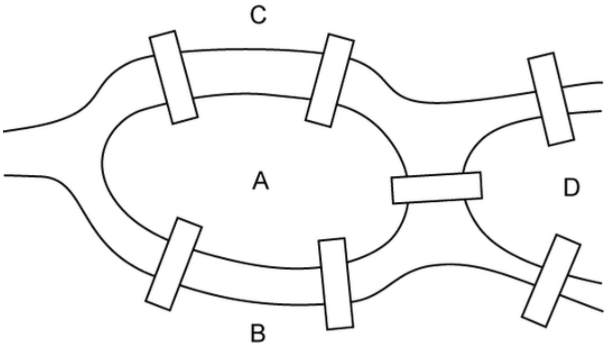
Graph Theory has applications in Computer Science, Operations Research, other parts of Mathematics, Chemistry, Physics, Economics.

Examples of graphs.

Notions: incident, adjacent, degree of a vertex, neighbors, loops, parallel (multiple) edges, simple graphs. Examples.

Königsberg Bridge Problem See **Example 1.1.1** in the book (p. 1–2). The Königsberg bridge problem: The historic Prussian city of Königberg (now part of Russia and called Kaliningrad) has land on both sides of the Pregel river, and also occupies two large islands in the river. There are 7 bridges over the river that connect different parts of the city as depicted below:



Examples of graphs: Complete graph K_n, edgeless graph O_n.

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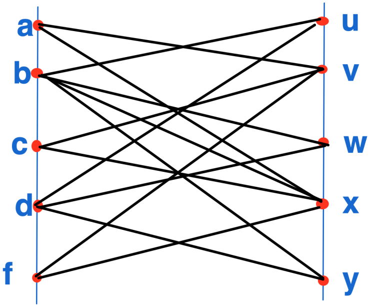
A path P_n is a graph whose vertices can be ordered $v_1, \ldots, v_n$ so that v_i and v_j are adjacent iff $|i - j| = 1$.

A cycle C_n is a graph obtained from P_n by adding edge $v_1 v_n$.

Job Assignment Problem: Example 1.1.9 in the book, p. 4.
Imagine you are a manager and you have 5 employees and 5 different jobs that need to be done. Each job needs to be completed, and each person can do only one job. However, not all employees can do every job. Is it possible to find a job assignment where each job gets covered?



Bipartite graphs, complete bipartite graphs; examples.

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More definitions and examples: complements of simple graphs, subgraphs, induced subgraphs, Walks, trails, paths and cycles in graphs.