Laboratorio de Programación

2016 -2

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[1]Departamento de Electronica y ciencias de la computación

Noviembre de 2016

Outline

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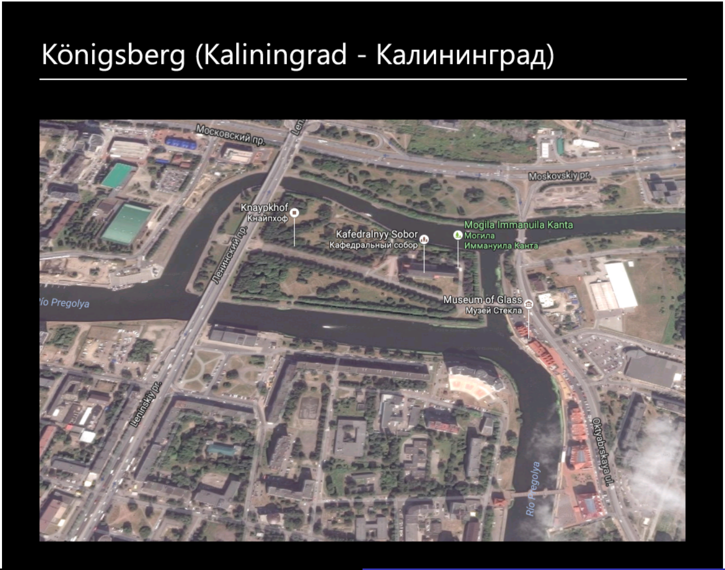
The Königsberg bridges problem



The Königsberg bridges problem

The problem (Euler 1736)

- Königsberg was the capital of the old East Prussia, now part of the Russian Federation and renamed as Kaliningrad

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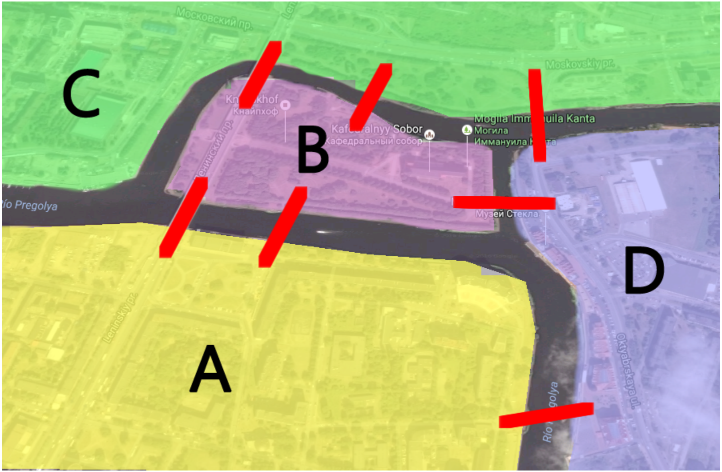
The problem (Euler 1736)

- Königsberg was the capital of the old East Prussia, now part of the Russian Federation and renamed as Kaliningrad
- Königsberg had 7 bridges over the Pregel River
- How can we walk through the city, crossing each bridge once and only once?

The Königsberg bridges problem



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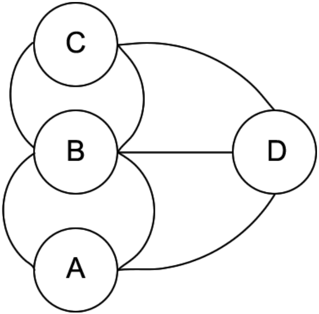
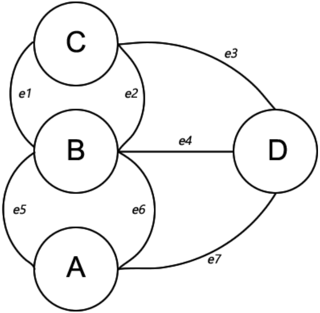


Graphs



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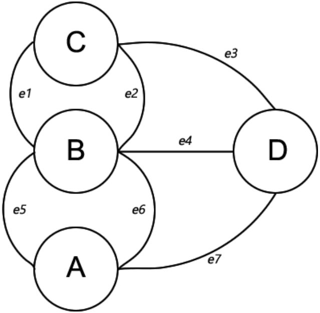
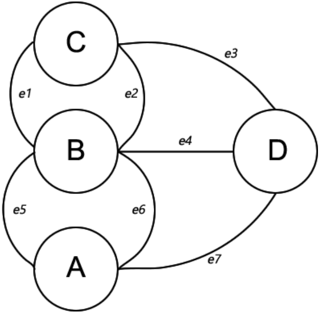


Definition

A graph $G = \{V, E\}$ is a collection of Vertexes (V), and Edges (E) which connects the vertexes.

Graphs



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Vertexes

$V = \{A, B, C, D\}$

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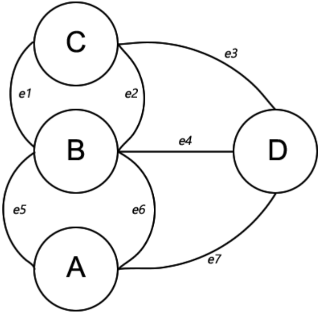

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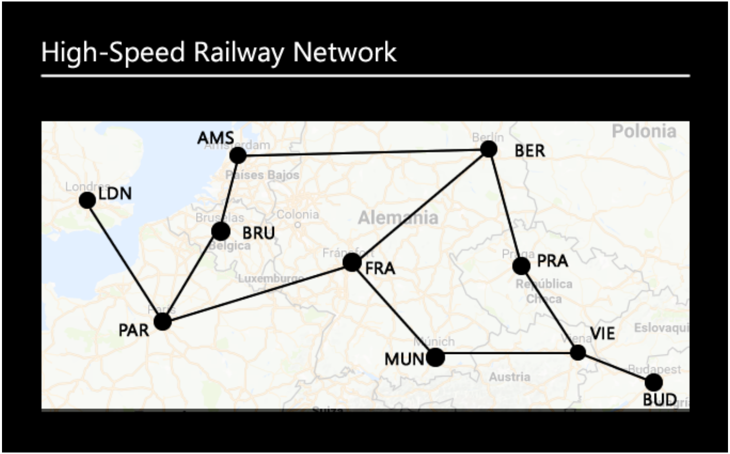
$V = \{A, B, C, D\}$

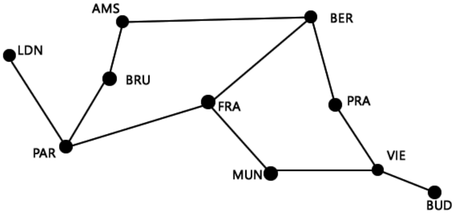
Edges

$e1 = \{C, B\}$ $e2 = \{C, B\}$ $e3 = \{C, D\}$
$e4 = \{D, B\}$ $e5 = \{B, A\}$ $e6 = \{B, A\}$
$e7 = \{A, D\}$

Graphs


High-Speed Railway Network
AMS
Amsterdam
BER
Berlín
Polonia
Londres
LDN
Países Bajos
Bruselas
Colonia
Alemania
BRU
Bélgica
Fráncfort
FRA
Praga
PRA
República
Checa
Luxemburgo
París
PAR
VIE
Viena
Eslovaqui
Múnich
MUN
Austria
Budapest
BUD
Suiza

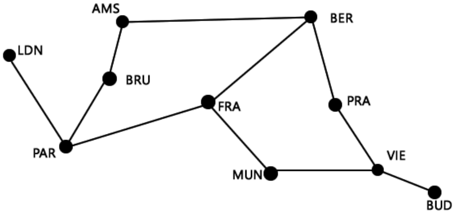
Graphs



Simple graph

A *Simple Graph* $G = (V, E)$ contains:

Graphs



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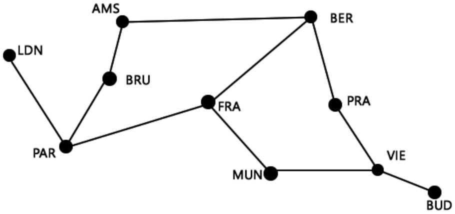

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A *Simple Graph* $G = (V, E)$ contains:

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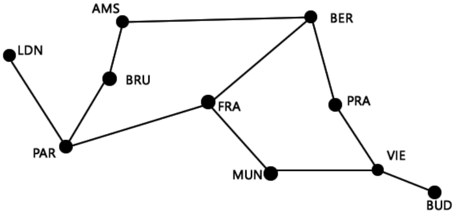

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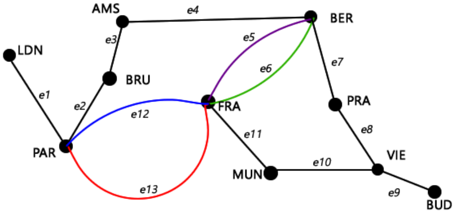
E.g:

$E = \{\{LDN, PAR\}, \{FRA, BER\}, ...\}$

Graphs



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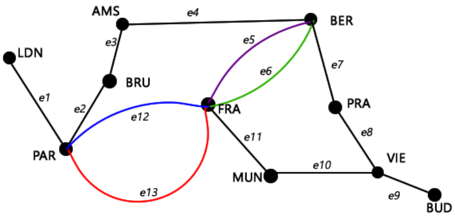

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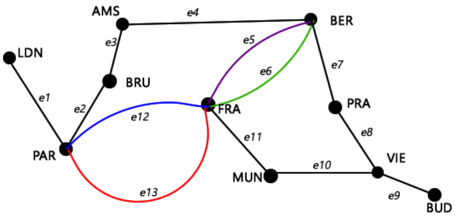


Multigraph

A *Multigraph* $G = (V, E)$ contains:

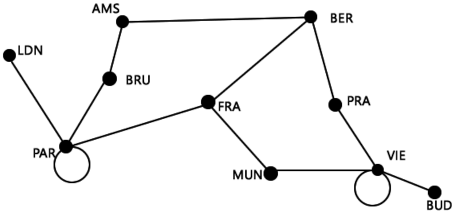
- V: A set of vertexes and E: A set of edges
- **Multiple edges** where $f(e1) = f(e2)$ and $e1 \neq e2$

E.g:

$f(e12) = \{FRA, PAR\}$

$f(e13) = \{FRA, PAR\}$

Graphs



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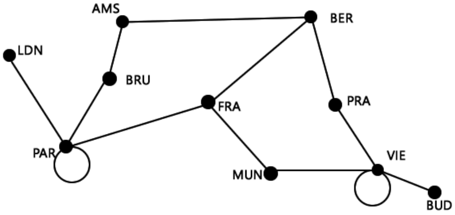

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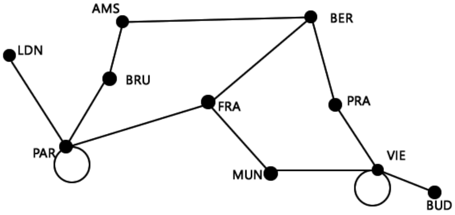

Pseudograph

A *Pseudograph* $G = (V, E)$ contains:

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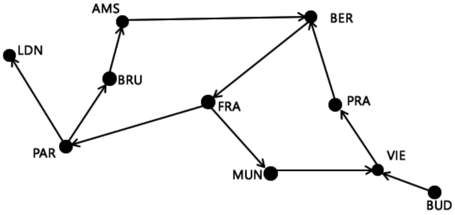
- **Loops** where $f(e) = \{u, u\}$

E.g: $\{PAR, PAR\}$ $\{VIE, VIE\}$

Graphs



Directed graph

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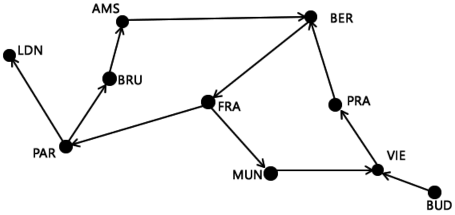

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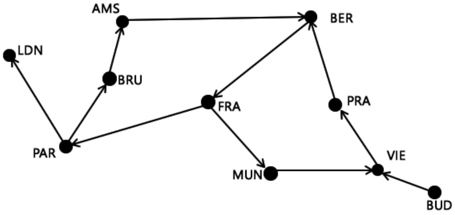

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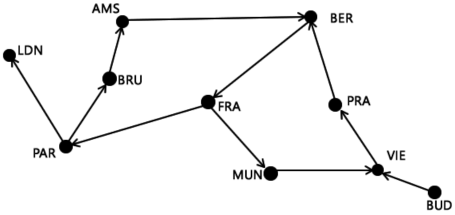

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E.g:

$E = \{(PAR, LDN), (VIE, PRA)...\}$

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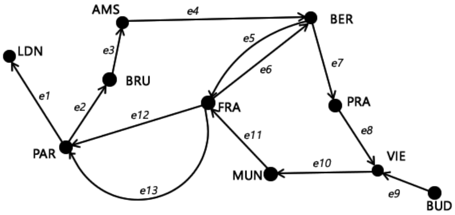
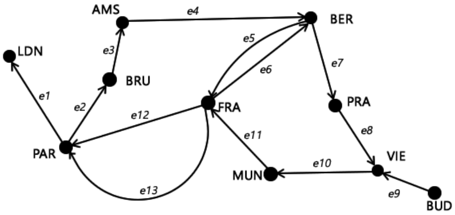


Directed Multigraph

A *Directed Multigraph* is a directed graph $G = (V, E)$ which contains:

Graphs



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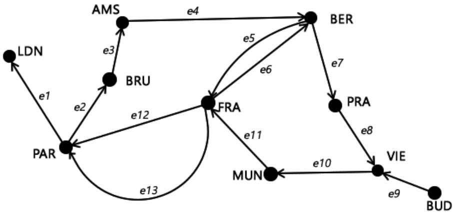

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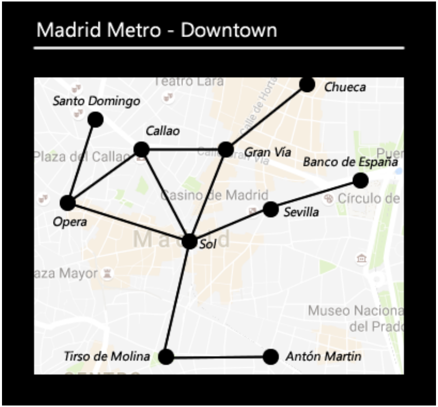
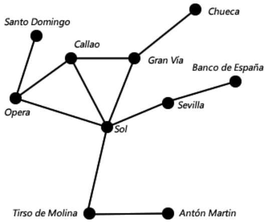

Madrid Metro - Downtown
Santo Domingo
Callao
Chueca
Gran Vía
Banco de España
Opera
Sevilla
Sol
Tirso de Molina
Antón Martin
Teatro Lara
Plaza del Callao
Casino de Madrid
Círculo de
aza Mayor
Museo Naciona
del Prad

Graphs - Terminology



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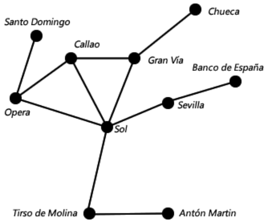
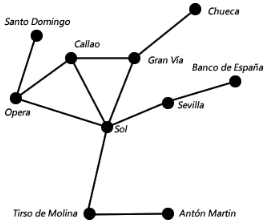


Adjacency

Vertexes u, v are **adjacent**

Opera and *Sol* are adjacent

Graphs - Terminology



Adjacency

Vertexes u, v are **adjacent**
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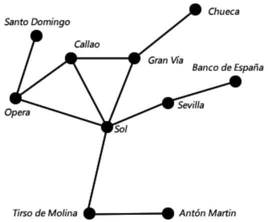
Incidence

Let's say $e = \{Sol, Sevilla\}$. The edge e is **incidence** with *Sol* and *Sevilla* so, e **connects** *Sol* and *Sevilla*

Graphs - Terminology



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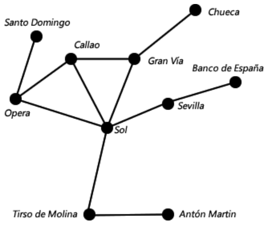
Degree

On a non-directed graph is the number of incidence Edges related to a vertex.
$\delta(Sol) = 5$, $\delta(Opera) = 3$
A **loop** has double **incidence**!

Graphs - Terminology



Path

Are the edges we need to traverse to go from a vertex (u) to another one (v).

Problem: Go from Callao to Sevilla

Paths:

- {Callao, Sol} {Sol, Sevilla}
- {Callao, Gran Via} - {Gran Via, Sol} - {Sol, Sevilla}
- {Callao, Opera} - {Opera, Sol} - {Sol, Sevilla}
- {Callao, Opera} - {Opera, Sol} - {Sol, Gran via} - {Gran via, Chueca} - {Chueca, Gran via} - {Gran via - Sol} - {Sol - Sevilla}