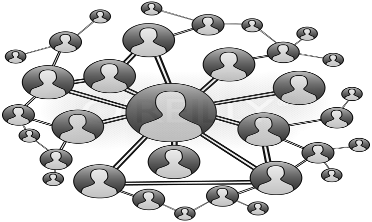
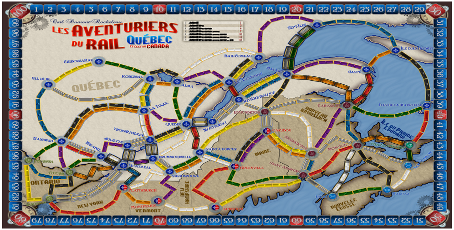
Road network between cities

Friendship on facebook



Ticket to Ride (board game)

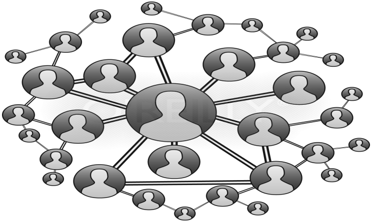


Metro map of Montréal

Road network between cities

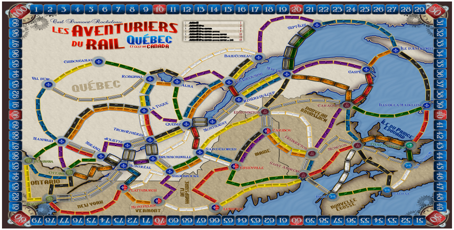
fastest route from Calgary to Québec

Friendship on facebook



everyone↔everyone in dist. 6

Ticket to Ride (board game)



build quickly tracks between places

Metro map of Montréal

visit all stops in shortest time

MATH 350: Graph theory and Combinatorics

Time: Tuesday and Thursday 8:35-9:55 AM ☹
Location: Burnside Hall 1B24

Pre-requisites

- MATH 235 (Algebra 1) or MATH 240 (Discrete structures 1)
- MATH 251 (Honours Algebra 2) or MATH 223 (Linear Algebra)
- Not open to who have taken/taking MATH 343 or MATH 340

MATH 350: Graph theory and Combinatorics

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Assignments

- Ten assignments in total (one per week), each with three questions
- Each assignment: one warm-up problem & one challenge
- The assignments count for 20% of your final grade

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Midterm & Final exams

- Midterm 20% + Final 60% of your final grade
- Final 80% of your final grade (if better)
- Both exams will be open-book

Who is going to teach this?

Instructor:	Jan Volec
Office:	Burnside Hall, room 1242
Office hours:	Tue, 10:30 AM - 12:30 PM and by appointment
Email:	jan [at] ucw [dot] cz
Homepage:	`http://honza.ucw.cz`

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Originally from the Czech Republic 

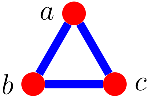
Questions?

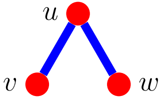
Let's start. . .

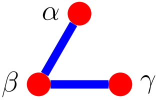
graph $G := (V, E)$

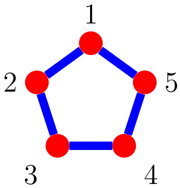
V – (finite) set of Vertices

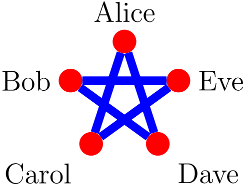
$E \subseteq \binom{V}{2}$ – set of Edges











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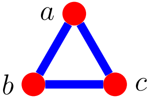
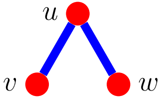


$V = \{a, b, c\}$

$E = \Big\{\{a, b\}, \{b, c\}, \{c, a\}\Big\}$



$V = \{u, v, w\}$

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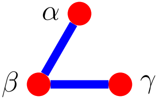

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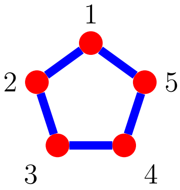

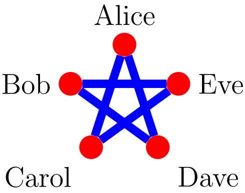

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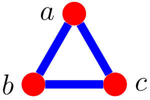

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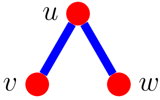

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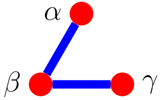

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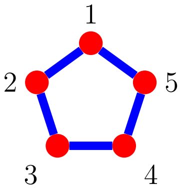
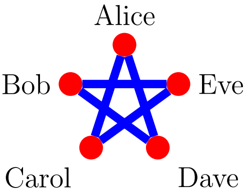


$V = \{1, 2, 3, 4, 5\}$

$\Big\{\{1, 2\}, \{2, 3\}, \{3, 4\}, \{4, 5\}, \{5, 1\}\Big\}$

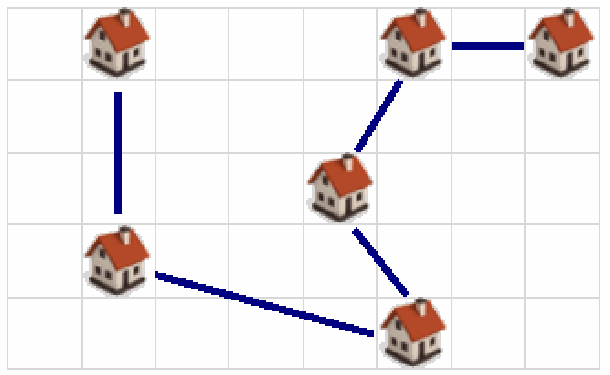


$V = \{A, B, C, D, E\}$

$\Big\{\{A, C\}, \{C, E\}, \{E, B\}, \ldots\Big\}$

Connect houses with electric wires / optical cables

Connect houses with electric wires / optical cables



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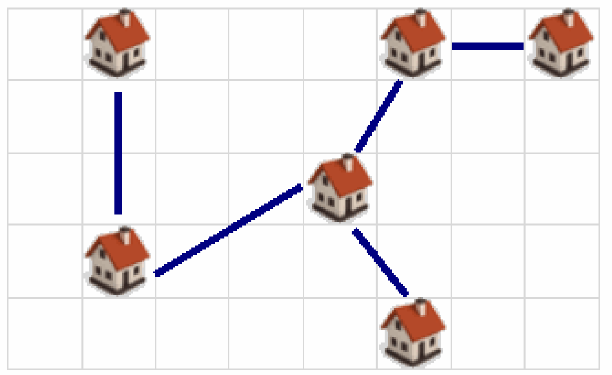
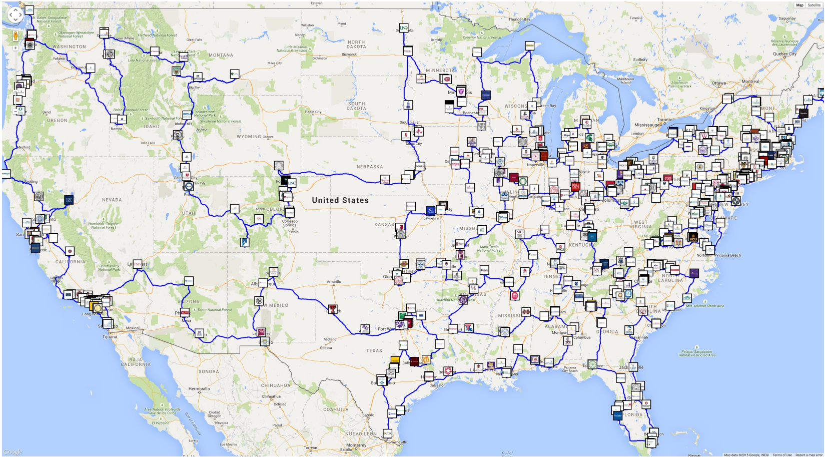


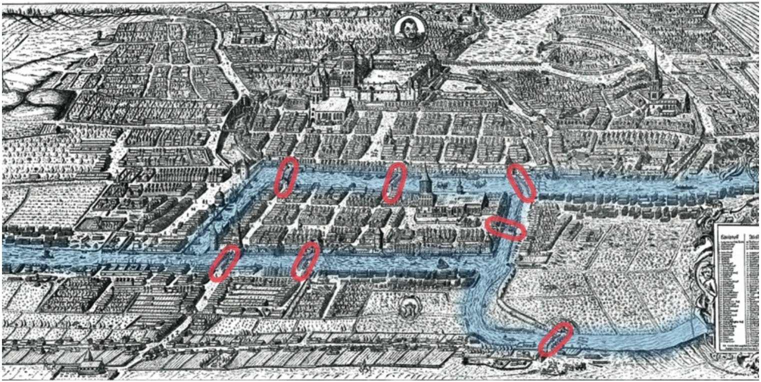
(1st algorithm by Otakar Borůvka in 1926 for electricity in Moravia)

Queen of College tours – shortest roadtrip for 647 colleges



(tour found in 2015 by William Cook from University of Waterloo)

Seven bridges of Königsberg puzzle – cross each just once?



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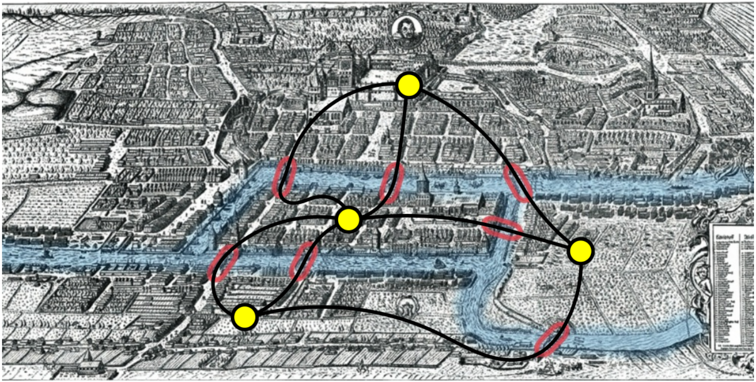
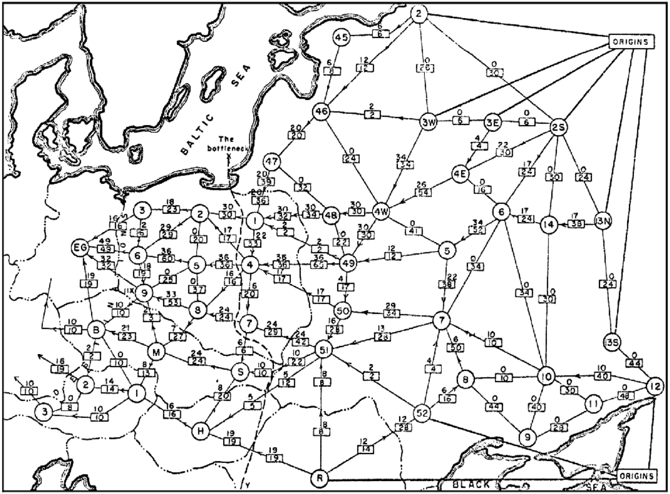


(solved by Euler in 1736)

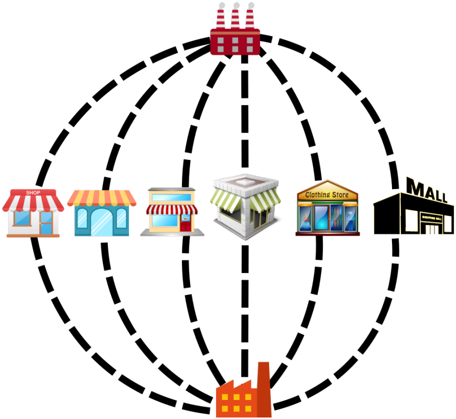
Disconnect railway between Soviet Union and East Europe



(from 1955 secret report by Harris and Ross)

Factories vs. stores in a non-crossing city

- No factory wants share a road with another factory,
- No store wants share a road with another store,
- No politician wants to maintain a road-crossing.



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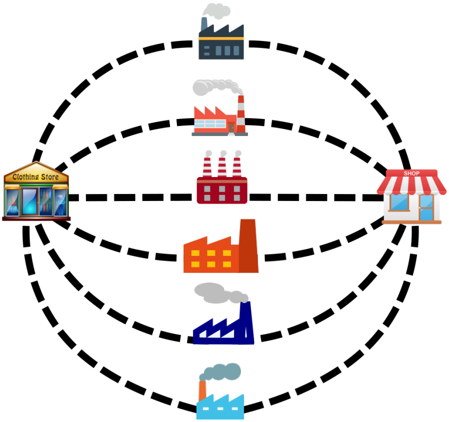

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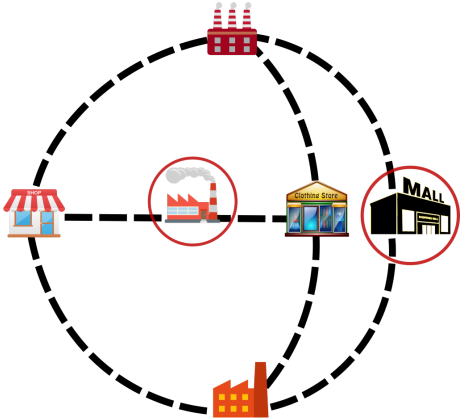

Can there simultaneously be ≥ 3 factories & ≥ 3 stores in the city?

Don't get lost in forest / Is this graph theory problem?!

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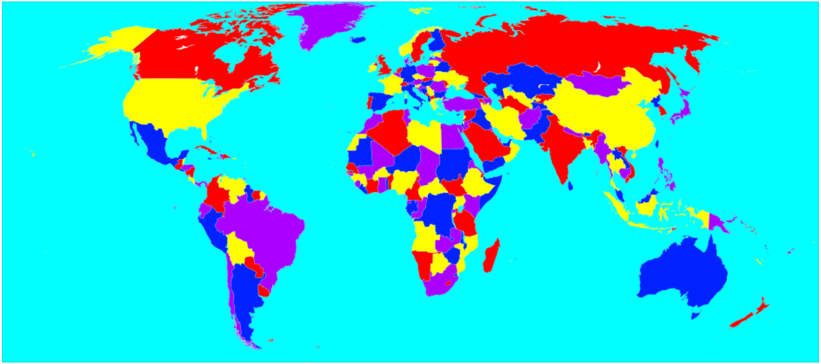
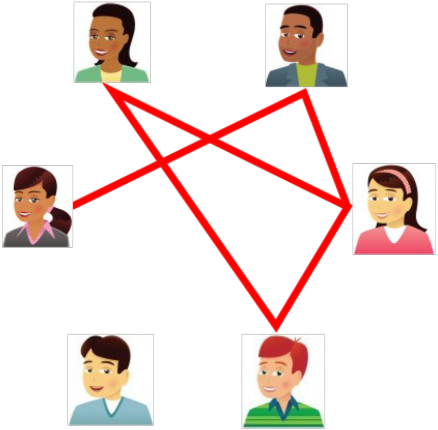
Coloring of graphs – is every political map 4-colorable?



(Appel-Haken: resolved after $>$ 100 years, proof needs computer)

Ramsey Theory – complete disorder is impossible!



(1950's in Hungary, sociologist Sandor Szalai observed:
among $\sim$ 20 children – always 4 s.t. all friends / no friendship. . .)

Questions?