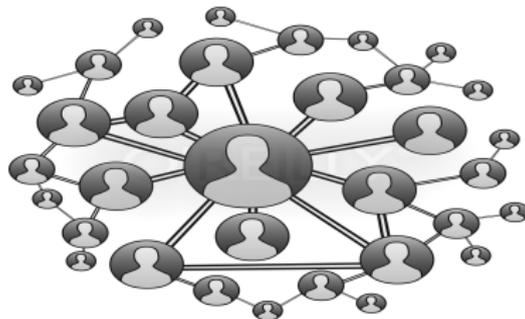


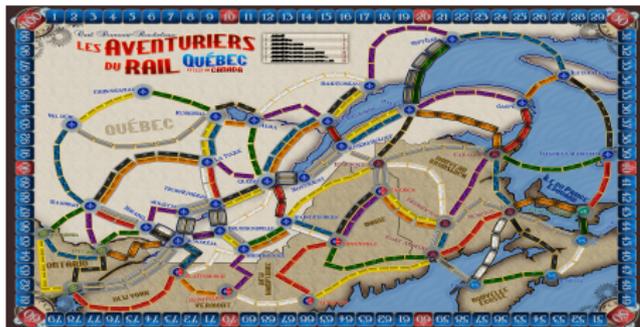
Road network between cities



Friendship on facebook



Ticket to Ride (board game)



Metro map of Montréal

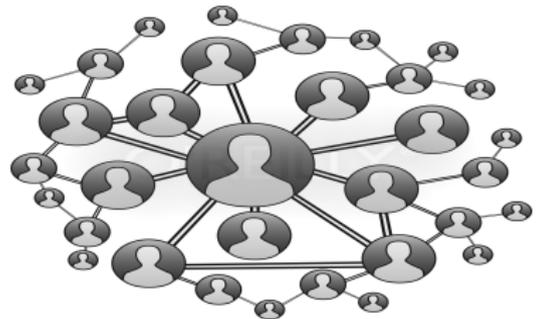


Road network between cities



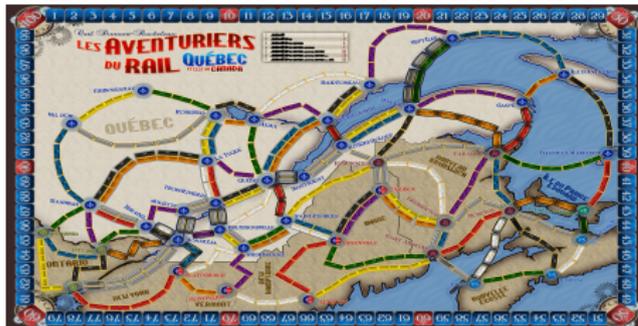
fastest route from Calgary to Québec

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: Monday and Wednesday 2:35-3:55 PM

Location: Burnside Hall 1B36

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

Assignments

- **Five** assignments in total
- Count for **20%** of your final grade

Midterm & Final exams

- **Midterm 20%** + **Final 60%** of your final grade
- **Final 80%** of your final grade (if better)
- Exams are open-book

Who is going to teach us?

Instructor: Jan Volec
Office: Burnside Hall, room 1131
Office hours: ~~Mon, 4:00-6:00~~ Tue, 2:00-4:00 PM and by appointment
Email: jan [at] ucw [dot] cz
Homepage: <http://honza.ucw.cz>

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(...arrived to Canada from Europe < 48 hours ago ...)

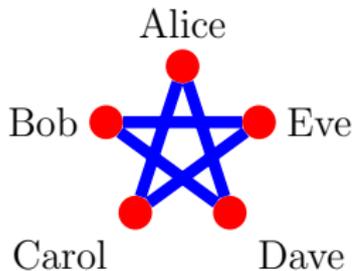
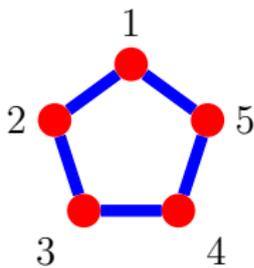
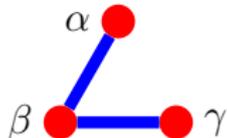
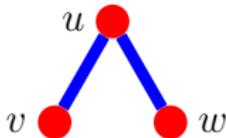
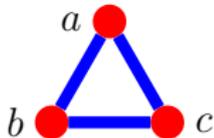
Questions?

Let's start...

graph $G := (V, E)$

V – (finite) set of Vertices

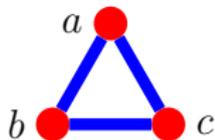
$E \subseteq \binom{V}{2}$ – set of Edges



graph $G := (V, E)$

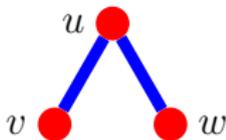
V – (finite) set of Vertices

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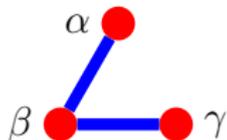
$V = \{a, b, c\}$

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



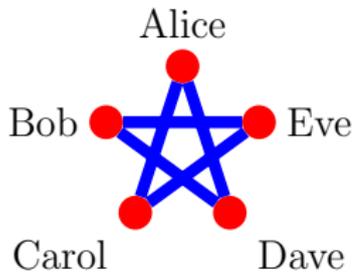
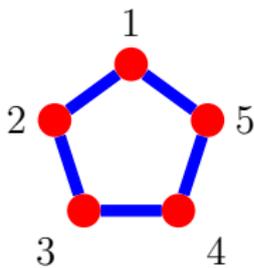
$V = \{u, v, w\}$

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



$V = \{\alpha, \beta, \gamma\}$

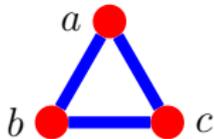
$E = \{\{\alpha, \beta\}, \{\alpha, \gamma\}\}$



graph $G := (V, E)$

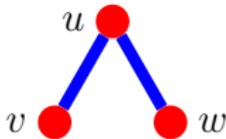
V – (finite) set of Vertices

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



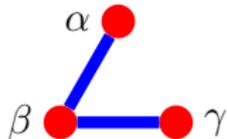
$V = \{a, b, c\}$

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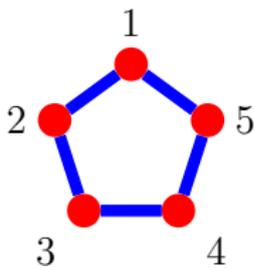
$V = \{u, v, w\}$

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



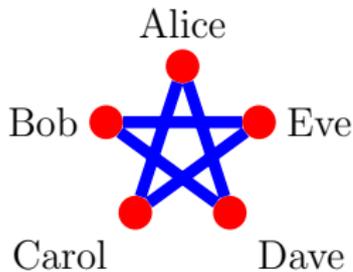
$V = \{\alpha, \beta, \gamma\}$

$E = \{\{\alpha, \beta\}, \{\alpha, \gamma\}\}$



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

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



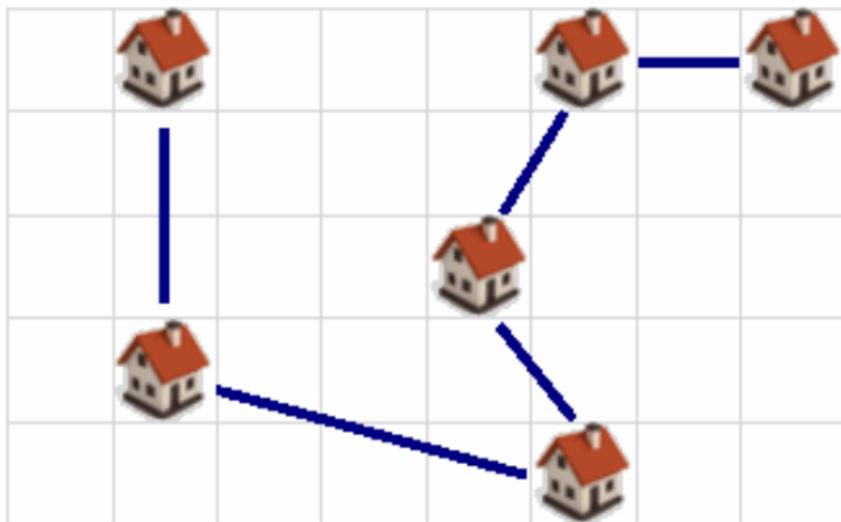
$V = \{A, B, C, D, E\}$

$E = \{\{A, C\}, \{C, E\}, \{E, B\}, \dots\}$

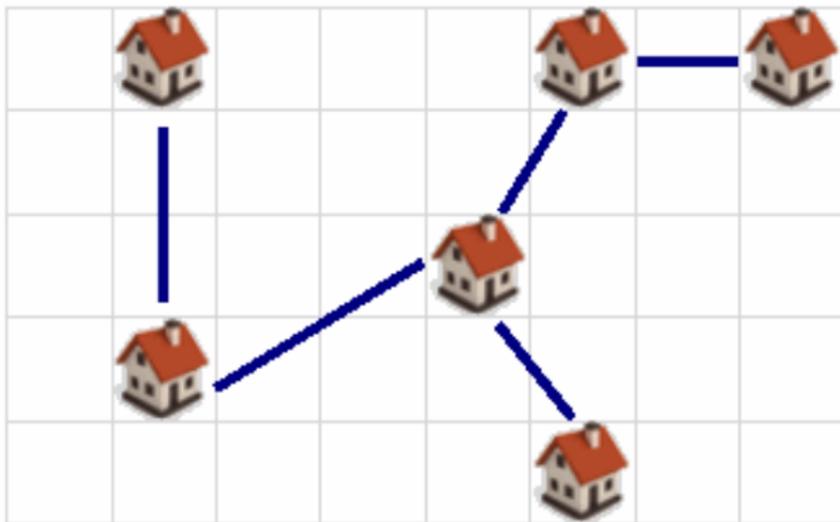
Connect houses with electric wires / optical cables



Connect houses with electric wires / optical cables

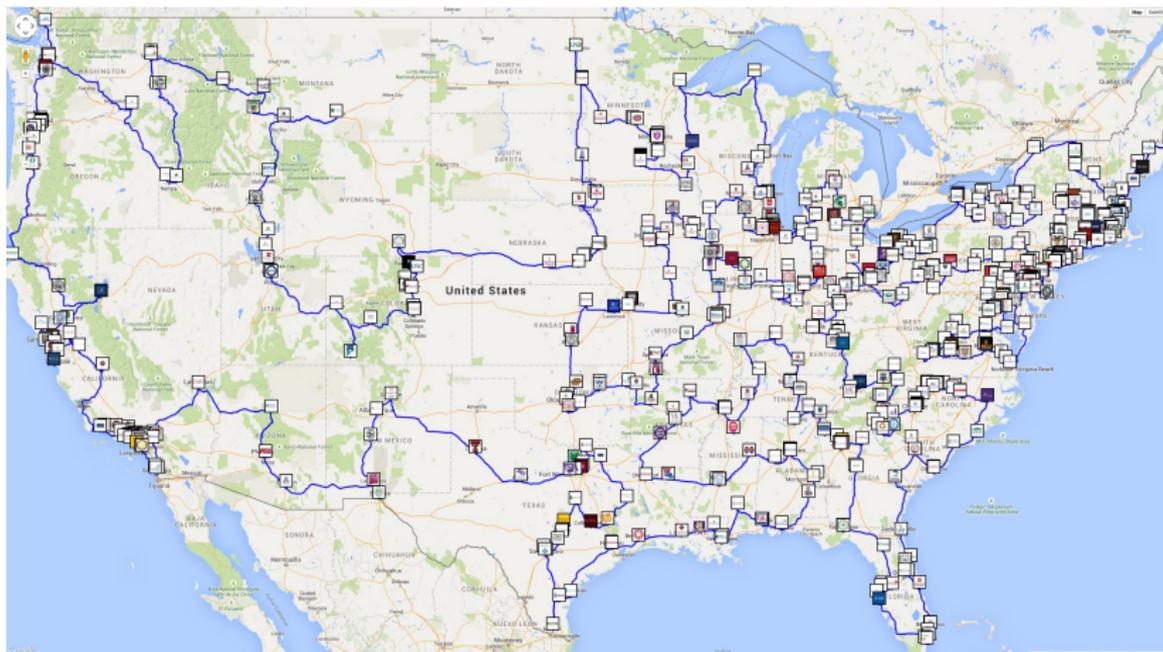


Connect houses with electric wires / optical cables



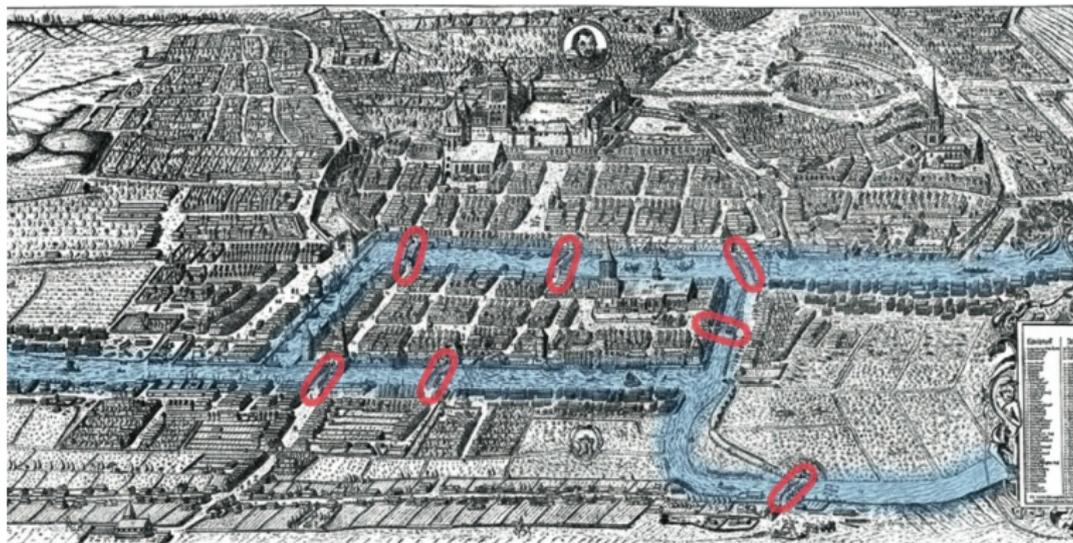
(1st algorithm by Otakar Borůvka in 1926 for electricity in Moravia)

Queen of College tours – shortest roadtrip for 647 colleges



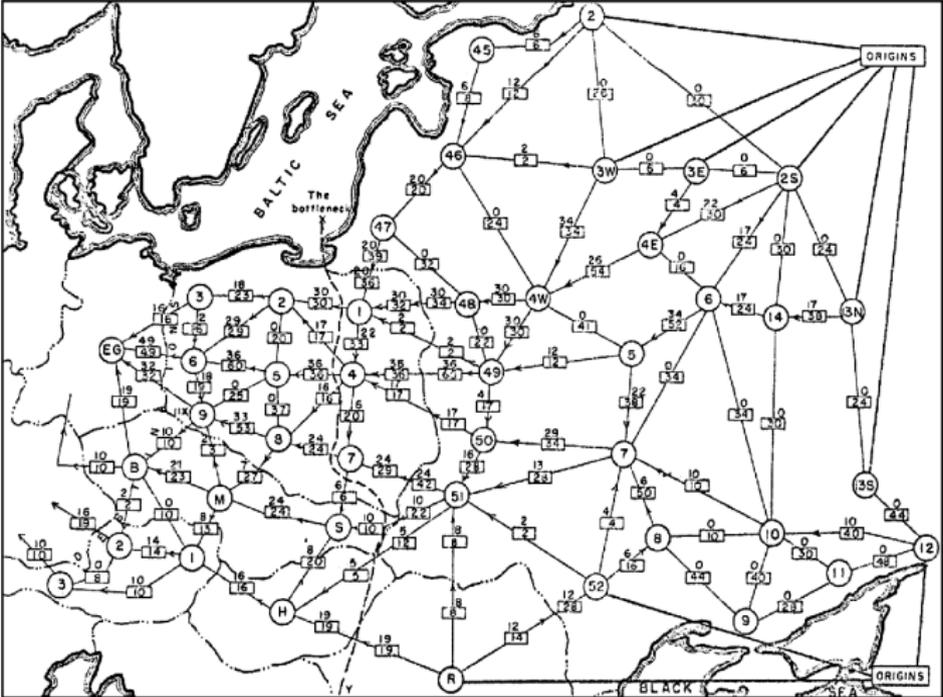
(tour found in 2015 by William Cook from University of Waterloo)

Seven bridges of Königsberg puzzle – cross each just once?



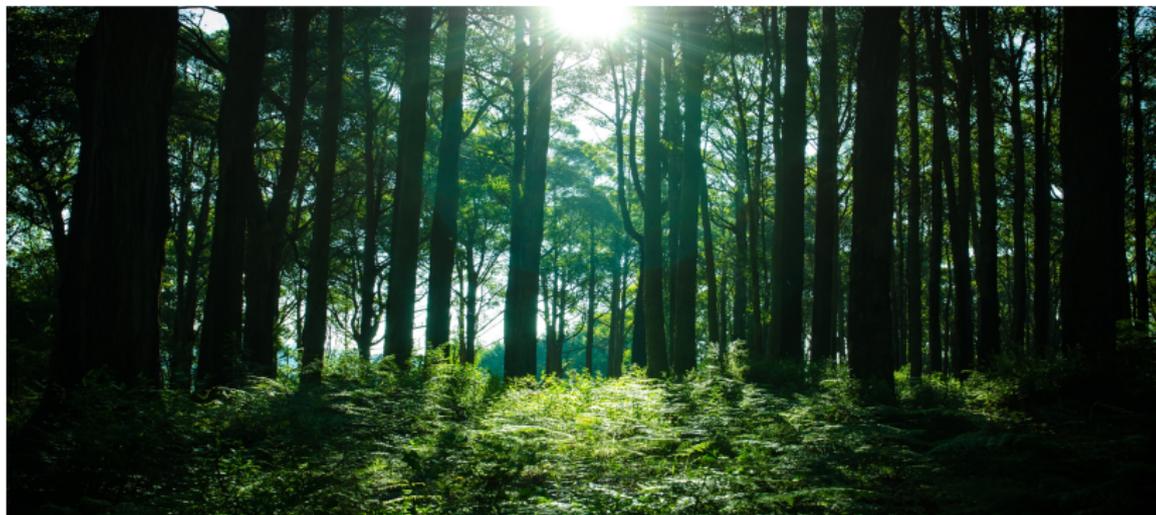
(solved by Euler in 1736)

Disconnect railway between Soviet Union and East Europe

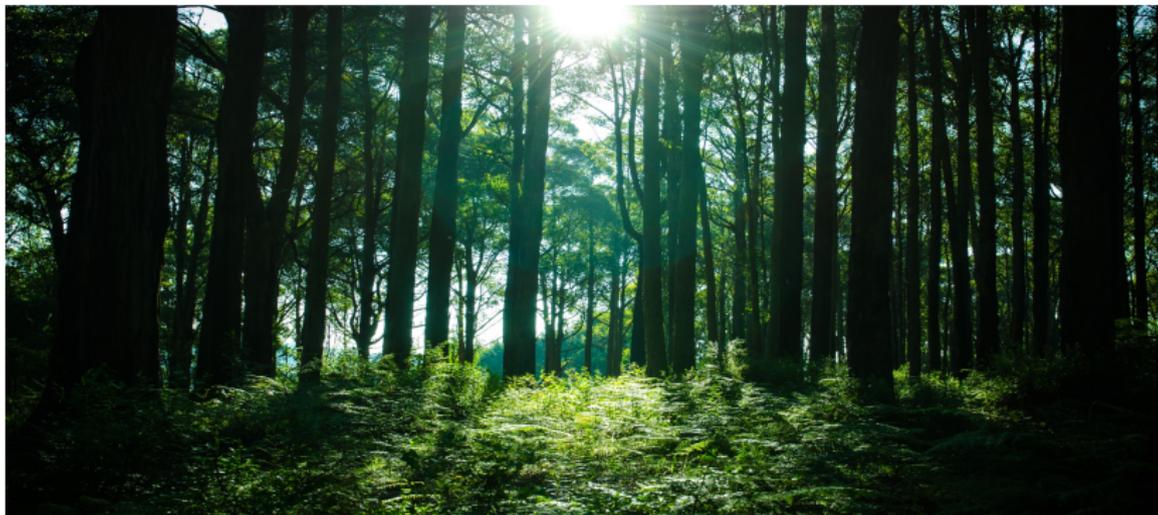


(from 1955 secret report by Harris and Ross)

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



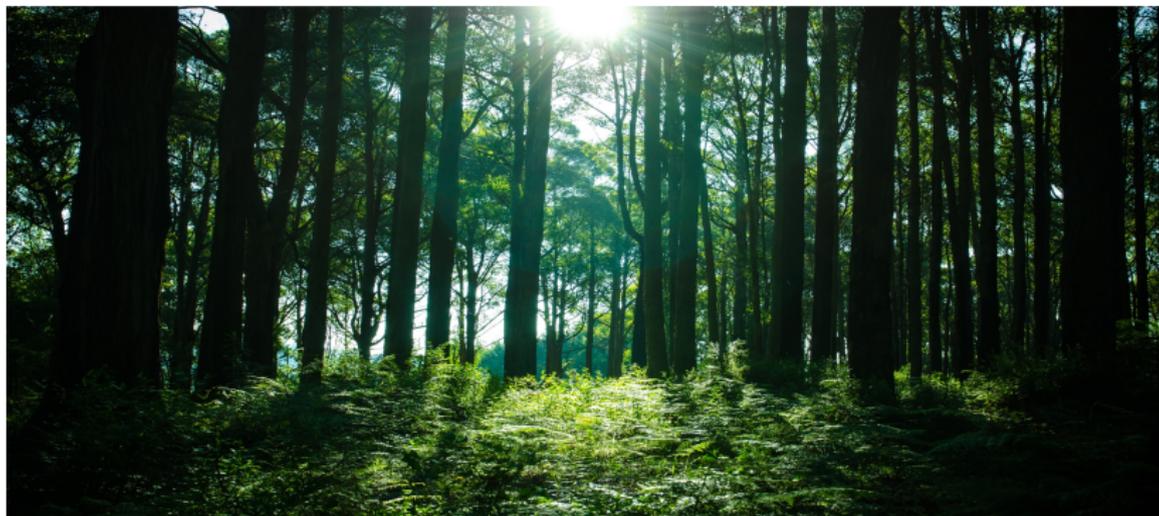
Don't get lost in forest / Is this graph theory problem?!



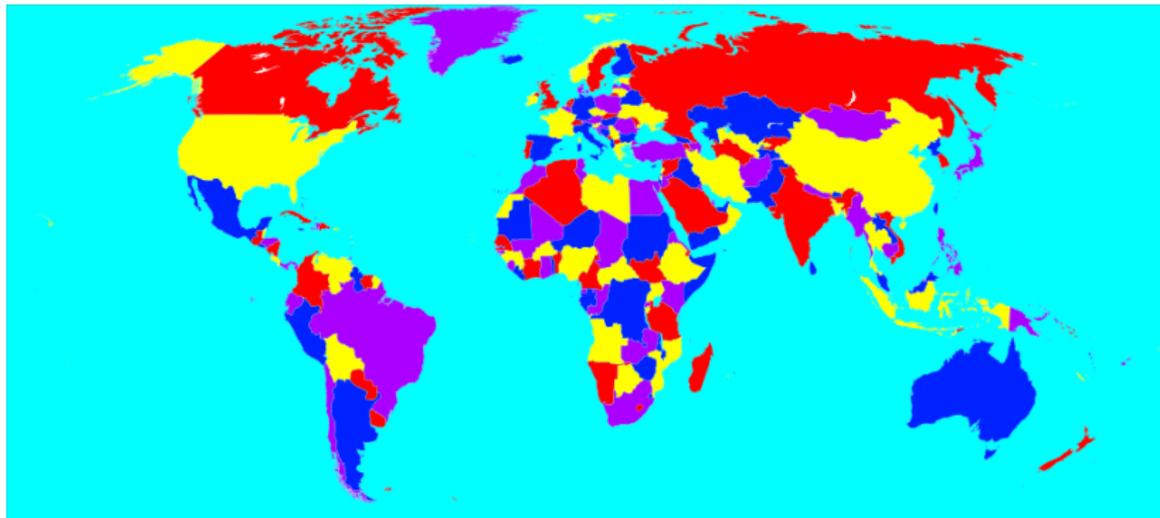
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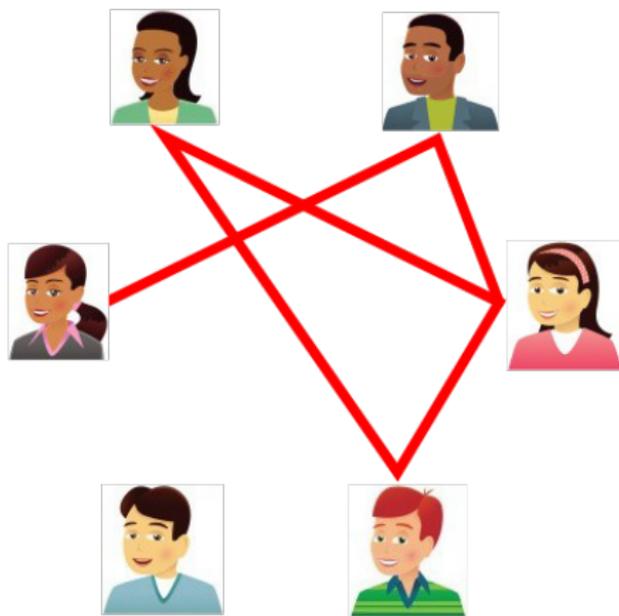


Coloring of graphs – is every political map 4-colorable?



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

Ramsey Theory – complete disorder is impossible!



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

Questions?