Flow behind enemy lines

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Description

Find a maximum flow and the corresponding minimum cut in a flow network that describes the railway system of the Eastern Bloc during the Cold War.

We're behind on the five year plan! The party secretary from Minsk has been tasked with reducing the capacity of one or two railway lines by 10 or 20 kilotons per day. Luckily, you have acquired data about the full Soviet railway system from an American double agent.

Requirements

Your algorithm successfully computes a maximum flow and a minimum cut on the Americans' data.

Moreover, you can use it to study the situation when you reduce the capacities on the lines from division 4W to divisions 48 and 49. Analyze the effects of reducing their capacities to 10 or 20 (on either or both).

Deliverables

1. The source code for your implementation
2. A report in PDF. Use the report skeleton in the `doc` directory.

Sources

The image on the next pages shows the Soviet railway network from T. E. Harris, F. S. Ross, "Fundamentals of a Method for Evaluating Rail Net Capacities", US Air Force Project RAND research memorandum RM–1573, October 24, 1955, declassified on 13 May 1999. You can find the original document on the net. Cool stuff. Print it and leave it on your desk, to impress friends and family.

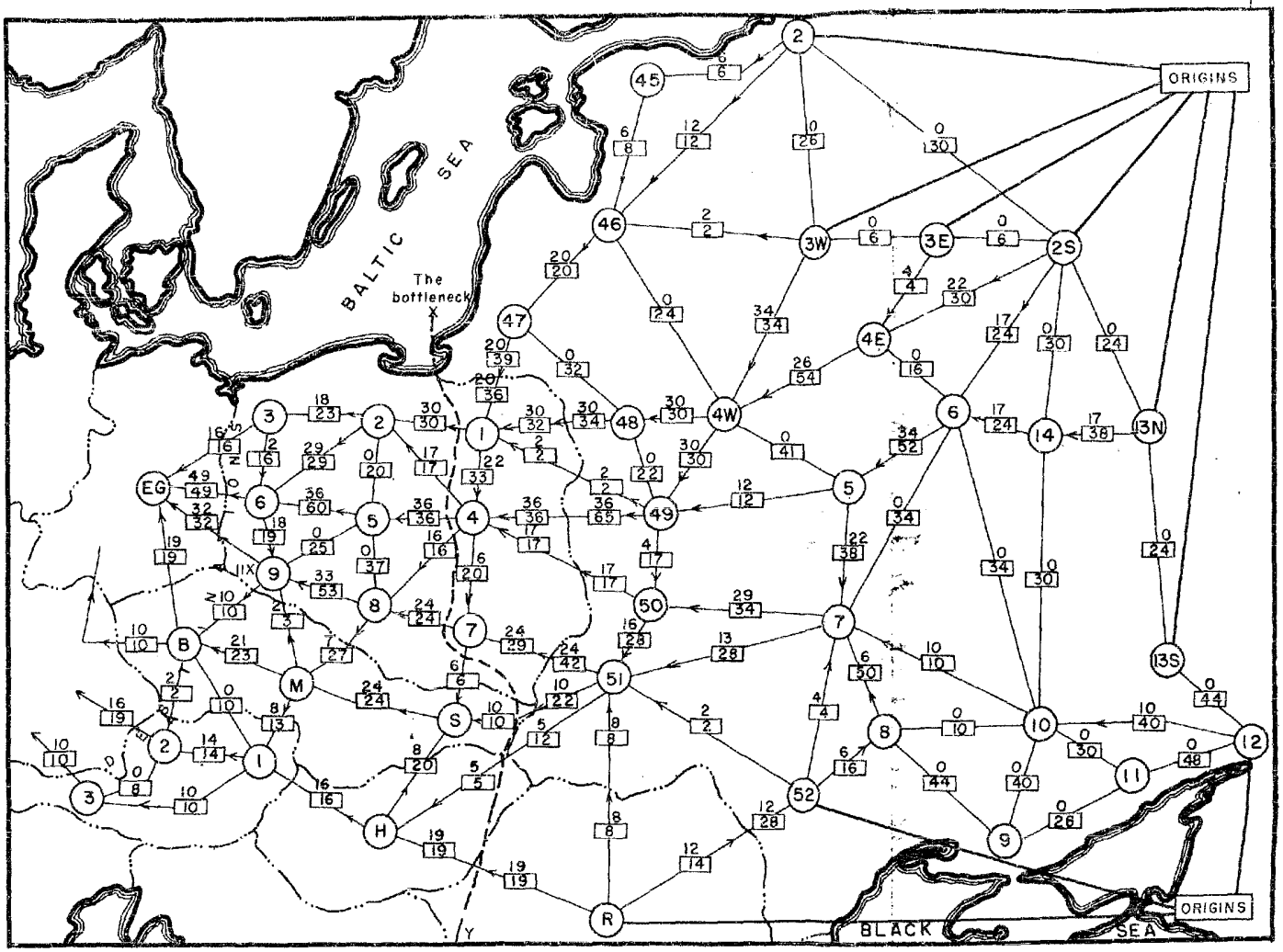

Fig. 7 — Traffic pattern: entire network available

Legend:

—·· —— International boundary

(8) Railway operating division

9/12 Capacity: 12 each way per day. Required flow of 9 per day toward destinations (in direction of arrow) with equivalent number of returning trains in opposite direction

All capacities in {trains / 1000's of tons} each way per day

Origins: Divisions 2, 3W, 3E, 2S, 13N, 13S, 12, 52 (USSR), and Roumania

Destinations: Divisions 3, 6, 9 (Poland); B (Czechoslovakia); and 2, 3 (Austria)

Alternative destinations: Germany or East Germany

Note IIX at Division 9, Poland

Assumption:

Entire network available for east–west traffic (no allowance for civilian or economic traffic)

Results:

(a) 163,000 tons per day can be delivered from points of origin to destinations.
(b) 147,000 tons per day can be delivered without using Austrian lines.
(c) 152,000 tons per day can be delivered into Germany by all lines.
(d) 126,000 tons per day can be delivered into East Germany without using Austrian lines.