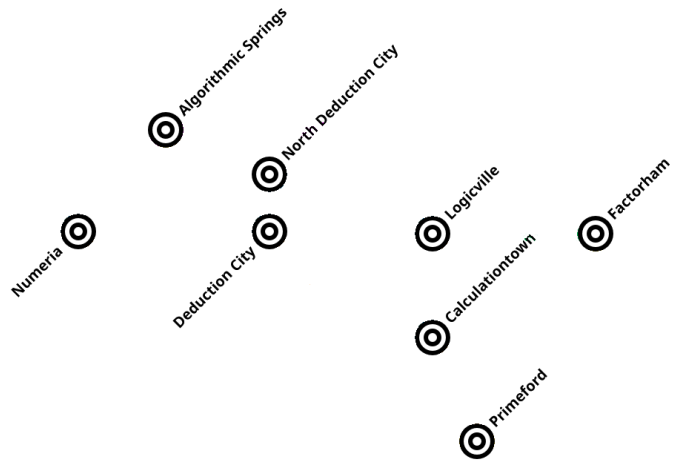
Names: _____ & _____

Fractalia City Rail

The railway company that looks after the train network in Fractalia City has decided to shut down one or more rail lines to reduce the cost.

- **Identify** which lines can we remove while still keeping all the stations directly or indirectly connected.
- **Sketch** your solution, showing the remaining rail lines.
- **Consider** the network before the changes were made. Travellers don't like to transfer between lines. Find the worst-case number of transfers a passenger would need to make travelling between stations on this network.
- **Compare** this to the worst-case scenario of a passenger travelling on your reduced network.



Names: _____ & _____

Tri-hex

Thomas O'Beirne created a new version of Tic-Tac-Toe.

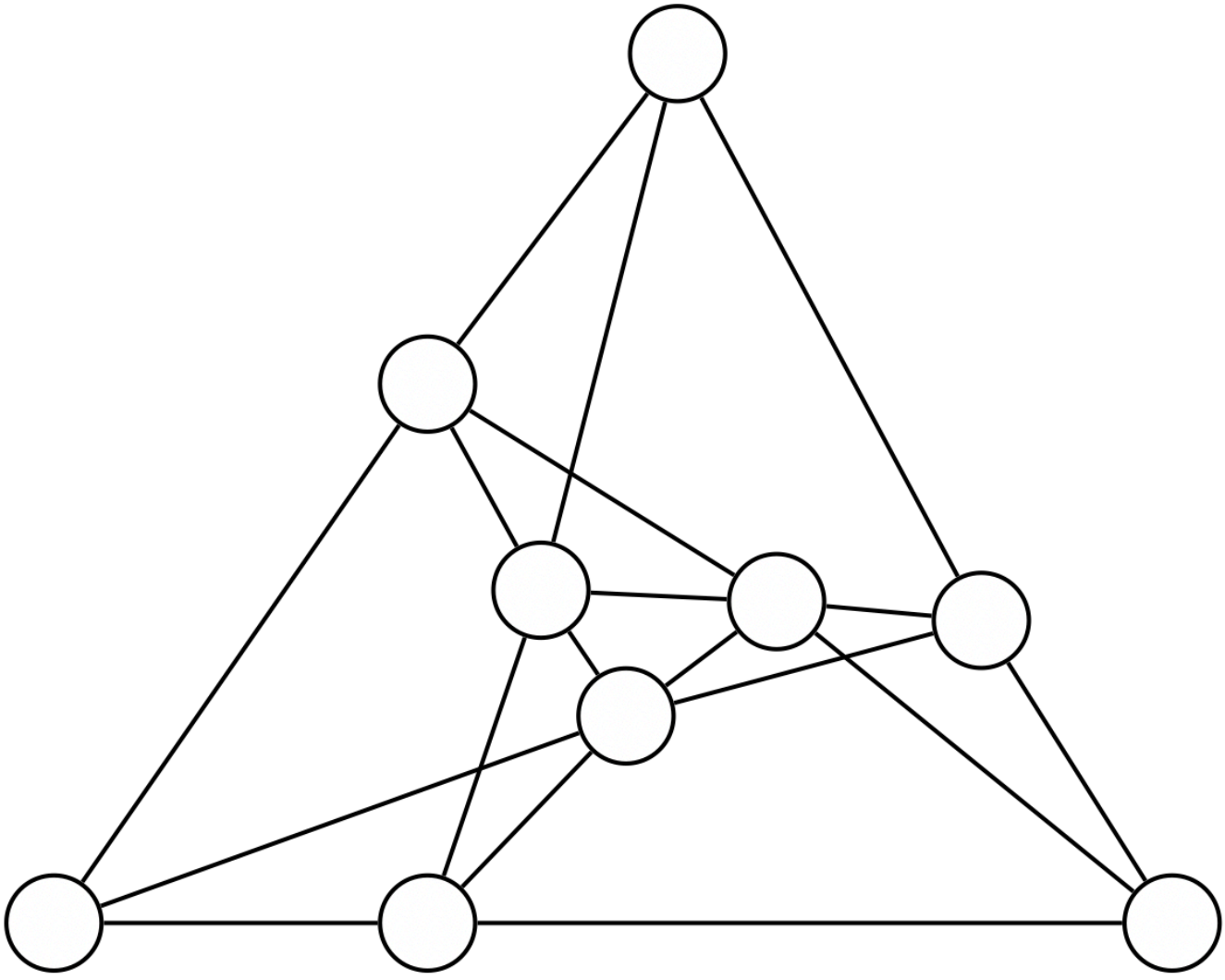
Each player has 4 counters.

The goal is to have 3 counters next to each other on a line.

Once all counters are on the board, players take turns to move one.

New Scientist

11 January 1962



Connecting Nodes - Game

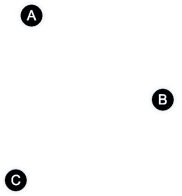
Take turns connecting **nodes**.

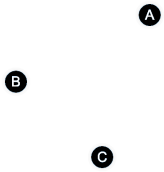
Make sure your connecting **arcs** look different to your partner's connecting **arcs**.

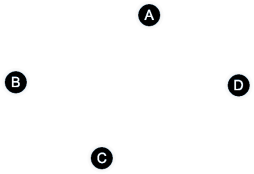
You cannot cross through an arc that has been drawn.

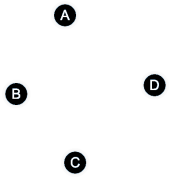
The first player who cannot connect 2 nodes (that are not already connected) without crossing through an arc loses the match.

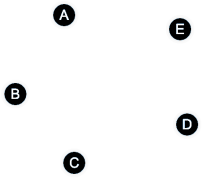
- **Investigate** networks that can be won by whoever goes first, or whoever goes second.
- **Explore** ways of placing arcs that prevent particular nodes from being able to be connected.
- **Record** sets of nodes that were not able to be connected.

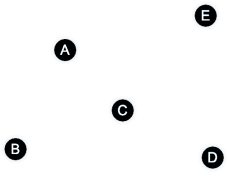


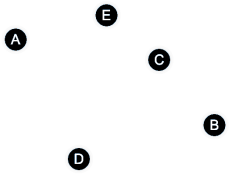


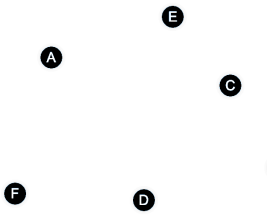


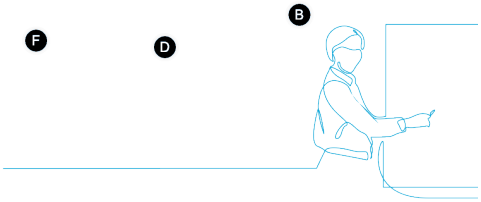












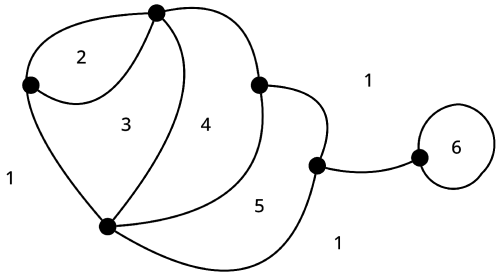
Arcs - Nodes - Regions

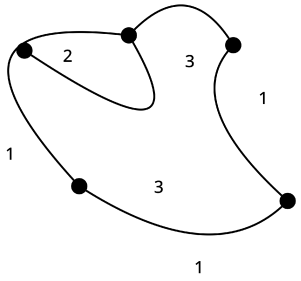
Here are 4 networks. They are shapes made up of arcs (lines), nodes (junctions) and regions (spaces).

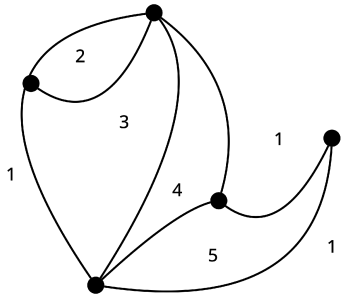
The regions are numbered for each network.

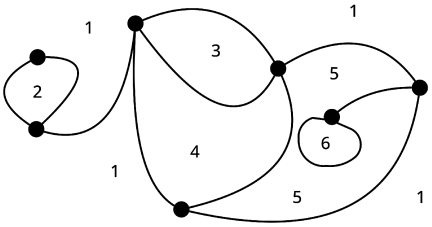
The outside is included as a region.

- **Draw** your own connected networks and record the number of arcs, nodes and regions.
- **Search** for a rule connecting the number of arcs, nodes and regions.
- Try to **explain** why your rule works.

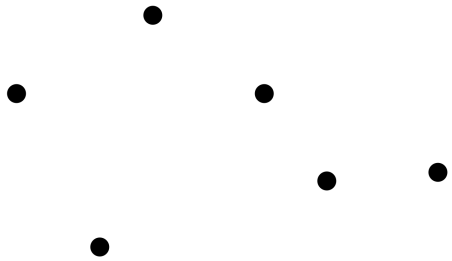


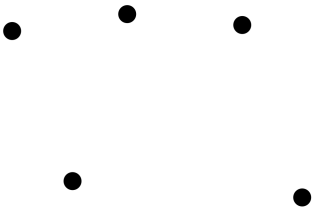


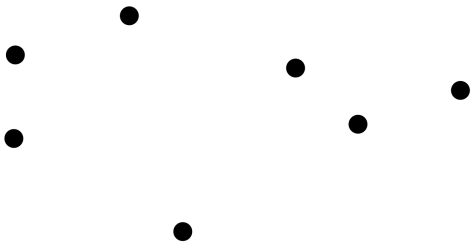


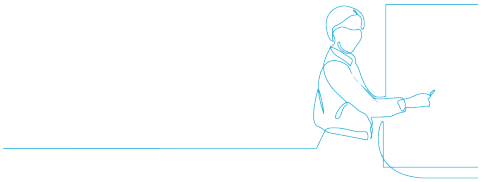


Nodes	Regions	Arcs	Rule?









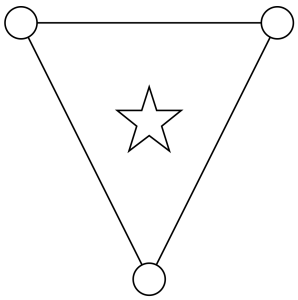
Names: _____ & _____

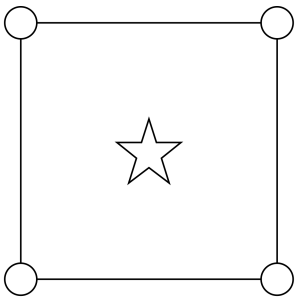
Exploring Eulerian Paths 1

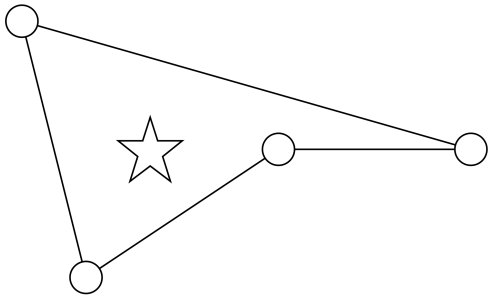
Mission 1: Find a path that starts at the star and crosses each arc of the network exactly once.

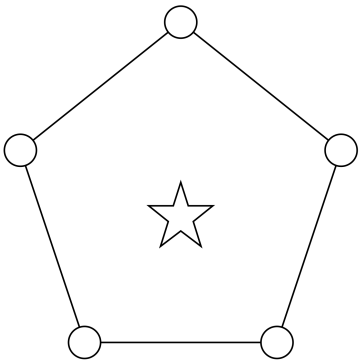
Mission 2: Find a path that starts at the star, crosses each arc of the network exactly once, and **finishes at the star.**

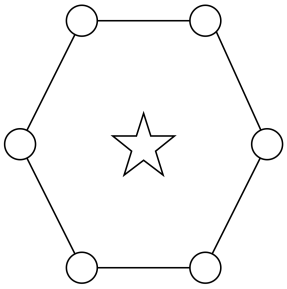
Mission 3: Identify the networks where neither of the above missions can be completed.

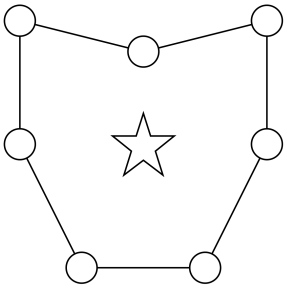


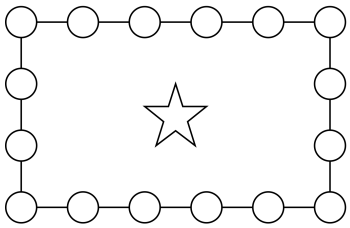


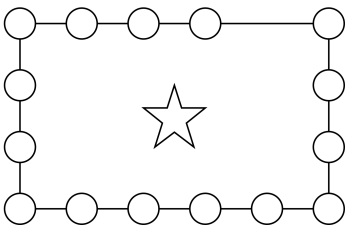


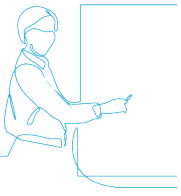












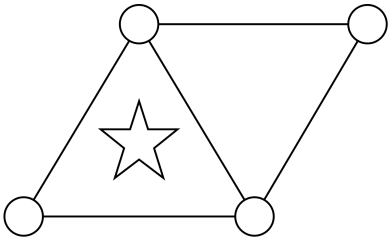
Names: _____ & _____

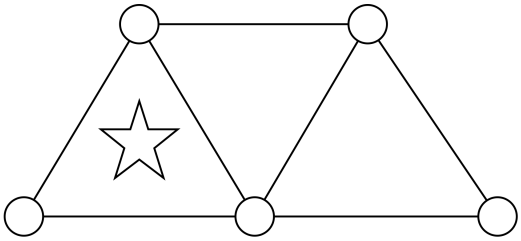
Exploring Eulerian Paths 2

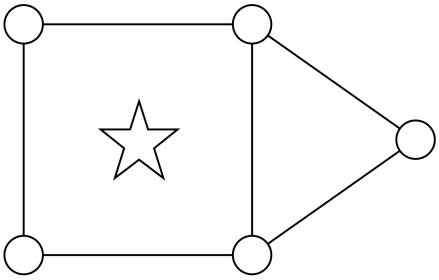
Mission 1: Find a path that starts at the star and crosses each arc of the network exactly once.

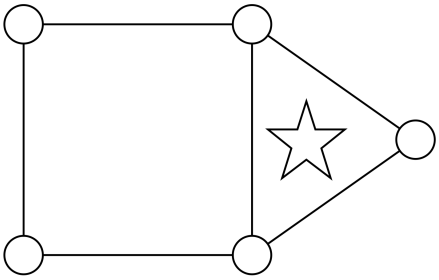
Mission 2: Find a path that starts at the star, crosses each arc of the network exactly once, and **finishes at the star.**

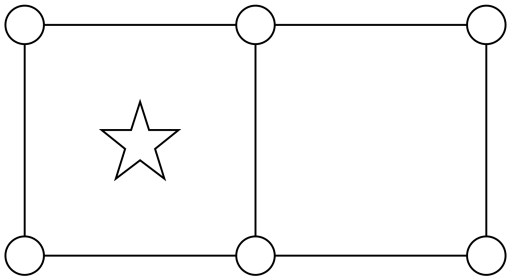
Mission 3: Identify the networks where neither of the above missions can be completed.

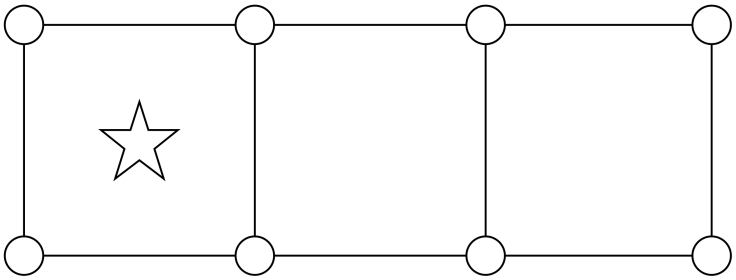


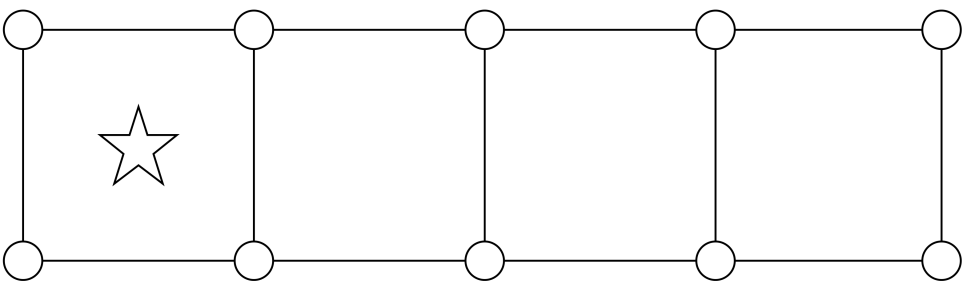












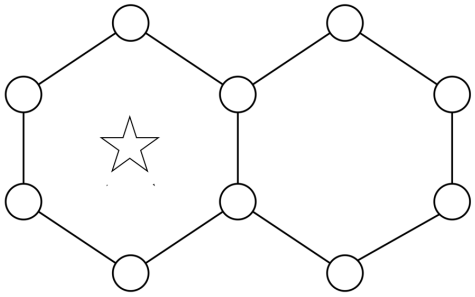
Names: _____ & _____

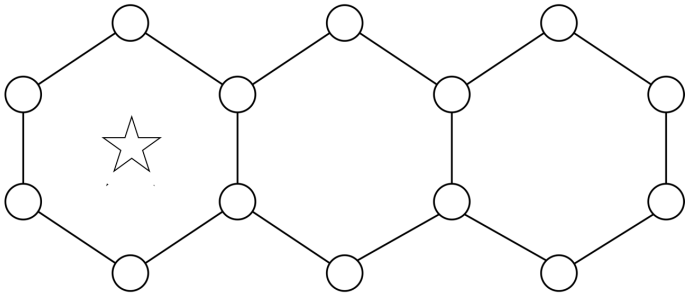
Exploring Eulerian Paths 3

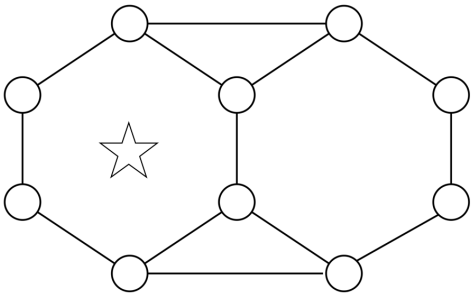
Mission 1: Find a path that starts at the star and crosses each arc of the network exactly once.

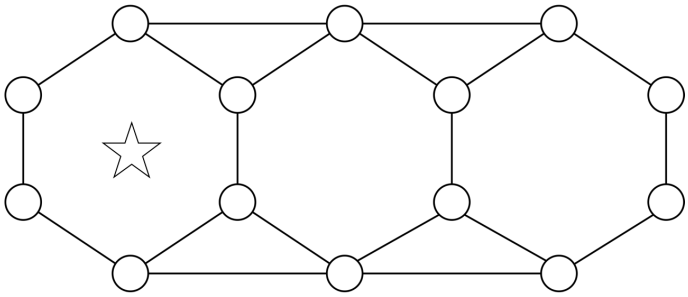
Mission 2: Find a path that starts at the star, crosses each arc of the network exactly once, and **finishes at the star.**

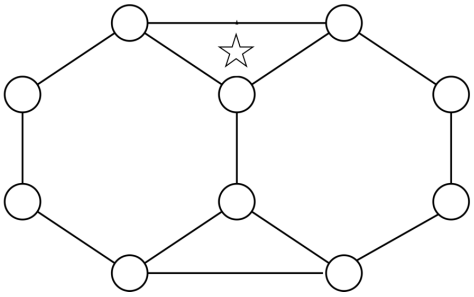
Mission 3: Identify the networks where neither of the above missions can be completed.

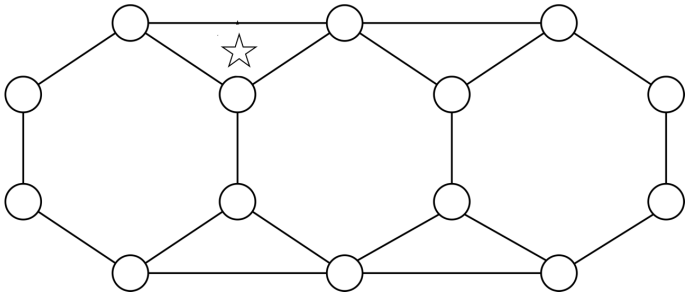






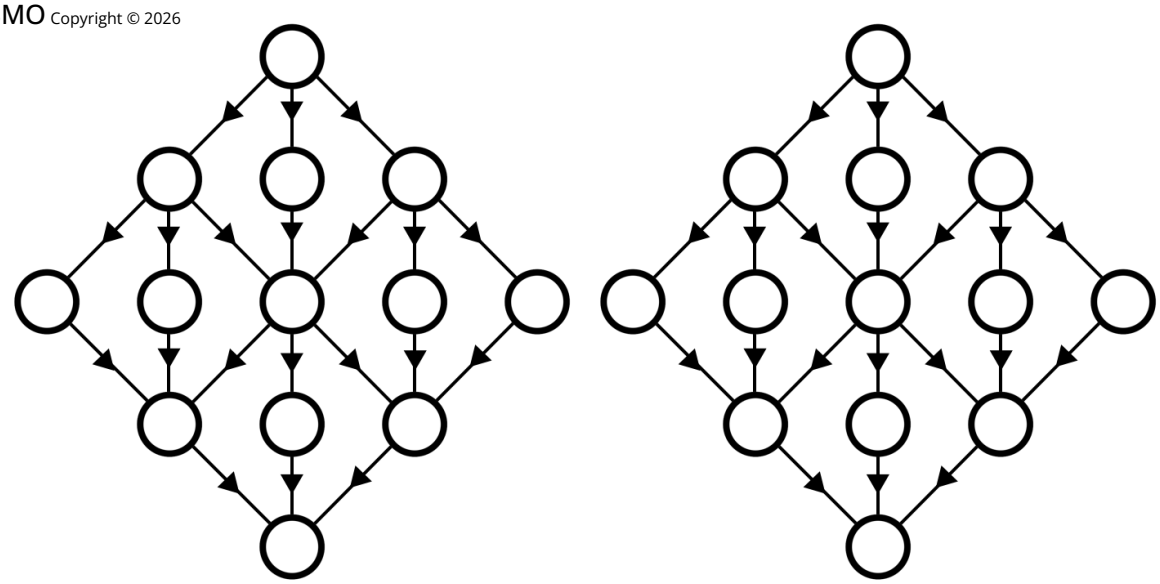




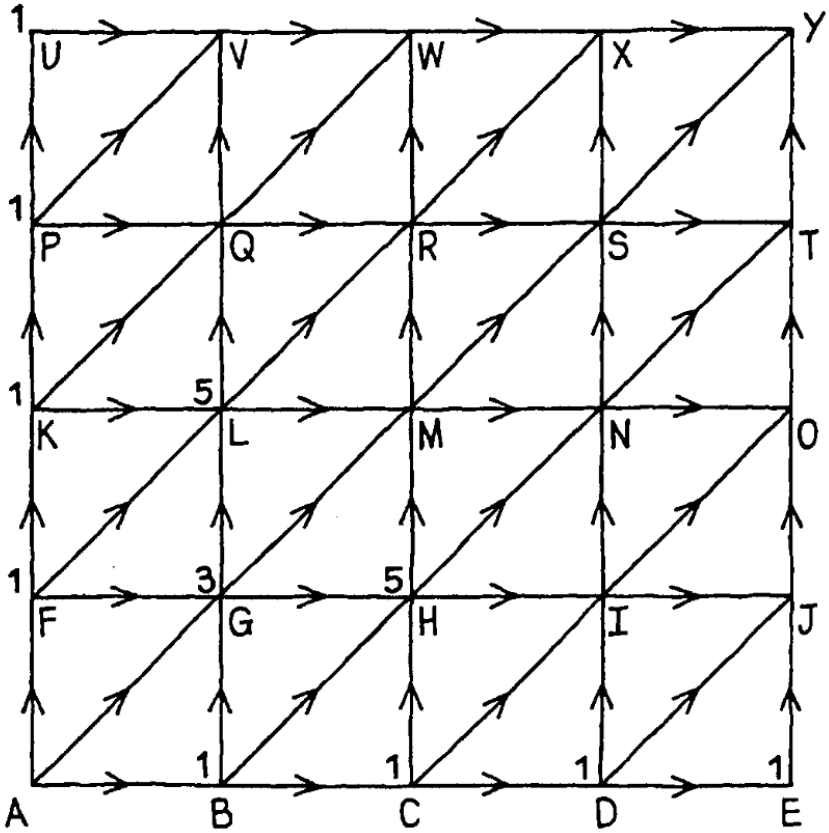


Good Paths

Given the graph shown, Abigail moves a piece from the top point to the bottom point.
She must move downwards, in either a straight or sideways direction.
How many different pathways are possible?



A good path is always moving away from A.
Is ABCH a good path from A to H? Is ABHG a good path from A to G?
Is there a good path from A to R that goes through D?
Are all good paths from A to another given point the same length?



Names: _____ & _____

Problem Solving with Networks - Esther's Dilemma

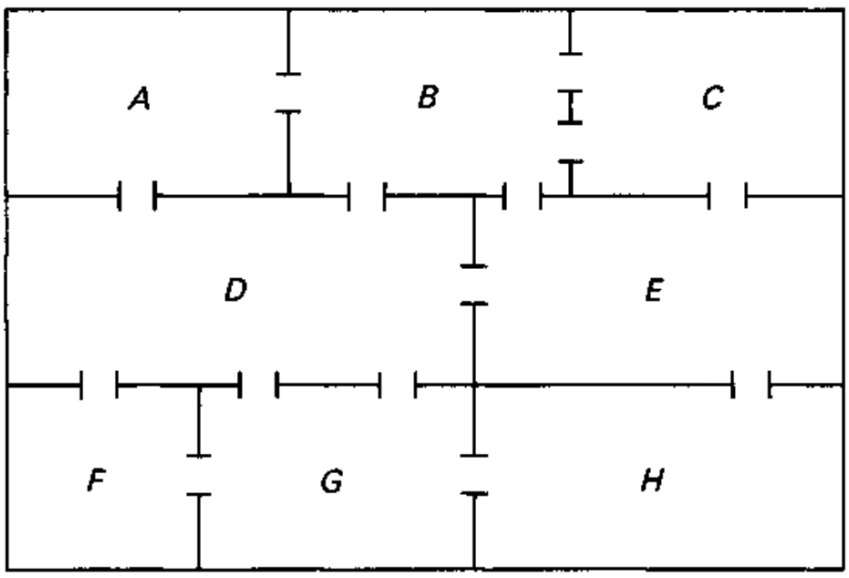
Esther McDougall lived on the ground floor of a very old Scottish manor house.

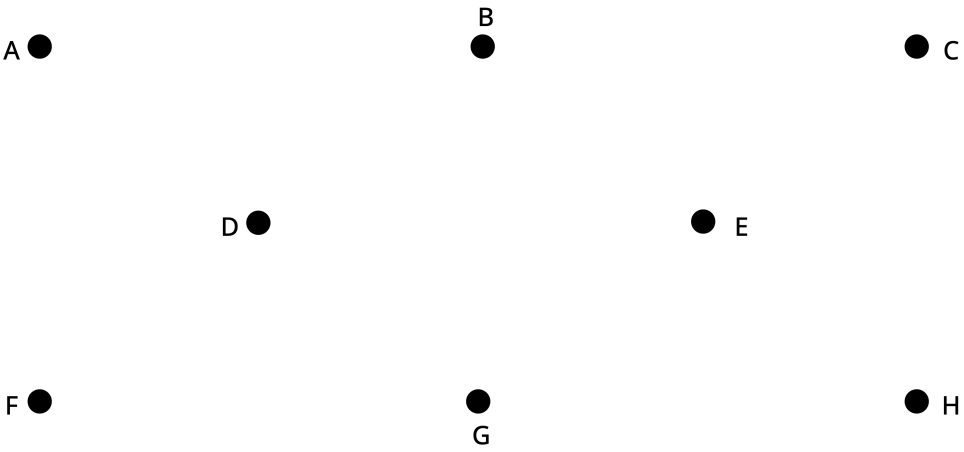
It had no corridors, but access between rooms was easily made using the many connecting doorways.

Since an early age Esther had often set herself the task, on a cold winter's day, of trying to find a route around her abode which passed through each of the internal doorways once only.

She is getting very frustrated at her lack of success and would dearly like to know whether or not a route is possible.

Can you help her?





Names: _____ & _____

Problem Solving with Networks - Japanese Water Garden

A Japanese water garden had been designed by damming a stream to form a large lake, creating three islands and building a number of bridges and stepping stones connecting them as shown.

The garden was very popular with the public, who flocked to see it in large numbers, particularly at holiday times. The result was that the narrow bridges became very congested and the visitors disillusioned at having to queue to cross them.

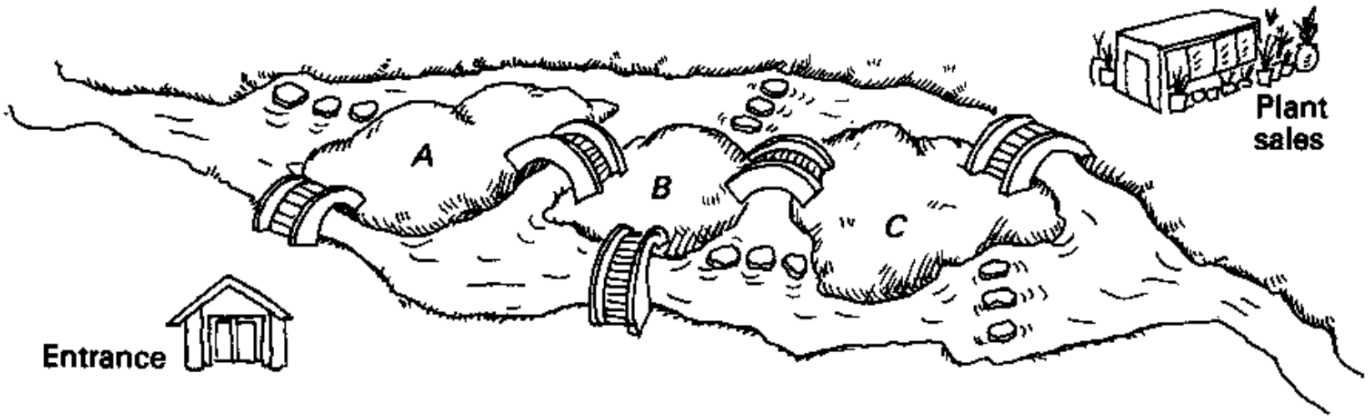
The head gardener decided that, to avoid the confusion, he would need to devise a route so that having entered at the south bank the visitors would cross the bridges and stepping stones in a predetermined order, crossing each one once, and ending up at the plant sales area before leaving.

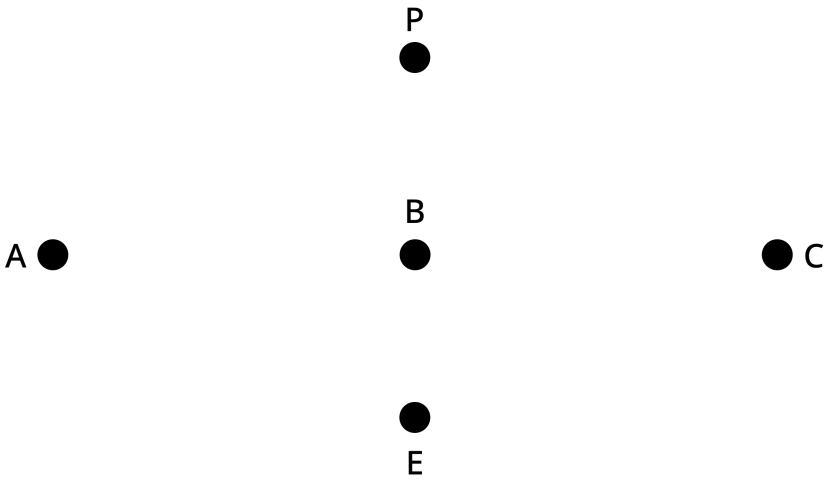
However, try as he could, he seemed unable to find such a route.

But his young assistant, Bridget Oiler, soon saw how to solve the problem by building another bridge.

Where would she build it?

Brian Bolt - A mathematical Pandora's box © Cambridge University Press 1993





 Names: _____ & _____

Problem Solving with Networks - Tree Transport

In forest (A) is an area where the beavers fell trees for their dams.

They transport the tree trunks to their new project - the biggest dam of all times (D) - through an infrastructure of channels.

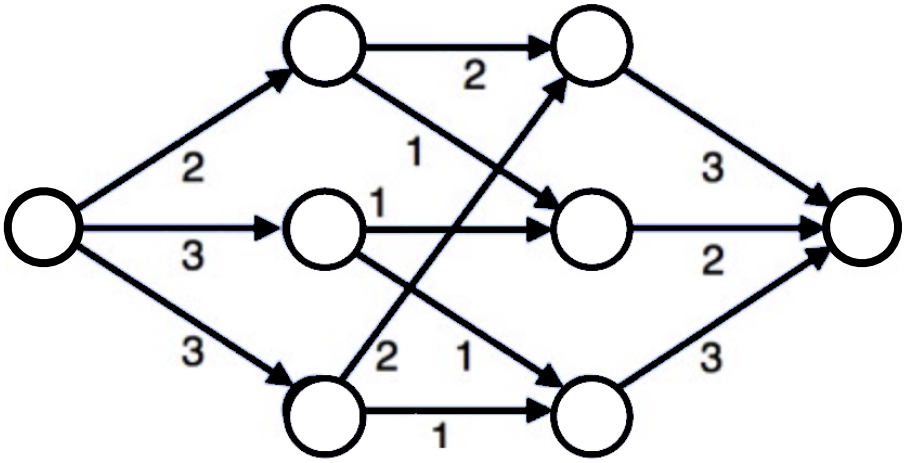
The arrows represent the channels, the dots are points where the water splits up or comes together.

Every channel has a restricted capacity.

The numbers next to the channels show how many tree trunks can be transported through the channels in one minute.

How many tree trunks can be transported from A to D at most in one minute?

Bebras Australia Computational Thinking Challenge 2014



Optical Network

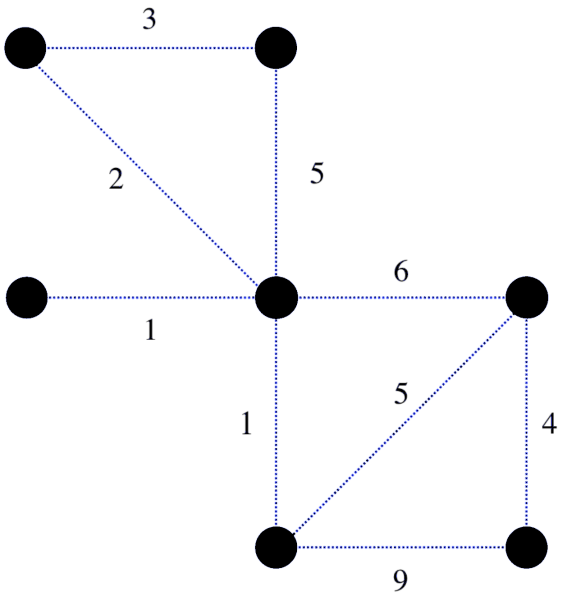
An internet service provider (ISP) wants to set up a new network.

There are seven cities which have to be connected so that every city can send and receive messages from any other city. The company has to pay to setup links between cities. The costs are shown on the lines linking the cities below.

Question:

Select the links that should be built to connect the cities with the least cost.

Bebras Australia Computational Thinking Challenge 2019

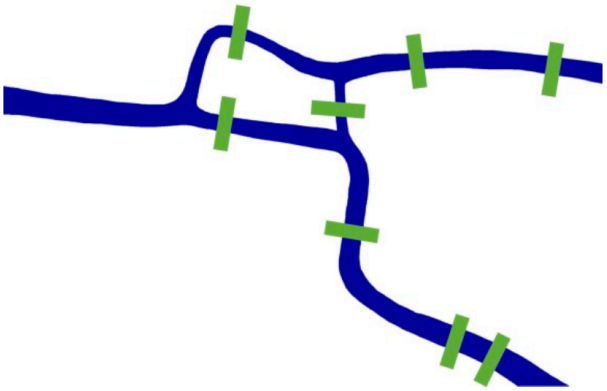


Names: _____ & _____

Problem Solving with Networks - The Bridges

Open Educational Resource University of Edinburgh

Kalingrad



Budapest

Gdańsk