

# Unit 2 Homework: Graphs and Networks

Course: Algorithmic Information Dynamics: A Computational Approach to Causality and Living Systems From Networks to Cells

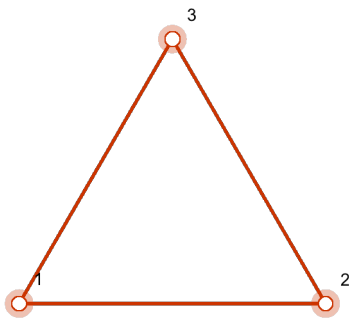
Hector Zenil and Narsis A. Kiani

Course available at the Sta Fe Institute MOOC platform the Complexity Explorer at: <https://www.complexityexplorer.org/courses/63-algorithmic-information-dynamics-a-computational-approach-to-causality-and-living-systems-from-networks-to-cells>

Out[79]= Tue 3 Jul 2018 18:14:21

## ■ Question 1

What is the adjacency matrix of the following graph:



Answer:

## ■ Question 2

Can you determine from looking at this adjacency matrix if it represents a directed or an undirected graph?

$$\text{AdjacencyGraph}\left[\begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{pmatrix}\right]$$

Answer:

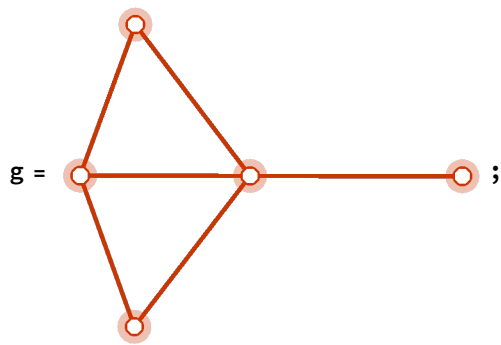
### ■ Question 3

Write down the adjacency matrix of a completely disconnected graph of 5 nodes in which every node has only a self-loop.

Answer:

### ■ Question 4

What is the degree distribution of the following graph? Sort the result from greatest to lowest degree.

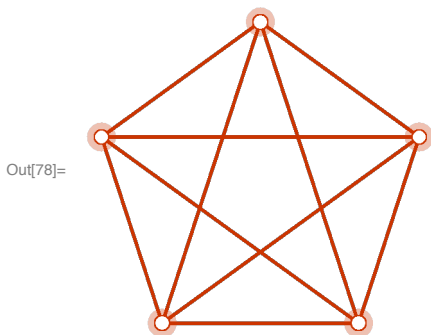


Answer:

### ■ Question 5

If relaxing the low degree requirement and only caring about node distance, is the following graph a small-world graph?

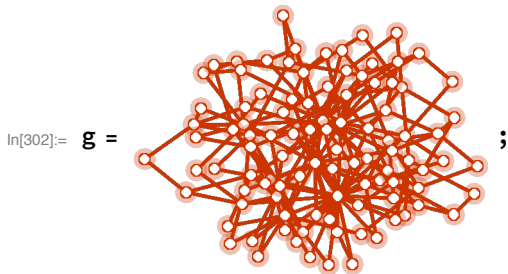
In[78]:= `CompleteGraph[5, ImageSize -> Small, PlotTheme -> "Web"]`



Answer:

### ■ Question 6

Is the following an example of a scale-free network?



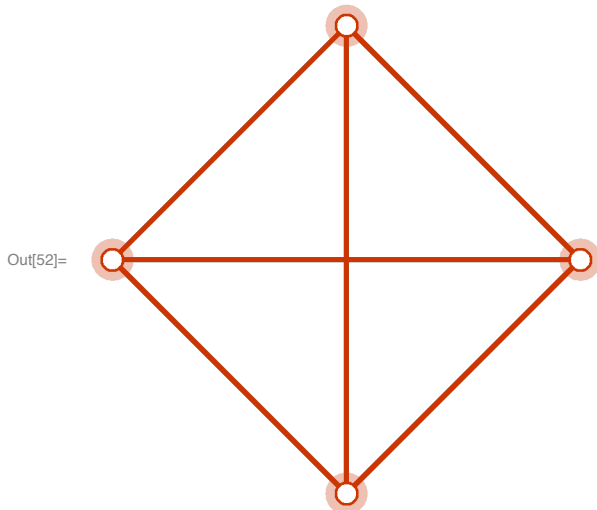
With degree distribution sorted from largest to smallest degree:

```
In[43]:= Reverse[Sort[VertexDegree[g]]]
Out[43]:= {31, 24, 18, 13, 10, 9, 8, 7, 7, 7, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 4,
4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,
3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2}
```

Answer:

### ■ Question 7

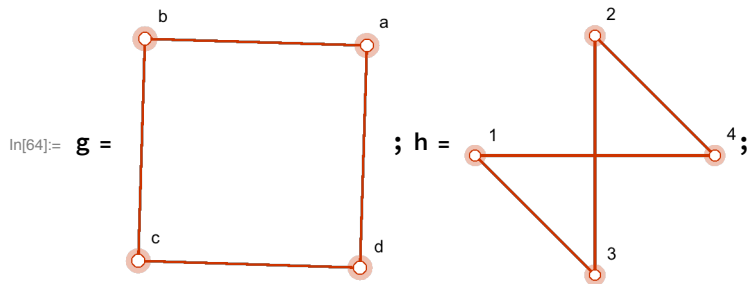
What is the graph spectrum of the Tetrahedral graph (sort it from largest to lowest eigen value)?



Answer:

### ■ Question 8

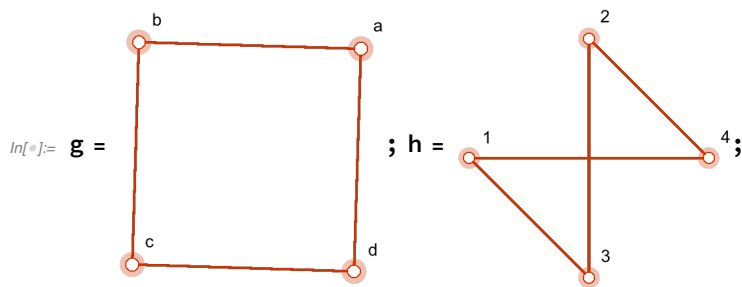
Are  $g$  and  $h$  isomorphic graphs? Justify (or provide mapping)



Answer:

### ■ Question 9

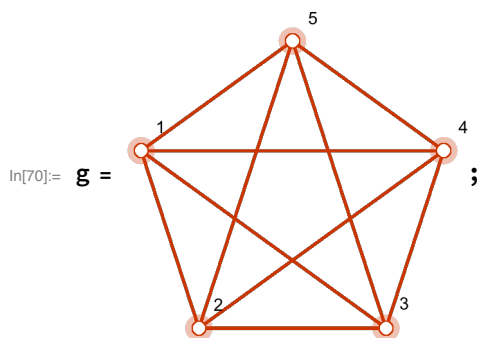
Are these two graphs co-spectral?

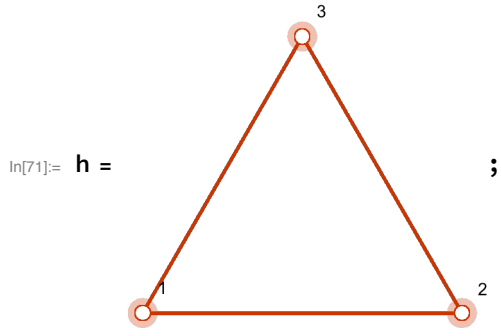


Answer:

### ■ Question 10

Is  $h$  a subgraph of  $g$ ?





Answer: