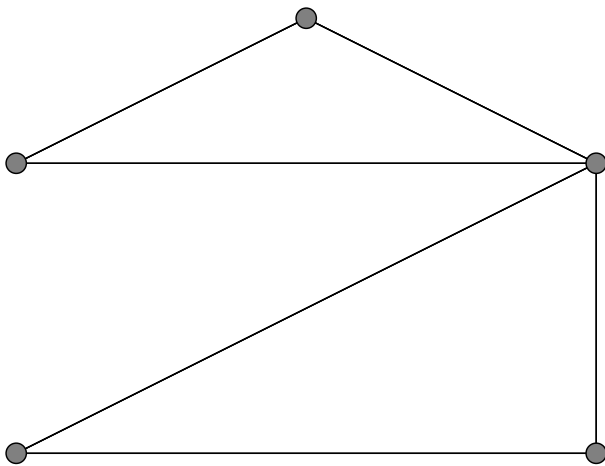


[Tableau de bord](#) / [Mes cours](#) / [SD212](#) / [Exam](#) / [Exam](#)**Commencé le** mardi 25 juin 2024, 09:30**État** Terminé**Terminé le** mardi 25 juin 2024, 11:21**Temps mis** 1 heure 51 minQuestion **1**

Correct

What is the clustering coefficient of the node of highest degree in this graph?



Type an integer or an irreducible fraction (e.g., 2/3)

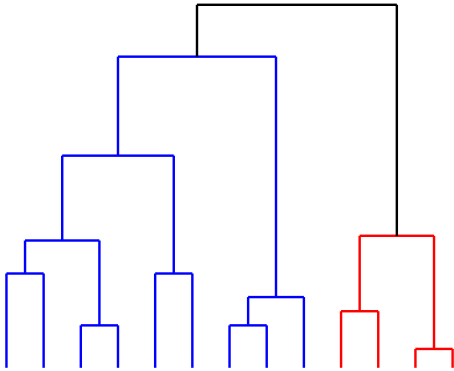
Réponse : 

La réponse correcte est : 1/3

Question **2**

Correct

What are the sizes of the top-4 clusters associated with this dendrogram?



Type your answer as a list of space-separated integers in increasing order (e.g., 2 4 6 8).

Réponse :

2 3 4 4



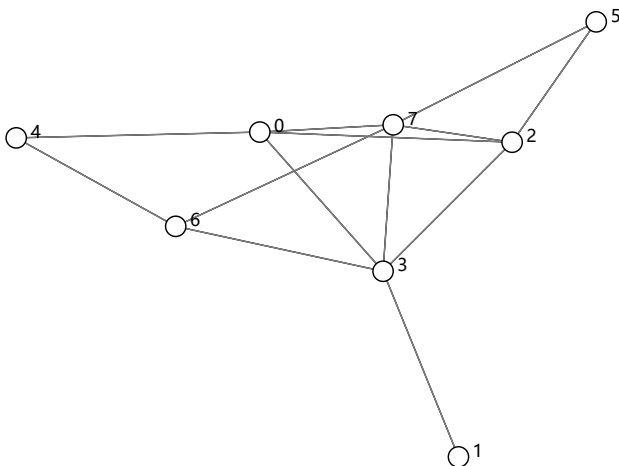
La réponse correcte est : 2 3 4 4

Question **3**

Incorrect

What is the resolution limit of this graph (above which Louvain gives one cluster per node)?

There are 13 edges.



Type the answer as an integer or an irreducible fraction (e.g., 2/3).

Réponse :

13/2

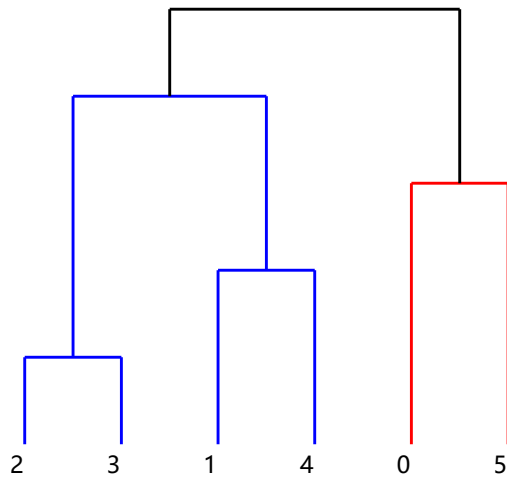


La réponse correcte est : 26/5

Question 4

Correct

Give the matrix representation of the following dendrogram, including heights and cluster sizes. Heights are integers from 1 to 5.



Type your answer, reading the elements of the matrix as a text (left to right, top-down), as a sequence of space-separated integers (e.g., 0 1 2 1 0 2 4).

Merged nodes must be listed in increasing order of indices (e.g., 1 2 and not 2 1).

Réponse : 2 3 1 2 1 4 2 2 0 5 3 2 6 7 4 4 8 9 5 6



La réponse correcte est : 2 3 1 2 1 4 2 2 0 5 3 2 6 7 4 4 8 9 5 6

Question 5

Correct

What is the time complexity to get the vector of degrees of a graph?

There are n nodes and m edges.

The graph is undirected.

The adjacency matrix is stored in CSR format.

- ☐ $O(m)$
- ☐ $O(n^2)$
- ☐ $O(\max(n, m))$
- ☒ $O(n)$ ✓

La réponse correcte est :

$O(n)$

Question 6

Correct

Which format would you recommend if you must update frequently a large sparse matrix?

- ☐ Coordinate
- ☐ Compressed sparse row
- ☒ List of list ✓
- ☐ Compressed sparse column
- ☐ None of them

La réponse correcte est :

List of list

Question 7

Correct

After clustering, you get an aggregate graph with the following adjacency matrix:

$$\begin{bmatrix} 10 & 1 & 1 \\ 1 & 8 & 1 \\ 1 & 1 & 22 \end{bmatrix}$$

What is the modularity of this clustering?

Type your answer as an integer or an irreducible fraction (e.g., 1/3).

Réponse : 255/529



La réponse correcte est : 255/529

Question 8

Correct

Consider the eigenvectors of the transition matrix of an undirected, connected graph.

All eigenvectors except one sum to 0.

Veillez choisir une réponse.

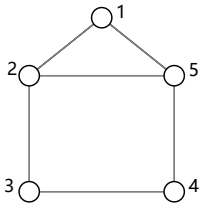
- ☐ Vrai
- ☒ Faux ✓

La réponse correcte est « Faux ».

Question 9

Correct

Consider a graph neural network trained on the following graph:



The features of the nodes 1, 2, 3, 4, 5 are the rows of the following matrix:

$$\begin{pmatrix} 0 & 1 & -2 \\ 0 & 1 & 0 \\ 2 & 3 & -1 \\ -2 & -1 & 0 \\ 2 & 0 & -1 \end{pmatrix}$$

Each layer consists of the sum of the embedding of the node and the average embedding of the neighbors, followed by a linear function and a ReLU activation function.

Consider a neuron of the first hidden layer, with weights $w = (1, 0, -\frac{1}{2})$ and bias $b = 1$.

What is the output of this neuron for node 4?

Type your answer as an integer or an irreducible fraction (e.g., 2/3).

Réponse :



La réponse correcte est : 3/2

Question 10

Correct

What is the maximum modularity of the clustering of a graph with 7 clusters?

Type your answer as an irreducible fraction (e.g., 2/3).

Réponse :

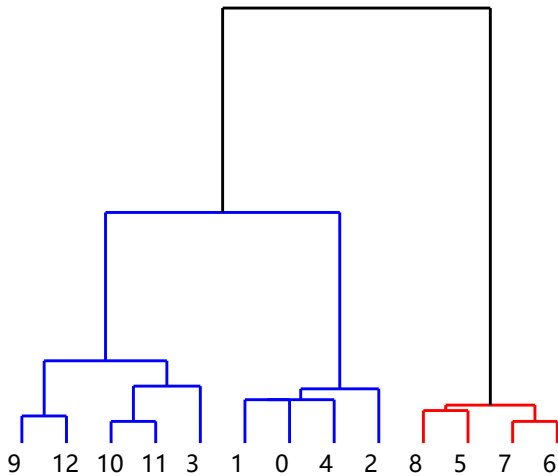


La réponse correcte est : 6/7

Question 11

Correct

What is the list of nested clusters associated with this dendrogram, starting from node 9?



Type your answer as a list of 13 space-separated integers, starting from 9 (e.g., 9 0 1 2 3 8 10 11 12 4 5 6 7).

Each node must appear exactly once in this list. Within each cluster, nodes must be listed in increasing order.

Réponse : 9 12 3 10 11 0 1 2 4 5 6 7 8



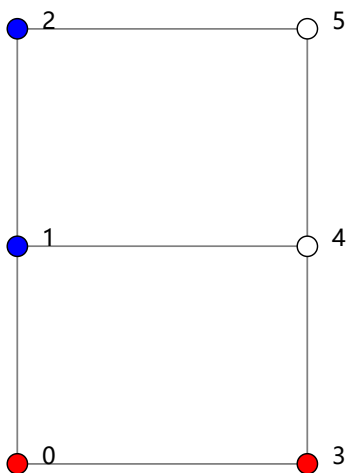
La réponse correcte est : 9 12 3 10 11 0 1 2 4 5 6 7 8

Question 12

Correct

You apply heat diffusion with temperature centering for node classification.

What is the label of node 4 predicted by this classifier in the following graph?



Veuillez choisir une réponse.

- ☐ Red
- ☒ Blue ✓

La réponse correcte est :
Blue

Question **13**

Incorrect

You cluster the graph of Openflights with the Paris algorithm (hierarchical clustering) followed by a straight cut of 8 clusters.

What is the size of the largest cluster (in number of nodes)?

Type an integer.

Réponse : 252



La réponse correcte est : 881

Question **14**

Correct

Under heat diffusion in continuous time with boundary constraints, the average temperature of free nodes remains constant.

Veuillez choisir une réponse.

- ☐ Vrai
- ☒ Faux ✓

La réponse correcte est « Faux ».

Question **15**

Correct

In the aggregation step of the Louvain algorithm, the modularity...

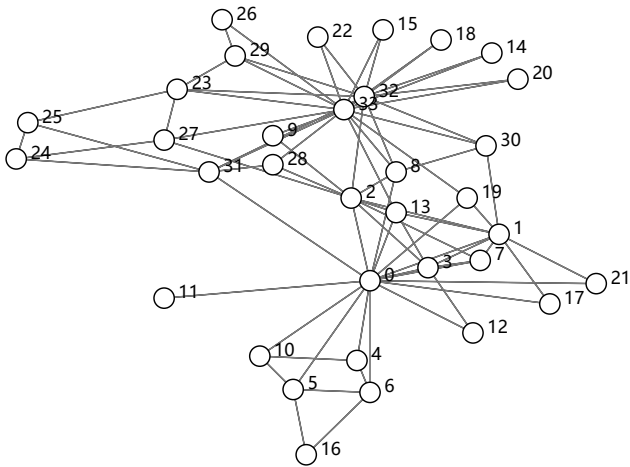
- ☐ increases
- ☐ may increase or decrease depending on the graph
- ☐ decreases
- ☒ remains the same ✓

La réponse correcte est :
remains the same

Question 16

Incorrect

Consider the spectral embedding in dimension 3 of the Karate-Club graph, based on the transition matrix.



How many pairs of nodes have a positive cosine similarity in the embedding space?

Consider all $\binom{n}{2}$ pairs of distinct nodes the graph.

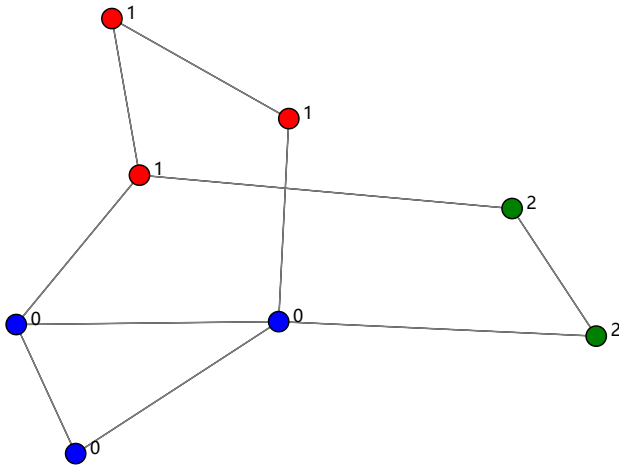
Réponse : ✖

La réponse correcte est : 190

Question **17**

Correct

Consider the following clustering.



The numbers correspond to the labels.

What is the weakest cluster?

Type an integer (0, 1 or 2).

Réponse : 2

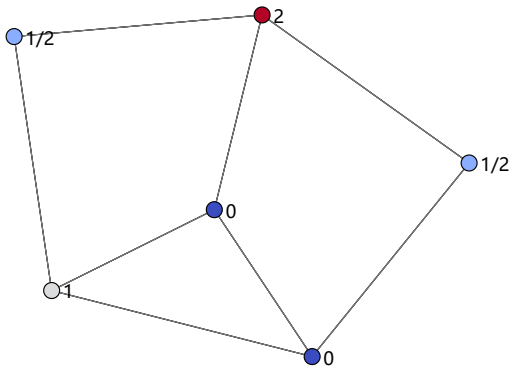


La réponse correcte est : 2

Question **18**

Correct

What is the common temperature of all nodes at equilibrium after heat diffusion in discrete time in this graph?



The numbers correspond to the temperatures in the initial state.

Type your answer as an integer or an irreducible fraction (e.g., 2/3).

Réponse : 11/16

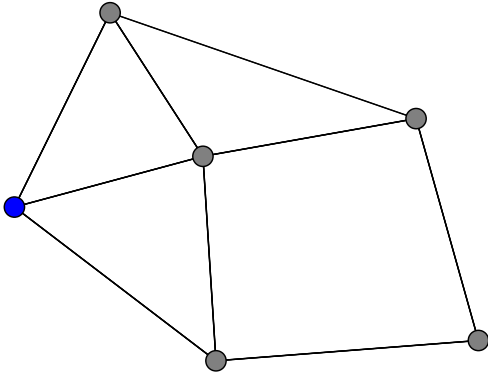


La réponse correcte est : 11/16

Question 19

Correct

Consider a random walk in this graph, without restarts.



What is the frequency of visits of the blue node?

Type your answer as an irreducible fraction (e.g., 2/3).

The graph has 9 edges.

Réponse :



La réponse correcte est : 1/6

Question 20

Correct

What is the sum of the elements in the second row of the following matrix, coded in the CSR format of scipy?

shape = (5, 5)

indices = [0, 1, 3, 4, 0, 2, 3, 2]

indptr = [0, 4, 6, 6, 7, 8]

data = [3, 2, 2, 1, 2, 3, 2, 1]

Réponse :

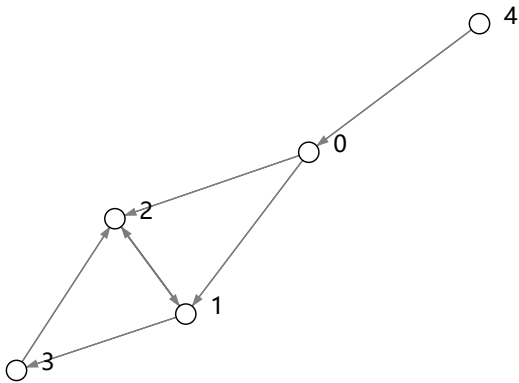


La réponse correcte est : 5

Question **21**

Correct

What is the indice vector (INDICES) of the adjacency matrix of this graph, in CSR format?



Type your answer as a list of space-separated integers (e.g., 0 1 2).

The graph has 7 edges.

Réponse :

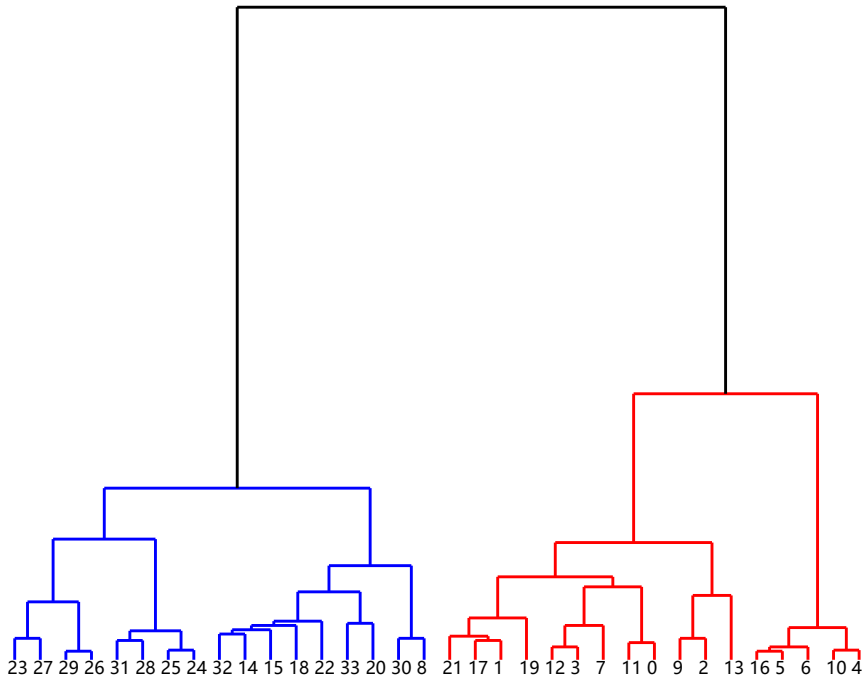


La réponse correcte est : 1 2 2 3 1 2 0

Question 22

Correct

Consider the following dendrogram:



You apply the following Python function to this dendrogram, represented as a numpy array:

```
def cut(dendrogram, node, level):
    n = dendrogram.shape[0] + 1

    cluster = {i: [i] for i in range(n)}
    cluster_index = node

    k = 0
    for t in range(n - 1):
        i = int(dendrogram[t][0])
        j = int(dendrogram[t][1])
        cluster[n + t] = cluster.pop(i) + cluster.pop(j)
        if cluster_index in {i, j}:
            cluster_index = n + t
            k += 1
        if k == level:
            return cluster[cluster_index]
```

with the following parameters:

```
cut(dendrogram, 30, 2)
```

What is the length of the returned list?

Type your answer as an integer.

Example:

3

Réponse :



La réponse correcte est : 9

Question **23**

Correct

You cluster the graph of links of Wikivitals using the Paris algorithm (hierarchical clustering).

Which node is merged first with the node corresponding to the article on "Laws of thermodynamics"?

Type the name of the article.

Example : Olympic Games

Réponse :

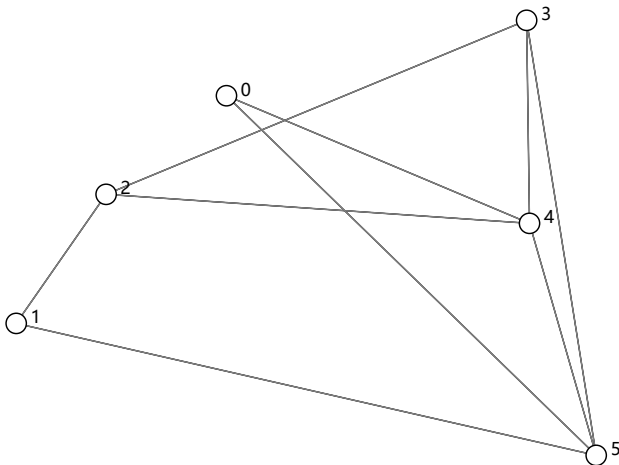


La réponse correcte est : Absolute zero

Question **24**

Correct

Which pair of nodes is merged first by the Paris algorithm?



Type your answer as a list of space-separated integers in increasing order (e.g., 2 3).

Réponse :



La réponse correcte est : 1 2

Question **25**

Correct

What is the Bacon number of Irina Petrescu (using the Cinema graph)?

Réponse :

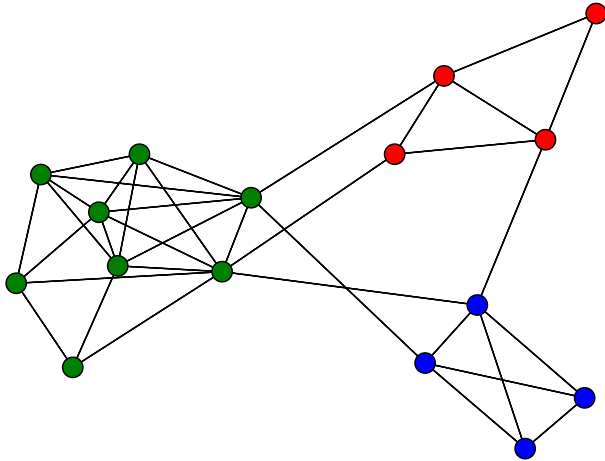


La réponse correcte est : 4

Question **26**

Correct

Consider the following graph with 3 clusters:



There are respectively 20, 5, 6 edges within clusters green, red, blue.

What is the adjacency matrix of the aggregate graph?

Type your answer as a list of 9 space-separated integers, reading this matrix as a text (from left to right and top-down).

The green, red and blue clusters must correspond to the first, second and third row or column of this matrix, respectively.

Example : 10 2 3 4 2 1 2 5 4

Réponse : 40 2 2 2 10 1 2 1 12



La réponse correcte est : 40 2 2 2 10 1 2 1 12

Question **27**

Correct

How many articles of Wikivitals have links to both Argentina and France?

Réponse : 312

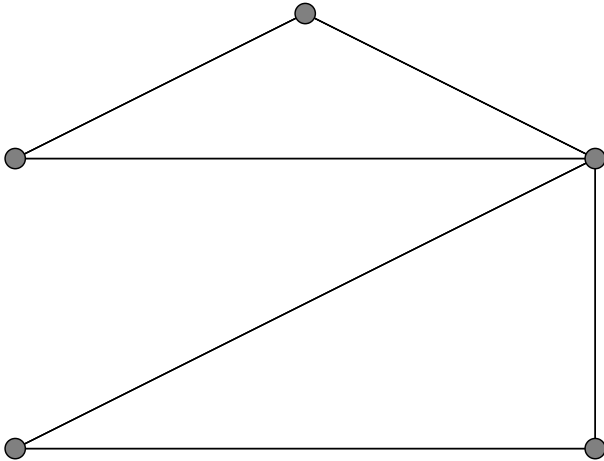


La réponse correcte est : 312

Question **28**

Correct

What is the expected degree under edge sampling in this graph?



Type an integer or an irreducible fraction (e.g., 2/3).

Réponse :

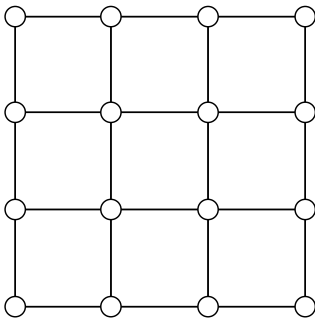


La réponse correcte est : 8/3

Question **29**

Correct

What is the maximum modularity of a clustering on a 4 x 4 grid?



Type your answer as an integer or an irreducible fraction (e.g., 2/3).

Réponse :



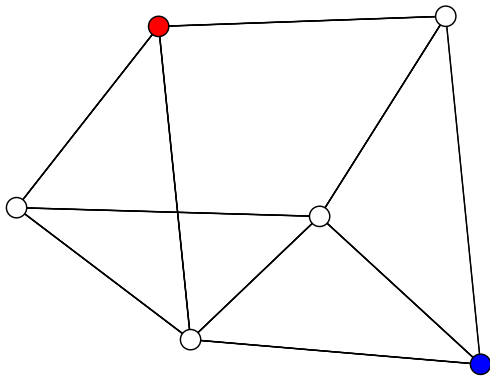
La réponse correcte est : 5/12

Question **30**

Correct

Consider a random walk in this graph.

Starting from the red node, what is the probability of reaching the blue node in at most 3 hops?



Type your answer as an irreducible fraction (e.g., 2/3).

Réponse :



La réponse correcte est : 43/144

Question **31**

Correct

You want to learn the representation of a graph with a GNN.

The graph has 1240 nodes and 6,230 edges. Each node is represented by a vector of features of dimension 12. The labels of 100 nodes are known and belong to the set 1, 2, 3

You decide to train a GNN with a single hidden layer of dimension 16 to predict the labels of the other nodes.

How many parameters must be learned (including the bias terms)?

Réponse :

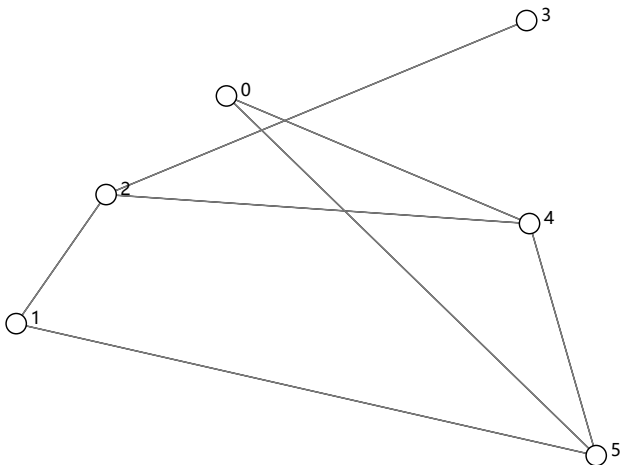


La réponse correcte est : 259

Question **32**

Incorrect

Consider PageRank with damping factor $\alpha = 0.01$ in this graph.



What is the best ranked node?

Type an integer.

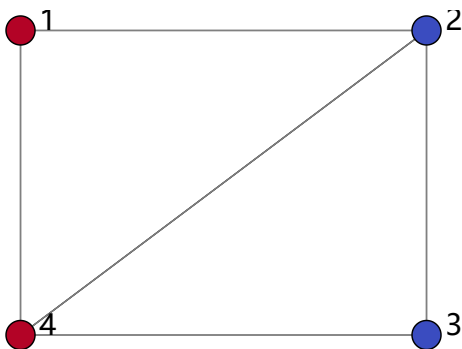
Réponse : ✗

La réponse correcte est : 2

Question **33**

Correct

Consider heat diffusion in continuous time in this graph:



At time $t = 0$, nodes 1, 4 have temperature 1 and nodes 2, 3 have temperature 0.

What is the ranking of nodes after heat diffusion at time $t = O^+$?

Type your answer as a list of 4 space-separated integers, listing nodes in decreasing order of temperature.

Example:

1 3 2 4

Réponse : ✓

La réponse correcte est : 1 4 2 3

Question **34**

Correct

Consider the transition matrix of a bipartite graph.

The multiplicity of the eigenvalue -1 is equal to the number of connected components of the graph.

Veillez choisir une réponse.

☒ Vrai ✓

☐ Faux

La réponse correcte est « Vrai ».

Question **35**

Correct

The rows of the Laplacian matrix:

Veillez choisir une réponse.

☒ Sum to 0 ✓

☐ Sum to 1

☐ Do not sum to 0 or 1 in general

La réponse correcte est :

Sum to 0

Question **36**

Correct

What is the **indice pointer (indptr)** vector of the following matrix in the CSR format of scipy?

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 3 & 0 & 0 \\ 1 & 0 & 0 & 2 & 1 \end{bmatrix}$$

Type your answer as a list of space-separated integers.

Example:

0 1 2 3 4

Réponse : 0 0 2 5



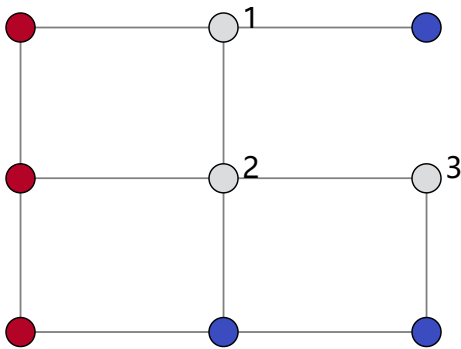
La réponse correcte est : 0 0 2 5

Question **37**

Correct

Consider the following Dirichlet problem.

What are the temperatures of nodes 1, 2, 3 at equilibrium?



The 3 red nodes have fixed temperature 1, the 3 blue nodes have fixed temperature 0.

Type your answer as a list of 3 space-separated integers or irreducible fractions, corresponding to the temperatures of nodes 1, 2, 3 (in this order).

Example:

0 1/2 1

Réponse : 9/19 8/19 4/19



La réponse correcte est : 9/19 8/19 4/19

Question **38**

Correct

In the Openflights graph, what is the best ranked airport in terms of Personalized PageRank starting from Amsterdam Airport Schiphol and Cairo International Airport (other than these 2 airports)?

Type the name of the airport.

Example:

Tokyo Haneda International Airport

Réponse : Atatürk International Airport

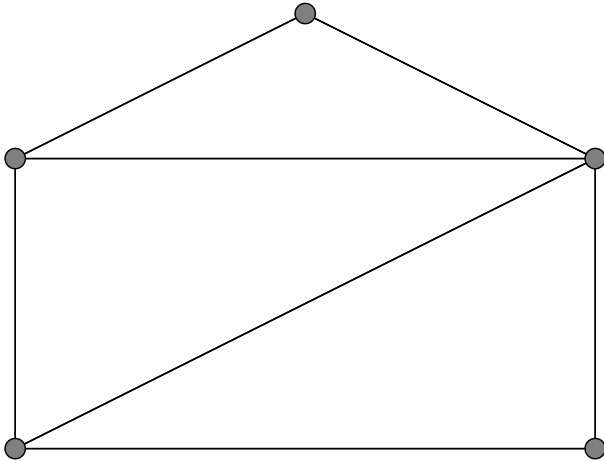


La réponse correcte est : Atatürk International Airport

Question **39**

Correct

What is the clustering coefficient of this graph?



Type an integer or an irreducible fraction (e.g., 2/3)

Réponse : 9/14



La réponse correcte est : 9/14

Question **40**

Correct

Wikivitals is a subgraph of Wikipedia with 11 categories of articles.

Consider the spectral embedding of this graph in dimension 20, based on the transition matrix.

We say that a category is topical if its average pairwise cosine similarity is high in the embedding space.

What is the less topical category among the following?

Veuillez choisir une réponse.

- ☐ Philosophy and religion
- ☐ Technology
- ☐ Everyday life
- ☐ Physical sciences
- ☐ Society and social sciences
- ☐ Biological and health sciences
- ☒ Arts ✓
- ☐ History
- ☐ Mathematics
- ☐ Geography

La réponse correcte est :

Arts

Aller à...

[Your questions during the exam ►](#)