Organising information: graphs

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Computational Thinking and Programming (A.Y. 2017/2018)

Second Cycle Degree in Digital Humanities and Digital Knowledge

Alma Mater Studiorum - Università di Bologna

Communication 1

Tomorrow will start the laboratory!

Updated timetable

- 12 December: 15:30 - 18:30
- 14 December: 15:30 - 18:30
- 15 December: 12:30 - 15:00
- 18 December: 9:30 - 11:30
- 19 December: 15:30 - 18:30
- 20 December: 9:30 - 11:30

Communication 2

Second partial written examination

Any question about the previous lecture?

Historic hero: Euler

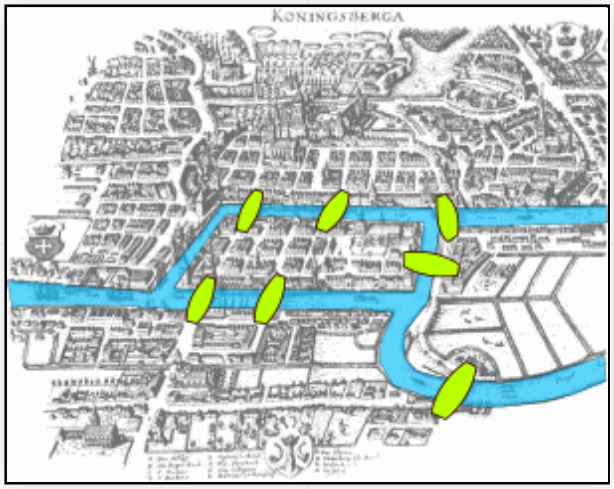
He was one of the most important men of Science of the whole history

Contributions in Mathematics, Physics, Astronomy, Logics

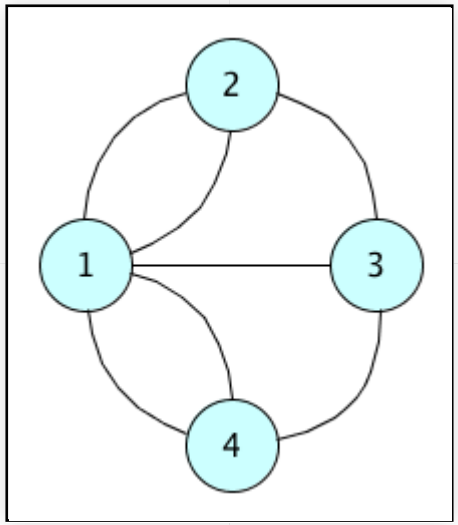
His works created entirely-new scholarly disciplines and fields

E.g.: graph theory - by demonstrating the problem of the seven bridges of Königsberg

The city of Königsberg



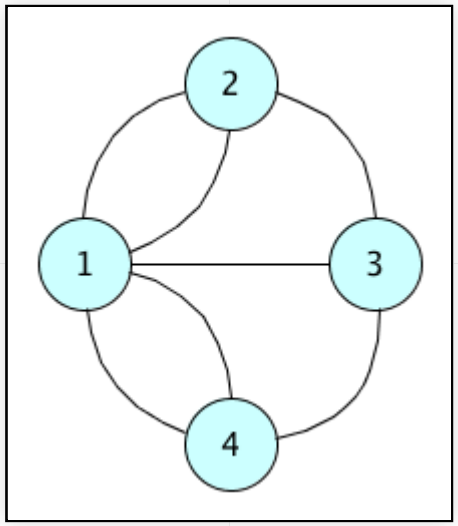
Is it possible to walk around the city and to cross each of the bridges once and only once?



Graph: *nodes* (circles) connected by *edges*

Resolution

An edge is followed every time one enters in a node, and another edge is needed to go out from that node



Each node, except the starting and ending nodes, should have an even number of edges for being satisfactorily traversed one or more times

But all the nodes in the graph have an odd number of edges

Contradiction: the problem of the seven bridges of Königsberg has no solution

Graph

Data structure used to describe in abstract terms several well-known situations

- Routes between cities
- Connections to people you know in social networks
- Organisation of links between webpages on the Web

Two different kinds of graphs

- *undirected graphs*, where an edge can be traversed in one way or the other indifferently
- *directed graphs*, where the edge has a clear specification of the node-to-node direction that can be followed

Python package: NetworkX

Undirected graph

Constructor: `def Graph()`

Used for creating undirected graphs without any possible multiple edge between two nodes

Constructor: `def MultiGraph()`

Used for creating undirected graphs which permit the specification of multiple edges between the same two nodes

NetworkX package allows us to associate as a node any possible immutable object definable in Python, that can be, thus, connected by means of one or more edges

Methods

add a node: `<graph>.add_node(<node>)`

If a node with that value is already present, the method has no effect on the graph

add an edge: `<graph>.add_edge(<node_1>, <node_2>)`

Inverting the position of the input nodes does not change the result

remove a node: `<graph>.remove_node(<node>)`

removes <node> from the graph as well as all the edges that involve it directly

remove an edge:

`<graph>.remove_edge(<node_1>, <node_2>)`

removes the particular edge between the two nodes specified

Example - Graph()

```
from networkx import Graph

my_graph = Graph()

my_graph.add_node(1)
my_graph.add_node(2)
my_graph.add_node(3)
my_graph.add_node(4)

my_graph.add_edge(1,2)
my_graph.add_edge(1,3)
my_graph.add_edge(1,4)
my_graph.add_edge(2,3)
my_graph.add_edge(3,4)
```

Example - MultiGraph()

```
from networkx import MultiGraph

my_graph = MultiGraph()

my_graph.add_node(1)
my_graph.add_node(2)
my_graph.add_node(3)
my_graph.add_node(4)

my_graph.add_edge(1,2)
my_graph.add_edge(1,2)
my_graph.add_edge(1,3)
my_graph.add_edge(1,4)
my_graph.add_edge(1,4)
my_graph.add_edge(2,3)
my_graph.add_edge(3,4)
```

Attributes

Additional information can be specified to nodes and edges by means of Python named parameters

E.g.: `my_graph.add_edge(1, 2, weight=4)`

`<graph>.nodes()` and `<graph>.edges()` return particular kind of lists (called `NodeView` and `EdgeView` respectively) that can be iterated by means of a foreach loop as usual - but no attributes of nodes/edges will be returned

Such attribution is explicit if we call `nodes()` and `edges()` by specifying the named parameter `data` as *True*, e.g.

`<graph>.nodes(data=True)`

Directed graph

Constructor: `def DiGraph()`

Used for creating directed graphs without any possible multiple edge between two nodes

Constructor: `def MultiDiGraph()`

Used for creating directed graphs which permit the specification of multiple edges between the same two nodes

Same methods presented for the undirected graphs

In this case, the order between `<node_1>` and `<node_2>` in the methods for adding and removing an edge is meaningful, since an edge specifies now a particular direction: `<node_1>` is the source node, while `<node_2>` is the target node

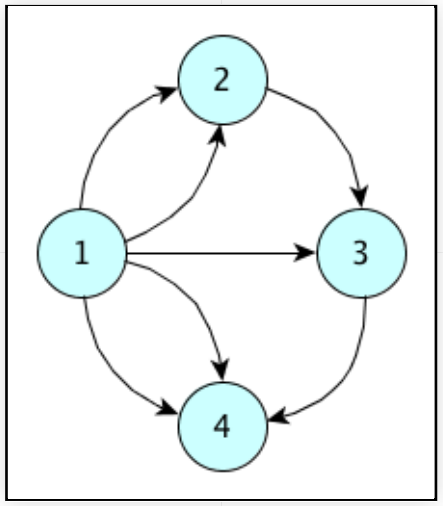
Example - MultiDiGraph()

```
from networkx import MultiGraph
from networkx import MultiDiGraph


my_graph = MultiDiGraph()

my_graph.add_node(1)
my_graph.add_node(2)
my_graph.add_node(3)
my_graph.add_node(4)

my_graph.add_edge(1,2)
my_graph.add_edge(1,2)
my_graph.add_edge(1,3)
my_graph.add_edge(1,4)
my_graph.add_edge(1,4)
my_graph.add_edge(2,3)
my_graph.add_edge(3,4)
```



END

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