

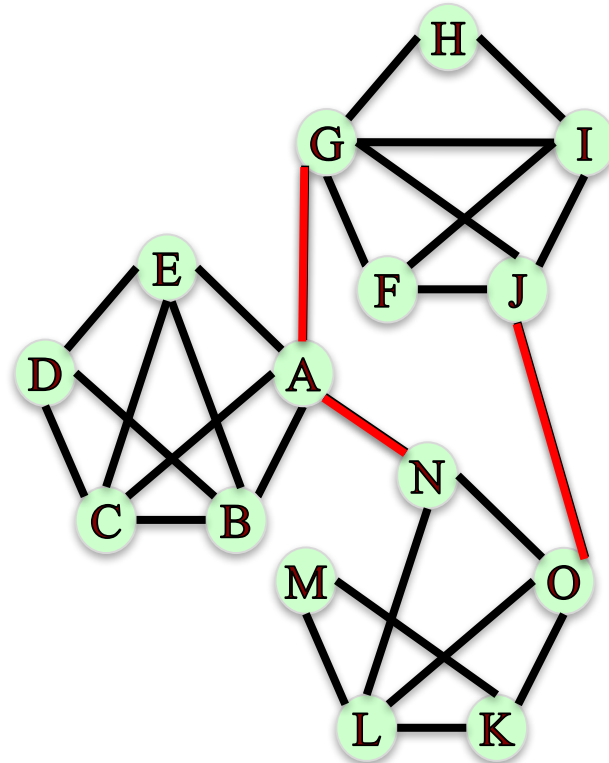
# Connected Graphs

An undirected graph is **connected** if, for every pair nodes, there is a path between them.

In: `nx.is_connected(G)`

Out: True

However, if we remove edges A—G, A—N, and J—O, the graph becomes disconnected.



# Connected Graphs

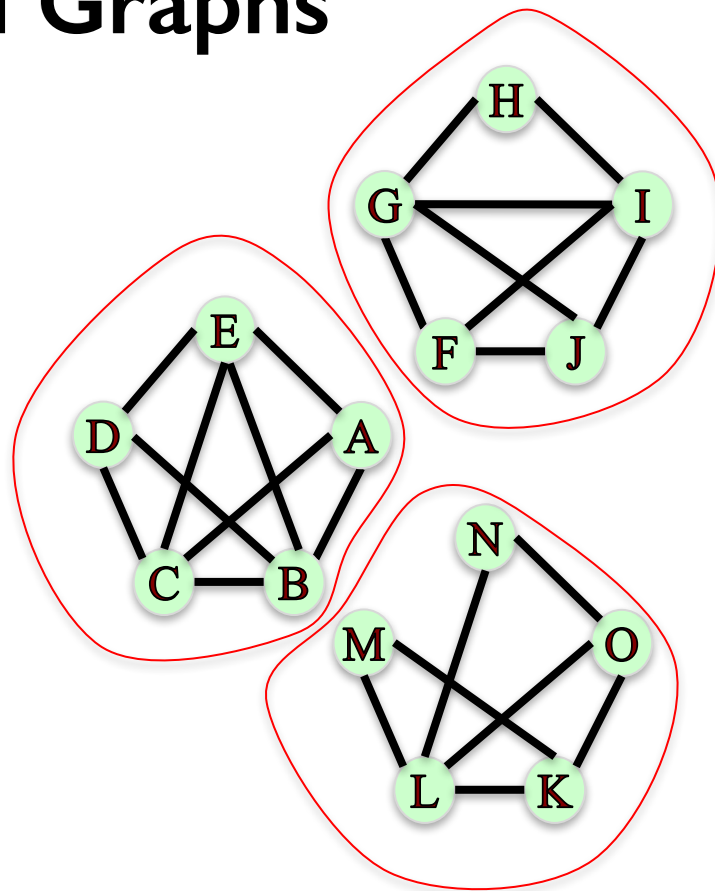
An undirected graph is **connected** if, for every pair nodes, there is a path between them.

In: `nx.is_connected(G)`

Out: True

However, if we remove edges A—G, A—N, and J—O, the graph becomes disconnected.

There is no path between nodes in the three different “communities”.



# Graph Components

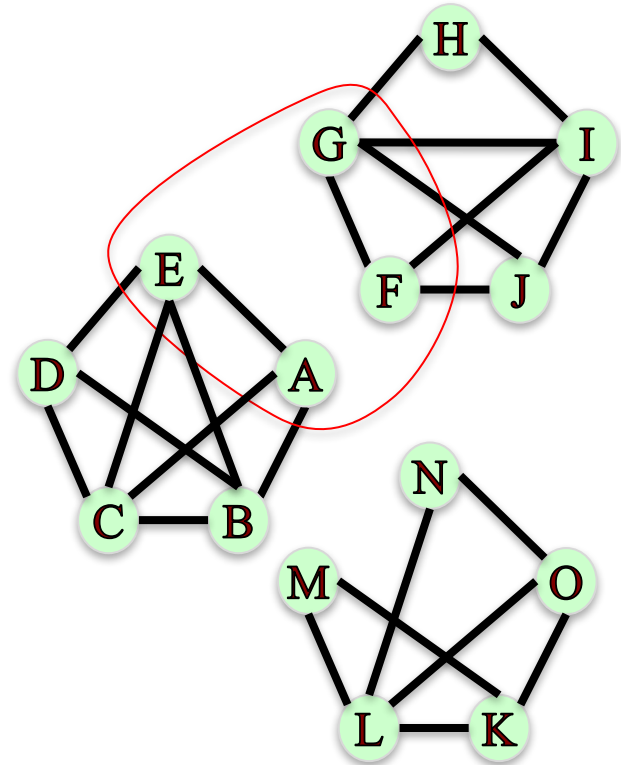
## Connected component:

A subset of nodes such as:

- i. Every node in the subset has a path to every other node.
- ii. No other node has a path to any node in the subset.

Is the subset  $\{E, A, G, F\}$  a connected component?

No, there is no path between nodes A and F.



# Graph Components

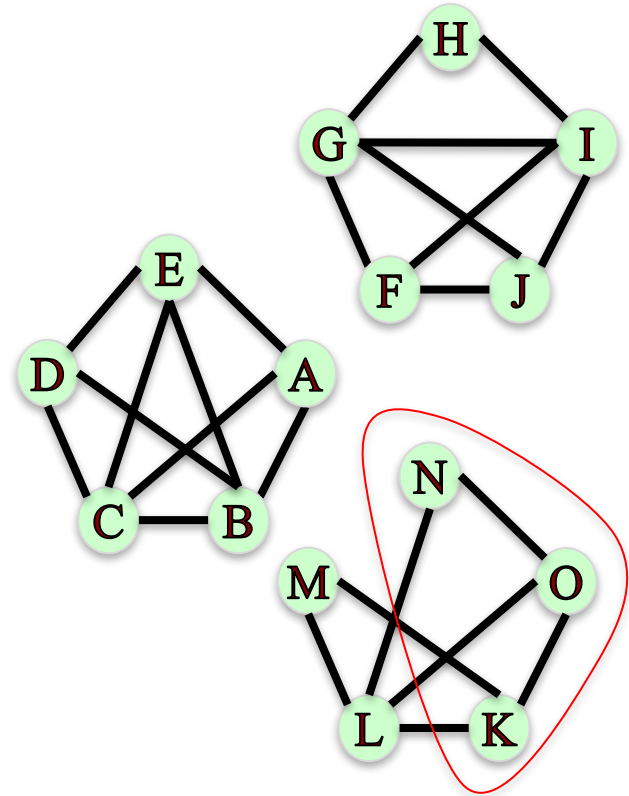
## Connected component:

A subset of nodes such as:

- i. Every node in the subset has a path to every other node.
- ii. No other node has a path to any node in the subset.

Is the subset  $\{N, O, K\}$  a connected component?

No, node L has a path to N, O, and K.



# Graph Components

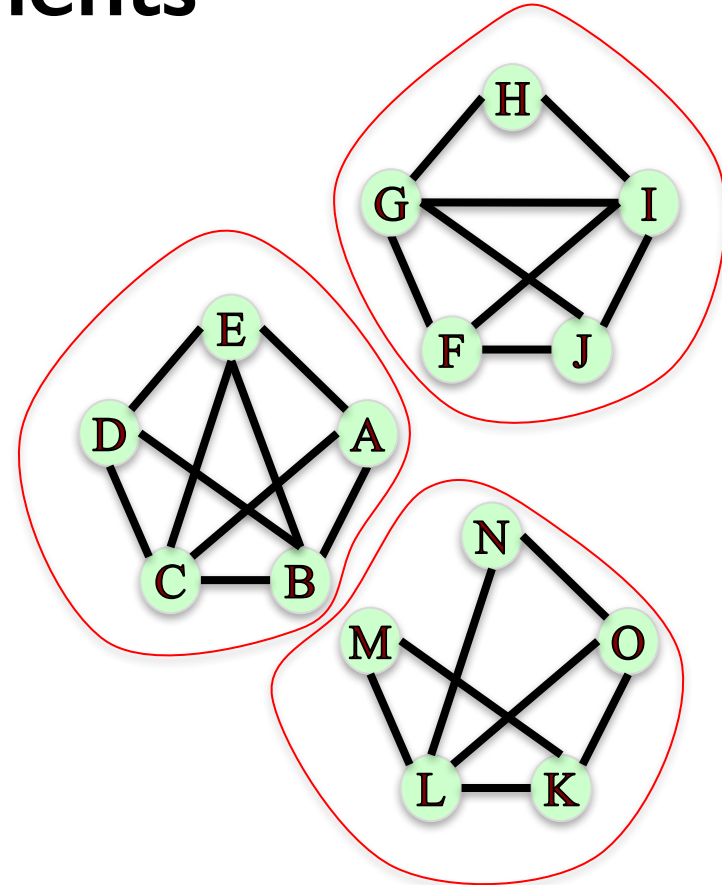
## Connected component:

A subset of nodes such as:

- Every node in the subset has a path to every other node.
- No other node has a path to any node in the subset.

What are the connected components in this graph?

$\{A, B, C, D, E\}$ ,  $\{F, G, H, I, J\}$ ,  $\{K, L, M, N, O\}$



# Graph Components

In: `nx.number_connected_components(G)`

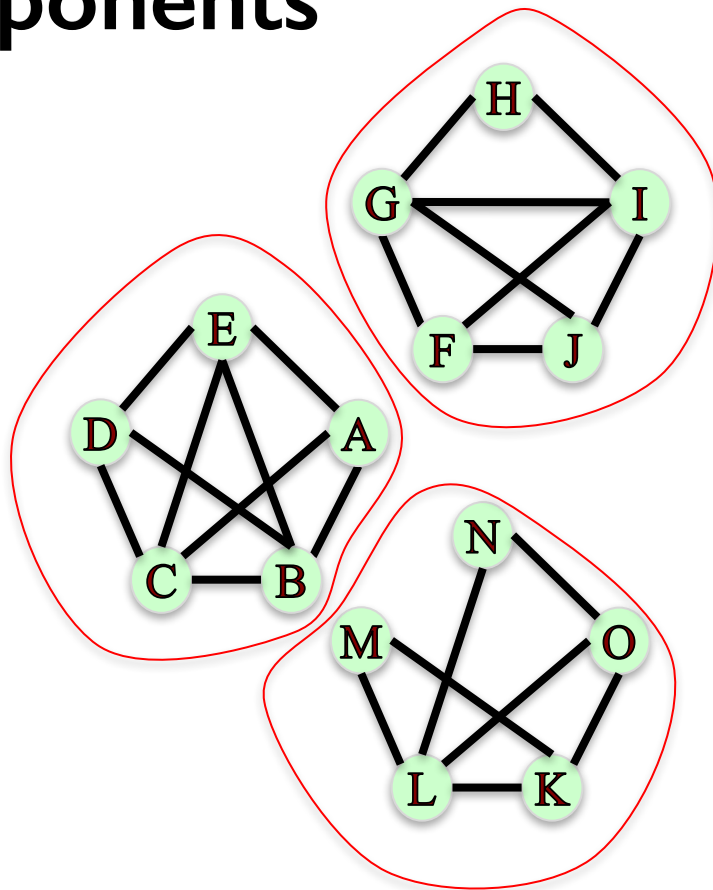
Out: 3

In: `sorted(nx.connected_components(G))`

Out: `[{'A', 'B', 'C', 'D', 'E'},`  
`{'F', 'G', 'H', 'I', 'J'},`  
`{'K', 'L', 'M', 'N', 'O'}]`

In: `nx.node_connected_component(G, 'M')`

Out: `{'K', 'L', 'M', 'N', 'O'}`



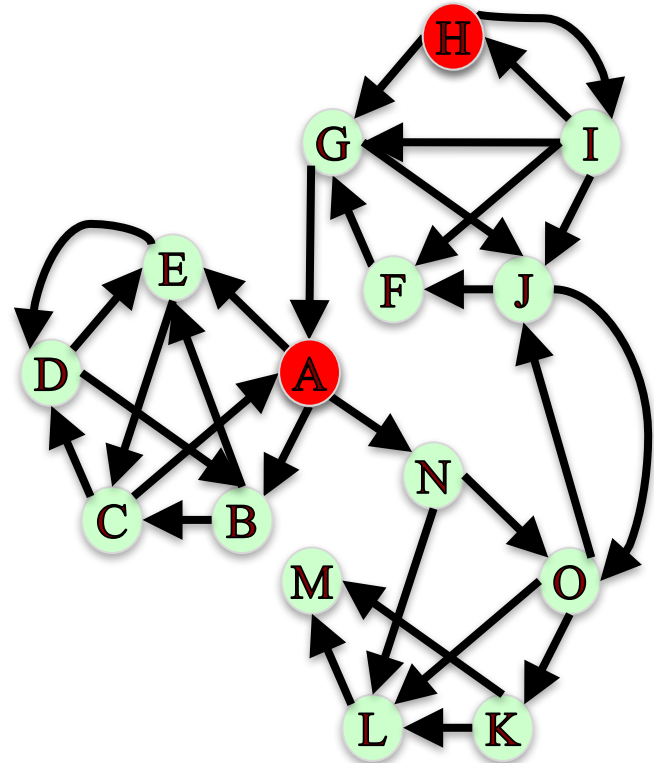
# Connectivity in Directed Graphs

A directed graph is **strongly connected** if, for every pair nodes  $u$  and  $v$ , there is a directed path from  $u$  to  $v$  and a directed path from  $v$  to  $u$ .

In: `nx.is_strongly_connected(G)`

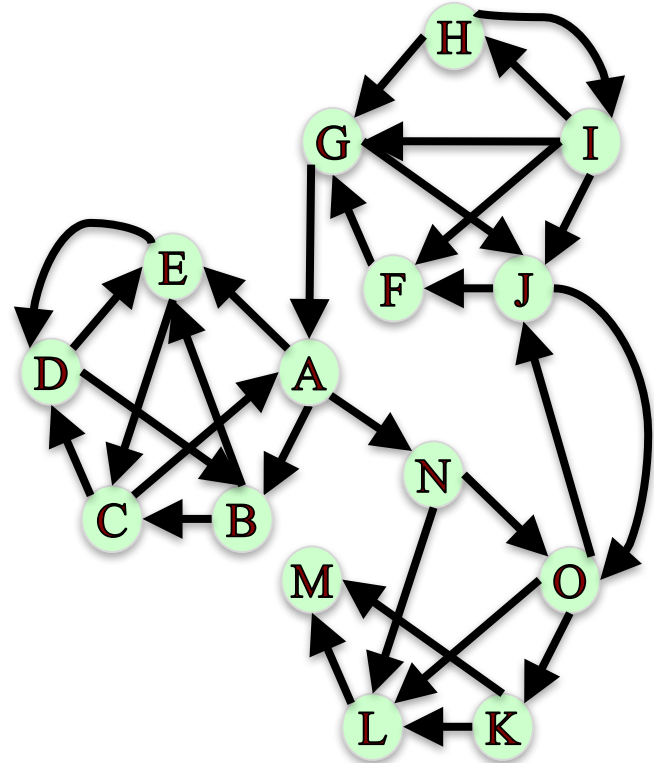
Out: False

Note: There is no directed path from A to H



# Connectivity in Directed Graphs

A directed graph is **weakly connected** if replacing all directed edges with undirected edges produces a connected undirected graph.



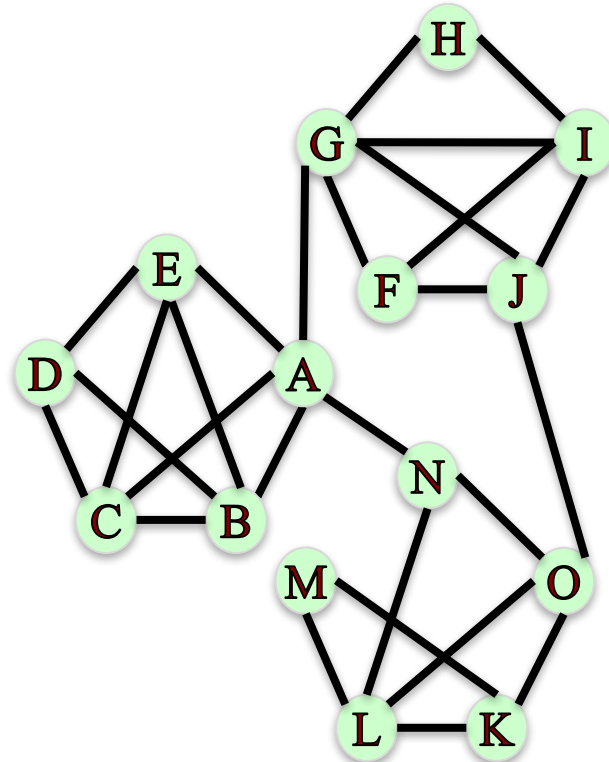


# Connectivity in Directed Graphs

A directed graph is **weakly connected** if replacing all directed edges with undirected edges produces a connected undirected graph.

In: `nx.is_weakly_connected(G)`

Out: True



# Connectivity in Directed Graphs

## Strongly connected component:

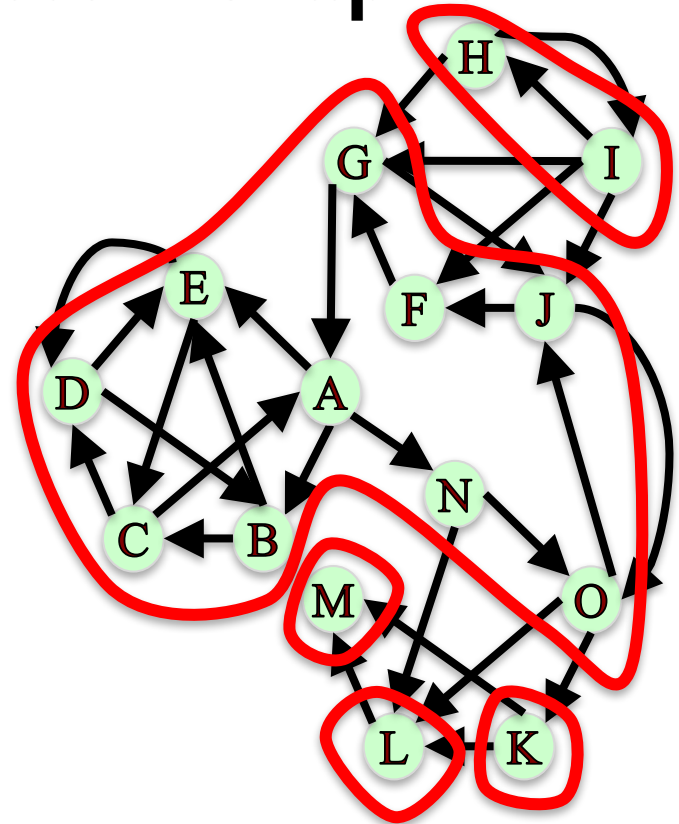
A subset of nodes such as:

- Every node in the subset has a **directed** path to every other node.
- No other node has a **directed** path to every node in the subset.

What are the strongly connected components in this graph?

In: `sorted(nx.strongly_connected_components(G))`

Out: `[{M}, {L}, {K}, {A, B, C, D, E, F, G, J, N, O}, {H, I}]`



# Connectivity in Directed Graphs

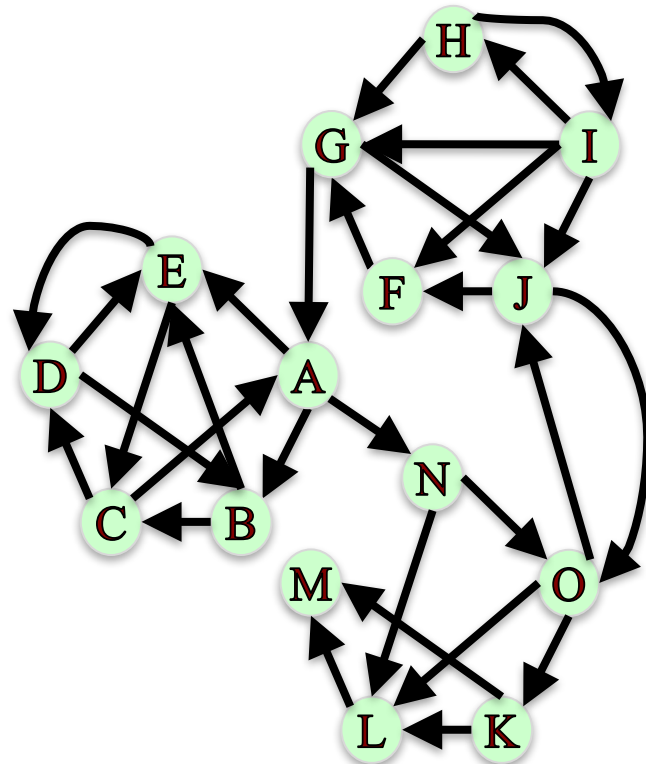
## Weakly connected component:

The connected components of the graph after replacing all directed edges with undirected edges.

In: `sorted(nx.weakly_connected_components(G))`

Out: `[{'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L', 'M', 'N', 'O'}]`

Since the graph is weakly connected it only has one weakly connected component.



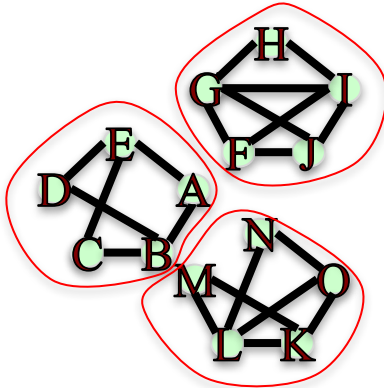
# Summary

## Undirected Graphs

**Connected:** for every pair nodes, there is a path between them.

**Connected components**

`nx.connected_components(G)`



## Directed Graphs

**Strongly connected:** for every pair nodes, there is a *directed* path between them.

**Strongly connected components**

`nx.strongly_connected_components(G))`

