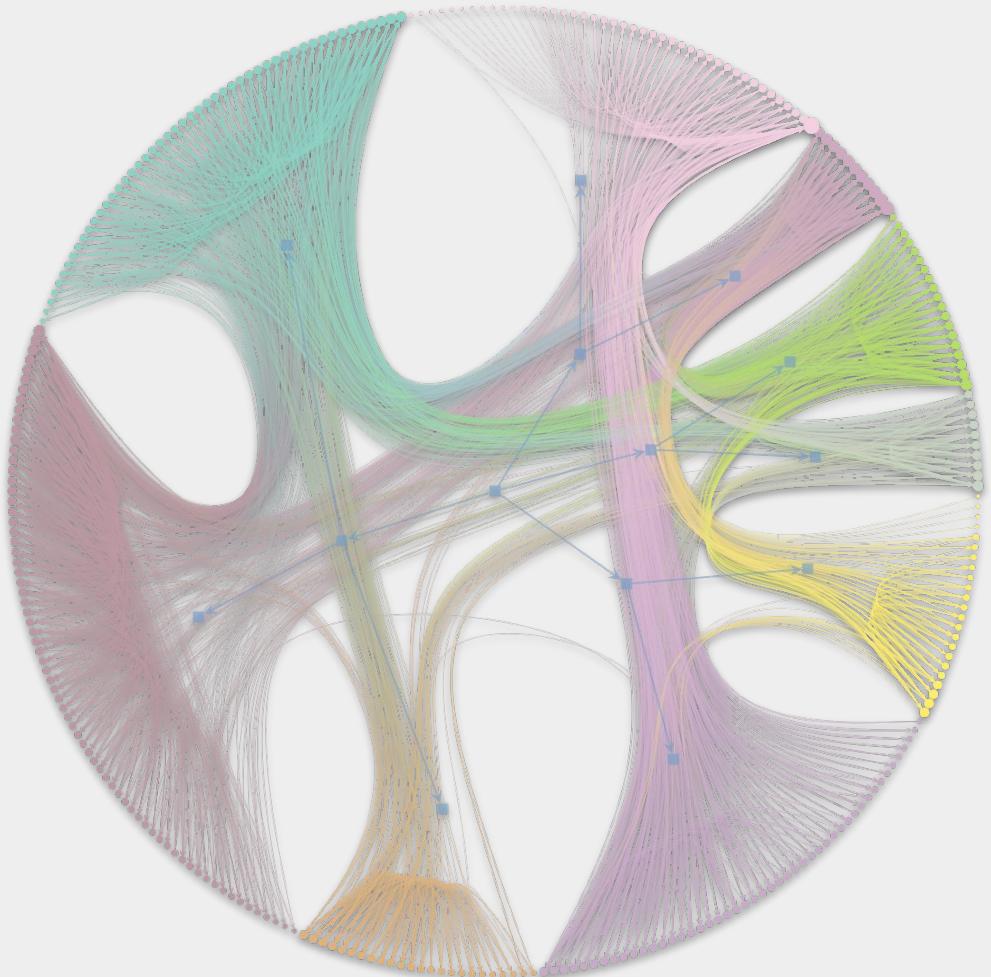


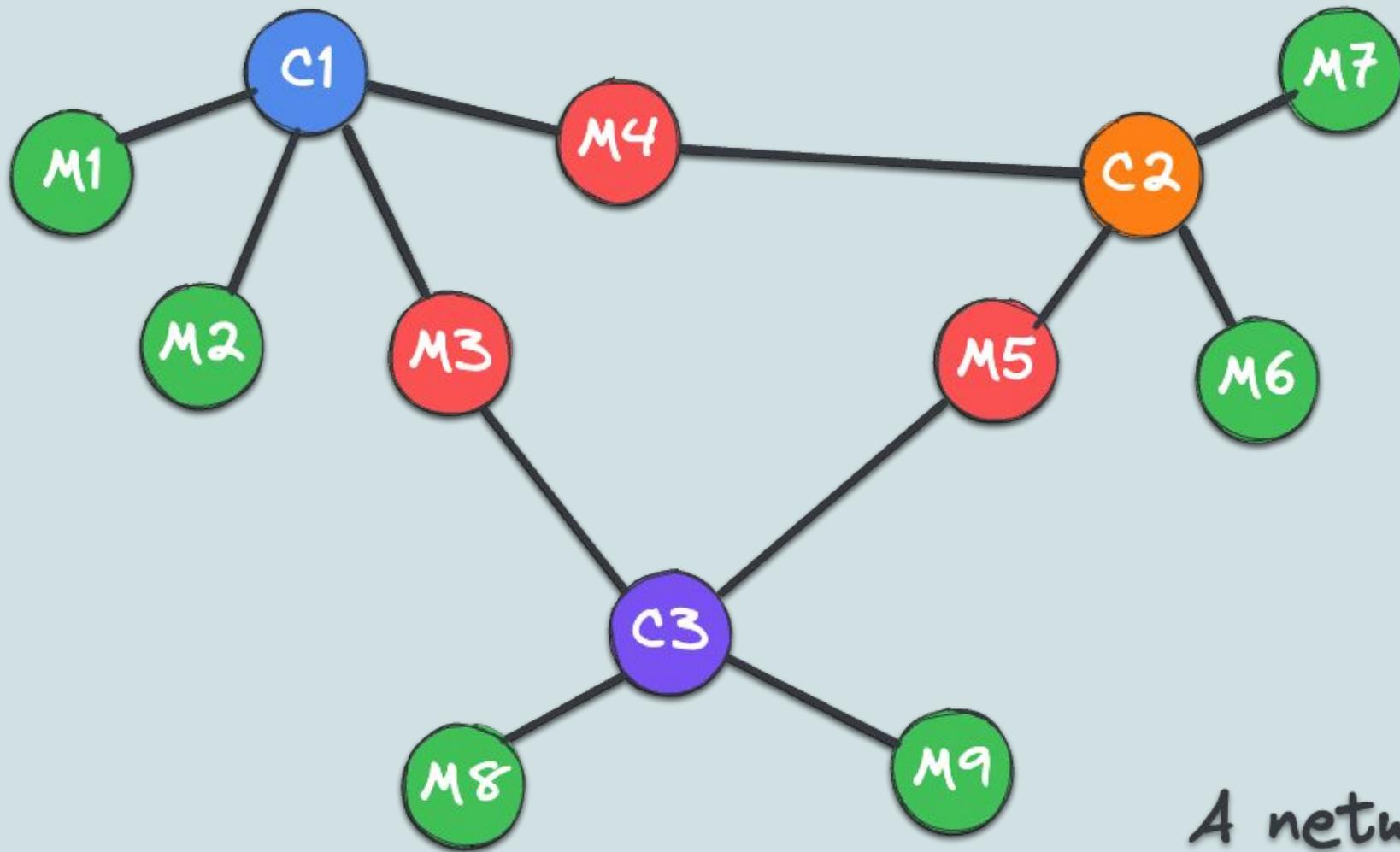
# Network Elements

## Part 01

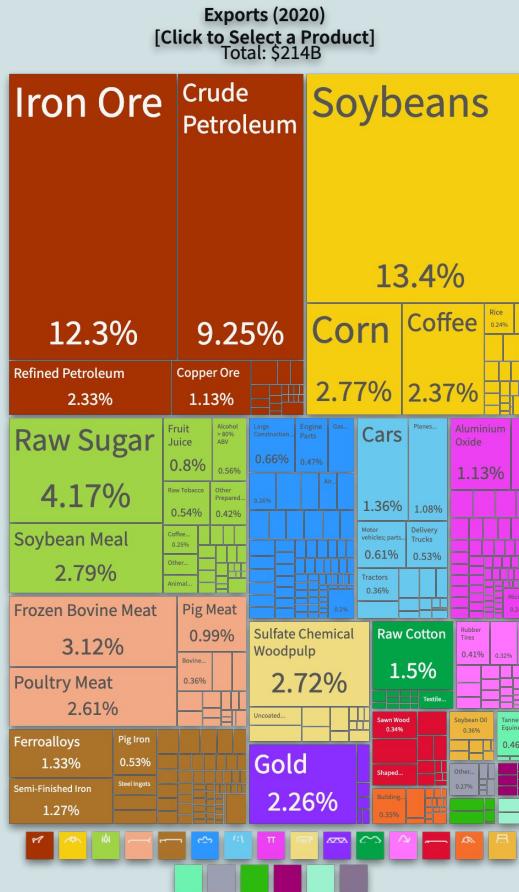
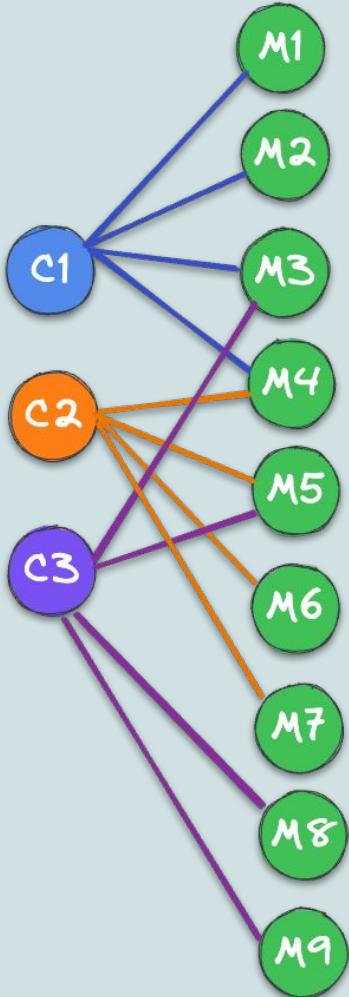
ivanovitch.silva@ufrn.br  
@ivanovitchm



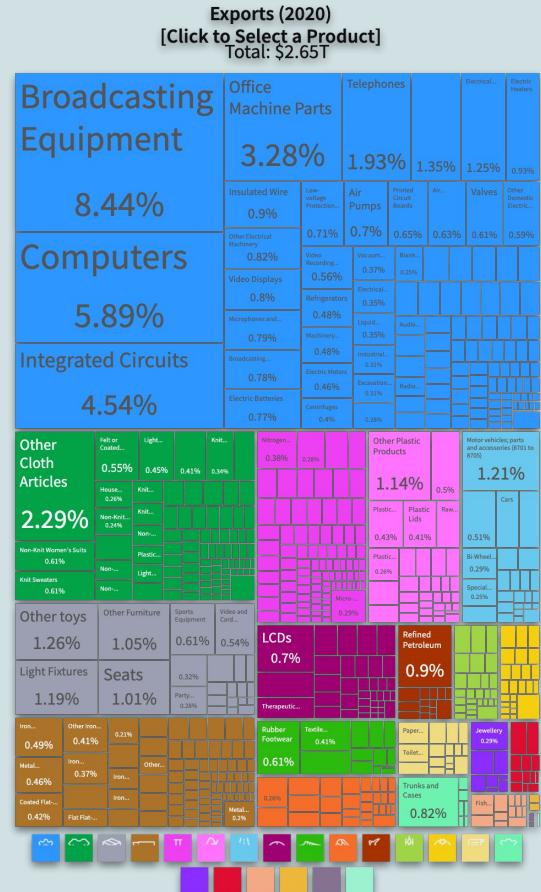




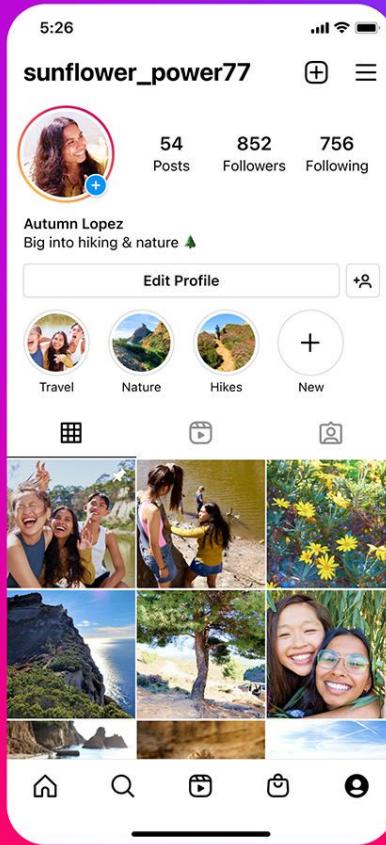
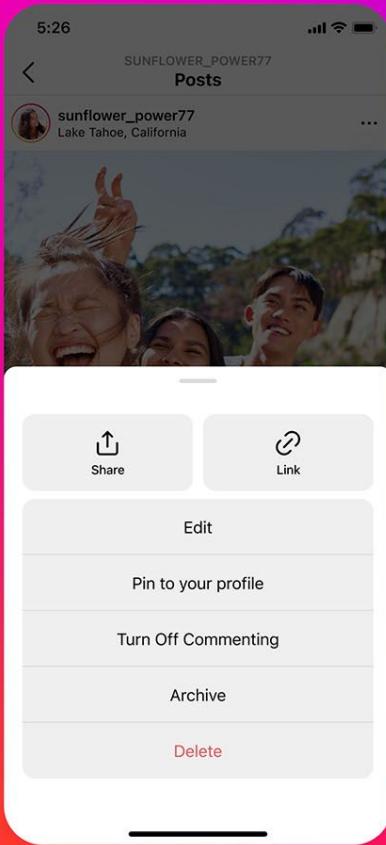
*A network*

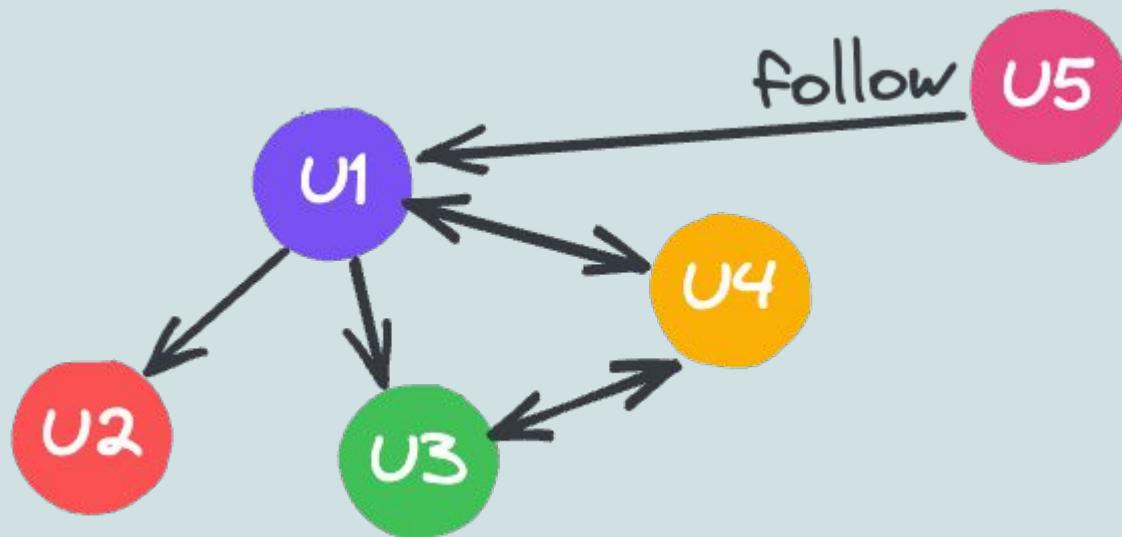


bipartite network



<https://oec.world/en/profile/country/chn>





leomessi ✅

Follow Message +1 ...

922 posts    365M followers    295 following

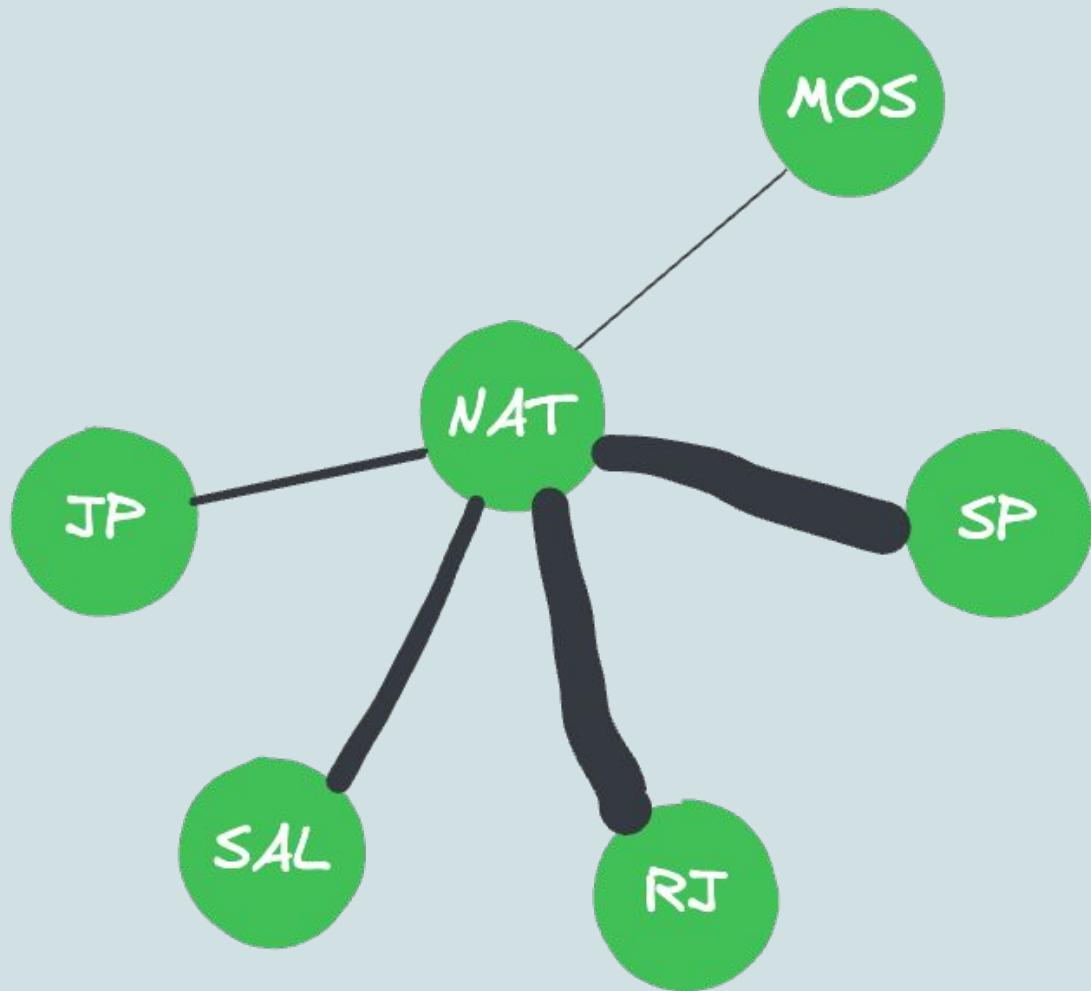
**Leo Messi**

Bienvenidos a la cuenta oficial de Instagram de Leo Messi / Welcome to the official  
Leo Messi Instagram account

[themessistore.com](http://themessistore.com)

This image shows the Instagram profile of the official account for Leo Messi (@leomessi). The profile picture is a family photo of him and his children. The bio welcomes users to the official account and provides a link to the official store. The account statistics show 922 posts, 365 million followers, and 295 accounts followed.





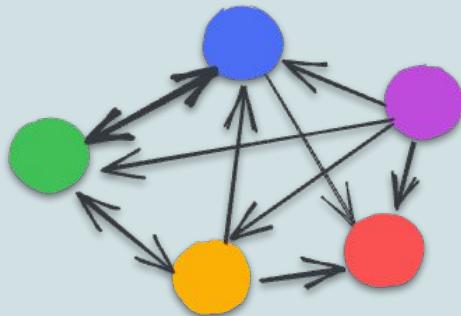


# WhatsApp

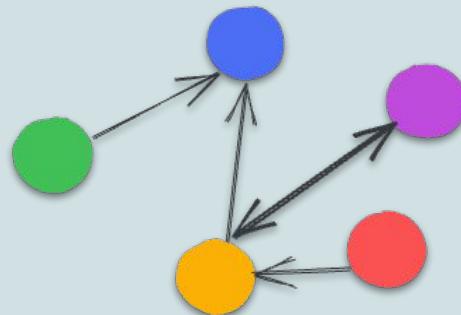


<https://github.com/kurasaitja/Whatsapp-Analysis>

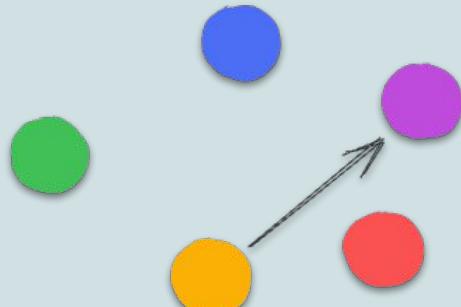
Monday



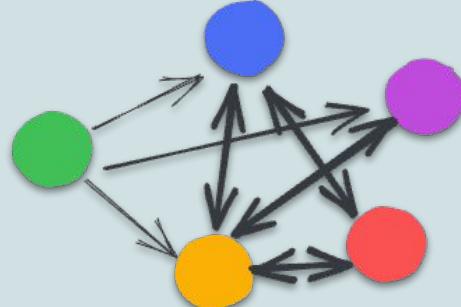
Tuesday



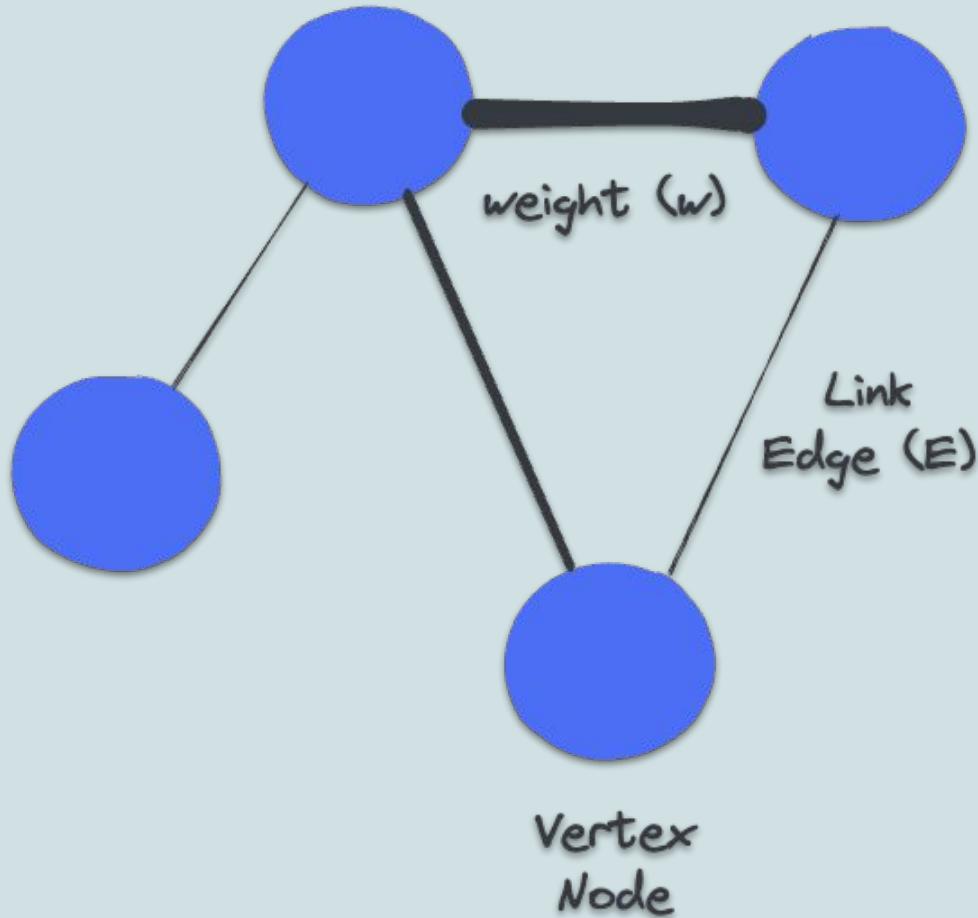
Wednesday



Thursday



Temporal network



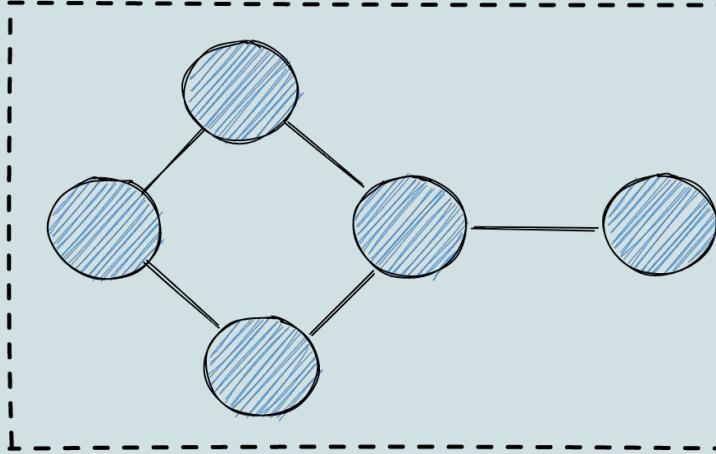
# Basic Definitions

$$G = (V, E, W)$$

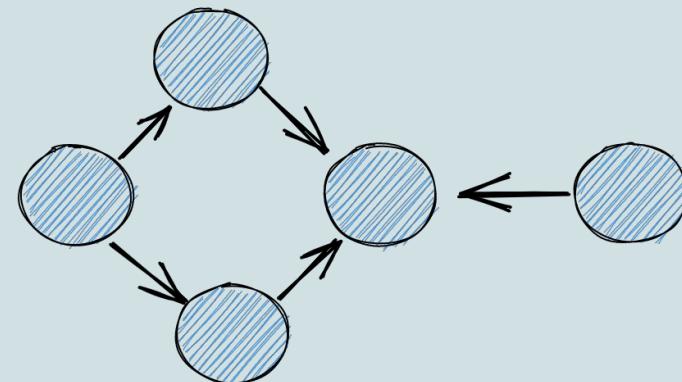
$$E \subseteq V \times V$$

$$W \subseteq R^+$$

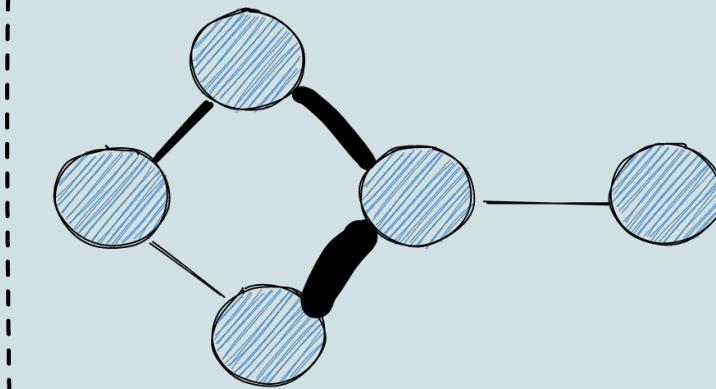
Undirected



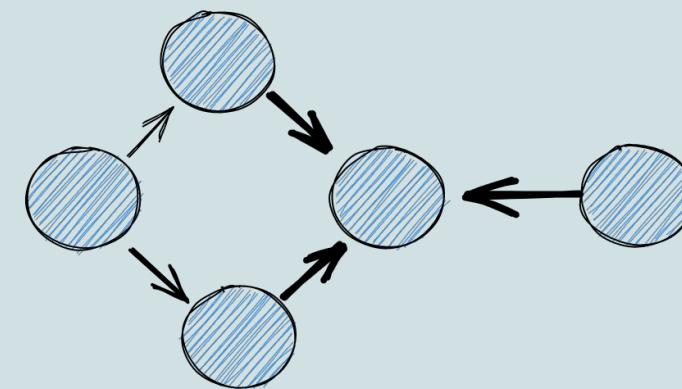
Directed



Unweighted



Weighted



# Other Fundamental Properties

Density and Sparsity

Subnetwork

Degree

Network Representation



# Further Reading



1 *Introduction* 9

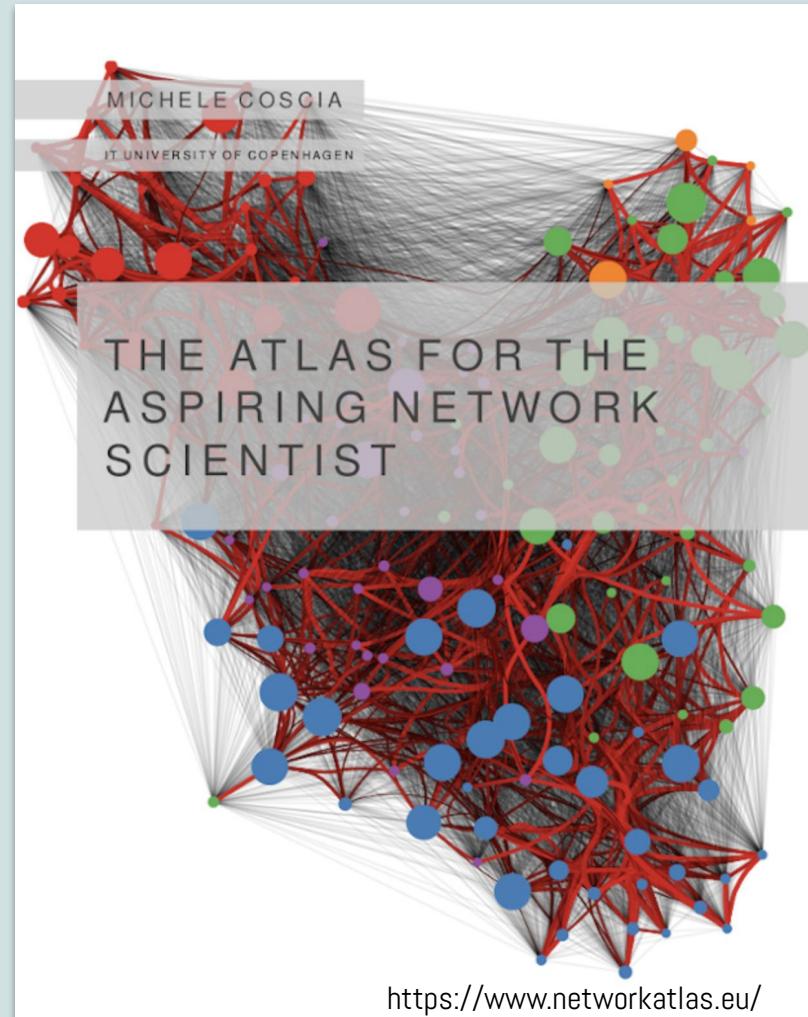
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## Contact

[Mailing list](#)

[Issue tracker](#)

[Source](#)

## Releases

### Stable (notes)

2.8.7 — October 2022

[download](#) | [doc](#) | [pdf](#)

### Latest (notes)

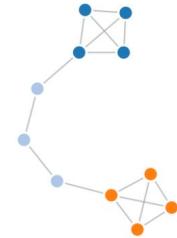
3.0 development

[github](#) | [doc](#) | [pdf](#)

### Archive



NetworkX is a Python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks.



## Software for complex networks

- Data structures for graphs, digraphs, and multigraphs
- Many standard graph algorithms
- Network structure and analysis measures
- Generators for classic graphs, random graphs, and synthetic networks
- Nodes can be "anything" (e.g., text, images, XML records)
- Edges can hold arbitrary data (e.g., weights, time-series)
- Open source [3-clause BSD license](#)
- Well tested with over 90% code coverage
- Additional benefits from Python include fast prototyping, easy to teach, and multi-platform

## What is graph-tool?

Graph-tool is an efficient [Python](#) module for manipulation and statistical analysis of [graphs](#) (a.k.a. [networks](#)). Contrary to most other Python modules with similar functionality, the core data structures and algorithms are implemented in [C++](#), making extensive use of [template metaprogramming](#), based heavily on the [Boost Graph Library](#). This confers it a level of [performance](#) that is comparable (both in memory usage and computation time) to that of a pure C/C++ library.

### ► It is *Fast!*

Despite its nice, soft outer appearance of a regular Python module, the core algorithms and data structures of graph-tool are written in C++, with performance in mind. Most of the time, you can expect the algorithms to run just as fast as if graph-tool were a pure C/C++ library. See a [performance comparison](#).

### ➊ OpenMP Support

Many algorithms are implemented in parallel using [OpenMP](#), which provides excellent performance on multi-core architectures, without degrading it on single-core machines.

### ⌚ Extensive Features

An extensive array of features is included, such as support for arbitrary vertex, edge or graph [properties](#), efficient "on the fly" [filtering](#) of vertices and edges, powerful graph I/O using the [GraphML](#), [GML](#) and [dot](#) file formats, graph [pickling](#), [graph statistics](#) (degree/property histogram, vertex correlations, average shortest distance, etc.), [centrality measures](#), standard [topological algorithms](#) (isomorphism, minimum spanning tree, connected components, dominator tree, [maximum flow](#), etc.), [generation of random graphs](#) with arbitrary degrees and correlations, [detection of modules and communities](#) via statistical inference, and much more.

### 👁 Powerful Visualization

Conveniently [draw](#) your graphs, using a variety of algorithms and output formats (including to the screen). Graph-tool has its own layout algorithms and versatile, interactive drawing routines based on [cairo](#) and [GTK+](#), but it can also work as a very comfortable interface to the excellent [graphviz](#) package.

### ✍ Fully Documented

Every single function in the module is documented in the docstrings and in the online [documentation](#), which is full of examples.

Download version 2.45

[Installation instructions](#) | [Changelog](#)

Conda installation (GNU/Linux|MacOS)

```
conda create --name gt -c conda-forge graph-tool  
conda activate gt
```

◀ ▶

