# A (not so) gentle introduction to ecological networks

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# Why should I care about networks?

- A good way to harness complexity
- A solid mathematical foundation
- Elegant algorithms
- That guy is going to talk about them for, like, two hours...

# What is a network?

A mathematical approach

A *graph* is a **representation** of a **set of objects** where some pairs of objects are **connected** by **links**.

Or more formally, $G = (V, E)$, a *graph G* is an ordered pair of *vertices V* linked together by *edges E*.

Each element of $E$ is a two-element subset of $V$.

The *order* of a graph is $|V|$, and its *size* is $|E|$.

# What is a network?

An example

In an omnivory scenario, one top predator $P$ consumes both an intermediate consumer $C$ and a primary producer $R$. The intermediate consumer also consumes the producer.

This network is specified by

$$G = (\{P, C, R\}, \{\{P, C\}, \{P, R\}, \{C, R\}\})$$

Or for brevity

$$G = (\{P, C, R\}, \{PC, PR, CR\})$$

# What is a network?

Edges can be *directed* (arcs, directed edges) or not. An edge between a vertex and itself (cannibalism) is a *self-loop*.

In an **undirected graph**, there are at most $|V|(|V|-1)/2$ edges if there are no *self-loops*.

In a **directed graph**, there are at most $|V|(|V|-1)$ edges if there are no *self-loops*.

Exercice: What is the maximal size of a graph of order $n$ if there are self-loops?

# Number of partners

The number of vertices *receiving* a link from a focal vertex are called its **successors**

The number of vertices *establishing* a link towards a focal vertex are called its **predecessors**

The *total* number of edges connected to a focal vertex is this vertex **degree**

# Where is the ecology in all that?

graph  The whole community, *i.e.* the populations and their interactions

vertices  The composition of the community (species present)

edges  The interactions between the populations

# Where is the ecology in all that?

Exemple of "networkable" systems

- ► Trophic systems
- ► Plant–pollinators
- ► Hosts–parasites
- ► Mutualism
- ► Social interactions

Any system in which the **same ecological interaction** happens several time in a community can (should) be studied using network theory

# Number of partners

The number of (*e.g.*) preys of a predator is its **generality** (number of successors)

The number of (*e.g.*) predators of a prey is its **vulnerability** (number of predecessors)

# The niche model of food webs