

# Introducing *Biospatial*

An Open Source graph-based computing framework for managing and  
modelling spatial ecological data

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Global Biodiversity  
Information Facility

# Ecosystems support life in Earth



Figure: primary production



Figure: water cycle



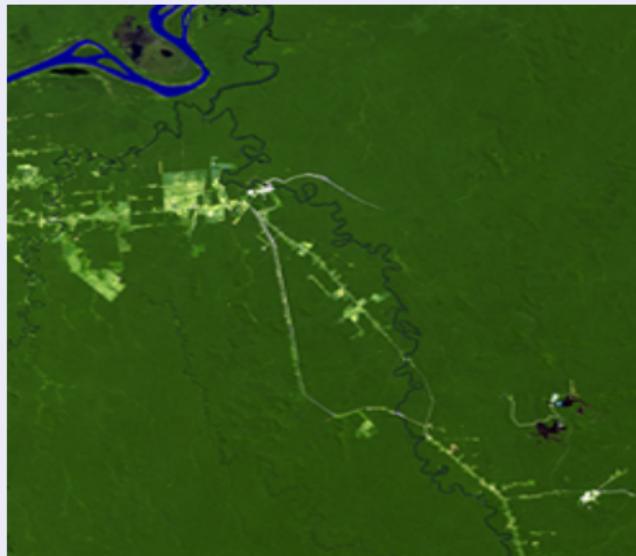
Figure: Disease regulation



Figure: food supply

# Why model them ?

The environment changes



**Figure:** Landsat 5 images from June 24, 1984, and August 6, 2011. (U.S. Department of the Interior — U.S. Geological Survey)

# Why model them ?

## Climate Change Mitigation and Response

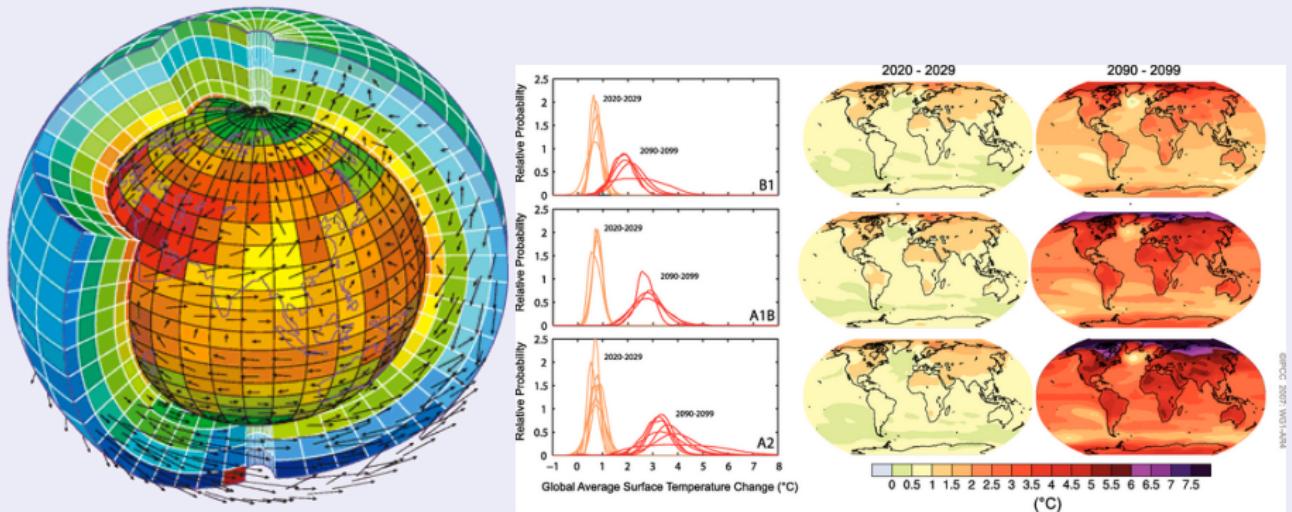


Figure: Earth System Models ((L. Fairhead /LMD-CNRS) and IPCC, 2007)

# Main question is ...

## Spatial regression of ecological networks

- *Find the underlying process that shapes the "species" assemblages.*

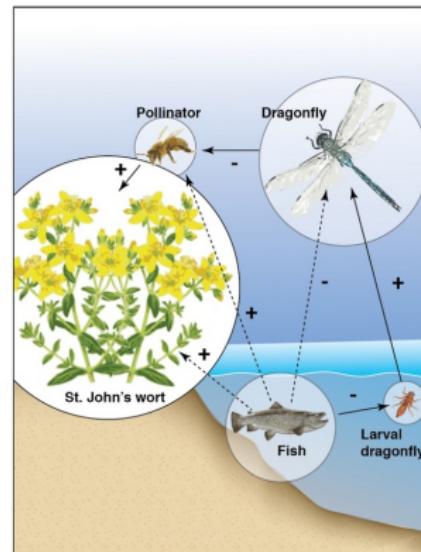


Figure: from Nature Education, 2012

# Main question is ...

## Spatial regression of ecological networks

- Infer the probability of assemblages of taxa for a given location.

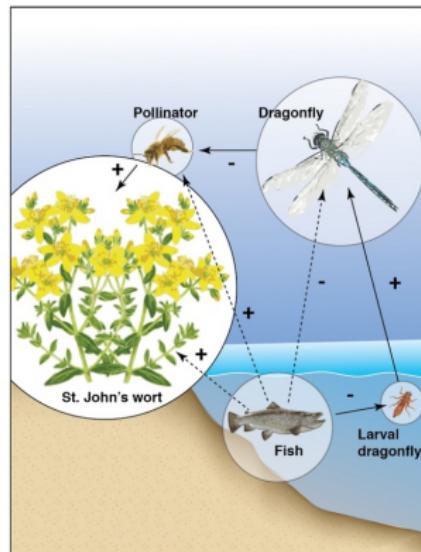
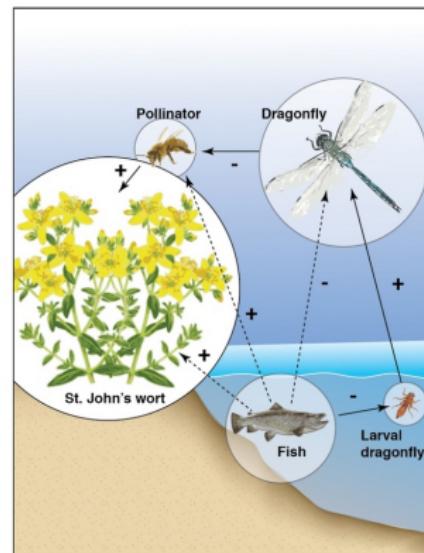


Figure: from Nature Education, 2012

# Main question is ...

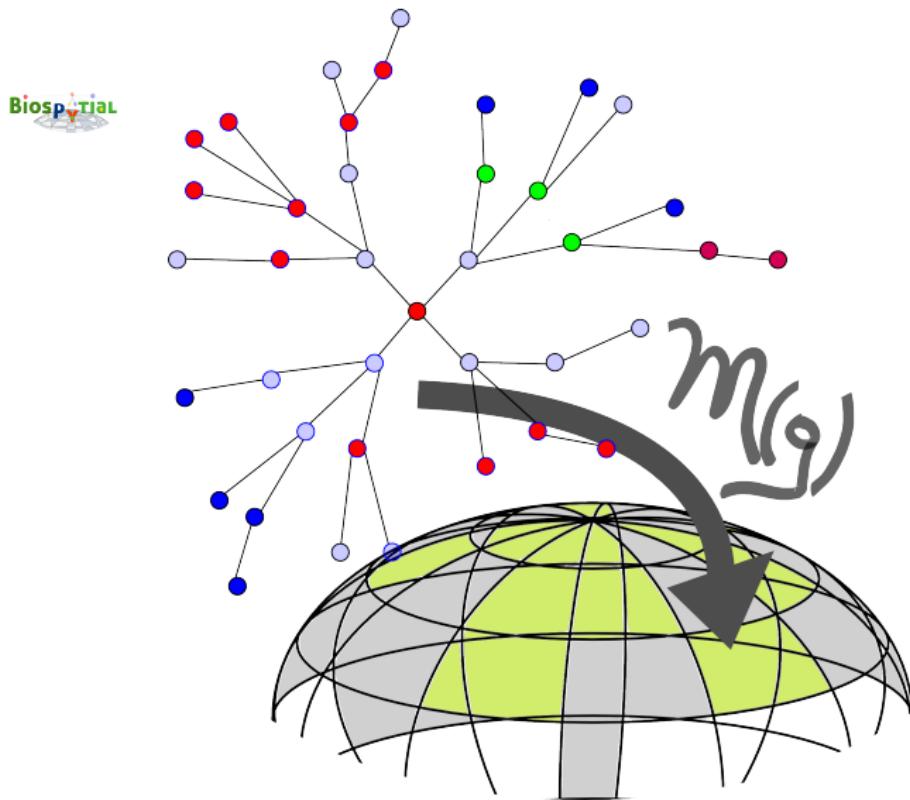
## Spatial regression of ecological networks

**fig:** An interaction food web shows that fish have indirect effects on the populations of several species in and around ponds.

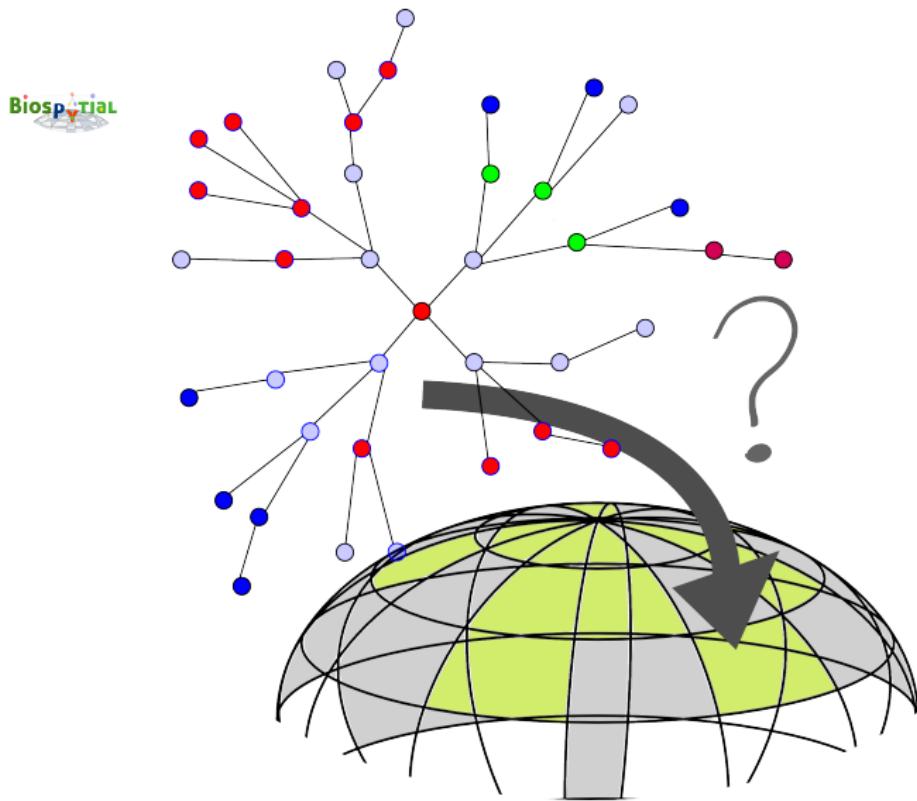


**Figure:** from Nature Education, 2012

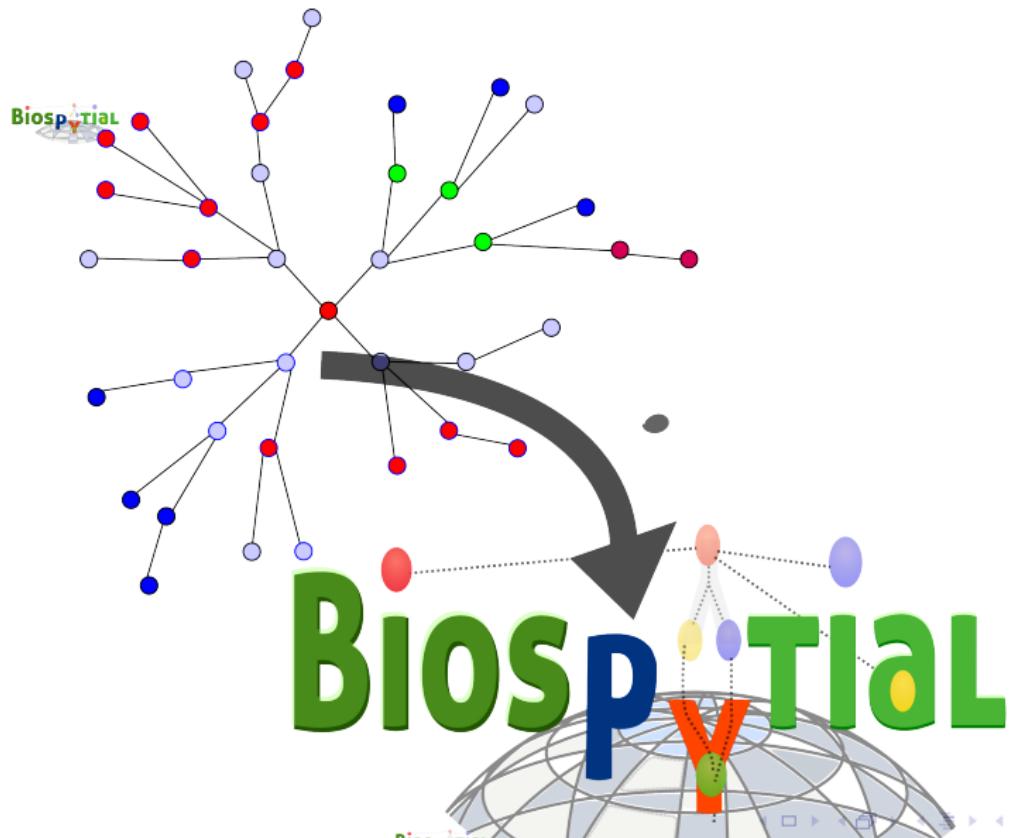
# Services and Modules



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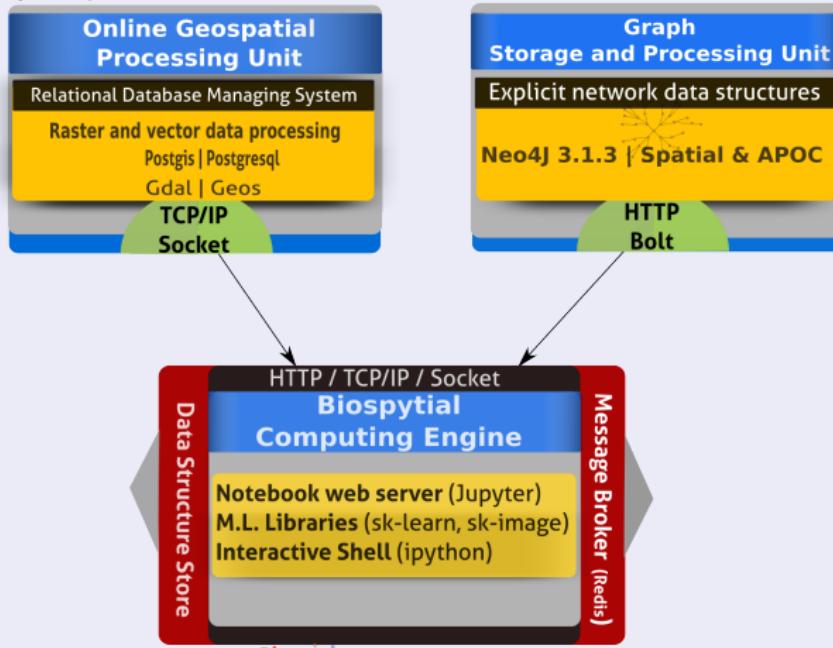
# Services and Modules



# What is Biospytial ?

A Graph engine

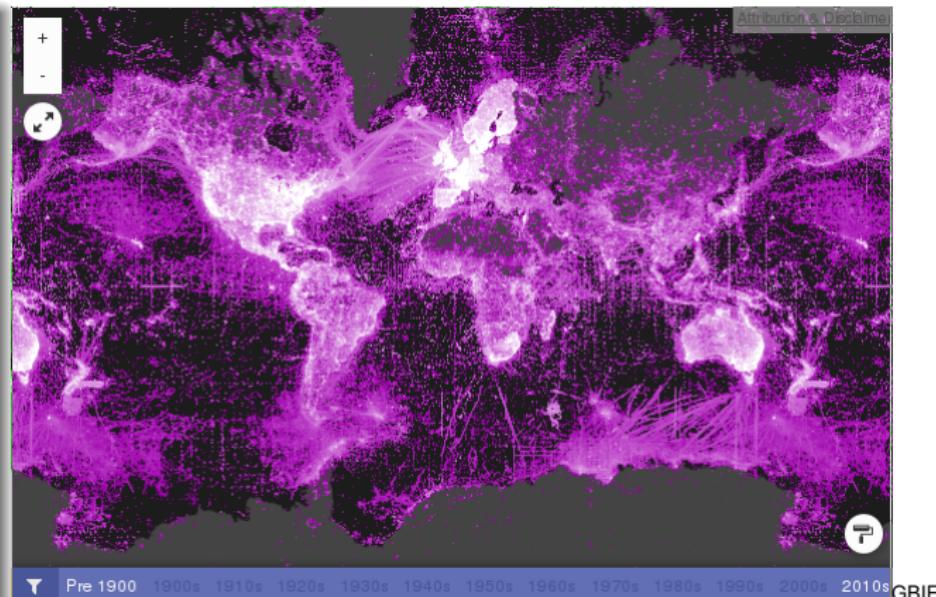
that integrates raster and vector data in explicit relational structures. (i.e. Networks / Graphs ).



# Vector data (points,lines,(multi)-polygons)

## Attributes

- id: Integer
- species id : Integer
- level: Integer
- latitude / longitude: float
- event date: DateTime
- name: String
- pk: 2406040
- geom: WKT
- levelname: String



(Global Biodiversity Information Facility) [www.gbif.org](http://www.gbif.org) The data is a joint effort in collecting all the publicly available data on biodiversity in the planet. This snapshot is from September, 2013

# Environmental Data

## BioClim - Datasource

Bioclimatic variables derived from monthly data 1978 - 2000 (12 Months, 30arc res.)

- Temperature (Max, Mean, Min)
- Precipitation
- Wind Speed
- Vapor Pressure
- Solar Radiation
- DEM-based (Aspect, Slope, Height)

Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of

Climatology 25: 1965-1978. \*

# The taxonomy as a partial order $\leq$

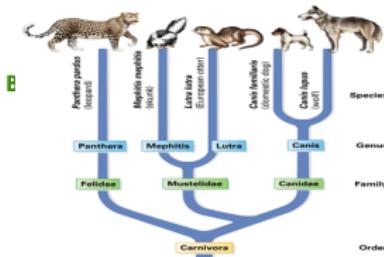


Figure: Common ancestor

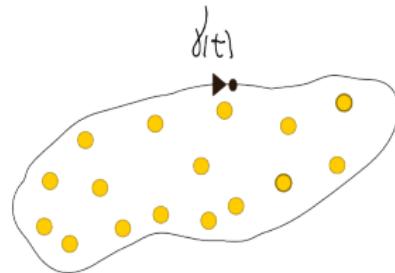


Figure: Occurrences contained in:...

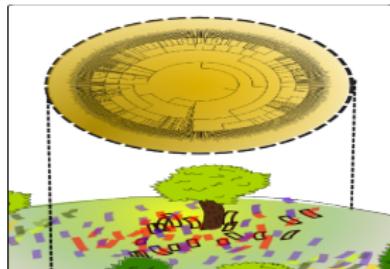


Figure: Tree structure

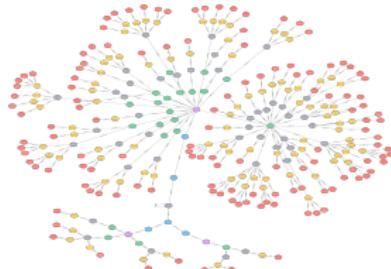


Figure: A sub-tree of the Tree of Life

# spatial Semi-lattice



Figure: An area cell an its neighbours

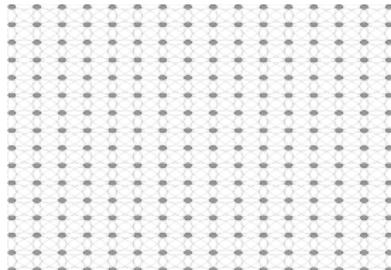


Figure: A lattice

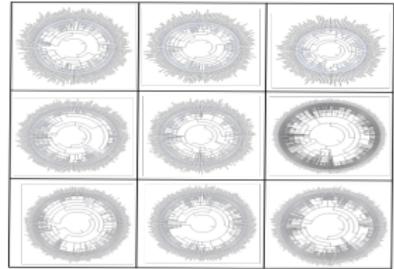


Figure: On every cell a tree

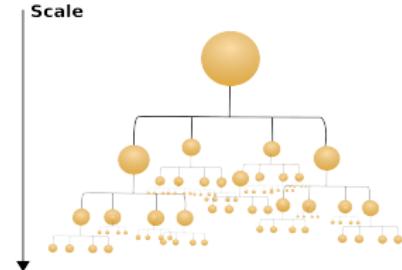


Figure: Another tree across scale

# Tree operations



## Semigroup

Let  $T$  be a set and  $m : T \times T \rightarrow T$  be an associative binary operation<sup>a</sup>. The duple  $(T, m)$  is called a semigroup and  $T$  is called the underlying set of the semigroup.

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<sup>a</sup>Meaning that if  $t, p, q \in T$  then  $m(m(t, p), q) = m(t, m(p, q))$

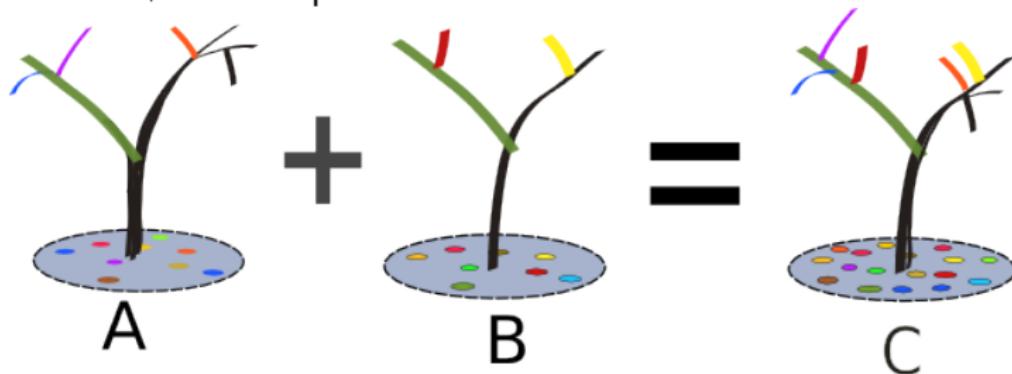
## Identity element

Let  $e \in T$  and  $T$  a semigroup.  $e$  is called *identity element* if and only if  $te = et$  for all  $t \in T$ . There can only be at most one identity element in a semigroup.

## Monoid

A *monoid* is a set that is **closed** under the associative operation of a semigroup with an identity element.

The + and – operator of taxonomic trees are monoids.



# Operations

BioSpa<sup>ti</sup>al

## Other available operations



$$A + B$$



$$A \& B$$



$$A - B$$



$$A \wedge B$$

# Some Demo



# Code and container availability

