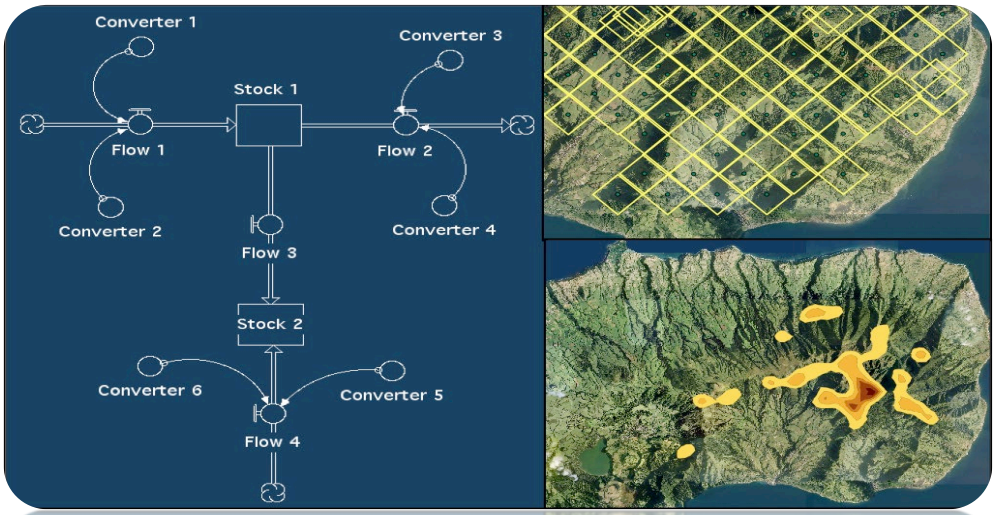
Workshop

The Stochastic Dynamic Methodology (StDM)

Fundamentals and description in practice

Part I



João Alexandre Cabral, Mário Santos & Rita Bastos

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Portugal

Ecological Modelling

"**Ecological modellin**g is the use of systems analysis and simulation to mimic complex ecological systems by summarizing available relevant information. The process includes the development of conceptual and quantitative models, and the evaluation and use of the model to answer the specific questions for which the model was built." (Pittroff and Pedersen, 2005)

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An **ecological model** is an abstract representation, usually mathematical, of an ecological system (ranging from individuals to populations, ecological communities, or even ecossystems), which is studied to gain understanding of the real system (Hall and Day, 1990).

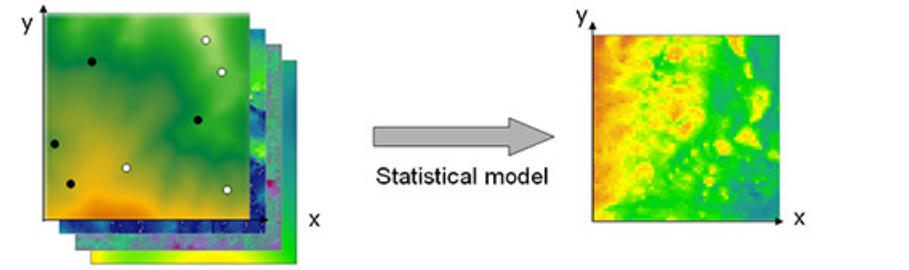
Ecological Models

Statistical

Mechanistic

Ecological Models

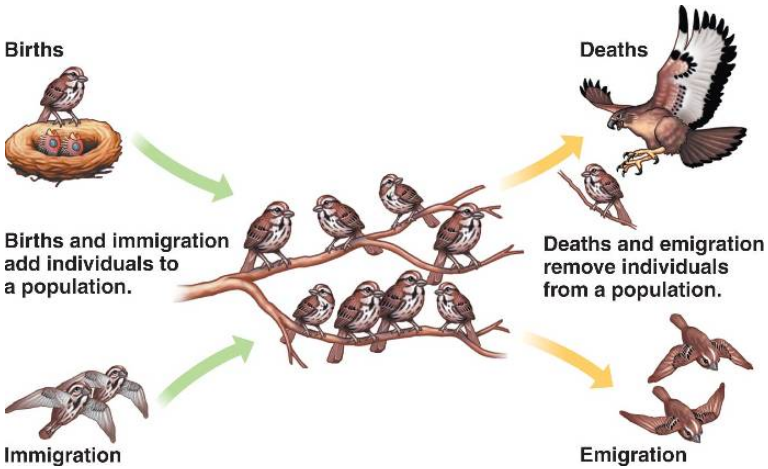
Statistical



Field records and maps of environment

Map of probability species is present

Mechanistic



Ecological Models

Statistical	**Mechanistic**
Static	**Dynamic**

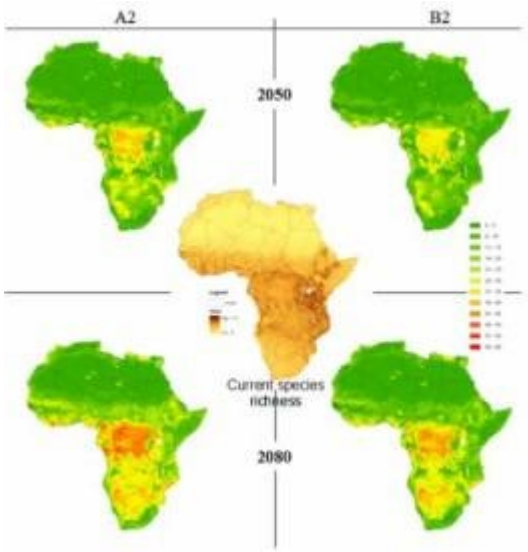
Ecological Models

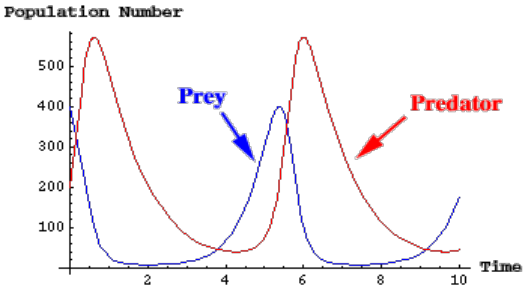
Statistical

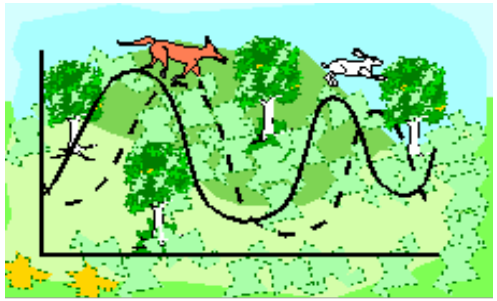
Mechanistic

Static

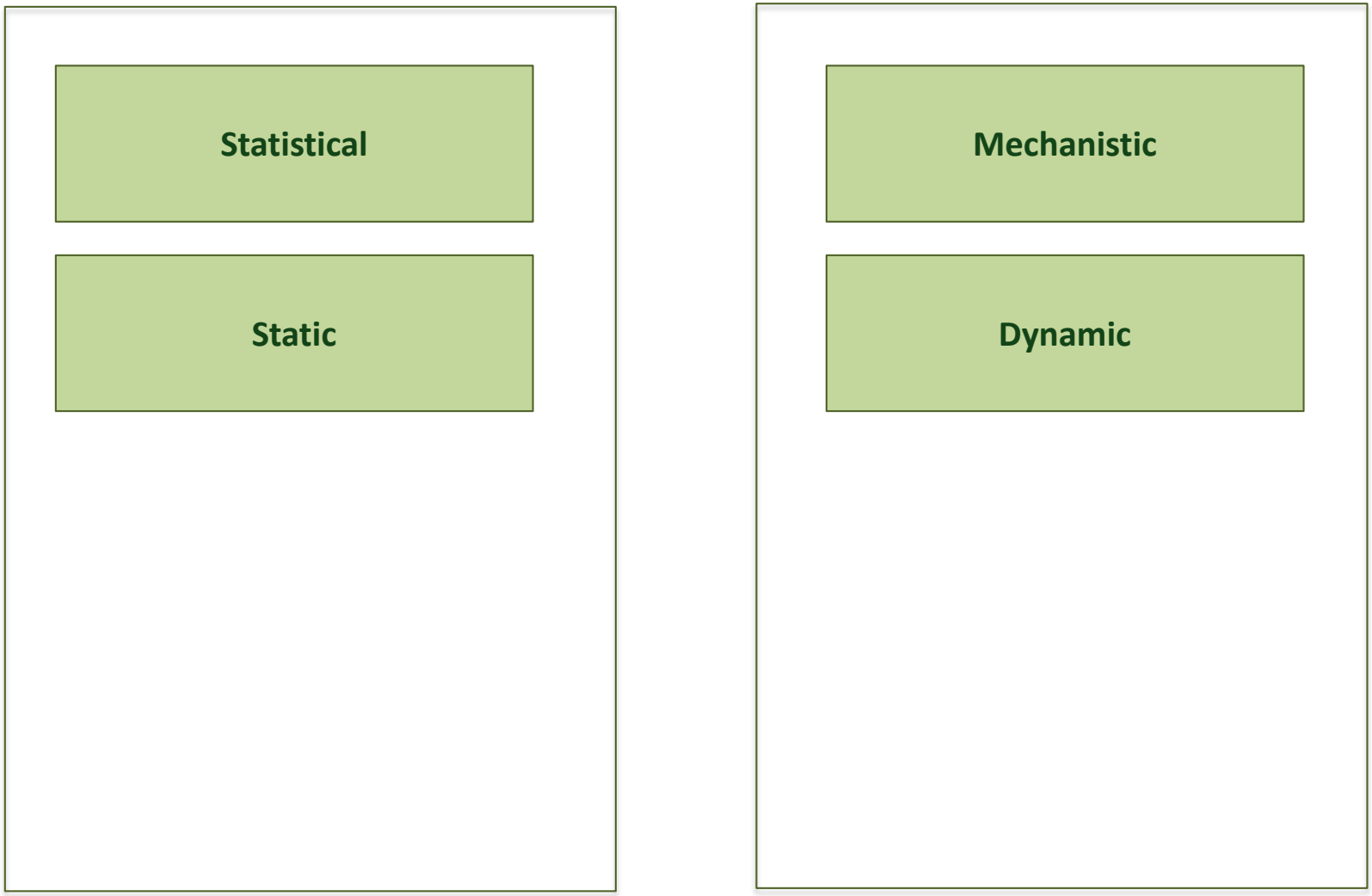
Dynamic







Ecological Modelling Approaches



Ecological Modelling Approaches

Correlative approaches

- Statistical
- Static

Process-based approaches

- Mechanistic
- Dynamic

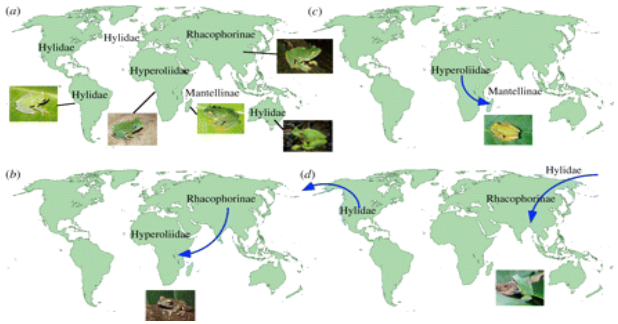
Ecological Modelling Approaches

Correlative approaches

Statistical

Static

Niche-based Models



Process-based approaches

Mechanistic

Dynamic

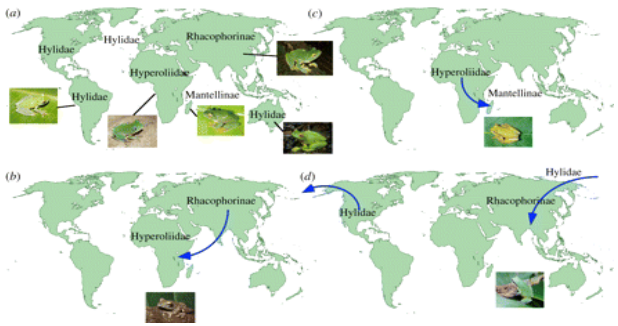
Ecological Modelling Approaches

Correlative approaches

Statistical

Static

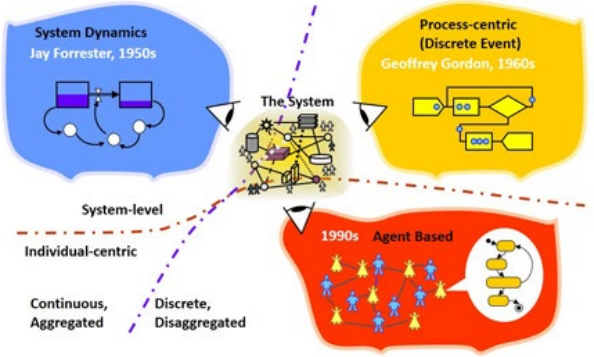
Niche-based Models



Process-based approaches

Mechanistic

Dynamic



System Dynamics

System dynamics is a methodology and computer simulation modeling technique to understand the non-linear behaviour of complex systems over time (Jay Forrester, 1950).

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The first issue encountered in the process of modeling is to decide at which level components shall be chosen, and to figure out how they interact with one another to realize the system.

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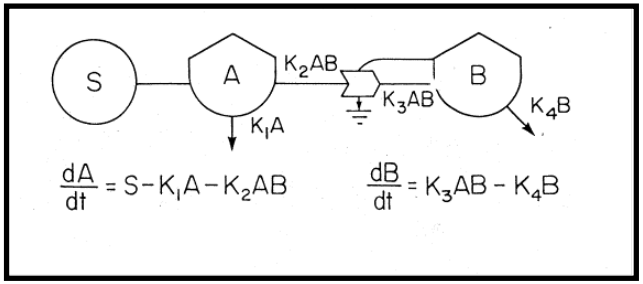
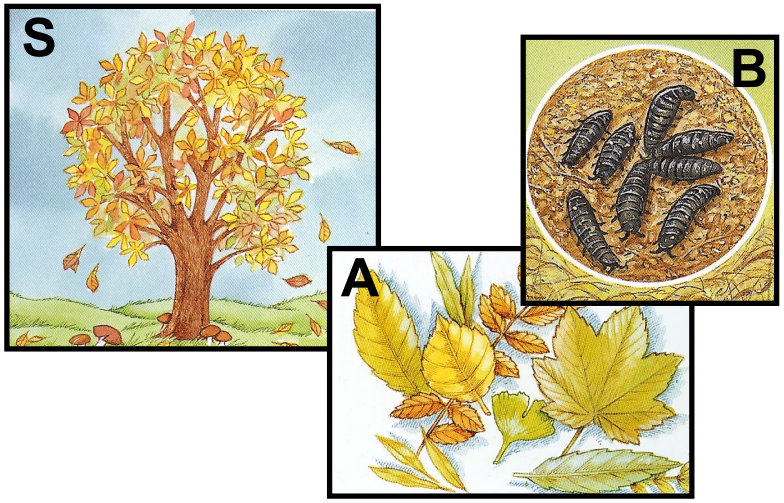
The first issue encountered in the process of modeling is to decide at which level components shall be chosen, and to figure out how they interact with one another to realize the system.

It is a formal expression, in mathematical terms, of the relationships/flows between defined entities (Forrester, 1961).



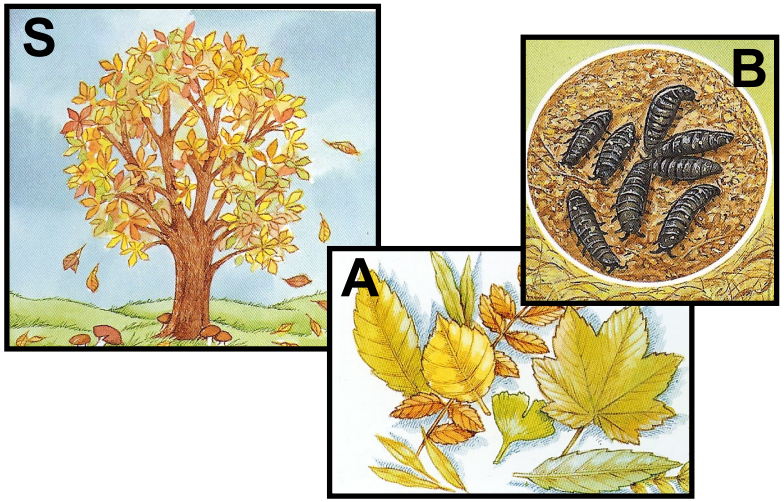
System Dynamics

System Dynamics



S – Source of organic matter in the system (grams)
A – Organic matter (grams)
B – Detritivorous community (no. individuals)

System Dynamics



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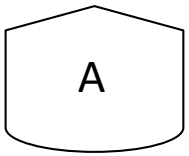
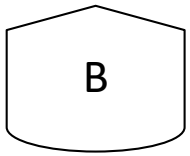
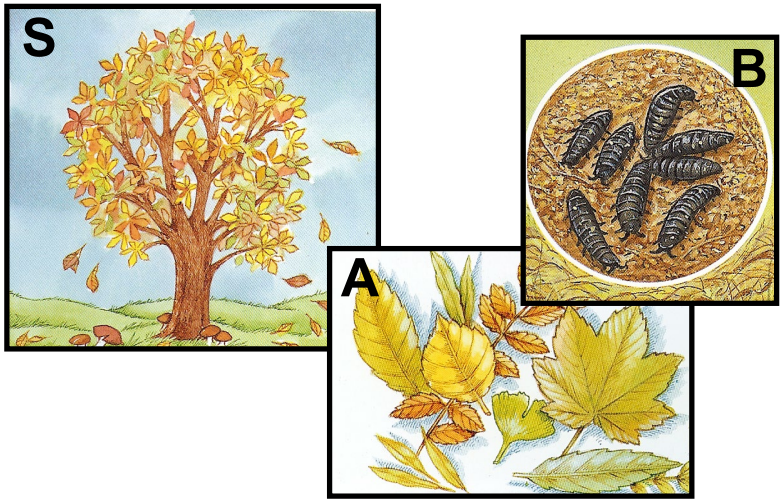




$\frac{dA}{dt} =$

$\frac{dB}{dt} =$

System Dynamics



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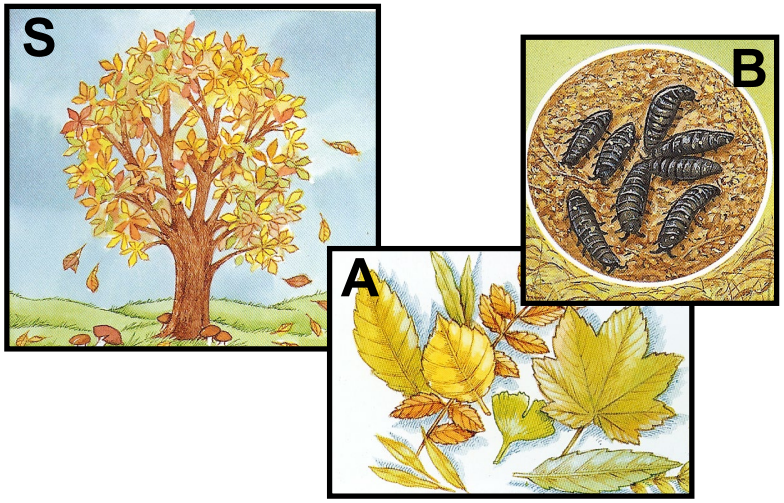

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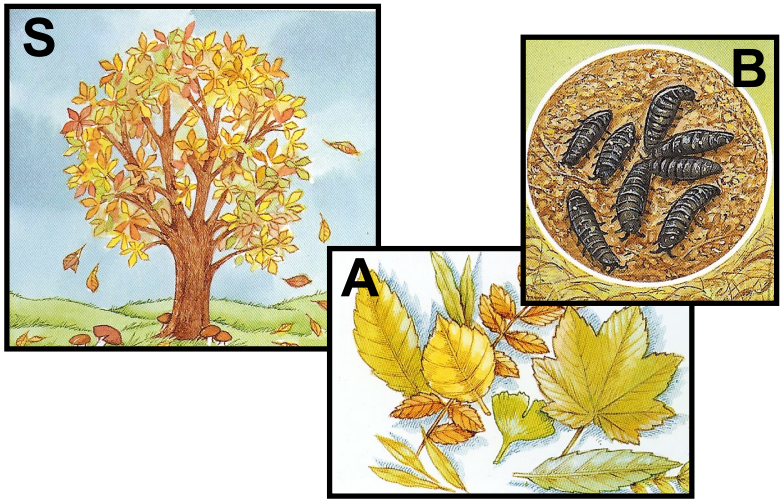
System Dynamics



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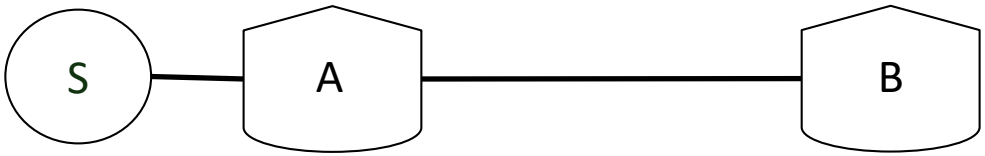

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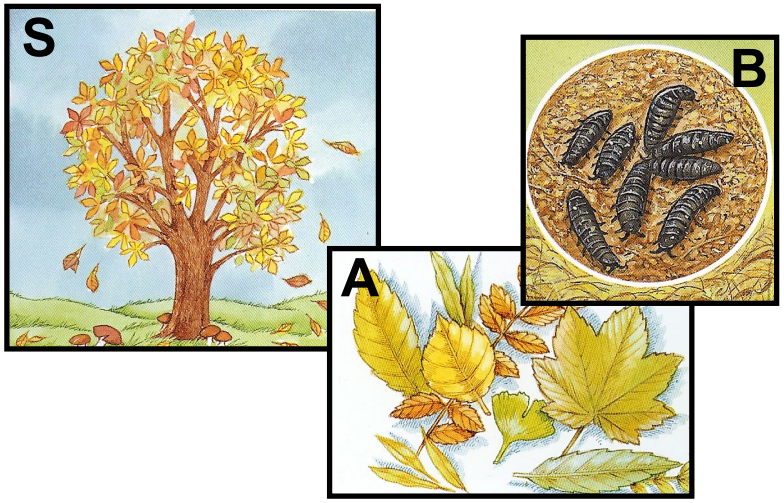
System Dynamics



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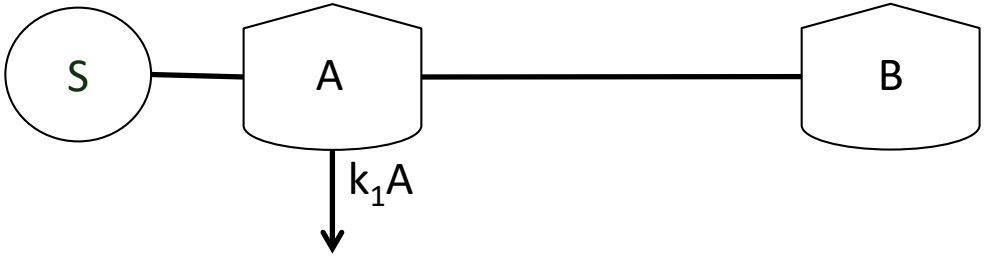
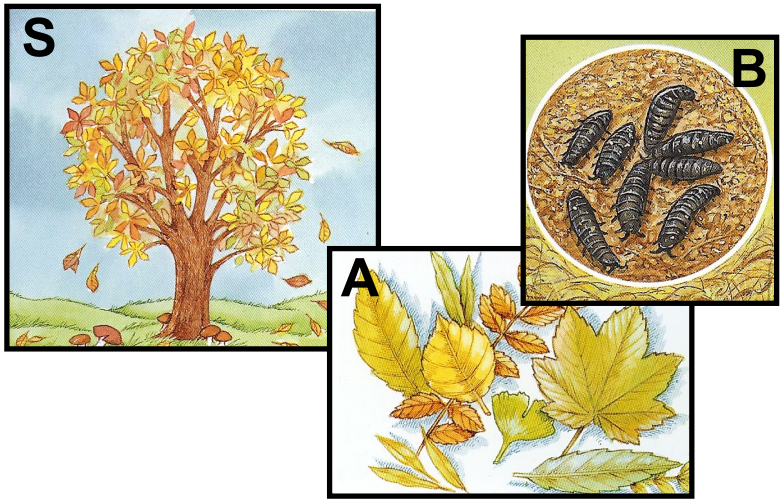


K_1 – Mineralization rate (gr)

$\frac{dA}{dt} = S - k_1A$

$\frac{dB}{dt} =$

System Dynamics



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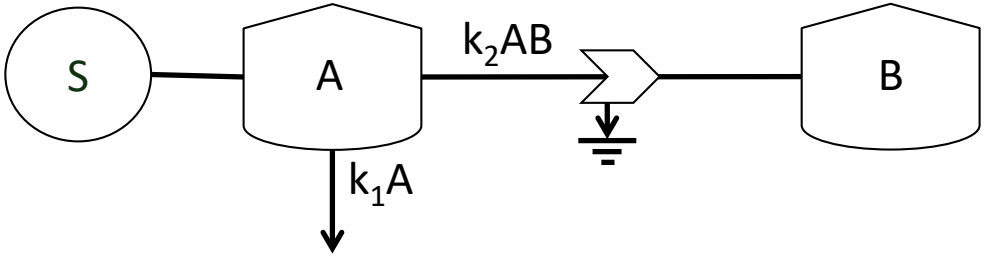


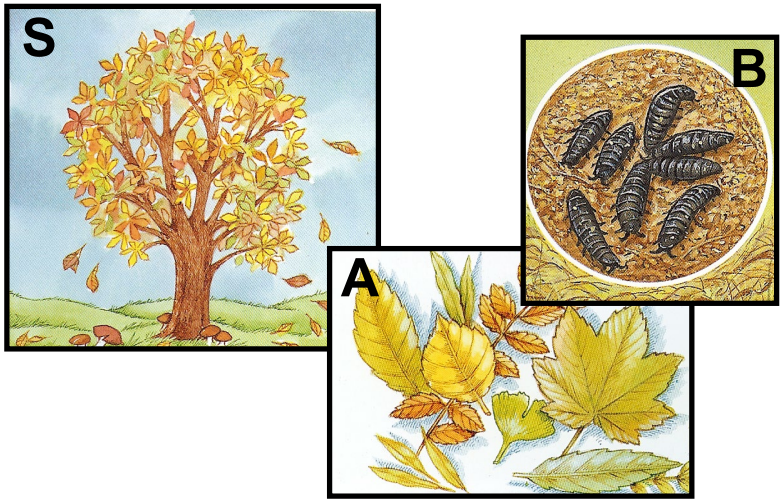
K_1 – Mineralization rate (gr)

K_2 – Consumption rate (no ind.)

$$\frac{dA}{dt} = S - k_1A - k_2AB$$

$$\frac{dB}{dt} =$$

System Dynamics



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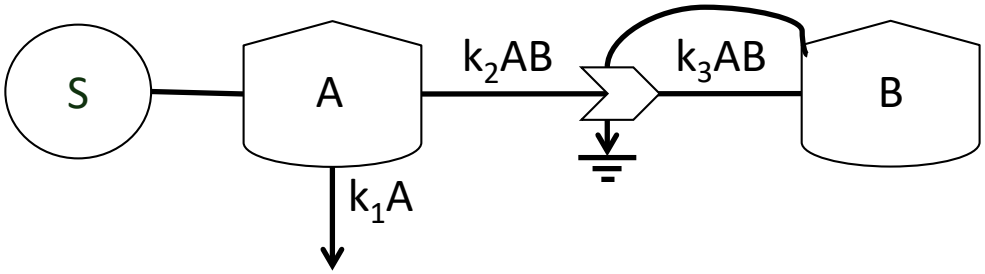


K_1 – Mineralization rate (gr)

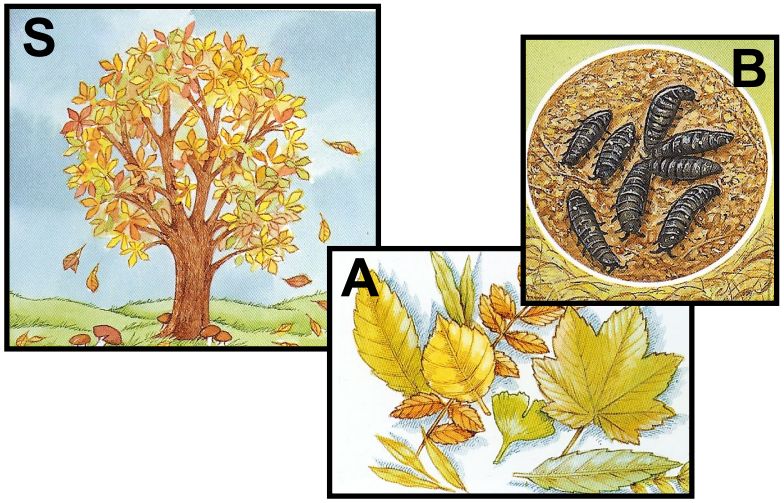
K_2 – Consumption rate (no ind.)

K_3 – Assimilation rate (no ind.)

$$\frac{dA}{dt} = S - k_1A - k_2AB$$

$$\frac{dB}{dt} = k_3AB$$

System Dynamics



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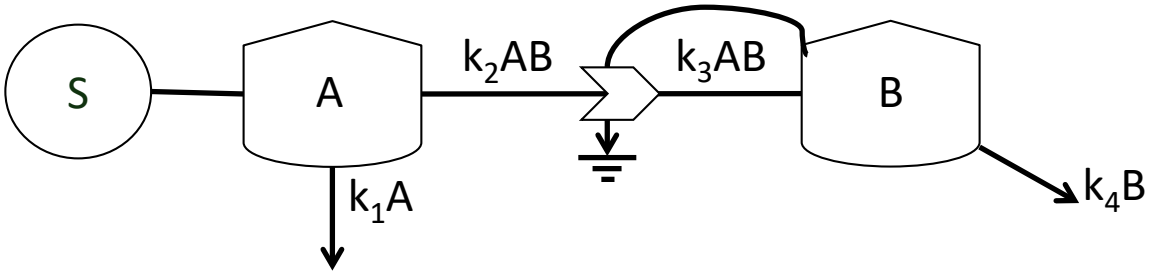

$\frac{dA}{dt} = S - k_1A - k_2AB$

$\frac{dB}{dt} = k_3AB - K_4B$

K_1 – Mineralization rate (gr)

K_2 – Consumption rate (no ind.)

K_3 – Assimilation rate (no ind.)

K_4 – Mortality rate (no. ind.)

System Dynamics

$$\frac{dA}{dt} = S - k_1 A - k_2 AB \qquad \frac{dB}{dt} = k_3 AB - K_4 B$$

System Dynamics

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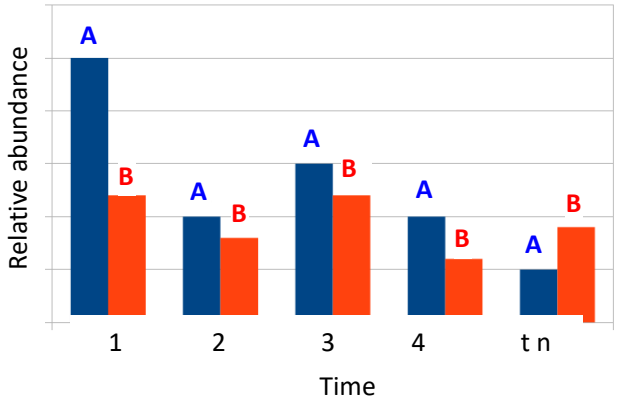
"Differentials of quantities"
DIFFERENTIAL EQUATIONS



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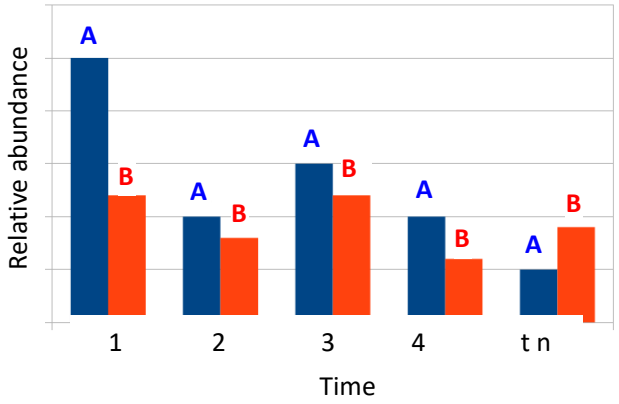

$$A_{(t+1)} = A_{(t)} + S - K_1 A_{(t)} - K_2 AB_{(t)}$$

$$B_{(t+1)} = B_{(t)} + K_3 AB_{(t)} - K_4 B_{(t)}$$

"Differences between quantities"
EQUATIONS OF DIFFERENCE

System Dynamics

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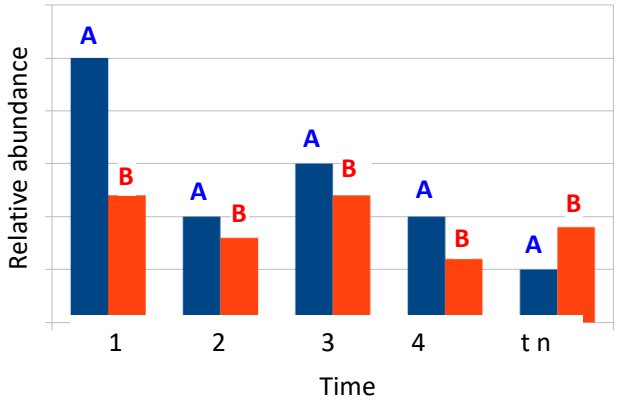
"Differentials of quantities"
DIFFERENTIAL EQUATIONS



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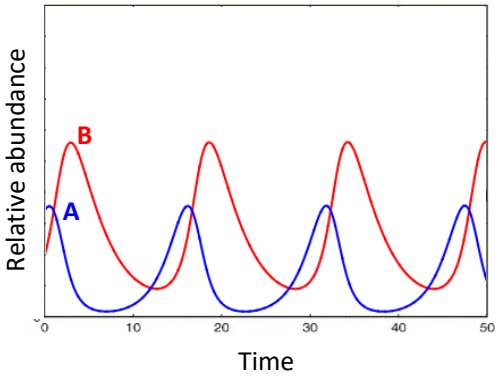
EQUATIONS OF DIFFERENCE



Stella Software

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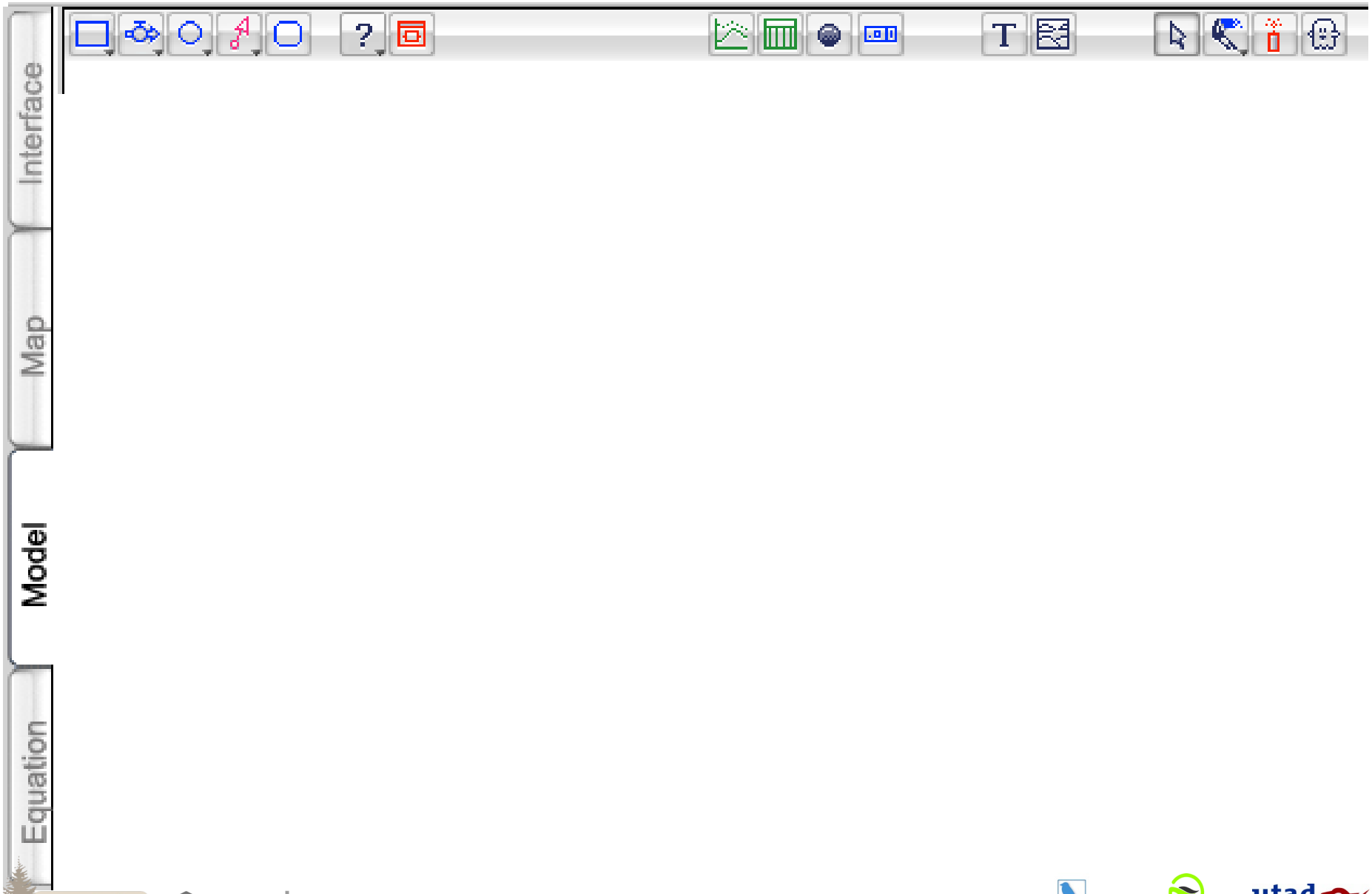
STELLA is a flexible computer modeling package with an easy, intuitive interface that allows users to construct dynamic models that realistically simulate biological systems.

Within STELLA, users are presented with a graphical user interface in which they may create graphical models of a system using four fundamentals: stocks, flows, converters and connectors.

Stella Software



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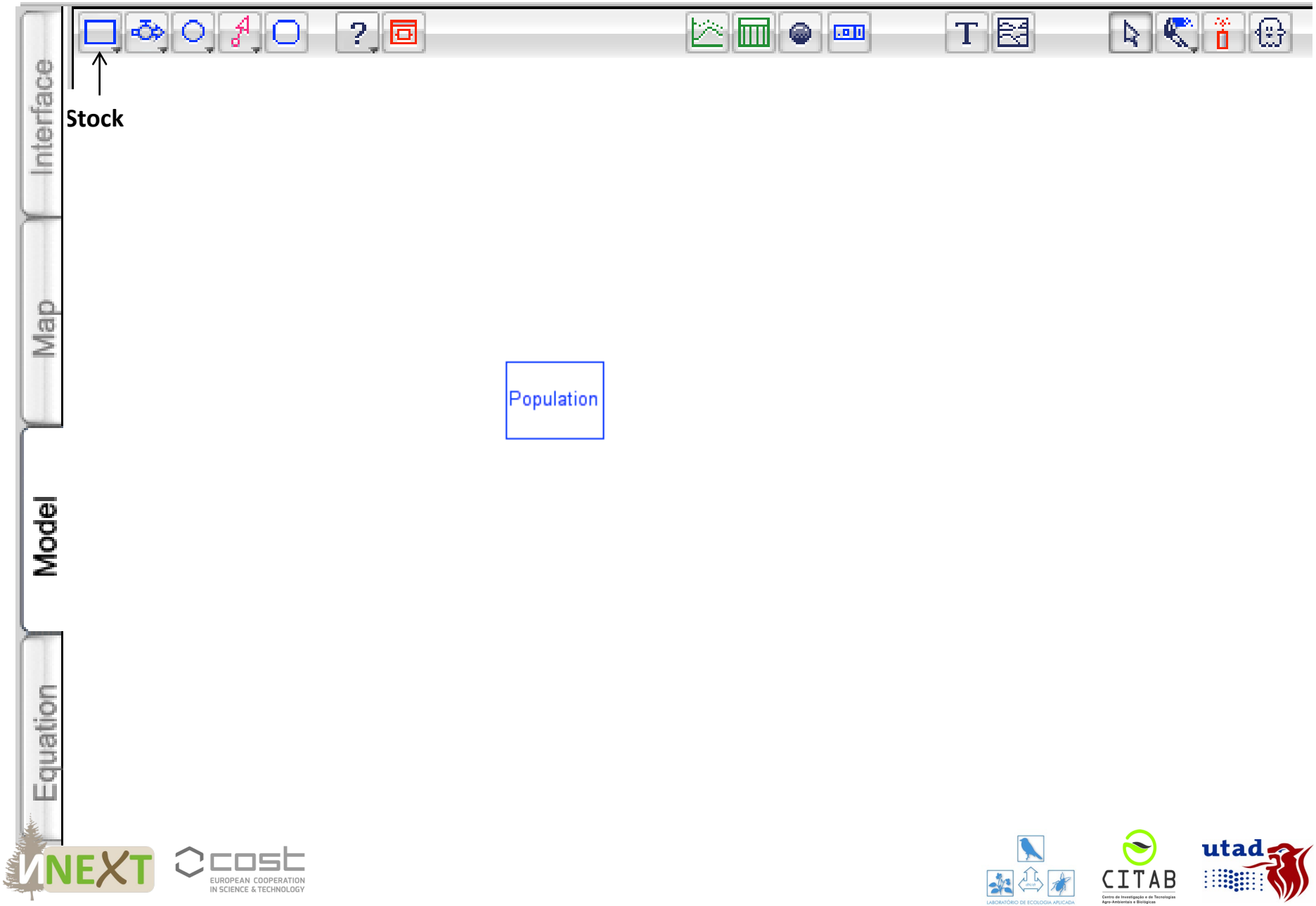

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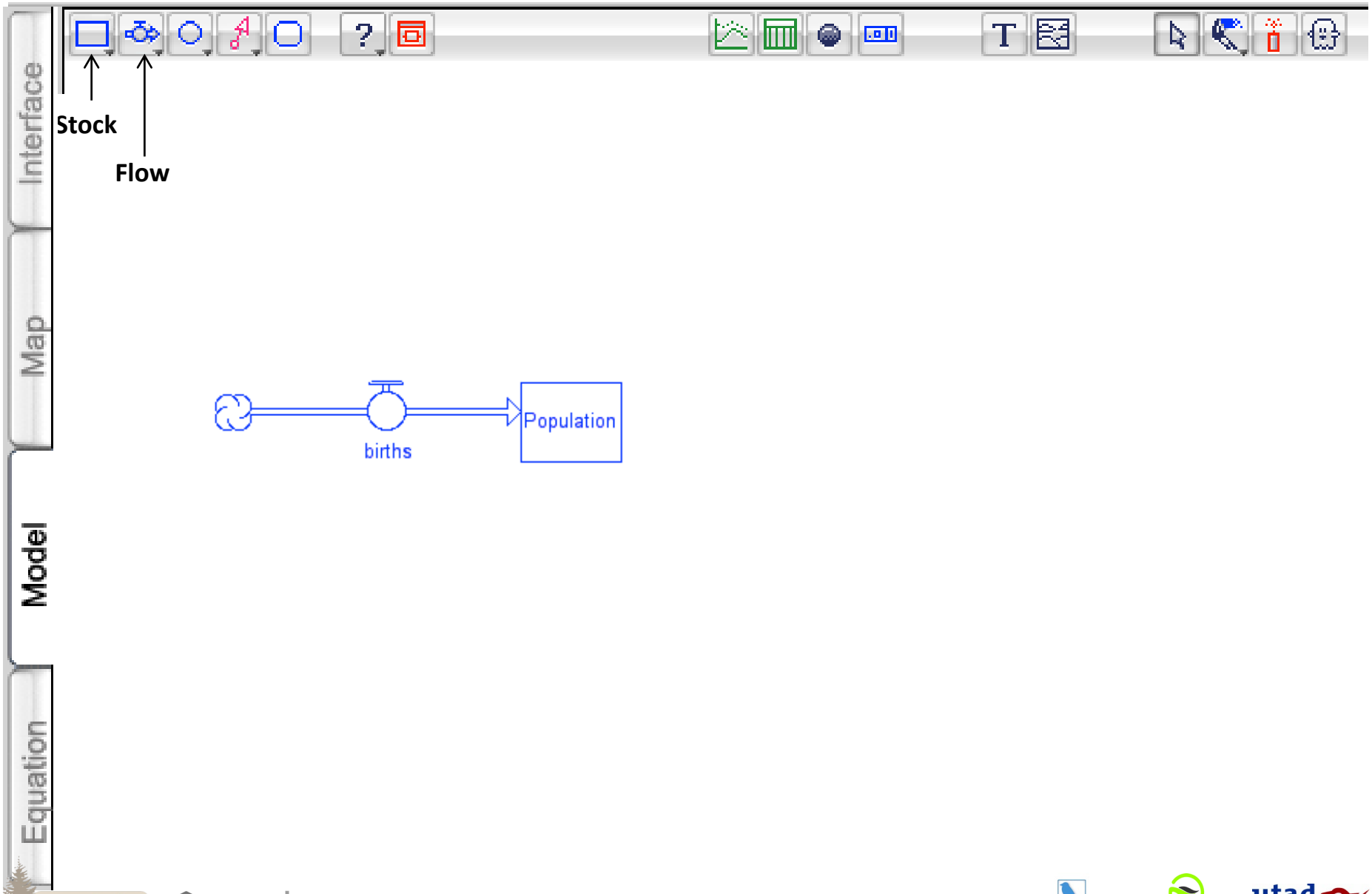

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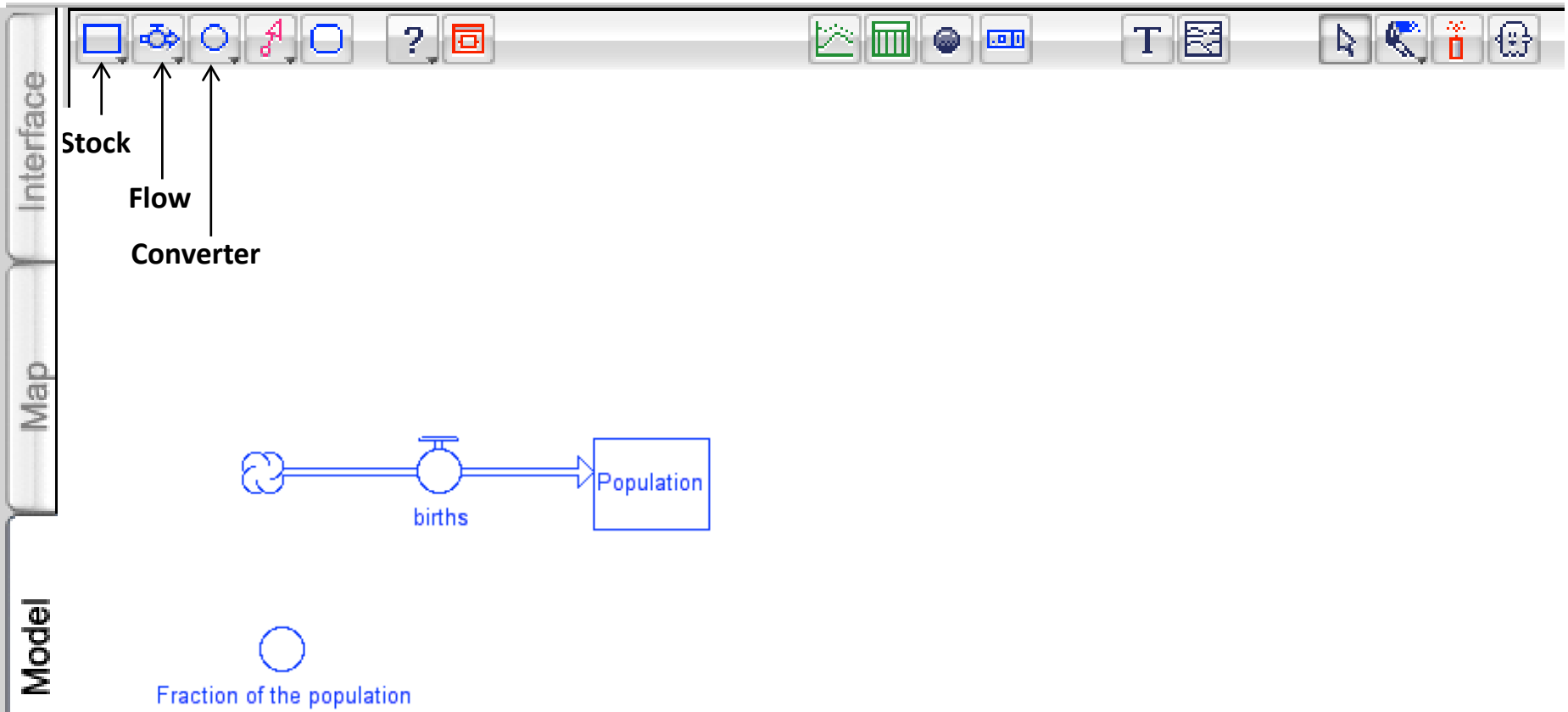

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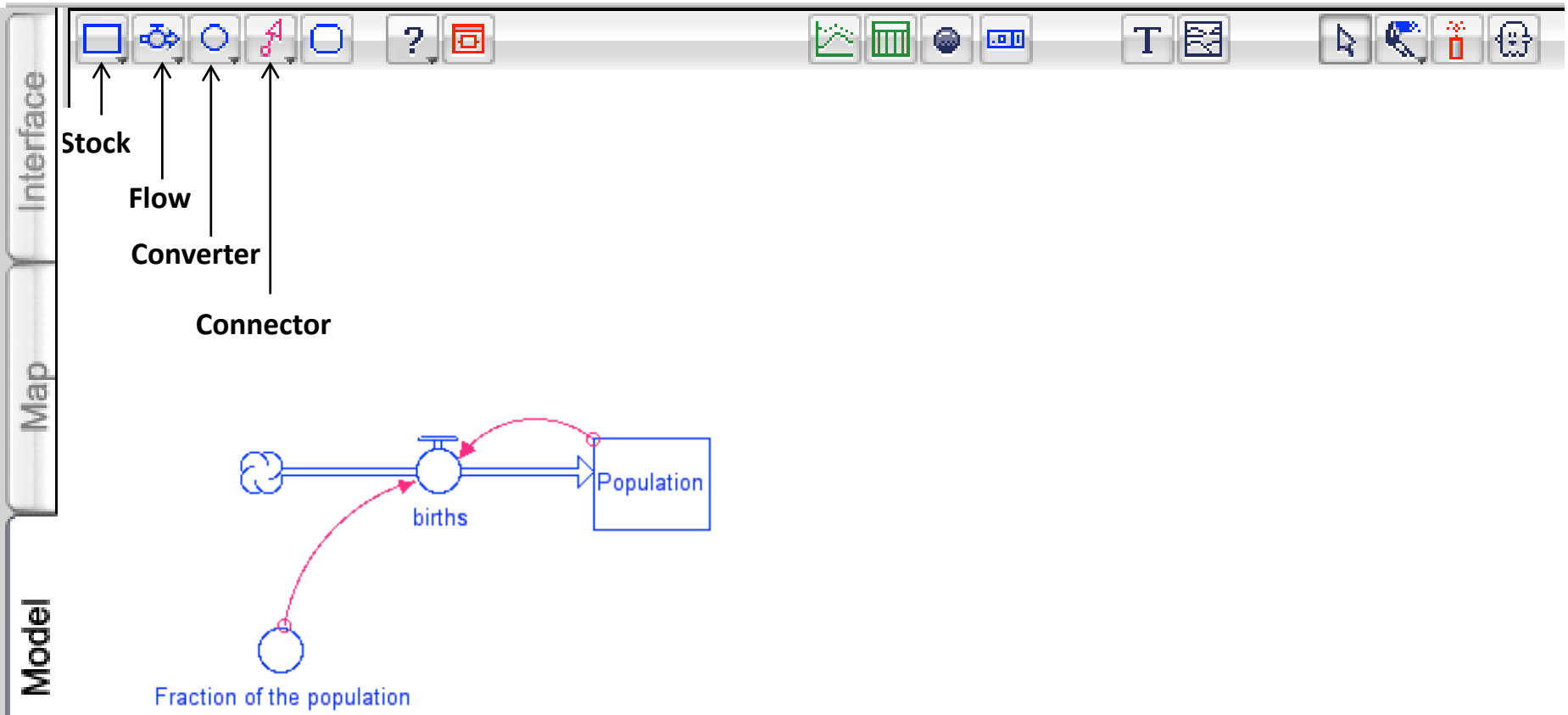


Stella Software

Interface
Map
Model
Equation

Stock

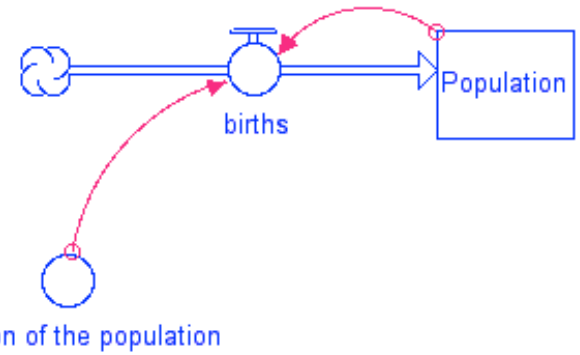
Flow

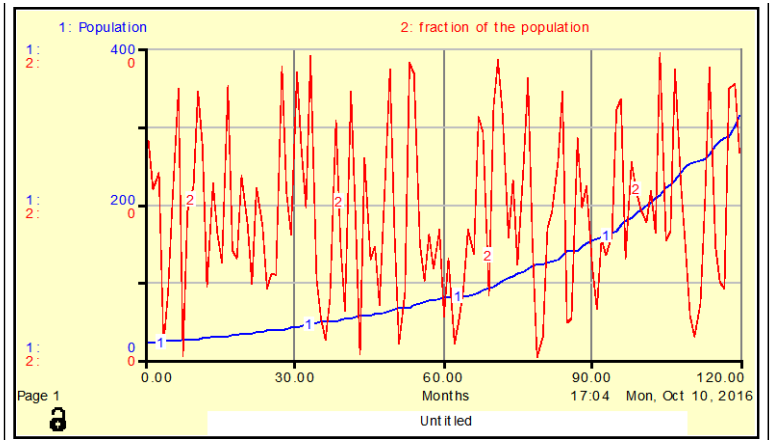
Converter

Connector

Graphics

Pop growth





Stella Software

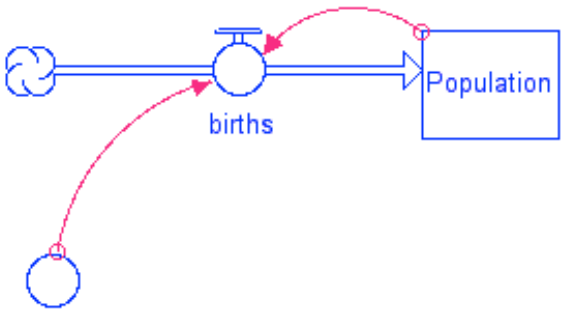
Interface | Map | Model | Equation

Stock

Flow

Converter

Connector



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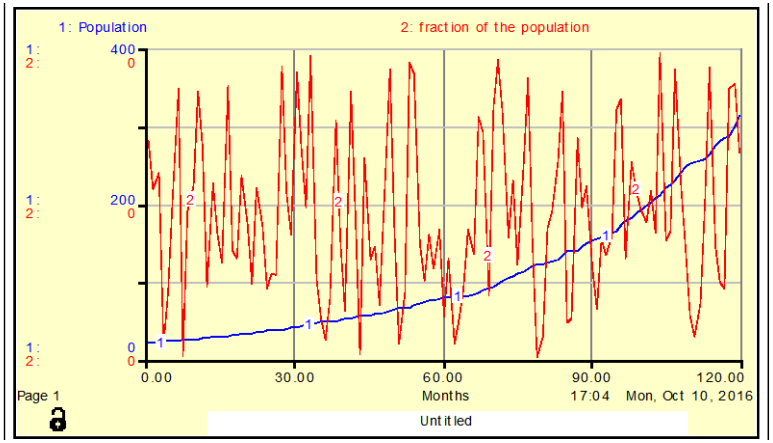


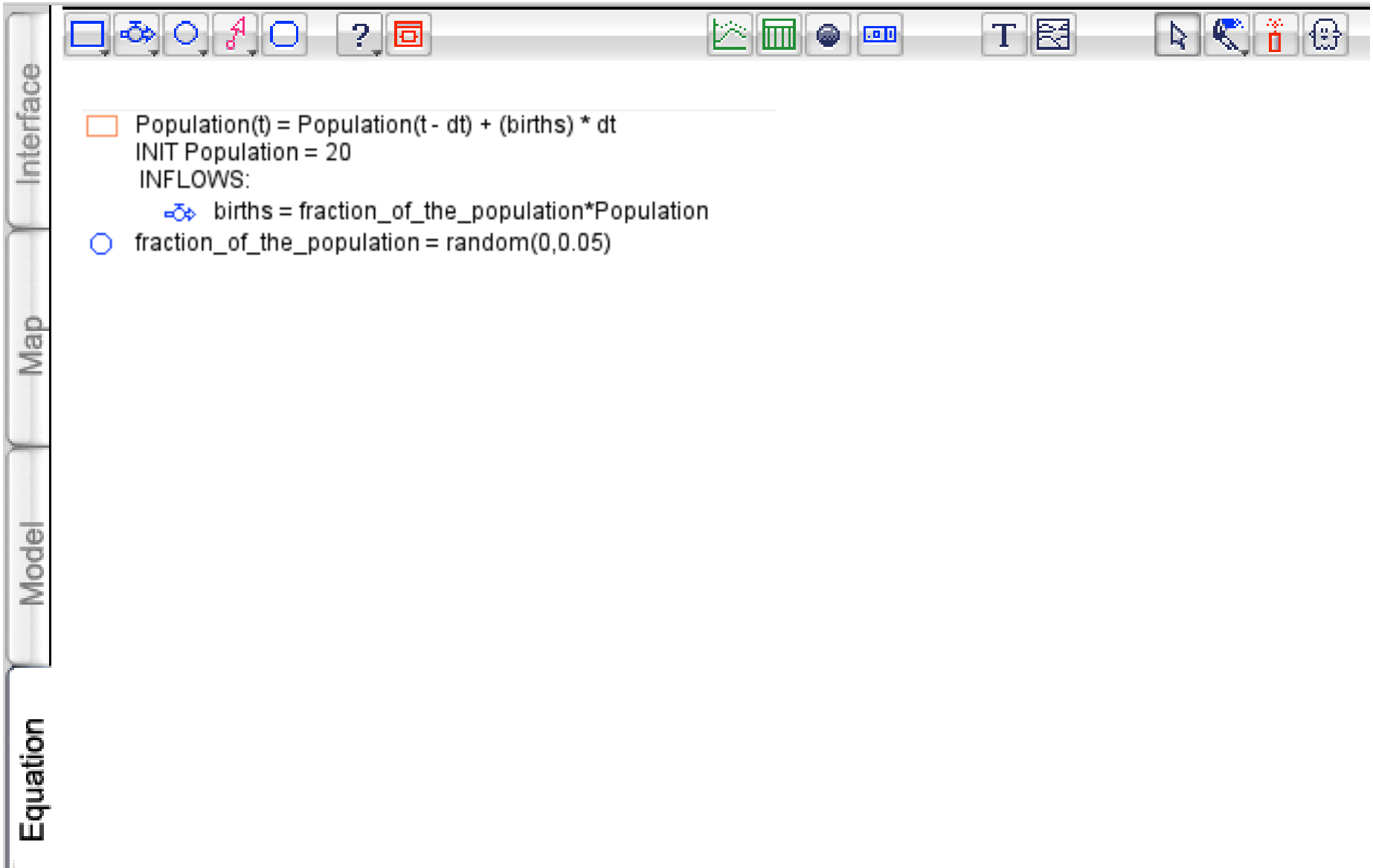
Tables

Table 1

16:58 10/10/16 Table 1 (Untitled Table)

Months	Population	fraction of the population
0	20.00	0.04
1	20.70	0.03
2	21.27	0.03
3	21.91	0.00
4	21.95	0.01
5	22.18	0.03
6	22.75	0.04
7	23.75	0.00
8	23.76	0.02
9	24.32	0.03

Stella Software



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