

Poster Sesimbra

Using CAPSIS to simulate the dynamics of tropical rain forests: developing new modelling tools for ecologists and forest managers

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Introduction

- Impossible to perform the same number of simulations with CapSIS as with previous systems of agents: model from individual to forest level and from year to the next.
- In order to catch most of forest and spatial or global phenomena, possible process modelling approaches were proposed and implemented.
- Depending on the needs and available data, users can configure "a la carte" models to handle specific questions from ecologists "back" to or to show them situations at the specific point they are interested in.

State of the art

- CapSIS was chosen as our best framework for simulation.
- It provides generality for low to high-level perspective (whole forest dynamics).
- It is portable, extensible and open.
- It holds most of the most specific tools of generality from the modelling of trees.

Goal

- To facilitate the development of a neutral model in order to assess the impact of human activities on forest dynamics.
- The goals are mainly to be experimental, but also to provide a better way to manage complexity and answer the kind of questions:
 - How quickly will the harvestable stock recover after a logging and what species will it be made off?
 - How the whole forest falling cycles can be shortened, with which type of economical and ecological consequences?

Project : current and future

- Chêne-Forest: Natural succession processes
- Sub-tropical: Succession of *Dioscorea guianensis* (*Caraculiphocea*)
- Diaphane: Succession of *Coumoussou americana* (*Caraculiphocea*)
- Méthys-Loumas: Growth dynamics of *Coumoussou cylindricum* (*Medusaceae*)

What is CAPSIS ?

- CapSIS is a multiplatform simulation framework with a large number of functionalities to build forest dynamics models.
- It is a portable reference, designed around formal which supports model development (classical, object-oriented or web) (real, test, conceptual).
- A plug-in architecture provides the possibility to build web for more general data collection, data visualization and connection with other software.

What is SELVA ?

- Selva is a three-dimensional model designed for the tropical rainforest of French Guiana (Gouy's Forest, 1959) re-vegetation.
- The three fundamental processes of forest dynamics are:
 - growth (Gouy's Forest & Hérault, 2000) (11 species)
 - mortality (mortality level and tree type of simulation)
 - succession (dispersal on local levelness)
- For particular species, which is present in the forest, from seed dispersal to sapling establishment.

Approach / Method

- Model generality is achieved thanks to a modular structure as a consequence of the model design: "plug-in" case of the simple library (Simple Growth, Simple Dispersal, etc.).
- Configurations are done through scripts that define the model level and model data. It will be "back model" to all data parameters.
- In order to avoid the danger of being subject to the too many properties, properties are dynamically defined through ready-to-use properties as available.

Architecture

References

Drey G., Bonner F., 1997. CAPSIS: Computer-Aided Projection of Succession & Silviculture: an interactive simulation and comparison tool for tree and stand dynamics, with individual treatment and spatial constraints. In: Proceedings of the 10th World Congress of Conservation Science, Vancouver and local quality through modelling, approaches and simulation software. Ecogeochem. Kyoto University of Forest Science, Japan, 2001, 1996. G. Nogués and F. Bonner (INRA Nancy), 1997, 194-202.

Guayard F., 1999. Individual-based spatially explicit modelling of forest stands in French Guiana. In: Y. Lecomte, B. Kapp, C. Lamy and R. Rousset (Eds) Proceedings of the International Conference on Modelling Using Remote Sensing and GIS in Tropical Forest Land Use Analysis. Jakarta, Indonesia, October 26-29, 1999, 477-480.

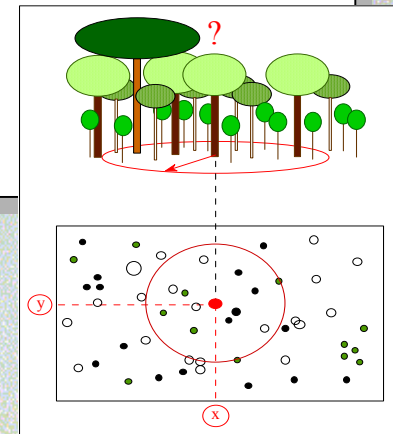
Guayard F., Bonner F., 2000. Modelling diameter increments in a tropical evergreen rain forest in French Guiana. Forest Ecology and Management 131(1-3): 209-289.

Selva

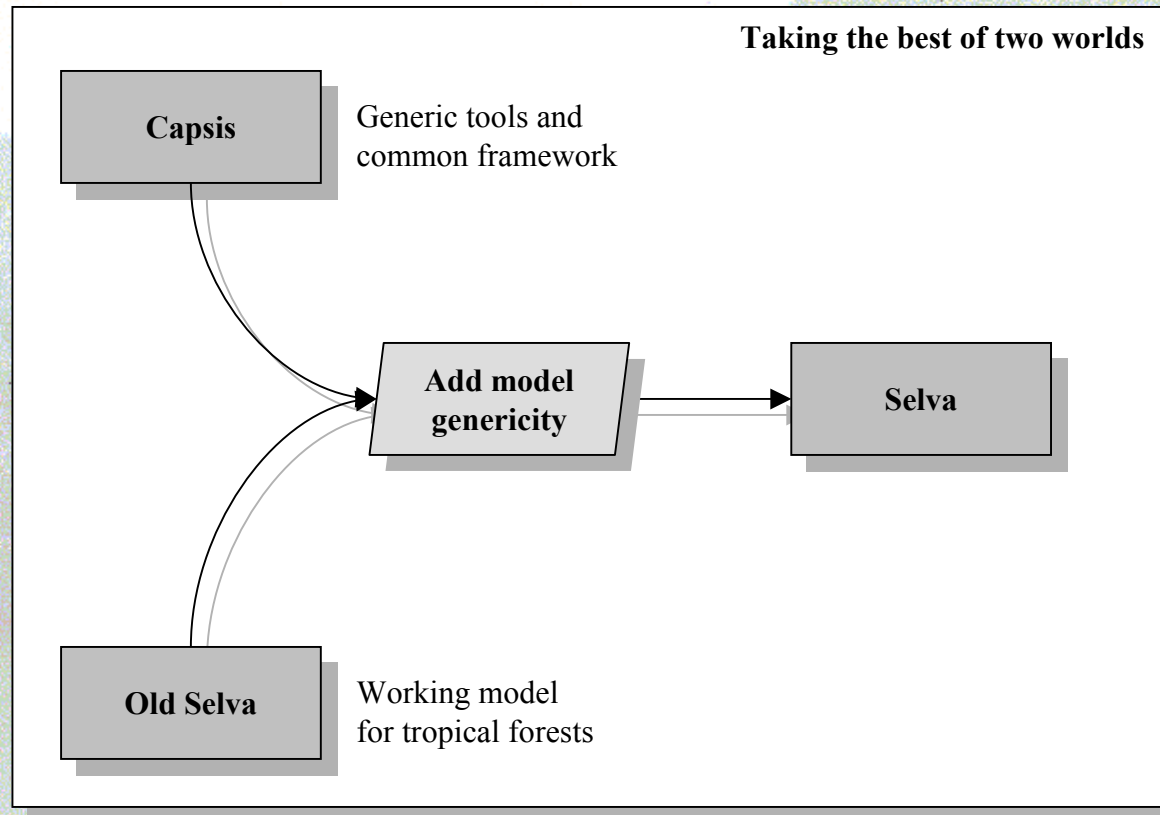
- Portage du simulateur Selva de SmallTalk vers Java et Capsis
- Pas uniquement portage mais refonte et abstraction pour faciliter le développement de points spécifiques
- L'objectif est d'avoir une boîte à outils de modélisation tropicale et que quelqu'un uniquement intéressé par la régénération de l'Angélique puisse se construire un modèle gris à partir des briques de base pour simuler la forêt autour

SELVA en bref

- Selva is a distance-dependent tree model, designed for studying the natural tropical rainforest of French Guiana (Gourlet-Fleury, 1999), running on plots of several hectares.
- The three fundamental processes of forest dynamics are described :
 - growth (Gourlet-Fleury & Houllier, 2000), 15 species groups
 - mortality (standing dead and two types of windthrow),
 - recruitment (depends on local basal area).
- For particular species, the whole regeneration cycle from seed dispersal to ingrowth is modelled



Garder le meilleur



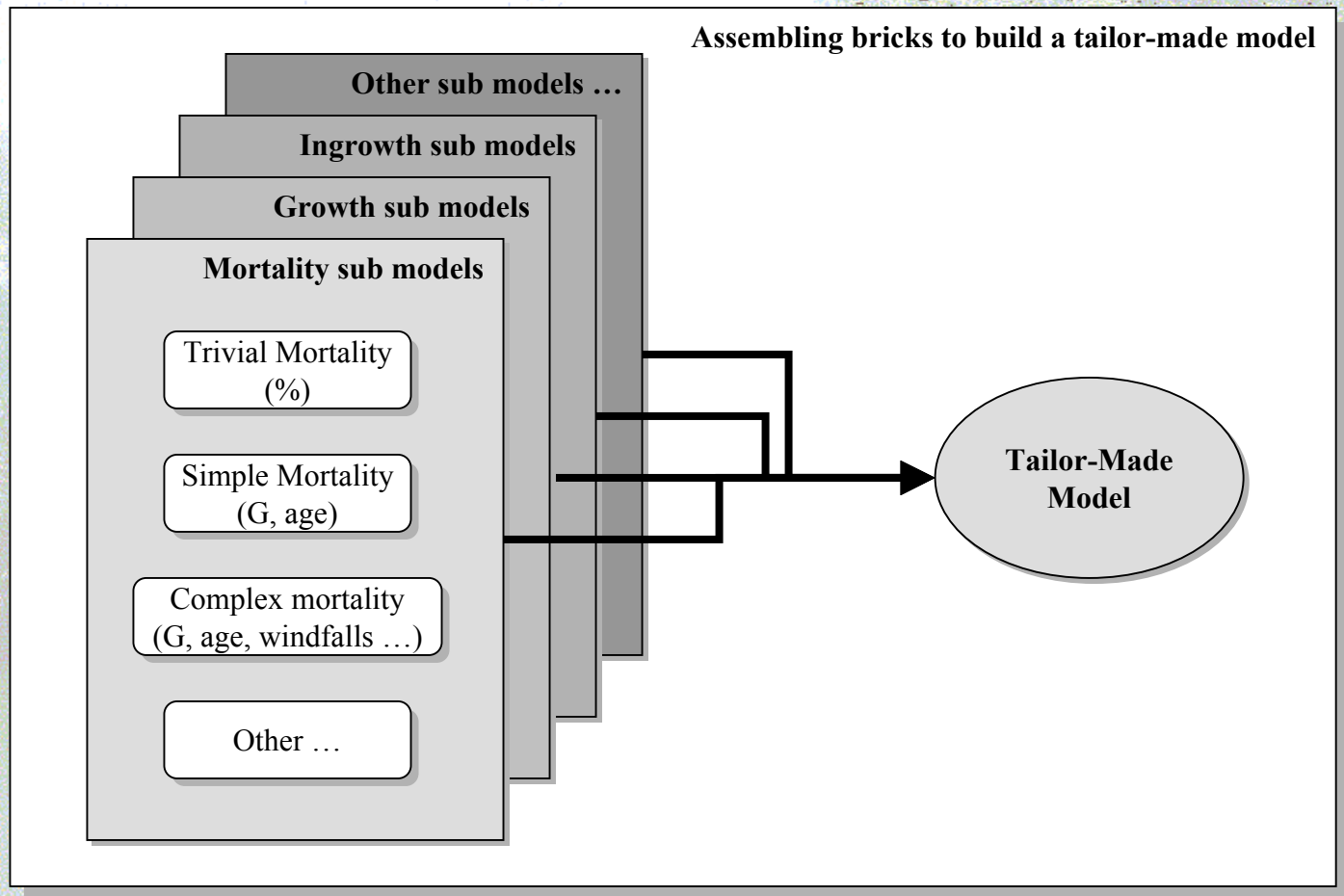
Approche

- Model genericity is achieved thanks to a modular structure. A model is defined as a sequence of sub-models that are “played” one after the other in a step. For example:

SimpleMortality/SimpleGrowth/ComplexIngrowth

- Configuration is done through a script that defines the structure of the custom model and feeds in initial data. It tells the “meta-model” what sub-models to use and their parameterization.
- So as to avoid the clutter of basic objects such as trees and species with a lot of static properties, properties are dynamically defined at runtime by sub-models, so only useful properties are available.

Assembler des briques



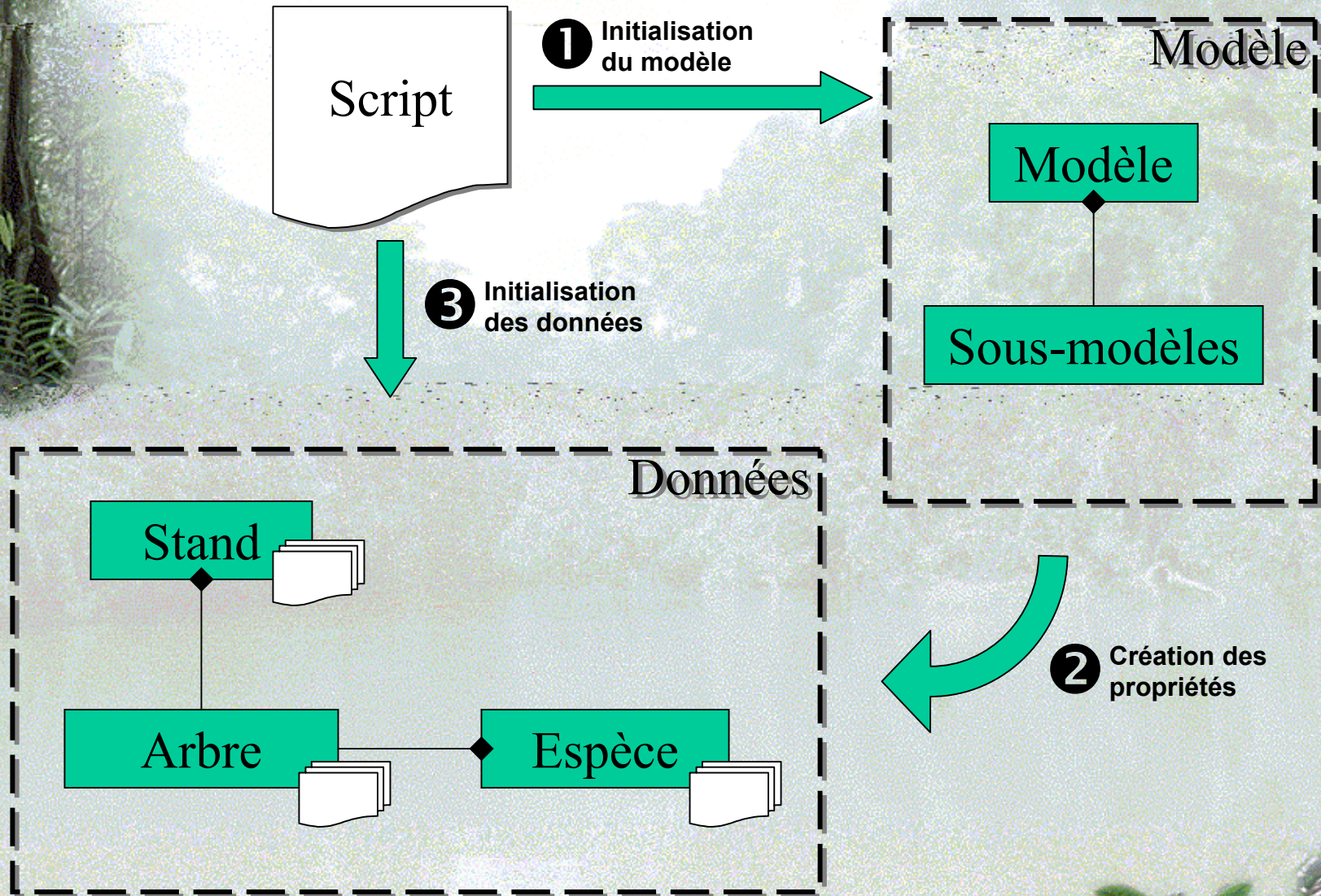
Des propriétés extensibles

An extensible set of properties

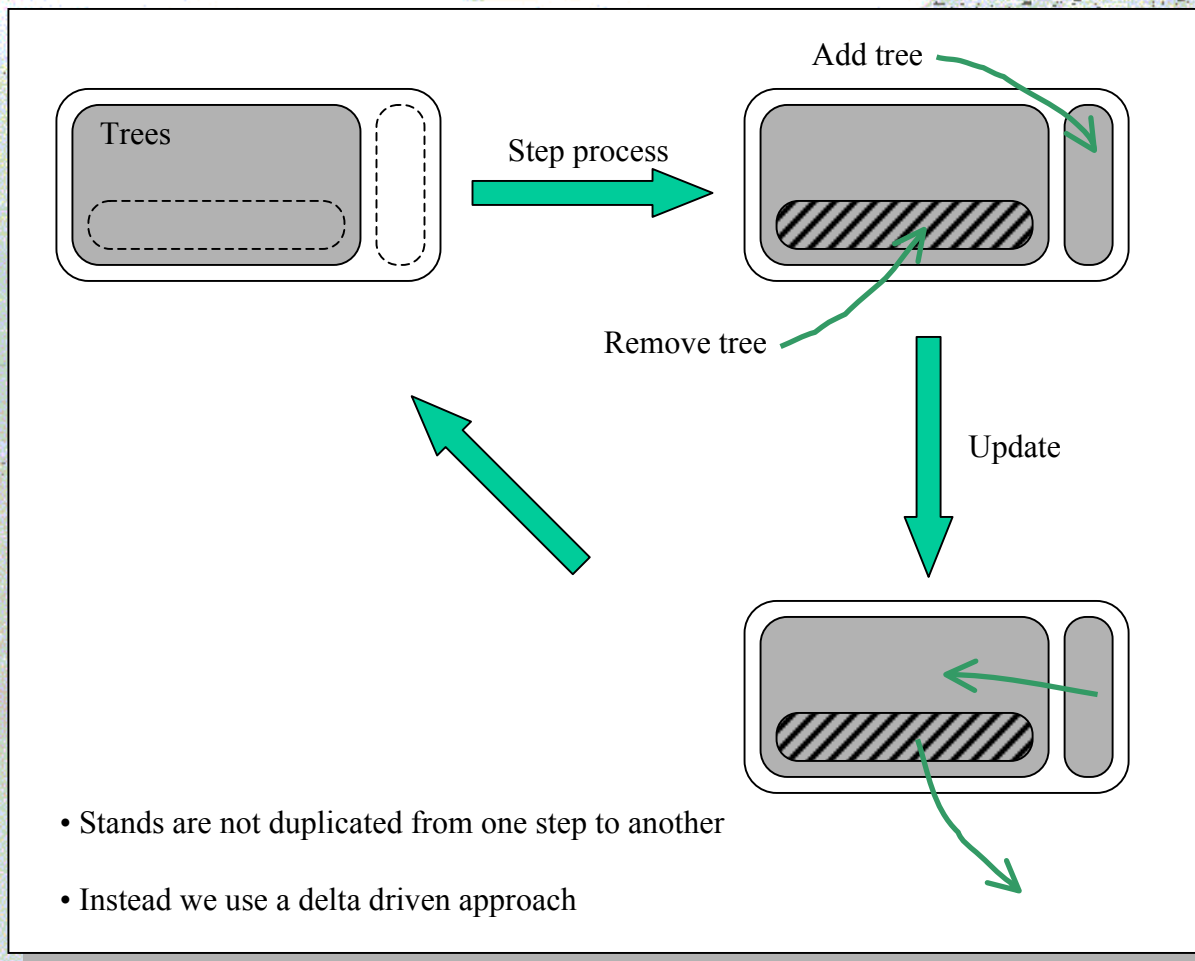
Properties are dynamically added to trees (as well as stands and species) to store extra data needed by sub models. For example a growth model may want to know what trees are within a radius of 30 m to compute a competition index.

Simple	A single value property with optional initial value
Calculated	Property value is computed on demand and is kept for subsequent use (Total stand basal area)
History	The last n values of this property are kept
Neighbourhood	Handle a list of neighbours that obey a neighbourhood rule (Competition index)
Gaps	Handle a list of shaped gaps and manage their life cycle
Others ...	

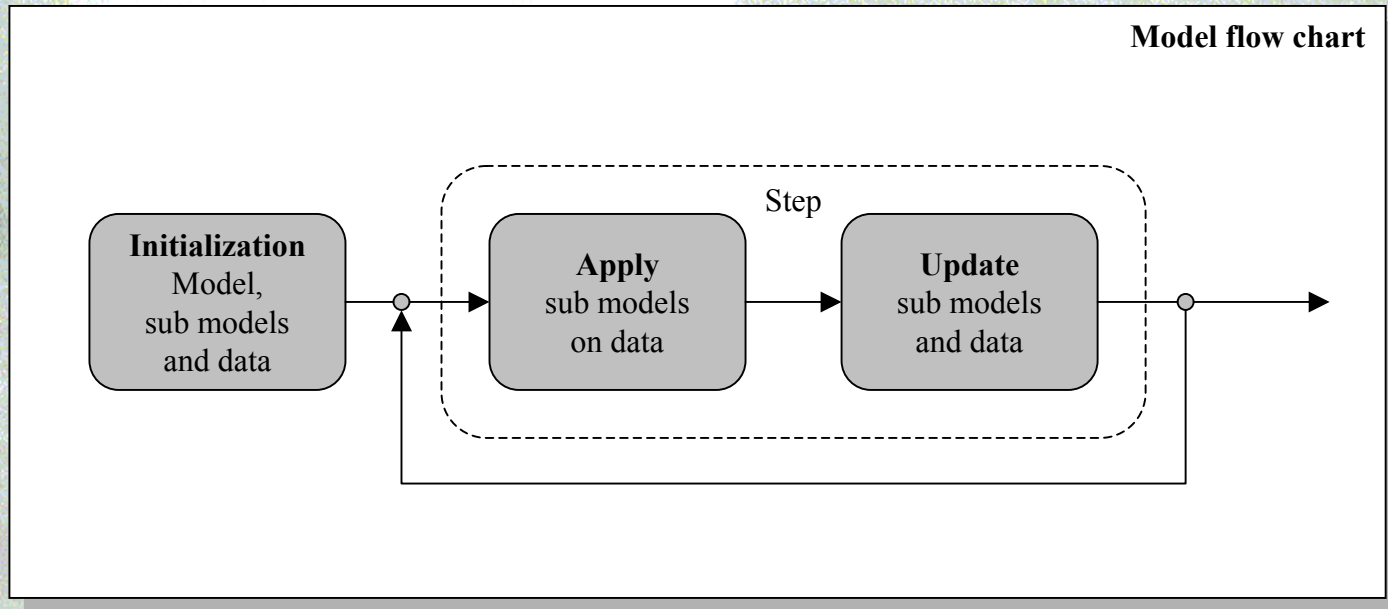
Selva - Synoptique



Cycle des arbres



Mécanique



Exemple de script

```
#import "selva.test"
#log_level 10
#log_file "paracou.log"

description = "Petit essai de simulation"

//! Choix des sous-modeles
subModels = (
  submodels.SimpleDeathSubModel {
    killer = killers.StandingDeadKiller {
      a=4.96
      b=3.42
    }
  },
  submodels.GrowthSubModel {
    grower = DummyGrower {
      increment = 1
    }
  },
  DummyIngrowthSubModel
)

//! Definition des especes
species = (
  SelvaSpecies {
    name = "Angelique"
    inventoryCodes = ( 103 )
    grower = growers.Gourlet13Grower {
      a=1    b=2    c=1
      d=0.5  m=0.3  K=1
      residualCorrelation=0.5
      residualMean=0.1
      residualDispersion=0.1
      neighbourhoodStrategy=neighbourhoods.BigTreesWithinRadius {
        radius=30
        minDbh=20
      }
    }
  }
)

//! chargement du peuplement
stand = SelvaStand {
  trees = SelvaInventoryReader {
    filename = "data/test.inv"
  }
}

do describe

do simulate(5) timed

//! Impression des resultats
do print
```

Projets : actuels et futurs

- Olivier Flores: Natural regeneration processes
- Sébastien Jéssel: Regeneration of *Dicorynia guianensis* (*Caesalpinaceae*)
- Stéphane Traissac: Spatial dynamics of *Vouacapoua americana* (*Caesalpinaceae*)
- Matthieu Lourmas: Genetic diversity of *Entandrophragma cylindricum* (*Meliaceae*)