Towards a representation of environmental models using Specification and Description Language
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To start
This poster explores how we can use Specification and Description Language (SDL) to represent environmental models. From the different phases of a simulation model construction, the formalization phase, sometimes is missed. This phase is needed in order to understand the model before any implementation.

Specification and Description Language
SDL [4] is a modern object oriented language that allows the definition of distributed systems. It has focused on the modeling of reactive, state/event driven systems, and has been standardized by the International Telecommunications Union in the Z.100.

Our cellular automaton generalization (mnCA)
Since the main concern in this kind of models is the representation of geographical information data, we need an structure able to contain all the information needed. The multi n dimensional cellular automaton (mnCA) [5] is composed by m layers with n dimensions each one. It is defined over a mathematical topological space.

The representation is:

\[ m : n = CA^k \]

where:
m is the automation number of layers.
n is the different layers dimension.
k is the number of main layers (1 by default).

Our SDL extensions
In order to represent environmental models in SDL is needed to use some extensions. This first extension is used to deal with time since is one of the most important variables in this kind of models. The second is needed to manage with mnCA.

As a first example we represent CA that calculate the well known Fibonacci function.

This first level of the SDL diagrams, in this case, only contains a single block, representing the CA that implements the Fibonacci function. Next, we must define the structure of this mnCA cellular automata. First the number of cells (the dimensions), using the DCL (declaration block). On this block, the mnca_DIM variable defines the number of dimensions of the CA, and mnca_Dn defines the size of each one of these dimensions. In that case we have a matrix (10x10) as is represented in the figure. Evolution function is defined in the ProcessLayer, to see its representation [8] can be consulted.

First the number of cells defines the structure of this cellular automata.

Fibonacci function model
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First, we set a delay to represent the time between sending and receiving the signal. This is useful, for example, to represent the fire propagation time between two cells. Second, note that the signal is send to the same element (TO SELF). In order to distinguish between the different cells represented in the mnCA we are using the extension mnca_cell[ ] which defines the cells of the mnCA block that receives the signal.

Wildfire model
As a second example we show the first diagrams of a wildfire model. In that case we are following a behavior model to represent the fire spread [1]. It is interesting to remark that since in this model we need different layers we must define them on the DCL block on the mnca block.

Inside the BlockCelda we can find the definition of the behavior of the model. The behavior is defined for one cell since it’s the same for all main cells of the mnCA.

On the left we show the aspect of the SEND signal that represents the propagation of the fire to other cells of the cellular automaton

Conclusions and future work
This poster shows how we can model environmental systems using Specification and Description Language. To do this the main concern is how model the behavior of CA graphically using SDL, and how to manage time. Two examples are quoted, a representative of a Fibonacci function over a cellular automaton, and the fire spread following the Behave model. Two proposed extensions to SDL are shown, one to manage on the SDL signals and other to simplify the representation of the CA structures.

The future work is focused in the verification of the implemented structures on SDL and the use of this system on some ongoing real projects involving industrial models or other environmental models like snow avalanche configurations. The representation of these models in a 3D Virtual Reality it’s also a working area of the project.

References