

DINAMICA Model *Fuzzy*

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1 Introduction

The submodel *Fuzzy* evaluates a fuzzy membership which represents the possibility that each cell of an input map belongs to a fuzzy set by evaluating a sigmoidal functions controlled by four control points (a,b,c y d) ordered from low to high on the measurement scale. The control points determinate the location where the membership function begins to rise above zero or where it reaches one. Points may be duplicated to create monotonic or symmetric functions:

- When a,b, and c have the same value the function is monotonically decreasing (Figure 1)
- When a,b,c have the same value, the function is monotonically increasing (Figure 2).
- In the other cases, the function is symmetric, first increasing and, after reaching one, decreasing (Figure 3). If points b and c have the same value, the function will fall immediately after reaching the value of one.

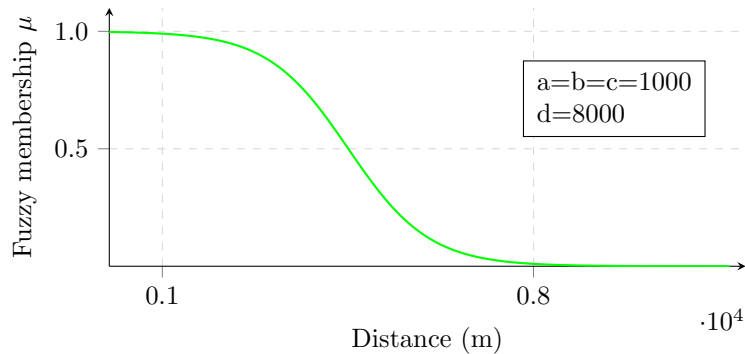


Figure 1: Monotonically decreasing membership function

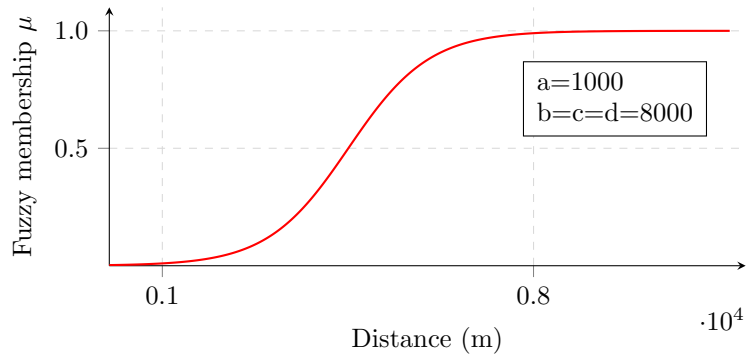


Figure 2: Monotonically increasing membership function

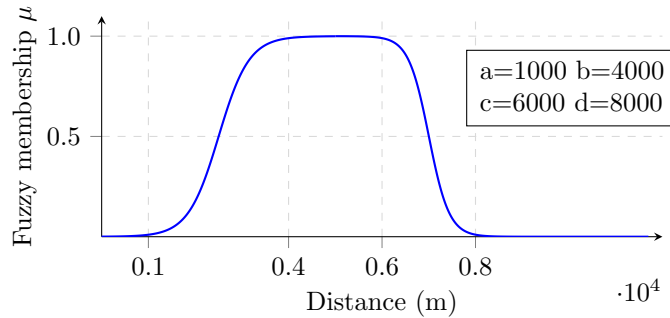


Figure 3: Symmetric membership function

2 Submodel operation

The formula for the sigmoidal function used by the submodel is $\mu = \frac{1}{1 + Ae^{-Bx}}$, where μ is the fuzzy membership value and A y B are coefficients which control the value of the inflection and saturation points of the function. The inflection point is located at the coordinates $(\ln(A)/B, 1/2)$. The submodel requires the input of the map of the input continuous variable, the value of the four control points, and the fuzzy set membership value of the controls points (by default 0.01 and 0.99). The output is a raster map scaled from 0 to 1 which represents the fuzzy membership.

In case that the four control points (a,b,c and d) are not ordered from low to high on the measurement scale, the submodel will report an error in the log file and produce a Null-data map.

The saturation value parameter controls the membership function value at the saturation points. By default, the membership value at the control point where the function begins to rise is 0.01 and 0.99 at the control point where it reaches one (Figure 4).

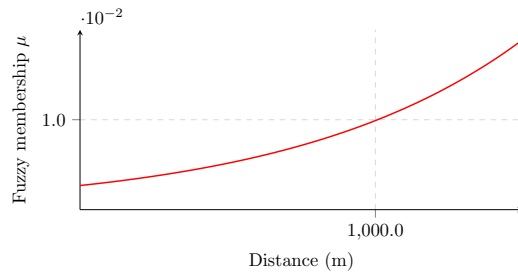


Figure 4: Membership value at the control point

3 Exampe

The model `modelo_fuzzy.egoml` transforms the map of distance from an object (Figure 5) into fuzzy set membership values. Figures represent the fuzzy membership maps corresponding to the cases of figures 1, 2 and 3.

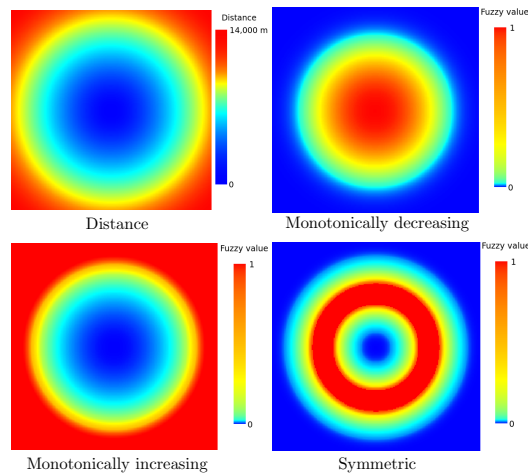



Figure 5: Map of distance and its transformation through the fuzzy functions described in figures 1, 2 and 3

4 Importing the Fuzzy submodel to another model

To import the Fuzzy submodel to another model, open both models. Activate the tab of the model to which you want to import the submodel (1), select the Local Submodels tab (2), click on the little black triangle next to `Modelo_Fuzzy` to visualize the submodels (3), drag the fuzzy submodel icon  Fuzzy to the model (Figure 6). Once the submodel is copied from one model to another one, the submodels can be modified and updated independently.

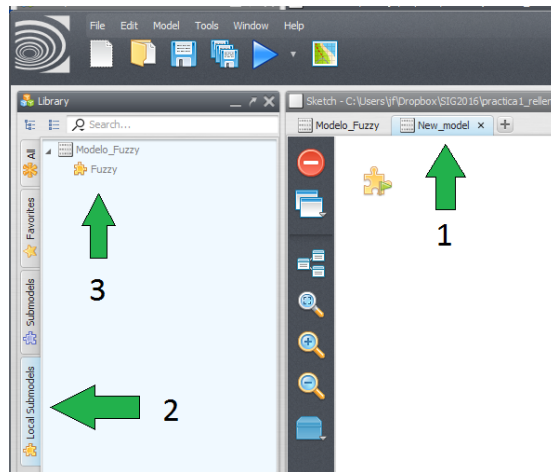


Figure 6: DINAMICA tabs

Acknowledgments

The model has been elaborated within the framework of the project *¿Puede la modelación espacial ayudarnos a entender los procesos de cambio de cobertura/uso del suelo y de degradación ambiental?* (SEP-CONACYT 178816).

Links

Information about the project is available [here](#)

The submodel is available at <https://github.com/jfmas/DINAMICA>