

## The GreedyGoat model: bringing new perspectives on woody plant-browser interactions by considering 3D plant architecture and its development

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Browsers eat plant leaves to survive. Plants need their leaves to survive. Both of these reigns have develop capacities to improve their survival chances. Plants protect their leaves by making them less tasty or accessible. Animals are able to adapt to plant poisons or structural protections. Focusing on mammalian browsers and woody plants, the ability of the animal to easily move from a part of the plant to another, the size of the bites, the sensitivity to woody or spiny obstacles and thus the potential protection of the branching structure of the plant are research topics that are raised. Anyway, from a mechanistic point of view, the way large mammalian herbivores impact woody plants remain poorly understood compared to other drivers such as drought, soil fertility, frost, fire, etc, and even compared to our understanding of herbaceous herbivory. Investigations of the role and importance of these factors are impaired by the fact that field observations and experiments are difficult, if possible at all.

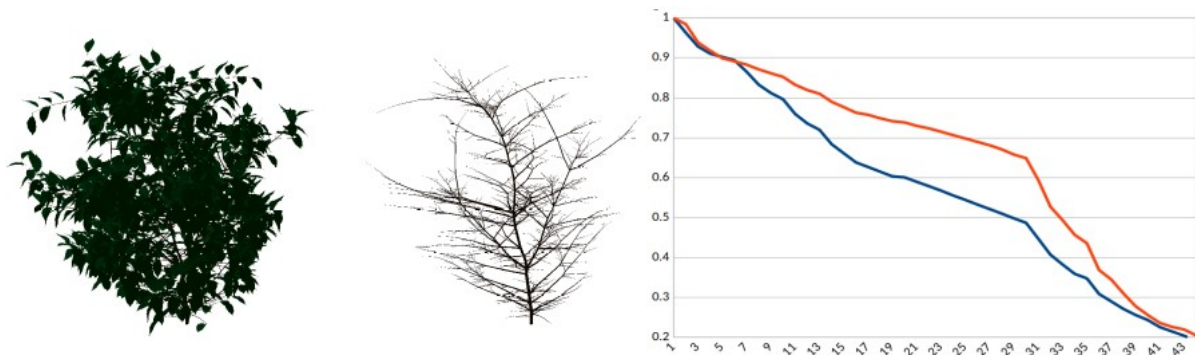
We propose GreedyGoat, a model that mimics a mammalian browsers behavior when attacking a woody plant. The model remains on browser capabilities facing the structure of this plant. This model will be coupled to the AmapSim model that dynamically grows plants (barczi 2008). AmapSim is able to accurately mimic plant growth with the correct number of branches, leaves and eventually spines.

The development of this model was motivated because we claim that plant architecture is a key trait that has been overlooked in the study of the interaction between browsers and woody plants, and that botanists and ecologists currently lack an appropriate model integrating this trait and allowing to (1) bring together our current knowledge, highlighting the gaps in our understanding and helping to derive new hypotheses to be tested *in silico* and *in natura*; (2) help estimating quantities that are difficult to record in the field, as for example the level of light interception of all leaves of a plant, or the number of leaves removed by a browser, or the cage protection effect on leaves surrounded by branches and needles; (3) make virtual experiments that would be difficult or even impossible to perform *in natura*, for example, exposing a sapling to browsing for 20 years, or simulating the browsing effect of an extinct herbivore; (4) understand the ecological and evolutionary conditions under which a plant or animal strategy is beneficial or detrimental to its fitness.

Thanks to GreedyGoat, a virtual browser is parametrized through its mouth size and max browsing height, its sensitivity to obstacles and its capacity to link up bites in a row before making a new try at an other place in the plant. GreedyGoat also allows to control the capability of the plant to resprout the buds that were browsed.

In this paper, we explain in details how GreedyGoat was built. We describe the set of parameters that are taken into account and the algorithms that are run. We also explain the

way how it is coupled to AmapSim and we illustrate the simulation of this coupled model through case study examples as shown in next figure. We finally discuss new avenues of research that could be considered thanks to the GreedyGoat model.



*Test plant before and after browsing. light interception (red) and leaf surface (blue) loss along browsing (%)*

## References

Barczi JF, Rey H, Caraglio Y, De Reffye P, Barthélémy D, Dong Q, Fourcaud T. 2008. AMAPsim: an integrative whole-plant architecture simulator based on botanical knowledge. *Annals of Botany* 101: 1125-38