Navarro, Jose

Reasons for GreenScilab based on peer reviewed papers

In this paper, I’ll explore the reasons for which I chose GreenScilab as the initial platform in order to conduct predictive growth simulations based on GreenLab model. I chose the GreenLab model due to its abstraction away from aesthetic and architectural detail in order to focus on the energetic production of biomass. This was done since the majority of plants grown in OpenAg are intended to maximize their fruit or leaf biomass for harvesting. Furthermore, GreenLab model revolves around numerical equations which can drastically increase computation time. For example according to P. De Reyeffe, biomass for organelles is simply the product of sink weight to the general pool of biomass available for repartition.[[1]](#footnote-1) This is important since the point of conducting the simulations is to obtain large scale data labels in order for supervised learning.

GreenLab’s abstraction is sufficient for our purposes since it revolves around basic factors controlling photosynthesis and biomass repartition. Although other factors such as pH and salinity can affect plant growth and even organelle production, such factors vary widely per species of plant and it is beneficial to have a model that is applicable to all plants since they all rely on photosynthesis for biomass production. On the other hand, some assumptions that the GreenLab model makes can be limiting for our purposes of data collection. Since data collection will revolve around environment recipes and biomass production, it is important to have a model as dynamic as possible in the sense that the environmental factors can change often. But the GreenLab model limits temperature variability to averages throughout a growth cycle. This is done as to have a direct correlation between thermal time and biomass production, but it limits us to data points bounded by the number of growth cycles.[[2]](#footnote-2) We have two ways to address such problem: Modify basic GreenLab model as to make environmental changes continuous[[3]](#footnote-3)or to approximate a continuous model by shrinking the growth cycles and making them more frequent to have the effect of increasing the available data points that can be collected while maintaining modifications to the current GreenLab model as minimal as possible.

Furthermore, the standard GreenLab model seems to not take into account senescence or extremities in growth (e.g., extreme temperatures, extreme solar radiation, and extreme availability or lack of water negatively affecting the plant). Such parameters for a plant seem to directly correlate to the actual genotype of plant, hence it would be difficult to have a general recipe in the model that would address these issues. However, the GreenLab implementation that I’m considering for our purposes, GreenScilab, seems to address such issues to a certain extent by allowing fitting to actual growth samples (biomass, dimensions of organelles, etc) as to take these parameters into account to a certain extent.[[4]](#footnote-4) However, I hypothesize that such fitting parameters might not be sufficient for the model to correctly say absurd temperatures would actually negatively affect the photosynthetic output. In such case, I plan to modify the GreenScilab model in order to take into account how temperature is correlated to stomata opening which as effect can negatively affect water and photosynthetic production. Similar rudimentary but effective actions would be taken to take into account extreme solar radiation (bleaching of leaf tissue negatively affecting light absorption).[[5]](#footnote-5)Final remark about GreenLab model specifically is its ability to output predictions of biomass for specific organelles (not just the whole plant) which is extremely relevant to our final goal of maximizing harvesting potential (which in turn means certain organelles).

Although GreenLab is not the only model for energetic means of biomass production, it does perform slightly better than 4 other prominent models (CERES,PILOTE,LNAS, and STICS).[[6]](#footnote-6) However, do note that the slightly advantage in performance was not hugely significant as to downturn the others. Regardless, this gives us confidence that if properly implemented, GreenLab model can perform as good as any other popular alternative growth model. A downside to such performance involved extensive calibration of GreenLab (Needed to be adapted into a continuous version), larger need for data in order to conduct calibration than in the other models, and slightly less predictive performance than CERES (which had the least amount of parameters that needed to be estimated).[[7]](#footnote-7)

I now change the focus to the chosen implementation of the GreenLab model: GreenScilab. GreenScilab is a collection of numerical scripts under a GUI in order to run growth simulations as described in the GreenLab model. It is written in the Scilab language which has the added benefit of including a rich resource of numerical functions out of the box. Scilab language is accessible enough to create modifications to the stock software (So far I removed necessity of a GUI and added a batch option in order to run multiple rounds of simulation under varying environments). The public version of GreenScilab has included basic plant parameters for a couple of plant species and for two of them has fitting parameters in order to approximate hidden parameters (This is important in order to have a more accurate prediction of growth and the possibility that it could take into account extremities in growth). Since the public version is outdated and only runs with Scilab 4.1, it proves to be a nuisance for the need to use an outdated version of Scilab (no support), and some modern functions in Scilab are not integrated in version 4.1 which makes development and modification less suitable. Scilab 4.1 editor seems to have small bugs that decrease development time (bugs in the “find and replace” in source code). Even considering these nuisances, they are small compared to the large overhead cost of modifying Java code (AmapStudio) with no source code (for Batch implementation). To a certain extent, the Scilab source code can be understood given enough time. Furthermore, GreenScilab both provides example environmental parameters and allows for a wide variety of parameters for such compared to GreenLab plugin of AmapStudio which was not only closed source, but had no documentation regarding these environment parameter files.

1. P. De Reyeffe, B. –G . Hu, *Relavent Qualitative and quantiative choices for building an efficient Dynamic plant growth model: GreenLab Case.* [↑](#footnote-ref-1)
2. Ibid. [↑](#footnote-ref-2)
3. Zhongping Li∗†‡, Vincent Le Chevalier∗‡, Paul-Henry Cournede, *Towards a continuous approach of functional-structural plant growth* [↑](#footnote-ref-3)
4. *Tutorial on GreenLab Model using GreenScilab software* [↑](#footnote-ref-4)
5. James Barber and Bertil Anderson, *Too much of a good thing: light can be bad for photosynthesis.*  [↑](#footnote-ref-5)
6. Charlotte Baey, Li Song, Paul-Henry Cournede, *Evaluation of the Predictive Capacity of Five Plant Growth Models for Sugar Beet* [↑](#footnote-ref-6)
7. Ibid. [↑](#footnote-ref-7)