An AI Approach to Integrating Climate, Hydrology, and Agriculture Models

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ABSTRACT

Understanding the interactions between natural processes and human activities poses major challenges as it requires the integration of models and data across disparate disciplines. It typically takes many months and even years create valid end-to-end simulations as the different models need to be configured in consistent ways so their results can be meaningfully interpreted. MINT is a novel framework that uses AI for model integration. MINT captures extensive knowledge about models and data, including their requirements and constraints. MINT guides a user to pose a well-formed modeling question, select and configure models, find appropriate datasets, set up scenarios and parameters, run the simulations, and visualize the results. MINT currently includes climate, hydrology, and agriculture models for different areas of Ethiopia, Kenya, and South Sudan. Our goal is to understand droughts through integrating meteorological, hydrological, and agricultural analyses.

Keywords: MINT, Model Integration, Simulations

1 Motivation

In many areas of Africa, where family-owned farming is predominant, crop yield is severely affected by droughts and floods. Despite the pressing needs for models to predict the effects of extreme climate events and their effects in curbing crop production, developing such integrated models typically takes many months of effort. A major initial challenge for modelers is finding relevant models to address a question. Then, to initialize each model they have to search through disparate data repositories in order to find data with the right granularity and quality. Once found, sophisticated data transformations are usually required to set up and execute a model. In addition, when different models are integrated the data they use and their assumptions must be compatible. Existing modeling frameworks support some of these modeling steps (e.g., (Peckham et al 2013)), but most of the work involved in modeling continues to be mostly done manually. There are many opportunities for artificial intelligence (AI) to provide assistance and automation in or- der to reduce the effort required.

2 Approach

We are developing a novel framework that uses AI to make modeling more efficient and useful for decision making. This Model INTegration (MINT) framework uses semantic representations to describe datasets and models to support users in specifying scenarios, finding appropriate models and data, setting up model parameters, executing models, and accessing results (Gil *et al.* 2021).

MINT has a rich representation of model versions and settings, execution requirements, and key model variables that enable the use of modeling goals to constrain modeling choices (Garijo *et al.* 2019). Figure 1 shows the MINT user interface to browse models and data.

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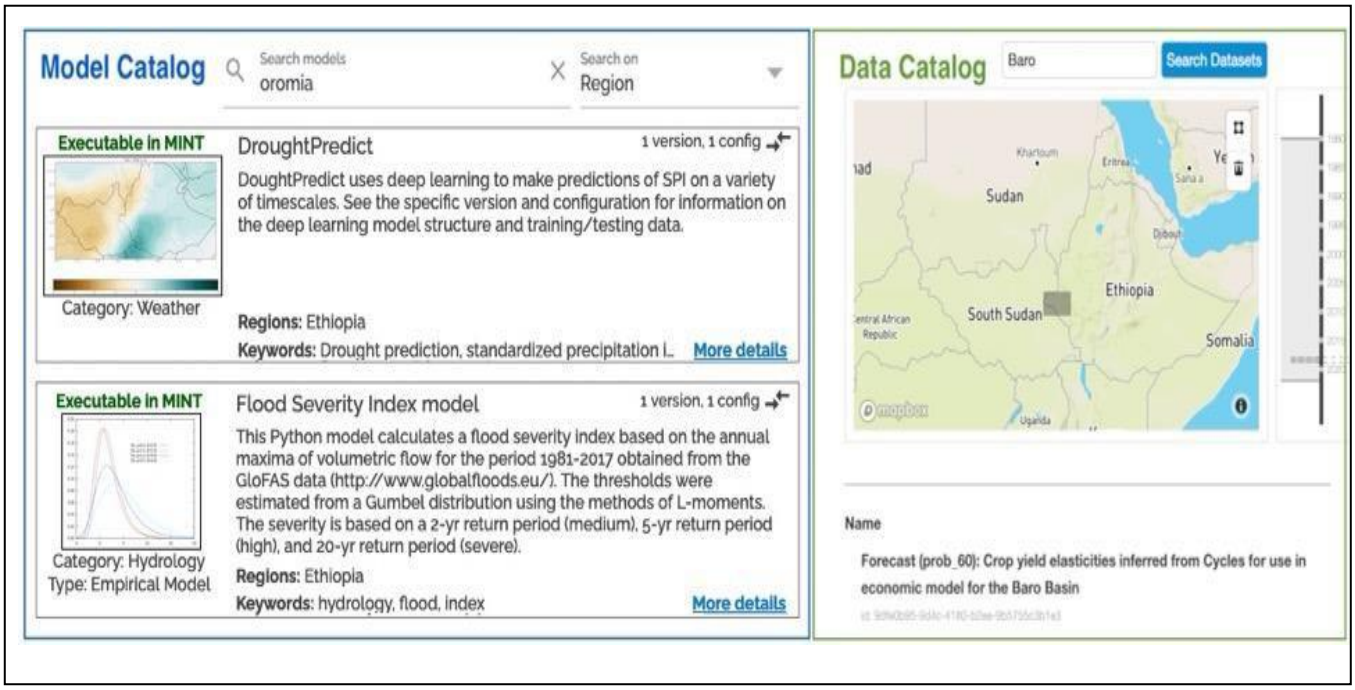

Figure 1: *MINT contains semantic information about a variety of models and datasets to analyze different aspects of droughts. The figure shows models for the Oromia region (left) and data for the Baro region (right) in Ethiopia.*

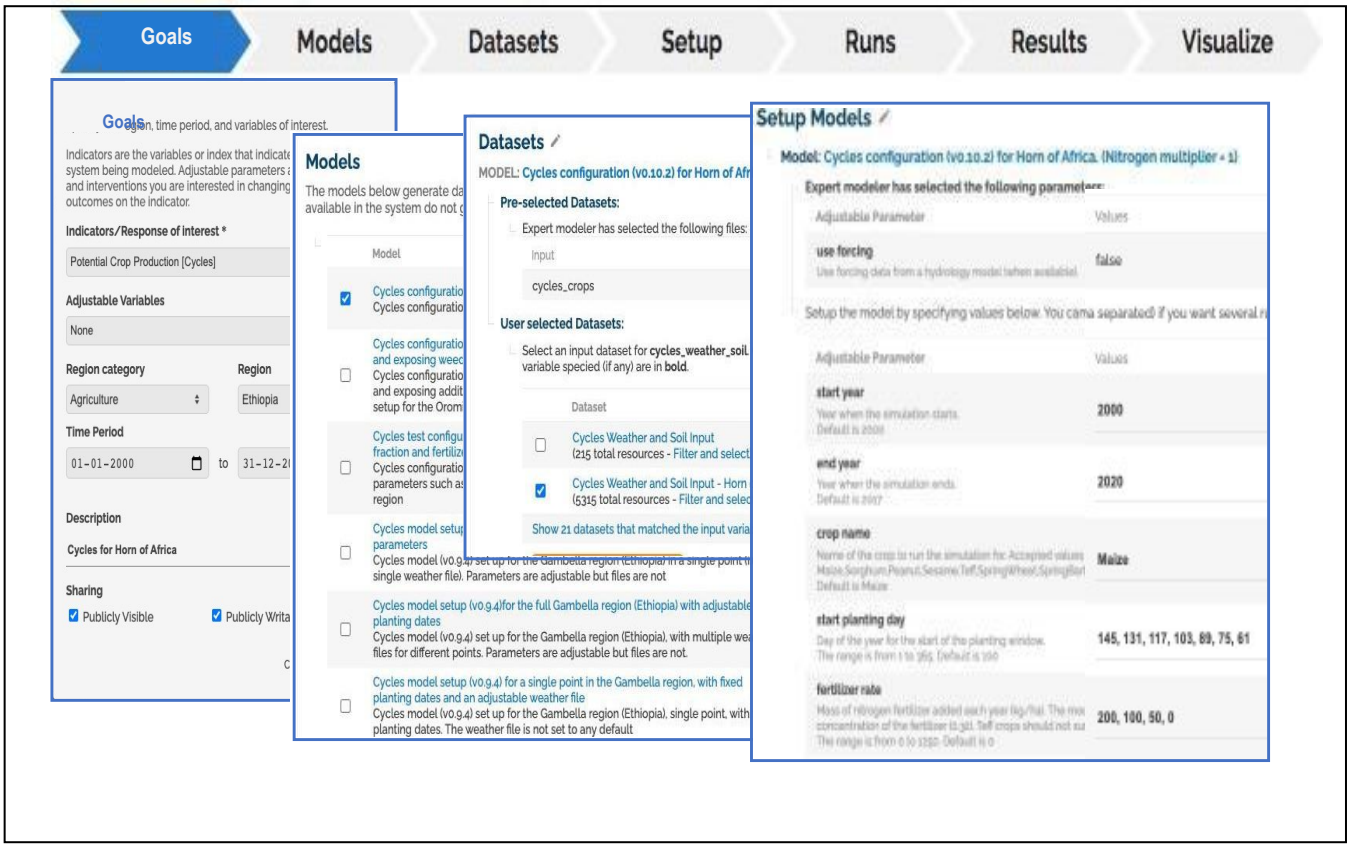

Figure 2: *MINT uses semantic representations for models and data to guide users through each modeling step.*

MINT's intelligent user interface guides users through interactive scenario exploration, which allows users to state modeling goals, guides them through modeling steps, assists them by constraining choices, and automates time-consuming aspects of data preparation. Figure 2 illustrates the guidance that users receive to find, set up and run models.

3 Modeling Scenarios

We are focusing on meteorological, hydrological, and agricultural aspects of droughts in Ethiopia (Bisrat and Berhanu 2019). We also have data and models for Kenya, South Sudan, and other areas in Sub-Saharan Africa. We have generated model results for thousands of runs under different conditions. To date, the models can be easily set up and run by following the guidance provided by MINT. Users can request specific outputs and specify scenarios for simulation. MINT guides users step by step, recording each choice and propagating the constraints that result from it.

4 Declarations

4.1 Acknowledgements

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