Updating and Standardizing Code for TSERI

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WeARE Research Area

Began transition from email sharing to GitHub, enabled better cooperation and collaboration with TSERI members. Created a NETCDF(Network Common Data Form) downloader code based off Dr. Giacomoni's algorithm in Julia. Migrated earlier TSERI Models to JuMP for standardization with CPLEX(IBM ILOG CPLEX Optimization Studio). Developing further knowledge of linear modeling for future TSERI use.

Motivation or Background

The motivation for this semester's work was to improve TSERI's ability to collaborate on coding and modeling. GitHub allowed for better architecture, such as branching which permitted easy testing and manipulation of the models without causing bugs on the main branch. Allowed easy sharing of algorithms created by TSERI employees such as the NETCDF downloader. The coding and bug testing for the algorithm was one of the reasons for the migration to GitHub as the previous method used to share code iterations was email. Keeping track of code iterations is very important as small changes to the parameters of a linear model can have significant changes to the result.

Objectives

- Learn about linear modeling for future use in recoding models in Julia and CPLEX
- Learn how to operate GitHub to improve TSERI's ability to share and cooperate in challenging models and algorithm
- Improve in Julia programing language to assist with creating algorithms

Methodology

This semester was focused on improving TSERI's backend for easier and more effective remote collaboration due to COVID-19. At the start of the semester we needed old data from a year ago. Unfortunately due to the NETCDF data being 23TB it was removed from SHAMU, the supercomputer we used a year ago. We created an algorithm to redownload the data from the FTP server using Dr. Giacomoni's algorithm as a template. Dr. Giacomoni's algorithm was coded in MATLAB; we coded ours in Julia.

After programing the NETCDF downloader, the migration to Github was started. Started to learn how to operate GitHub. The algorithm first used in GitHub was the model in *Modeling and Optimization of Biomass Quality Variability for Decision Support Systems in Biomass Supply Chains* by Mario Aboytes. The algorithm in the paper used MPS(Mathematical Programming System). TSERI is migrating to CPLEX/JuMP. The migration from MPS to CPLEX was completed using the journal article, the algorithm's previous data, and with the assistance of both mentors.

Results

The NETCDF algorithm was able to read through the 23TB of weather data to only pull the NETCDF file required for our current model. The algorithm was able to reduce the amount of downloaded data from 23TB to less than 1TB. Shamu wasn't required because of the reduction of data download which led to a much faster workflow.

The migration from MPS to CPLEX was successful. Currently in the process of adjusting model to have a 100% match to the MPS counterpart.

Fig. 1
First Model migrated from MPS to CPLEX. (Mario, 2019)

$$Min: \sum_{j\in\mathcal{D}} \xi_j W_j + \sum_{k\in\mathcal{B}}\sum_{l\in\mathcal{L}} \varrho_{kl}\beta_{kl} + \sum_{j\in\mathcal{D}}\sum_{k\in\mathcal{B}} \psi_{jk} Z_{jk} +$$

$$\sum_{o\in\Omega} p(o)\left[\sum_{i\in\mathcal{C}}\sum_{j\in\mathcal{D}}\sum_{l\in\mathcal{L}} c_{ijl}^{'T}(o) X_{ijl}(o) + \sum_{j\in\mathcal{D}}\sum_{k\in\mathcal{B}}\sum_{l\in\mathcal{L}} c_{jk}^{R} Y_{jkl}(o) + \alpha\Pi(o)\right] \quad (1)$$

Subject to:

$$\sum_{j\in\mathcal{D}}\sum_{l\in\mathcal{L}} X_{ijl}(o) \le s_i(o) \quad \forall i\in\mathcal{C}, \quad o\in\Omega, \quad (2)$$

$$\sum_{i\in\mathcal{C}}(1-e_i) X_{ijl}(o) = \sum_{k\in\mathcal{B}} Y_{kjl}(o) \quad \forall j\in\mathcal{D}, \quad l\in\mathcal{L}, \quad o\in\Omega, \quad (3)$$

$$\sum_{j\in\mathcal{D}}\sum_{k\in\mathcal{B}}\sum_{l\in\mathcal{L}} g_{kl} Y_{jkl}(o) + \Pi(o) = d \quad \forall o\in\Omega, \quad (4)$$

$$\sum_{l\in\mathcal{L}} Y_{jkl}(o) \le v_{jk} Z_{jk} \quad \forall j\in\mathcal{D}, \quad k\in\mathcal{B}, \quad o\in\Omega, \quad (5)$$

$$\sum_{i\in\mathcal{C}}\sum_{l\in\mathcal{L}} X_{ijl}(o) \le u_j W_j \quad \forall j\in\mathcal{D}, \quad o\in\Omega, \quad (6)$$

$$\sum_{j\in\mathcal{D}} g_{kl} Y_{jkl}(o) \le q_{kl}\beta_{kl} \quad \forall k\in\mathcal{B}, \quad l\in\mathcal{L}, \quad o\in\Omega, \quad (7)$$

$$X_{ijl}(o) \ge 0 \quad \forall i\in\mathcal{C}, \quad j\in\mathcal{D}, \quad l\in\mathcal{L}, \quad o\in\Omega, \quad (8)$$

$$Y_{jkl}(o) \ge 0 \quad \forall j\in\mathcal{D}, \quad k\in\mathcal{B}, \quad l\in\mathcal{L}, \quad o\in\Omega, \quad (9)$$

$$\Pi(o) \ge 0 \quad \forall o\in\Omega, \quad (10)$$

$$W_j \in \{0,1\} \quad \forall j\in\mathcal{D}, \quad (11)$$

$$\beta_{kl} \in \{0,1\} \quad \forall k\in\mathcal{B}, \quad l\in\mathcal{L}, \quad (12)$$

$$Z_{jk} \in Z^{+} \quad \forall j\in\mathcal{D}, \quad k\in\mathcal{B}, \quad (13)$$

Skills and Experience

- Continued proficiency in Julia
- Gained experience with FTPClient package in Julia
- Improved usage of JuMP
- Gained skills in creating branches and usage of GitHub

What I Learned

- The basics of linear modeling with JuMP and CPLEX
- Improved ability with Julia especially around the package JuMP
- Learned how to use Julia as a connection point to a NETCDF FTP server
- Learned how to use GitHub for building linear modeling and preventing coding errors
- Learned how to read Linear models from Journal articles and algorithm into JuMP

Future Plans

- Continued development of skills in linear modeling to help TSERI transition into JuMP, CPLEX, and Julia.
- Moving more algorithms into GitHub.
- Learning how to build a linear model from the ground up.

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