

New Simulation Methods to More Effectively Integrate High Levels of Renewable Energy Resources

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Introduction

MISO runs thousands of production cost modeling (PCM) simulations every year. These simulations take large amounts of processing time due to high model dimension with a large number of load and generation profiles. The projected growth of renewable penetration in the MISO footprint, and the resulting increase in modeling data, will only exacerbate the situation.

The purpose of this project is to develop a method of selecting certain sections of the data that best capture the variability of features chosen by the user. Then to design a program and user interface around this method. Finally, testing will be performed to determine the loss of profile fidelity against different inputs.

The intended users of our program are system engineers wishing to access PCM simulation results faster while being able to accept a certain loss of accuracy.

The intended users of our results are researchers and engineers who wish to look into this topic further.

Design Requirements

Functional:

- The program selects a subsection of profile data that simulates in a shorter amount of time than the full data set.
- The selected subsections capture the variability of the original dataset to within a margin allowed by the user.

Nonfunctional:

- The code has to be understandable to the client and other users.
- There must be a GUI that allows the user to define all the inputs.
- An instruction manual was written outlining how to use the GUI.
- Research comparing the results of different approximations must also be provided

Technical Details

Simulation software: Plexos

Programming language: Python v.2.7.16

Libraries utilized: Numpy, Pandas, Scikit-Learn, Tkinter, Itertools, Matplotlib

Design Approach

The method follows four steps to select ideal sections:

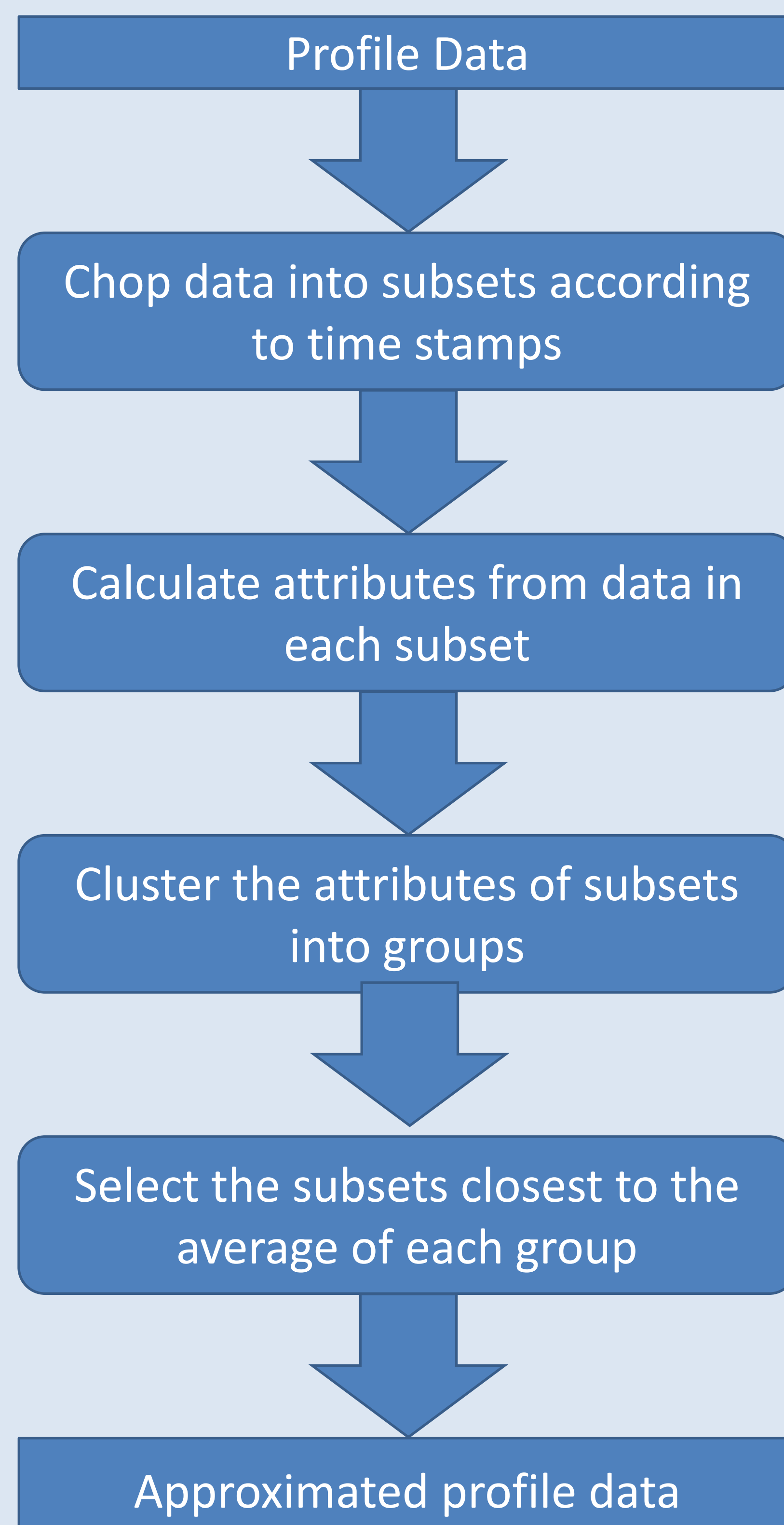
- Divide the data into subsets by time
- Calculate attributes related to each subset
- Cluster around these attributes to determine ideal, imaginary attributes
- Determine the subsets whose attributes closely match these ideal, imaginary ones. These subsets now represent all the subsets with similar attributes.

For the actual implementation, the user must be able to define:

- The subset size (i.e. 168 hourly measurements represents a week)
- The number of representative subsets
- What attributes to calculate and cluster around.

Finally, the program must return these selections in the same format as the input.

It must also return the mapping of selected weeks to the weeks they represent.



Testing

Our client provided Plexos profile with yearlong load and renewables data. To research the outcomes of this tool, we ran three comparisons/tests:

Attribute selection comparisons:

This test looked at a chosen attribute to see if it would affect the selection process. An example of an ineffective attribute would be the minimum value of solar generation during a subset, which obviously reaches zero at least once during every subset, so long as subsets were longer than a day. This test also showed how effective the program was at capturing each of these attributes, or which attributes were being "shown" in the final results.

Attribute Combinations:

This comparison was about running every combination of attributes for a single file (512 combinations). We then grouped the results so we could see if including one attribute or not changed which weeks were selected. This determined whether that attribute was "important." The results showed us the attributes that did little to nothing and could be eliminated to reduce runtime.

Plexos Simulation Tests:

After simulating the full and approximated profiles, we calculated the error between the simulations for PCM results such as locational marginal pricing (LMP), total production cost, and capacity factor.

Results

For each section of our tests, we can't be sure that we found the best solution. We can only know that we found a good solution given the attributes that we used and the input data we received. Our attribute selection comparisons showed that the most important attributes were different for each input file. The attribute combinations showed us the final list of best attributes was:

Wind: Max, Min, Difference, Total Energy, Max and Min Ramp

Load: Max, Min, Difference, Total Energy

Solar: Max, Difference, Total Energy

The Plexos simulation tests determined that our chosen week was very likely one of the best approximators of the entire year based on our 3 simulations.

