Assignment 4: Decomposition using consensus ADMM

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Introduction:

A market clearing problem is chosen for the scenario-based stochastic problem with wind power plant causing uncertainty in the system. This problem is similar to the problem submitted for assignment 2. The python code is tested in two models namely a simple example as discussed in the lecture and with the IEEE RTS 24-bus system. The stochastic problem is solved using the consensus ADMM technique. The derivation and the results to this iterative problem is discussed in this assignment.

Problem derivation:

The problem discussed in the assignment 2 or using the market clearing problem discussed in the Lecture 5, slide 60 can be extended and the optimization problem can be solved using a consensus ADMM technique. Reframing of the equations will result in the following problem derivation for this assignment.

Python Model:

- Input file
  - 2-bus system (based on lecture) / 24-bus IEEE data (Excel data input)
- Scenario size:
  - Any number of random scenarios can be generated using rand_scenario.py
  - Here, 100 random scenarios are generated added to input_data.xlsx file.
- Probability distribution
  - The probability distribution for different scenarios can be a constant or random.
  - The random distribution is done using Dirichlet function.
- Specifications
  - Scenarios: 5
  - Lambda update iterations: 50
  - Solver: Gurobi using Pyomo
  - Processor: Core i7 8550
  - Total time: 20 seconds (A progress bar is included)
- Output
  - Iterative convergence plot + cost optimal value

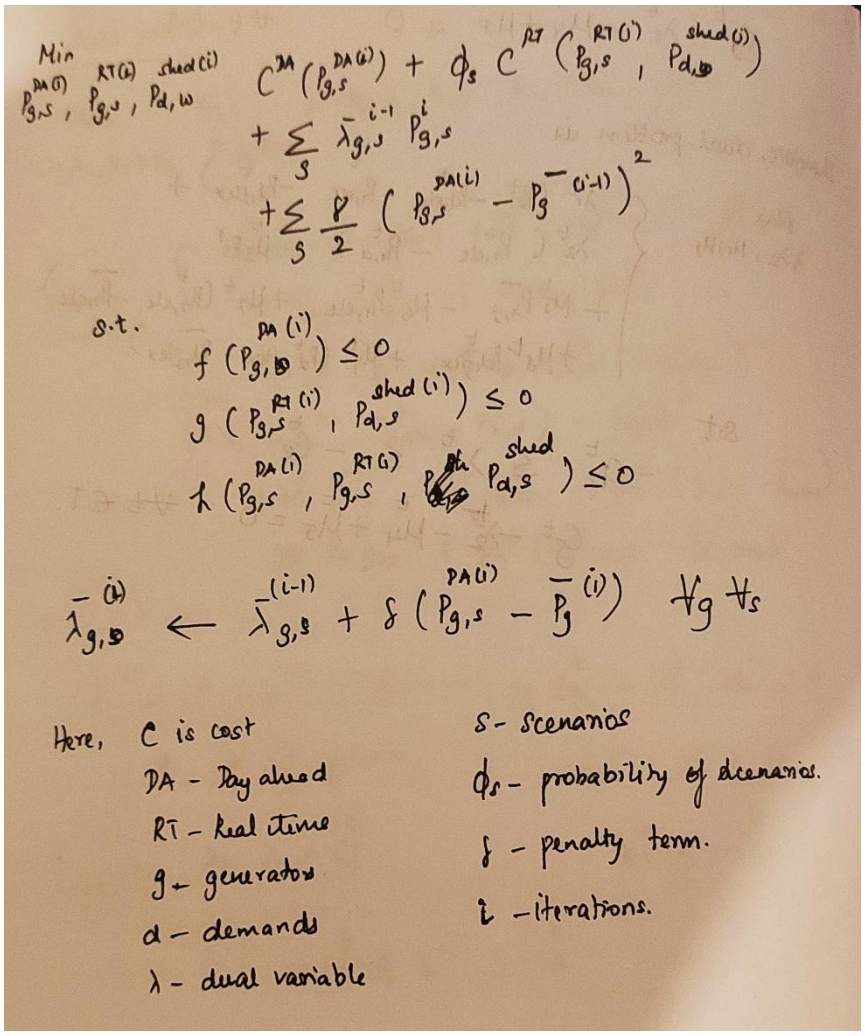

Figure 1 Problem derivation for ADMM convergence

Results

In the following section, the simple dataset is chosen here since an observable difference was seen as compared to the IEEE 24 bus dataset and the time taken to run each case for IEEE 24 bus systems is more than 5 minutes. Therefore, for simplicity the 2-bus system is used below. The input file can be changed in order to run the same test for IEEE 24 bus system.

```
IPython  -- An enhanced Interactive Python.

In [1]: runfile('C:/Babu_Local/PhD/DTU - 31792/Assignment/DTU31792_CP4_BabuKumaranNalini/
Python codes/ADMM_Decomposition.py', wdir='C:/Babu_Local/PhD/DTU - 31792/Assignment/
DTU31792_CP4_BabuKumaranNalini/Python codes')
  0%|          | 0/50 [00:00<?, ?it/s]Restricted license - for non-production use only -
expires 2022-01-13
100%|██████████| 50/50 [00:01<00:00, 39.60it/s]

----------------------------------------
Solution of ADMM problem in 50 iteration
The cost optimal convergence value is observed to be:  4501.964090025232
----------------------------------------
```

Figure 2 Snippet from python program execution

Figure 1 shows a snippet from the python program which results in the converged cost optimal solution using consensus ADMM that is reached after 50 iterations with 5 different scenarios. Figure 2 shows the convergence plot of market clearing price with respect to iteration.

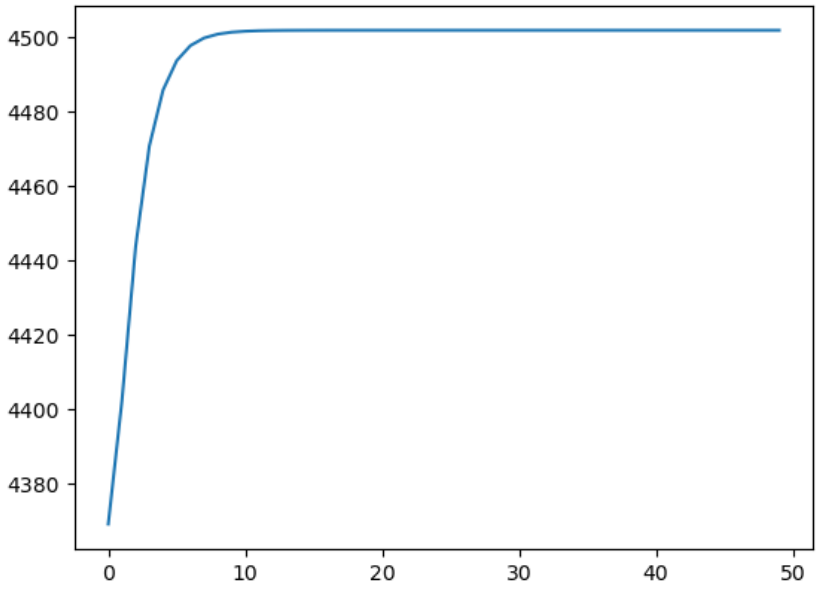

Figure 3 Cost convergence with respect to iteration

Discussion

- A neat convergence pattern was seen in the case of simple example case with 5 scenarios and 50 iterations.
- A small value for the gamma was chosen and the manually increased to improve the convergence.
- When higher number of iterations or more scenarios or more stochastic wind plants are included the student version of the Gurobi throws an error to upgrade the license. Therefore, a simple problem was studied.
- The consensus ADMM method relatively reduces the complexity of solving a problem in comparison to Bender's decomposition.

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Missed out from submission: *I would like to inform this PDF was missed out when the ZIP was created. Kindly consider this submission. I regret for the mistake. – Babu Kumaran Nalini*