Electricity Provisioning based on Demand Prediction

The goal of this homework is to test the performance of different electricity provisioning algorithms based on the demand predictions you obtained in Homework 1.

Continue to use the separate datasets for 3 users that contain the load demand (in kW) for each 30-minute interval that covers 1 year given in Homework 1. Your objective is to utilize existing provisioning algorithms (online gradient descent, online balanced descent, receding horizon control, commitment horizon control) to provision electricity for each user.

The performance is measured by the following objective function

$$\sum_{t=1}^{T} p(t)x(t) + a * \max\{0, y(t) - x(t)\} + b|x(t) - x(t-1)| \qquad (1)$$

This is the only objective function in this homework. Therefore, you will use it to evaluate both offline algorithms and online algorithms. In particular, when you evaluate the cost of an algorithm, you plug in the decision x(1), x(2), …, x(T) into (1), where p(t), a, and b are constants, and y(t) is the true value (not the predictions).

You need to decide $x(t)$ possibly based on historical information and predictions of future demands. We assume $x(0) = 0$.

Here $p(t)$ is the electricity price at time t, which you can assume as a constant $0.40/kWh. Optional: you can use some real-time pricing, e.g., https://www.iso-ne.com/isoexpress/web/reports/pricing.

We assume $a = b = \$4/kwh$, and you need to vary them to see the impacts.

You can use the prediction of $y(t)$, which is the output from your Homework 1, in the online balanced descent algorithm, receding horizon control, and commitment horizon control.

No predictions needed for the offline solution (either dynamic or static), or the online gradient descent algorithm.

Pick T=672 (2 week). Pick the first 14 days in November (Nov 1-Nov 14).

Required tasks:

- Solve the offline optimization problem, e.g., using tools CVX in Matlab or Python.
- Try online gradient descent (with different step size), receding horizon control (with different prediction window size), commitment horizon control (with different commitment levels). For the latter two algorithms, use predictions from at least two prediction algorithms for the default value of a and b.
- Compare the costs of these algorithms to those of the offline static and dynamic solutions.
- For the best combination of control algorithm and prediction algorithm, vary a and b to see the impacts.
- Try at least two algorithm selection (one deterministic, one randomized) to see if their performance.

Bonus task:

- Try online balanced descent algorithm
- Try to develop better control algorithm or algorithm selection.

In your report, please discuss in details about each task.