ARPA-E GO COMPETITION CHALLENGE 2: SCORING
UPDATED 2021-04-16

1. TERMINOLOGY

The following terminology will be utilized throughout the GO Competition and in this scoring document:

- ***Power system network model***: a defined topological structure and characteristics including, but not limited to, locations of generators, loads, transmission lines, transformers, equipment detail, control equipment, and operating parameters.
- ***Scenario***: an operating instance in time on a power system network model. The scenarios define a demand at each bus, renewable resource availability, and other system conditions.
- ***Dataset***: a collection of power system network models and scenario data on those models.
- ***A scenario score*** a score calculated for each scenario of a power system network model.
- ***A power system network model score*** a combined score for all of scenarios associated with a power system network model.
- ***A dataset score*** a combined score from all of the power system network models in a given dataset.

2. GO COMPETITION DIVISIONS

The GO Competition will host four different "divisions" with separate leaderboards. Two divisions will be focused on real-time optimization (with a 5-minute time limit per scenario) and two focused on offline optimization (with a 60-minute time limit per scenario). Unlike in Challenge 1, all four scoring divisions will focus on the value of the objective function (maximizing the market surplus aka market efficiency). All Entrants will be ranked with respect to the scenario scores within each division. The Eligible Entrants who rank at the top of each division will receive a prize based on their rank as either prize money or as a grant for follow-on research approved in writing by ARPA-E (for more details on prize money versus grant eligibility, see the Challenge 2 Rules document). Prizes and grants for placing in multiple divisions are additive. Figures 1 and 2 depict algorithm scoring by division for Trial 3 and the Final Event. Scoring for all four divisions is discussed below.

Figure 1. Breakdown of the Divisions and Prize/Grant Money for Eligible Entrants in Trial Event 3.

Figure 2. Breakdown of the Divisions and Prize/Grant Money for Eligible Entrants in the Final Event.

Figure 3 shows a visual representation of two notional algorithms, with Algorithm 1 winning Division 1, and Algorithm 2 winning Division 2. Entrants will be able to submit their executable program (source code) with the ability to adjust their algorithmic approach based on division; there will be an input parameter that will reflect the selected division.

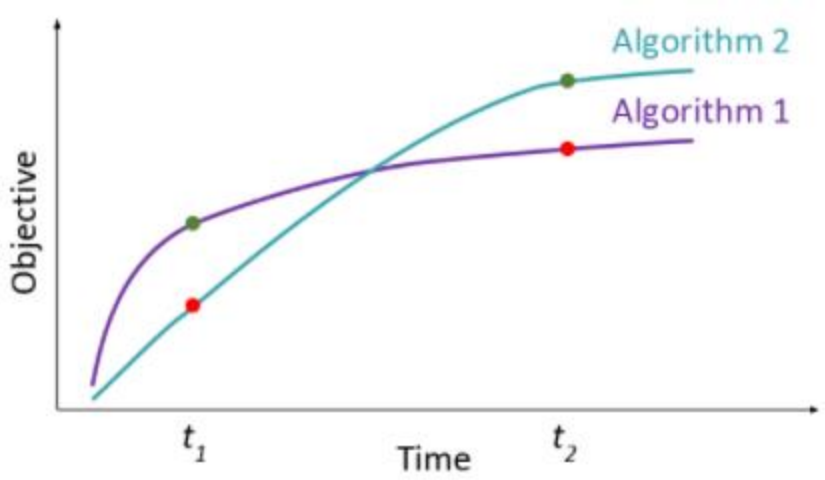

Figure 3. Algorithm Performance over Time.

3. SCORING

For a given scenario, the solution provided by each entrant is assigned a score representing the increase in market surplus of that solution relative to the market surplus of the prior point solution. The market surplus of a solution is defined (details in the formulation document) as

$$MS^{total} = MS_0 + (\sum_{k \in Kc} MS_k)/|K_c|$$

where MS_k is the market surplus in case k, $k = 0$ is the base case, K_c is the set of contingency cases, and $K = \{0\} \cup K_c$ is the set of all cases. The market surplus in case k is defined as

$$MS_k = \sum_{i \in I} MS_{ik} + \sum_{j \in J} MS_{jk} + \sum_{e \in E} MS_{ek} + \sum_{f \in F} MS_{fk} + \sum_{g \in G} MS_{gk} \text{ for all } k \in K$$

where I is the set of buses, J is the set of loads, E is the set of lines, F is the set of transformers, G is the set of generators. Finally, the element-specific market surplus MS_{xk} is the sum of all benefit terms minus cost terms for a given grid element x in case k. For a given scenario s, let MS^{total}_s denote the market surplus objective of a solution on scenario s.

As discussed, Division 1 and 3 will evaluate this score after 5 minutes on the competition platform, while Division 2 and 4 will do so after 60 minutes. Transmission lines and transformers may not have their on/off status switched in Divisions 1 and 2, but competitors may use any other feature of the loads, generators, and transmission assets described in the formulation and within the limits of the input datasets to optimize each scenario for both the base case and each contingency response. Divisions 3 and 4 will allow competitors to employ all previously described features including switching the status of transmission lines and transformers as permitted by the input datasets.

4. NETWORK AND TOTAL DATASET SCORING

For Trial 3 and the Final Event, the following process described in this section will be employed to calculate scores for each scenario for each division. The total dataset score will be the score used to determine the ranking within each division for purposes of assigning prize awards to each team.

For each scenario *s*, a prior point solution is constructed by keeping all variables fixed to their values in the prior operating point in the base case and the contingencies, projecting first the base case and then the contingencies to ensure feasibility of all hard constraints (details in the formulation document). Let MS^{pp}_s denote the market surplus of the prior point solution for scenario *s*. This value is computed independently from the solutions provided by competitors.

For any entrant, the solution to scenario *s* is evaluated and a market surplus MS^{total}_s is assigned. If no solution is returned, or the solution is incorrectly formatted, or the solution is determined to be infeasible, or the evaluated market surplus is less than MS^{pp}_s, then the assigned market surplus is MS^{pp}_s.

The score MS^{gain}_s, representing the gain in market surplus relative to the prior point, is computed as

$$MS^{gain}_s = MS^{total}_s - MS^{pp}_s$$

The score over a given set S of scenarios is

$$MS^{gain} = \sum_{i \in S} MS^{gain}_s$$

Each event is scored independently of other trial or competitive events. Within each event, each division is scored separately. For each division, competitor rankings will be determined based upon the total score (MS^{gain}) for the dataset.