CHANGING WHAT'S POSSIBLE

Grid Optimization (GO) Competition

File formatting and solution evaluation

March 1, 2019

This webinar is being recorded for instructional purposes.

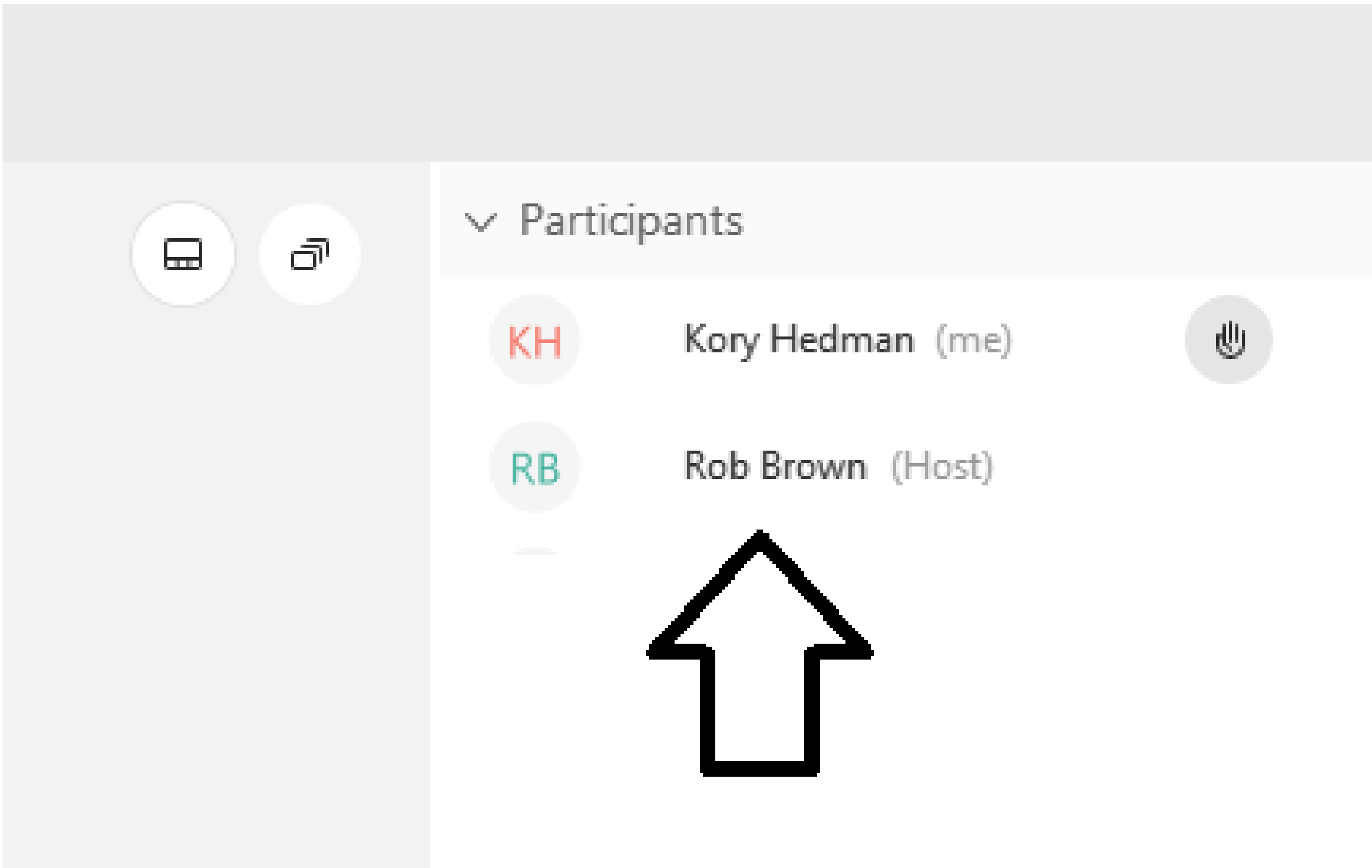
Webinars

- Reminder: All webinars are recorded!!!

- Slides and the recorded video of Webinar 1 (Feb 4) are online
  - https://www.youtube.com/watch?v=yX5u9KVclm4
- Feb 21 webinar:
  - https://www.youtube.com/watch?v=OTqCRYSHOWs

- Today’s webinar will be posted soon.

Please send webinar questions to: Rob Brown

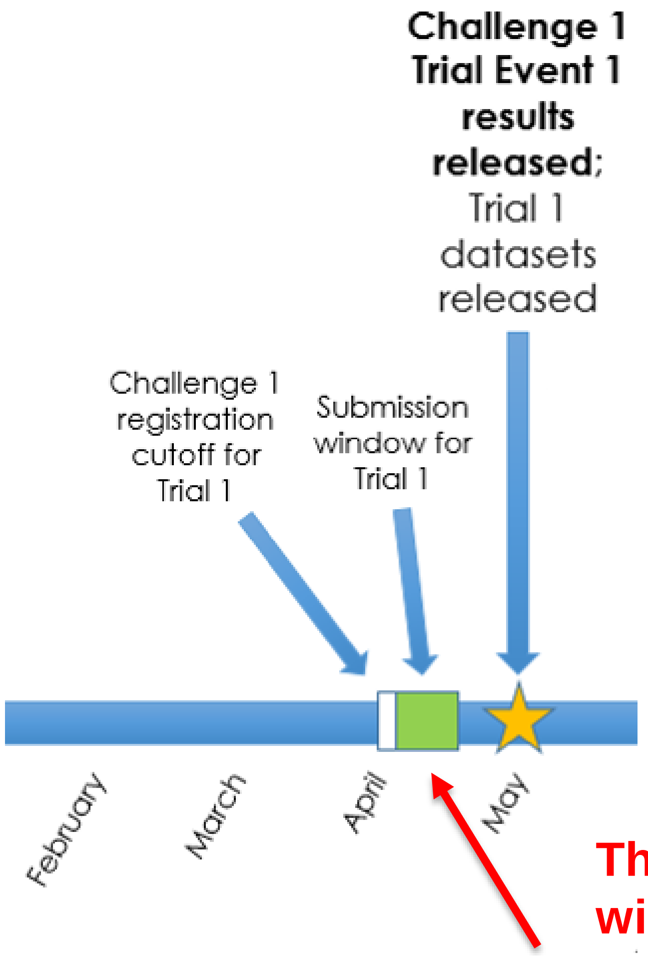


Email List

- If you want to join the email list for this competition, email:

- Kory.Hedman@hq.doe.gov

Trial 1 is coming up



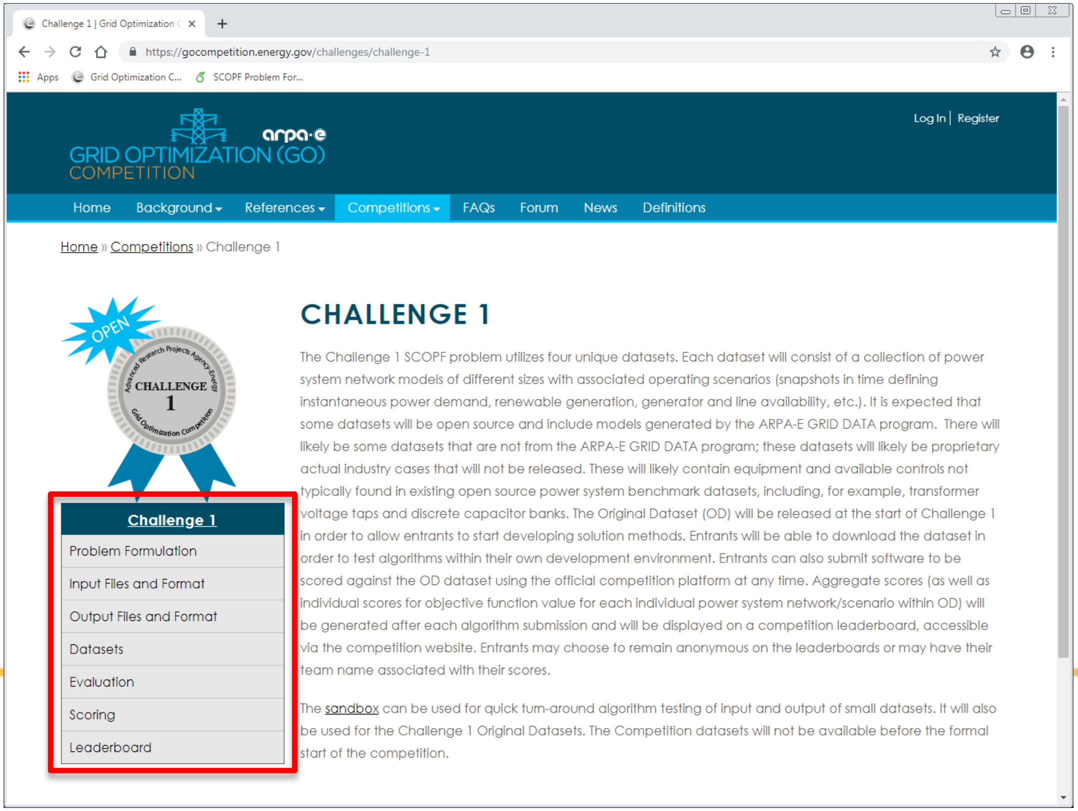
The Trial 1 submission window is coming up fast! (April 1-15)

Use the GO Competition Sandbox to practice submission and identify problems ahead of Trial 1.

More information on website

- Additional details on formatting and evaluation procedures available on the website
- For information on the ***formulation*** and ***scoring***, please see the competition website:

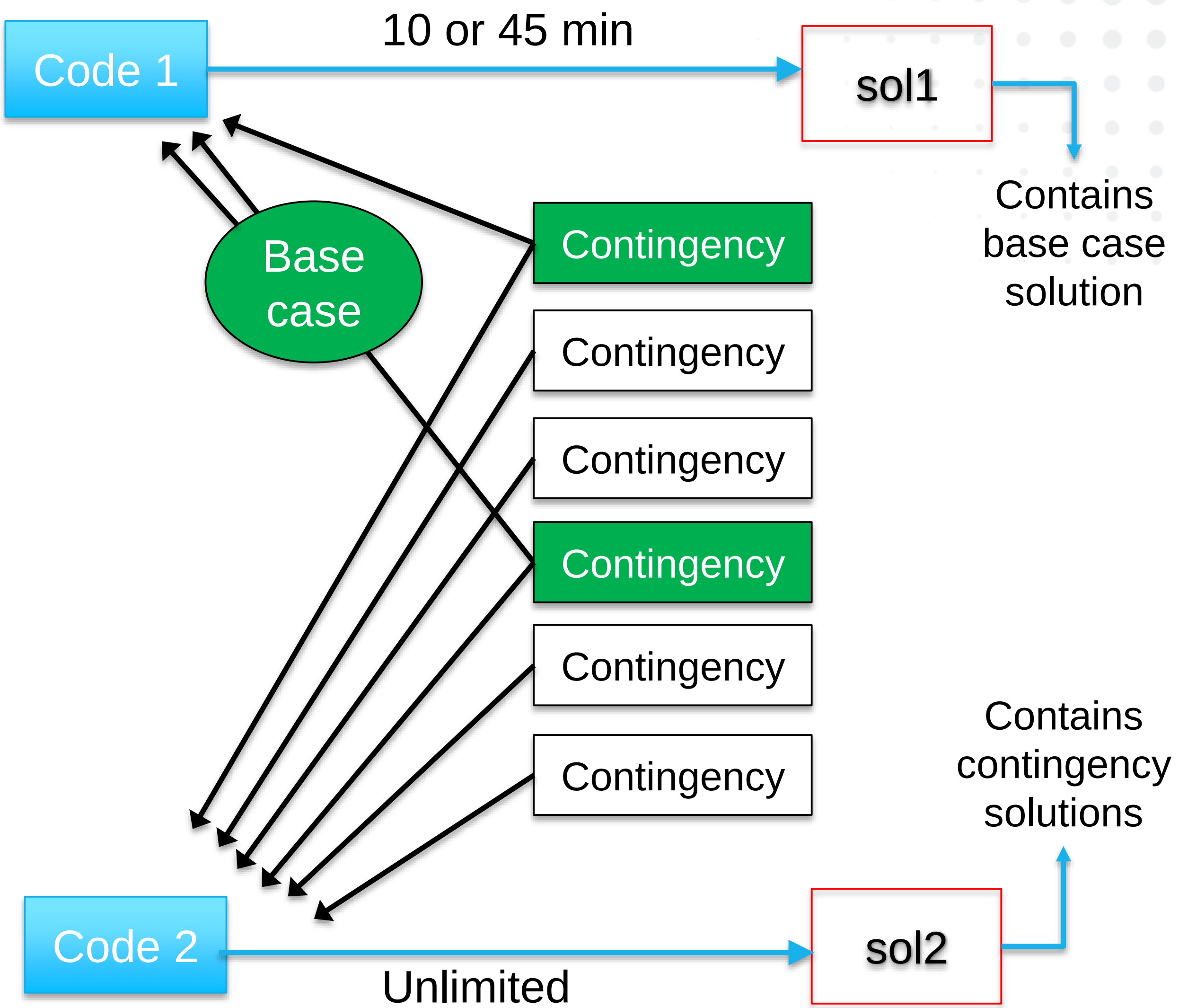
  https://gocompetition.energy.gov/challenges/challenge-1



Code 1 and Code 2

Code 1 solves for the base case operating point and writes sol1. Contingencies or a subset of contingencies may be considered to determine the base case solution.

Code 2 uses the base case operating point found by Code 1, determines solutions for each contingency and writes contingency solutions to sol2. Contingencies may be infeasible given the base case solution. **Changes to the base case solution by Code 2 will not be considered.**



Please send general questions to ARPA-E

Good luck to all entrants!

GRID OPTIMIZATION (GO) COMPETITION

For any further questions or comments after the webinar, please contact us:

GO Competition Administration Team
Website: https://gocompetition.energy.gov
E-mail: arpacomp@pnnl.gov

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Grid Optimization (GO) Competition File Formatting and Solution Evaluation

JESSE T. HOLZER

Webinar 3

March 1, 2019, 1:00 pm ET

Input Data – Instance Definition

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- The data defining an instance of the GO Competition Challenge 1 SCOPF problem is contained in four text files.
  - case.raw – buses, loads, fixed shunts, generators, lines, transformers, switched shunts, areas
  - case.rop – generator cost function parameters – sample points on the piecewise linear cost function of each generator
  - case.inl – generator participation factors
  - case.con – contingency list, specifies for each contingency a generator, line, or transformer going out of service.
- The data files are valid for a common industry data format: PSS®E 33.5
- Complete specification of fields used and file formatting is in Appendix A of the formulation document (https://gocompetition.energy.gov/challenges/challenge-1/formulation)
- Python code for reading input files is available (https://github.com/GOCompetition/Evaluation)

Output Data – Instance Solution

- The solution of an instance of the GOComp SCOPF problem will be read from two text files created by Code1 and Code2.

  solution1.txt
  - base case solution (operating point)
  - created by Code1
  - read by evaluation after Code1 completes, before Code2 runs

  solution2.txt
  - solution in each contingency
  - created by Code2
  - read by evaluation after Code2 completes

- solution1.txt
  - Bus section, for each bus i:
    - $BusNum_i, v_i, \vartheta_i, b^{cs}_i$
  - Generator section, for each generator g:
    - $BusNum_g, GenID_g, p_g, q_g$

- solution2.txt – for each contingency k:
  - Contingency section:
    - $CtgLabel_k$
  - Bus section, for each bus i:
    - $BusNum_i, v_{ik}, \vartheta_{ik}, b^{cs}_{ik}$
  - Generator section, for each generator g:
    - $BusNum_g, GenID_{gk}, p_{gk}, q_{gk}$
  - Delta section:
    - Δ_k

- Complete specification of output file formatting is in Appendix E.2 of the Problem Formulation
- Python code for reading output files is available: https://github.com/GOCompetition/Evaluation

Solution Normalization

The values in the solution files are reported in the data unit convention, i.e. per unit voltage magnitude, deg, MW, MVAR, MVAR at 1 p.u.

See Appendix E1 in the Problem Formulation document

https://gocompetition.energy.gov/challenges/challenge-1/formulation

Solution1.txt Example

--bus section

i, v(p.u.), theta(deg), bcs(MVAR at v = 1 p.u.)

1, 1.01, 5.0, 10.0

2, 0.99, 0.0, 0.0

--generator section

i, id, p(MW), q(MVAR)

1, '1', 100.0, 10.0

1, '2', 50.0, 0.0

Solution2.txt Example (2 contingencies)

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--contingency

label

'G-1-1'

--bus section

i, v(p.u.), theta(deg), bcs(MVAR at v =p.u.)

1, 1.02, 5.0, 10.0

2, 0.98, 0.0, 0.0

--generator section

i, id, p(MW), q(MVAR)

1, '1', 150.0, -10.0

1, '2', 0.0, 0.0

--delta section

delta(MW)

50.0

--contingency

label

'L-1-2-1'

--bus section

i, v(p.u.), theta(deg), bcs(MVAR at v = 1 p.u.)

1, 1.005, 0.0, 0.0

2, 0.995, 0.0, 0.0

--generator section

i, id, p(MW), q(MVAR)

1, '1', 130.0, 0.0

1, '2', 40.0, 0.0

--delta section

delta(MW)

-30.0

Example procedure to run submitted algorithms

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code1 code2

- (Python example) Competitor provides MyPython1.py and MyPython2.py.
  1. Platform Runs "python MyPython1.py InFile1 InFile2 InFile3 InFile4 TimeLimitInSeconds1 ScoringMethod NetworkModel >> MyPython1.log"
     - **a)** **InFile1** = case.con (Contingency Description Data)
     - **b)** **InFile2** = case.inl (Unit Inertia and Governor Response Data)
     - **c)** **InFile3** = case.raw (Power Flow Raw Data)
     - **d)** **InFile4** = case.rop (Optimal Power Flow Raw Data)
     - **e)** **TimeLimitInSeconds1** = the amount of time before the execution will be terminated
       - a) 600 (10 minutes) for Divisions 1 & 3
       - b) 2,700 (45 minutes) for Divisions 2 & 4
     - **f)** **ScoringMethod** = 0 or 1
       - a) zero indicates Objective Function Scoring (Divisions 1 & 2)
       - b) one indicates Performance Profile Scoring (Divisions 3 & 4)
     - **g)** **NetworkModel** = a 10 character string identifying the Network Model of the input files
  2. MyPython1.py writes solution1.txt
  3. Platform reads solution1.txt
  4. Platform Runs "python MyPython2.py InFile1 InFile2 InFile3 InFile4 TimeLimitInSeconds2 ScoringMethod NetworkModel >> MyPython2.log"
     - **a)** **InFile1 – InFile4, ScoringMethod,** and **NetworkModel** same as above
     - **b)** **TimeLimitInSeconds2** = **i**ntended only to stop runaway situations, and are yet to be determined
  5. MyPython2.py reads solution1.txt and writes solution2.txt
  6. Platform reads solution2.txt
  7. Python code and solution files should be in the same directory
- No changes to solution1.txt after step (2)
- T2 is longer than T1 to allow full solution of each contingency, given the base case solution.
- Want to reward algorithms that get a good base case solution quickly by avoiding fully solving each contingency, but contingency solutions needed to do evaluation.

Solution evaluation

- Evaluation: read solution1 and solution2 for a single scenario (problem instance), determine feasibility and objective value
- Scoring: Evaluate solution of all scenarios in a dataset, and return a score based on either the geometric mean or a performance profile calculation
- Evaluation code is available in a public github repo https://github.com/GOCompetition/Evaluation.
- Contains examples and info on how to run it.
- If you submit a pull request, that is OK. But we will not pull your code. We may review it and incorporate your ideas.
- For information on the scoring method, see the GO Competition website: https://gocompetition.energy.gov/challenges/challenge-1/scoring

Solution Evaluation

- Read solution files
- Convert units from data convention to model convention
- Check bounds (hard constraints)
- Compute flows
- Compute flow bound violations (soft constraints)
- Compute generator contingency real power output
  - We do not use p_{gk} provided in solution2
  - We use equations (84, 86) from the formulation

$$p_{gk} = \Pi_{[\underline{p}_g, \overline{p}_g]}(p_g + \alpha_g \Delta_k) \quad \forall k \in \mathcal{K}, g \in G_k^P$$

- Compute balance violations (soft constraints)
- Check generator reactive power contingency response (hard constraints)
- Compute the objective – generator cost and soft constraint penalties
- Generate outputs
  - Feasibility – (true or false)
  - Objective – USD/h
  - Maximum of any type of violation for base and each contingency

Finding things in the formulation document

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Finding things in the formulation document

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Nomenclature

i	bus
g	generator
k	contingency
$BusNum_i$	bus number of bus i
$BusNum_g$	bus number of generator g
$GenID_g$	generator ID of generator g
$CtgLabel_k$	contingency label of contingency k
v_i	voltage magnitude of bus i
ϑ_i	voltage angle of bus i
${b^{ss}}_i$	total susceptance of controllable (switched) shunts at bus i
p_g	real power output of generator g
q_g	reactive power output of generator g
v_{ik}	voltage magnitude of bus i in contingency k
ϑ_{ik}	voltage angle of bus i in contingency k
${b^{cs}}_{ik}$	total susceptance of controllable (switched) shunts at bus i in contingency k
p_{gk}	real power output of generator g in contingency k
q_{gk}	reactive power output of generator g in contingency k
Δ_k	contingency k multiplier on participation factors of responding generators

Questions?

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