The ARPA-e Benchmark Algorithm

Carleton Coffrin

Advanced Network Science Initiative

https://lanl-ansi.github.io/

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Power Systems Optimization Foundation

- **Staff Scientists at Los Alamos National Laboratory**
  - Advanced Network Science Initiative

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- **AC Optimal Power Flow**
  - Convex Power Flow Relaxations (QC formulation)
  - Power Flow Approximations (LPAC formulation)
  - In collaboration with Pascal Van Hentenryck and Hassan Hijazi

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- **OPF Benchmarking**
  - Highlighted significant problems with open-test cases
  - IEEE Task Force on Benchmarks for Optimization Algorithms
  - Power Gird Library Benchmarks (PGLib)

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IEEE PES Power & Energy Society™

PGLib

Open-Source Optimization Software

- **PowerModels.jl**
  - Tool for Research in Power System Optimization
  - Read Matpower and PSSE files
  - State-of-the-art AC-OPF Solutions
  - Convex Relaxations (SOC, QC, SDP, …)
  - Optimization Based Bound Tightening
  - …

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Add SCOPF to the PowerModels Toolbox!

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My Roles in the Competition

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My Roles in the Competition

- **Dataset Validation and Ranking**
  - Look for problems in the datasets
  - Check that problems are not “too easy”
  - Attempt to rank scenarios based on hardness

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- **Develop the “APRA-e Benchmark” Algorithm**
  - Test drive the evaluation platform
  - Compare and contrast different solution approaches

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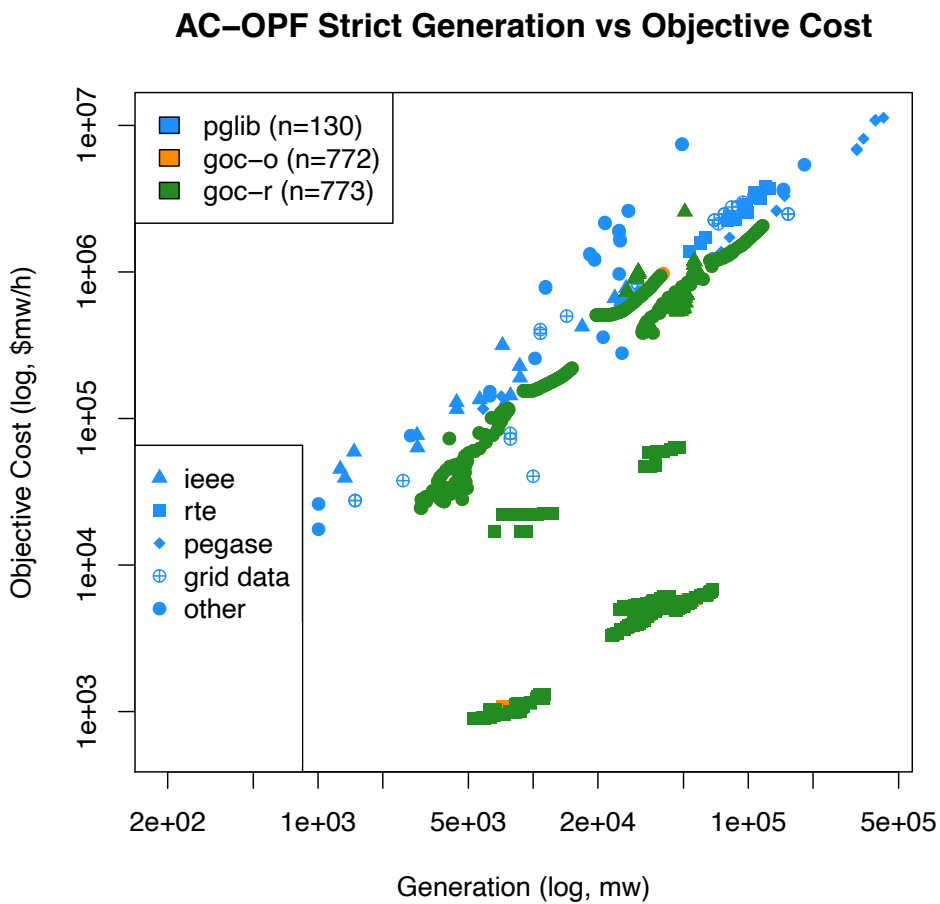
Data Validation Example

Public Network Data

Competition Synthetic Network Data



Data Validation Example

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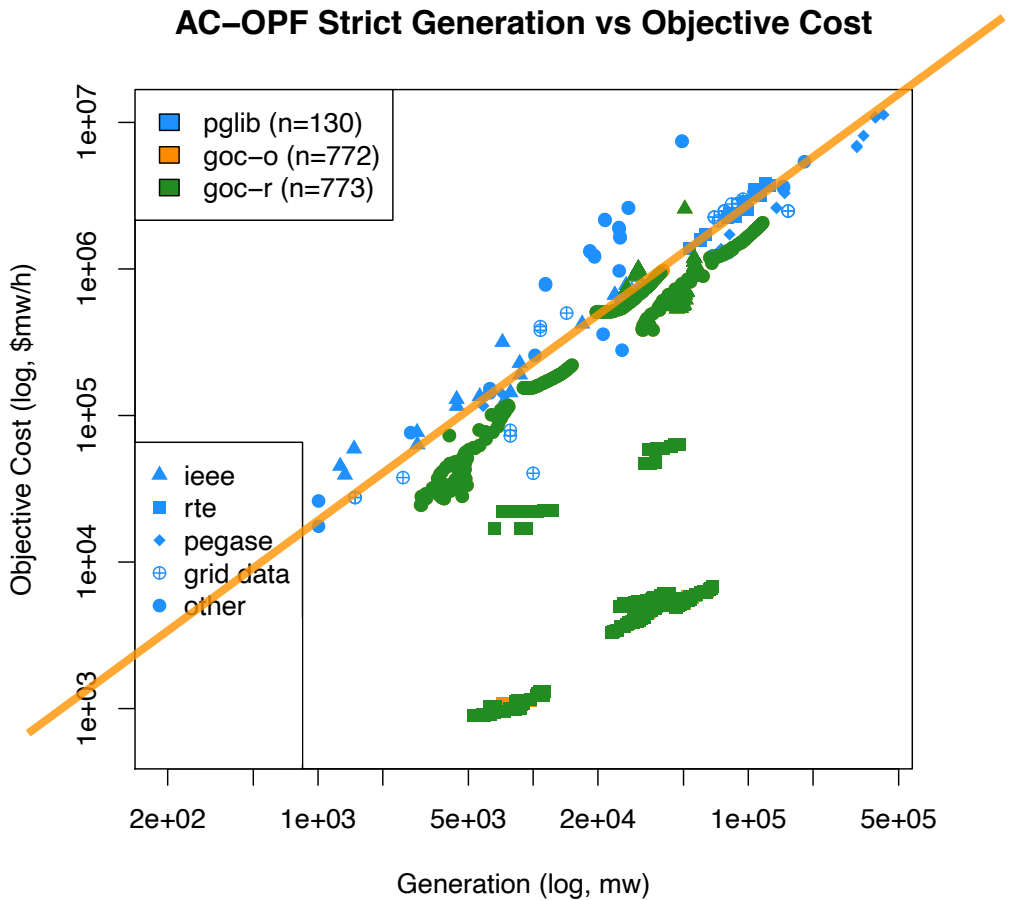

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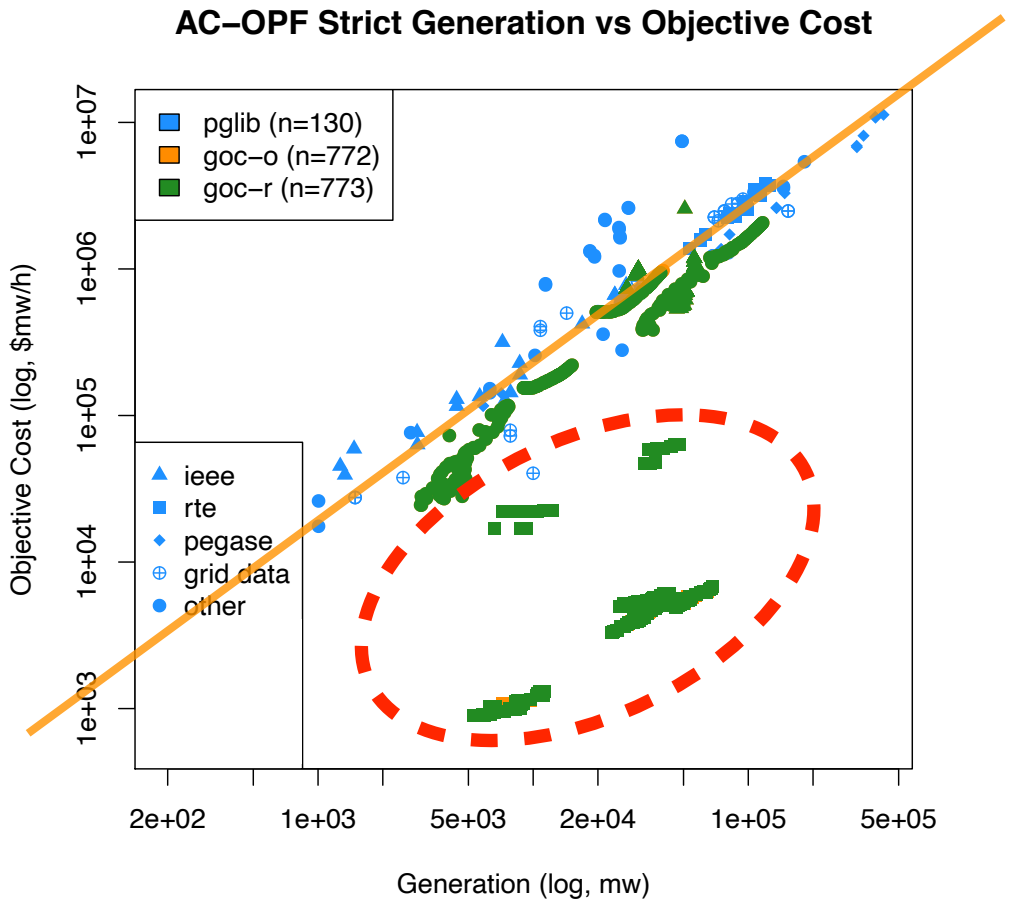
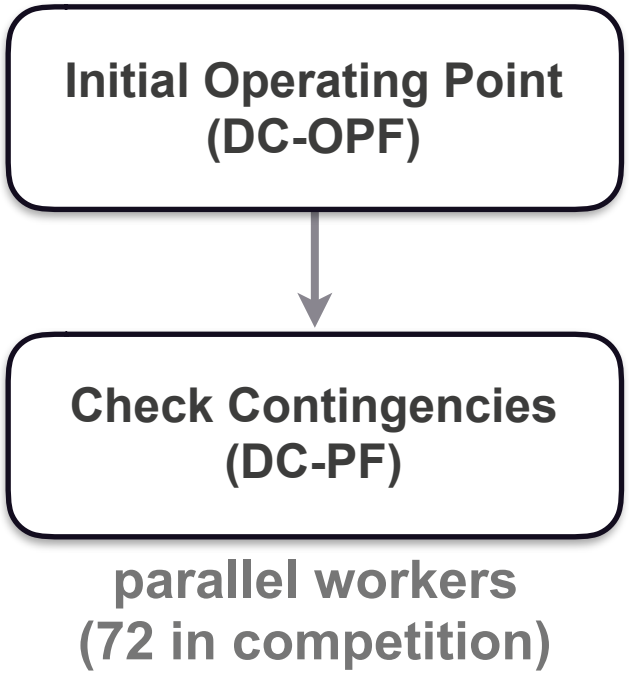


The Benchmark Algorithm

Basics of the ARPA-e Benchmark Algorithm

Initial Operating Point
(DC-OPF)

Basics of the ARPA-e Benchmark Algorithm



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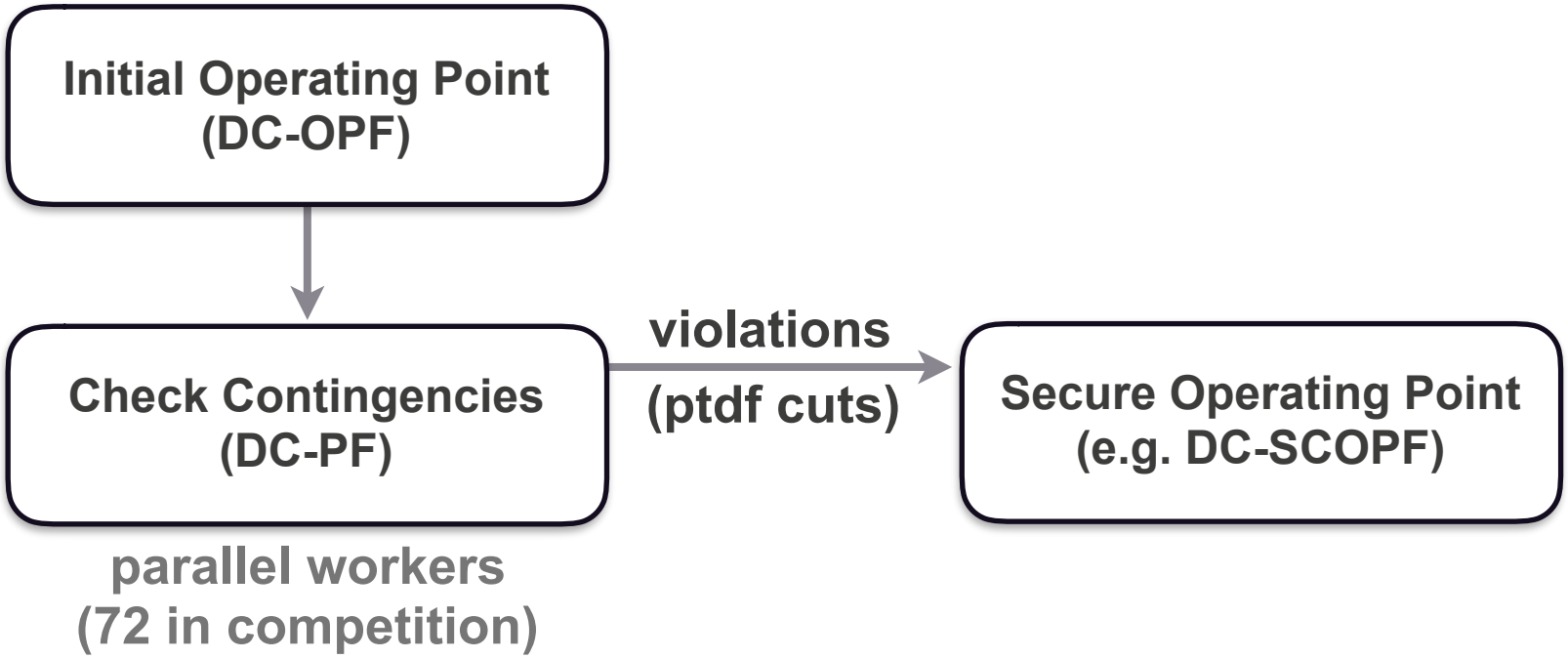

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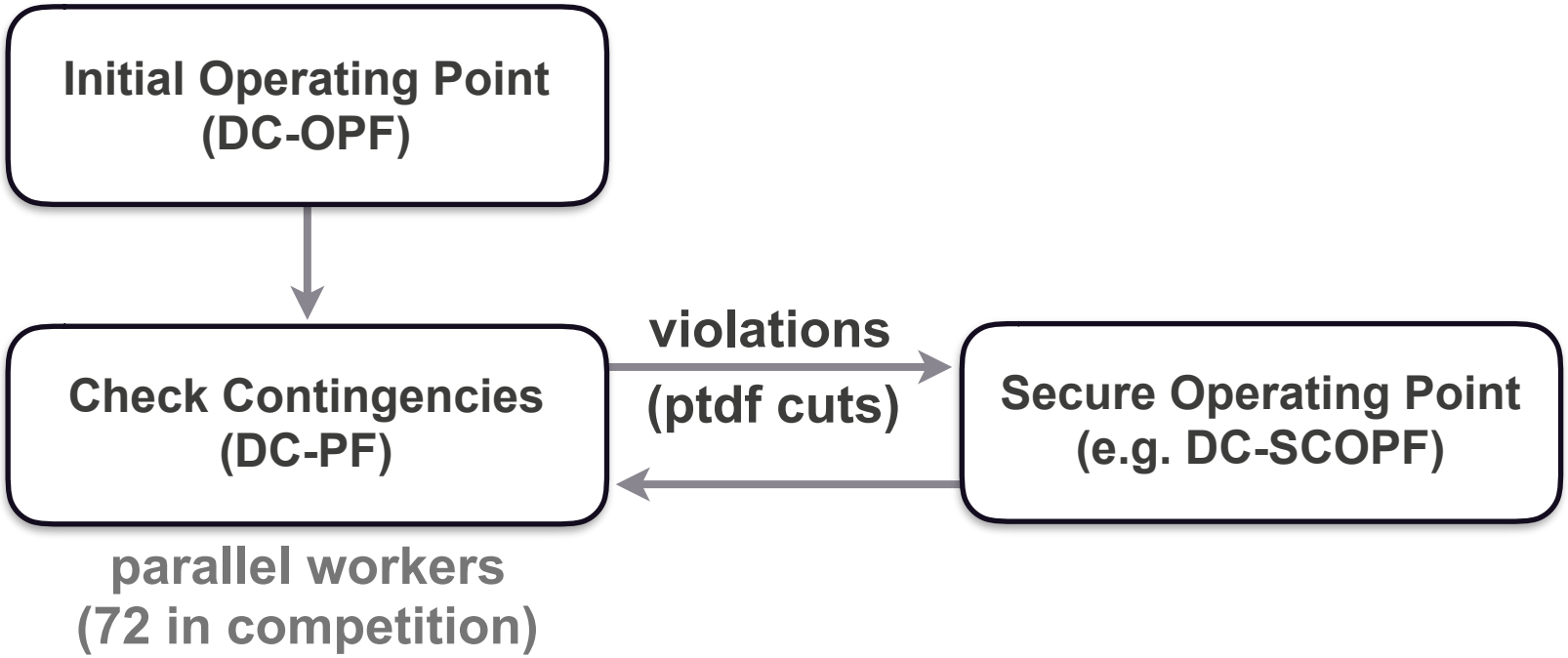

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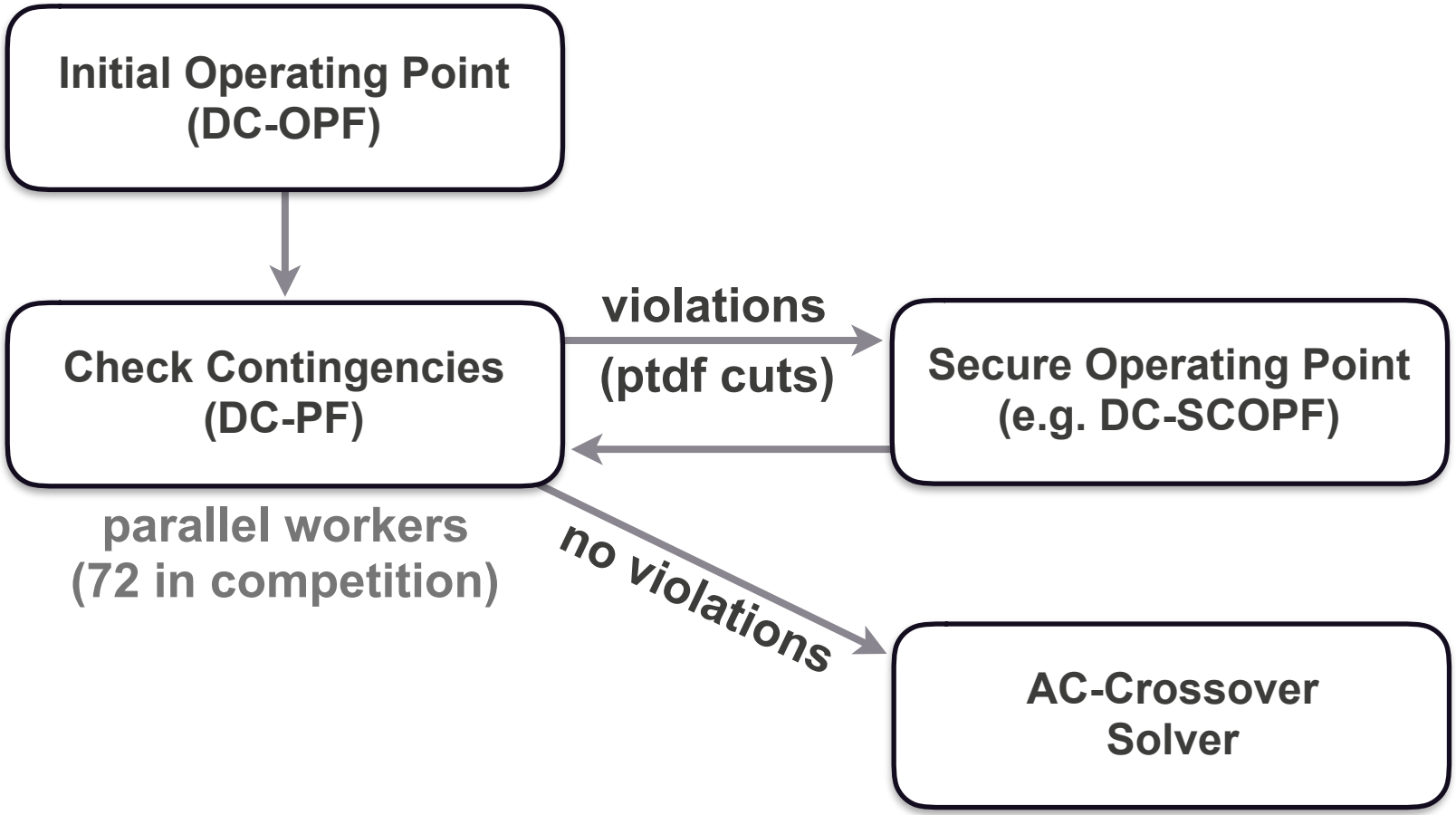

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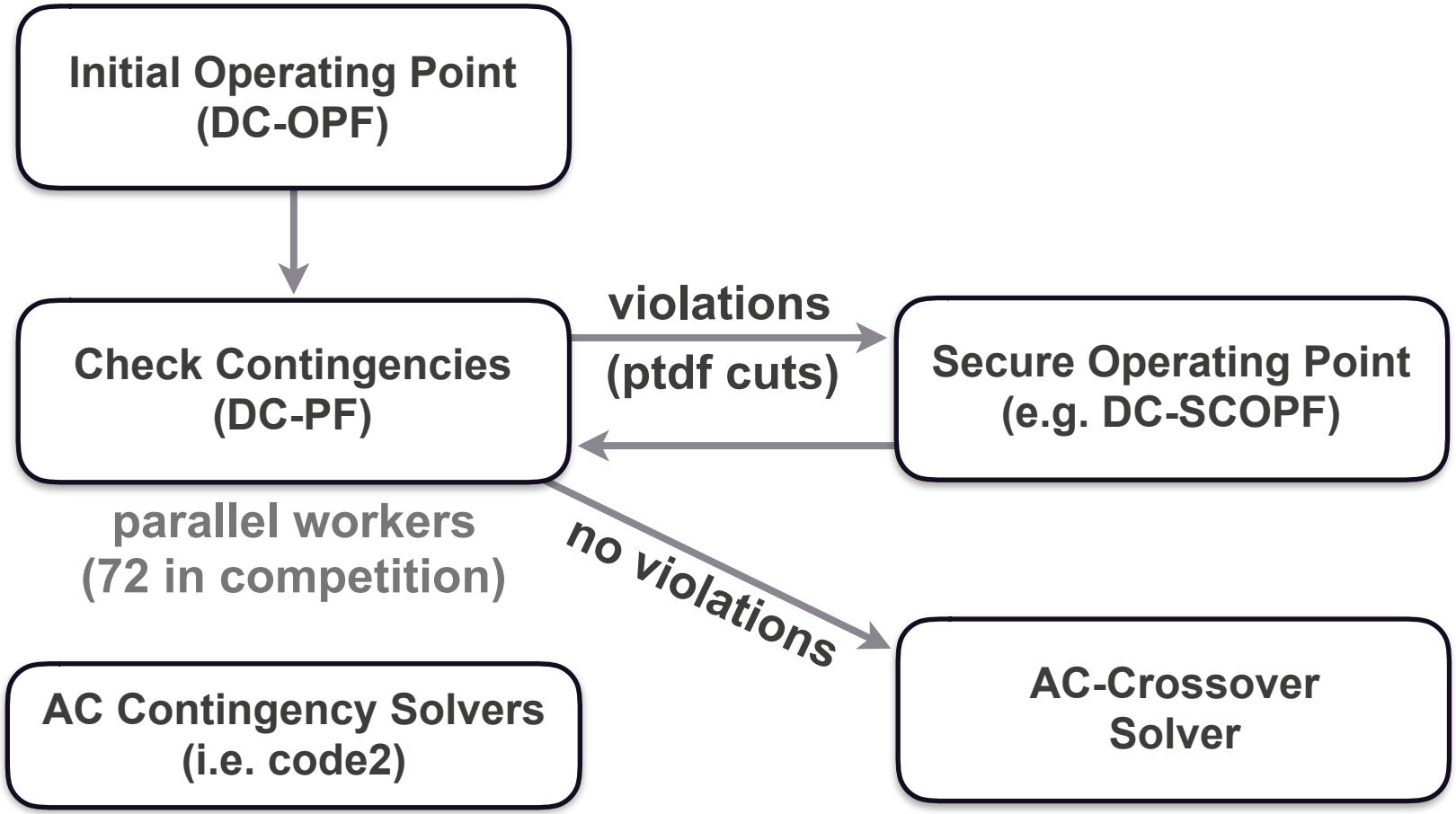

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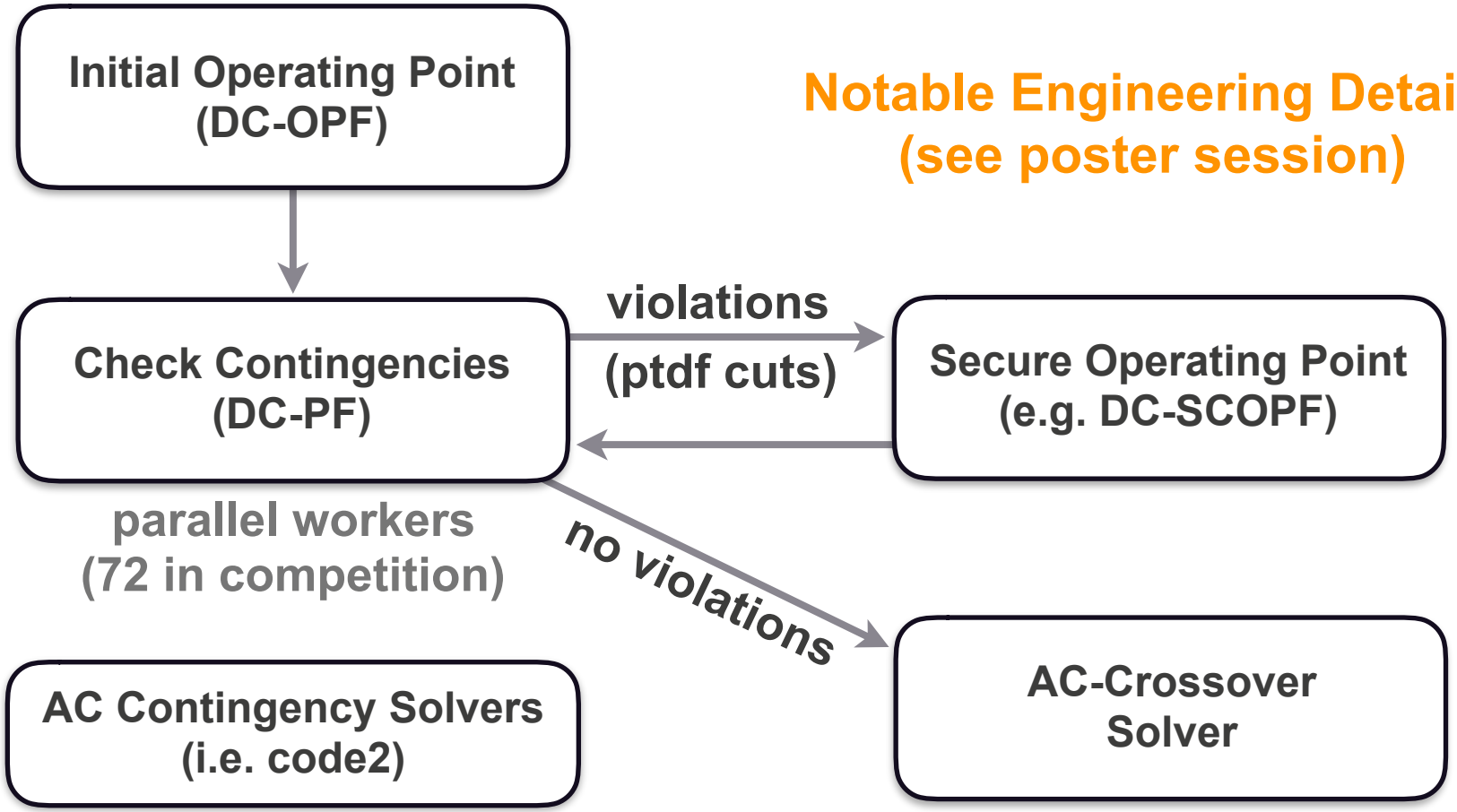

Notable Engineering Details
(see poster session)

The ARPA-e Benchmark Algorithm Source Code

PowerModelsSecurityConstrained

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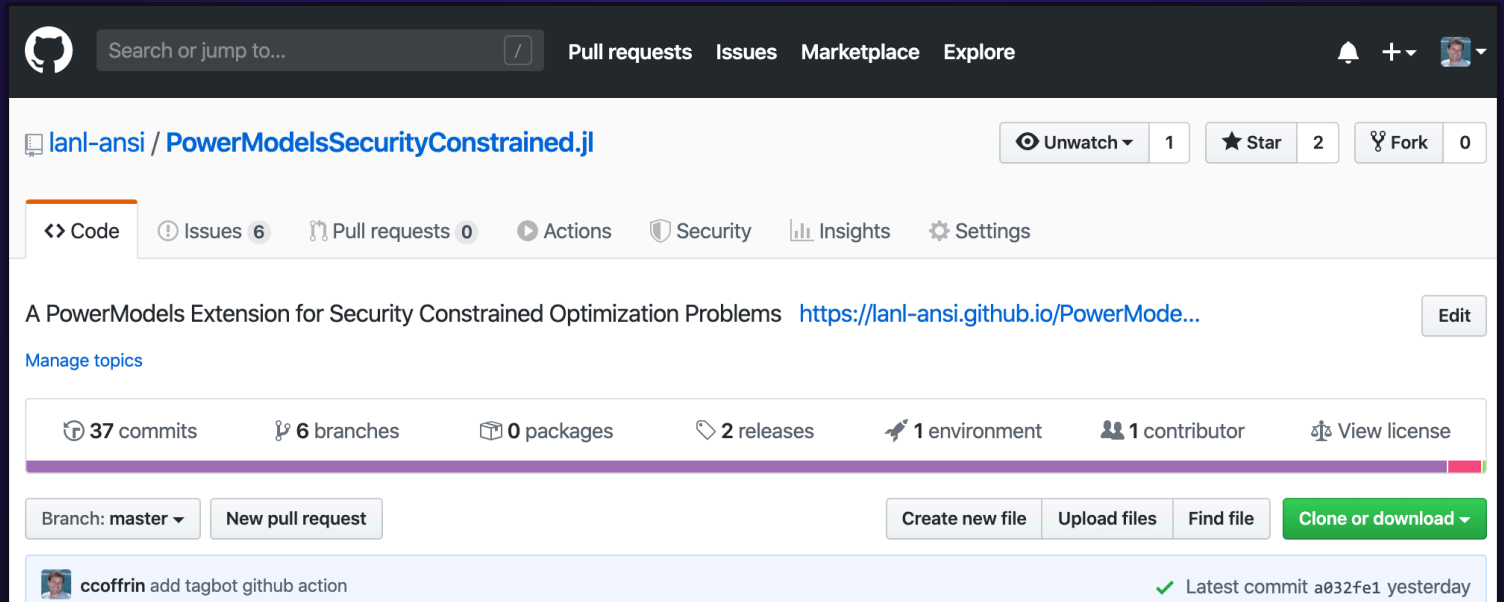
The ARPA-e Benchmark Algorithm Source Code

https://github.com/lanl-ansi/PowerModelsSecurityConstrained.jl



PowerModels with Security Constraints

- **Solve Grid Optimization Competition Challenge 1 Problems (v0.1)**
  - Fully open-source with solvers like Ipopt, Cbc (zero licenses, easy for HPC)
  - Easy to use with faster commercial solvers (e.g. Gurobi)

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  - a foundation for SCOPF research (e.g. the “Matpower” of SCOPF)
  - optimization with contingency constraints

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- **More problems on the way, e.g. SCED and SCUC…**

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Two Concluding Thoughts

Looking back to the 2014

ARPA-e OPF Algorithms Workshop

Optimization Super Heroes

Thanks!