TOURNAMENTS TO ADVANCE KNOWLEDGE AND PERFORMANCE OF THE ACOPF

BETTER THINGS FOR BETTER LIVING THROUGH SOFTWARE

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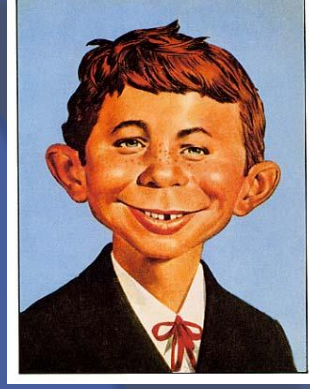
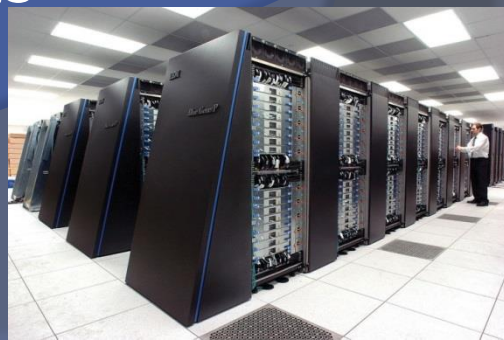
History



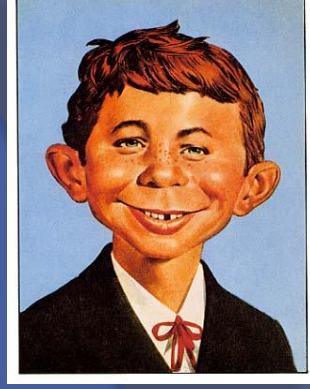
- Carpentier (1962) introduces the ACOPF
- Circa 1967 IBM 360
  - 17 million instructions per second.
  - 8 MB of internal main memory
- 1970s the Committee on Algorithms (COAL) started
  - collecting test problems and testing protocols
  - Guidelines for reporting of results
  - produced a public test set for linear programs
- Vertically integrated utility value proposition (cost-of-service) was to add more hardware

today

- laptop 2.5GHz 2GB of RAM; Hyper computing in 10^{12} FLOPS
- ISO value proposition approach: first better software for market efficiency. benefit/cost ratio >100
- AC optimality has been an unachievable goal for 50+ years
  - Takes too long to solve
  - May not solve (not good for operations)
- Academic claims are all over the map
- What is the problem being solved?
  - Massaging the problem
  - Starting points: exogenous and endogenous
  - Convergence tolerance and criteria
  - Replicability
- Need better repeatable reporting



What me worry?



- US future: 1% savings is ≈ $1 to $4 billion/yr
- Worldwide future: 1% savings is ≈ $4 to $16 billion/yr

- The bulk of the world have AC systems
- Over linearized models could be leaving 10% or more of costs on the table

Current status of solving the AC optimal power flow

- The heart of AC problem are the network flow equations
- Non-convex with local optima
- Several formulations
  - polar or rectangular coordinates
  - P,V and I, V variables
  - I, V representation has linear network equations
- Many decompositions
  - benders, DW, Shur, geography, temporal
- Many approximations some convex
  - $\sin(\theta) = \theta$
  - $\cos(\theta) = 1 - \theta^2/2$
- Algorithms:
  - Generic NLPs: IPOPT, Minos, CONOPT, …
  - Specialized codes

Goals for solving the AC optimal power flow

- For real-time market and optimal topology: seconds to 5 minutes
- For day-ahead market, 1 or 2 hour
- For longer term planning, one or more days

The needs for solving the AC optimal power flow

- Avoid local optima
- Greater robustness
- Terminate with a feasible (near optimal) solution in
  - 5 minutes
  - One hour
  - 4 hours
- Need at least an order of magnitude reduction in solver time
- Better than current approach

AC optimal power flow test set

- Standard test set has
  - no transmission constraints
  - no 'D' curve
  - Most general purpose NLPs find the global optima
  - Global optima (verified by SDP)
  - Fixed demand

- Upgraded Standard test set needs
  - transmission constraints
  - 'D' curve
  - Global optimal value (verified by SDP)
  - Price-responsive demand

Tournament design

- Independent tester
- Standard test problems and surprise test problems
- Iterative code development including collaboration
- ISO problems
- Standard platform free of operating system noise
- Interface solver protocols
- Who will compete
  - Existing NLP codes
  - Power system software venders
  - Experimental codes

Tournament design

- Tournament one period, single processor
  - Solve the Standard test problems with 'D' curve and transmission limits
  - Solve a perturbed set of standard test problems
  - Involve the ISOs to test the software on their dispatch problem
- Advanced ACOPF Tournaments
  - with unit commitment
  - with transmission switching and unit commitment
  - N-1 ACOPF transmission switching and unit commitment
  - Solve using multiple processors
  - Add discrete variables

Tournament results and evaluation

- Reporting standards: Output files
- Evaluation of results
  - Raw speed
  - Robustness
    - how many found a feasible solution
    - how many found a local solution
    - how many found a proven global solution
- Prize $$$ and prestige

Minimum reporting standards and organizing knowledge

- Hardware characteristics
- Software and parameter settings
- Convergence and feasibility criterion
- Starting points
- Reproducibility

- Otherwise publish in the journal of irreproducible results