Improved Optimization Modeling

Presenter: Tim Magee

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Modeling Challenges

1. Probable Maximum Flood (PMF)
   - One model, but many uses
2. Alternative Optimal Solutions
3. Optimization Modeling Practices

TVA PMF Modeling

- Goal: One model for PMF & Daily Opt/Sim
- Why?
  - Want the model ready to use if the moment arrives
    - Data updates, DMI updates, RiverWare updates, etc.

PMF Briefly

- Large, unusual events that cause damage
  - Esp. Nuclear power plants
- Large rain / Runoff
- Seismic events
- More Info Available

RiverWare Changes for PMF

- Simulation
  - Multiple Unregulated Spillways
  - Failure during the run - triggered by elevation
- Optimization
  - Compatibility
  - Not modeling failure during the run
- Canal Convergence
  - Some algorithmic changes
  - More coming: trust regions

Model Changes

- New data for PMF
- Table extensions
- Method changes
- Based off of a previous simulation model

Model Merging: Opt Model and PMF Model

- Harder than it sounds
  - Functional for both uses
- Need for supporting tools
  - Modelcomp is of use
    - Designed for another purpose: small output changes
  - Comparing method selection selections
  - Comparing slot configurations
  - Export data tables and Unix Diff/Merge

Additional New Tools?

- Focus on the “Inputs” that differ
  - Policy statements, activation, prioritization
  - Methods
  - Tabular data range, values, and shape
  - Columns per slot
  - Series inputs
  - Dates
- Diff and Merge assistance
- Graphical assistance

Alternative Optimal Solutions

- Important issue
  - Within RiverWare and other optimization
- Analogous to underdetermined Sim/RBS
  - Difference – you get a solution.
- Useful in some ways
  - What makes prioritized policy work in Opt and RBS
  - Low priority policy is limited by higher priorities
  - Gradually remove degrees of freedom

Alternate Optima Pose a Challenge

- Within optimal solutions, arbitrary choice
- Small data changes can result in large solution changes
- Simple Example (but the essence of the issue)
  - Subset of 3 1-unit reservoirs & 3 time periods
  - System generation in each period: 1 unit
  - Total generation for each reservoir: 1 unit
  - 3! = 6 alternative optima
- Imagine more time periods and reservoirs!

Reducing Alternative Optima

1. Add more “real” low priority policy
   - Why aren’t the solutions equally good in practice?
2. Smooth out the solution
   - Simple and automated
3. All other things being equal, get as close to the previous solution as possible
   - Key question: close in what sense?
     - System generation, total reservoir release, elevations?

Smoothing the Solution

- First Differential: $|\Delta QT_t| \leq$ Ramping Limit
  - Still allows frequent ramps up and back down
- Second Differential:
  - $|\Delta QT_t - \Delta QT_{t-1}| = QT_t - 2QT_{t-1} + QT_{t-2}$
  - Constraints on sum of second differential during run
- Allows normal peaking in response to prices but prevents arbitrary ramping up and down

Optimization Modeling Practices

- Enhancing post-opt RBS modification of the solution – Incorporating post-processing in RW
- Global Function Sets
  - Reuse the same function in Opt and RBS
  - Soon to be savable with the model file
  - Reuse in other models
- Data objects with pre-RBS opt solution
- Rules that report significant RBS changes
- Reducing activation/deactivation of constraints