Center for
Advanced
Decision
Support for
Water and
Environmental
Systems

New Optimization Language and Editor

(Using RPL and the Rules Editor)

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RiverWare Optimization

Supported by: Tennessee Valley Authority

Outline

- Existing Optimization
- Rules vs. Optimization
- Vision: Integrated Rules and Optimization Policy
- Status
- Optimization Policy Demonstration

Goal Programming

Satisfying competing demands for limited resources

- Simultaneously solve all objects and time periods
- Prioritized sequence of objectives and soft constraints
  - Highest priority: Move towards normal region
    - Flood control, minimum flows, etc
  - Lowest priority: In the normal region
    - e.g. Optimizing hydropower
- “Freeze” each objective.
- Use remaining solution space for other objectives.
- Objectives
  - Minimize or Maximize function
  - Derived Objectives: Minimize constraint violations
    - Summation – minimize total deviations
    - MiniMax – minimize the largest violation

Optimization: Pros and Cons

+ Makes system and time tradeoffs easily.
+ Uses flexibility well.
- Outcomes are less transparent.
- Some if-then logic is difficult.
- Some nonlinearities are difficult.
- Limited set of decision variables.

Long Term Vision

Rules and Optimization Together

- Remove the existing need to choose.
  - Best of both tools.
  - Start with one and add the other.
- Shared interface.
- Shared underlying software.
- Short Term: share RPL and GUI, but separate controllers.

Mixing Optimization and Rules

Easier Integration

- Optimization with a little Rules
  - If-then logic for which constraints and objectives to solve and what to do with the results.
  - Return values with RBS
- Rules with a little Optimization
  - Rules functions that contain an optimization problem.
  - e.g. Optimizing over future time steps to set values in the current time step.

Mixing Optimization and Rules, cont'd

- Optimization overridden by rules
  - Rules have higher priority.
  - Optimize "underdetermined" values.
  - Could "refire" as necessary.
- Mixed Optimization and Rules.
  - Add time step control to the policy.
  - Optimize in one case, fire a rule in another.
  - A rule with higher priority can overwrite optimization and/or provide inputs.
  - A rule with lower priority could be retained if it didn't affect the optimal value of a higher priority optimization.

Status

- Using rules editor to formulate optimization
- Reproduced existing goal types
  - Added Single MiniMax
- Controller with post-optimization RBS
- Finished most engineering objects
  - Reproducing functionality used at TVA
  - No sloped reservoirs
  - Thermal Object nearly finished
- More Testing