

# An approach to Robust Optimization of Large Scale Complex River System

Arpan Biswas

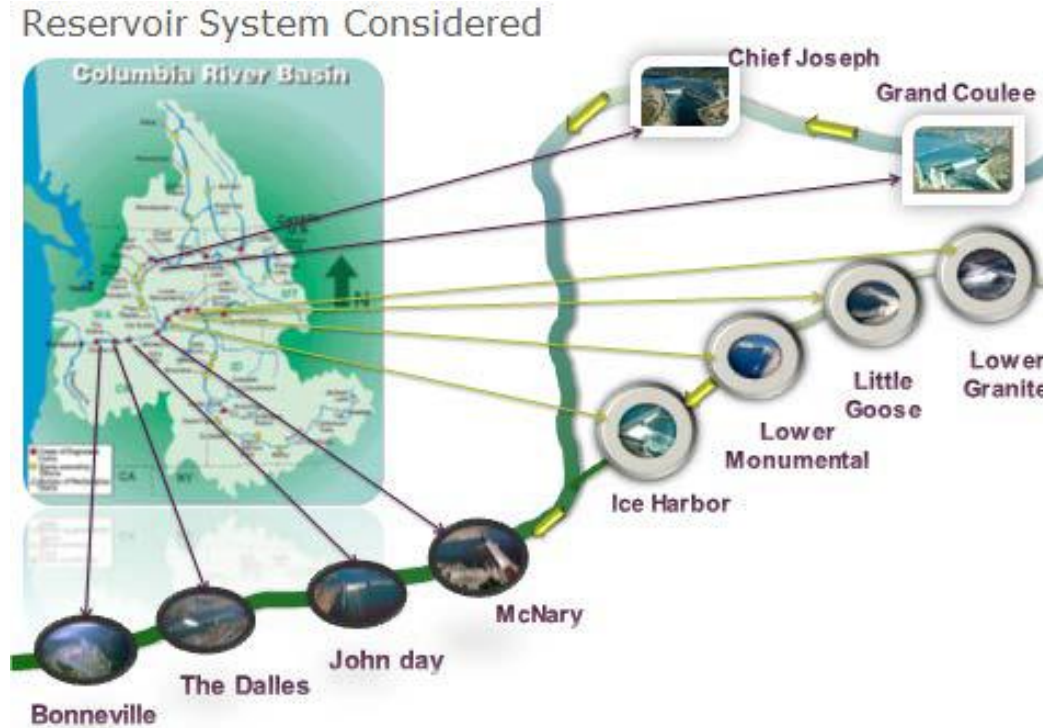
ST 541 Project

28<sup>th</sup> Nov, 2018

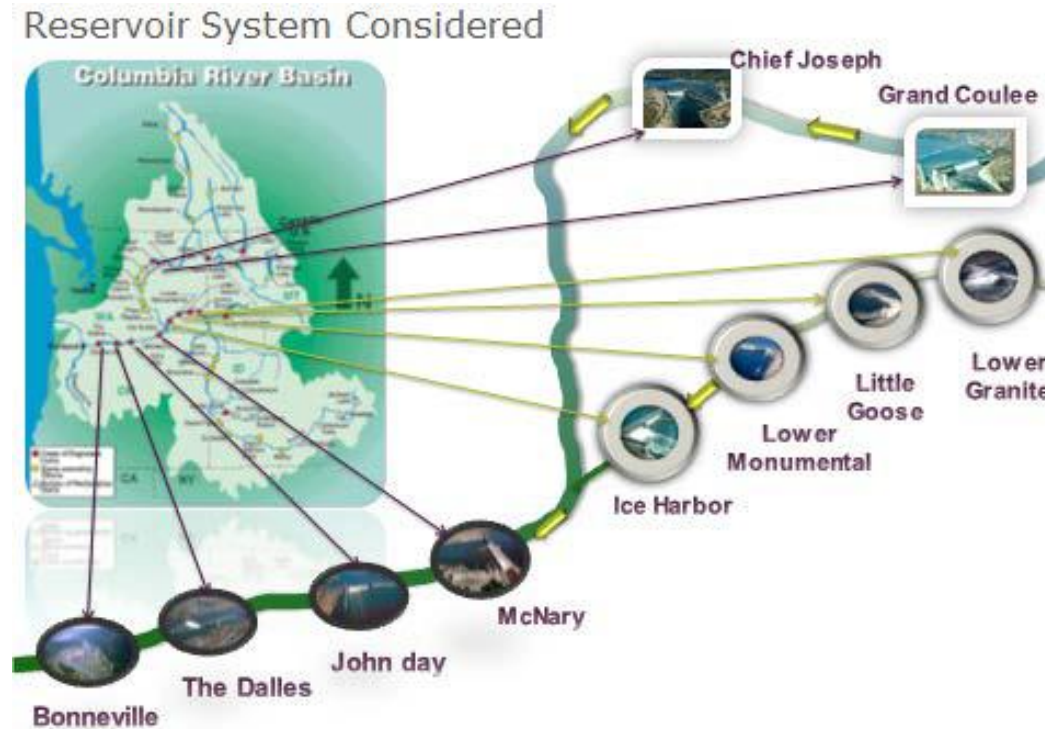
GitHub Link: <https://github.com/ST541-Fall2018/arpanbiswas52-project-ComplexRiverSystem>



# Hydro energy generation problem



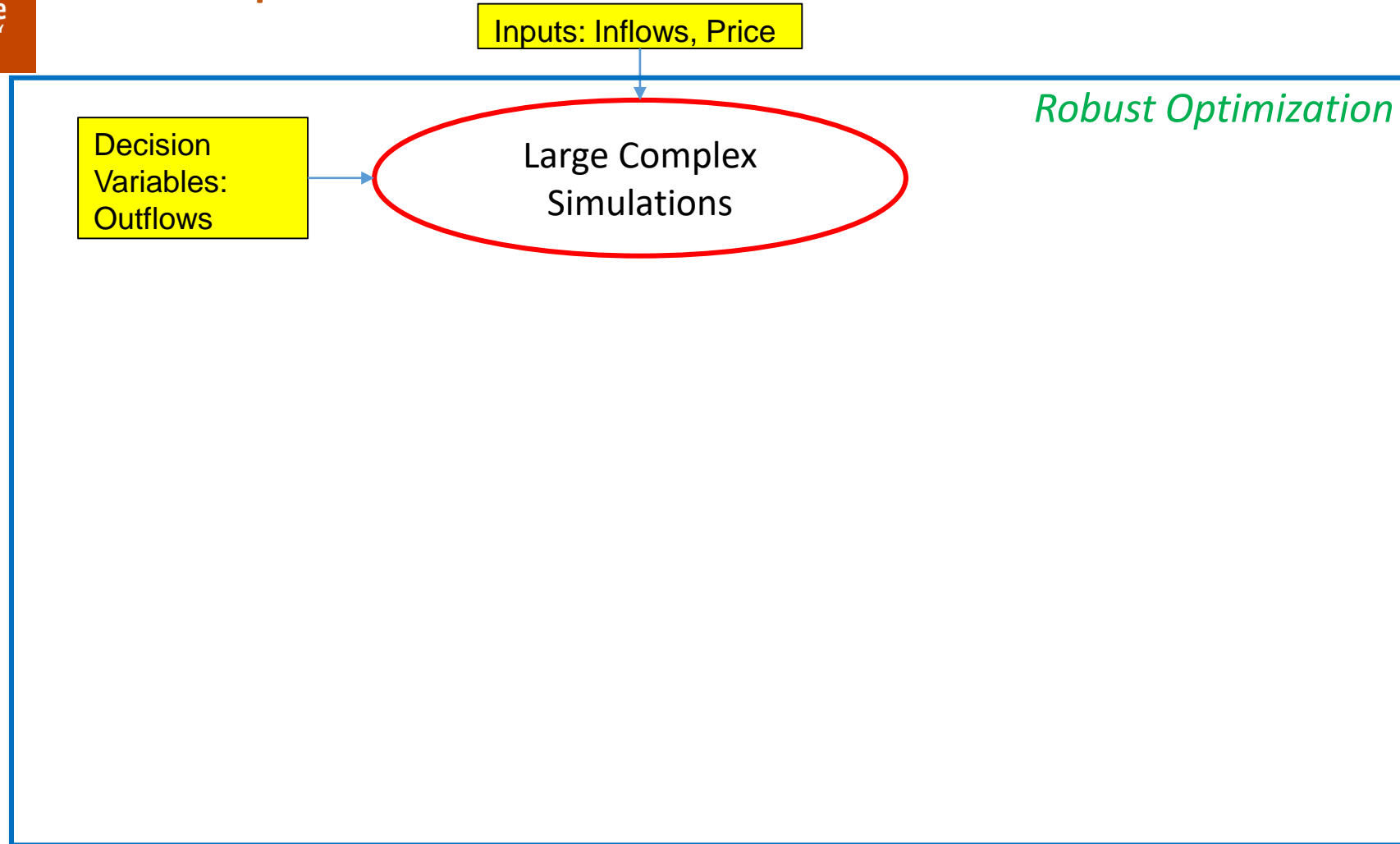
# Hydro energy generation problem



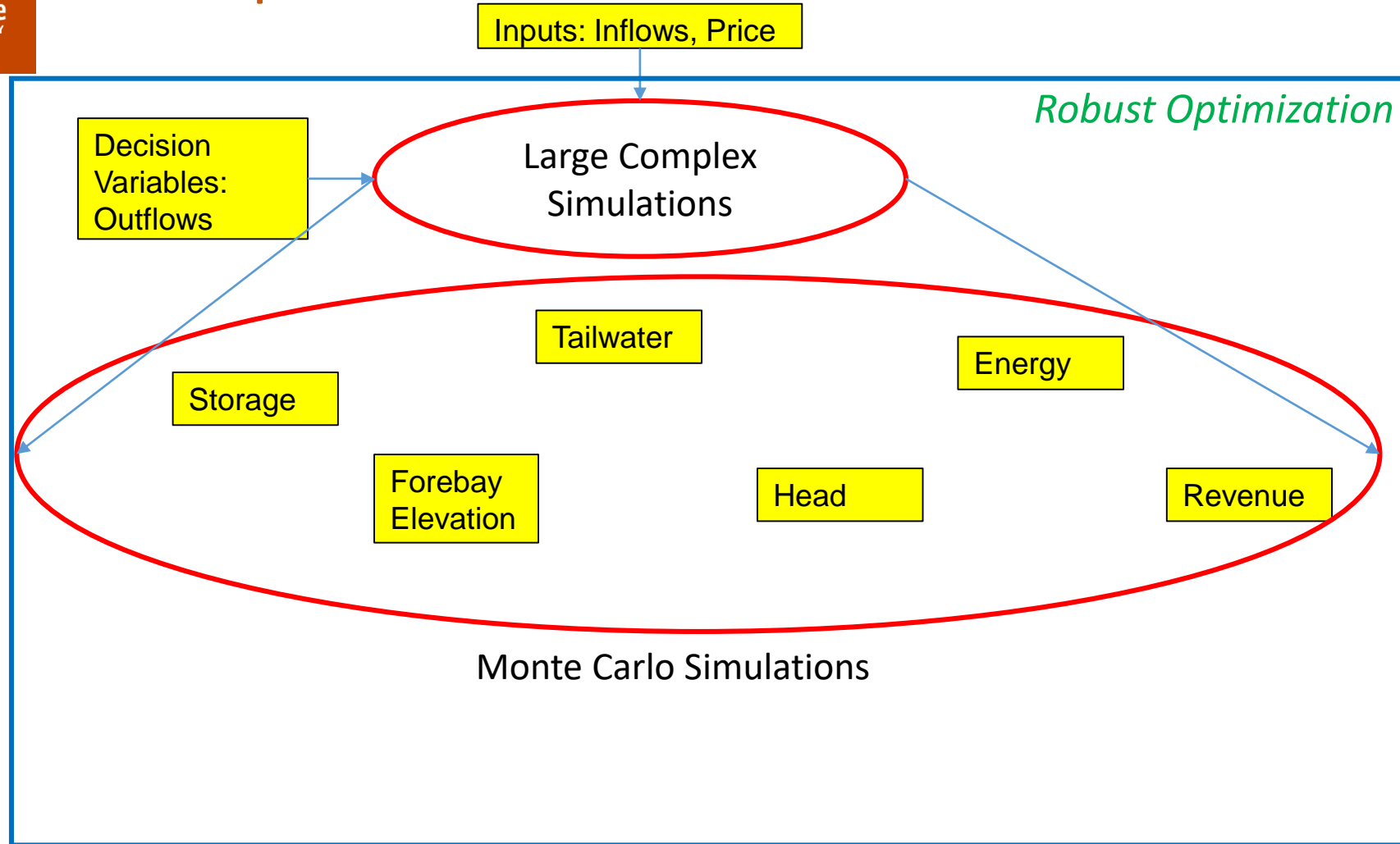
Goal:

- **Uncertainty Quantification** of Inflows, Prices etc.
- **Robust Decision** of Optimal Energy Allocation.

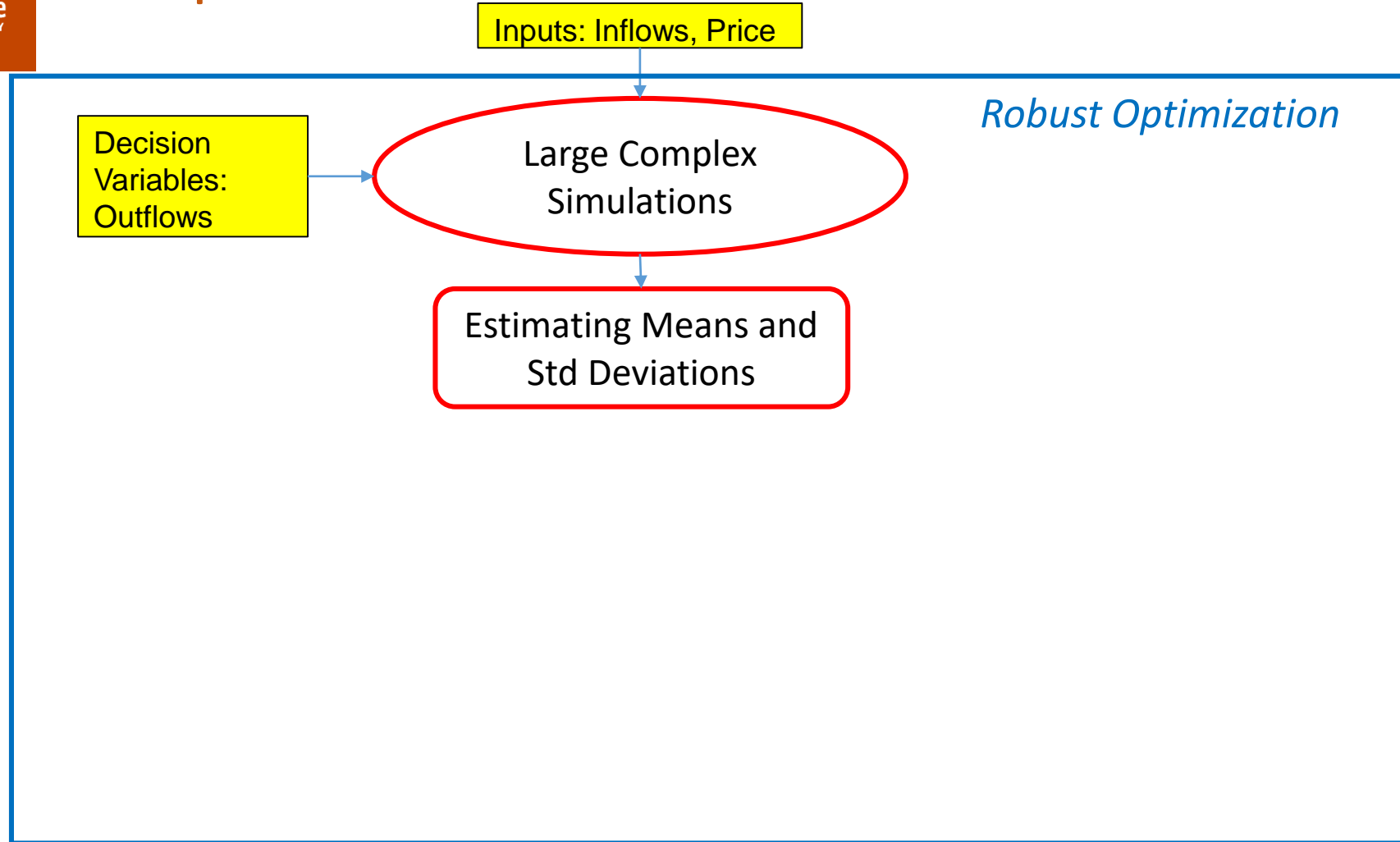
# Optimization Model Framework



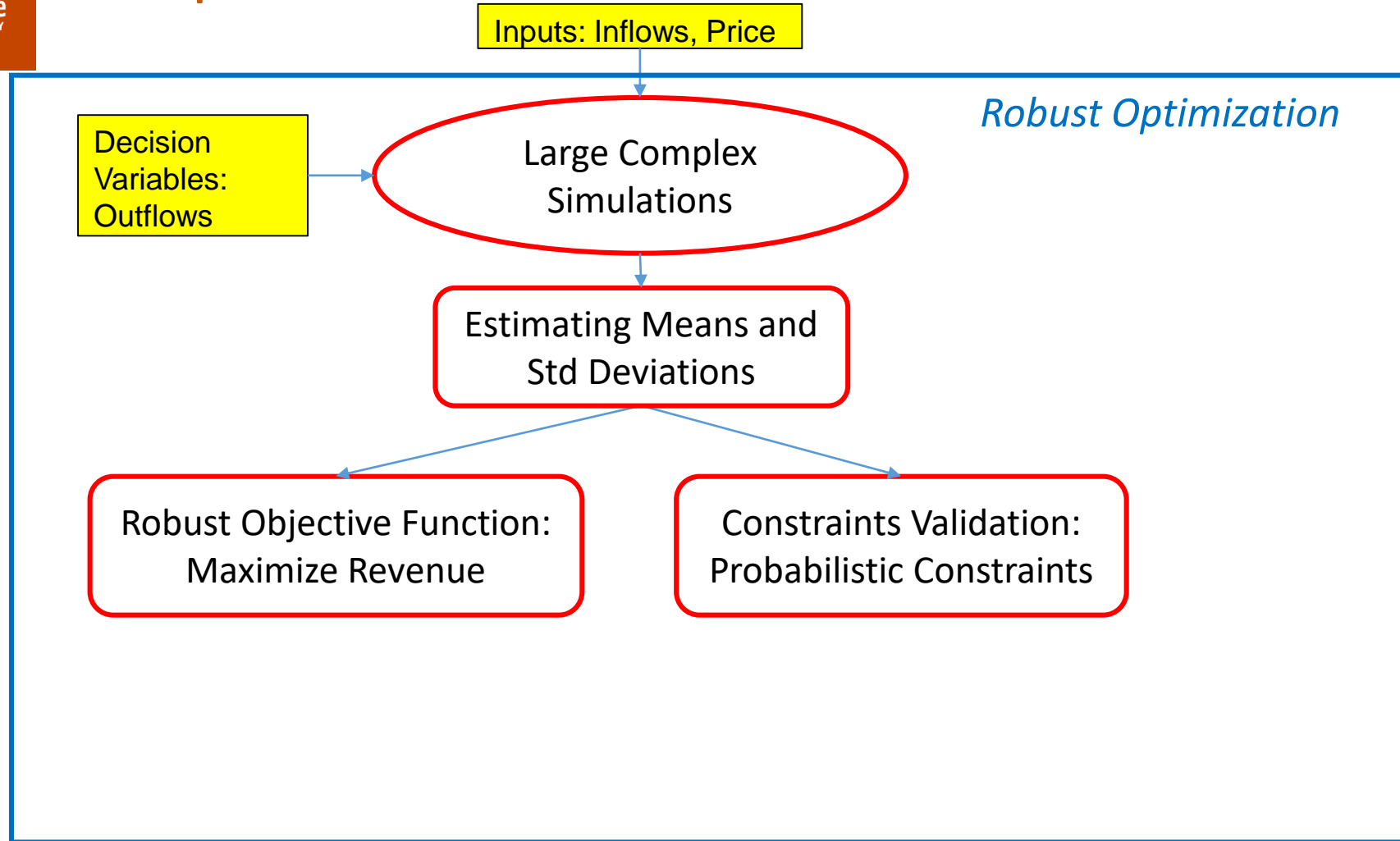
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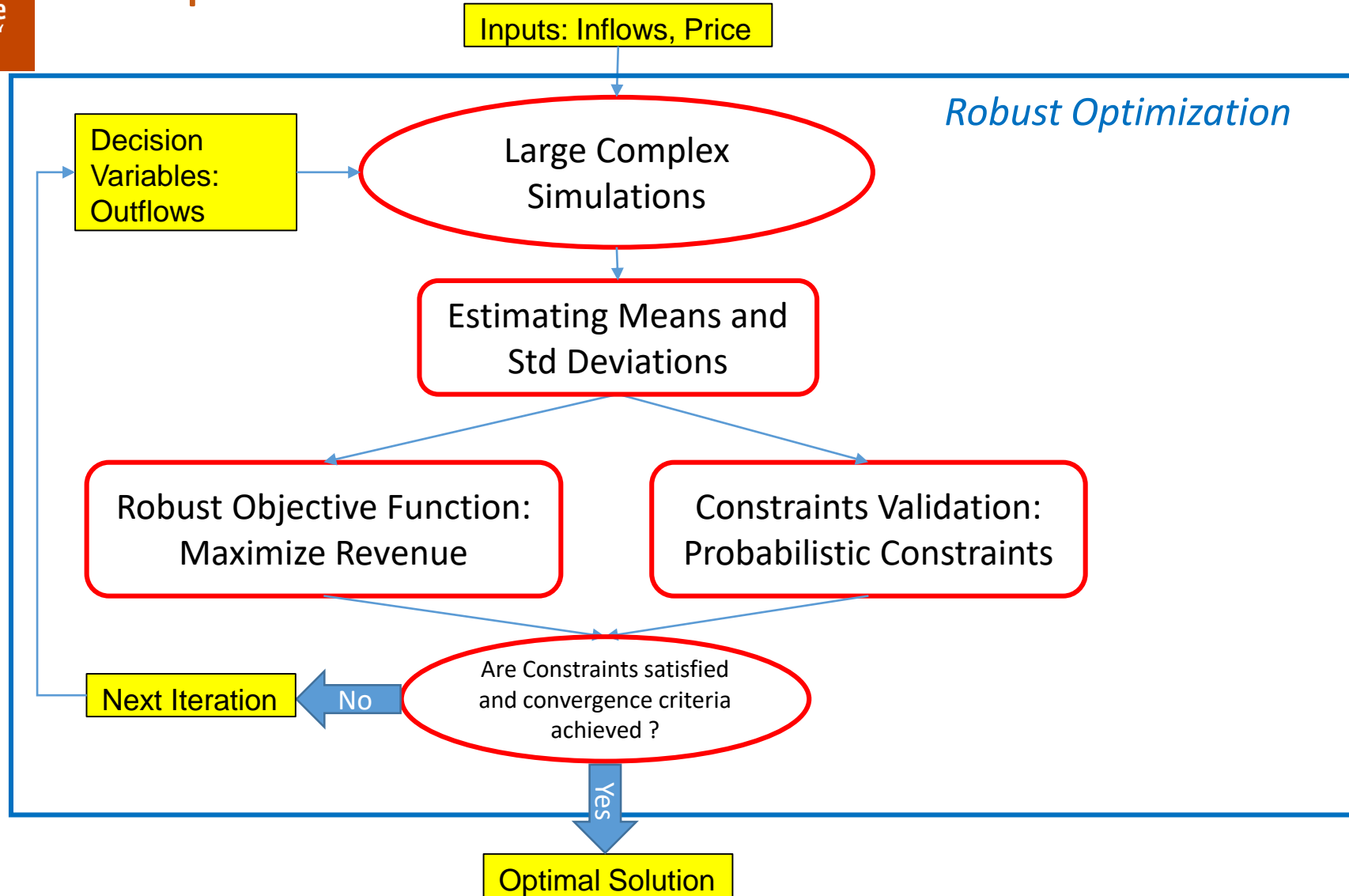
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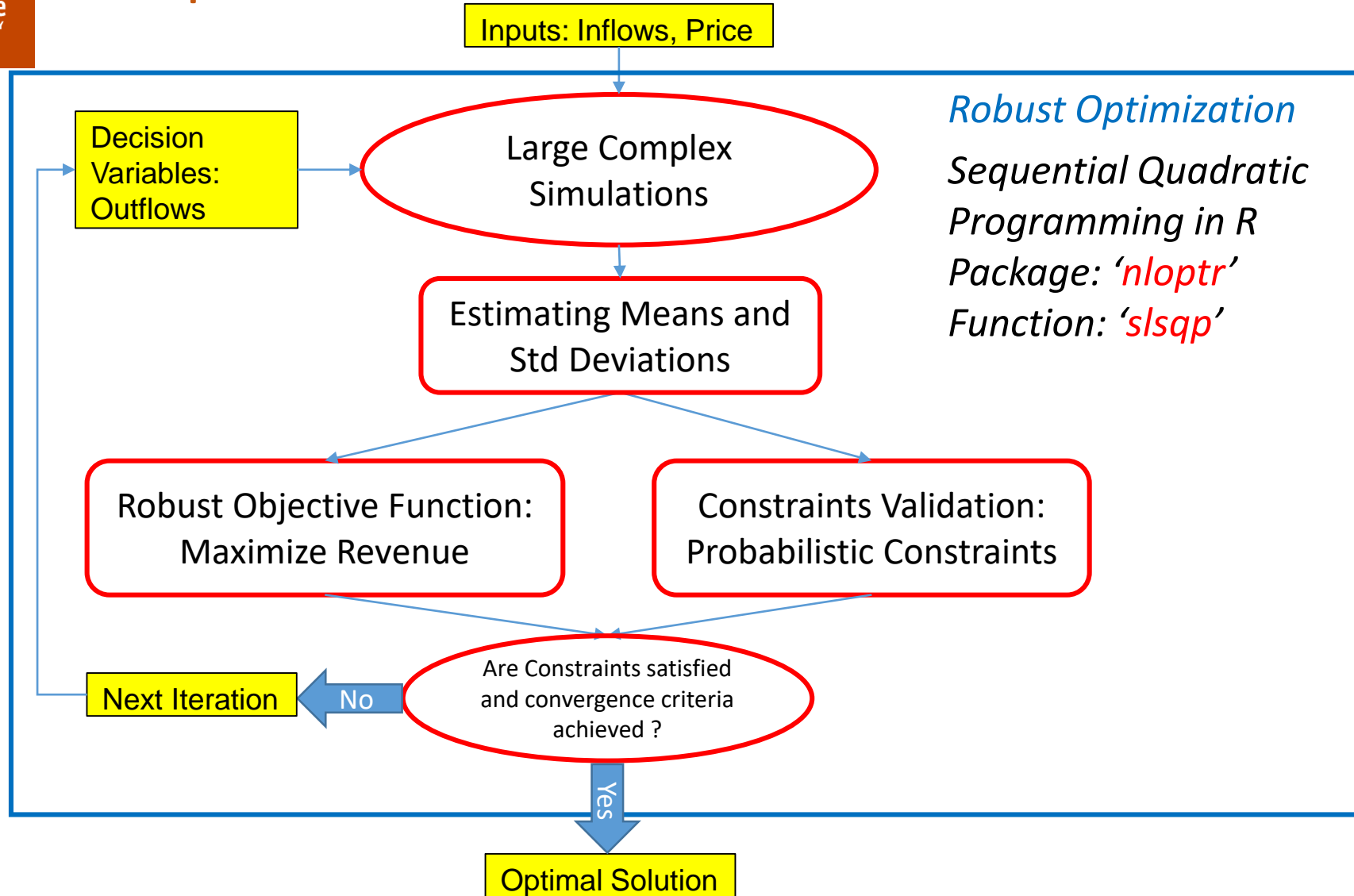


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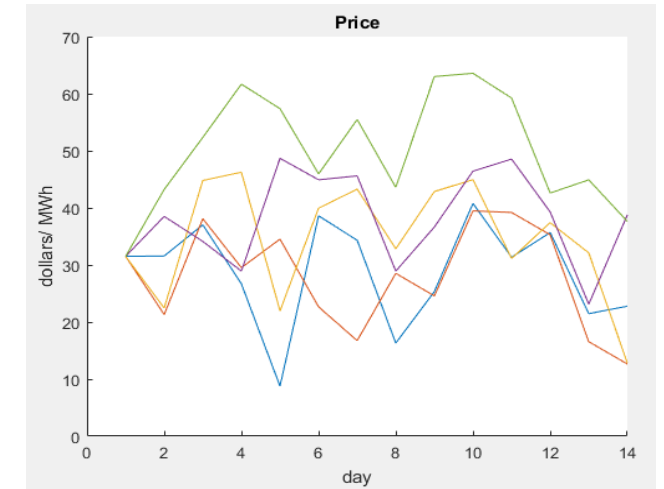
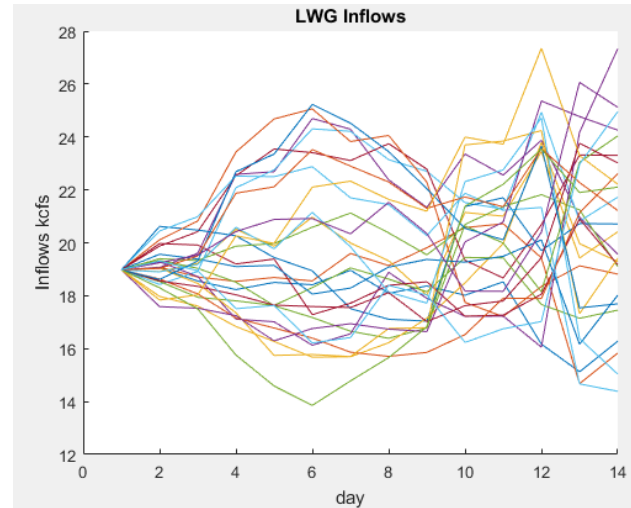
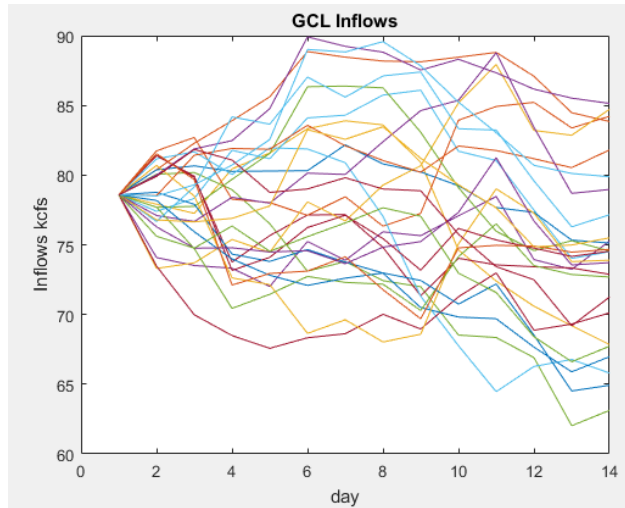


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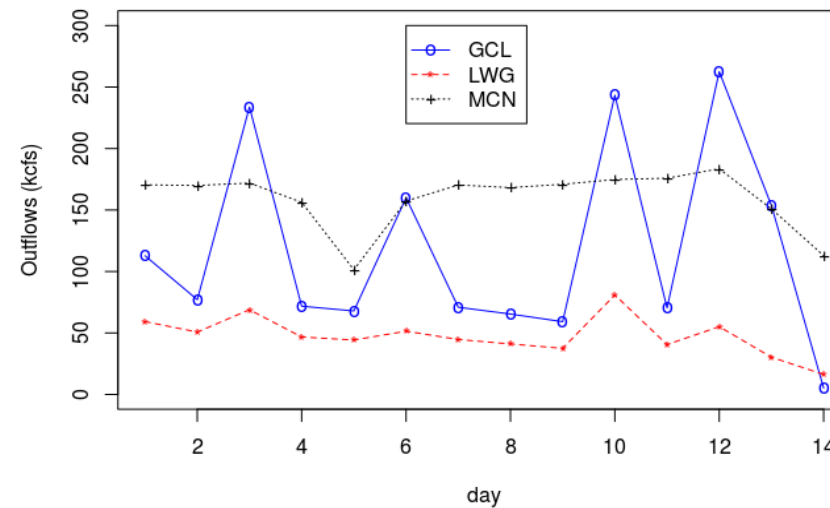


# RESULTS

**Reservoirs:** Grand Coulee, Lower Granite and McNaire



**Optimal Outflows**



# Challenges

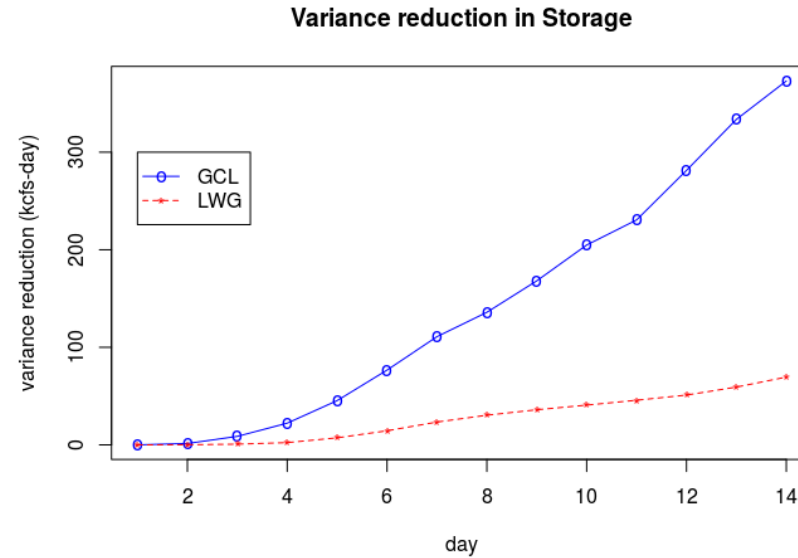


# Challenges



- **Antithetic Variable Approach** for efficient UQ and better decision

# COMPARISON



	MC approach	Antithetic variables approach
No. of simulations	500	100
Run-time per iterations (approx.)	128 s (Total time = 19 min approx.)	4.64 s (Total time = 8 min approx.)
Revenue (at optimal sol.)	\$88 M	\$88.9 M
Improvement in Revenue		\$0.9 M (1%)



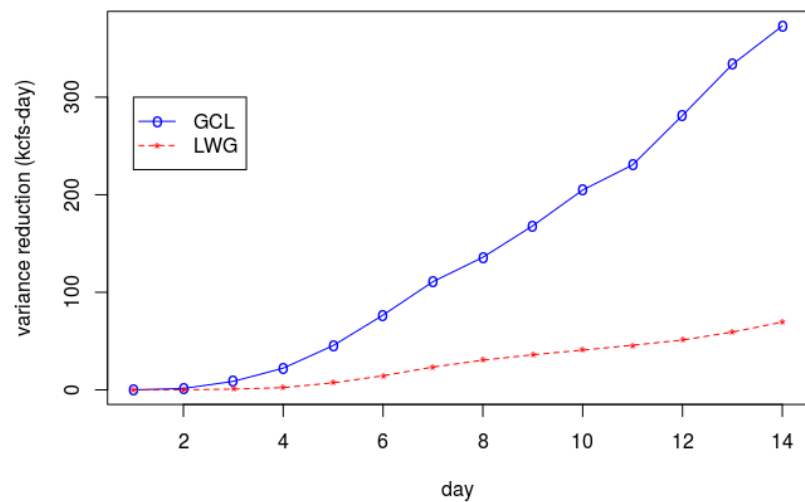
**Thank  
You!!!**

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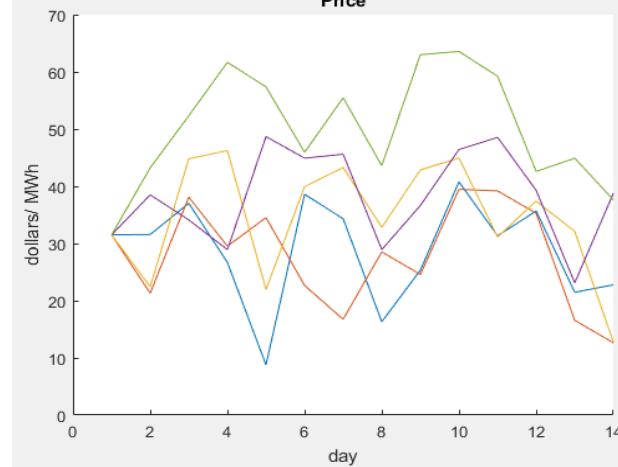


# COMPARISON

Variance reduction in Storage

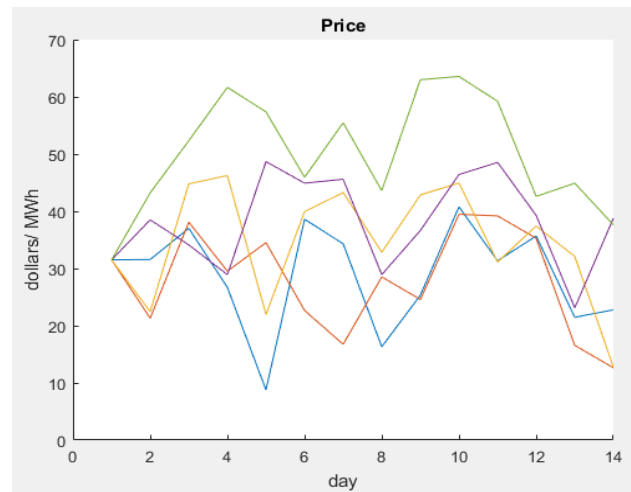
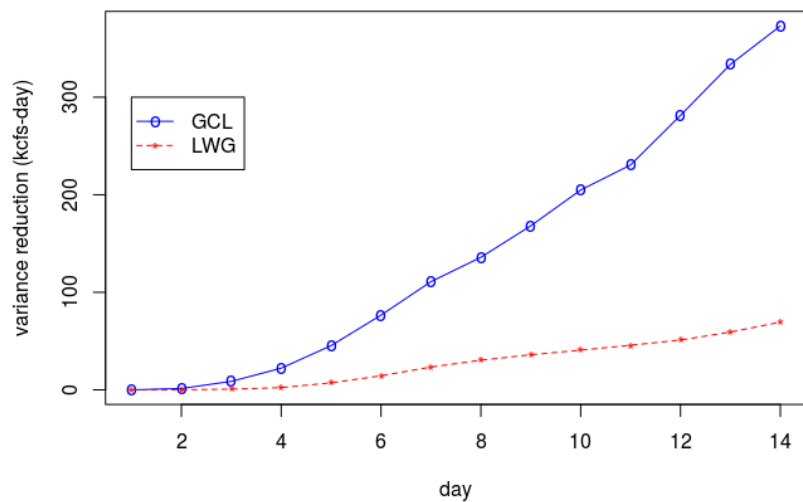


Price



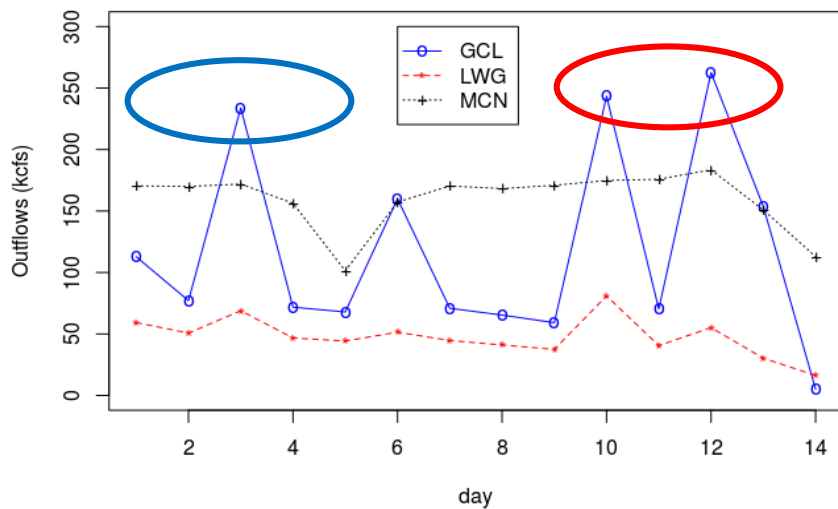
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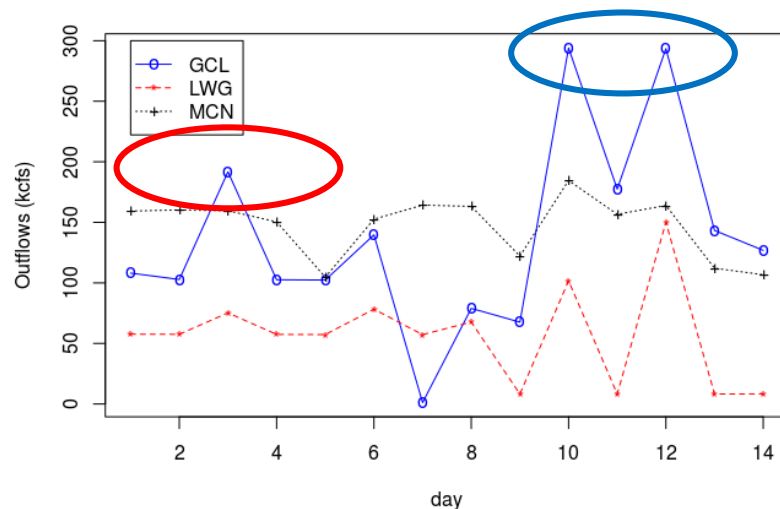
MC approach

Optimal Outflows



Antithetic variables approach

Optimal Outflows



lower

higher