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Industrial and Manufacturing Systems Engineering

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Resource Allocation under Deep Uncertainty, with Case Study of Deepwater Horizon

1. Objectives

- ❑ Model applied problems in decision analysis under deep uncertainty
- ❑ Provide decision makers with a recommended interval for allocating resources that guarantees a certain level of optimality

2. Deep Uncertainty

- Levels of uncertainty (Walker et al. 2013)
  - Level 4: Enumerate possible outcomes but no likelihoods
- Uncertain about (Lempert et al. 2003)
  - Appropriate models for interactions of variables
  - Probability distributions
  - Value the desirability of outcomes
- Model or structural uncertainty

3. Model Solution

- A decision maker may not follow an optimal point in reality
- A unique algorithm is proposed to find the interval. If decision maker allocates resource amount within the interval, economic losses (objective value) will be below threshold
- Interval provides decision maker with flexibility

Optimal Interval Determination

Minimize economic losses

↓ Uncertainty threshold

Calculate Intervals (one interval per uncertainty)

↓ Comparing with various models

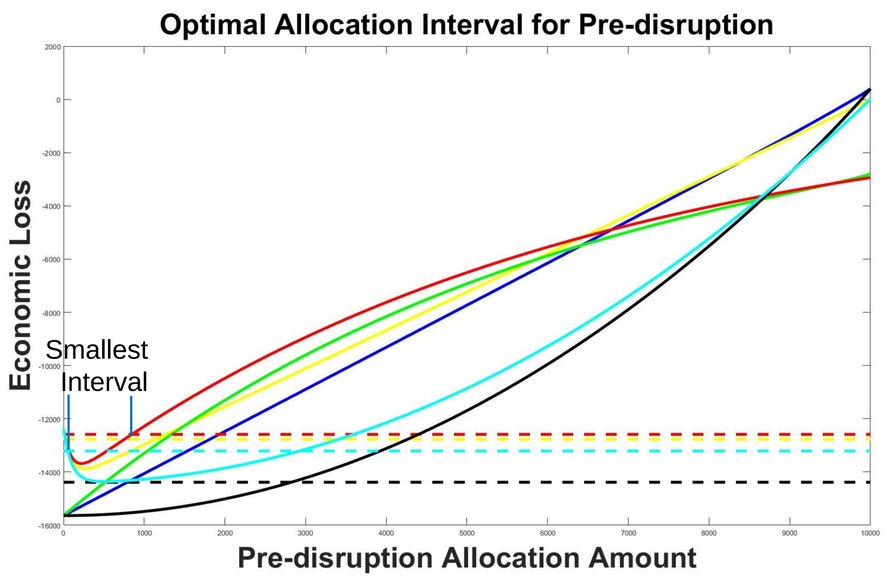
Find smallest interval

4. Deepwater Horizon Case Study

- Minimize economic losses from an oil spill
- Five coastal states: Florida, Alabama, Mississippi, Louisiana and Texas
- Resources allocated before disruption can reduce the probability of disruption and reduce the economic consequences
- Resources allocated after disruption reduces economic consequences

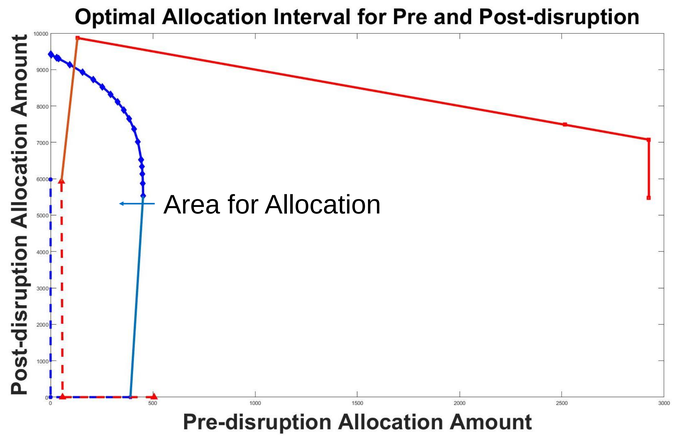
5. Interval for Allocating Resources before Disruption

- Optimization model to allocate resources before disruption
- Several different possible functions could be appropriate
- ***Result***: Decision maker should allocate resource between \$10 to \$570 million before a disruption



6. Interval for Allocating Resources before Disruption and after Disruption

- Optimization model to allocate resources before and after disruption
- ***Result***: Decision maker should allocate between \$53 and \$452 million before disruption, and \$0 to \$9080 million after disruption



7. Potential Benefits

- Interval helps decision maker to allocate resources and provides flexibility
- Interval incorporates uncertainty about model, parameters, and functions
- Interval provides solutions that are within threshold

Reference: Walker, W.E., R.J. Lempert, and J.H. Kwakkel, 2013. Deep uncertainty. In Encyclopedia of Operations Research and Management Science, S.I. Gass and M.C. Fu, eds. New York: Springer, pp. 395-402.

Lempert, R.J., S.W. Popper, and S.C. Bankes, 2003. Shaping the Next One Hundred Years: New Methods for Quantitative Long-Term Strategy Analysis, MR-1626-RPC, Santa Monica: The RAND

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