A Generalized Framework for Optimization with Risk

Damaris Zipperer &
Andrew Brown

Agenda

- Problem
- Overview of Results
- Methodology Review
- Further Applications
- Wrap-Up

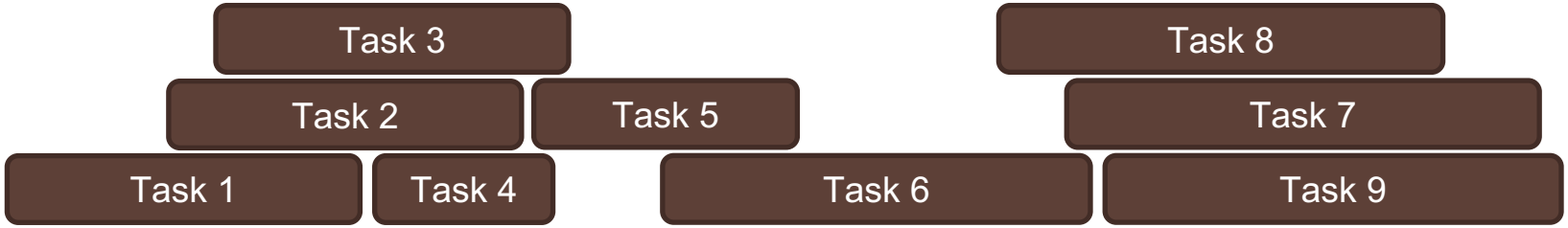
Background

Problem

- Long term forecasts
- Underlying risk
- Trying to optimize in volatile environments

Building a Schedule

So, which problem do we fix: cost or coverage?



Cost vs. Coverage

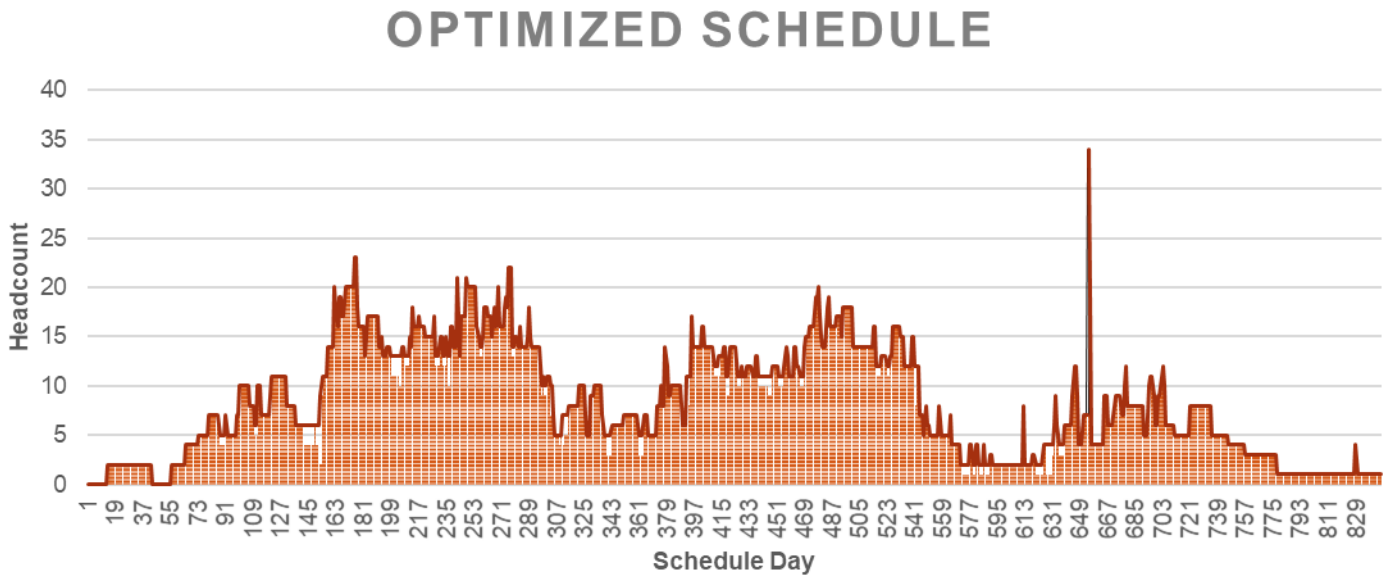
Cost ($):

Labor Cost (Including Extra Costs Due to Forecast Inaccuracy)

Coverage (%):

The chosen solution’s performance against the actualized schedule

Current Schedule Optimization isn't… Optimal



Results Overview

Deterministic Optimization Solution:

~62% Coverage, $770,000 Cost

Risk-Integrated Optimization Solution

Range of Cost/Coverage Options

At Equivalent Cost ($770,000), 84% Coverage

Creating a Deterministic Solution

Duration	Description
Block of Hours	One worker for one full day
6 Month	One worker for 130 Work days
7 Month	One worker for 152 Work days
8 Month	One worker for 174 Work days
9 Month	One worker for 195 Work days
10 Month	One worker for 217 Work days
11 Month	One worker for 239 Work days
12 Month	One worker for 260 Work days

	A	B	C	D	E	F
1	work_unit_	type	start_day	end_day	headcount	
2	1	3	625	626	3	
3	2	3	612	612	3	
4	3	2	221	226	2	

9574	62.99	
10942	62.89	
12309	63.12	
13677	63.03	
15045	62.95	
15858	60.99	

Creating a Deterministic Solution

Objective Function:

$$\sum_{j=1}^{m}\sum_{i=1}^{n} x_{i,j}\, c_j \;;$$

where m = total contract types and n = total schedule days

Costs for each contract type (j) are denoted as:

$$c_j$$

Decision variables of the model, x, planned hires, by day (i) and contract type (j) :

$$x_{i,j}$$

Cumulative Hires matrix:

$$y_{i,j}$$

Constraints:

$$x_{i,j} \geq 0$$

$$y_{i,j} \geq 0$$

$$\sum_{j=1}^{m} y_{i,j} \geq headcount\ requirement\ at\ day\ i$$

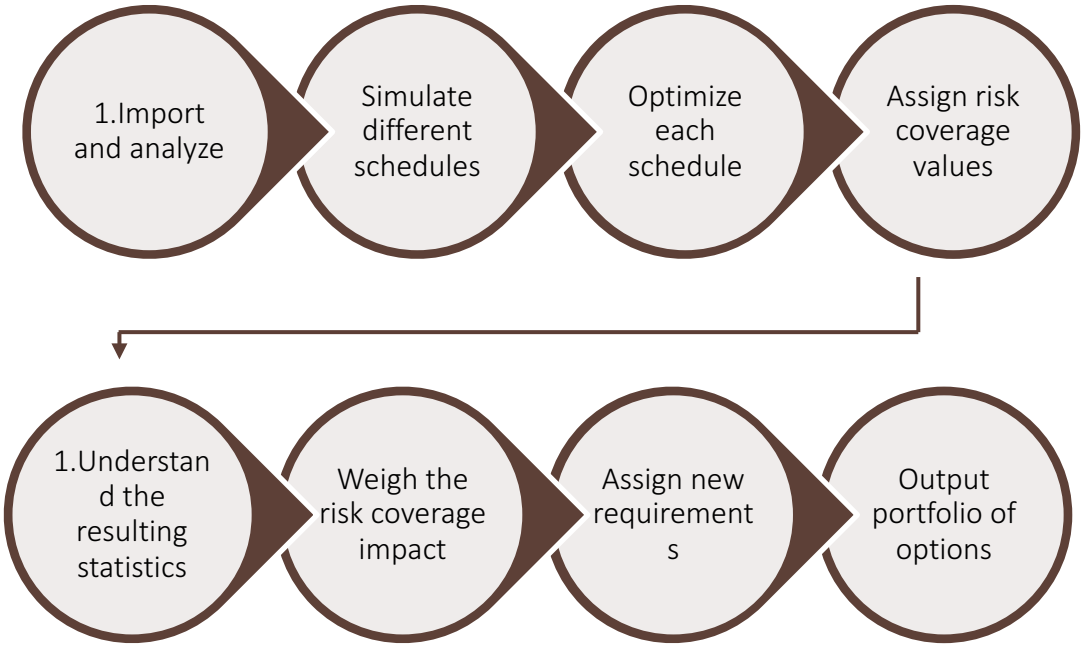
Defining How and Why Schedules Change

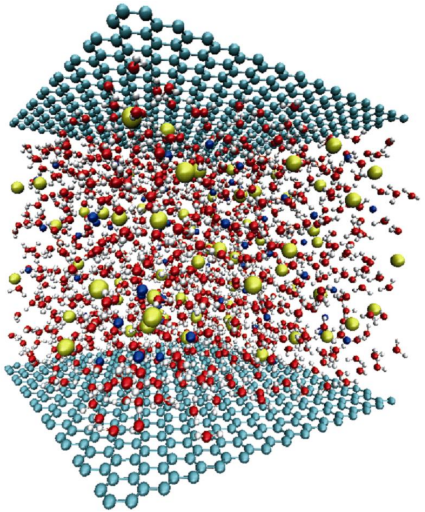
Risk Parameterization

- Which task types move
- What is the probability that they move
- Which direction do they move
- Are there interdependencies
- Are there tensions that must be preserved

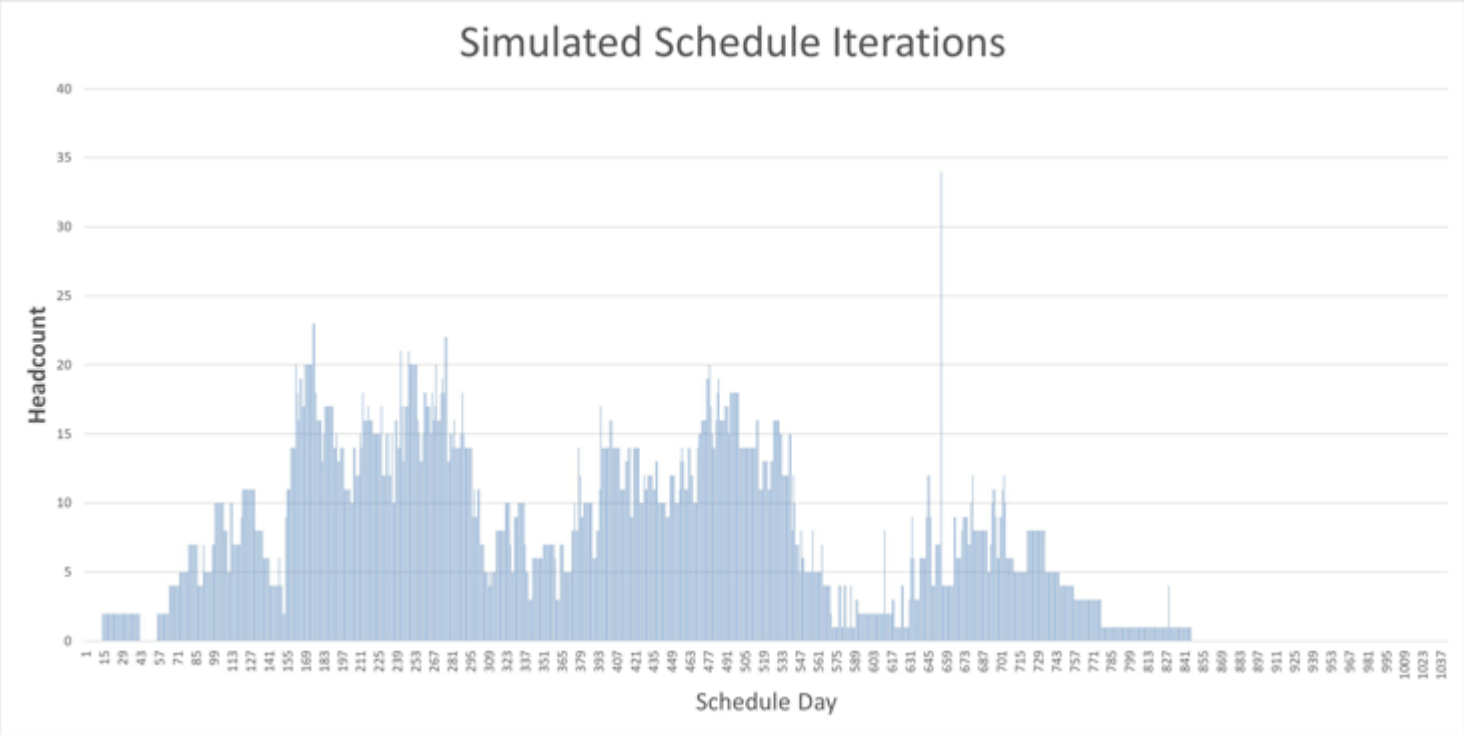
Using Historic Data

Simulation Tasks

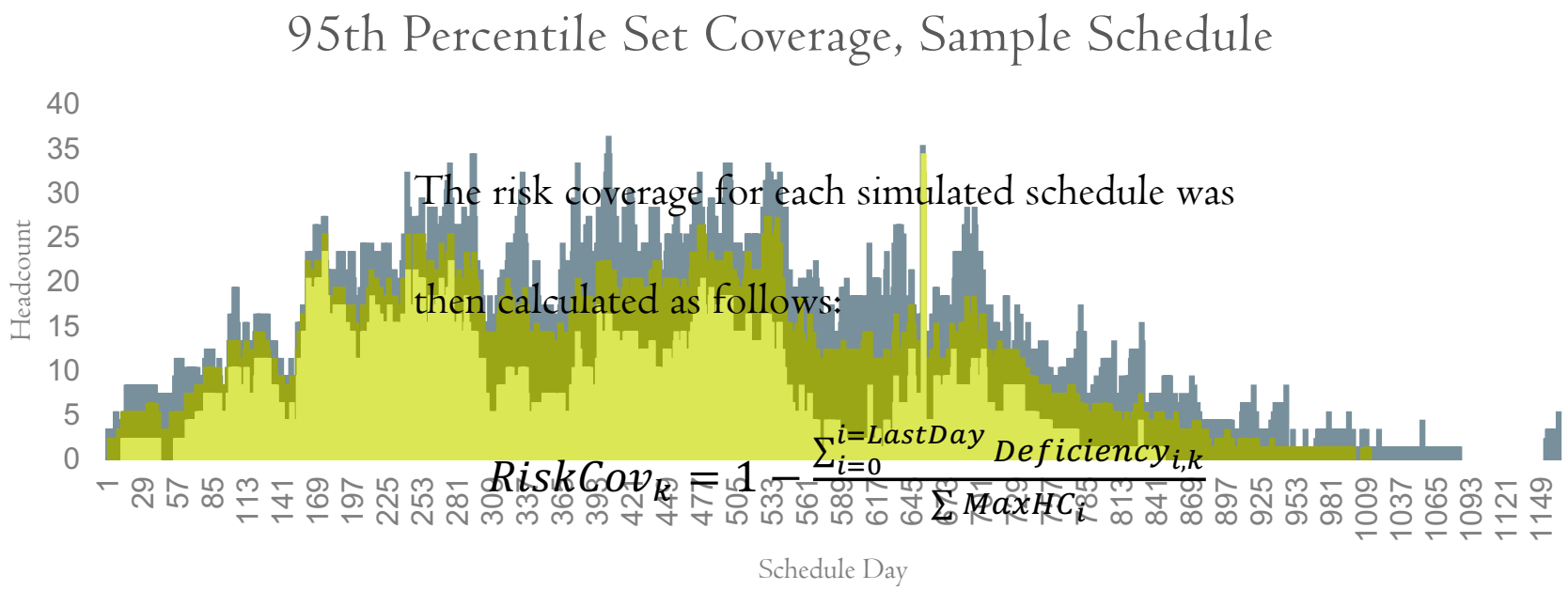




Using Risk to Simulate Schedule Iterations



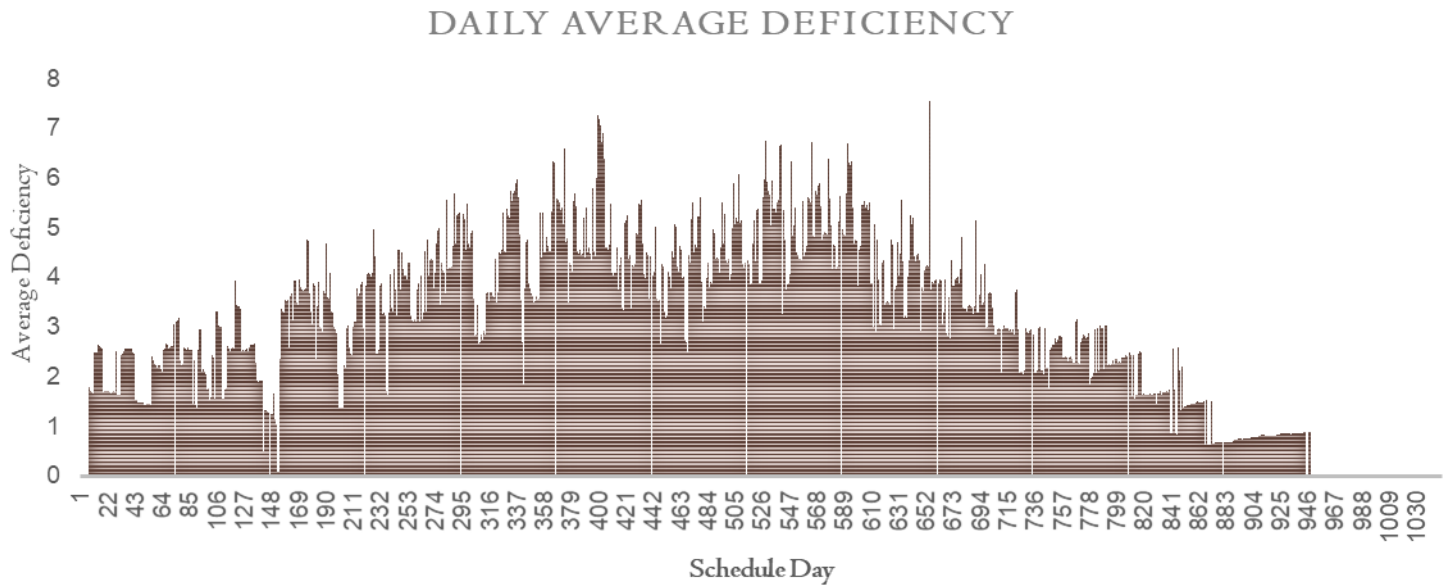
Risk Coverage Assessment



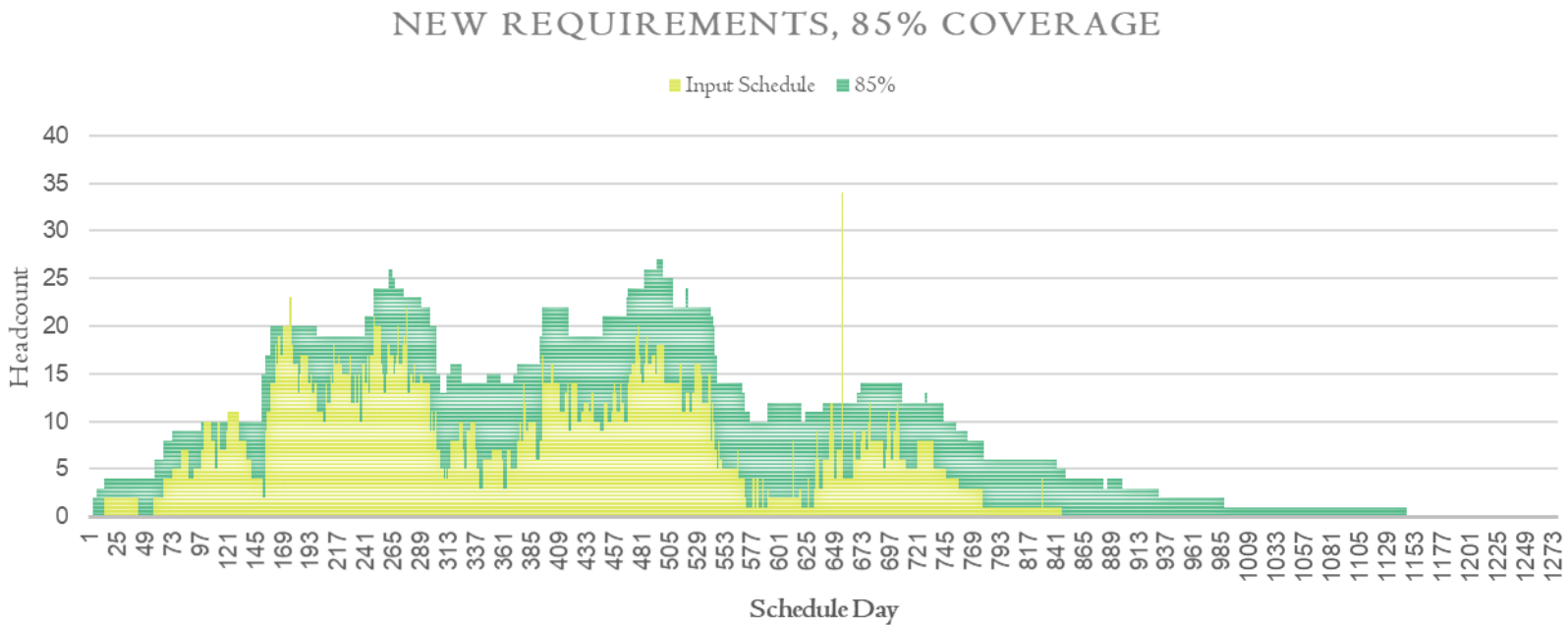
The risk coverage for each simulated schedule was then calculated as follows:

$$RiskCov_k = 1 - \frac{\sum_{i=0}^{i=LastDay} Deficiency_{i,k}}{\sum MaxHC_i}$$

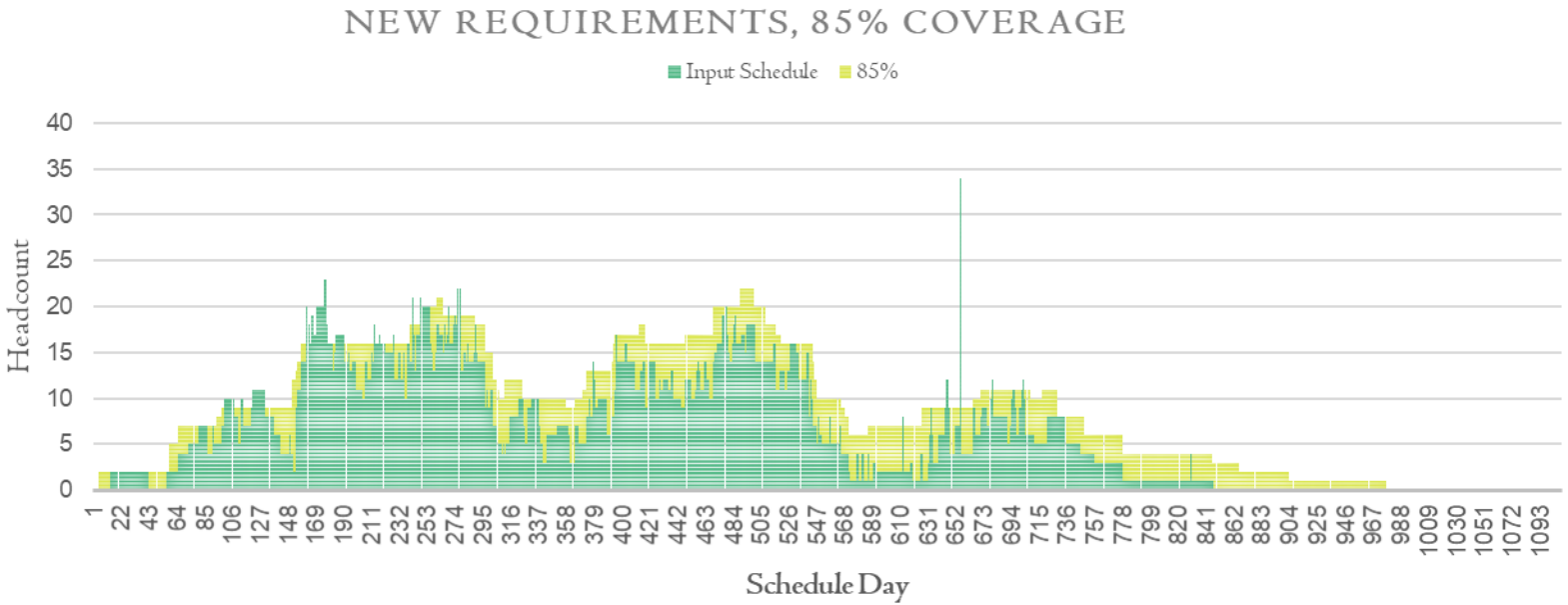
Risk Statistics



Bottom-Up Risk Integration

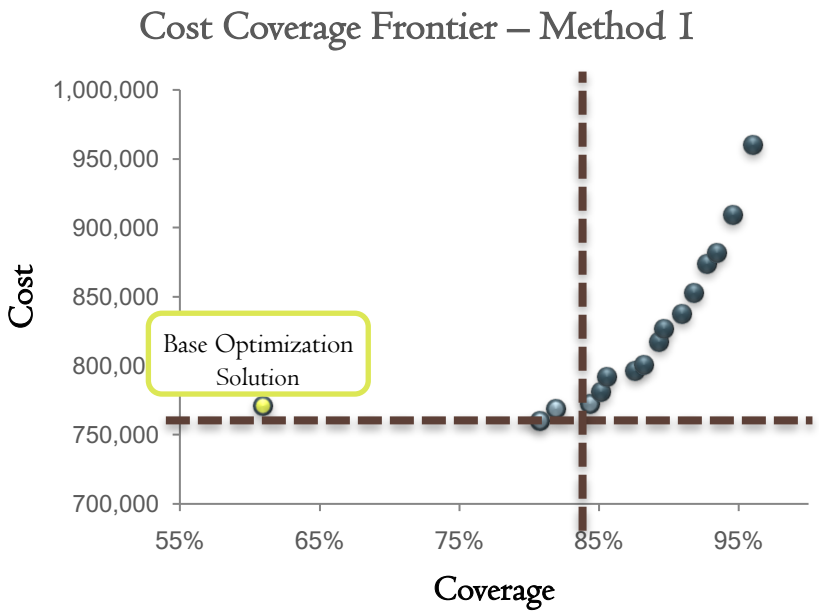


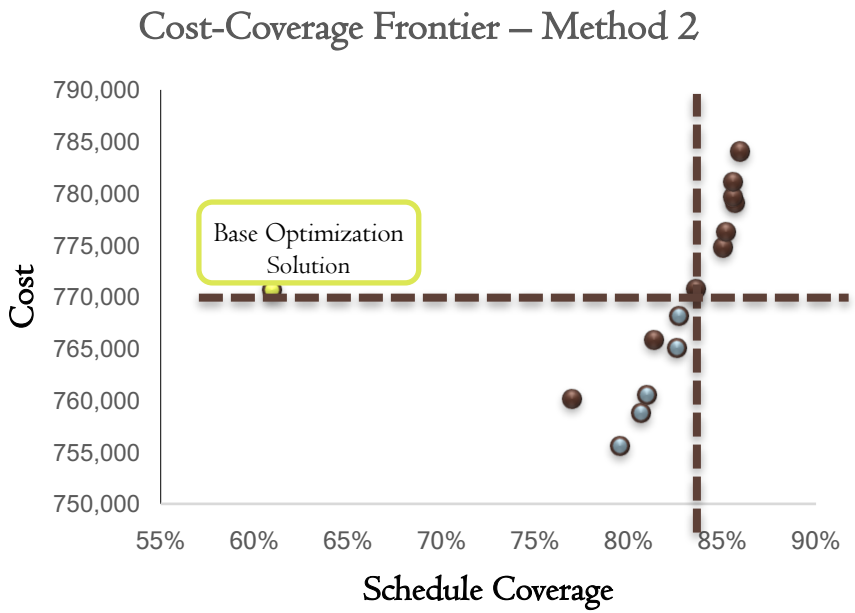
Top-Down Risk Integration



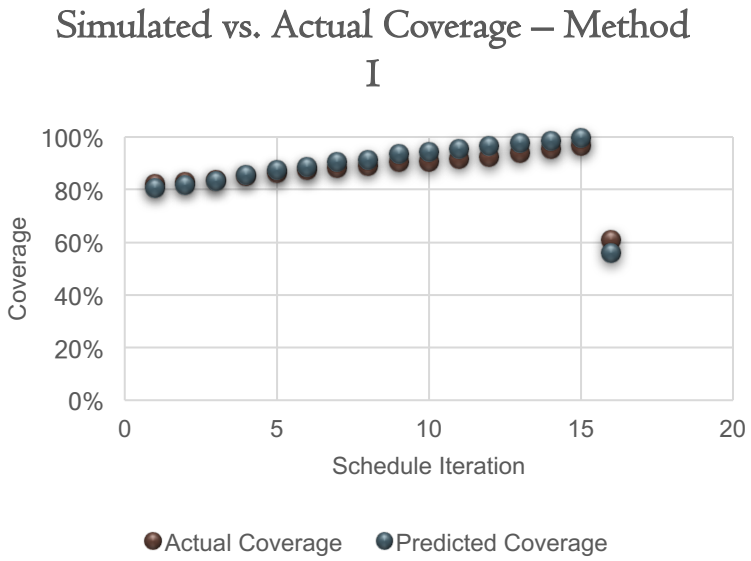
Results

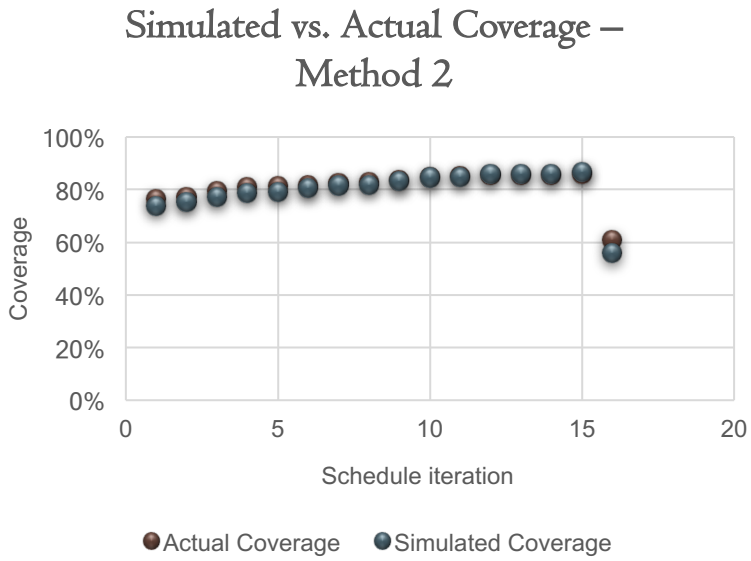
Cost-Coverage Frontier



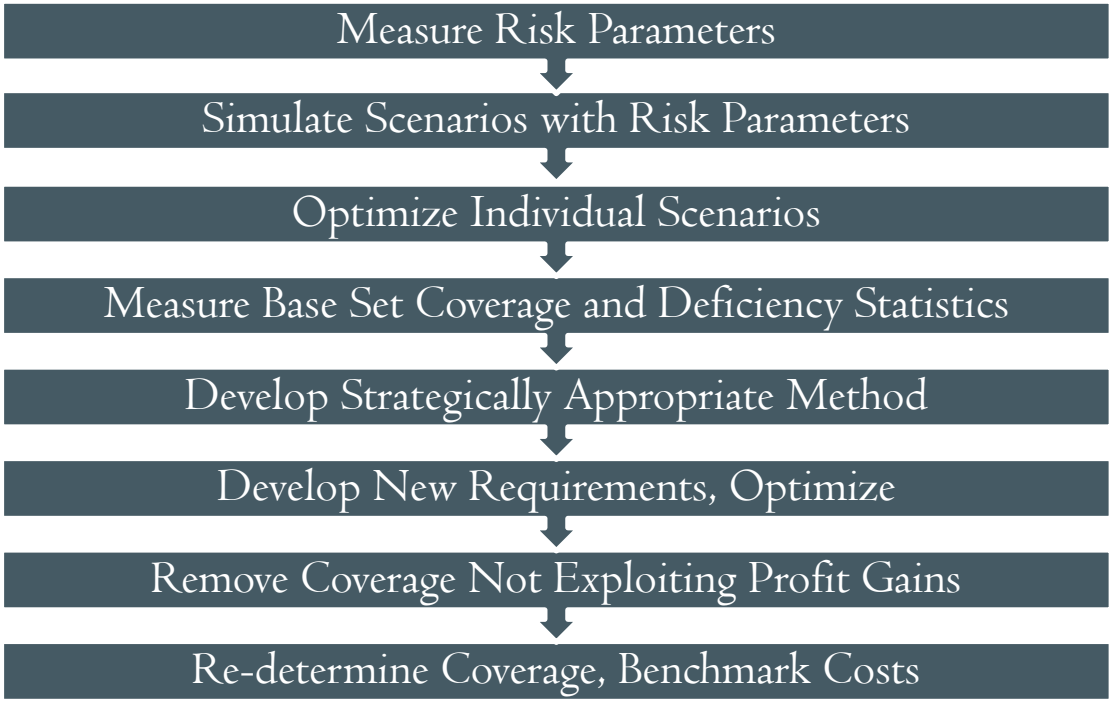


Coverage Assessment & Prediction





Generalized Framework



Further Applications

- Genetic Algorithms approach
- Applications for other S.C. functions
- Other Industries
- Method for situations without prior history

Any Questions?