2026 IISE Annual Conference

Operations Research Hackathon

By: Raneem Aldhirgham, Parker Coates, Matthew De Armas, William Vass

TEXAS A&M UNIVERSITY

Big Question:

"How can we optimally staff and schedule a mixed nursing home workforce?"

1. Research
2. Model
3. Verification of Results
4. Next Steps
5. Software Demo

Constraints

- No applicable union rules for Indiana nursing homes
- 8-hour shifts vs. 12-hour shifts
- RN must be onsite a minimum of 8 consecutive hours per day

Other Approaches

- Two-stage stochastic model chosen to separate long-term scheduling from short-term demand response
- Bayesian forecasting used to create new demand scenarios

SEIU HCII
Illinois ▪ Indiana ▪ Missouri ▪ Kansas

Motivating Principles

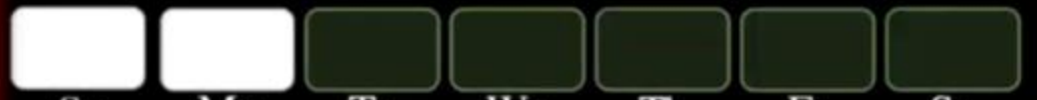
- Repeatable weekly schedule templates ensure staffing consistency and support regulatory compliance
- Quarterly schedule updates balance long-term staffing consistency with regular demand reanalysis
- Recourse staffing through agency/contract nurses provides flexibility during demand spikes without baseline operations

Two template families:

- 12-hour: 3 work days, then 4 days off
- 8-hour: 5 work days, then 2 days off

$Sch = \{Su12, M12, \ldots, Sa12, Su8, M8, \ldots, Sa8\}$

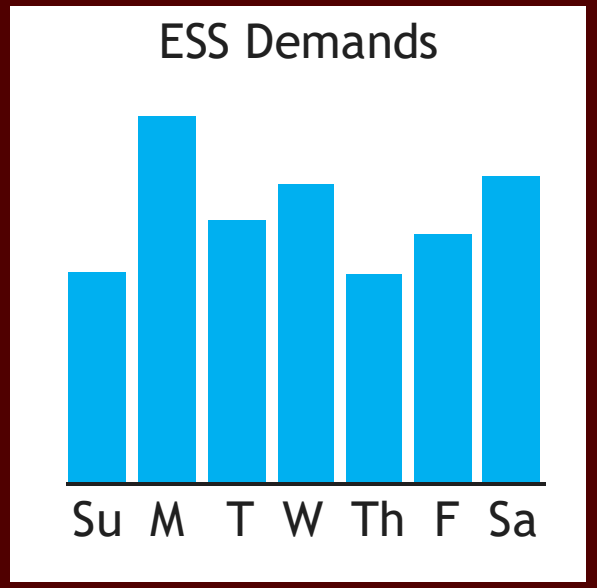
Example: T8 works Tue–Sat (off Su, Mo)



How It Works:

Find Expected Patient Demands

(Bayesian Forecasting)



1. Daily patient demands for the selected period are analyzed using 3 forecasting models:
   - Category-Weekday (CW)
   - Global Category (GC)
   - Total-Census Weekday (TC)

2. The results of the analyses are combined into a projected demand for each date in the period

$$Projected\ Demand = 0.75(CW) + 0.25(0.7(GC) + 0.3(CW))$$

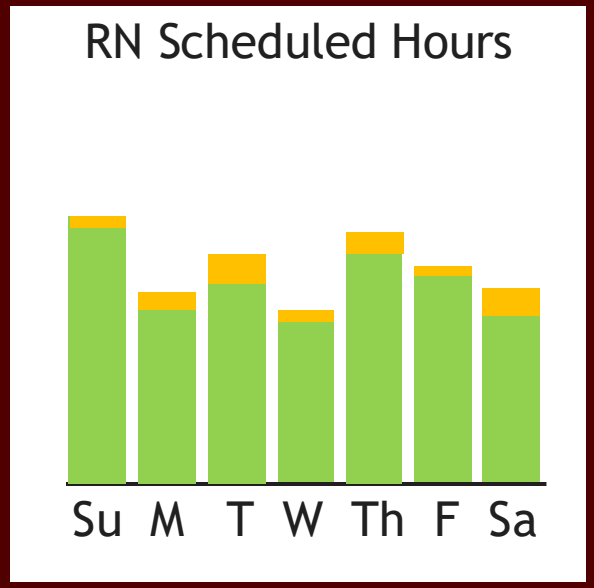
3. Projected patient demands are collapsed into AMPL-ready quantile-based scenarios

```
[ESS,*,*] :  1   2   3   4   5   6   7   8   9  10 :=
  Su   5  12  13  14  15  16  17  18  20  22
  Mo   5  11  13  14  15  16  17  18  20  22
  Tu   5  11  13  14  15  15  16  17  19  21
  We   5  11  13  14  15  16  17  18  19  22
  Th   5  11  12  14  15  15  16  17  19  21
  Fr   5  11  13  14  15  16  17  18  19  22
  Sa   5  11  13  14  15  16  17  18  19  22
;
```

How It Works:

Find Optimal Nursing Schedule

(2-Stage Stochastic Model)



4. Forecasted patient demands are converted to nurse-hour demands for each weekday

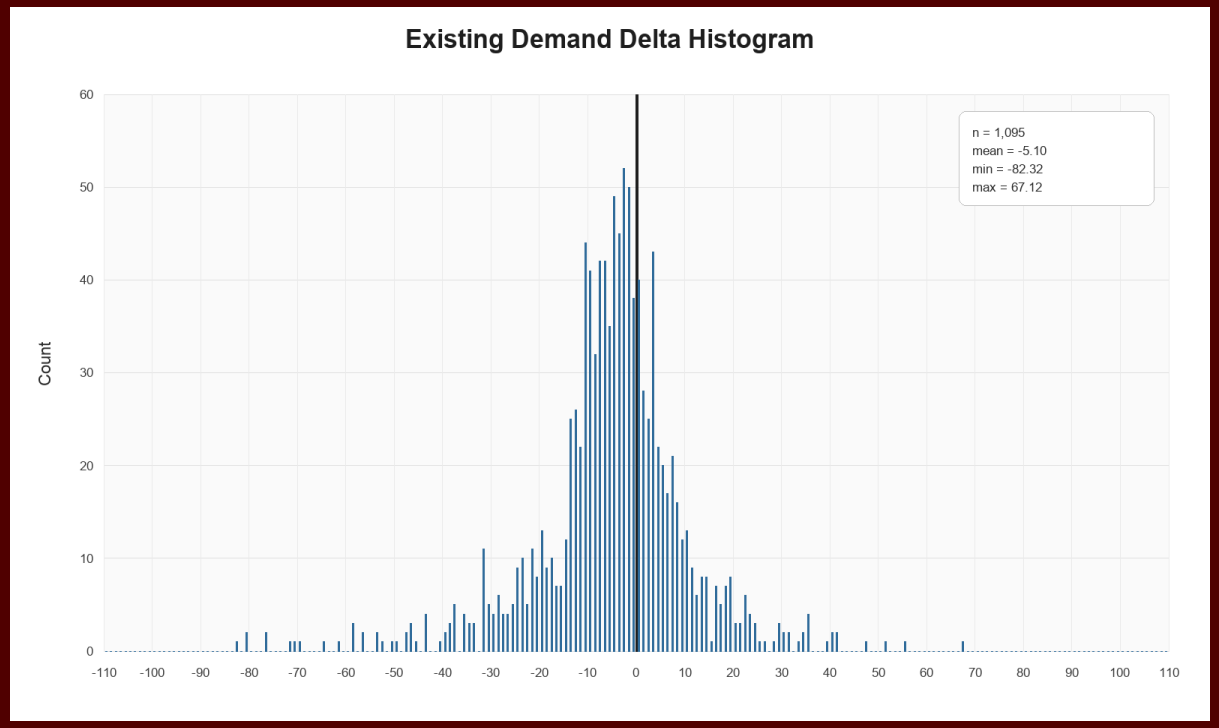
```
[RN,*,*] :  1      2      3      4      5      6      7      8      9     10 :=
  Su   65.2   91.4   98.8  104.1  109.5  115.3  121.6  128.0  136.4  149.2
  Mo   64.7   90.1   97.5  103.2  108.6  114.0  120.7  127.5  135.2  148.0
  Tu   66.0   89.7   96.8  102.5  107.9  113.4  119.8  126.6  134.1  146.9
  We   67.1   92.0   99.3  105.0  110.8  116.6  123.2  129.5  137.8  151.0
  Th   66.5   91.2   98.6  104.4  109.9  115.8  122.1  128.9  136.9  150.4
  Fr   63.8   88.5   95.9  101.2  106.7  112.0  118.4  125.1  132.5  145.8
  Sa   64.9   89.3   96.5  102.0  107.5  113.2  119.6  126.0  133.9  147.1
;
```

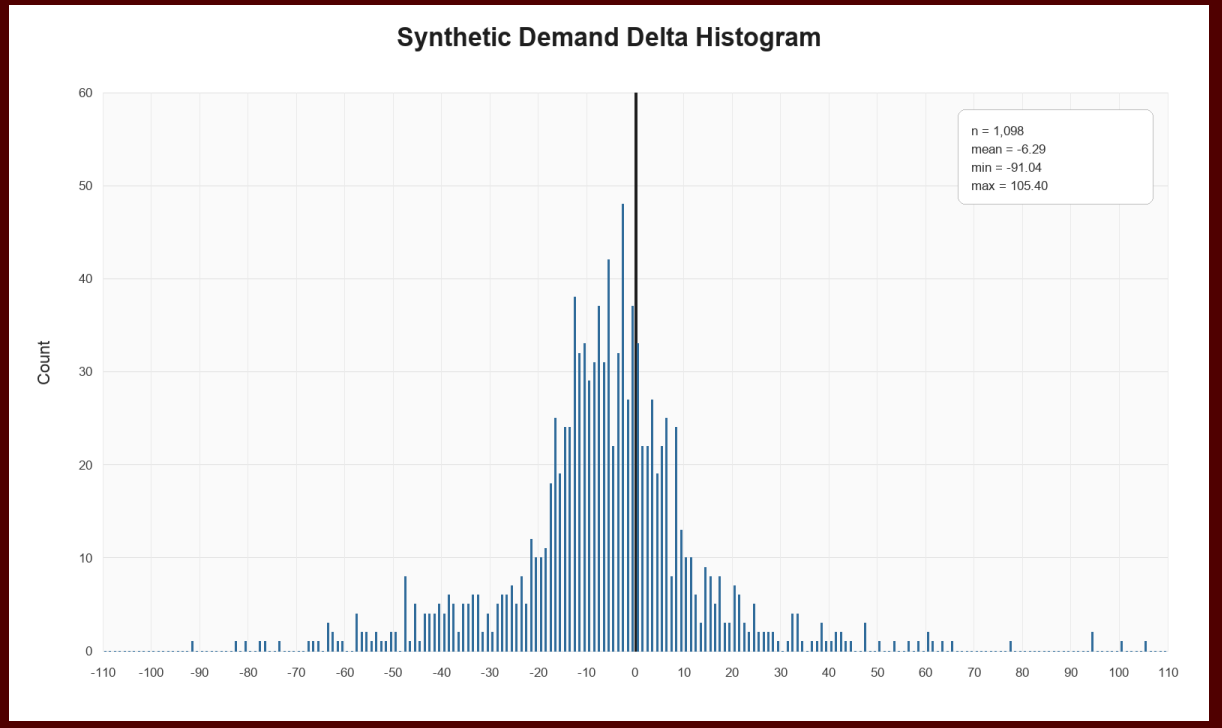
5. A cost-minimizing 2-Stage Stochastic Model identifies the most cost-effective scheduling scheme for meeting demand

$$\min (\text{full-time staffing costs} + \text{contract staffing costs})$$

6. The optimal first stage variable x[t, d] represents the schedule for full-time nurses that should be implemented

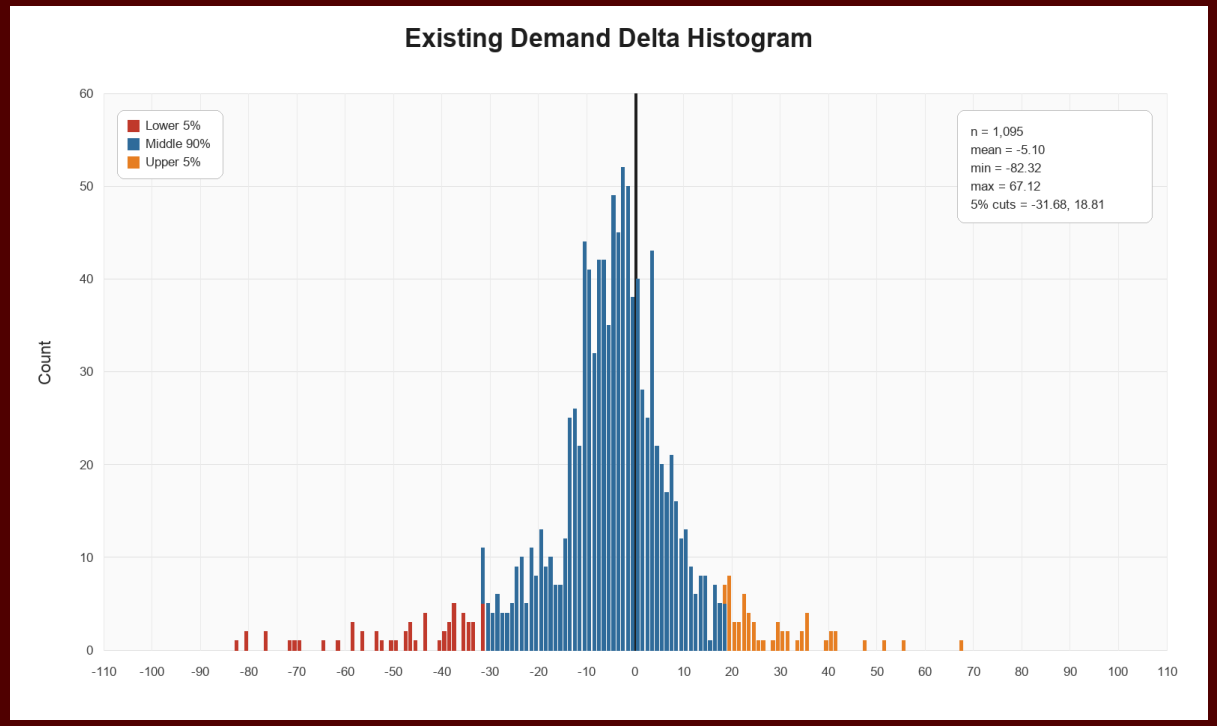
Validation + Performance





Validation + Performance

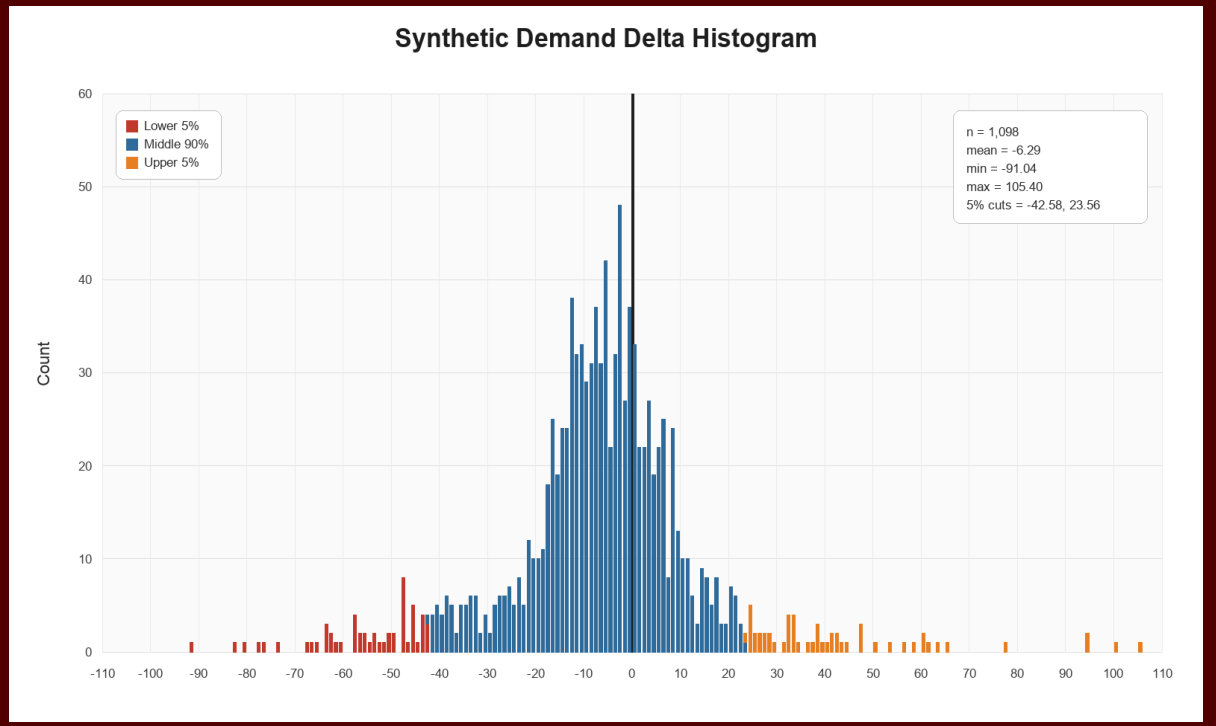
Total Staffing Costs: $5.33M



Total Tail Costs: $117k

2%

Total Staffing Costs: $5.08M

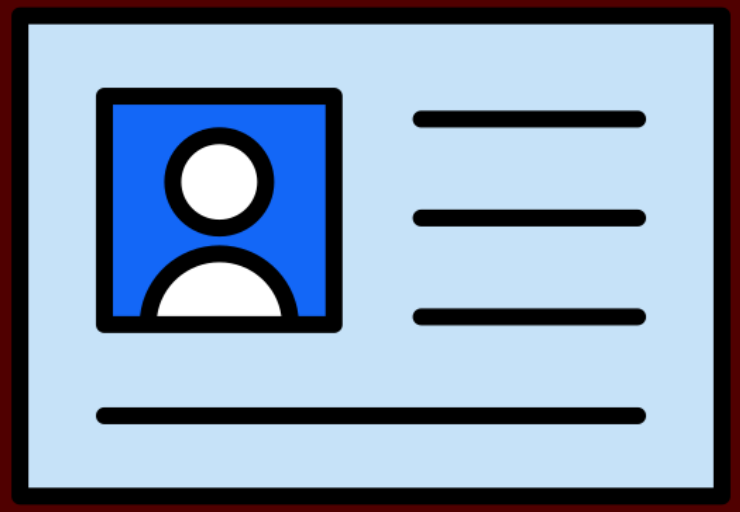


Total Tail Costs: $151k

3%

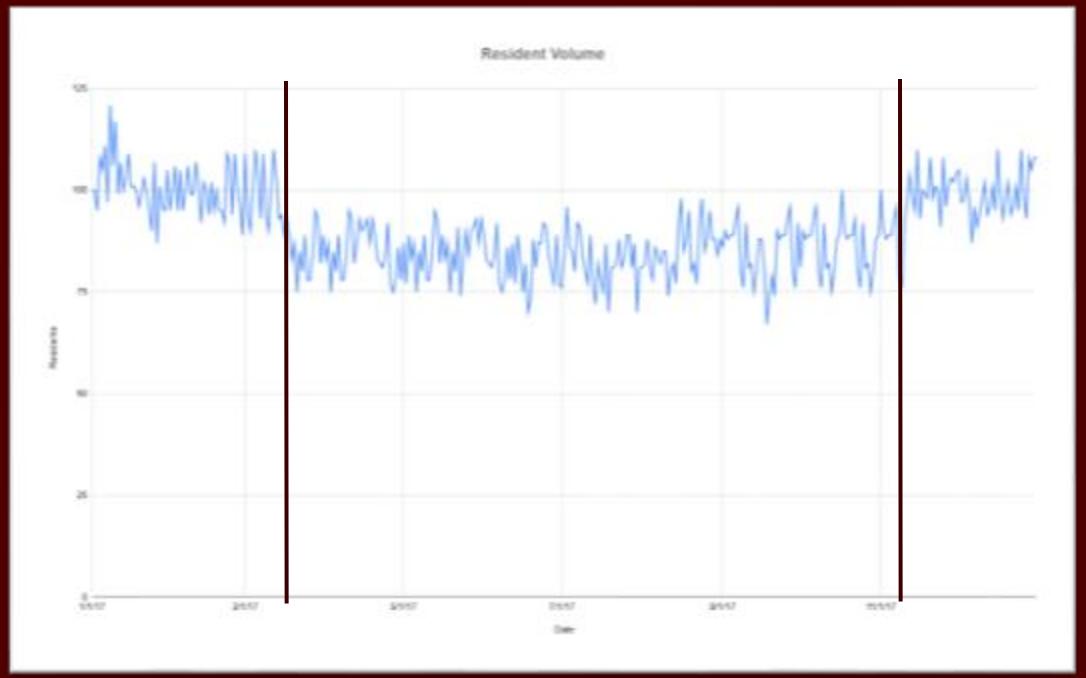
Nurse & resident ID Tracking

- Track nurse-resident interactions
- Quantify caregiver continuity & familiarity to strengthen relationships
- Enable resident-level assignment optimization in future model extension



Data Quality & Demand Accuracy

- Collect clearer operational data independent of legacy staffing practices
- Remove bias caused by historical understaffing / overstaffing patterns
- Improve forecasting accuracy for stronger recommendations



Software Demo