PROCEDURE PRICING OPTIMIZATION MODEL

DEVELOPED USING MIXED-INTEGER LINEAR PROGRAMMING (MIP) AND PYOMO

BLUE CROSS LOUISIANA – HEALTHCARE PRICE & TRANSPARENCY DATA ANALYTICS PROJECT

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OVERVIEW: WHAT THE MODEL DOES AND WHY IT MATTERS

- This project builds a Mixed-Integer Linear Programming (MIP) model using Pyomo and the CBC solver.

- Purpose: Optimize healthcare procedure reimbursement rates across providers while ensuring fairness and compliance.

- Who benefits: Blue Cross Louisiana pricing analysts and compliance teams.

- Value: Reduces total payouts, enforces consistent pricing, and maintains regulatory fairness.

OPTIMIZATION MODEL SUMMARY

- Objective:
- Minimize total reimbursement spending across all procedures and providers.

- Decision Variables:
- x[i,p] – price paid to provider i for procedure p.
- a[i,p,t] – binary variable for assigning provider i to a price tier t.
- x_min[p,r], x_max[p,r] – fairness bounds (lowest and highest price per region).

- Constraints:
- One tier per provider per procedure.
- Prices must fall within legal compliance bands.
- Enforce provider-specific minimums and regional fairness caps.
- Total spend must meet savings target relative to baseline.

EXAMPLE INPUT DATA (SIMULATED)

- Providers: 3 hospitals (Ochsner, Baton Rouge General, Lafayette General)
- Procedures: MRI and CT Scans
- Tiers: Low, Mid, High – represent allowed pricing levels per regulatory limits.
- Compliance Bands: 85%–115% of benchmark price.
- Provider Floors: Minimum price per facility to maintain fairness.
- Baseline Spend (S_0): $1.71M
- Savings Target: 3% ($\tau = -0.03$)

OPTIMIZATION RESULTS (TINY EXAMPLE)

- Baseline Spend: $1,710,000
- Optimized Spend: $1,568,000
- Savings: $142,000 (8.3%)

- Provider-Level Pricing:
- Ochsner → Tier 1 for MRI & CT ($800, $540)
- Baton Rouge General → Tier 1 for MRI & CT ($800, $540)
- Lafayette General → Tier 2 for MRI & CT ($900, $600)

- Fairness Spreads:
- MRI = $100 (cap $150)
- CT = $60 (cap $150)
- → All constraints satisfied.

DISCUSSION AND INSIGHTS

- Key Takeaways:
- MIP optimization effectively identifies cost-efficient yet fair reimbursement schedules.
- The model respects all regulatory, provider, and fairness constraints.
- Demonstrates data-driven pricing transparency for healthcare payers.

- Limitations:
- Small simulated dataset; real-world deployment would require scaling with provider network data.
- Does not yet include quality-based adjustments or multi-procedure interactions.

- Next Steps:
- Integrate real pricing and utilization data from transparency reports.
- Expand model to include region-specific and specialty-specific fairness targets.

TECHNICAL IMPLEMENTATION DETAILS

- Tools & Libraries:
- Pyomo (modeling framework)
- CBC solver (open-source MILP solver)
- Python (data handling, validation, and analysis)

- Model Type:
- Mixed-Integer Linear Program (MILP)

- Solver Parameters:
- Time limit: 60 seconds
- MIP gap: 0.001 (0.1% optimality tolerance)

- Runtime:
- Tiny test case solved in < 1 second.

SUMMARY

- This project demonstrates how MIP optimization can support Blue Cross Louisiana's pricing transparency and cost management goals.

- By combining analytics, regulatory logic, and optimization modeling, we can:
- Reduce spending while maintaining fairness.
- Enforce data-driven consistency in reimbursement rates.
- Build a scalable foundation for advanced health economics modeling.