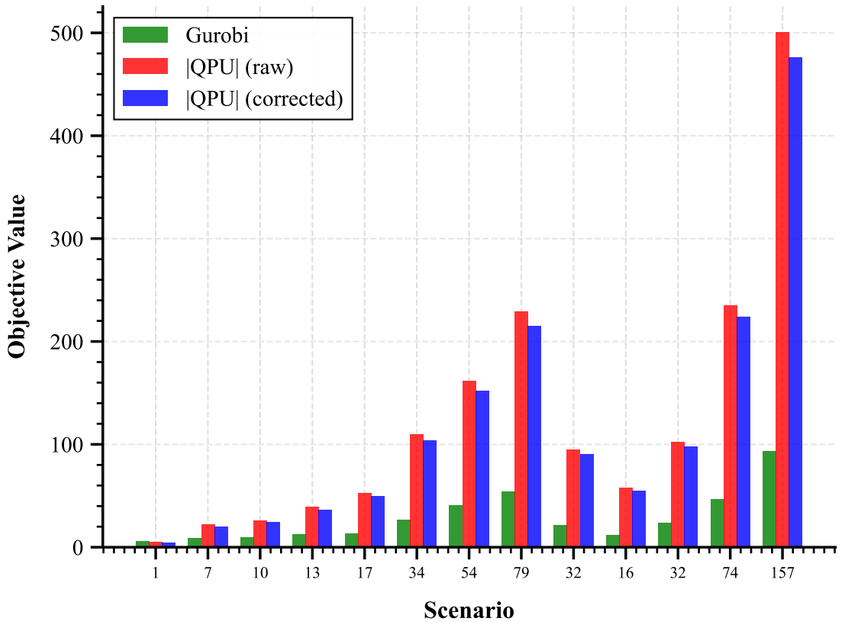
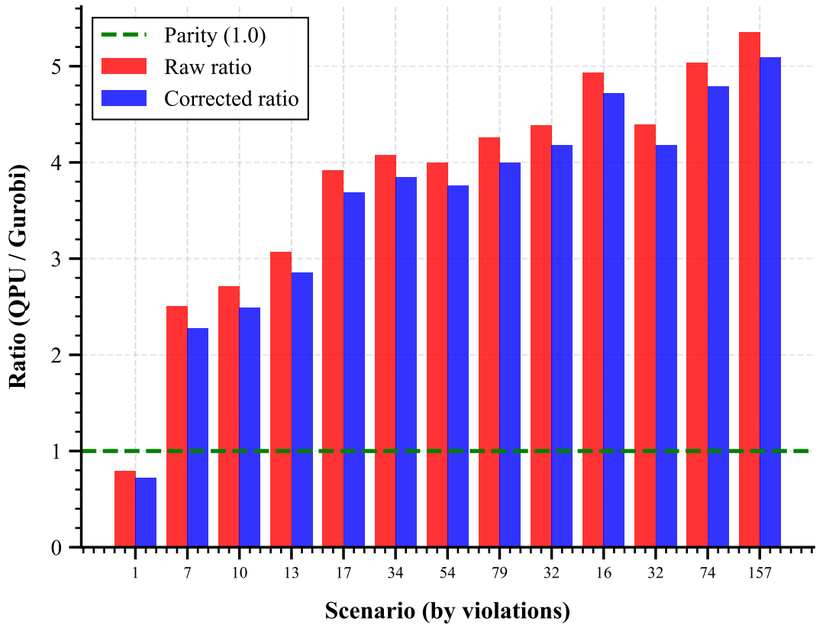
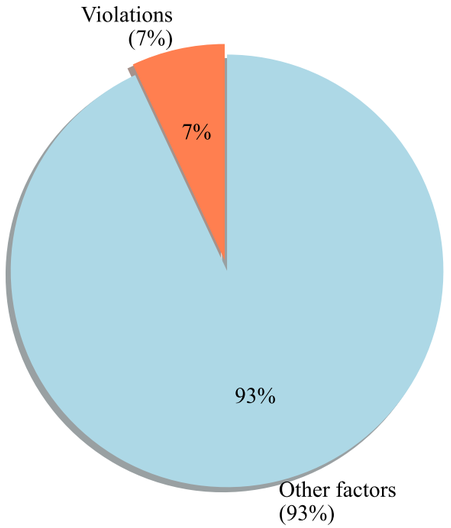
Objective Comparison: Raw vs Corrected



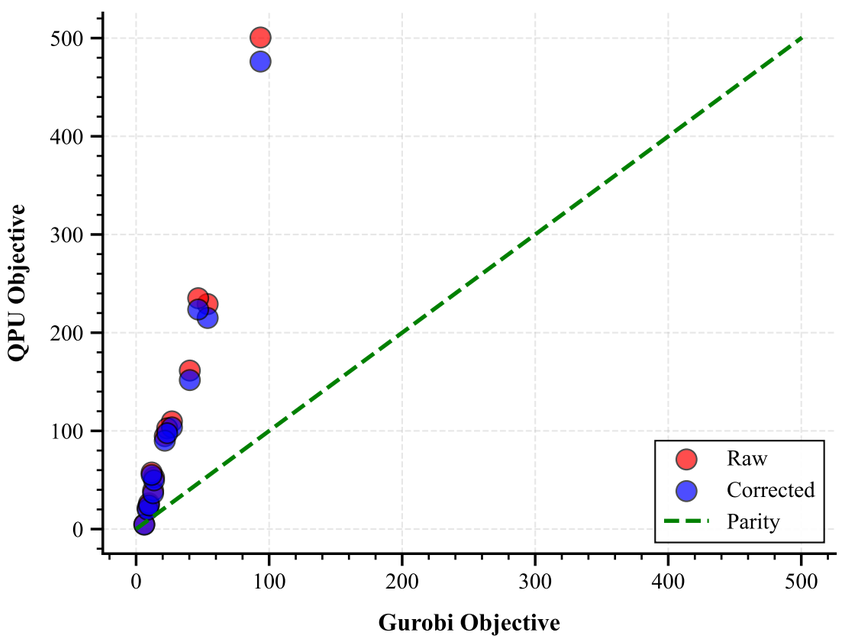
Ratio Analysis: Violations Have Minor Impact



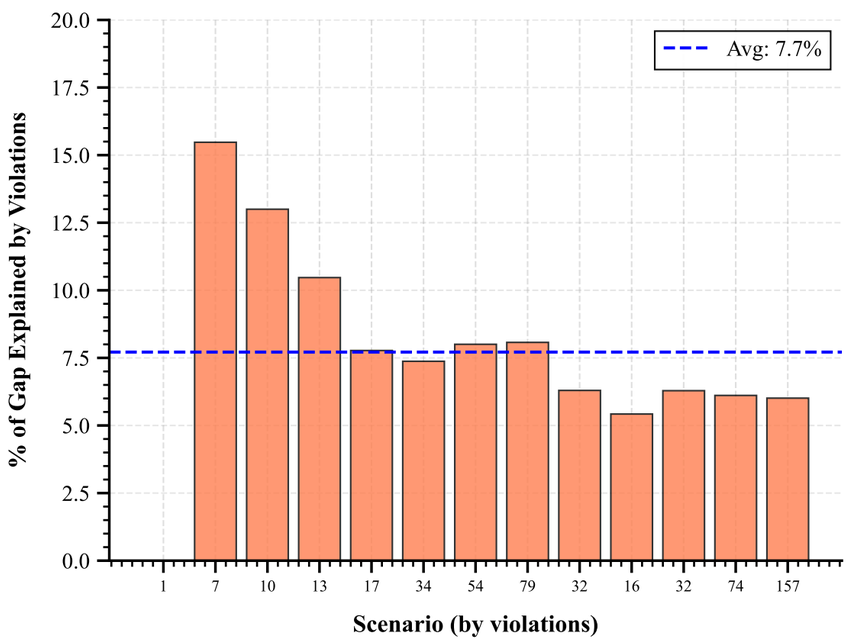
Gap Attribution



QPU vs Gurobi: Violation Correction Impact



Violation Impact by Scenario




```
DEEP DIVE FINDINGS

1. VIOLATION IMPACT IS MINOR
   - Violations explain only 7% of gap
   - Correction improves ratio from 3.80x to 3.58x
   - Still ~3.5x gap remains after correction

2. THE 93% UNEXPLAINED GAP
   Main causes (in likely order of importance):

   a) DECOMPOSITION APPROXIMATION
      Hierarchical method ≠ global optimization

   b) QUBO TRANSFORMATION
      Energy landscape differs from MIQP

   c) LOCAL MINIMA
      Quantum annealing may not find global min

   d) EMBEDDING NOISE
      Chain breaks and physical imperfections

3. KEY INSIGHT
   Fixing violations would NOT make QPU
   competitive with Gurobi on solution quality.
   The fundamental gap is algorithmic, not
   due to constraint satisfaction failures.

4. IMPLICATIONS
   - Post-processing repair has limited value
   - Better decomposition strategies needed
   - Consider hybrid classical-quantum approaches
```