
HEALTHCARE FACULTY SCHEDULING: PREDICTING STAFFING PREFERENCES

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SCHEDULING CHALLENGE

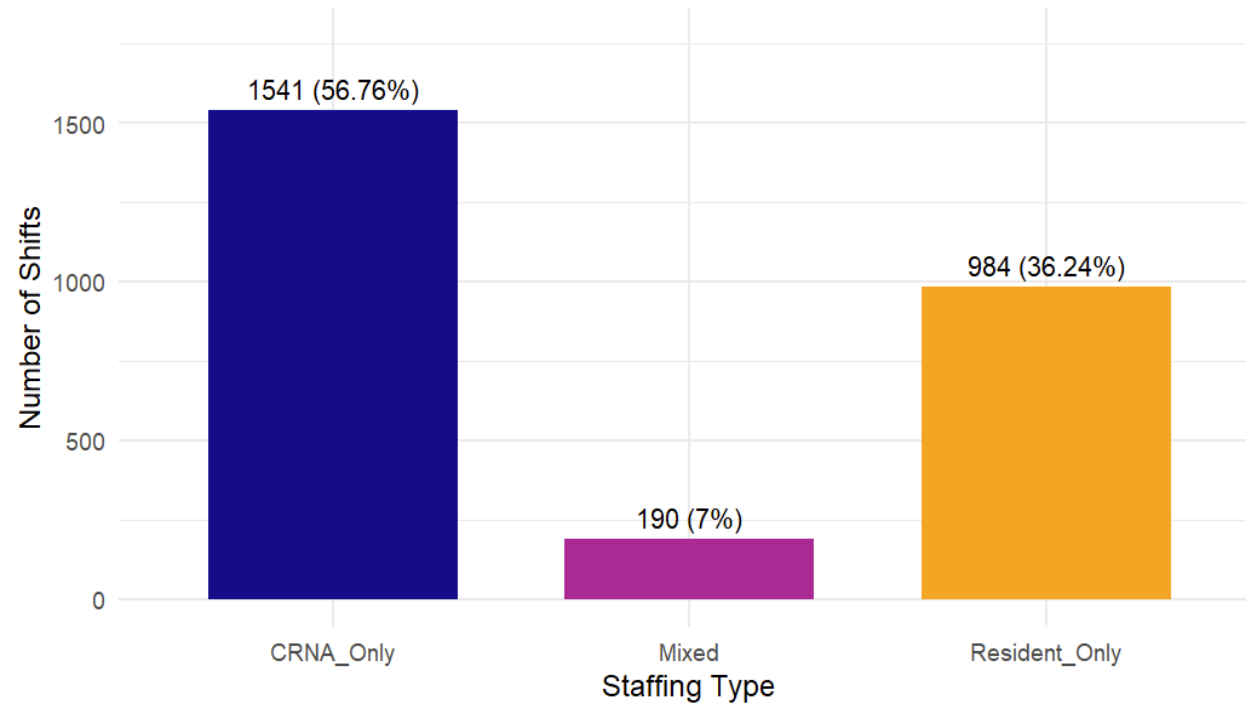
- Complexity
 - Coordinating 53 faculty with 80+ CRNAs and 80+ residents
 - Multiple operating rooms and shift types
- Why It Matters
 - Better staff matching improves patient outcomes
 - Higher satisfaction and reduced burnout
- Research Questions
 - Staffing Type- Do faculty prefer CRNAs only, residents only, or mixed teams?
 - Team Size- Do faculty prefer small (1-2), medium (3-4), or large (5+)?
 - Specific Staff- Which individual CRNAs does each faculty prefer?

DATA

- Key Statistics
 - 2,924 shift records
 - 53 unique faculty
 - 160+ CRNA and Residents
 - 1 year of data (August 2024-August 2025)
- Key Variables
 - Temporal: Date, weekday, holiday, shift type
 - Faculty: Experience, Team memberships, demographics
 - Staffing: 80+ CRNA columns, 80+ Resident columns (binary True/False)
- Key Challenge- Class Imbalance
 - CRNA only: 57%
 - Resident only: 36%
 - Mixed: 7%

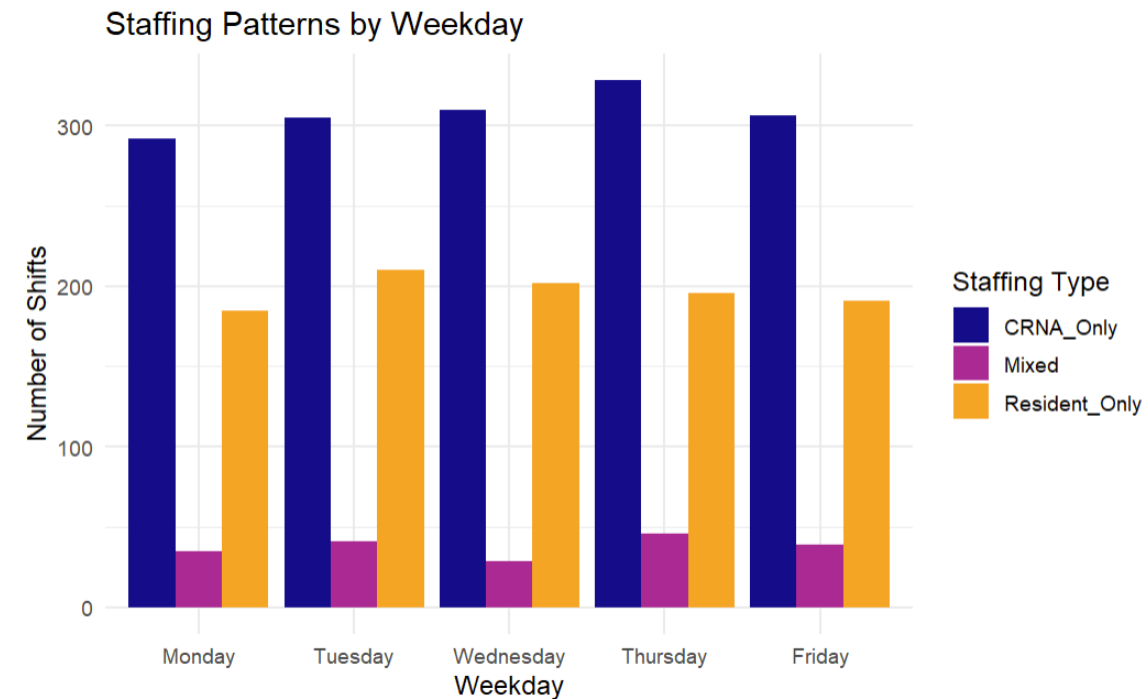
Distribution of Staffing Types

Data is highly imbalanced - Mixed staffing is rare (~7%)



EXPLORATORY DATA ANALYSIS

- Faculty Preferences Vary Significantly
 - FacultyQ: 100% CRNA only
 - Faculty31: 81% Resident only
 - FacultyE: 38% CRNA, 45% Resident, 17% Mixed
 - Chi-square test: $X^2 = 948$, $p < 0.001$
- Strong Room-Team Correlation
 - $R = 0.76$, $p < 0.001$
 - More rooms = larger teams
- Weekday has no effect
 - Chi-square: $p = 0.779$
 - Staffing consistent Monday-Friday
- Holidays have no effect
 - T-test: $p = 0.758$
 - Team sizes same on holidays vs regular days



FEATURE ENGINEERING

- Created Target Variables:
 - Staffing_Type: CRNA_Only, Mixed, Resident_Only
 - Team_Size_Category: Small (1-2), Medium (3-4), Large (5+)
 - CRNA Pairing: Binary indicator for each top CRNA
- Temporal Features:
 - WeekdayNum (1-7)
 - Holiday indicator
 - Shift duration (7-3 vs 7-5)
- Key Predictors – Faculty Historical Features:
 - Hist_CRNA_Only_Rate (% of shifts with CRNA only), Hist_Mixed_Rate, Hist_Resident_Only_Rate , Hist_Avg_Team_Size, Hist_Avg_CRNA, Hist_Avg_Resident
- Availability Metrics:
 - Avg_CRNA_Count, Avg_Res_Count, Avg_Room_Count
- Data Split: 80% training (n=2,116), 20% test (n=530)

MODEL 1 – STAFFING TYPE PREFERENCES

- What Worked: All models beat baseline by 16+ percentage points
- Limitation: Mixed class (only 7% of data) cannot be predicted - 0% sensitivity
- Key Insight: All three methods found identical solutions - relationship is linear

Model Comparison Table:

Model	Accuracy	Kappa
Logistic Regression	90.9%	0.76
LDA	90.9%	0.76
SVM (Radial)	90.9%	0.76
Baseline	74.3	0.00

Performance by Class:

Class	Sensitivity	Prevalence
CRNA_Only	96.7%	74%
Resident_Only	84.2%	23%
Mixed	0%	3%

MODEL 2 – TEAM SIZE PREFERENCES

- Key Findings:
 - Models beat baseline by 21 percentage points
 - Room count ($r=0.76$) strongly predicts team size
 - Historical faculty patterns are strong predictors - Large teams too rare (<1%) to predict

Model Comparison Table:

Model	Accuracy	Kappa
Logistic Regression	91.9%	0.80
LDA	91.9%	0.80
SVM (Radial)	91.9%	0.80
Baseline	70.8%	0.00

Performance by Class:

Model	Sensitivity	Prevalence
Small (1-2)	82.1%	28%
Medium (3-4)	96.8%	71%
Large (5+)	0%	<1%

MODEL 3 – SPECIFIC CRNA PREFERENCE

- The Challenge: Extreme Class Imbalance
 - Each CRNA works with any given faculty only 4-6% of shifts
 - A model predicting "no pairing" every time achieves 95%+ accuracy
- What Made It Work:
 1. Class Weights - Penalize missing TRUE cases more heavily
 2. Random Split - Ensures all faculty in train & test sets

Initial Approach (Failed):

Model	Accuracy	Sensitivity
Logistic Regression	95.3%	0%
SVM	95.3	0%
Baseline	95.9	0%

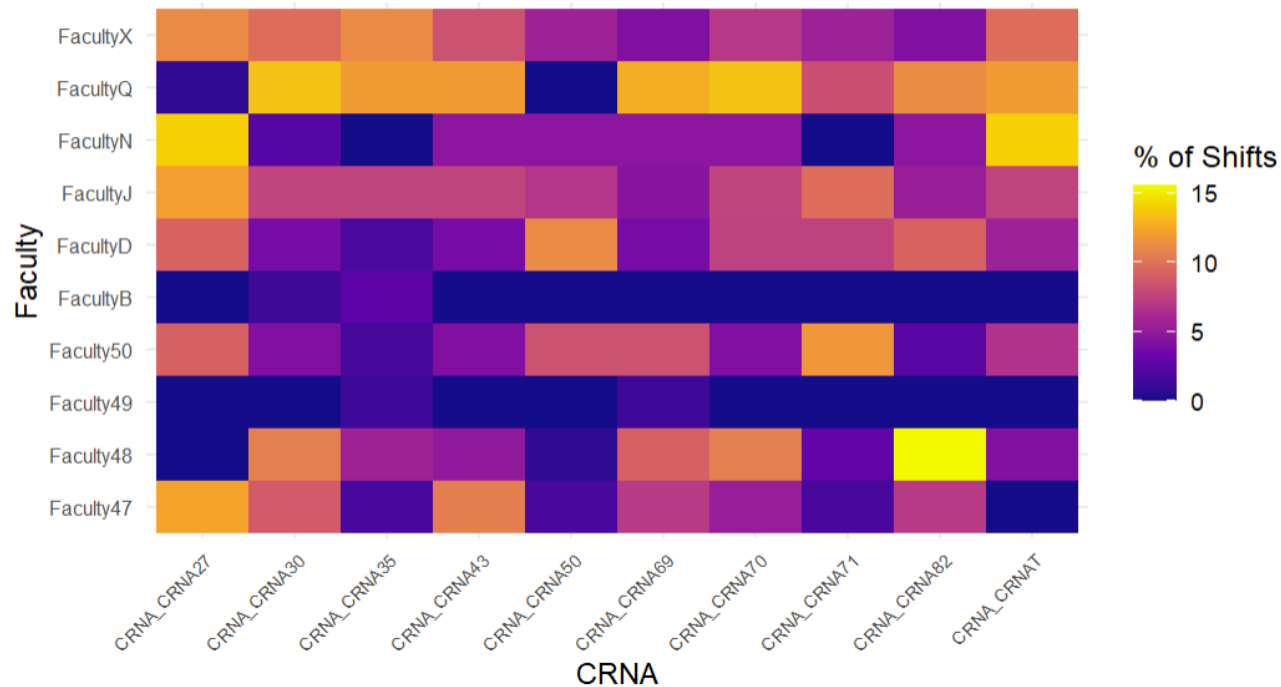
Improved Approach (Success):

Model	Accuracy	Sensitivity
Ridge + Weights	39.9%	82.7%
SVM + Weights	67.5%	61.2%

MODEL 3 – EXAMPLE PREDICTIONS (CRNA27)

Faculty-CRNA Pairing Frequency

Percentage of shifts where faculty worked with each CRNA



Predicted probability of working with CRNA_CRNA27:

Top 5 Predicted (High Probability):

Faculty	Actual %	Model Probability
FacultyN	28.6%	60.1%
FacultyD	20.0%	59.8%
FacultyX	16.7%	69.1%
Faculty47	14.3%	72.6%
Faculty50	14.2%	69.8%

Bottom 5 Predicted (Low Probability):

Faculty	Actual %	Model Probability
Faculty48	0%	4.1%
Faculty37	0%	3.2%
Faculty49	0%	2.7%
FacultyB	0%	2.7%
FacultyQ	0%	19.1%

CONCLUSIONS AND RECOMMENDATIONS

- Key Successes:
 - 91% accuracy predicting staffing type
 - 92% accuracy predicting team size
 - 83% sensitivity for CRNA pairings
- Limitations:
 - Rare classes (Mixed, Large) cannot be predicted
 - Some scheduling factors not captured in data
 - Models may need retraining as staff changes
- Key Insight:
 - Faculty preferences are intrinsic. They don't depend on day of week, time, or other external factors.
- Recommendations for Schedulers:
 - 1. Use historical preferences as primary guide
 - 2. Note that most faculty strongly prefer either CRNA-only or Resident-only teams; only 1 faculty regularly uses mixed staffing
 - 3. Consider prediction probabilities as suggestions to inform assignments