**Scheduling medical trainees via linear programming models implemented in Excel**

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### Initial Clinical Experience (ICE)

**Background**

New medical school curricula replace the traditional 2+2 format with continued science education and clinical exposure throughout medical school.

The "Old Model"

- Longitudinal Professional Development
- Basic Science (M1)
- Clinical Rotations (M2)
- Clinical Rotations and Electives (M4)

The "New Model"

- Scientific Truth (M1)
- Clinical Truth (M2)
- Branches (M3 and M4)
- Organization Learning
- Clinical Rotations
- Clinical Rotations and Electives

### Solution Approach

We formulated a linear programming model and implemented in a Microsoft Excel workbook, using the OpenSolver add-in.

#### Problem Statement

ICE schedules must assign 168 first-year medical students (M1s) to clinics in which they shadow healthcare professionals, subject to numerous rules.

#### Model

- Decision Variables
  - \( x_{crd} \) 1 if resident is assigned to clinic \( c \) in rotation \( r \)
  - \( c_i \) 1 if resident is assigned to inpatient service \( c \)
  - \( c_s \) 1 if resident is assigned to inpatient clinic \( c_s \)
  - \( c_{msp} \) 1 if resident is assigned to Medical Spanish requirement

- Objective Function
  
  \[
  \text{min} \sum_{c \in C, r \in R} \sum_{i \in I} \sum_{s \in S} (a + b) x_{crd} + v_i x_{crd} + c_s x_{crd} + c_{msp} x_{crd} \]

  - \( a + b \) Assignments to least-preferred clinics
  - \( v_i \) Inpatient/Outpatient violations
  - \( c_s \) Car Violations
  - \( c_{msp} \) Medical Spanish Violations

- Constraints
  - Generalized full schedules rapidly (solve time < 15 seconds)
  - Collaborated with program directors to fine-tune assignments
  - Applied tool to schedule four semesters to date
  - Output number of rule violations for directors' review
  - Improved medical student satisfaction
  - Derived high impact from mathematically simple, straightforward modeling with undergraduate-led project team
  - Fostered long-term collaboration with medical school

### Pediatric Inpatient Night Team

**Background**

Night teams in the Pediatric inpatient units are composed of residents and interns from the Pediatrics, Medicine-Pediatrics, and Emergency Medicine programs.

Three senior residents and three interns are assigned to the night team at any time.

**Solution Approach**

We formulated a linear programming model and implemented in a Microsoft Excel workbook, using the OpenSolver add-in.

#### Problem Statement

Night Team schedules must effectively balance residents' competing responsibilities and ensure adequate coverage of the Pediatric Emergency Department.

#### Model

- Decision Variables
  - \( x_{crd} \) 1 if resident is assigned to team on date \( d \)
  - \( x_{c_{msp}} \) 1 if resident is assigned to attend conference on date \( d \)

- Constraints
  - 1. Activity per resident per day
  - 2. Every activity must be adequately covered each day
  - 3. No resident can work more than two consecutive nights in any work sequence
  - 4. No resident can work more than six consecutive nights in any work sequence
  - 5. Emergency Medicine residents must attend at least one of their conferences during rotation

### Impact/Results

- Generated full schedules rapidly (solve time < 5 seconds)
- Reduced chief resident burden from approximately 6 hours per month to half hour
- Automated scheduling to more effectively balance resident responsibilities
- Improved compliance with resident day-off requests
- Completed by undergraduate-led project teams
- Provided quick, impactful outcomes that strengthened relationships with Michigan Medicine residency programs

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