Using OpenSolver for Scheduling Medical Trainees

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Background

• The U.S. physician training process is shifting
• Changes have included development of a new Medical College Admission Test (MCAT) and modifications to medical school curricula nationwide
• New curricula replace the traditional 2+2 format with continued science education and clinical exposure throughout medical school

The "Old" Model

Basic Science (M1)
Clinical Science (M2)

Longitudinal Professional Development
Clinical Rotations (M3)
Clinical Rotations and Electives (M4)

Scientific Task (M2)
Organ-Based Learning

The "New" Model

Clinical Science
Clinical Rotations
Clinical Rotations plus Electives

INTERPROFESSIONAL CLINICAL EXPERIENCE (ICE)

Problem Statement

• ICE is designed to expose students to a variety of clinical environments, but raises a number of scheduling issues
• Schedules must assign approximately 170 M1’s to clinics in which they shadow healthcare professionals subject to numerous rules

Solution Approach

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

Winter Session Model

Sets

S set of students
C set of clinics
C_s subset group of hospital-based clinics
C_r subset group of rotation 2 clinics
C_e subset group of off-site clinics
C_d subset group of off-site clinics that require cars for every student

Parameters

\( l_c \) 1 if clinic is open
\( w_c \) upper bound capacity for clinic c
\( v_s \) 1 if student s has a car
\( \mu_s \) 1 if student s can’t be assigned to clinic c due to prior clinic assignment
\( t_s \) 1 if student s needs an assignment to clinic type c
\( m_s \) 1 if student s is in Medical Spanish

Decision Variables

\( x_{sc} \) 1 if student s is assigned to clinic c

Constraints

(1) Student Coverage Requirements
Every student s must be assigned to exactly one clinic c
\[ \sum_{c \in C} x_{sc} = 1, \quad \forall s \in S \]

(2) Clinic Capacity Requirements
The number of students assigned to clinic c must be at least 1 if open and not exceed clinic capacity \( w_c \)
\[ l_c \leq \sum_{s \in S} x_{sc} \leq w_c, \quad \forall c \in C \]

(3) Student Car Requirements
Only those students s with a car are allowed to be assigned to a clinic c that requires a car.
\[ x_{sc} \leq v_s, \quad \forall s \in S, c \in C_d \]

(4) Student Carpooling Requirements
Students without a car may be assigned to off-site clinics, but for every student s without a car, there must be one student s with a car, such that the net number of drivers of a given clinic is greater than or equal to 0.
\[ \sum_{c \in C} v_s x_{sc} - v_s x_{sc} \geq 0, \quad \forall s \in S, c \in C \]

(5) Prior (and similar) Clinic Assignment Prohibitions
Students cannot be assigned to the same fall clinic or a clinic that is similar to their fall clinic assignment.
\[ x_{sc} + x_{sc'} \leq 1, \quad \forall s \in S, c, c' \in C \]

(6) Medical Spanish Location Requirement
A student s taking Medical Spanish cannot be assigned to an off-site clinic c.
\[ x_{sc} + m_s \leq 1, \quad \forall s \in S, c \in C_d \]

Objective Function: Minimize

\[ \text{Minimize} \left( \sum_{s \in S} \sum_{c \in C} d_{sc} x_{sc} \right) \]

Solution

Impact/Results

• Generated 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 role violations, and where these violations are occurring, for directors’ review
• Reduced program administrator burden
• Improved medical student satisfaction by incorporating preferences
• Derived high impact from mathematically simple, straight-forward modeling with undergraduate-led project team
• Fostered long-term collaboration with the medical school

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