Proposal Talk Example: Exam Scheduling

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Exam Scheduling with Conflict Minimization

Basic problem:
- 4 exam periods per day of final exams.
- Given length of exam period, minimize exam conflicts.
- Looking for sensitivity and threshold phenomena.
- Data to model UBC.

More difficult problems:
- Minimize exam conflicts (need student schedules).
- What happens if large class exams given section by section.
- What about other universities?
- Are there heuristics better than ILP solver with 45,000 students?
Models, Part 1

Basic model:

- \( n \) classes, \( m \) exam periods.
- For \( i = 1, \ldots, n \), and \( k = 1, \ldots, m \), have variable \( x_{ik} = 0, 1 \); our intention is that \( x_{ik} = 1 \) if exam \( i \) scheduled in period \( k \), 0 otherwise.
- Constraint \( \forall i \in [n] \)

\[
x_{i1} + x_{i2} + \cdots + x_{im} = 1
\]

means each class assigned to one exam period.
- No conflicts: given \( P \) set of pairs \((i, j)\) where class \( i \) and \( j \) have common students, \( \forall (i, j) \in P \) and \( k \in [m] \),

\[
x_{ik} + x_{jk} \leq 1.
\]

Question: is there a feasible point?
Models, Part 2

With the same $n, m$ and variables $x_{ik}$, we allow conflicts:

- Let $y_{ij} = 1$ if classes $i, j$ are scheduled simultaneously, 0 otherwise.
- $y_{ij}$ are the minimum 0, 1-valued solution to
  \[ x_{ik} + x_{jk} \leq 1 + y_{ij} \quad \forall k \in [m]. \]
- Can minimize an objective function
  \[ z = \sum_{i<j} \text{Weight}(i, j)y_{ij}, \]
  where $\text{Weight}(i, j)$ is larger for $(i, j)$ with more conflicts.
More elaborate model: same $n, m$ and variables $x_{ik}$. Have $s$ students, and for $\ell \in [s]$ given

$$A_\ell \subset [n]$$

i.e., the subset of classes taken by $\ell$-th student.

Exam hardship: student $\ell$ has hardship if $\min h_\ell = 0, 1$ s.t.

$$\sum_{j=k}^{k+3} \sum_{i \in A_\ell} x_{ij} \leq 2 + 2h_\ell \quad \forall k \in [m - 3]$$

is $h_\ell = 1$. Objective:

$$\text{Minimize } \sum_{\ell=1}^{s} h_\ell$$

This is larger problem (e.g., 45,000 students for 2,000 classes), more data.
Another Slide or Two

- Maybe a slide about obtaining data.
- Maybe a slide about how parameters will be varied.
- Maybe a slide about algorithms (if you are going to try something to compete with LP/ILP/QP solvers).