Scheduling a Professional Sports League in Microsoft Excel*

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Outline

• Class background and goals
• MLS setup
• Problem approach
• Individual teams
• Schedule composition
• Assessment
Background and Goals

Start in sophomore level class at U. of Michigan
- Prior preparation in linear programming with Excel Solver
- Earlier case involving integer variables

Goals
- Develop sound modeling skills
- Illustrate value of decomposing problems
- Impress with power of optimization
Major League Soccer Setup

- Two divisions of five teams each
- Schedule just Western Division: Dallas, Denver, Kansas City, Los Angeles, San Jose
- Two home-away series (8 games total each team)
- Play 2 games over weekend
- No more than 2 game road trip
- One bye each game “date”
- Wrap-around 10 “date” schedule plus “opening game”
- Schedule to minimize travel distance (and “be fair”)

11/19/2004
Western Division Teams

Basic schedule sheet
Problem Approach

Perspective

- Single team first
- What is the best for that team?
- What if everyone follows best for each team?

Start with Traveling Salesperson Problem

- Single team
- How to put into Excel?
Dallas’s Best Schedule

Excel for Denver

- Start with assignment form
- Observe problems
- Remedy with extra constraints (no subtours)
Class Homework

• Use Excel to find the best for each team
• How to find if each can have “best” schedule?
• Try to find a “best” schedule
• What process to follow?

Results

• Find improved schedules (not close to optimum)
• Some thoughts about how to combine
Schedule Composition

- Need to define decisions – what mathematically?
- How to represent rules about the schedule?
- Build up formulation
  - Reference to “column generation”
  - Ideas of decomposition
- Start variables:
  \[ y_{ijk} = 1 \] if team \( i \) starts trip \( j \) on day \( k \) and 0 otherwise.
  \[ z_{ijk} = 1 \] if team \( i \) starts reverse-trip \( j \) on day \( k \) and 0 otherwise.

At most all done once:
\[
\sum_{k=1}^{10} y_{ijk} + \sum_{k=1}^{10} z_{ijk} \leq 1, \text{ for all } i = 1 \ldots, 5, j = 1, 2.
\]
Other Constraints

No more than 2 road games in a row:

\[(l+2) \mod 10 \sum_{k=l}^{(l+2) \mod 10} (y_{i1k} + y_{i2k} + z_{i1k} + z_{i2k}) \leq 1, \text{ for } i = 1,...,5; l = 1,...,10\]

At home when another team visits:

\[\sum_{l \neq i, i \text{ first in } j(i,l)} (y_{lj(i,l)} + z_{lj(i,l)}) + \sum_{l \neq i, \text{ second in } j(i,l)} (y_{lj(i,l)}(k-1) \mod 10 + z_{lj(i,l)}) \leq 1 - \sum_{m = (k-1) \mod 10} \sum_{j=1,2} (y_{jim} + z_{jim}),\]

Visits to i on Day k <= 1 – (Road-trips i started on Day k or (k-1)mod 10).

Starter spreadsheet
Schedule Solution

Add in all the constraints
Maximize the total number of trips that can be placed
Only follow one of each pair of road trips
Result: They all fit!

- Final MLS spreadsheet

Substantial reductions over “hand” schedules
Results

Class “consulting” presentations
Most found an optimal schedule
No one found a least distance schedule by “hand” method

Issues:
- Some frustrations with the constraints, variable definitions
- No big issues with “sports” theme
- Satisfaction with successful completion