

Game Scheduling for NHL and NBA using optimization

Martin Joborn
RISE Research Institutes of Sweden
 and
Linköpings universitet
 and
Calatea Consult AB

DATUM	BORTALAG	HEMMALAG	TID	KANAL/RESULTAT
TO MAR 27, 2014	VANCOUVER	MINNESOTA	12:30 FM CET	SNET-P,FS-N
TO MAR 27, 2014	PHILADELPHIA	NY RANGERS	1:00 FM CET	RDS,TSN2,NBCSN
TO MAR 27, 2014	ANAHEIM	CALGARY	3:00 FM CET	TSN,FS-W
FR MAR 28, 2014	CHICAGO	BOSTON	12:00 FM CET	NHLN-US,CSN-CH,NESN
FR MAR 28, 2014	PHOENIX	NEW JERSEY	12:00 FM CET	FS-A,MSG
FR MAR 28, 2014	LOS ANGELES	PITTSBURGH	12:00 FM CET	FS-W,ROOT
FR MAR 28, 2014	MONTRÉAL	DETROIT	12:00 FM CET	RDS,TSN,FS-D
FR MAR 28, 2014	NY ISLANDERS	TAMPA BAY	12:30 FM CET	MSG PLUS,SUN
FR MAR 28, 2014	CAROLINA	FLORIDA	12:30 FM CET	FS-CR,FS-F
FR MAR 28, 2014	MINNESOTA	ST LOUIS	1:00 FM CET	FS-N,FS-WI,FS-MW
FR MAR 28, 2014	BUFFALO	NASHVILLE	1:00 FM CET	MSG-B,BELL TV,FS-TN
FR MAR 28, 2014	VANCOUVER	COLORADO	2:00 FM CET	SNET-P,ALT
FR MAR 28, 2014	WINNIPEG	SAN JOSE	3:30 FM CET	TSN-JETS,CSN-CA
LÖ MAR 29, 2014	TORONTO	PHILADELPHIA	12:00 FM CET	RDS2,SNET-O,CSN-PH
LÖ MAR 29, 2014	PITTSBURGH	COLUMBUS	12:00 FM CET	ROOT,FS-O
LÖ MAR 29, 2014	CHICAGO	OTTAWA	12:30 FM CET	CSN-CH,SNET-E
LÖ MAR 29, 2014	NASHVILLE	DALLAS	1:30 FM CET	FS-TN,FS-SW
LÖ MAR 29, 2014	NY RANGERS	CALGARY	2:00 FM CET	MSG PLUS,SNET-CGY
LÖ MAR 29, 2014	ANAHEIM	EDMONTON	2:30 FM CET	PRIME,SNET-W



Martin Joborn

- Forskare RISE Research Institutes of Sweden
- Adjungerad universitetslektor Linköpings universitet
- Mest järnväg



- Civ.ing: Teknisk Fysik & Elektroteknik, Linköping
- Doktor i Optimeringslära vid Matematiska inst., Linköpings universitet
- Konsult i optimering i ~10 år: Jeppesen, Transrail
- Åter inom akademi och forskning sedan 2013





Background

How come Martin is involved?

- Jeppesen-office next door to NHL in Montreal
- Consultant in Denver made schedules
- Collaboration with Bortz, started 2005
- Martin "kept" project when leaving Jeppesen
- Today NHL in focus, NBA is the same



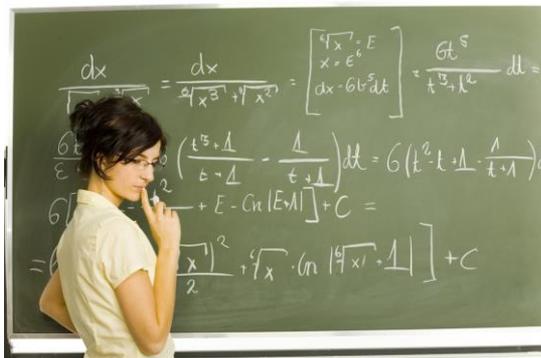
NHL



- 31 teams
- Total 1312 games
- 175 days
- Per team: 82 games (41 home, 41 away)
- 0,1,2,3 games at home towards each team
- Long distances – private jets
- Profit maximizing sompanies
- Teams own (expensive) arenas
- Schedule in Sverige: Fair!
- Schedule in NHL: Maximize profit!

Optimering

- Hitta den lösning som är bäst
- Bevisa att bästa lösningen är hittad!
- Matematisk tolkning:
- maximera $f(x)$ (målfunktion)
då
 $Ax = b$ (ekvationssystem med många lösningar)
 $x \geq 0$



Optimeringsmetodik

- Vad är x ?
Definiera beslutsvariabler
- Vilka är begränsningarna?
Definiera villkor
- Vad är målet?
Bestäm målfunktion (objective function)
- Hur hittar vi lösningen?
Bestäm optimeringsmetod

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Researchers' approach...

Traveling tournament problem

“Standard” (theoretical) problem in literature/research:

- All n teams play each other home & away
- Max 3 home games in a row
- Max 3 road games in a row
- $2n-2$ rounds
- A@B not followed by B@A
- **Minimize travel cost**

- Extremely difficult!

Optimization expert vs. Game scheduling experts

- Experts approach (3 Ph.D:s in optimization) :
Generate lots of trips (trip = travel incl. Games);
optimize by selecting best set of trips
(Column generation + set partitioning)
- Practitioner: "I don't believe in that approach..."

Regler – Hårda och mjuka och diffusa

"Hårda villkor": måste följas

"Mjuka villkor": bör följas

"Diffusa villkor": svår att värdera

- Aldrig match 3 dagar i rad (för ett lag)
- Endast en match per dag (för ett lag)
- Arena tillgänglig 50-60 dagar (för varje lag)
- Alla matcher ska spelas
- Undvik 4 matcher på 5 dagar
- Undvik match 2 dagar i rad
- Heta matcher på bra TV-tider
- Bra resor
- Inte för tätt mellan möten med samma lag
- Ingen dagmatch dagen efter kvällsmatch
- Gärna hemmamatcher fre, lör, sön
- ...



Objective? Constraints?



- What is a good solution??
 - Minimize travel costs?
 - Few "back-to-back"-games (games 2 day in a row)?
 - Many weekend games?
 - Fresh players?
 - Fair schedule?
 - ...
- All teams have different objectives!!
- How handle soft constraints??
- Delicate judgements are needed!!

Optimization problem

- Extremely hard
- Others have tried - and failed
- NHL does not believe in a complete, automatic, tool
- Too many intangible, soft-hard, political constraints
- Now: I don't believe in a complete one-shot optimization tool

Schedule cleanup problem

- Input: Work-in-progress-schedule (with $x\%$ of games scheduled)
- Solve specific problem, e.g.:
 - add unscheduled game
 - reduce back-2-backs for a specific team
 - arena no longer available
- Objective function: **Move as few games as possible**

Process:

- Optimization:
 - Gives all solutions that moves less than n games
- Manually:
 - Evaluate solutions
 - Decide what solution to include (or find other solution inspired by generated solution)

Constraints

- # games per day for each team ≤ 1
- only home game if arena is available
- schedule all games
- limit on number of back-to-backs for each team
- max 2 games in 3 days
- No (new) 4 games in 5 days
- No (new) back-to-back-travel > 2,5 hours
- No (new) home-back-to-back on weekdays
- No (new) night-day back-to-backs
- Separate similar games
- Don't regenerate a solution
- ...
- ***Human planner is allowed to break rules, optimization is not***
- ***Optimization must be able to handle any rulebreak (and let it be)***

Solution method

- Use FICO software (Mosel modelling language, Xpress solver)
- Solution time 1 -- 3600 sec.
- Iteratively add new constraints to forbid last solutions
- Run over and over again until user finds good solution
(or user decides to take other action, like negotiate with teams or ask for new date at an arena)

Conclusion

- Problem very fuzzy, both constraints and objective are “negotiable”
- Optimization is a tool in manual process
- Attack whole problem/process in small parts
- Not very fancy optimization (for a scientist)

- Success!! Saves weeks of work!
- Successful way to combine mathematics and human knowledge

Optimering vid Chalmers

Enligt Ann-Brith Strömberg vid Matematiska Vetenskaper:

- MVE165/MMG631 Linear and Integer Optimization with Applications (år 2, lp4)
- TMA947/MMG621 Nonlinear Optimization (år 3, lp1)
- TMA521/MMG511 Large-Scale Optimization (år 3/4, lp 2)

Martin Joborn

Martin.joborn@ri.se

070-570 99 92