AMMM - Course project

Master in Research and Innovation in Informatics

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Problem Statement

Main requirements

1. Each contestant will play exactly once against each of the other contestants.
2. Each round will consist of $\frac{n-1}{2}$ matches.
3. Players will play 50 % of their games as white, 50 % will be played as black.

Subtle requirements

- A player can only play up to 1 game per round
- A player can't play against himself

Problem Statement: Inputs & Outputs

Inputs

- Number of contestants, n. Has to be odd
- Matrix of points per day per player, $p_{n \times n}$

Outputs

- Schedule with the set of pairings $\{\{r_1, p_i, p_j\}, \ldots, \{r_n, p_k, p_h\}\}$ that maximizes total score. Ensured to be optimal if it's obtained through the ILP.

Problem Statement: Definitions

In order to specify the constraints, we need to specify the sets and variables we're going to work with:

- $M(x, y)$ matches played among x and y (1)
- $R(r)$ matches played at round r (2)
- $W(p)$ matches played by player p as white (3)
- $B(p)$ matches played by player p as black (3)
- $G(p, r)$ games played by p at round r (4)
- $F(r)$ free players at round r (5)

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4. Players can play up to 1 match per round
5. Objective function

Integer Linear Programming Model: Variables

Every set will be constructed from a boolean multidimensional array. *matches*$[w][b][r]$ will be 1 whenever player w plays player b in round r, and 0 otherwise.

Set constructions

$$\begin{aligned}
M(x,y) &= \{\{x,y,r\} && \mid \text{matches}[x][y][r] = 1 \lor \text{matches}[y][x][r] = 1 && \forall r \in [1, Rounds]\} \\
F(r) &= \{p && \mid \text{matches}[p][o][r] = 0 \land \text{matches}[o][p][r] = 0 && \forall o \in [1, n]\} \\
W(p) &= \{\{p,b,r\} && \mid \text{matches}[p][b][r] = 1 && \forall r \in [1, Rounds], b \in [1, n]\} \\
B(p) &= \{\{w,p,r\} && \mid \text{matches}[w][p][r] = 1 && \forall r \in [1, Rounds], w \in [1, n]\} \\
R(r) &= \{\{w,b,r\} && \mid \text{matches}[w][b][r] = 1 && \forall w, b \in [1, n]\} \\
G(p,r) &= \{\{o,p,r\} && \mid \text{matches}[p][o][r] = 1 \lor \text{matches}[o][p][r] = 1 && \forall o \in [1, n]\}
\end{aligned}$$

Integer Linear Programming Model: Constraints

$$|M(x,y)| = 1 \quad \forall x, y \in P \mid x \neq y \tag{1}$$

$$|R(r)| = \frac{n-1}{2} \quad \forall r \in [1,\ \text{Rounds}] \tag{2}$$

$$|W(p)| = \frac{n-1}{2} \quad \forall r \in [1,\ \text{Rounds}], \forall p \in P \tag{3}$$

$$|G(p,r)| \leq 1 \quad \forall p \in P, r \in [1,\ \text{Rounds}] \tag{4}$$

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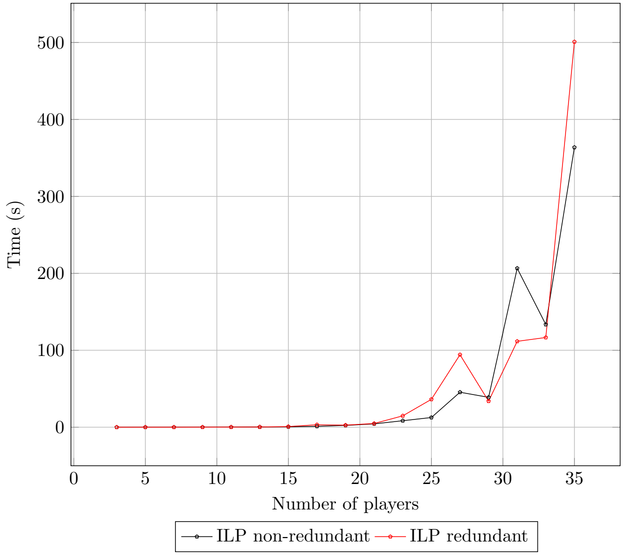
Integer Linear Programming Model: Redundant constraints

Redundant constraints might appear to make the model faster but they seem make it slower in the long run

$$|M(x,x)| = 0 \quad \forall x \in P$$

$$|B(p)| = \frac{n-1}{2} \quad \forall r \in [1,\ \text{Rounds}], p \in P$$



Metaheuristics: Greedy algorithm

Greedy cost function

$$q(c, day) = c.points\_per\_day[day]$$

Algorithm Greedy algorithm

```
1: Players ← Set of Players
2: rests ← {}
3: for day in 0..days do
4:     playersToRest ← filter Players(p) | p.hasNotRested
5:     sortedPlayers ← sort playersToRest(p) by q(p,day) (DESC)
6:     select p ∈ sortedPlayers[0]
7:     rests[day] ← p
```

Metaheuristics: Local Search

Algorithm Local Search

```
1: for i in 0..days do
2:     best_swap_points ← 0
3:     best_swap ← i
4:     for j in 0..days do
5:         change = EvaluateRestSwap(i,j)
6:         if change > best_swap_points then
7:             best_swap_points ← change
8:             best_swap ← j
9:     rests[i] ↔ rests[best_swap]
```

Metaheuristics: GRASP

Algorithm constructRCL(day)

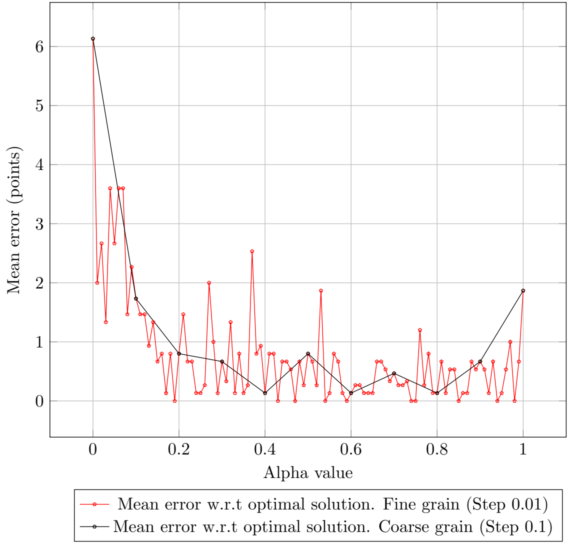
```
1: $q_{max} \leftarrow$ sortedPlayers.first().points[d]
2: $q_{min} \leftarrow$ sortedPlayers.last().points[d]
3: $RCL_{max} \leftarrow \{p \in sortedPlayers \mid p.points[d] >= q_{max} - \alpha \cdot (q_{max} - q_{min})\}$
```

Algorithm GRASP

```
1: rests ← {}
2: for day in 0..days do
3:     RCL ← constructRCL(day)
4:     select p ∈ RCL randomly
5:     rests[day] ← p
```

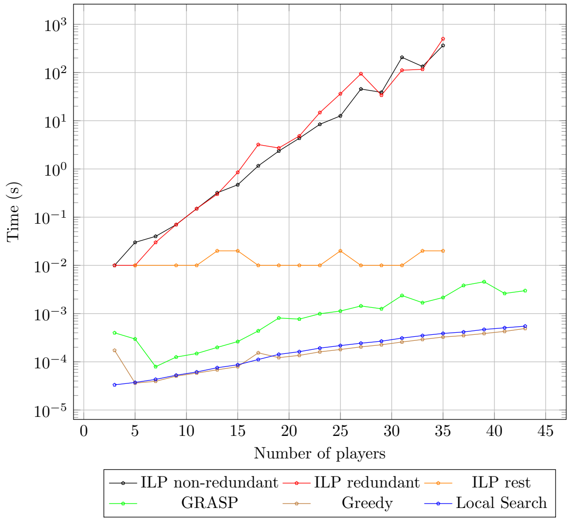
GRASP: Parameter tuning

- Hemos probao no se que no se cuantos
- Muchos alphas nos valen porque hay muchos 0 calvo de mierda



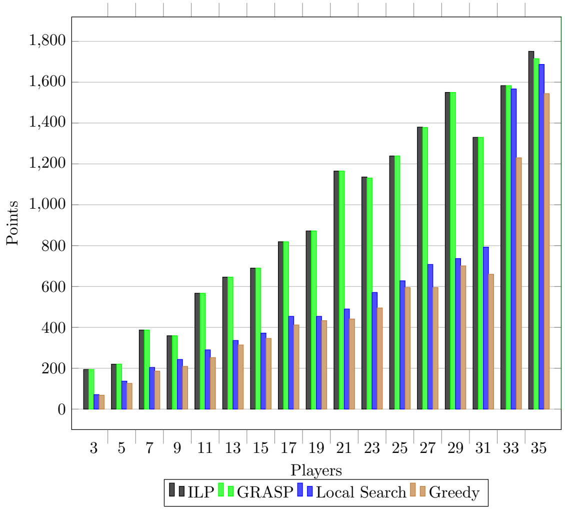
Results: Time

- ILP rest blabla
- texto



Results: Quality of solutions

- ILP rest blabla
- texto


Points
Players
ILP
GRASP
Local Search
Greedy