



IMMC 2025



Developing a fair and effective
schedule for
Global Sports League

TEAM IMMC 2025043



Why Football?

- Football is loved and played in almost every country, making it a truly global sport.
- Suitable for representation and participation from all regions, promoting inclusivity on a global scale.
- The rules are simple, and you don't need expensive equipment



Concept of League

1

Every team plays against every other team in the league.

2

Each matchup happens twice – one game at home and one away.

3

A win gives 3 points, a draw gives 1 point, and a loss gives 0 points.



Why Double Round Robin?

Single Round Robin

- Only 19 matches per team resulting in long gap between matches or a very short and underwhelming season
- Teams play only once, the home and away balance is uneven—some teams get more home games than others, which can be unfair.

Double Round Robin

- 38 matches per team which can be perfectly fit in a weekly schedule over 8-9 months.
- Ensures fairness by having each team play every opponent twice—once at home and once away

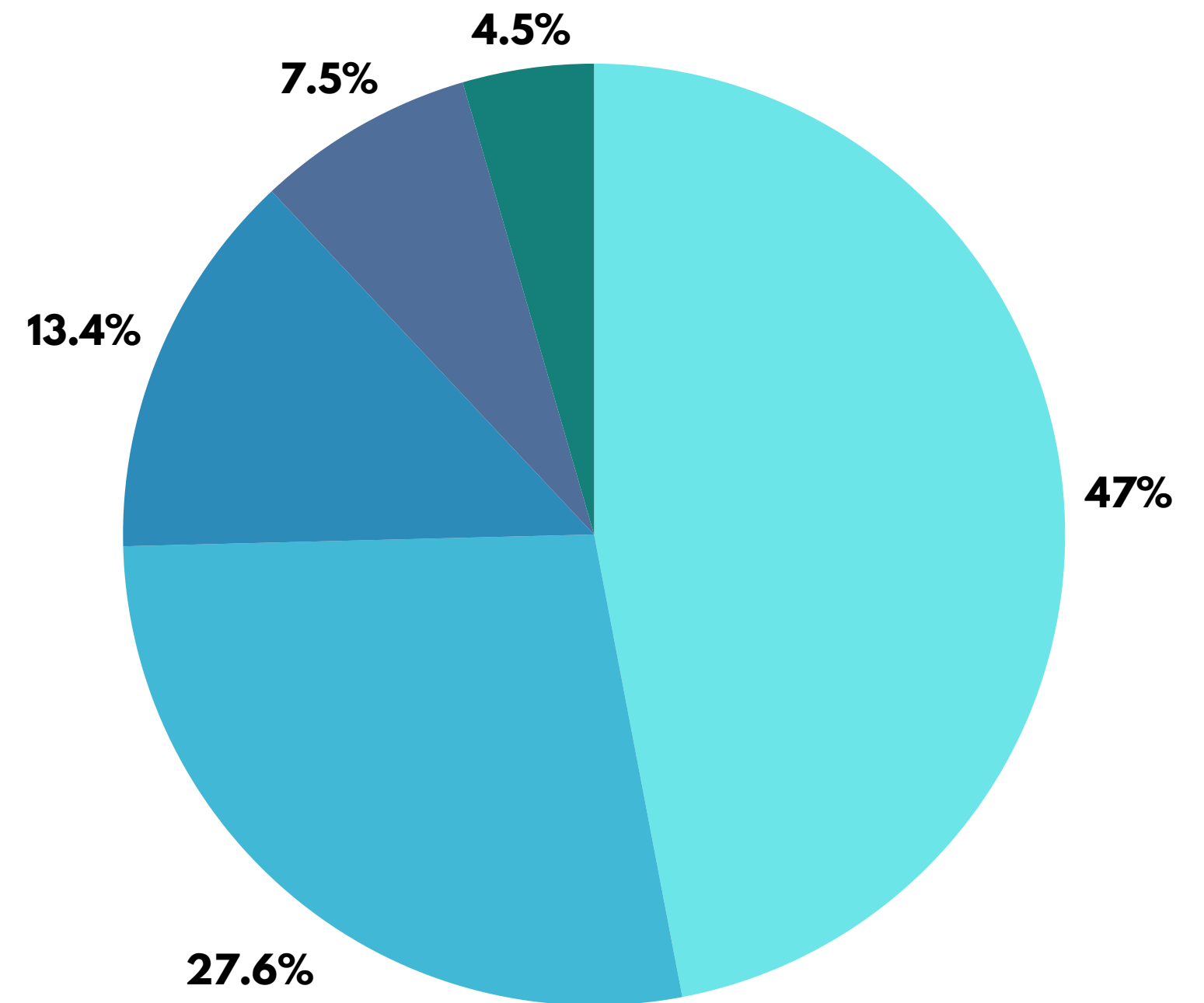
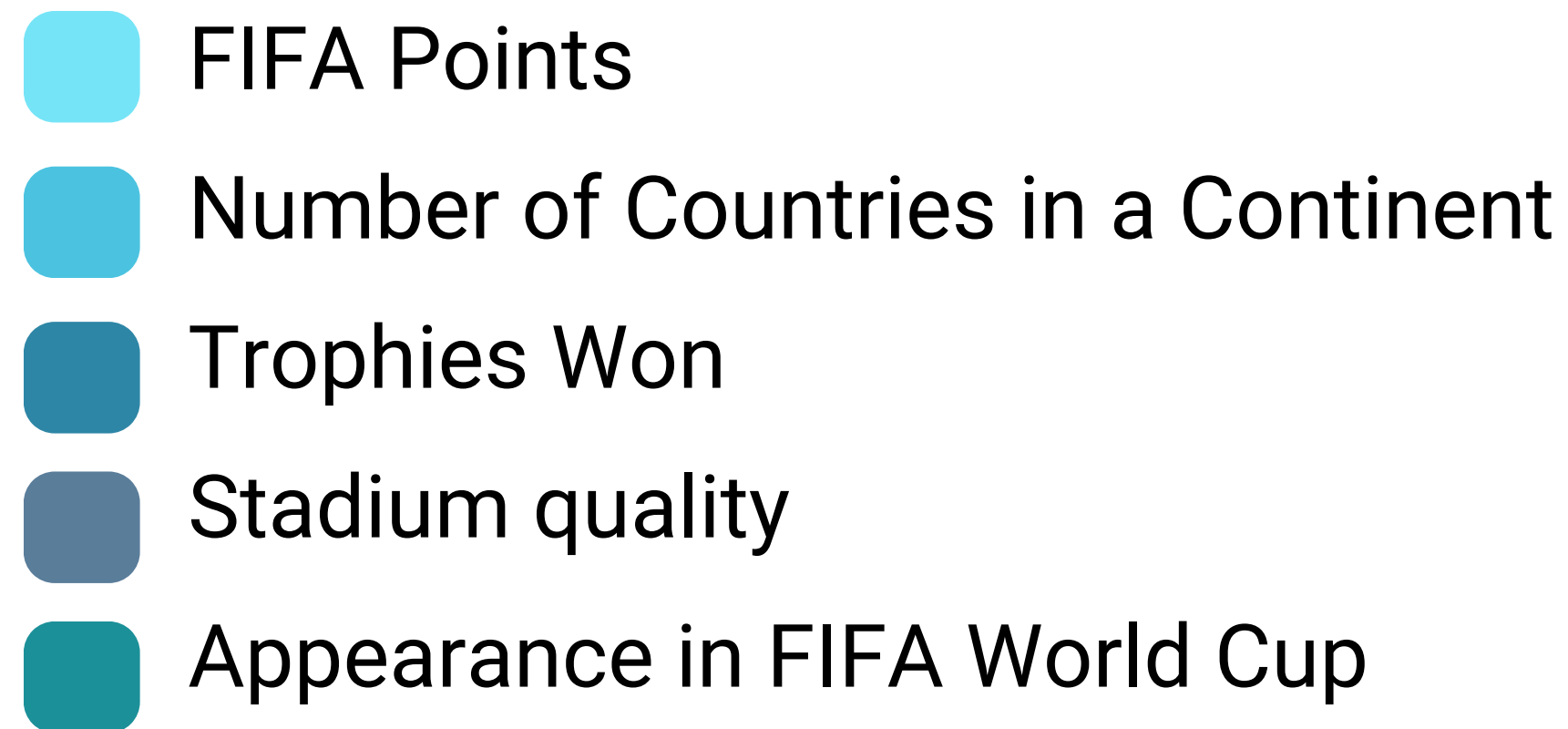
Triple Round Robin

- 57 matches per team, would require well over a year to complete at the same pace.
- Teams face each other three times, which means the home and away games cannot be equally split.

Our Basic Assumptions:

- The **season starts and ends at fixed, predetermined times** with no significant changes in weather, national holidays, or events that would disrupt the schedule.
- There are **enough fit players** to play in a team match who are available throughout the duration of the league, including the players affiliated with any clubs.
- The **quality of a stadium** is represented by the number of seats.
- Routes are taken by **flights** that give the **shortest distance between 2 cities**.
- The capital city is considered the home stadium of the respective country.
- The first position holder has a distinct point value at the end of season.

Criteria For Team Selection



Criteria For Team Selection

We used AHP to compare the criteria and decide which are more important.

$$M = \begin{bmatrix} 1 & m_{FN} & m_{FT} & m_{FS} & m_{FA} \\ \frac{1}{m_{FN}} & 1 & m_{NT} & m_{NS} & m_{NA} \\ \frac{1}{m_{FT}} & \frac{1}{m_{NT}} & 1 & m_{TS} & m_{TA} \\ \frac{1}{m_{FS}} & \frac{1}{m_{NS}} & \frac{1}{m_{TS}} & 1 & m_{SA} \\ \frac{1}{m_{FA}} & \frac{1}{m_{NA}} & \frac{1}{m_{TA}} & \frac{1}{m_{SA}} & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 4 & 6 & 8 \\ 1/2 & 1 & 2 & 4 & 7 \\ 1/4 & 1/2 & 1 & 2 & 3 \\ 1/6 & 1/4 & 1/2 & 1 & 2 \\ 1/8 & 1/7 & 1/3 & 1/2 & 1 \end{bmatrix}$$

and we achieved weights

$$\text{weight} = [0.470 \quad 0.276 \quad 0.134 \quad 0.075 \quad 0.045]^T$$

and then, consistency was checked by evaluating consistency ratio = 0.008 which is less than 0.1

Then, we calculated Global Competence Value G which we used for selecting country

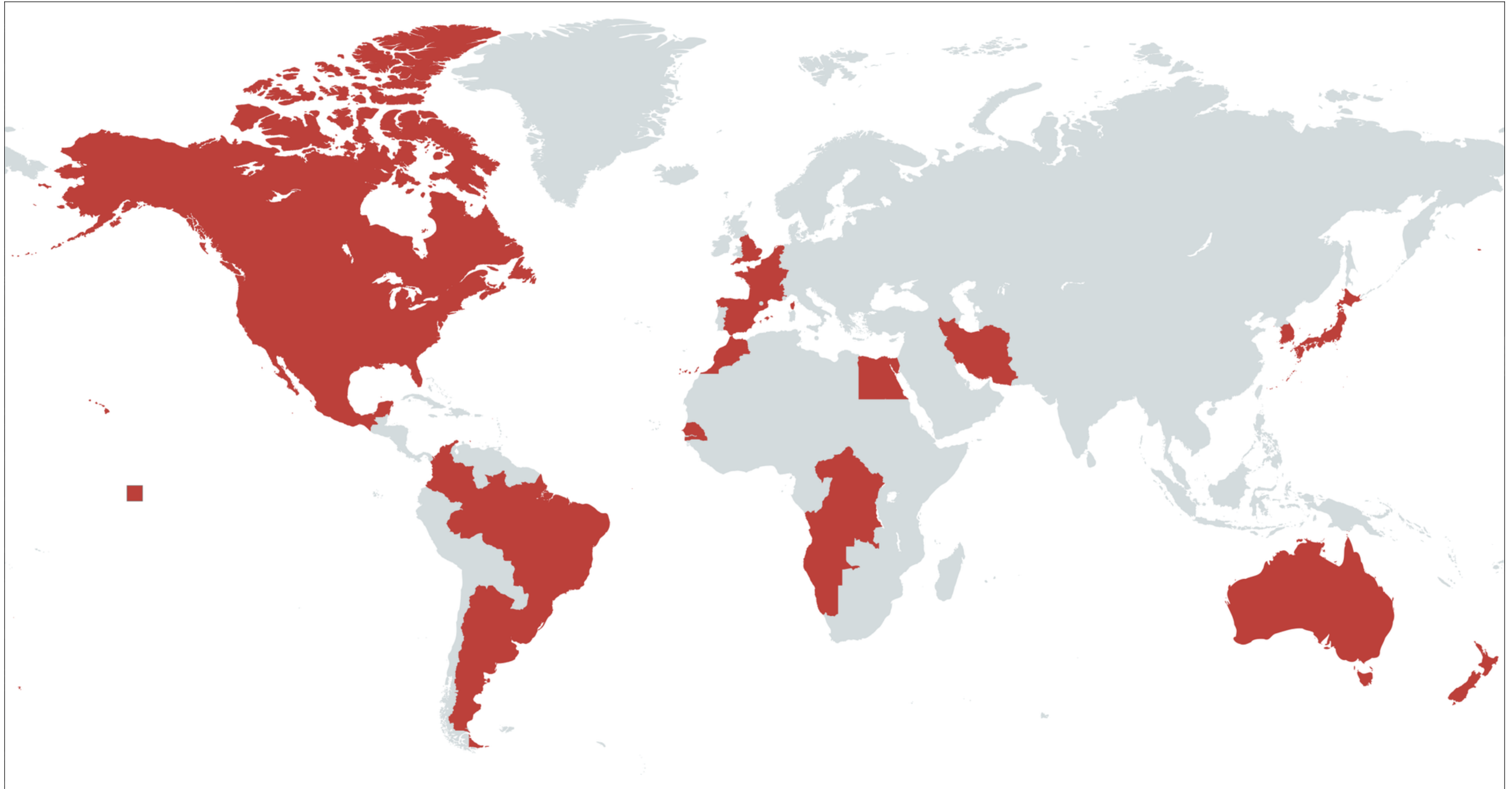
$$G = w_F \cdot F_S + w_N \cdot N_S + w_T \cdot T_S + w_S \cdot S_S + w_A \cdot A_S$$

We first select 12 countries on the basis of condition that atleast 2 countries must be from a continent.

Then, 8 remaining slots were distributed proportionally

Additional slots for continent $i = \left\lfloor \frac{G_i}{\sum G} \times 8 \right\rfloor$

Continent	Slots
Europe	2
South America	2
North America	1
Africa	1
Asia	1
Oceania	0



Key Components



**Minimum travel
distance**



**Home vs Away
Balance**



**Fair Number of
Games**



**Equitable
Balance**



**Sufficient
Rest Days**

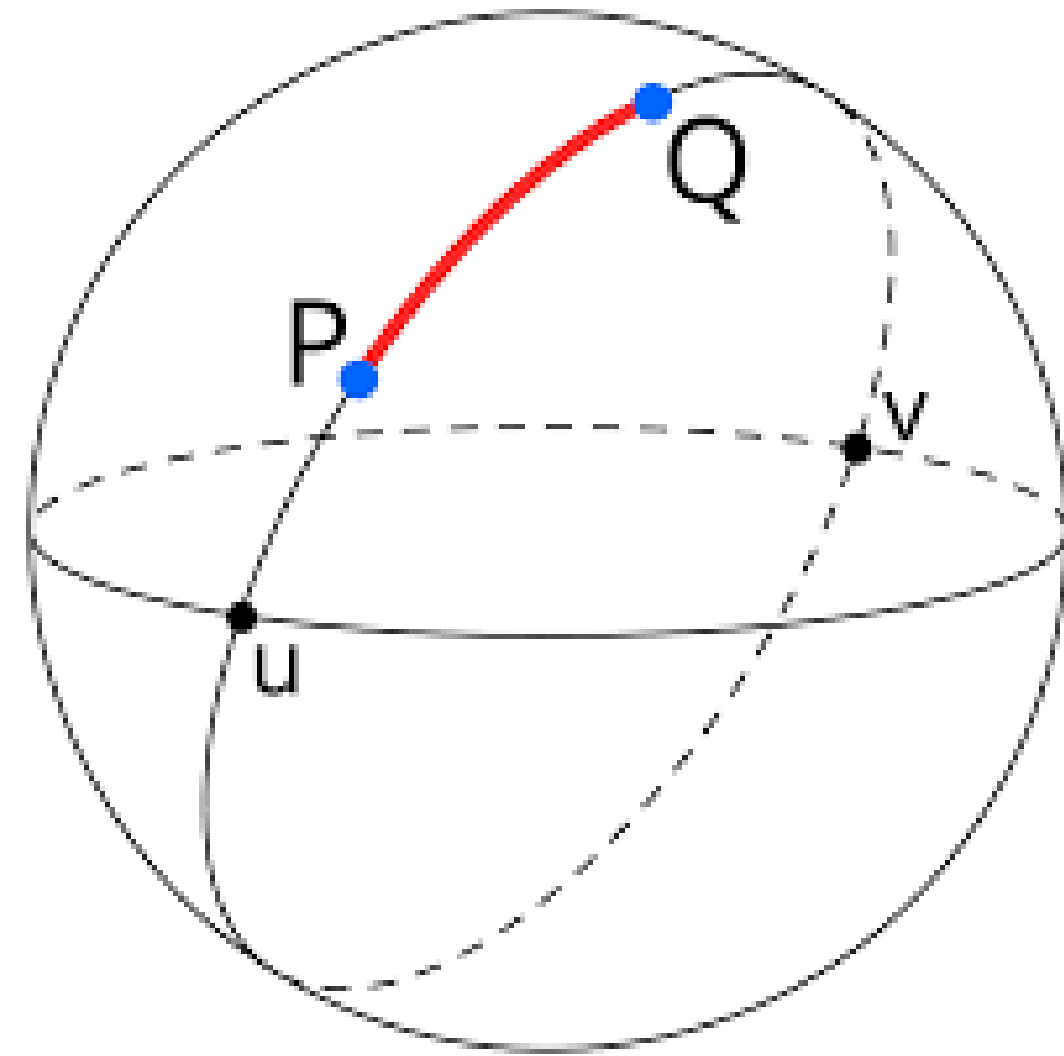


**Double
Round Robin**

Haversine distance

**Uses latitudes and longitudes
to calculate distance on a
curved surface**

$$d = 2r \arcsin \left(\sqrt{\sin^2 \left(\frac{\phi_2 - \phi_1}{2} \right) + \cos(\phi_1) \cos(\phi_2) \sin^2 \left(\frac{\lambda_2 - \lambda_1}{2} \right)} \right)$$



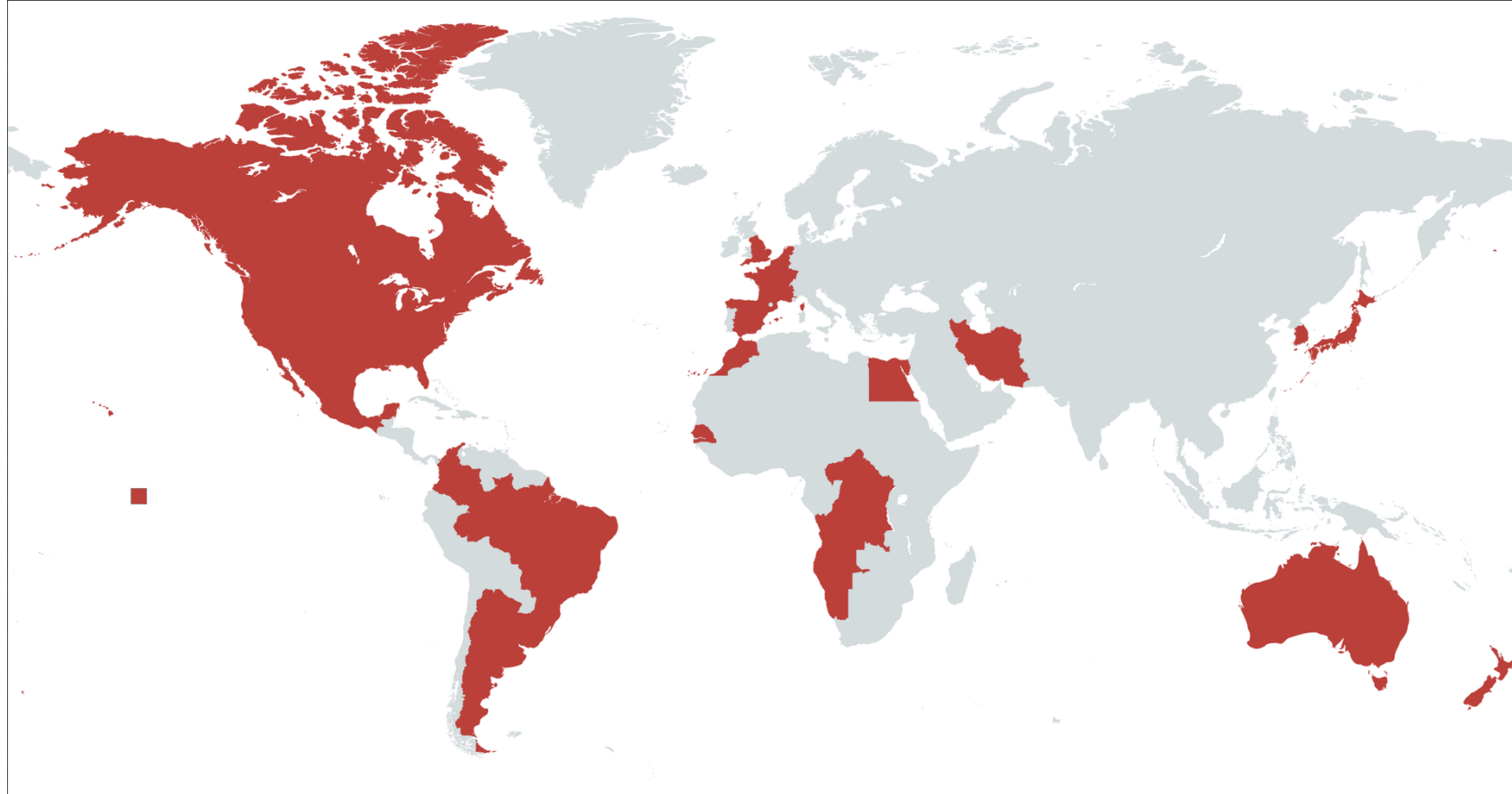
Even works on an orange

Matchday optimizer

- **Stores coordinates of capital cities**
- **Calculates static distance between all cities**
- **Static distance: The distance for a team to travel to an away venue and back to their own home**
- **Adds up all the static distance of a team for a given country**
- **Arranges them in a PRIORITY ORDER**



Priority order



**In this case, New Zealand
will be prioritized**

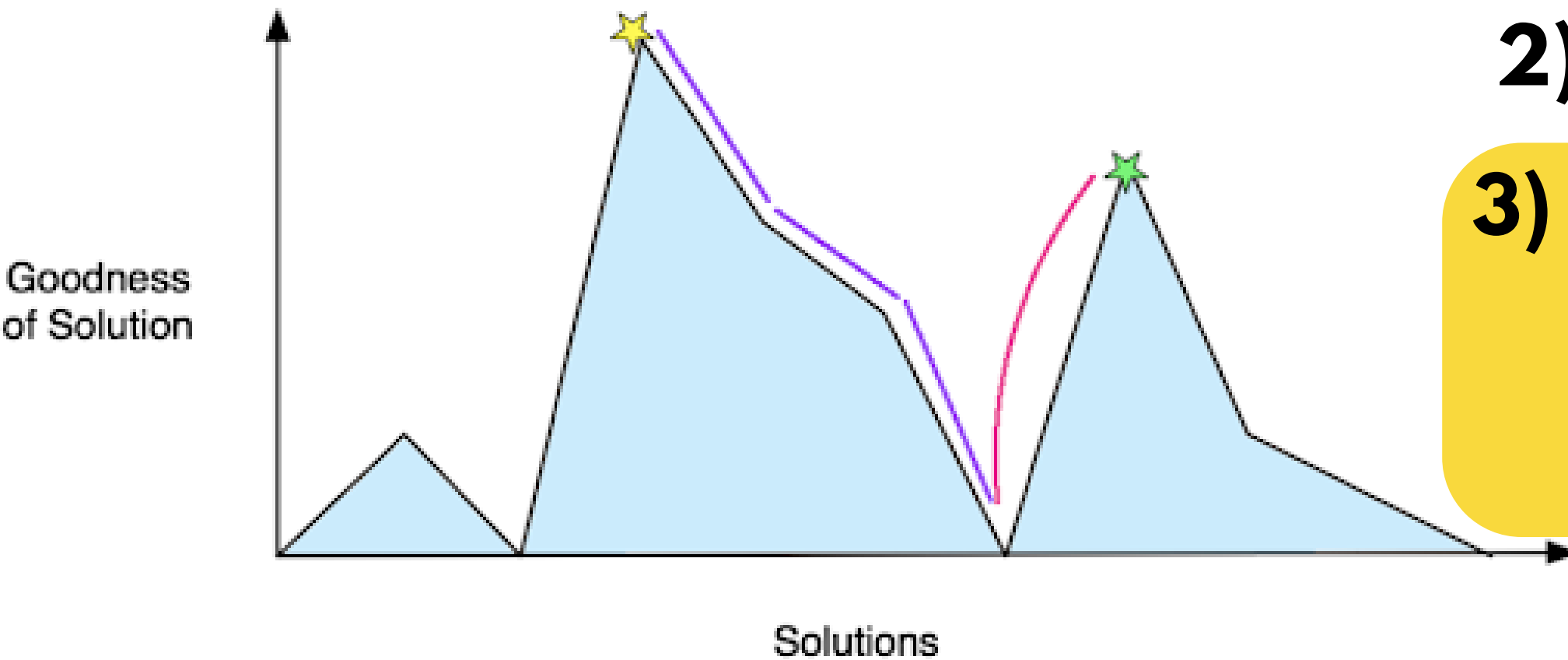
New Zealand	Dynamic: 119672.29 km Static: 536777.65 km
Australia.	Dynamic: 144782.68 km Static: 526014.59 km
Japan	Dynamic: 142533.75 km Static: 422583.94 km
South Korea	Dynamic: 128389.32 km Static: 417408.34 km
Argentina	Dynamic: 155969.44 km Static: 376918.56 km

**The team that has the most
static travelling distance
gets prioritized first**

**Dynamic distance: A team travels from one
country to the next without stopping**

**Nearest neighbour approach
along with circle method is
used to create an initial
schedule**

Simulated Annealing



- 1) Randomly swaps matchups
- 2) Checks if it violates any validation

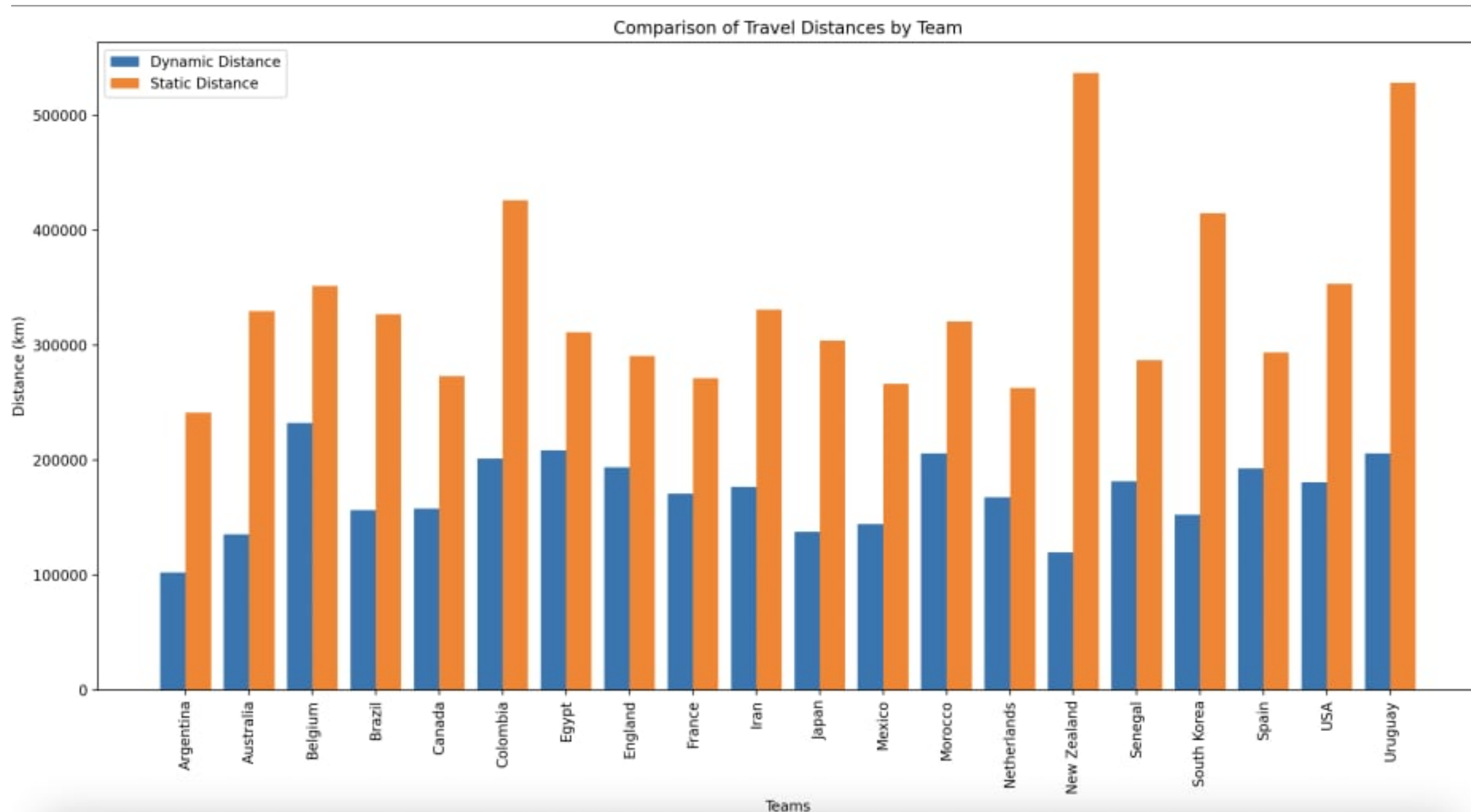
3) Accepts better values of objective function

4) Occasionally accepts a worse values to escape a local minima

5) Repeats until the computing time is exhausted

6) Displays the best possible matchup schedule

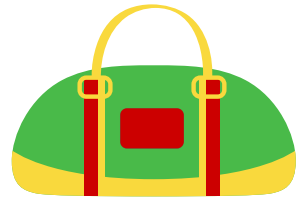
Results



214,216 metric tons of CO₂

Standard deviation changed from 88,084.77 km to 15149.66 km

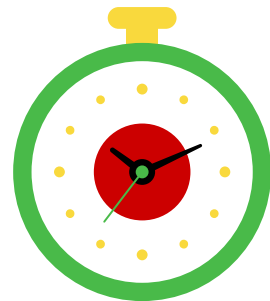
Trade Offs



Travel Distance vs. Competitive Equity



Home/Away Balance vs. Travel Minimization



Player Welfare vs. Season Length

Determining League Winner

We first calculate the probability of winning of the strongest team

$$P = \frac{1}{1 + 10^{(F_{avg} - F_a) \div 400}} = 0.8$$



If y be the number of remaining games and x be the number of games already played

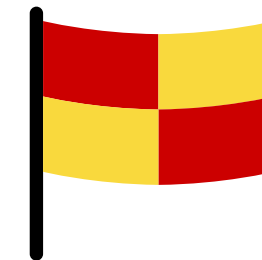
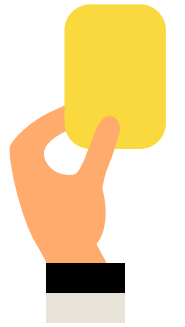
Then, we get,

$$3 \times 0.8 \times y + a > 3y$$

$$x > \frac{22.8 - a}{0.6}$$

Here, a is the minimum amount of points for deciding league which is 1

$$x > 36.33 = 37 \text{ (min)}$$



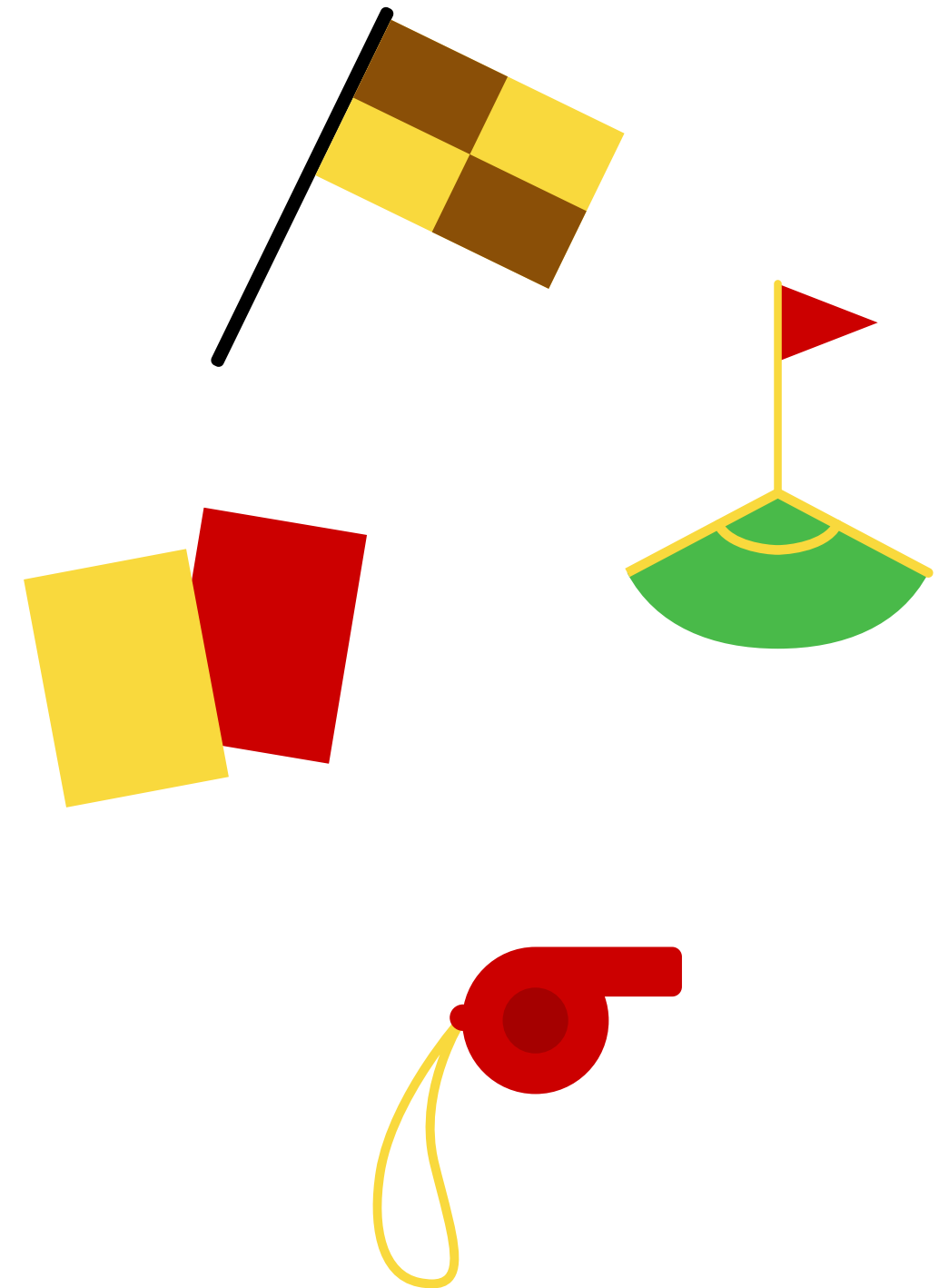
Expanding the league

To expand the teams from 20 to 24:-

The G value was recalculated, and the continents having higher G score were awarded the slots.

We decided on rewarding the GSL champion continent with an extra slot.

For the initial season, that slot will be awarded to the continent with greater G value.



Impact on the league schedule

1

The number of games for each team rises from 38 to 46

3

6 days rest time to 5 days rest time in-between games

2

Total number of matches rises from 360 to 552

4

More carbon emissions being produced and higher transportation fees

Analyzing Changes to Key Constraints

Travel Distances



Number of
League Games



Changing Home
Location





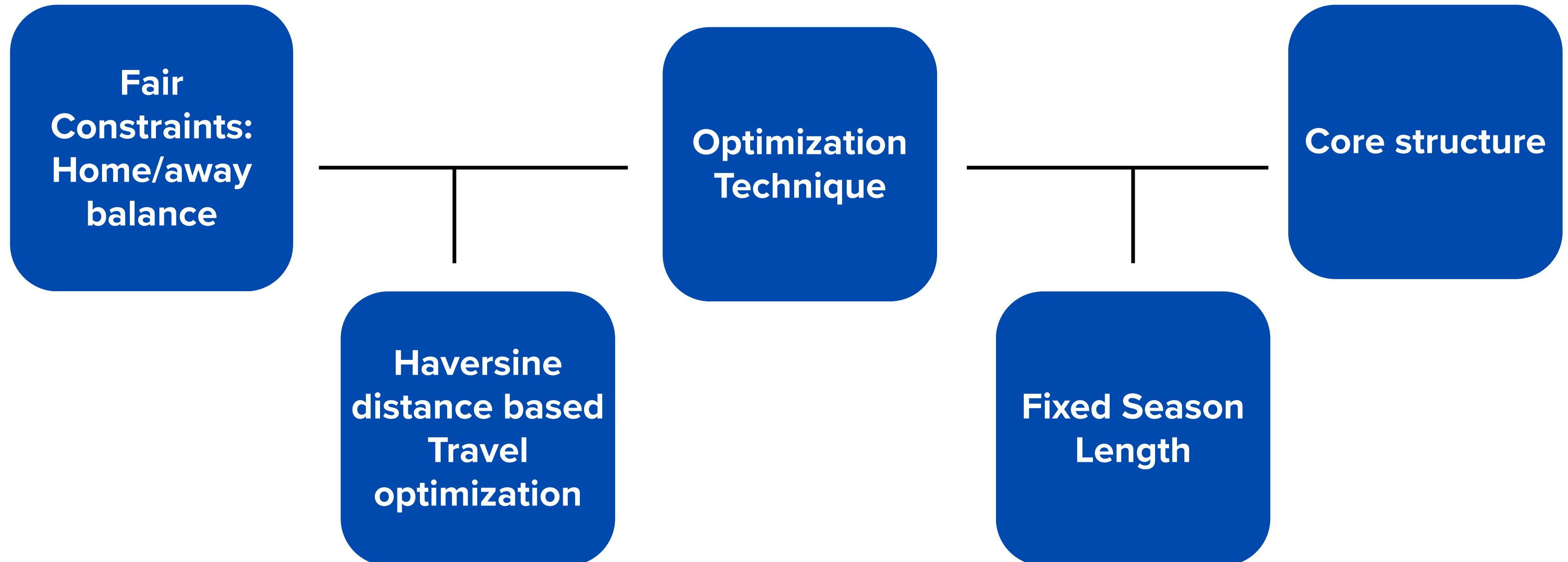
Generalizing the Scheduling Model



Adapting the Model Across Different Sports



What Remains Constant Across Sports



What Can Be Adapted for Other Sports

- Team strength rankings can be changed
- Adjustments in the number of games and rest days based on sport intensity.
- Consideration of unique requirements (e.g., stadium quality for hockey).



Team
Strength

Number of
Days

Unique
Quality



Summary Table: Sport-Specific Adjustments



Sport	Ranking System	Rest Days	No. of Games	Special Notes
Rugby	World Rugby Rankings	6-7 days (OK)	Same as soccer	No major changes needed
Hockey	FIH Rankings	Similar to soccer	Same as soccer	Stadium quality is critical
Basketball	FIBA Rankings	Shorter (Low)	~76 games, 2/week	More frequent games allowed
Baseball	WBSC Rankings	Short (Low)	~76 games, 2/week	Reduced from 162 due to travel

THANK YOU!

