Proposing an Optimal Formula 1 Race Schedule with Minimal Emissions and Maximal Total Attendance

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Problem Statement

Formula 1 is a sport with **very complex logistics:**

- Teams and equipment need to **travel the globe** in very **short timeframes** over a 24-race calendar.
- Teams cannot sustain many repeated races and need to **return home often**, with a **maximum number of consecutive races** allowed.
- Many races close to each other **decreases overall attendance** because of saturation in that area

➡ **How to optimize the 2023 race schedule for minimal emissions and maximal attendance?**

Model Formulation

Objective: Minimize emissions and attendance loss

Vehicle Routing

(*the teams that return home, determines consecutive races*):

- Every race is visited exactly once
- At most 2 triple consecutive races (triple header)
- At most 6 double consecutive races
- Never have more than 3 consecutive races

Travelling Salesman

(*logistics between races, determines overall race schedule*):

- Triple and double headers from VRP are fixed

Emissions and Attendance Trade-Off

Emissions as a function of distance $D_{i,j}$:

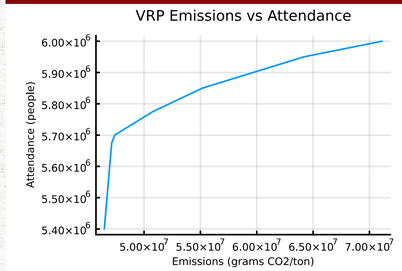
$$E_{i,j} = \begin{cases} D_{i,j} * 62 & if\ D_{i,j} \leq 5000\ km \\ D_{i,j} * 500 & if\ D_{i,j} > 5000\ km \end{cases} \quad (grams \frac{CO_2}{ton})$$

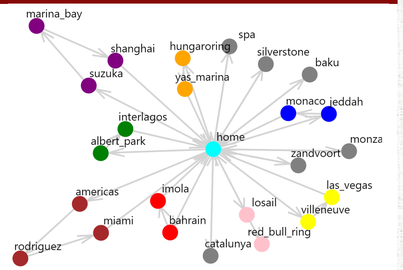
(i.e., do we go by truck or by plane?)

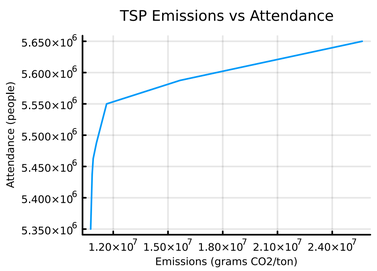
Attendance loss as a function of distance $D_{i,j}$:

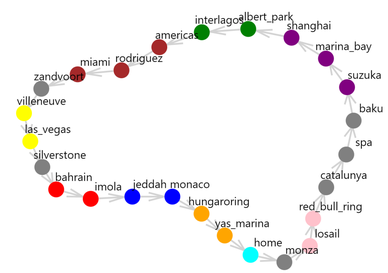
$$A_{i,j} = \begin{cases} 150\,000 & if\ D_{i,j} \leq 250\ km \\ 125\,000 & if\ D_{i,j} \leq 500\ km \\ 100\,000 & if\ D_{i,j} \leq 1000\ km \\ 50\,000 & if\ D_{i,j} \leq 3500\ km \\ 0 & otherwise \end{cases} \quad (less\ people)$$

Trade-Off Results









Improvement Over Actual Schedule

Under our assumptions, the optimal trade-off VRP solution leads to the teams having **37% less emissions** compared to the actual schedule.

Based on this optimal VRP, our optimal trade-off TSP solution leads to the race supporting logistics having **69% less emissions** than in the actual schedule.

Overall race attendance is given by the TSP, and in our optimal solution **attendance increases by 5.7%** compared to the actual 2023 race schedule.

Potential Next Steps

1) Improve efficiency

VRP model consists of 17M+ constraints and 14K+ variables, not tractable for consumer hardware

➡ Explore ways to make problem **more computationally tractable**

2) What about the weather?

A Formula 1 race can only be held if the weather is clear or if there is a limited amount of rain

➡ Add time dimension and weather data to the TSP to **minimize chances of races being cancelled** due to bad weather