# Modelling of a Mobility Meeting Scheduler

Alexandre Abreu, Pedro Seixas, Xavier Pisco
Faculty of Engineering of the University of Porto
Porto, Portugal
{up201800168,up201806227,up201806134}@up.pt

May 10, 2022

## 1 Introduction

In a globalized world, people can easily have friends in other parts of the world, one situation that can make this happen in a moment where people tend to travel more is exchanges programs, which are rising substantially in the last years [Messer and Wolter, 2007]. Friends from a university will be separated for a semester, each in their own destination, but they are in a moment of their lives dedicated to knowing more about other places and cultures, so, nothing more fitting than visiting cities together. Even more so, when we consider that the most common destinations of students in exchange programs are in Europe [Van Mol and Ekamper, 2016], which is a place with lots of touristic regions with distinct cultures very close to each other [Antonakakis et al., 2015].

But this comes with one problem, the calculation of prices and scheduling of flights becomes increasingly harder when the number of people and origin cities grows. Making decisions with that many variables is hard without aid of technology. In our case, that help will consist mainly of using constraint programming to deal with lots of variables and constraints.

With this project, we aim to create an application that can help people to make decisions about their travelling plans taking into consideration their costs and times, among other variables. But, the main goal is to compare different implementations for this exact problem, using as tools: *SICStus Prolog*, *Google OR-Tools* and *IBM ILOG CPLEX Optimization Studio*, some of the most well-known constraint programming solvers [Stuckey et al., 2014].

The main idea is to have an application that can receive information of the students with their respective stay and the destinations they are pondering to go. Together with some constraints like their available hours, minimum time of the trip and even their preferences about flights, like duration and number of connections.

## 2 Formal Definition

### 2.1 Data Attributes

The project uses data related to flights, trips, students and groups, all of them are vectors and their definitions are regarded in this section.

#### 2.1.1 Flights

Each flight is defined as:

$$f = \langle origin, destination, departure, arrival, duration, price\rangle$$

Where:

- **origin** and **destination** are codes of the cities or airports, following the same convention as Google Flights, which has replaced other travel websites due to its user-friendliness, processing and advanced features [Gerth, 2019];
- **departure** and **arrival** are timestamps in the same timezone as their respective locations';
- **price** is always in euros.

### 2.1.2 Trips

Each trip is defined as a list of flights:

$$t = \langle f_1, f_2, f_3, ..., f_n \rangle$$

Where:

- For any two consecutive flights $f_i$ and $f_{i+i}$, the destination of $f_i$ is the same as the origin of $f_{i+i}$;
- The **origin** and **departure** of the trip are the same as of $f_0$;
- The **destination** and **arrival** of the trip are the same as of $f_n$;
- The **duration** of the trip is the time difference between its **arrival** and **departure**, in minutes, so, it includes connection times;
- The **price** of the trip is the sum of all the individual flight prices;
- The **number of connections** of the trip is the number $n$ of flights;
- For most purposes, we treat trips as flights with a **number of connections** attribute.

### 2.1.3 Mobility Students

Each mobility student is defined as:

$$s = \langle city, availability, max\ connections, max\ duration, earliest\ departure, latest\ arrival \rangle$$

Where:

- **city** is the current location of the student, that is, the place where they are located during their mobility time;
- **max connections** is the maximum number of connections the student is willing to take, it includes the departure and arrival trips;
- **max duration** is the maximum duration for each trip, it is represented in minutes;
- **earliest departure** and **latest arrival** are represented in hour and minutes of the day in the same timezone used in **city**;
- **availability** is represented as a list of dates where the student is available to travel.

### 2.1.4 Problem Input

An input to the problem is defined as:

$$i = \langle group, minimum\ useful\ time, destinations \rangle$$

Where:

- **group** is a list of all the students;
- **minimum useful time** is the minimum value between the last arrival and first departure in the destination between the members of the group;
- **destinations** is a list of the possible destinations.

### 2.1.5 Solution

Finally, a solution is defined as a list of pairs:

$$s = \langle (to_0, ti_0), (to_1, ti_1), ..., (to_n, ti_n) \rangle$$

Where:

- $n$ is the number of people in the group;
- $to_i$ and $ti_i$ represent, respectively, the outgoing and incoming trips of the $i$th member of the group. The pair $(to_i, ti_i)$ can be referred to as $p_i$;
- All incoming trip's **origin** and outgoing trips' **destination** have the same value, which represents the place all students will travel to;

## 2.2 Restrictions

The restriction attributes are defined for students or for the global context, this section will enumerate each one of the restrictions by their type.

Restrictions for students:

- The student will leave its city after **earliest departure**, and they will arrive before **latest arrival**. These are hard restrictions relative to the departure of the outgoing trip and arrival of the incoming trip of the student;
- The entire travel time will entirely take place within the days of the week the student is available;
- The trips that will be considered include less than **max duration** minutes and less than **max connections**.

Global restrictions:

- All people of the group must travel to the same place, that is an element of **destinations**;
- The intersection of the time each person stays in the destination is larger than **minimum useful time**;

## 2.3 Objective

The objectives of the application are:

- Minimize the sum of the trips' cost for every group member, referred to as **individual cost**;
- Minimize the sum of students' costs, referred to as **total cost**;
- Maximize the time all the students are together in their destination, referred to as **useful time**;
- Minimize the time when each person is in the destination, but not the entire group, referred to as **separated time**.

# 3 Next Steps

We want to start the implementation of the problem now. With parallel development of applications using each one of the three tools.

# References


[Antonakakis et al., 2015] Antonakakis, N., Dragouni, M., and Filis, G. (2015). How strong is the linkage between tourism and economic growth in europe? *Economic Modelling*, 44:142–155.

[Gerth, 2019] Gerth, K. M. (2019). *Creating sustainable competitive advantage in the German B2B lending business: the case study of Google llc*. PhD thesis.

[Messer and Wolter, 2007] Messer, D. and Wolter, S. C. (2007). Are student exchange programs worth it? *Higher education*, 54(5):647–663.

[Stuckey et al., 2014] Stuckey, P. J., Feydy, T., Schutt, A., Tack, G., and Fischer, J. (2014). The minizinc challenge 2008–2013. *AI Magazine*, 35(2):55–60.

[Van Mol and Ekamper, 2016] Van Mol, C. and Ekamper, P. (2016). Destination cities of european exchange students. *Geografisk Tidsskrift-Danish Journal of Geography*, 116(1):85–91.