Technical University of Catalonia (UPC)

Technical report

Visualization tool for the TechNET planning system

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1. Versions

- This version: Luigi Ceccaroni, August 22, 2005
- Original: Himanshu Agrawal, 23/7/2005

2. Purpose of the document

The work described in this document has been carried out in the frame of the @LIS TechNET project, which aims to create a live network across Europe and Latin America as a new, virtual, and interactive learning environment, based on software-agent technology. The purpose of this document is to describe a visualization tool developed for the TechNET's planning system. As background, this document also briefly describes what mixed-initiative planning is.

3. Terminology used

GPA: global planner agent
MIA: mixed initiative agent
Non-expanded itinerary: itinerary in which some nodes are not *expanded*

4. Introduction to mixed-initiative planning

Interaction between humans and information system is a complex and dynamic task. Mixed-initiative interaction is a *flexible interaction strategy* in which each agent contributes what is best suited at the most appropriate time. Agents can be computer systems as well as human agents. Roles of agents are not pre-determined; instead they are negotiated among them as the problem is being solved.

In mixed-initiative planning, the user collaborates with an automated assistant to generate and carry out different courses of action. Effective collaboration between a human planner and an automated planning system requires that the participants work in areas where they perform best, use appropriate representations for communication, and effectively acquire and transfer authority for planning tasks. A number of mixed-initiative systems have been developed (e.g., TRAINS, TRIPS, COLLAGEN, AIDE) and significant progress has been made on abstract models of mixed initiative.

Mixed-initiative systems provide assistance to users in information intensive environments. A mixed-initiative system can increase the user's situational awareness:
- by collecting, extracting, and analyzing relevant information from the partially-instantiated itinerary and from the rules that are potentially applicable at any given moment;
- by providing abstractions of that information;
- by displaying information at the user interface, in such a way that that information is easier to be managed.

Knowing the user and how to best present information to her is central in this assistance. The interaction between humans and information system involves:
- the acquisition,
- the visualization,
- the manipulation and
- the suppression of knowledge.

In this respect, each component of the above interaction of an intelligent mixed-initiative system (IMIS) with a human can be viewed as a mixed-initiative planning task. One of the advantages of using a mixed-initiative system is the ability to allocate tasks and goals between a human user and the planning system to improve the individual performance (effectiveness and efficiency) of each. A user's strength lies in the ability to provide guidance and insight concerning information that is necessary to draw complex, higher level inferences from data. The system's strength lies in its ability to perform data acquisition and management, to display information from many heterogeneous sources, to perform low-level quantitative and qualitative analysis, and to perform routine inference to enable decision support.

Two main issues need in general to be addressed in IMISs:

- ***Deciding when to intervene and provide assistance*** – For the planning system to work efficiently, each agent must know when to interfere with the other one and provide assistance. Control of the planning task must be passed on between the agents at the most appropriate moment so that each agent can perform to the best of its abilities.

- ***Uncertainty about the user's actual goals, needs and attention*** – Planning system must know exactly what the user wants. His goals and needs must be precisely mentioned. The focus of his attention should be clearly expressed.

5. Objective

Purpose of work package 4 of TechNET is to deploy and demonstrate enhanced, personalized user-services for tourists and citizens in the cultural, heritage and tourism domains in the countries represented by partners in the TechNET network. The work includes requirements analysis with tourism authorities, modeling the domain, deploying services, providing wired and wireless access as well demonstrating dynamic composition of services in the network. In TechNET's planning system (which is part of a **multi-agent system** implemented using FIPA standards) an itinerary is created for a user who wants to visit one or more countries. We introduced mixed initiative to give the user more control over the process of planning. Mixed-initiative interaction comes into the picture during the itinerary refinement in the planning process (see Figure 1). This stage is where the basic planning is done. Here the user is prompted to agree to the plan. The idea is to issue a not completely expanded itinerary and let the user agree on further decomposition or correct the plan proposed. This results in lesser number of backtracking instances. By introducing mixed initiative planning, we wish to eliminate the cases where the planning system plans the whole itinerary and then the user discards it in the end just because he wants to change the order of the countries to visit, or the days he plans to spend in a particular country, or other small aspects of the itinerary.
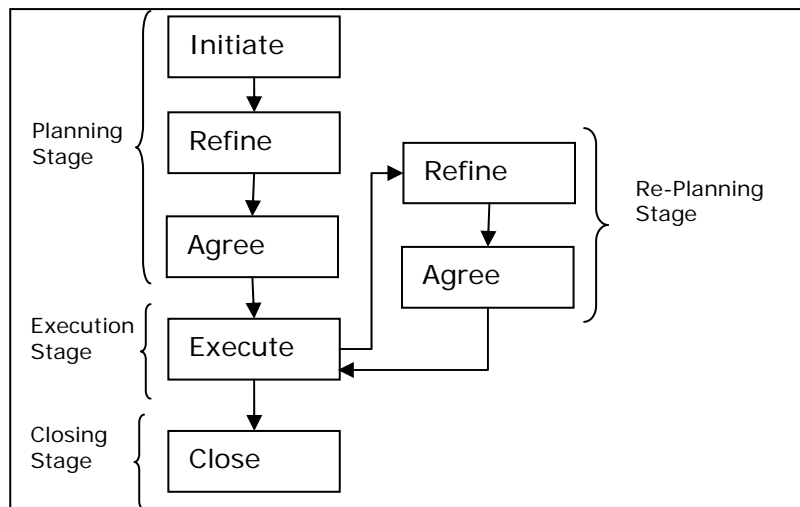
Figure 1. *Life cycle of an itinerary*

As the planning system goes down through the stages in the hierarchical task network (see Figure 2), the user is prompted to correct the plan. At present, we apply mixed initiative only at the top two levels of decomposition.

- ### *Decomposition Level 1*

  o This is the most abstract level of the hierarchy. The *Event* class is the top class in this hierarchy. It is the most abstract class which no node expanded. As we decompose at this level, *Event* is divided into *CountryVisiting* events (see Figure 2). *Transportation* events are also added to provide transportation between different countries.
  o The order in which countries are visited, the days to spend in each country and budget assigned to each country are defined by the rules of this decomposition level.

- ### *Decomposition Level 2*

  o At this level, the *CountryVisiting* event is decomposed into *FirstDivisionPlaceVisiting* events (corresponding, for example, to regions). Again *Transportation* events are added to provide transportation between various places.
  o The order in which places are visited and the days to spend in each first-division place are defined by the rules of this decomposition level.
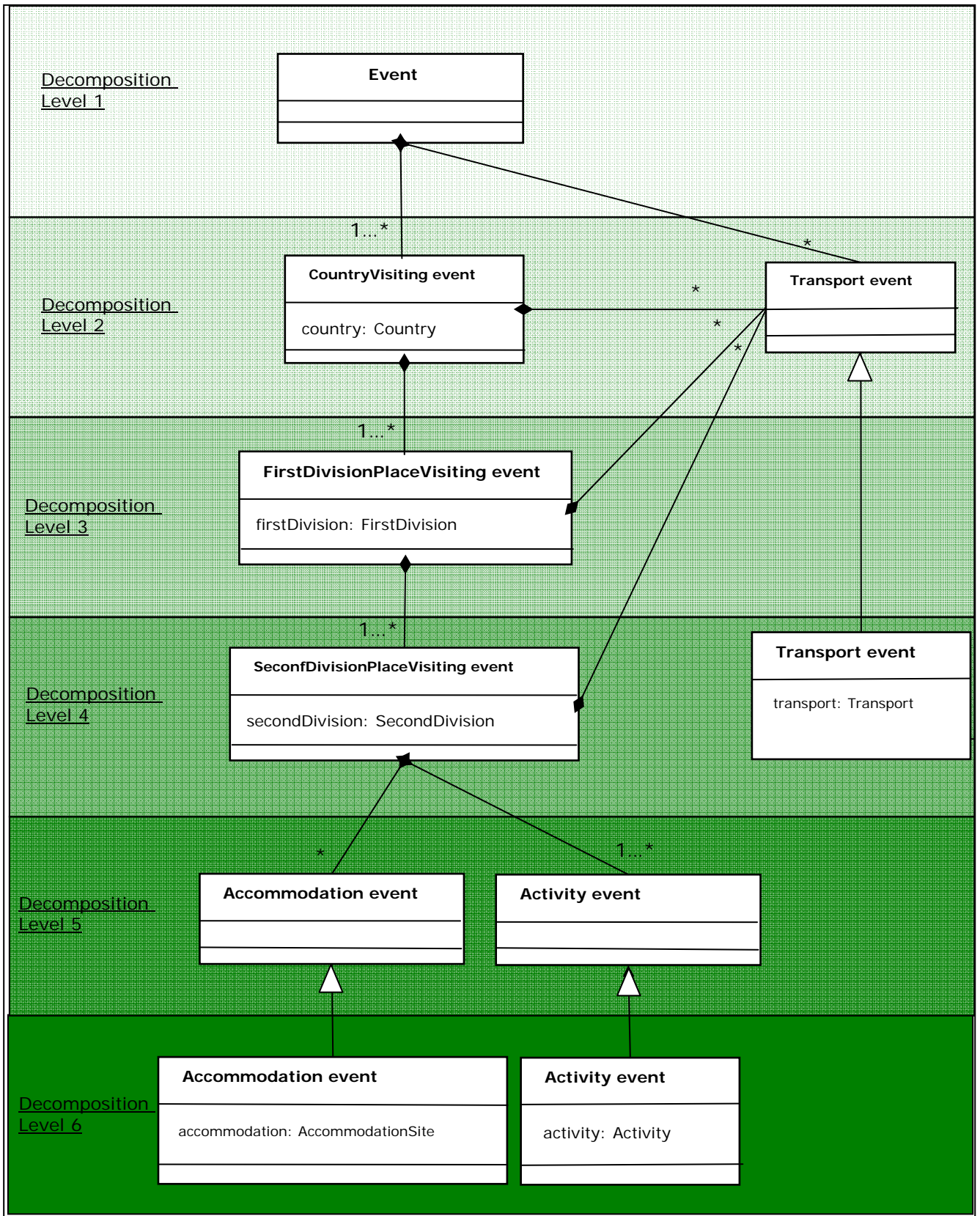
Decomposition Level 1

Event

Decomposition Level 2

1...*

CountryVisiting event

country: Country

*

Transport event

*

*

Decomposition Level 3

1...*

FirstDivisionPlaceVisiting event

firstDivision: FirstDivision

Decomposition Level 4

1...*

SeconfDivisionPlaceVisiting event

secondDivision: SecondDivision

Transport event

transport: Transport

Decomposition Level 5

*

Accommodation event

1...*

Activity event

Decomposition Level 6

Accommodation event

accommodation: AccommodationSite

Activity event

activity: Activity

Figure 2. Event-class diagram showing the hierarchy of decomposition

Figure 3. Ontology diagram including the itinerary

6. Implementation

Mixed initiative planning is achieved through the implementation of a MIA (mixed initiative agent) which communicates with the global planner agent (GPA) to carry out the planning process. The itinerary object is the basic means of data exchange. It simplifies the conversations that agents need to have in order to know what they want from each other. The MIA runs on a JADE (Java Agent Development Framework) platform which simplifies the implementation of multi-agent systems through a middle-ware that complies with FIPA specifications. The communication between MIA and GPA is via FIPA messages.

The MIA requests the itinerary from the GPA, extracts relevant information from the itinerary and shows it to the user in an appropriate representation. The user agrees with the plan proposed or makes some modification before agreeing. The MIA then sends this modified itinerary back to the GPA which continues with its planning process until MIA again makes an itinerary request. This exchange goes on for a number of times until the plan gets into deeper decomposition levels.

Issues addressed

- ***Deciding when to intervene and provide assistance*** – As mentioned, at the moment we are only concerned with the top two levels of decomposition:
  - *Event* decomposition level
  - *CountryVisiting*-event decomposition level

- ***Uncertainty about the user's actual goals, needs and attention*** – This uncertainty about the user's actual goals and needs has been eliminated by asking the user his preferences at the very beginning of the planning process.

The GPA uses DROOLS, which is a rule based reasoning engine, to select and fire rules, and to decompose the abstract plan. User preferences are used as the pre-condition to fire the appropriate rule. Figure 3 gives a brief scheme of these constraints.

6.1. **Event** *decomposition level*

The MIA requests the GPA the abstract plan decomposed into the *CountryVisiting* events. The MIA then extracts the starting country and the destination countries along with the corresponding days and budget for each country from the itinerary object.

This information is then graphically represented for the user using JAVA Swing. User is first asked to check the order of the countries to be visited (see Figure 4). Right now the initial order of the countries is random and the user is allowed to change this order (see Figure 5). In fact, he is even allowed to change the countries as well. At the moment, we have itinerary specifications for four countries, namely Mexico, Costa Rica, Chile and Cuba. So user is allowed to pick up any of these countries as his destination country.


Figure 4. Interface to ask the user to check the order of the countries to be visited
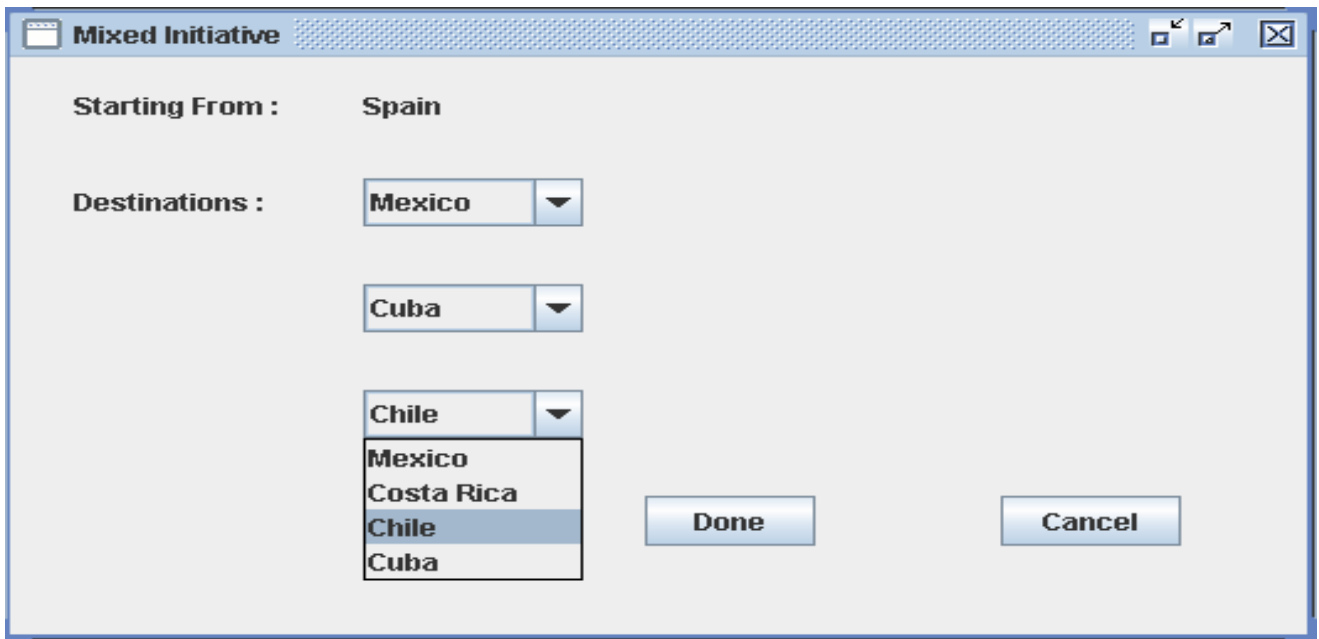
Figure 5. Interface to change the order of the countries to be visited

When the user changes the order and the countries, it is checked that he has not included the same country more than once. When the user agrees with the proposed order or is done changing it, he is then shown the information about the days to spend in each country (see Figure 6). He is allowed to change the number of days for particular countries as long as he does not change the total plan duration.
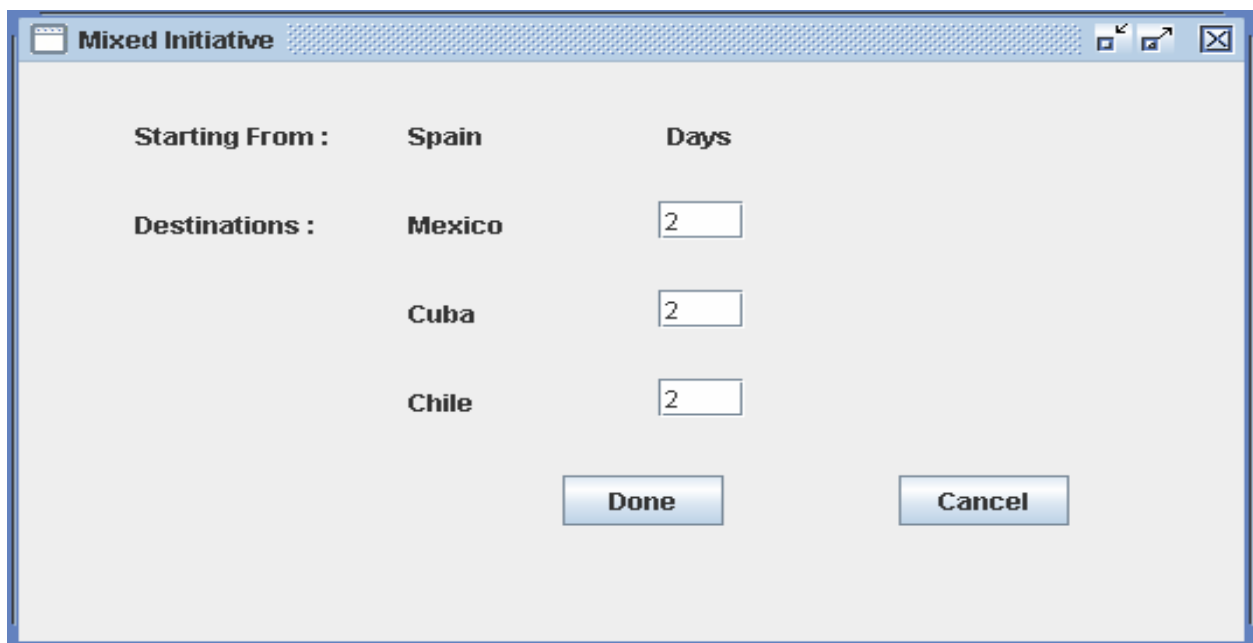
Figure 6. Interface to show the user the information about the days to spend in each country

After this, he is presented with the information about the budget (see Figure 7). Again the user is allowed to change his budget for each country.

Figure 7. Interface to show the user the information about the budget in each country

When the user is done with his changes, the modified itinerary is sent back to GPA with same data structures.

6.2. CountryVisiting-*event decomposition level*

In this case, MIA requests the GPA the abstract plan decomposed into the *FirstDivisionPlaceVisiting* events. MIA then extracts, from the itinerary object, the destination places along with the corresponding days for each place.

Again the user is first prompted to check the order of the places to be visited (see Figure 8). The specific names of *FirstDivision* places not being yet available in the main system, some generic names are used here. Again the user is not only allowed to change the order but also the place itself.
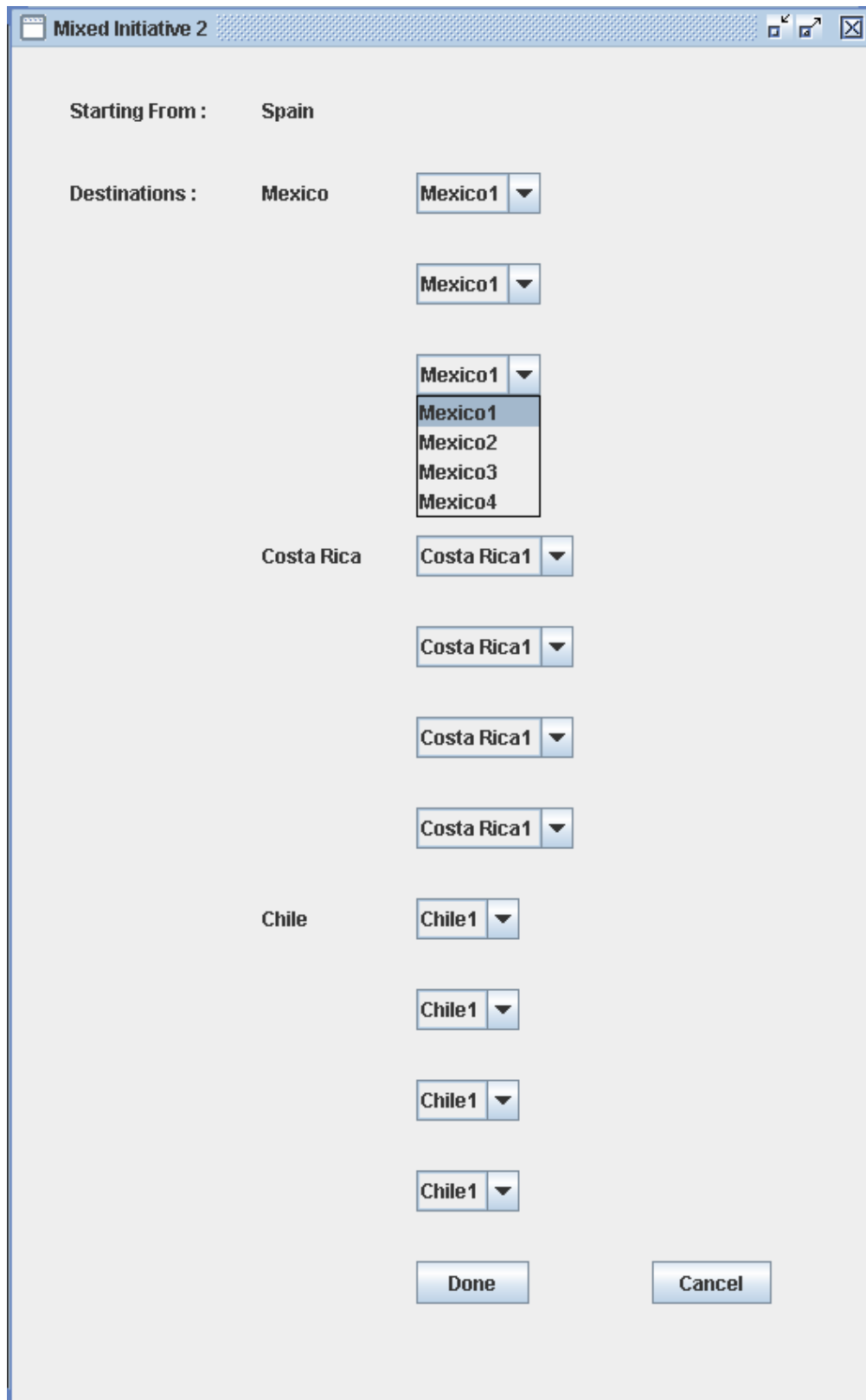
Figure 8. Interface to change the order of the regions to be visited in each country

After this step, information about the time to spend in each place is presented to the user, who is allowed to change it keeping the total duration constant (see Figure 9).

Figure 9. Interface to show the user the information about the days to spend in each region

7. Possible future upgrades

- Current error messages are not quite informative. They can be improved.
- The type of transportation in not included at the moment. It can be considered.
- An interface for the activities to be carried out each day, similar to the ones presented here, can be considered to let the user change the order in which he wants to perform the activities as well as the activities themselves.
- At present, the communication between GPA and MIA is simulated as the rules are not live and the GPA is not active. This communication needs to be implemented using FIPA specifications.