Brief Article

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1 Context Knowledge

OM-1
Identifying knowledge-oriented problems and opportunities in the organization

Organization Model	**Problems and Opportunities Worksheet OM-1**
Problems and opportunities	Difficulty for the travel agent in designing pesonalized itineraries, due to customers lack of knowledge on the subject and great variety of points of interest in a location. The process of building personalized itinerary is time-consuming for the agent, and could be subjected to multiple revisions or discarded altogether from the client.
Organizational context	**Mission, vision, goals**: efficient itinerary design, customer satisfaction, improving time schedule of the travel agent, increasing the number of satisfied requests; **External factors**: requirements of the client, client profile (age, interests), set up of the destination, geographical topology of the location; **Strategy:** given a list of possible locations, assemble an itinerary that best suits the customer's requirements; 4. Its value chain and the major value drivers
Solutions	Automatization of the selection process for the locations and the revision of compiled itinearies, leaving to the travel agent the task of interacting with the client and proposing the drafts.

OM-2
Description of organizational aspects that have an impact on and/or are affected by chosen knowledge solutions

Organization Model	**Variant Aspects Worksheet OM-2**
Structure	See Figure 1
Process	See Figure 2
People	Single-customer Travel Agent
Resources	**Database** of locations containing all the available infomation. **Database** of customers containing personal features and preferences. **Designing software** capable of assembling the itinerary.
Knowledge	**Requirement rules**: knowledge to choose a set of locations based on the client features; **Preference rules**: knowledge to favour a some location more than others based on client expressed preferences; **Constraint rules**: knowledge to exclude or include specific locations based on client explicit directives.
Culture & power	The opinion of the client is highly prioritized. Being a small agency no particular power influence is noticeable between co-workers: the hierarchical structure is vertical, with the president occupying the highest position and in charge of all important decisions.

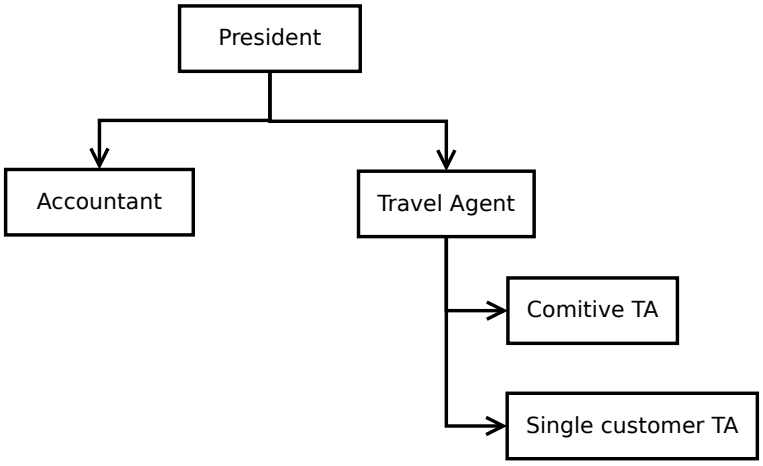

Figure 1: Organization structure

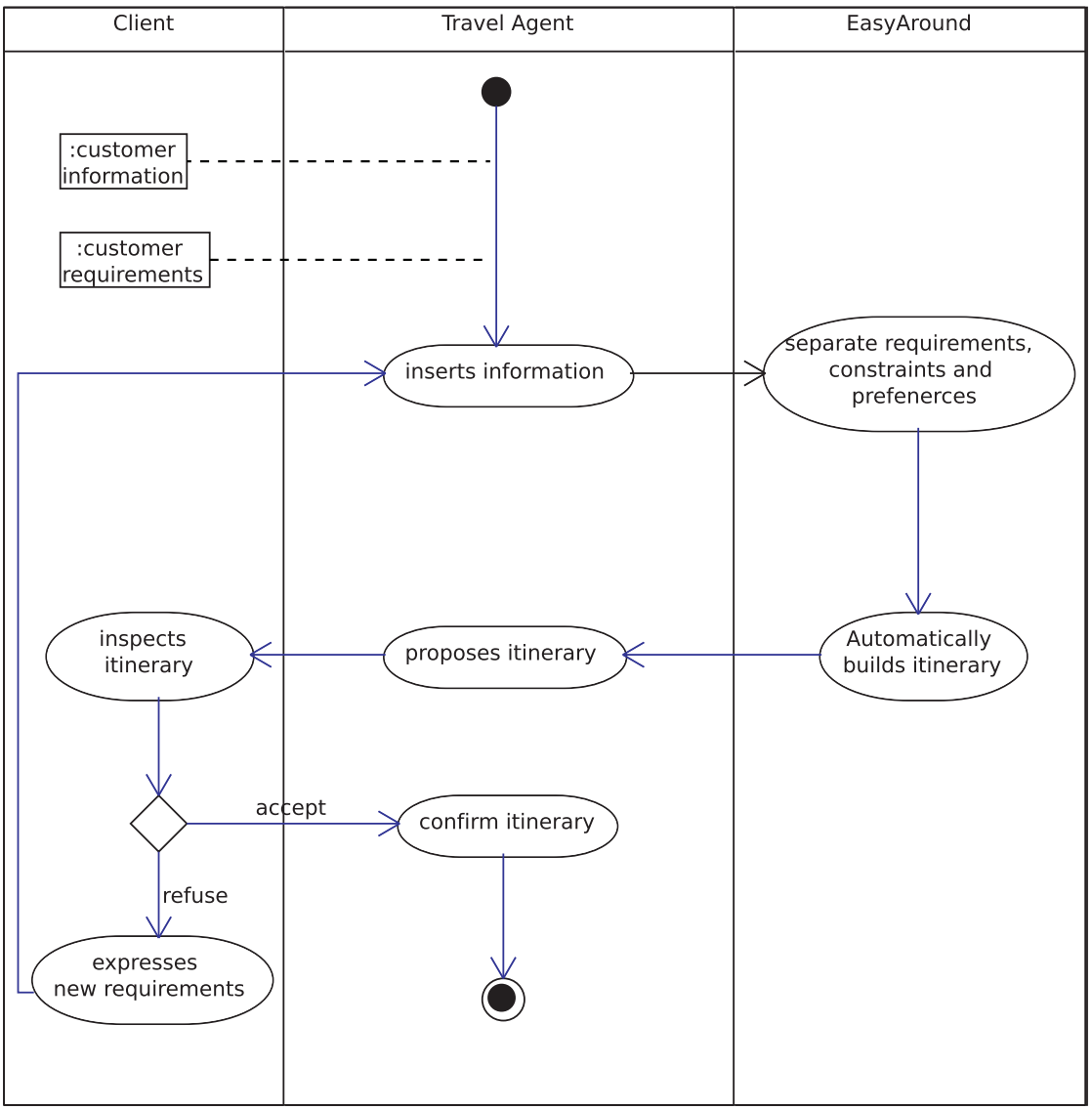

Figure 2: Organization process

OM-5
Checklist for the feasibility decision document

Organization Model	Checklist for Feasibility Decision Document: Worksheet OM-5
Business feasibility	**Benefits**: the itinerary process is quicker, the client is more satisfied, travel agents can schedule their work time on a higher number of customers; **Added value**: the speed up should be quite significant, it is expected that the TA can satisfy a client surplus of 30% with the time he saved in building and reviewing degigns. **Costs**: the costs are a summation of the salary of the employees working on building the software (programmers, experts) and the time spent in integrating the licenced content into the automated system; **Organizational Changes**: the system is built to avoid organizational changes. **Risks**: the system could have difficulties in selecting the right locations based on customer's requests, not posing as an advantage to the Travel Agent. In this case the workload would not decrease.
Technical feasibility	**Complexity**: the complexity level of the required reasoning is high, because it need the integration of a lot of informal knowledge into a formal system, and the handling of many constraints; **Critical aspects**: the solution must be developed correctly, otherwise the risk of losing clients grows. Furthermore, if the results are not as expected, the software could not be accepted or used inside the acency. **Success Measures**: if the design is coherent with the requirements, if there are no constraint violations, if it corresponds to the preferences of the client, and it is at least the same or better than a manual design done by the TA, then it is a success. **User Interface**: the UI can be constructed to be very simple and intuitive, requiring no additional knowledge about IT systems from the user. **Additional Interactions**: the only extern interaction is with the structured database of locations, which basic structure is fully impemented and documented in many shapes and programming languages. **Further technological risks**: there are no further risks;

PROJECT FEASIBILITY	**Commitment**: the TAs are interested in a mechanism that allows them to save time for single-customer itinerary design, the president is interested in employing new technologies to increment profit. **Resources**: since the expertise is provided by the agency itself, the necessary resources left are the ones needed for the programmers. Being freelancers, their cost is relatively limited by the absence of an organization that coordinates the work. **Knowledge**: the knowledge is available since it's provided by the agency itself, and it's largely available on public means such as the web; **Expectations**: the expectation are realistic; **Communication**: the communication is efficient, both between the programmers who have worked with each other previously, and between the expert consultant and the team since they are acquaintances.
PROPOSED ACTIONS	1. *Focus:* speed-up of the design process, increased number of customers; 2. *Target solution:* Automatization of the design and revision process; 3. *Results, costs, and benefits:* satisfaction of the client, saved workload and working time for the TA; 4. *Project actions*: building the Knowledge Model, create the Design Model, create the Communication Model, implement the system, embed the knowledge in the software, test the software and collect results; 5. *Risks:* the system could have difficulties in selecting the right locations based on customer's requests, not posing as an advantage to the Travel Agent. In this case the workload would not decrease

TM-1
Refined description of the tasks within the target process

Task Model	**Task Analysis Worksheet TM-1**
TASK	Automated Design
ORGANIZATION	Task is controlled by the Travel Agent and executed by the appointed software. It is the product of non-human intervention.
GOAL AND VALUE	The goal is the design of an itinerary composed of multiple locations, based on the preferences and the requirements set by the customer.
DEPENDENCY AND FLOW	*Input tasks*: Evaluate Request *Output tasks*: Propose Itinerary
OBJECTS HANDLED	*Input objects*: requirements, preferences and constraints from the customer. *Output objects*: itinerary. *Internal objects*: database of locations.
TIMING AND CONTROL	**Frequency and duration**: whenever a client asks for a custom-made itinerary, arbitrarily short duration. **Control relation**: (I) *Preconditions*: the request from the client must be organized in a set of requirements, constraints and preferences; (II) *Postconditions*: the itinerary must satisfy the request of the client.
AGENTS	Travel Agent
KNOWLEDGE AND COMPETENCE	Requirement rules, preference rules, constraint rules.
RESOURCES	Database of exsting locations, automated software for itinerary design, Travel Agent for customer interaction; The duration of the interaction depends on the satisfaction of the client and he number of reviews requested on the itinerary. It should be in every occasion shorter than the duration of an interaction that does not include the automated system.
QUALITY AND PERFORMANCE	If the design is coherent with the requirements, if there are no constraint violations, if it corresponds to the preferences of the client, and it is at least the same or better than a manual design done by the TA, then it is of good quality.

TM-2
Specification of the knowledge employed for a task, and possible bottlenecks and areas for improvement

Task Model	**Knowledge Item Worksheet TM-2**
NAME	Requirement Rules
POSSESSED BY	Travel Agent
USED IN	Automated Design.
DOMAIN	Travel Planning

Nature of the knowledge		**Bottleneck / to be improved?**
Formal, rigorous		
Empirical, quantitative	X	X
Heuristic, rules of thumb	X	X
Highly specialized, domain-specific	X	
Experience-based	X	
Action-based		
Incomplete		
Uncertain, may be incorrect	X	X
Quickly changing		
Hard to verify	X	X
Tacit, hard to transfer	X	X

Form of the knowledge		
Mind	X	
Paper		
Electronic		
Action skill		
Other		

Availability of knowledge		
Limitations in time		
Limitations in space		
Limitations in access		
Limitations in quality	X	X
Limitations in form		

Task Model	**Knowledge Item Worksheet TM-2**
NAME	Preference Rules
POSSESSED BY	Travel Agent
USED IN	Automated Design.
DOMAIN	Travel Planning

Nature of the knowledge		**Bottleneck / to be improved?**
Formal, rigorous		
Empirical, quantitative	X	X
Heuristic, rules of thumb	X	X
Highly specialized, domain-specific	X	
Experience-based		
Action-based		
Incomplete		
Uncertain, may be incorrect	X	X
Quickly changing	X	X
Hard to verify	X	X
Tacit, hard to transfer	X	X

Form of the knowledge		
Mind	X	
Paper		
Electronic		
Action skill		
Other		

Availability of knowledge		
Limitations in time	X	X
Limitations in space		
Limitations in access		
Limitations in quality	X	X
Limitations in form		

Task Model	**Knowledge Item Worksheet TM-2**
NAME	Constraint Rules
POSSESSED BY	Travel Agent
USED IN	Automated Design.
DOMAIN	Travel Planning

Nature of the knowledge		**Bottleneck / to be improved?**
Formal, rigorous	X	
Empirical, quantitative		
Heuristic, rules of thumb		
Highly specialized, domain-specific	X	
Experience-based		
Action-based		
Incomplete		
Uncertain, may be incorrect		
Quickly changing	X	X
Hard to verify		
Tacit, hard to transfer		

Form of the knowledge		
Mind	X	
Paper		
Electronic		
Action skill		
Other		

Availability of knowledge		
Limitations in time	X	X
Limitations in space		
Limitations in access		
Limitations in quality		
Limitations in form		

AM-1
Agent specification according to the CommonKADS agent model

Agent Model	**Agent Worksheet AM-1**
NAME	*Single-customer Travel Agent*
ORGANIZATION	Human, sub-category of the Travel Agent
INVOLVED IN	Automated Design
COMMUNICATES WITH	Customer
KNOWLEDGE	Requirement rules, Preference rules, Constraint rules
OTHER COMPETENCES	Social skills to interact with a customer
RESPONSIBILITIES AND CONSTRAINTS	Collect the request from the client, and provide the customer's personal featues to the software; supervise the automated process of design and propose the itinerary to the customer; modify the request in case of review of the proposed itinerary.

2 Task Knowledge

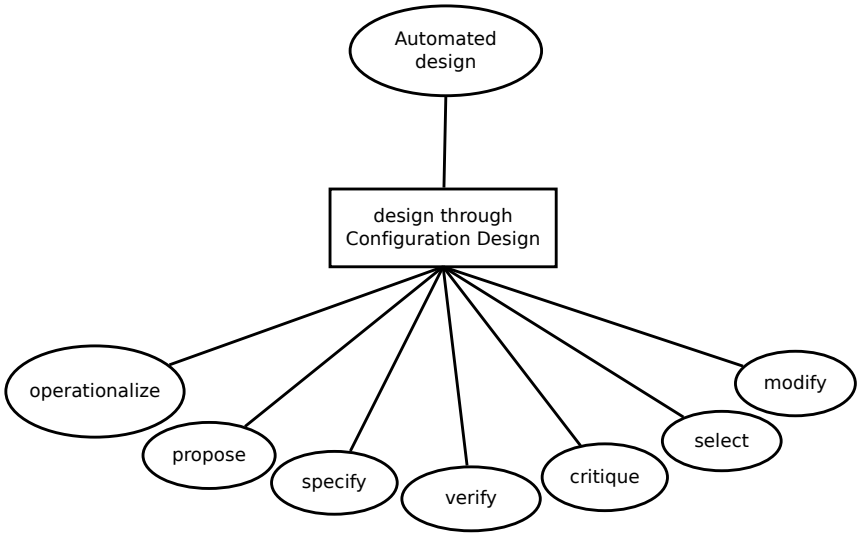

Figure 3: Task knowledge

The "propose and revise" method for configuration design presented in its original form in the textbook for the course has been slightly modified to obtain a method that reflects the needs of our software. The *WHILE* loop to revise the the design has been postponed from a state of *propose* to a state of *verify*, and the internal *REPEAT UNTIL* loop to select the actions has been integrated in the outer cycle. This way the method reflects exactly the intended steps to be realized in the software.

Listing 1: Task and task method description

```
TASK automated-design;
  ROLES:
    INPUT: requirements: "requirements for the design";
    OUTPUT: itinerary: "the resulting design";
END TASK configuration-design;

TASK-METHOD propose-and-revise;
  REALIZES: automated-design;
  DECOMPOSITION:
    INFERENCES: operationalize, propose, specify, verify,
       critique, select, modify;
  ROLES:
    INTERMEDIATE:
      preferences-and-requirements: "requirements and
         preferences to be preferably fulfilled";
```

```
        constraints: "requirements that have to be fulfilled";
        sketal-design: "set of slots to be filled";
        proposal: "a possible compilation of the sketal-design";
        customer-input: "set of new requirements or constraints";
        violation: "new constraints violated by the current
            design";
        truth-value: "boolean indicating the result of the
            verification";
        action-list: "ordered list of possible repair (fix)
            actions";
        action: "a single repair action";
        itinerary: "a new possible compilation of the sketal-
            design";
    CONTROL-STRUCTURE:
        operationalize(requirements -> preferences-and-requirements
            + constraints);
        specify(requirements -> sketal-design);
        propose(constraints + preferences-and-requirements + sketal
            -design -> proposal);
        itinerary := proposal ADD itinerary;
        WHILE verify(customer-input + itinerary -> truth-value +
            violation) IS truth-value == false DO
            critique(violation + itinerary -> action-list)
            select(action-list -> action)
            modify(itinerary + action -> itinerary)
            verify(itinerary + customer-input -> truth-value +
                violation);
        END WHILE
END TASK-METHOD propose-and-revise;
```

3 Inference Knowledge

As inference model we use a modified version of the Configuration design template, because given predefined components we need to find and assembly that satisfies the requirements. The inference model deriving from this task can be found in Figure 4. The standard inference model for the configuration design template (propose and revise) has been modified to better express the needs of our software:

- Soft and hard requirements have been transformed in “preferences and requirements” and “constraints” respectively
- Extension has been changed into “proposal”

- Verify requires the direct input of the customer, since it's a verification of subjective correctness more than a verification of constraint violation.
- Design has been changed int "itinerary" for coherency purposes.

It has to be noted that the subsystem building the proposal, in the implementation of the system, does not permit a constraint violation, so the verification of the constrait has been removed because redundant.

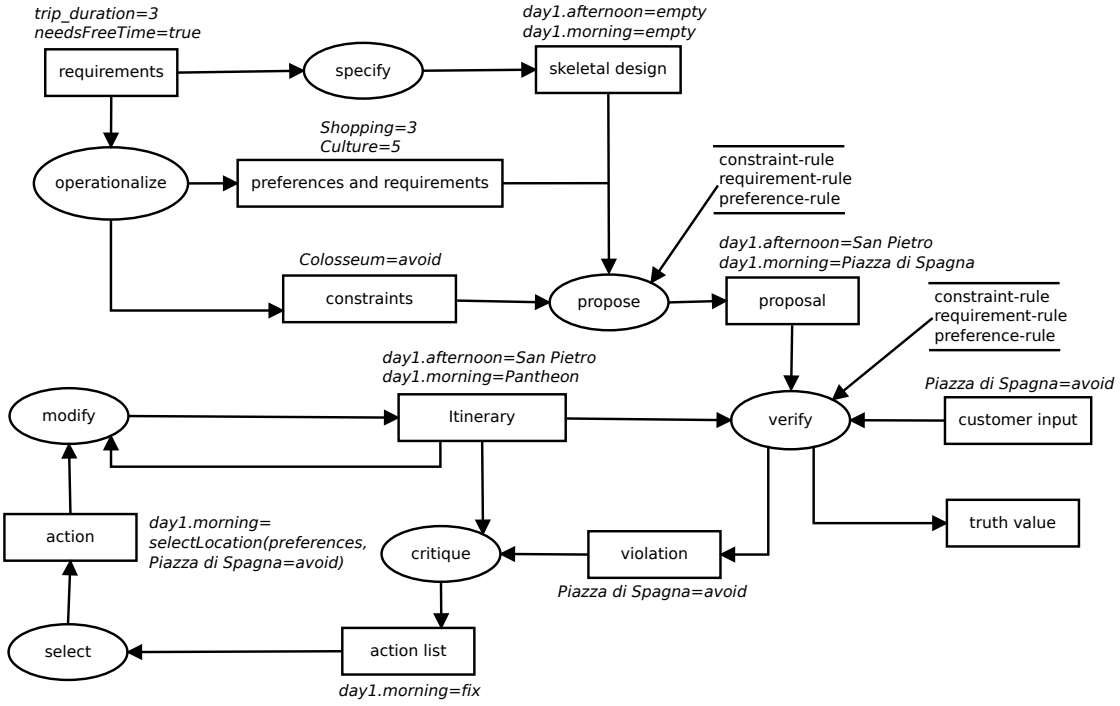

Figure 4: Inference structure

inference	Input	Output	Description
specify	requirements	sketal design	the function look-up the default sketal design: the basic structure of a trip day (heavy activity during the morning, relaxing afternoon, evening and meal).
optionalize	needs of the customers	preferences, requirements, constraints	the needs and desires are translated into preferences ("I would like to have time for shopping and visit many cultural places. I am not interested so much in food places"), requirements ("I want a quiet trip") and contraints ("In Rome I want to visit the *Colosseum* and avoid *Piazza di Spagna*").
propose	preferences and requirements, sketal design slots	filled sketal design	fill the slots of the sketal design with locations that fits the preferences and requirements.
verify	contraints, extension design	the list of violated contraints	it checks with the help of the internal contraints and those supplied by the user whether the current configuration is internally consistent. If the verification fails, it produces the violated contraints as an additional output
select	fix actions list	fix action	It simply selects an action from the fix actions list generated by the critique function.
modify	itinerary design, fix actions list	fixed itinerary design	it applies the fix actions to the design.
critique	itinerary, viola-	fix actions list	it creates a series of

4 Domain knowledge

4.1 Domain schema

The domain schema can be found in Figure 5

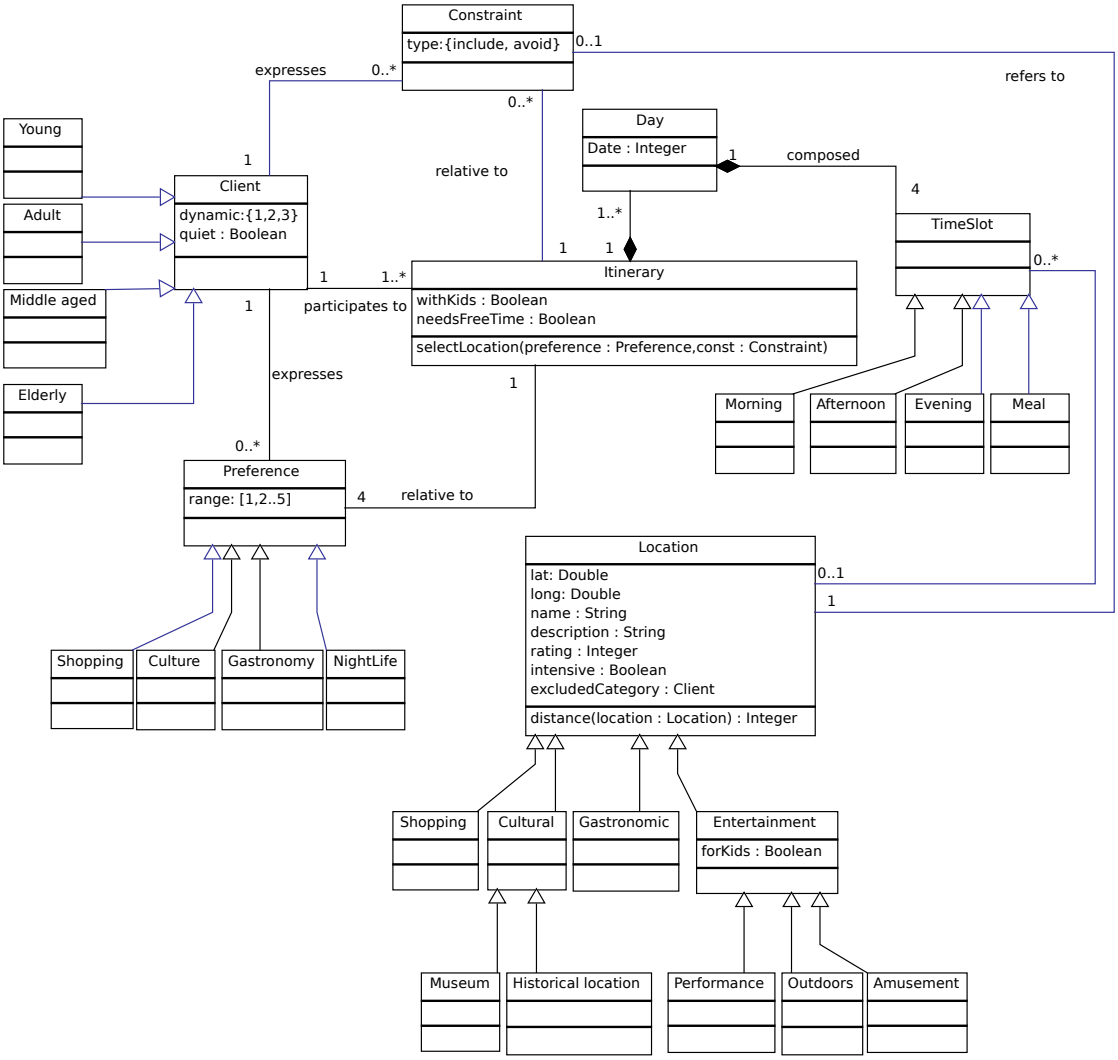

Figure 5: Domain schema

This schema seems complicated, for this reason every model is explained in the following list:

Client

The client who goes to the travel agency. He could be a quite person who normally wants to visit a lot of things or very few (*dynamic*). The clients are categorized by their age because some locations are not suitable for a people category (ex: elderly

people in a climbing location).

Preference

Each client needs to specify a list of preferences, valued from 1 to 5, where 1 is "I'm not so interested" and 5 is "I love to do it!". These preferences are related to the itinerary we want to create, consequently if the same clients wants to create another itinerary, it will specify again all the preferences he wants in this second trip.

Contraint

Each client needs to specify a list of contraints that have to be fulfilled. As for the *Preference*, they are related to the single itinerary.

Itinerary

This represents the itinerary we want to create. It is composed by a fixed number of *Day* and it is related to a *Client* who has specified his own list of *Contraint* and *Preference*. If there will be kids in the itinerary, the system needs to select some *Location* that could entertain them. This is a requirement as the *needsFreeTime* attribute, which specifies that the clients needs to have some not scheduled time in the arrival city.
The method *selectLocation* takes a list of *Preference* and produces a list of *Location* that could fit this preferences.

Day

This describes a day of the itinerary.

Timeslot

A timeslot is a fixed part of a day. The division of the day came from the expert interview.

Location

This model represents the point of interests that a customer could visit. The attribute *rating* describes the quality of this place, *intensive* describes if the place is not for quite people and *excludedCategory* specifies if a client category is not suitable for the location (ex: elderly people in a climbing location). The method *distance* takes two locations and returns the distance between them. It is useful in order to create the combination of locations to visit during a trip.

4.2 Domain mapping

knowledge role	type	domain mapping
requirements	dynamic	Client
skeletal design	static	Timeslot
preferences and requirements	dynamic	Client, Itinerary, Preference
constraints	dynamic	Constraint
customer input	dynamic	Constraint
proposal	dynamic	Itinerary
itinerary	dynamic	Itinerary
violation	dynamic	Constraint, Location

4.3 Rule types

Listing 2: Rules

```
RULE TYPE constraint-rule;
    DESCRIPTION: "rule stating the relation between client and
       the choice for a location in the itinerary, by means of
       defining strict boundaries that must be respected.";
ANTECEDENT: Client;
CONSEQUENT: Itinerary;
CONNECTION-SYMBOL: restricts;
END RULE-TYPE constraint-rule;

RULE TYPE requirement-rule;
    DESCRIPTION: "rule stating the relation between the client
       and the choice for a location in the itinerary, by means
        of defining boundaries that should be respected.";
ANTECEDENT: Client;
CONSEQUENT: Itinerary;
CONNECTION-SYMBOL: requires;
END RULE-TYPE requirement-rule;

RULE TYPE preference-rule;
    DESCRIPTION: "rule stating the relation between the client
       and the choice for a location in the itinerary, by means
        of defining preferences that could be satisfied with
       probability X (calculated on the input values) .";
ANTECEDENT: Client;
CONSEQUENT: Itinerary;
CONNECTION-SYMBOL: prefers-with-probability;
END RULE-TYPE preference-rule;
```

Here are presented also some example in order to better understand all the rule types.

Listing 3: The client wants to include a destination into the itinerary.

```
client.constraint.location.name=A AND client.constraint.type=
    include
RESTRICTS
∃itinerary.day.timeslot, timeslot.location.name=A;
```

Listing 4: The client is a quite person

```
client.quiet=true, client.needsFreeTime=true, client.active=1
REQUIRES
itinerary.day.timeslot.location, location.intensive=false;
itinerary.day.timeslot, timeslot.location=NULL;
∑_{i=1}^{n-1} i.distance(i+1) < δ, ∀i ∈ location;
```

Listing 5: The client expresses four preferences with four ranges (from 1 to 5). The method selectLocation will compose the itinerary selecting the locations that fits the preferences. For example it could select 3 shopping 1 gastronomy and 1 cultural locations.

```
Var A, B, C, D: client.preference;
Var E: client.constraint;
A.type=shopping AND A.range=x
B.type=cultural AND B.range=y
C.type=gastronomy AND C.range=w
D.type=nightlife AND D.range=z
E.type = avoid AND E.location = Colusseum
PREFERS-WITH-PROBABILITY
∀itinerary.day.timeslot, timeslot.location=selectLocation(A, B,
    C, D, E);
```

4.4 Knowledge Base

5 Scenarios

5.1 Scenario 1

Rose, a 76 years old lady would like to visit Rome for three days with her nephew John who is ten years old. She would like to have her trip planned but with the possibility to explore the city on her own.

Are you used to walk long distances?
Not at all, I usually don't walk a lot.

In a scale from one to five, how do you enjoy shopping?
I really love to do shopping, so five!

In a scale from one to five, how do you enjoy cultural places?
I am going to Rome, so four!

In a scale from one to five, how do you enjoy nightlife?
Have you looked at me? 1!

In a scale from one to five, how much would you like to try new restaurants?
I guess... I don't know, 3?

Is there anything that you'd absolutely like to see?
Yes, I've never seen the Colosseum.

Is there anything that you have already seen or don't want to see?
Not really, everything is fine.

The travel agent while is interviewing the customer, inserts the acquired data into the system through graphic interface.

Listing 6: Domain instance of the data inserted into the system

```
REQUIREMENTS:
  client.quiet = true
  client.dynamic = 1
  itinerary.withKids = true
  itinerary.needsFreeTime = true
  VAR a,b,c: day;
  a.date = "14/05/2014"
  b.date = "15/05/2014"
  c.date = "16/05/2014"
PREFERENCES:
  VAR a,b,c,d : preference;
  a.type = shopping
  a.range = 5
  b.type = culture
  b.range = 4
  c.type = nightlife
  c.range = 1
  d.type = gastronomy
  d.range = 3
CONSTRAINTS:
  constraint.location.name = Colosseum
  constraint.type = include
```

5.2 Scenario 2

Richard a 30 years old guy, would like to visit Rome for four days alone.

Would you consider yourself a quite person or ready to have some fun?
Definitely have fun.

Are you used to walk long distances?
Yeah.

In a scale from one to five, how do you enjoy shopping?
Not that much I only need to buy some souvenirs, 1.

In a scale from one to five, how do you enjoy cultural places?
I am going to Rome, so four!

In a scale from one to five, how do you enjoy nightlife?
I don't know... 5?

In a scale from one to five, how much would you like to try new restaurants?
I definitely like to eat, 5.

Is there anything that you'd absolutely like to see?
Yes, I've never seen the EUR.

Is there anything that you have already seen or don't want to see?
I'm not interested in San Pietro.

The travel agent while is interviewing the customer, inserts the acquired data into the system through graphic interface.

Listing 7: Domain instance of the data inserted into the system

```
REQUIREMENTS:
  client.quiet = false
  client.dynamic = 3
  itinerary.withKids = false
  itinerary.needsFreeTime = false
  VAR a,b,c,d: day;
  a.date = "14/05/2014"
  b.date = "15/05/2014"
  c.date = "16/05/2014"
  d.date = "17/05/2014"
PREFERENCES:
  VAR a,b,c,d : preference;
  a.type = shopping
  a.range = 1
```

```
  b.type = culture
  b.range = 4
  c.type = nightlife
  c.range = 5
  d.type = gastronomy
  d.range = 5
CONSTRAINTS:
  VAR a,b : constraint;
  a.location.name = EUR
  a.type = include
  a.location.name = San Pietro
  a.type = avoid
```

6 Communication Knowledge

The communication model specifies the information exchange between tasks carried out by different agents. It has been designed as an Activity Diagram where the name of the interaction corresponds to the type of communication happensing between the agents in the connected lanes.
It has to be noted that the only task knowledge intensive is "Automatically build the itinerary" carried out by the automated system *easyAround*.
The mapping between the activities in the communication model and the inference model is schematized as follows:

- "operationalize" corresponds to "differentiate constraints, requirements and preferences"
- "specify" and "propose" are mapped to "automatically build the itinerary"
- "verify" corresponds to "obtain feedback"
- "critique" corresponds to "edit itinerary"

7 Design Knowledge

Appendix A Design Knowledge

In preparation for the interview with the expert we listed a series of concepts to be clarified in order to better structure the application domain.

1. Target of the application: which kind of customer the application is more suitable for;

2. Subcategories of the target: is it possible to recognize different subcategories in the target that correspond to different needs for the creation of an itinerary;

3. Locations of interest: understand which categories of locations can be created and in which way they can be matched with the customer's preferences;

4. Composition of the itinerary: understand the basic structure of an itinerary, and whether it can be composed automatically.

The interviewing techniques applied were mainly two: problem solving (the interviewer poses himself as a customer and watches the expert "in action") and 20-Questions (the interviewer thinks about a destination for an hypothetical itinerary and the expert needs to guess which one it is). Relatively to the categorization of the locations, it has also been used the "Card sorting". The results of the interview were satisfying:

1. The target of the application are the "lonely travelers", people who prefer traveling on their own, at most with their family.

2. It has been concluded that the target can be divided in four age-based category, such as "Young" (18-30), "Adults" (30-40), "Middle aged" (40-60), "Elderly" (60+). Relating to these categories the aspects that change the most are: need for entertainment, need for quiet, free time available, amount of time spent walking.

3. The locations can be divided in four main categories such as "shopping", "gastronomy", "cultural" and "entertainment"; of these, "cultural" can be divided in "historical locations" (such as monuments) and "museums", and "entertainment" can be divided in "amusement" (such as clubs, pubs and discos), "performance" (such as cinemas, theatres, ...) and "outdoor" (such as amusement parks or gardens).

4. It has been concluded that the itinerary can be seen as an aggregation of days, which in turn have a basic fixed structure.

   Morning non intensive activity (monuments, gardens...);

   Afternoon intensive activity (museums, shopping...);

   Evening the intensity of the activity depends on personal preferences.

From the interview emerged an aspect not considered before, that is to say the presence of kids. The expert pointed out that in case a child is present, the itinerary is to be built as usual but having care of including children activities every once in a while. A constraint to be considered is the fact that the customer can request a location to be included or excluded from the itinerary.

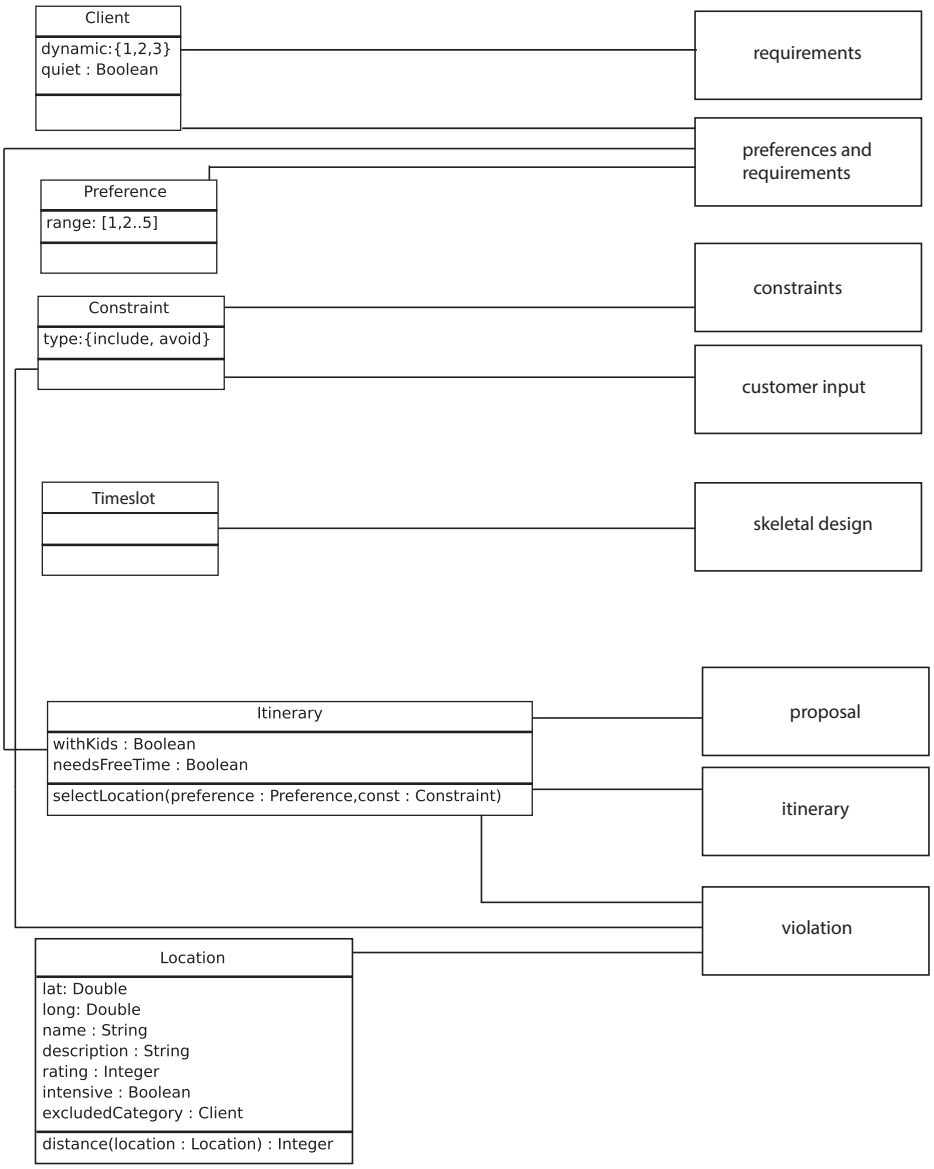

Figure 6: Mapping between the domain model and the inference model

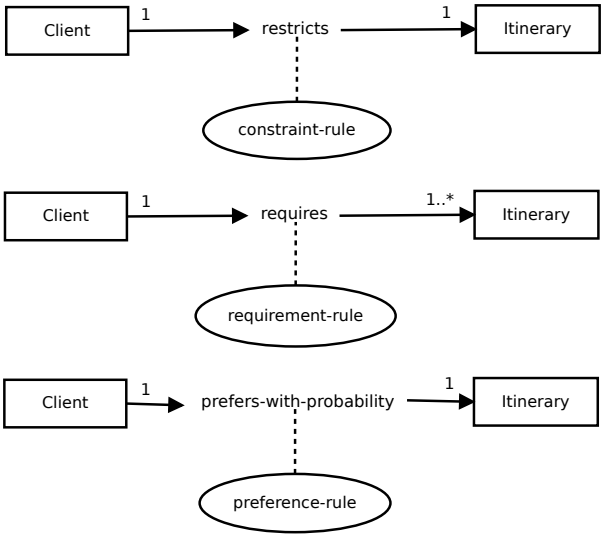

Figure 7: Knowledge base

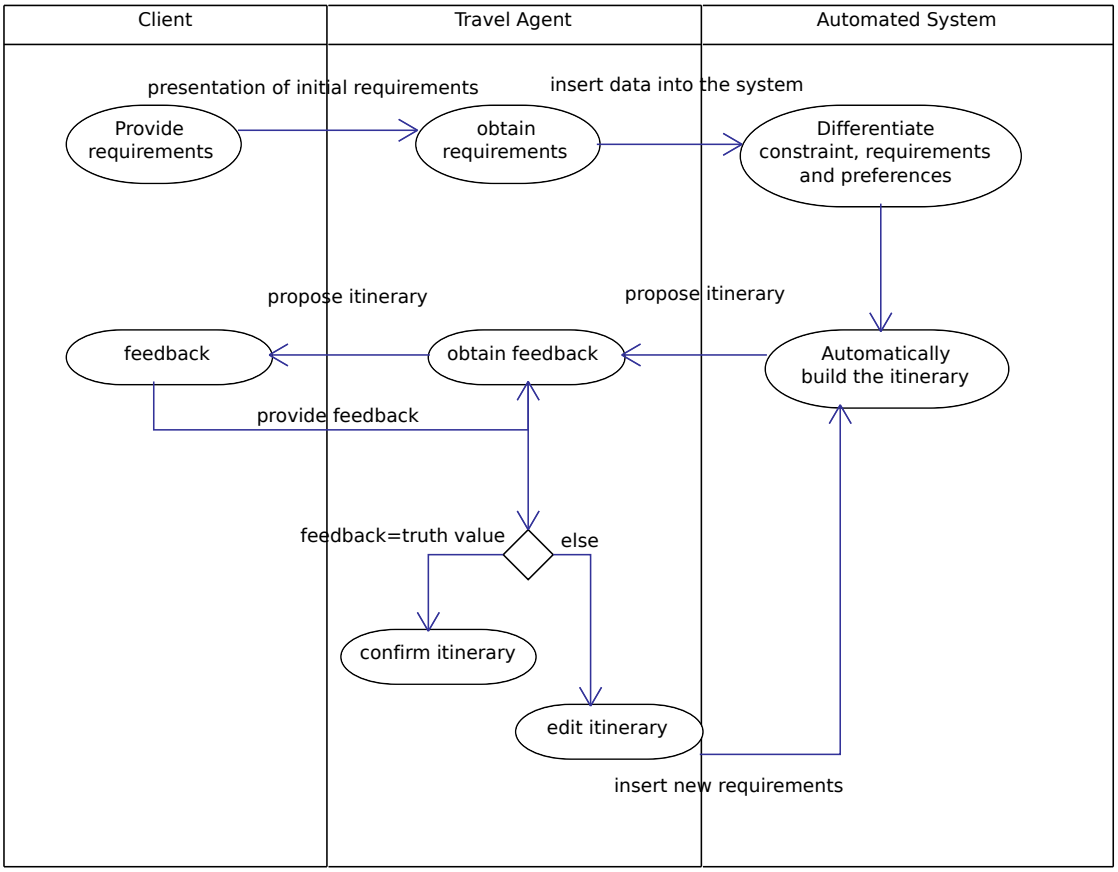

Figure 8: Communication process