OnDroad Planner: Building Tourist Plans
Using Traveling Social Network Information

Isabel Cenamor and **Tomás de la Rosa** and **Daniel Borrajo**

Departamento de Informática, Universidad Carlos III de Madrid
Avda. de la Universidad, 30. Leganés (Madrid). Spain
icenamor@inf.uc3m.es, trosa@inf.uc3m.es, dborrajo@ia.uc3m.es

Abstract

One of the key challenges in automated planning is to define
the sources of information that will feed the initial state and
goals of each planning task. In many domains, the informa-
tion comes from company's databases. In other applications,
the information is harder to obtain and it is usually partial.
In this paper, we will describe an application on travel plan-
ning, where the initial state and goals will be obtained by
crowdsourcing. Travel planning requires the use of plenty
Internet-based resources; some of them are related to human
generated opinions on all kinds of matters (e.g. hotels, places
to visit, restaurants, . . .). We present the ONDROAD planner, a
system that creates personalized tourist plans using the human
generated information gathered from the MINUBE traveling
social network.[1] ONDROAD proposes an initial tourist guide
according to the recommendation of the users profiles and
their contacts. In addition, this guide can be continuously
updated with newly generated data.

Introduction

Traveling information systems have become very popular ap-
plications for recommending and planning tourist trips (Berka
and Plößnig 2004; Castillo et al. 2008; Moreno et al. 2013).
In the same direction, the widespread use of tourist mobile
applications allows users to request for real time information
about the schedules, guides or plans that fulfill their prefer-
ences (Rodriguez-Sanchez et al. 2013). For many websites, it
is very difficult to have updated information about all points
of interest. Data may come from different services, so middle
layers should be developed, as wrappers and crawlers that get
and integrate available data. Moreover, most of these sites
cannot create a tourist plan automatically.[2] An alternative
approach consists of getting this information directly from
the users of a traveling social network.[3] Additionally, the
network structure facilitates the acquisition of personalized
information related to user's contacts.

From a crowdsourcing perspective, users of traveling so-
cial networks do not receive an explicit call for supplying
relevant tourist information or composing a plan. Instead,

---

[1]www.minube.net

[2]As an example, www.tripomatic.com is a powerful tool for
travel planning, but requires the user to select places to visit and
manually set up the plan.

[3]As, for instance, TripAdvisor (tripadvisor.com).

they are encouraged to share their experience of past trips
and give recommendations to everyone. Therefore, users are
helping to acquire personalized relevant information with
a collaborative filtering approach (Lucas et al. 2012). Col-
laborative filtering provides a subset of recommendations
on what to visit, where to sleep or where to eat. But, these
techniques do not compose plans. So, in this paper, we use
those recommendations as information for defining the initial
state and goals of a planning task. This task is solved by an
automated planner and the plan is then given to the user. The
plans include generic visit-place, eat-at, or sleep-at actions.
Thus, we solve planning tasks that go beyond a classical path
finding problem, since we take into account soft information
(as recommendations), opening schedules of places, and we
suggest places to eat and sleep. Related work on crowdsourc-
ing for *itinerary* planning focused on arranging a given plan
to fullfill users' constraints (Zhang et al. 2012), but not on
composing plans automatically. In this paper we summarize
ONDROAD, an ongoing project where we are developing
a framework for the management and planning of digital
contents and services for tourists. Within this project, the
ONDROAD planner is the sub-system in charge of building
the tourist plans for users visiting a particular city or region.
The following sections describe the architecture with all its
components and suggest future work.

Architecture

The service comprises two main sub-services. On the one
hand, the Tourist Plan Manager creates the initial proposal
for a tourist plan. On the other hand, the Monitor and Re-
planning Service uses the initial proposal and updates it tak-
ing into account information provided by the user (or even by
other people who are visiting the same place). The input of
ONDROAD is some information related to a travel: the city
or region the user is going to visit, when he/she is going to
be available, and possibly some preferences.

MINUBE

MINUBE is a traveling social network where users can: 1)
get inspiration from other users photos and experiences to
decide the destination of their next trip; 2) manually create
a tourist plan for the city or region they are visiting; and
3) after the trip, share with others their experience, photos
and recommendations. The minimal piece of information
is the Point of Interest (POI). Users continuously add new
POIs with their photos and any relevant information about

them. The ONDROAD planner uses some information from the POIs, such as geo-localization and votes from MINUBE users, in order to build the initial proposal for the tourist plan.

Tourist Plan Manager

This module generates a planning task that is given to an automated planner, using the information extracted from MINUBE services. In the first step, it queries MINUBE about the set of the N best POIs for the selected destination. This set is built taking into account the votes each POI has received from the user's contacts in the MINUBE network. The idea in this process is to make an initial filter for just considering a subset of POIs which may be the most interesting ones. The second step consists of splitting the set of best POIs in subgroups that are geographically close. This is an intuitive approach people use when preparing their visits in plans for several days. Therefore, each subgroup of POIs is assigned to a day within the whole schedule. ONDROAD uses k-means (Hartigan and Wong 1979), where the number of clusters is set to the number of available days.

This service also pre-processes information users have given such as POI timetable and the expected duration of the visit. Additionally, the module computes the estimated time for moving by car and walking from each point of the sub-group to the rest. All described information for a given day is compiled into a planning task, which is formulated in the Planning Domain Definition Language (PDDL (Fox and Long 2003)). PDDL is the "de facto" standard for encoding automated planning tasks. Each planning task is given to the automated planner, explained in the following section. The resulting plans are handled by the service and joined in a single tourist plan.

Automated Planner

We use automated planning to build our tourist plans (Ghallab, Nau, and Traverso 2004). An automated planner receives a planning task (domain and problem descriptions) in PDDL and creates a plan that achieves the goals specified in the task. In the case of ONDROAD, the domain encodes which actions can be included in a plan, such as visit a POI, walk or drive to one point to another, have lunch in a restaurant, spend some free time, etc. Since these actions are common to all tasks, the domain file is fixed in ONDROAD. The problem file encodes the initial state and the goals of the planning task. The initial state is formed with all information described in the previous section related to the selected POIs for the day. The goals are the visit to the list of selected POIs. These goals are soft goals (the plan does not have to achieve all of them), each one with a preference value for the POI computed from the recommendations.

Planners use a search that tries to optimize a metric that considers the user preferences. Since, in many cases, it is not possible to carry out all activities in the goals, at the end, the planning process will try to include as many activities as possible, favoring those with higher preferences. In our case we are using the Metric-FF planner (Hoffmann 2003), since it is one of the state-of-the-art planners that handles all the language features we need for the system (as numeric preconditions).

Current and Future Work

We have built the planning system, and we are currently developing the monitoring and re-planning service. It receives the initial tourist plans and iteratively updates them before/during their execution. The user, or any other traveler to the same location, will be able to update the default information in ONDROAD. For instance, a user can specify the real opening hour of a museum. So, ONDROAD will take into account new information to rebuild the plan. These kinds of scenarios will be used to incrementally complete the available information and to improve the accuracy of plans. In these cases, human computation is a substitute of web crawlers that are looking for new information. In MINUBE, users can also manually provide plans. We have already worked in the past on capturing human plans in other domains (Addis and Borrajo 2010). So, shortly we will also benefit from this other kind of human computation.

Acknowledgements

References

Addis, A., and Borrajo, D. 2010. *Information Retrieval and Mining in Distributed Environments*. Studies in Computational Intelligence. Springer Verlag. chapter From Unstructured Web Knowledge to Plan Descriptions, 41–59.

Berka, T., and Plößnig, M. 2004. Designing recommender systems for tourism. In *Proceedings of the 11th International Conference on Information Technology in Travel & Tourism*.

Castillo, L.; Armengol, E.; Onaindía, E.; Sebastiá, L.; González-Boticario, J.; Rodríguez, A.; Fernández, S.; Arias, J. D.; and Borrajo, D. 2008. SAMAP. A user-oriented adaptive system for planning tourist visits. *Expert Systems with Applications* 34(2):1318–1332.

Fox, M., and Long, D. 2003. PDDL2.1: An extension to PDDL for expressing temporal planning domains. *Journal of Artificial Intelligence Research* 61–124.

Ghallab, M.; Nau, D.; and Traverso, P. 2004. *Automated planning: theory & practice*. Access Online via Elsevier.

Hartigan, J. A., and Wong, M. A. 1979. Algorithm as 136: A k-means clustering algorithm. *Journal of the Royal Statistical Society. Series C (Applied Statistics)* 28(1):100–108.

Hoffmann, J. 2003. The METRIC-FF planning system: Translating "ignoring delete lists" to numeric state variables. *Journal of Artificial Intelligence Research* 20:291–341.

Lucas, J. P.; Luz, N.; Moreno, M. N.; Anacleto, R.; Figueiredo, A. A.; and Martins, C. 2012. A hybrid recommendation approach for a tourism system. *Expert Systems with Applications*.

Moreno, A.; Valls, A.; Isern, D.; Marin, L.; and Borràs, J. 2013. Sigtur/e-destination: ontology-based personalized recommendation of tourism and leisure activities. *Engineering Applications of Artificial Intelligence* 26(1):633–651.

Rodriguez-Sanchez, M.; Martinez-Romo, J.; Borromeo, S.; and Hernandez-Tamames, J. 2013. Gat: Platform for automatic context-aware mobile services for m-tourism. *Expert Systems with Applications*.

Zhang, H.; Law, E.; Miller, R.; Gajos, K.; Parkes, D.; and Horvitz, E. 2012. Human computation tasks with global constraints. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 217–226. ACM.