Chapter 8
Human-Computer Cloud and Its Applications in E-Tourism

Andrew Ponomarev
St. Petersburg Institute for Informatics and Automation of Russian Academy of Sciences (SPIIRAS), Russia

Nikolay Shilov
St. Petersburg Institute for Informatics and Automation of Russian Academy of Sciences (SPIIRAS), Russia

ABSTRACT

The chapter addresses two problems that typically arise during the creation of decision support systems that include humans in the information processing workflow, namely, resource management and complexity of decision support in dynamic environments, where it is impossible (or impractical) to implement all possible information processing workflows that can be useful for a decision-maker. The chapter proposes the concept of human-computer cloud, providing typical cloud features (elasticity, on demand resource provisioning) to the applications that require human input (so-called human-based applications) and, on top of resource management functionality, a facility for building information processing workflows for ad hoc tasks in an automated way. The chapter discusses main concepts lying behind the proposed cloud environment, as well as its architecture and some implementation details. It is also shown how the proposed human-computer cloud environment solves information and decision support demands in the dynamic and actively developing area of e-tourism.

INTRODUCTION

Vast majority of cyber-physical systems rely on some kind of human involvement. They are built for human benefit (it is natural), besides, they usually operate alongside with humans, or are supported by them. The exploration of possible interactions of humans and cyber-physical systems have recently led to widening the traditional scope of research in cyber-physical systems and to the emergence of the area of socio-cyber-physical systems (e.g., Hozdic, 2019; Calinescu, Camara & 2019), or cyber-physical-social systems (e.g., Wang et al., 2019). This new area not only explores cyber-physical systems in a

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wider scope, but also offers new approaches on building systems of heterogeneous components. This trend also goes well with the fact that the development of the Internet and communication technologies (allowing to access the Internet from virtually any place on the Earth) has led to the emergence of a new kind of hybrid human-machine systems, where distributed group (crowd) of people becomes involved in the process of information provision and processing. Particular examples of such systems include microtask markets (with the most prominent Amazon Mechanical Turk), various citizen science projects (Franzoni & Sauermann, 2014; Shamir, Diamond & Wallin, 2016), community sense and response systems (e.g., Faulkner et al., 2014), general collaborative mapping (e.g., OpenStreetMap, Google Map Maker, WikiMapia), crisis mapping (e.g., Ushahidi; Meier, 2017) and many others.

The approach described in this chapter addresses two particular problems that typically arise during the construction of human-machine computational systems. The first problem is resource management: all systems that require human attention and human input require a large number of contributors and collecting this number of contributors may require significant time and effort. This problem is typically addressed with a help of specialized platforms (e.g., Amazon Mechanical Turk), but these platforms (unlike modern cloud systems) do not usually provide any guarantees about resources available to particular applications making it virtually impossible to employ them for human-based applications that require operative output. The second problem has a bit wider scope, it is the complexity of decision support in dynamic environments, where it is impossible (or impractical) to implement all possible information processing workflows that can be useful for a decision-maker.

This chapter discusses a human-computer cloud architecture that addresses both of these problems. The environment includes two parts: the first one (platform), provides a unified resource management environment, that can serve as a basis on which any human-based application could be deployed decoupling computing resource management issues from application software. Leveraging this platform can significantly streamline the development of human-based applications and services that are important and inevitable in some application areas. The second part (decision support software, running on top of the platform) allows to automatically decompose tasks to subtasks and distribute them among human participants, making it possible to automatically compose a workflow for an ad hoc decision support problem without explicit programming. One of the core mechanisms of the cloud environment is ontological representation of cloud resources, which simplifies the problem of human resource description and discovery. Ontological representations and mechanisms are also used on top of the unified resource management to implement an ad hoc decision support environment, where ontology-driven human-computer service composition allows to perform decision support tasks that don't have specialized services.

One of the important areas for human-computer decision support systems is e-Tourism, where human input and human involvement is essential due to the subjective nature the domain. Therefore, to motivate the development of the human-computer cloud, decision support in tourism is discussed and projected on the generic architecture of the cloud environment.

The paper is organized as follows. Background section clarifies the topic and the goal of the paper by providing more details on how modern human-powered and cloud systems are interrelated. It also shows the importance of human-driven information processing in eTourism domain. The Architecture section contains the description of the proposed architecture, including principal actors, service layers and interactions needed to implement some typical cloud environment operations. Implementation section describes main foundational technologies used for implementation of the system. Applications in Tourism section discusses how the proposed human-computer cloud environment can be used to implement