An Agent Based Approach to Patient Scheduling Using Experience Based Learning

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ABSTRACT

This paper describes an agent based approach to patient scheduling using experience based learning and an integer programming model. The evaluation on different learning techniques shows that the experience based learning (EBL) provides a better solution. The time required to process a particular job is reduced as the experience processed by it increases. The processing time can be calculated with the help of EBL. The main objective of this patient scheduling system is to reduce the waiting time of patient in hospitals and to complete their treatment in minimum required time. The proposed framework is implemented in JADE. In this approach the patients are represented as patient agent (PA) and resources as resource agent (RA). This mathematical model provides an optimal solution. The comparisons of the proposed framework with other scheduling rules shows that an agent based approach to patient scheduling using EBL gives better results.

Keywords: Agent Based Approaches, Experience Based Learning, Integer Programming, Multi-Agent Systems, Patient Scheduling

INTRODUCTION

Patient scheduling is the allocation of timeslot for resources according to their request. The dynamic nature of hospital patient scheduling together with the decentralization of scheduling makes the tasks more complex. It is also dynamic in nature. A more suitable approach to patient scheduling may be one that fits the problem domain better. A distributed multi-agent system together with experience based learning technique would be a good choice (Kanaga, Valarmathi, & Murali, in press). Here we consider each patient and resources as agents and they interact with each other (Janiak & Rudek, 2005).

The agent based approach considers the patients as Patient Agents (PA) and resources as Resource Agents (RA). The PA requests for the resource. A special agent named Common Agent (CA) is also introduced in this framework. CA refers to a general physician who decides on what tasks the patient has to undergo. The proposed framework is trying to reduce the
patients waiting time and tardiness. We can further reduce this by incorporating experience based learning.

The learning models in scheduling are based on the learning curve introduced by Wright (Janiak, Janiak, Rudek, & Wielgus, 2009). In scheduling problems with a new experience-based learning model, job processing times are described by “S”-shaped functions that are dependent on the experience of the processor. In patient scheduling, decisions are made according to the learning model (Becker, Navarro, Krempels & Panchenko, 2003).

Problem Domain

The hospital contains different autonomous wards and ancillary units. Each department has the authority to take their own decision so it is decentralized. In addition to the complexity arising from the distributed structure of hospitals, patient scheduling has to be performed in the face of a high degree of uncertainty about the treatment pathways of patients within the hospital (Biskup, 1999).

The patients arrive continuously at the hospital and the necessary medical treatments are often not able to be completely determined at the beginning of the treatment process. Moreover the results of a diagnostic examination might change the (medical) priority of the patients, invoke additional activities and/or make other medical actions obsolete (BenHassine, & Ho, 2007 Wainer, Ferreira, & Constantino, 2007). Also, emergencies or complications lead to disturbances in the schedule and result in variable waiting times for other patients. Hospital patient scheduling can be implemented using agent based approach.

PROPOSED FRAMEWORK FOR PATIENT SCHEDULING

An agent based approach is suitable for scheduling patients in hospitals because of its reactive and proactive nature (Czap, Becker, Poppensieker, & Stotz, 2005). Here the agent based approach is incorporated with experience based learning. Patients and resources are represented as an agent and an experienced based learning is used during the scheduling of patients and resources (Decker & Li, 1998).

Problem Description

The framework consists of Patient Agent (PA), Resource Agent (RA) and Common Agent (CA) as mentioned in the previous work (Kanaga, Valarmathi & Darius, 2010). The framework for patient scheduling using experience based learning is shown in Figure 1.

The CA is a physician and they collect and maintain information about patients and resources. It also determines the tasks that have to be taken, which consists of consultation of doctor, diagnostic procedures like MRI scan, CT scan lab tests etc. The Resource Agent may be X-Ray, CT scan, Lab Tests, consultation with Physician etc. Each RA has multiple time slots. The PA requests for the required time slots. Multiple PAs may request for the same slot. In this framework a agent called Learning Agent is included. The LA calculates the experience of each resource and find out the processing time according to the experience they possessed. As the experience increases the time required for processing a task is reduced (Vermuelen, Bohle, La Poutre, 2007).

In hospitals when patient comes for a test, the required equipment and other resources has to be made ready. The time required for the preparation is called changeover time. It comprises of setup time and removal time. Setup time is the time span required to prepare the machine (Janiak & Rudek, 2007; Wang, Ng, Cheng, & Liu, 2008). The removal time is the time span needed to restore initial state of resource. In older patient scheduling systems this changeover is included with in processing time itself (Cheng, Wu, & Lee, 2008).

For example during the task of CT scan an initial preparation time for patient and resource is needed. After the scanning process is done return back to the initial state of scanning machine. If a person who is doing this have experience
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