Functions for the management of valuable goals: Goal scheduling and action mode selection done by an autonomous agent on the basis of situational urgency

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Abstract

The purpose of this research is to design an autonomous agent that is required to set and achieve multiple goals with various degrees of urgency in a simple world of a video game type. This poster presentation first introduces the design of our simple world. A task given for the agent is to rescue as many falling objects as possible, which appear randomly in the world. Symbolic descriptions of states constituting the problem space and a plan that the agent would generate, based on the expected utility taking into account the success probability of operation, are given (Feldman and Sproull, 1977). After the formulation of the urgency value for a goal (Toda, 1995), the two phases in the agent's problem solving, the goal scheduling and the action mode selection, are discussed. The goal scheduling produces a quasi-optimal goal queue in a dynamic fashion in accordance with the urgency of the current goal (Minton et al., 1992; Zilberstein, 1996). The action mode selection allocates limited time for actual execution and deliberate planning. High urgency value of the current goal may make the agent stay in the execution mode for a period of the available time. Finally, the current level of implementation and future directions of our research is discussed.

1 Introduction

The functional studies have considered human beings with multiple goals as efficient problem solving systems. While this approach revealed the situated nature of cognitive architecture, it still leaves out some important issues concerning the everyday problem solving. One such issue is that of time, and another is that of the subjective values assigned to achieving each goal, which are necessary for sustaining the unity of an individual human being. In order to deal with the multiple goals, a person ought to be efficient in setting, concentrating, suspending, discarding, and achieving some of possible goals in accordance with the person's cognitive appraisal of the urgency with which each goal presents itself. The urgency of a goal is an important situational cognition made by a problem solver with a limited temporal resource. During the period when no action is taken, the urgency of each goal will increase as the available time for accomplishing the goal-achievement action diminishes.

The purpose of this research is to design an autonomous agent that is required to set and achieve multiple goals with various degrees of urgency in a simple world of a video game type. For the functional study of architecture, Simon (1967) discussed an interruption mechanism of ongoing processes on a serially fashioned cognitive architecture. This research employs a serially fashioned architecture for coping with situations in the simplified world, and intends to specify various functions for the management of goals.

The agent embedded in the world is designed to have three phases in its course of problem solving. The first phase is planning to make a better plan searched as a solution path of operators in the problem space for achieving each single goal. The second phase is goal scheduling in the face of multiple goals, whose function is to schedule how to achieve the given set of goals in what order. Note that, while the target goal is being achieved, the urgency values of other goals in queue will increase due to the decrement in the available time for their achievements. The scheduling rule by a heuristics called urgency comparison is proposed. What it is aimed to do is to reduce the sum of urgency values of all the goals. The third phase, that of action mode selection, does the switching of its action mode between the execution mode and the deliberation mode to be done in accordance with the urgency presented by the current goal. If this urgency value is very high, the agent should allocate its time for rush execution of some operators in a plan, despite of its limited plausibility. On the other hand, if the urgency is relatively low, the agent may be able to engage in a more deliberate appraisal of the global situation.

The poster presentation deals mainly the two phrases in the problem solving of the agent, namely, the goal scheduling phase and the action selection phase, with the example of one such agent implemented in a visualized world. In the following, the design of our world and the formulation of the urgency value for a goal are briefly introduced.

2 The world and urgency

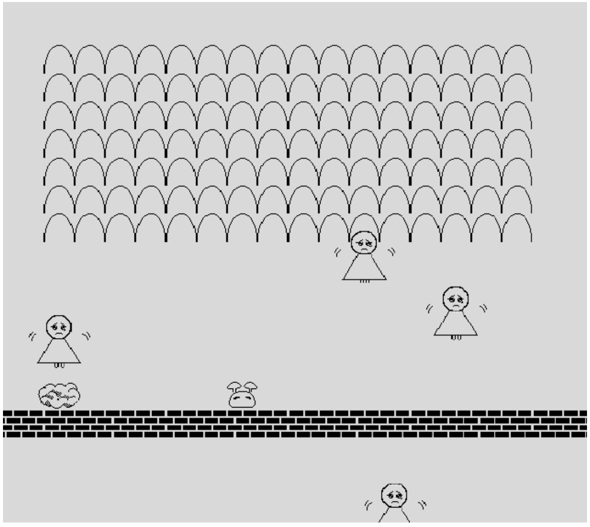

Figure1: The snapshot of the world

Figure 1 shows a snapshot of this world. An agent appears around the center on the floor. A task given for the agent is to rescue as many falling objects as possible. There are four falling objects in Figure 1, one of which has already passed the floor and cannot be rescued. The agent can move horizontally on the floor and put under a falling object a life preserver looking like a cloud in Figure 1. The success probability of this operation called “PUT-LIFE-PRESERVER” is 0.5. A life preserver can be put only if an object is falling over it. A preserver disappears, once it is used for an object. A new object appears randomly. While an object is falling, no other object appears in the same row. The speeds of the agent’s moving and of the object’s falling are fixed.

If a goal is assigned to rescuing a particular object, the planner in the agent would generate a plan, which is based on the expected utility taking into account the success probability of PUT-LIFE-PRESERVER operation (Feldman and Sproull, 1977), a plan such as “repeat MOVE operation of going under the object and then repeat PUT-LIFE-PRESERVER operation until it succeeds.”

The urgency of each goal at a given time is defined by the following three parameters, namely, the subjective value of each goal, the subjective probability of achieving it, and the available time for doing so. By an extension of the classical decision making formula to make it include time, Toda (1995) defined expectation of the subjective value of a goal at available time t :

$$V_t = P_t V ,$$

where

V is the value of a goal when it is actually gained.

P_t is success probability to achieve that goal at available time t ; $0 \le P_t \le 1$.

Urgency value of a goal at available time *t* is defined as the expectation of the subjective value that could be lost:

$$U_t = (1 - P_t)V ,$$

The value of P_t is defined in terms of the two parameters, the subjective probability for the success of prescribed operation and the available time. The formula is

$$P_t = P_t(\mathrm{MOVE})P_t(\mathrm{PUT-LIFE-PRESERVER}),$$

where

$P_t(\mathrm{MOVE})$ is success probability of MOVE operation given the available time.

$P_t(\mathrm{PUT-LIFE-PRESERVER})$ is success probability of PUT-LIFE-PRESERVER operation given the available time.

If the agent has time for a MOVE operation, the available time for PUT-LIFE-PRESERVE operation is determined by the following three temporal parameters: the time that a falling object takes to reach the floor, the required time for MOVE operation, and the time needed for information processing done by the agent. If the agent spares the available time to repeat PUT-LIFE-PRESERVE operation until it succeeds the urgency value of the goal decreases and the expected goal value increases.

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