CPT302 Week 11 InClass Exercises

Name and Surname:_____

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Q1. Explain the five stages of task-sharing protocol in Contract Net.

Ans:

The five stages are (1) Recognition; (2) Announcement; (3) Bidding; (4) Awarding; and (5) Expediting.

1. Recognition: In this stage, an agent recognizes that it needs help to solve a problem. Either it has a goal that it cannot realize because of lack of skills, knowledge, or resources. It might be that it would prefer not to achieve the goal in isolation. This recognition is the result of initial deliberation, based upon its initial set of beliefs, desires, intentions, and resources.
2. Announcement: In this stage, the agent sends out an announcement to the other agents in the system describing the task. The task specification includes a description of task itself, any constraints (e.g., deadlines, quality constraints), and meta-task information. The announcement is then broadcast. Consequently only those who are subscribed to broadcasting can receive the announcement.
3. Bidding: Agents that receive the announcement must first deliberate to determine whether or not the task can be done, given their BDI and resources. If an agent has the ability to do the task it must next decide whether or not it intends to do it and wish to bid for the task. Based upon its intention, resources, and cost constraint an agent might decide to bid or defer.
4. Awarding: The agent that sent out the announcement may wait until sufficient number of tenders are received. It chooses the agent whose price and quality constraints meet its goals and awards the task for execution.
5. Expedite: The successful contractor then expedites the task. This in turn may involve generating another contract-net protocol.

Q2. This question considers Cooperative Distributed Problem Solving (CDPS). Answer the following two questions:

- With the aid of an example, explain what is meant by CDPS and why the concept of “cooperation” plays a relevant role in CDPS.
- Discuss also the main issues that arise in CDPS.

Ans:

CDPS studies how a loosely coupled network of problem solvers can work together to solve problems that are beyond their individual capabilities. Each problem solving node in the network is capable of sophisticated problem solving and can work independently, but the problems faced by the nodes cannot be completed without cooperation. Cooperation is necessary because no single node has sufficient expertise resources and information to solve a problem and different nodes might have expertise for solving different parts of the problem. For example, geographically separated nodes that are monitoring aircraft movements will have different perceptions because their sensors will pick up different signals. Only by combining information about their views they will be able to form an overall picture of aircraft movements.

The main issues to be addressed in CDPS include the following:

- How can a problem be divided into smaller tasks for distribution among agents?
- How can a problem solution be effectively synthesized from subproblem results?
- How can the overall problem-solving activities of the agents be optimized so as to produce a solution that maximizes the coherence metric?
- What techniques can be used to coordinate the activity of the agents, thus avoiding destructive (and therefore unhelpful) interactions, and maximizing effectiveness (by exploiting any positive interactions)?

[For those who are interested]

3. The Contract Net (CNET) protocol is a high-level protocol for cooperation through task sharing, inspired by the way companies put out contracts. These are the steps of the CNET protocol:

    1. Agent **A** starts up the protocol when it recognises it cannot carry out some task.
    2. Agent **A** communicates with other agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$ and advertises a task announcement, then acts as a manager of that task.
    3. Agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$ listen to the task announcements and evaluate them with respect to their capabilities and resources. When they find a task suited to them, they place a bid; a bid indicates what the agent can do and the associated costs.
    4. Agent **A** receives all bids and selects the one(s) it prefers and tells agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$ of its decision.

    In our CNET protocol an advertisement is represented as a pair (t,ag) where

    - t is the task identification,
    - ag is the advertiser (agent) identification

    Bids are represented as tuples (t,ag,x,y), where

    - t is the task identification,
    - ag is the bidder (agent) identification,
    - x (an integer) is the cost for ag to perform task t
    - y (an integer) is how long ag takes to perform task t

    Assume that some tasks may be broken down into sub-tasks, that is, t breaks down into $s_1,\ldots,s_n$; however, some tasks are *atomic*, that is, they cannot be broken down into sub-tasks. Agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$ should check if a task can be broken down, and, if so, they may, in their turn, use the CNET protocol to manage the breakdown of that task, reporting back to Agent **A**; however, an agent $\mathbf{B}_i$ can only use the CNET protocol if it can carry out <u>at least one</u> of the sub-tasks $s_1,\ldots,s_n$.

    In this item you are asked to:

    i. Define (in pseudo-code) the behaviour of agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$

Solution: This item gauges Knowledge, Understanding and Intellectual Skills. The CNET protocol was covered in lectures. Students will have to demonstrate understanding of design issues of software agents. Students have had experience looking at actual code for software agents as well as programming their own. There are various alternative answers for this item, with different levels of detail. The basic mechanism for agents $\mathbf{B}_1,\ldots,\mathbf{B}_n$ is given below:

1. Receive adverts from agents
2. Select those adverts whose tasks are within agent's capabilities and send back a bid for each of them
3. Check those adverts with non-atomic tasks such that it can perform at least one of them
4. Use the CNET protocol to send requests for all those tasks it cannot perform
5. Receive bids
6. Check which of the non-atomic tasks can be performed with the received bids
7. Send a bid for each non-atomic task the agent can perform (i.e., it has all the subtasks commissioned)
8. Receive decisions from agent **A**.
9. Use decisions from agent A to notify the subcontracted agents if it is taking their offers or not.

Steps **3-5** ensure non-atomic tasks are broken down and their sub-tasks are seconded to other agents, if there are takers. Steps **6-7** ensure non-atomic tasks can be "packaged" and a bid can be made to perform them – the cost for the non-atomic task should be the sum of individual sub-tasks. Steps **8-9** ensure the decisions as to whether bids for non-atomic tasks are accepted or not are passed back to the agents subcontracted to perform individual sub-tasks.

ii. Explain if there is a risk of "loops", that is, agents advertising task announcements to other agents who, on their turn, advertise the same task announcements to other agents and so on.

Solution: This item gauges Knowledge, Understanding and Intellectual Skills. The answer is no. The original CNET protocol poses a risk of infinite loops, that is, agents announcing tasks other agents have originally announced, these advertisements being received by other agents who pass them on and so on. However, because of the requirement that an agent should be able to perform at least one of the sub-tasks in order to announce sub-tasks, then there is no risk of loops. If an agent cannot perform an atomic task advertised by another agent, then the advertisement for that task is ignored; if an agent cannot perform any of the sub-tasks of a non-atomic task advertised then this task is ignored; if at least one sub-task can be performed then the remaining sub-tasks are advertised.