Sample Translation

Informatics (National Taiwan University)

- See below for the original Chinese manuscript.
- **A native-speaker of English who has studied this field** proofreads the translated English.
- The quality of the translated manuscript is suitable for publication in an international journal.

Overview of Agents Technology

Agents and Multi-Agent Systems

Agent technology is one of the fastest developing areas of research in artificial intelligence, and is widely used in businesses and industries. There are several similar but different academic views on the correct definition of an agent as there is no official definition among the scholars in this field. From an artificial intelligence perspective, an agent is "a computer program that simulates human relations by executing particular tasks" [Ch2-1]; from a software engineering point of view, an agent is "a part of the software, and it can be used to communicate and exchange information using a set of languages" [Ch2-2]; in a distributed system, an agent represents "a method that is able to overcome the incompatibility in programming interface, data formats and protocols in heterogeneous computer networks" [Ch2-3]. Although various domains have proposed different definitions of agents, most of them are based on the same concept: in simple terms, an agent is a software program that executes automatically and continuously according to the environment specified by the user, and is able to perform appropriate actions and responses without user intervention.

Even though an agent is a software program, it lacks some of the features of conventional software programs. Generally speaking, all agents have the following fundamental characteristics:

(1) Autonomy: After an agent is given a task, it will autonomously execute the task until the goal is attained. The feedback of execution results can be an "asynchronous" operation, which means users do not have to constantly monitor execution or give commands to the agent. [Ch2-4]

(2) Social Ability: Agents can achieve the predefined goal by communicating with other agents.

[Ch2-2]

(3) Reactivity: Agents should be able to sense changes in the external environment and apply artificial intelligence to respond and take actions in real time. [Ch2-5]

(4) Pro-activeness: Agents can operate in accordance with their designed framework and purposes, i.e. goal-directed behavior is present. [Ch2-5]

(5) Veracity: An agent faithfully executes the tasks based on the user's settings, where the state of the task is represented accurately. [Ch2-2]

Due to increasing complexity in application areas and environment, an individual agent often cannot effectively solve all the problems alone. This has given rise to the concept of a multi-agent system [Ch2-6, Ch2-7], which uses multiple agents responsible for different tasks and goals to effectively address the distributed, complex problems. The concept of multiple agents is closely related to the concept of human society as pointed out by Zambonelli, *et al.* [Ch2-8], in which the multi-agent system is an agent society, and agents themselves are organized or have interactive relationships to communicate their respective goals to one another and ultimately make a logical response.

Jennings, *et al.* [Ch2-7] considered multi-agent systems to have the following characteristics:

- Each agent has incomplete information or capabilities for solving the problem, thus each agent has a limited viewpoint.
- There is no global system control.
- Data is decentralized.
- Computation is asynchronous.

Nwana, *et al.* [Ch2-9] divided multi-agent coordination into four main categories:

- Organizational structuring
- Contracting
- Multi-agent planning
- Negotiation

Huhns, *et al.* [Ch2-10] indicated that when multiple agents interact, their goals may not be the same since they are working in different environments, thus conflicts of behavior often occur. To enable coherent performance of agents, communication between agents is required to coordinate their actions

and behaviors. The collaborative approach can be either cooperation or competition; respective agents are self-interested under the competitive collaboration model, but they mainly operate under the cooperation mechanism.

Agents and Multi-Agent Systems

代理人 (agent) 是人工智慧 (artificial intelligence) 技術中快速發展的研究領域，且已被廣泛的應用在工商業界中。對於何謂代理人的見解，各學者略有不同且並無一個正式學理上的定義。以人工智慧的角度，認爲代理人是「一種藉由執行某些工作，模擬人類關係的電腦程式」[Ch2-1]；以軟體工程的角度，則認爲代理人是「軟體的一部分，能用一組語言相互溝通、交換訊息」[Ch2-2]；在分散式系統的看法，代理人代表著「一種可以克服異質性電腦網路中，程式介面、資料格式與通訊協定之間不相容的方法」[Ch2-3]。雖然不同領域對代理人有不同的定義，但概念上大同小異，簡單來說，代理人是一種能在使用者指定的環境下持續並自動執行指令，且能在不需使用者干預的情況下針對環境的改變做出是當的動作及回應的軟體程式。

代理人雖然是軟體程式，但是其擁有一些傳統的軟體程式 (traditional software) 所缺乏的特性。一般而言，代理人皆具備以下幾個基本特性：

(6) Autonomy: 代理人接受任務委託後，便會自主性的執行任務，直到目標達成爲止。執行結果的回傳也可以採用「非同步化」的作業，意即使用者不必持續監控代理人執行，也不需要一直對代理人下達指令[Ch2-4]。

(7) Social Ability: 代理人能透過其溝通模式與其他代理人進行溝通，以達到其目的 [Ch2-2]。

(8) Reactivity: 代理人應該能感知外在環境的變化，並以人工智慧的規則做立即性的反應來產生動作 [Ch2-5]。

(9) Pro-activeness: 代理人能夠以符合其設計架構以及其設計目的的活動，來顯示其是以目標爲基礎的行爲 (goal-directed behavior) [Ch2-5]。

(10) Veracity: 依據使用者的設定，忠實的執行任務，並且確實反映任務狀況 [Ch2-2]。

隨著應用領域及環境愈趨複雜，單一代理人往往無法有效的解決各個層面的問題，於是有了多重代理人系統 (multi-agent system) 觀念的產生[Ch2-6, Ch2-7]，藉由許多代理人各自所賦予不同

的任務及目標，各司其職以有效解決各種分散式的複雜問題。多重代理人的概念與人類社會的概念相當接近，Zambonelli 等人 [Ch2-8] 指出，多重代理人系統像人類社會一樣，它其實就是一個代理人社會，代理人彼此間有組織性或互動關係，彼此有溝通及各自的目標，能對事件作出合理的反應。

Jennings 等人 [Ch2-7] 認爲多重代理人系統具備如下特性：

- each agent has incomplete information, or capabilities for solving the problem, thus each agent has a limited viewpoint,
- there is no global system control,
- data is decentralized, and
- computation is asynchronous.

Nwana 等人 [Ch2-9] 將多重代理人協同合作 (coordination) 分爲四大類：

- organizational structuring,
- contracting,
- multi-agent planning, and
- negotiation.

Huhns 等人 [Ch2-10] 指出，多重代理人在互動時，由於所處的環境可能是分散的，各個代理人的目標也可能不盡相同，彼此的行爲往往可能產生衝突。爲使代理人系統能有一致 (coherent) 的表現，代理人透過溝通 (communication) 進行協同合作，以協調彼此的活動與行爲，協同合作方式可分爲合作式 (cooperation) 及競爭式 (competition) 二種；在代理人各自具有利害關係 (self-interested) 的競爭式的協同合作模式中，又以協商的運作機制爲主。