Sample Translation

IT - Agent Technology

- 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.

智能代理 (agent) 是人工智能 (artificial intelligence) 技术中快速发展的研究领域，并且已被广泛运用于商业界中。对于何谓智能代理，不同学者有不同见解并且尚无一正式的学术定义。以人工智能的角度理解，认为智能代理是“一种用于执行某些工作，模拟人类关系的电脑程序”[Ch2-1]；以软件工程的角度理解，则认为智能代理是“软件的一部分，能用一组语言相互通讯，交换信息”[Ch2-2]；以分布式系统的看法，智能代理代表着“一种可以克服不同网络特质，不同程序，以及不同数据格式的方法”[Ch2-3]。虽然不同领域对智能代理有不同的定义，但是概念上大同小异。简单来说，智能代理是一种能在使用者指定的环境下持续并自动执行指令，并且能在不需使用者干预的情况下针对环境的改变做出适当的动作及回应的软件程序。

智能代理虽然是软件程序，但是其拥有一些传统软件程序（traditional software）所缺乏的特性。一般而言，智能代理应具备以下几个基本特性：

(6) Autonomy: 当智能代理接收到认为后，便会自动的执行任务，直到目标达成为止。执行结果的反馈可以是“异步”操作，这意味着用户不用持续的监控执行过程或对智能代理下达指令。[Ch2-4]

(7) Social Ability: 智能代理能通过与其它智能代理通讯交流以达成预定的目标。[Ch2-2]

(8) Reactivity: 智能代理应该能感知外界环境的变化，运用人工智能的规则予以回应并实时地做出动作。[Ch2-5]

(9) Pro-activeness: 智能代理能以符合其设计框架以及设计目的方式而工作。也就是，当采用目标导向的方式时。[Ch2-5]

(10) Veracity: 智能代理应该能依据用户的设定，忠实的执行任务，并且准确的反映任务状况。[Ch2-2]

由于运用领域以及外界环境不断增加的复杂度，单个智能代理通常不能有效的解决所有问题。于是多智能代理系统（multi-agent system）的概念孕育而生[Ch2-6, Ch2-7]。基于这种概念，不同智能代理负责于处理不同任务而最终目标是有效地处理分布式的复杂问题。如 Zombonelli 等人[Ch2-8]指出的，多智能代理的概念与人类社会的概念非常相似。它其实就是一个多智能代理社会，智能代理彼此之间有组织性或互动关系，对他们各自的目标进行彼此交流以最终做出合理的回应。

Jennings 等人[Ch2-7]认为多智能系统具有以下一些特性：

- 在处理问题时，每个智能代理具有不完整的信息或能力，因此，每个智能代理的观点是局限的。
- 其不具备全局控制系统。

- 其数据是分散化的。
- 其计算过程是异步的。

Nwana 等人[Ch2-9]将多智能协同合作大致划分为以下四类：

- 组织结构化
- 合同化
- 多智能代理计划
- 协商

Huhns 等人[Ch2-10]指出，当多智能代理互动时，由于所处环境是分散的，各个智能代理的目标也可能不尽相同，彼此的行为往往会产生冲突。为使智能代理系统达成一致性，智能代理通过通讯进行协同合作，以协调彼此的活动与行为。协同合作方式可分为合作式（cooperation）或竞争式（competition）两种。在智能代理各自具有利害关系（self-interested）的竞争式的协同合作模式中，又以协商的运作机制为主。