Artificial Intelligence

School of Electronic and Computer Engineering
Peking University

Wang Wenmin

Contents:

Part 1. Basics

Contents:

Objectives 教学目的

- Overview several approaches for AI.
  纵览AI的各种研究途径。
- Discuss the nature of intelligent agents, the diversity of environments, and the resulting menagerie of agent types.
  讨论智能体的性质、环境的多样性、以及由此产生的各种类型的智能体。

2. Intelligent Agents

Contents:

- ☐ 2.1. Approaches for Artificial Intelligence
- ☐ 2.2. Rational Agents
- ☐ 2.3. Task Environments
- ☐ 2.4. Intelligent Agent Structure
- ☐ 2.5. Category of Intelligent Agents

2.1. Approaches for Artificial Intelligence

Contents:

Overview 概述

- In 1940s and 1950s, a number of researchers explored the connection between neurology, information theory, and cybernetics.
  1940年代至1950年代，许多研究者探索神经学、信息论和控制论之间的关系。
- Some of them built machines that used electronic networks to exhibit rudimentary intelligence.
  他们当中有些人采用电子网络打造机器来展现初步的智能。
- Many of these researchers gathered for meetings of the Teleological Society at Princeton University and the Ratio Club in England.
  许多研究者聚集在普林斯都大学和英国Ratio俱乐部，召开了目的论学会的会议。
- By 1960, this approach was largely abandoned, although elements of it would be revived in the 1980s.
  到了1960年，这种途径基本上被抛弃了，尽管有些要素于1980年代复活。

Overview 概述

- Herbert Simon and Allen Newell studied human problem-solving skills and attempted to formalize them.
  赫伯特·西蒙和艾伦·纽厄尔研究了人类问题求解技能，并且试图对其形式化。
- Their work laid the foundations of artificial intelligence, as well as cognitive science, operations research and management science.
  他们的工作奠定了人工智能、以及认知科学、运筹学和管理学的基础。
- Their research team used the results of psychological experiments to develop programs that simulated the techniques that people used to solve problems.
  他们的团队采用了心理学实验结果开发程序，仿真人们解决问题的技巧。
- Soar, a cognitive architecture, was originally created at CMU in the middle 1980s, now maintained at University of Michigan.
  Soar，一种认知架构，是以CMU为核心于1980年代中期开发，如今由密歇根大学维护。

2.1. Approaches for Artificial Intelligence

Contents:

Symbolic AI 符号AI

- Symbolic AI is based on high-level “symbolic” (human-readable) representations of problems, logic and search.

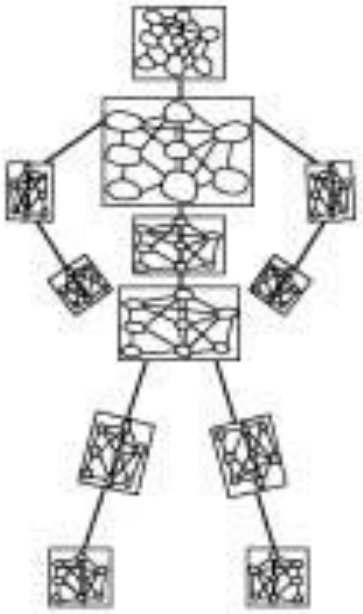
  符号AI是基于人类易懂的高级“符号”来表现问题、逻辑和搜索。

- The approach is based on the assumption that many aspects of intelligence can be achieved by the manipulation of symbols.

  该方式是基于这样一种假设：智能的许多方面能够通过符号操作来获得。

- The most successful form of symbolic AI is expert systems, it processes the rules to make deductions and to determine what additional information it needs, i.e. what questions to ask, using human-readable symbols.

  符号AI最成功的形式是专家系统，它对规则进行操作来进行推断和确定需要什么附加信息，即采用人类易懂的符号询问一些问题。



Symbolic

Sub-symbolic AI 亚符号AI

- By the 1980s, many researchers believed that symbolic systems would never be able to imitate all the processes of human cognition, especially perception, robotics, learning and pattern recognition.

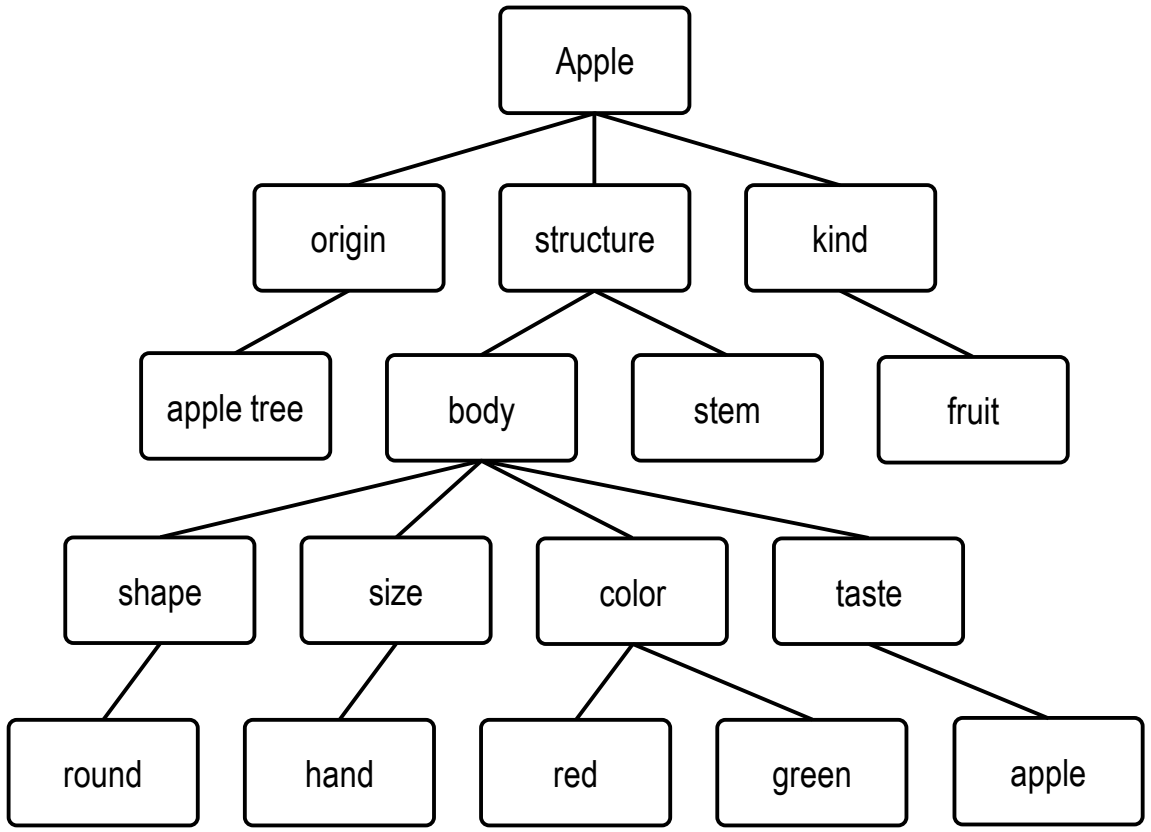
  到了1980年代，许多研究者已确信，符号系统将永远无法模仿人类认知的全部过程，尤其是感知、机器人技术、学习和模式识别。

- A number of researchers began to look into “sub-symbolic” approaches, based on neural networks, statistics, numerical optimization, etc.

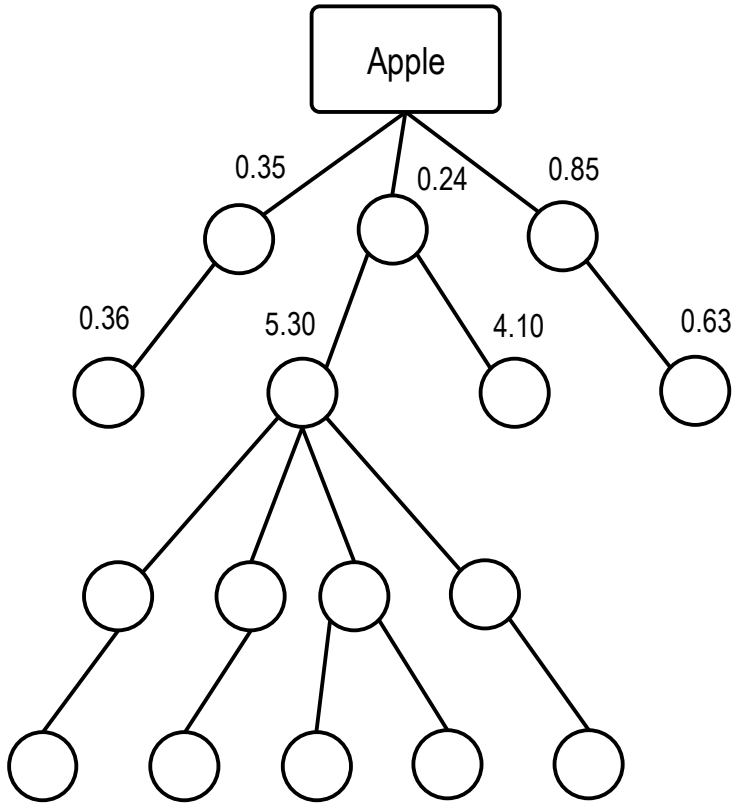
  一些研究者开始关注“亚符号”方式，以神经网络、统计学、数值优化等为基础。

sub-symbolic

Examples: Symbolic vs. Sub-symbolic AI 符号与亚符号AI



Symbolic Apple
符号化苹果



Sub-symbolic Apple
亚符号化苹果

2.1. Approaches for Artificial Intelligence

Contents:

Logic-based 基于逻辑

- Unlike Newell and Simon, John McCarthy felt that machines did not need to simulate human thought, but should instead try to find the essence of abstract reasoning and problem solving, regardless of whether people used the same algorithms.

  与纽厄尔和西蒙不同，麦卡锡觉得机器无需仿真人类的思考，反倒应该试图去发现抽象推理和问题求解的本质，不管人们是否使用同样的算法。

- His AI laboratory at Stanford (SAIL) focused on using formal logic to solve a wide variety of problems, including knowledge representation, planning and learning.

  他的斯坦福大学AI实验室（SAIL）专注于用使用形式逻辑来解决各种问题，包括知识表征、规划和学习。

- Logic was also the focus of the work in Europe, which led to the development of the programming language Prolog and the science of logic programming.

  逻辑也被欧洲的研究工作所专注，导致编程语言Prolog和逻辑编程科学的发展。

Anti-logic 反逻辑

- Researchers at MIT (such as Marvin Minsky) found that solving difficult problems in vision and natural language processing required ad-hoc solutions.

  MIT的研究者（比如明斯基）发现，解决视觉和自然语言处理的难题需要特别的解决办法。

- They argued, there was no simple and general principle (like logic) to capture all the aspects of AI.

  他们主张，没有简单和通用的原理（如logic）能涵盖AI的所有方面。

- Roger Schank described their “anti-logic” approaches as “scruffy”, as opposed to the “neat” paradigms at CMU and Stanford.

  罗杰·尚克描述他们的反逻辑方式属于“不整齐”，与CMU和斯坦福的“整齐”范式形成对照。

- Commonsense knowledge bases are an example of “scruffy” AI, since they must be built by hand, one complicated concept at a time.

  常识知识库就是“不整齐”AI的示例，因为它们必须用手工构建，每次一个复杂的概念。

Knowledge-based 基于知识

- Around 1970, researchers began to build knowledge into AI applications.
  1970年前后，研究者开始在AI应用中构建知识。
- This “knowledge revolution” led to the development and deployment of expert systems, the first truly successful form of AI software.
  这场“知识革命”导致专家系统的开发和部署，这是第一个真正成功的AI软件形式。
- Expert systems was introduced by Edward Feigenbaum at Stanford University, often called the “father of expert systems”.
  专家系统是由斯坦福大学的爱德华·费根鲍姆提出的，人们通常称他为“专家系统之父”。
- The knowledge revolution was also driven by the realization that enormous amounts of knowledge would be required by many simple AI applications.
  知识革命也是由这样的实现所驱动的，许多简单的AI应用需要庞大的知识。

2.1. Approaches for Artificial Intelligence

Contents:

Symbolism vs. Connectionism 符号主义与联结主义

Symbolist AI 符号主义AI

- It represents information through symbols and their relationships.
  符号AI凭借符号及他们之间的关系来表征信息。
- Specific algorithms are used to process these symbols to solve problems or deduce new knowledge.
  特定算法用于处理这些符号来解决问题和推导新的知识。

Connectionist AI 联结主义AI

- It represents information in a distributed form within a network.
  联结主义AI用网络内部的一种分布式形式来表征信息。
- It imitates biological processes underlying learning, task performance, and problem solving.
  模仿生物学过程的基础学习、任务功效和问题求解。

2.1. Approaches for Artificial Intelligence

Contents:

Statistical Approach 统计方法

- In 1990s, AI researchers developed sophisticated mathematical tools to solve specific sub-problems. Stuart Russell and Peter Norvig describe this movement (statistical approach) as “the victory of the neats”。

  1990年代，AI研究者开发了复杂的数学工具来解决特定的子问题。斯图尔特·罗素和彼得·诺维格描述这个运动（统计方法）为“整齐观点的胜利”。

- Critics argue that these techniques are too focused on particular problems and have failed to address the long term goal of general intelligence.

  批评者认为，这种技巧过于关注特定的问题、并且未能解决通用智能的长期目标。

- There is an ongoing debate about the validity of statistical approaches in AI, exemplified in part by exchanges between Peter Norvig and Noam Chomsky.

  关于AI统计学方式相关性和有效性的辩论一直在进行，部分体现在彼得·诺维格和诺姆·乔姆斯基之间的交锋。

2.1. Approaches for Artificial Intelligence

Contents:

What is an Intelligent Agent 什么是智能体

- Operate autonomously
  自主操作
- Perceive their environment
  感知环境
- Persist over a prolonged time period
  持续动作
- Adapt to change
  顺应变化
- Create and pursue goals
  实现目标
- The best outcome, or the best expected outcome (when there is uncertainty).
  最佳结果，或最佳预期结果（存在不确定性时）。

What is an Intelligent Agent 什么是智能体

- Broadly, an agent is anything that can be viewed as

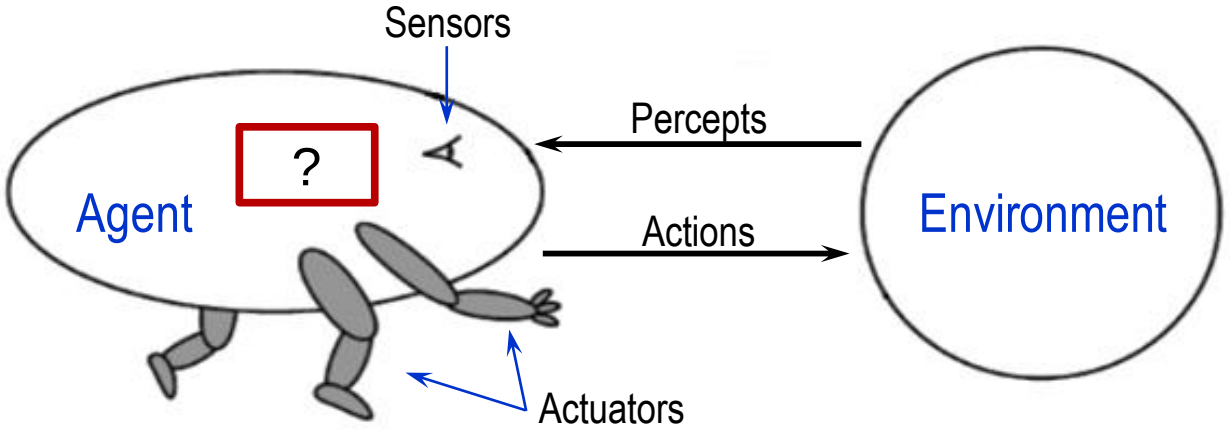
  概括地说，一个智能体可以被看作具有如下功能的任何事物：

  - Perceiving its environment through sensors, and acting upon that environment through actuators.

    通过感受器感知外部环境，并且通过执行器作用于外部环境。

  - May also learn or use knowledge to achieve their goals.

    还可以通过学习或者应用知识来实现其目标。



Intelligent agents Include humans, robots, softbots, etc.

智能体包括人类、机器人、软件机器人，等等。

Q: Which one could be better, Why? 哪种方法较好，为什么

- Cybernetics and brain simulation
  控制论和大脑仿真
- Symbolic vs. Sub-symbolic
  符号与亚符号
- Logic-based vs. Anti-logic
  基于逻辑与反逻辑
- Symbolism vs. Connectionism
  符号主义与联结主义
- Statistical approach
  统计方法
- Intelligent agent paradigm
  智能体范式