Hybrid Intelligent Systems

Lecture 1

Introduction.

Artificial General Intelligence

Agenda

- About this course
- Why hybrid approach in AI appeared and what is it?
- What is Artificial General Intelligence (AGI)?

Aims of this course

- Presentation of systematic performance about problems of development of Artificial General Intelligence, features, modern approaches and application of hybrid intelligent systems
- You can use this material for more detail study and practical application
- Like in other previous my courses I will most attention to your term projects

Course evaluation

- Mid Term exam: 1 exam 20%
- Final Exam: 1 exam 40%
- Term Project: 1 project 40%
- Total 100%

Possible term projects

- Review of papers in determined area of HIS.
- Development of connection between neural network and logical expert system for concrete determined application.
- Development of simple determined hybrid expert system (by team of students)
- Development of work in your lab related with content of course

Requirements to term projects

- Implementation as program in Matlab, C++ (most appropriate for me CBuilder) or Delphi (most appropriate for me CBuilder)
- Must finish by presentation in class (from 15 to 30 minutes)
- Must include presentation (ppt), description (doc), sources of programs (may be exclude in special cases with confirmation with me)
- Theme of term project must be confirmed with me no later than 1 October
- During working under project you must discuss with me and present current materials at least 1 time per month (meeting or by email)

Why hybrid ?

Two reason of appearance of hybrid approach in AI (end of 80th)

- To combine achievements of two direction of simulation of mind
  - Classical AI (logical approach or symbolic approach)
    - Representation of knowledge
    - Inference
  - Methods of Computational Intelligence (sub-symbolic approach)
    - Neural networks
    - Evolution programming
    - Smart intelligence (social intelligence)
- To simulate human-like mind able to deal with symbolic and numerical information and also more

Paradigms in Logical (classic) Intelligent Systems and Neural Systems

- Logics
- Rules
- Frames
- Semantic networks
- Fuzzy logics
- Space of decisions
- Semantics spaces
- and so on

- Multi-layers perceptrons
- Kohonen's maps
- Hopfield's model
- ART
- RBF networks
- Bayesian nets
- Spikes Neural Nets
- and so on

Hybrid Approach is needed because there are disadvantages:

- In Logical Intelligent Systems -
  - formalization of knowledge is needed
  - learning is difficult
  - parallel processing is difficult
  - low tolerance and reliability
- In Neural Networks -
  - verbalization is difficult
  - verification and proving are difficult
  - exact repetion of processes is unable

Kinds of known Architectures of Hybrid Intelligent Systems:

mixture of models

- Combination of different knowledge models of knowledge engineering
- Combination of knowledge models and neural networks
- Combination of neural networks and genetic algorithms
- Integration of Knowledge engineering and usual data processing

What is Artificial General Intelligence (AGI)?

Artificial General Intelligence
(in “AGI Open Letter” http://www.agiri.org/wiki/AGI_Open_Letter)

1. AGI is a legitimate field that seeks to build software systems with general intelligence, that is, AI that can independently find problem-solving strategies and solutions for problems in biology, physics, engineering, architecture, nanotechnology, cognitive science, and programming, with quality equalling or surpassing the brightest human minds.
2. AGI is a subfield of Artificial Intelligence with the greatest long-term consequences. Most of Artificial Intelligence is focused on building software systems for narrow tasks, rather than flexible general intelligence.
3. AGI, if built, would be intelligent enough to improve on its own programming and robotics without human assistance. Because of its superior cognitive hardware, AGI could self-improve very rapidly by human standards. This represents significant risk but also significant promise. Rogue AI is a legitimate, near-term threat to the human species, on par or exceeding the risk of nuclear war, bio-terror, or asteroid impact.
4. The problem of how to ensure that AI remains friendly to humanity as it gains the ability to reprogram itself is unsolved. Before we build human-equivalent Artificial General Intelligence, there should be extensive theoretical and experimental studies to ensure that future AGIs are good global citizens, even given the ability to reprogram themselves, adhering to the "spirit" and not just the "letter" of their goal programming.
5. Ultimately, human-equivalent AI cannot be avoided. So AGI researchers should do their best to ensure that AGIs benefit humanity rather than hinder it. Because the benefits of successful AGI would be so large, arguing about the specifics of the distribution of benefits is not as important as ensuring that everyone receives them.
6. We must not anthropomorphize AI, and assume that AGIs will be motivated by the same things that motivate us, find challenging the same obstacles that challenge us, arrange themselves in social configurations the same way that we do, etc.
7. A number of potential paths to AGI exist, including symbolic AI, genetic algorithms, universal inference and decision theory, and whole brain emulation.

Famous scientists in AI signed AGI Open Letter

- J. Storrs Hall, Ph.D
- Ray Kurzweil
- Eric Drexler, Ph.D
- Nick Bostrom, Ph.D
- Robin Hanson, Ph.D
- Bart Kosko, Ph.D
- Hugo de Garis, Ph.D
- Marvin Minsky, Ph.D
- Steve Omohundro, Ph.D
- Anders Sandberg, Ph.D
- Ben Goertzel, Ph.D
- Aubrey D.N.J. de Grey, Ph.D
- Eric Baum, Ph.D
- Pei Wang, Ph.D
- Hans Moravec, Ph.D

Criteria for AGI projects

1. The project is based on a theory about “intelligence” as a whole (which may encompass intelligence as displayed by the human brain/mind, or mayspecifically refer to a class of non-human-like systems intended to display intelligence with a generality of scope at least roughly equalling that of thehuman brain/mind).
2. There is an engineering plan to implement the above conception of intelligence in a computer system.
3. The project has already produced some concrete results, as publications or prototypes, which can be evaluated by the research community.

First examples of AGI projects

- CYC (http://www.cyc.com)
  - **Cyc** is an artificial intelligence project that attempts to assemble a comprehensive ontology and database of everyday common sense knowledge, with the goal of enabling AI applications to perform human-like reasoning (Wikipedia)
- Soar (http://sitemaker.umich.edu/soar/home)
  - general cognitive architecture for developing systems that exhibit intelligent behavior.

The Novamente Project

Long-term goal:

- creating "artificial general intelligence" approaching and then exceeding the human level
- to be approached via a series of incremental phases
  - Learning programme inspired by human developmental psychology
  - The system is taught via its embodiment in a 3D simulation world

- **Novamente AI Engine:** an integrative AI architecture
  - Overall architecture inspired by cognitive science
  - a "weighted labeled hypergraph" knowledge representation
    - smoothly spans perception, cognition and action
    - Aspects in common with semantic nets and attractor neural nets
  - Learning via computer science algorithms:
    - **evolutionary programming** (a special kind of EDA)
    - **probabilistic inference** (Probabilistic Logic Networks)
  - efficient, scalable C++/Linux implementation
- Currently parts of the Novamente codebase are being **used for commercial projects**
  - natural language processing
  - biological data analysis

Centers of research in AGI

- Artificial General Intelligence Research Institute (USA) http://www.agiri.org/
- Singularity Institute for Artificial Intelligence (USA) http://www.singinst.org/
- Novamente LLC (USA) http://www.novamente.net/
- Adaptive A.I. Inc. (Great Britain) http://www.adaptiveai.com/