# Human–Level Intelligence

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**Modeling general intelligence has a long history: At the beginnings of AI, researchers searched for the general problem solving mechanism to model intelligence. While researchers failed to solve this complex problem, AI achieved great success when modeling cognitive abilities separately. In recent time a growing number of research endeavors aims again at human–level intelligence via integrating multiple cognitive abilities in unified architectures.**

It seems to be the case that human–level intelligence (HLI) has been playing an important role in artificial intelligence already from the very beginnings of the discipline's development. Historically important challenges such as the Turing test or the task to develop a general problem solver support this claim to a substantial degree. As the original goals turned out to be too ambitious, AI shifted to modeling isolated cognitive abilities in a second phase (like the development of natural language interfaces, theorem proving, or chess playing). However, recently one can observe a return to the overall goal HLI. Here are three examples that document such activities to "re–discover" HLI (all taken from the year 2006).

- Volume 27, No. 2 of the *AI Magazine* was dedicated to HLI: "Achieving Human–Level Intelligence through Integrated Systems and Research". Not surprisingly a large part of the volume discussed cognitive architectures and the integration of cognitive abilities.
- A symposium at CogSci 2006 was entitled "Building and Evaluating Models of Human–Level Intelligence". In this symposium, the speakers (all working in AI) examined cognitively inspired approaches to reach HLI.
- A symposium at the AAAI spring symposium series 2006 entitled "Between a Rock and a Hard Place: Cognitive Science Principles Meet AI–Hard Problems" showed an effort to focus on cognitive architectures, in order to integrate various human abilities and to end up with something approximating HLI.

These few examples show that HLI is an issue in current cutting–edge research endeavors of the AI community. But what is the difference between these new attempts and the rather old idea to build a general problem solver? In other words, what is new in these attempts in comparison to good old fashioned AI? Although the history of science seems to re–invent things over and over again, in this case, there are some important new aspects to this questions:

- *Integration:* For the first time the integration of rational behavior, emotional behavior, autonomy, communication, setting of own goals etc. is on the agenda. The integration of the entire width of human cognitive abilities lies in the focus of HLI.
- *Architecture:* An aspect that seems to be an issue for many attempts in the HLI direction is the development of cognitive architectures. Researchers try to implement frameworks for systems in the large comprising cognition as an integral phenomenon.
- *Methodology:* From a methodological point of view newer approaches allow a variety of different techniques, ranging from classical symbolic methods to subsymbolic methods. In particular, an interest in hybrid systems (and neuro–symbolic integrated systems) can be identified.
- *Learning:* Learning from the environment did not play an important role in the past, but is considered currently as being crucial for the success of HLI.
- *Embodiment:* The achievement of reaching artificial human–level intelligence is only conceivable, if, in a final model, a real–world robot can be released into freedom.

There is a variety of potential applications for frameworks of HLI. All kinds of intelligent (embodied or virtual) support systems in everyday life, like e–assistants able to accompany and to consult humans in all situations, require large parts of cognitive capacities that go significantly beyond a mathematical model of an isolated cognitive ability. Imagine, for example, a robot assisting you in everyday life by not just scheduling your appointments and searching the web for you, but also telling you during a joint shopping tour which trousers underline your lank body or just listening to you during the time of your divorce. Although robots with such abilities are currently utopian, as a final goal of HLI they make sense.

Another line of applications is connected to the defense industry. The demand to build autonomous systems with large and heterogeneous knowledge bases, that can communicate and cooperate with humans in a more or less natural way is inevitable. Necessary ingredients for achieving this goal are communication devices based on (subsystems of) natural language, embodiment, cognitively adequate behavior, learning capabilities, and the ability to deal with vast amounts of information of different types. These constraints make the integration of different computational paradigms unavoidable.

Like every research endeavor, there is no guarantee that HLI will be successful. But a necessary (although not sufficient) condition is the study and modeling of cognition in integrated large–scale cognitive systems.

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