Artificial intelligence

Cognitive modelling, multi-agent systems, autonomous and perceptive systems, language sound and cognition…

The field of Artificial Intelligence (AI) has been enjoying a tremendous speed-up in recent years. It is the discipline of the designers of the Google search engine, and the search algorithms used in GPS navigation. Current travel and logistics software is based on AI insights of the 1960s and 1970s. Computer games are being equipped with increasingly sophisticated, 'believable' agents. The tools of AI are pervasively present, often without mentioning the 'AI' acronym. At the same time, the field is maturing as a scientific discipline and the numbers of highly ranked (ISI/Thomson) journals and prestigious peer reviewed international conferences are still increasing. Today, its sub-disciplines are covering a wide two dimensional spectrum, from formal logic to statistical machine learning, and from biologically inspired computing to high-level cognitive modelling. The Artificial Intelligence and Cognitive Engineering (ALICE) institute of the University of Groningen, the Netherlands, is a good example of an exciting research environment that has produced a number of important advances in the field.

Continuous autonomous learning: the 'Monk' system

Lambert Schomaker

The automatic recognition of historical, handwritten manuscripts is not a solved problem. Powerful commercial sorting systems do exist in closed applications, such as address reading of scanned handwritten envelopes. However, historical documents present a huge challenge: the noisy images, unknown character shapes, unknown words and unknown linguistic statistics make the use of traditional approaches impossible.

We have investigated how to process historical documents and their transcriptions in such a way that a continuously learning, high-performance computer could learn how to search words in such documents. The result is an advanced architecture, Monk, which allows volunteers and interested human users to enter text labels over the internet. These text labels are used to train a large list of word classifiers, so that users can Google these words. The result is an ever growing list of word indices to handwritten collections. At this moment, the system has learned over 20,000 word classes from various styles and periods, processing hundreds of millions of word images.

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The handwriting recognition algorithms are based on biologically inspired shape features. Various research projects are focused around Monk as a source of fresh, labelled image data, for instance a Dutch NWO project on computer-based dating of medieval manuscripts on the basis of style evolution. The test bed currently contains one petabyte of disk space and will grow towards a 10-petabyte platform for e-science in the final stage. Experience has shown that the idea of 24/7 machine learning has a very general applicability far beyond its original application domain of handwriting recognition.

Today, we do not only address machine-printed book material and images of decorative initials in historical printed books, but also astronomical data (star classification) and RNA-expression array data (genomics). There is no data like more data.

RoboCup@Home: the amazing complexity of domestic tasks

Tijn van der Zant

The RoboCup global robot soccer competition is an exciting branch of technical research. However, one of the young researchers in ALICE (Dr Tijn van der Zant) noted that this competition runs the same risk as 'computer chess': the competition remains within a closed world of artificial game rules. The stakes needed to be set even higher in order to mimic natural cognition. The RoboCup@Home league aims to develop service and assistive robot technology with high relevance for future personal domestic applications. It is the largest international annual competition for autonomous service robots. A set of benchmark tests is used to evaluate the robot's abilities and performance in a realistic home environment setting. Although such systems seem very simple from the outside, they are equipped with advanced sensing, learning and reasoning capabilities to watch and assist the ageing individual and to allow for convenient communication. The University of Groningen has chosen 'Healthy Ageing' as one of its spearhead research themes.

Logical and computational models of higher-order social cognition

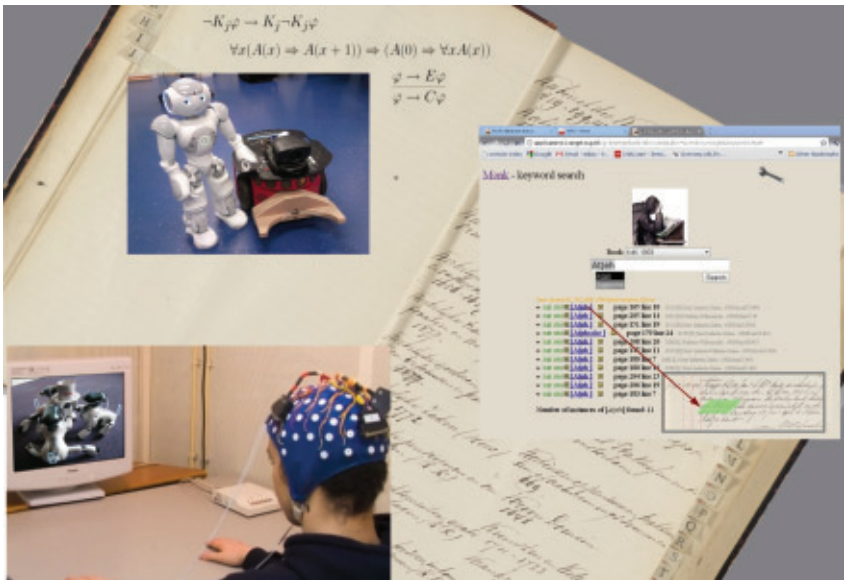
Rineke Verbrugge

Humans are exquisitely able to perform higher-order social reasoning. They make inferences about the other person's intentions and are able to reason about knowledge that the other person may or may not possess. Some animals also perform behaviours that, at least on the surface, may indicate some aspects of social intelligence. For instance, why do corvids hide their food in another spot if they have detected other corvids watching them? These are interesting research topics for which we were able to obtain prestigious grants, such as a Dutch NWO (NSF) Vici project of €1.3m. In order to construct formal logical systems of social reasoning, we investigate the development of children and the limitations of adults in reasoning about the mental states of other agents, including the representations that these agents have of other agents' mental states. While computer programs can correctly apply any arbitrary amount of recursion, humans frequently lose track beyond second or third-order social reasoning. To better understand the cognitive processes involved in higher-order social cognition, we are using a close-knit combination of empirical research, logic and computational modelling.

Cognitive modelling: From abstract models to predictions of brain-activity patterns

Niels Taatgen

Within psychology, the art of formal and computational modelling has not attracted many scholars as yet, but within AI, modelling is the daily routine. In cooperation with Carnegie Mellon University, we were able to make model-based (ACT-R) predictions concerning brain activity that were indeed confirmed by actual fMRI brain-scanning experiments. A central research focus concerns human multitasking. Together with Dario Salvucci of Drexel University, we have developed the concept of threaded



cognition. This research enables us to make predictions about when human multitasking is productive and when it may become problematic. A large EU/ERC grant of €1.1m was obtained on the topic of human multitasking.

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Sensory cognition and the sustainable society

Tjeerd Andringa

Humans are able to perform a wide range of sound processing tasks, from understanding speech in a cocktail party to the recognition of one particular animal sound in a noisy zoo. Our knowledge of the biophysics of the human cochlea has allowed us to construct working models of, for instance, human aggression detection by analysing typical sound features of angry shouting. These systems were installed in video camera systems in the city of Groningen. We are also able to classify different vehicle types in surface and air traffic. In order to produce a total map of sound pollution in a wide urban area, a dense array of microphones will be installed, extracting a number of abstract sound features and level categories on the spot. Our fundamental knowledge of human sound cognition has shown that loudness is but one parameter in sound annoyance. We have been successful in a long list of regional, national and international grant applications. 'Sustainable society' is one of the large research themes of the University of Groningen.

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