Worldwide AI

■ *One of the consequences of the growth in AI research in South Africa in recent years is the establishment of a number of research hubs involved in AI activities ranging from mobile robotics and computational intelligence to knowledge representation and reasoning and human language technologies. In this survey we take the reader through a quick tour of the research being conducted at these hubs and touch on an initiative to maintain and extend the current level of interest in AI research in the country.*

Alexander Ferrein, Thomas Meyer

A Brief Overview of Artificial Intelligence in South Africa

Despite a peaceful transition to a democratic dispensation in 1994, South Africa is still struggling to achieve the goal of providing decent basic education to the majority of its citizens. The lack of quality education on the primary and secondary levels also serves as a barrier to obtaining tertiary-level education. According to a 2008 OECD review of national policies for education in South Africa, typically only 15 percent to 18 percent of secondary school students who sit for their final year exams every year qualify automatically for university-level education; and this number seems to be decreasing as more students choose to complete subjects on so-called standard grade instead of higher grade, a trend that is especially apparent for mathematics and science, the two fields with critical skills shortages in the country. The South African tertiary education sector is quite small for a country with a population of around 50 million, with 11 "traditional" universities, 6 technical universities, and 6 comprehensive universities. The latter university types focus on more technical or vocational education. The public sector also funds 16 research institutions.[1]

In spite of these obstacles, South African universities participate in world-class research activities in many fields and range among the best on the African continent. There are 3 African universities ranked among the top 500 worldwide, and all 3 of them are South African. Partly due to increased public funding, this description is also applicable to research in information and communication technologies in general, and artificial intelligence in particular, and the field of artificial intelligence can rightly be described as one that has experienced some growth in recent years. This is also evidenced by AI-related events such as the Mobile Robotics Competition[2] and a special session on AI and

robotics at the recent IEEE African Conference.[3] One of the consequences of this growth is the establishment of a number of research hubs, focusing on different aspects of artificial intelligence, ranging from mobile robotics and computational intelligence, through to knowledge representation and reasoning and human language technologies. It is on these hubs that we focus in this survey. This survey should not be viewed as an attempt to provide a comprehensive account of all AI activities, but rather as indicative of the scope and breadth of AI in South Africa.

Following our discussion of the different research hubs, we conclude with a brief mention of an initiative to strengthen AI research in South Africa.

Computational Intelligence Research

The Computational Intelligence Research Group, or CIRG,[4] is based at the University of Pretoria (UP) in the Department of Computer Science. It was officially established in 2003 and focuses on research in the broad realm of computational intelligence. Under this umbrella, work is done in the fields of swarm intelligence, evolutionary computation, neural networks, and artificial immune systems, with applications to optimization, classification, predication, data and text mining, data clustering, image analysis, bioinformatics, and financial analysis. A major application area is in optimization with a focus on multiobjective optimization, optimization in dynamic environments, and locating multiple solutions to highly multimodal problems. Work is also done in classification, prediction, clustering, and data analysis in dynamic environments.

CIRG focuses on development of new and improvement of existing computational intelligence algorithms, and on application-oriented research, using computational intelligence techniques to solve real-world problems, and is actively involved with industry through consultation and contract research. The major thrust of CIRG is toward the continued development of CIlib, a collaborative, open source framework for the implementation of a vast number of CI algorithms and their hybridizations.

Human Language Technologies

The Human Language Technologies groups[5] at the Meraka unit of the Council for Scientific and Industrial Research (CSIR Meraka) and North-West University are primarily focused on developing-world applications of speech technology. The HLT group at CSIR Meraka was officially established in 2003. Since speech technology is traditionally quite resource intensive, and such resources are typically scarce in the developing world, these groups have developed a number of innovative approaches for problems such as the creation of pronunciation dictionaries and usable speech corpora. Researchers in those teams are also active in studies aimed at maximizing the practical impact of speech technology in environments where conventional information technology has not penetrated — for example, through the development of speech-based services for information access.

Robotics and Agents

The Robotics and Agents Lab (RAL)[6] at the University of Cape Town (UCT) is engaged in research on autonomous robots. It was founded in 2007 as a merger between mechanical engineering and computer science. The aim of the lab is to combine solid mechanical design with AI-based control technologies from computational intelligence, learning, and knowledge representation. The lab is engaged in RoboCup activities as this is a good vehicle to showcase the latest developments. During the last three years RAL took part in the RoboCup Standard Platform League with the ZaDeAt team, a research collaboration between the RWTH Aachen University in Germany, the Graz University of Technology, Austria, and UCT. Part of the work in this project concentrated on several robotics aspects, such as the robot system architecture or motion control, and on intelligent high-level control. On the high-level control side, the ongoing work focuses on deploying the robot programming and plan language Golog on resource-restricted robot platforms. Other activities focus on the design of search and rescue robots and underwater vehicles. As a capacity building measure for underprivileged pupils, which is particularly important in the (South) African context, RAL supports RoboCup Junior activities. In 2010 a RoboCup Rescue Junior initiative was started. RAL supported a team of learners from a nearby township to participate in the 2010 RoboCup Junior competition.

Mobile Intelligent Autonomous Systems

Another group involved in research on intelligent systems design is the Mobile Intelligent Autonomous Systems group (MIAS),[7] which was established in 2007. It is an emerging research area (ERA) within the modeling and digital science unit of the Council for Scientific and Industrial Research in South Africa (CSIR MDS). The MIAS group carries out research in field robotics. MIAS research focuses on intelligent autonomy aspects of robotics systems. Many of the problems on

which the group works involve enabling systems to operate with high levels of adaptability to respond creatively to challenging situations or environments — whether by explicitly using machine-learning methods or through the development of signal processing and other algorithms to achieve these goals. Jointly with other CSIR researchers, from the Centre for Mining Innovation and from the Materials Science and Manufacturing unit's Mechatronics and Micro Manufacturing group, MIAS researchers are working on development of a system to perform safety inspections autonomously in underground mines. A further area of research in MIAS concerns outdoor navigation. In particular, the group is working in the area of autonomous mule development, on implementing capability for a robot to follow a person to a destination and navigate autonomously using GPS waypoints — enabling it to act as a support vehicle. Other examples of research in outdoor navigation in MIAS include work on visual SLAM (simultaneous localization and mapping) in self-similar environments and on visual servo control for human following. Another project within the group concerns the development of an intelligent manipulator and an associated computer vision system. The aim is to equip a robot arm with the ability to cooperate with a person in completing a task. The platform for the work is a compliant manipulator.

Artificial Intelligence Research

The recently established Centre for Artificial Intelligence Research (CAIR),[8] is a joint initiative of the School of Mathematics, Statistics, and Computer Science at the University of KwaZulu-Natal (UKZN) and the Meraka unit of the Council for Industrial Research (CSIR Meraka). CAIR grew out of collaboration between the Knowledge Representation and Reasoning group[9] at CSIR Meraka and the School of Computer Science at UKZN. Its current focus is on research in knowledge representation and reasoning, ontology engineering, computer vision, modeling and optimization, and adaptive architectures.

CAIR is particularly strong in the areas of belief change, nonmonotonic reasoning, and the use of logic-based ontologies represented in description logics and is leveraging these strengths to contribute to research on the emerging area of ontology evolution. It is also looking at the application of ontology-based technologies to facilitate information integration and semantic operability in the areas of health informatics and biodiversity information management.

Strengthening AI in South Africa

As is clear from this survey of the various research hubs, South Africa is currently experiencing growth in various AI-related research activities. A recent initiative to maintain the current level of interest in AI is the establishment of a South African AI Society. Although it is early days yet, we hope to be able to report on progress in this regard, and indeed, on more detailed progress in AI research in South Africa in a future edition of *AI Magazine*.

Acknowledgements

Notes

1. See also www.dst.gov.za/s-t-landscape/public-research-institutions-science-councils.

2. See www.robmech.co.za.

3. See www.africon2011.org.

4. See cirg.cs.up.ac.za.

5. See www.meraka.org.za/humanLanguage.htm.

6. See ibots.mec.uct.ac.za/IBOTS.

7. See www.csir.co.za/mias.

8. See cair.meraka.org.za.

9. See krr.meraka.org.za.

Alexander Ferrein is a professor of robotics and foundations of computer science at FH Aachen University, Department of Electrical Engineering and Information Technology. His research focuses on AI and cognitive robotics. Ferrein was a former staff member at the Robotics and Agents Research Lab at the University of Cape Town. He received his doctoral degree in computer science in 2008 from RWTH Aachen University.

Thomas Meyer is director of the Centre for Artificial Intelligence Research, chief researcher at the CSIR Meraka Institute, and professor in computer science at the University of KwaZulu-Natal. Prior to this he held positions as a senior researcher at National ICT Australia (NICTA), a conjoint associate professor at the University of New South Wales, an associate professor at the University of Pretoria, and a senior lecturer at the University of South Africa.

Please join us as we bring together communities of researchers in a variety of disciplines for three days of conversation, discussion, and scientific discovery …

2012 AAAI Fall Symposium Series

Friday through Sunday, November 2–4

The Westin Arlington Gateway

Arlington, Virginia

Details:

www.aaai.org/Symposia/Fall/fss12.php