From AI to SciTS: Team Science and Research Intelligence

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On a trip to Chicago this past March, I attended the Web Science Meets Network Science Workshop and the NICO (Northwestern Institute on Complex Systems) and SONIC (Science of Networks in Communities Research Group at Northwestern) Complexity Conference. There was a great deal of discussion at both concerning the collaborative approach toward scientific research with today's new technological advancements. The focus was on the *science of team science* (SciTS), which is an emerging field of study conceived as "a beacon for 21st century scientific collaboration."

I feel strongly that data mining, social computing, and many related intelligent systems will stand as the core disciplines necessary to ensure the success of SciTS. For this to happen, however, we need to rethink AI and consider it not as artificial intelligence but as academic intelligence.

The Science of Team Science

SciTS is about group-effort scientific research and development; it's an emerging international and interdisciplinary area particularly focused on studying the facilitation of collaborative science. Specifically, it examines the initiation, organization, and interactive processes that occur during team-based investigations.

SciTS's core mission is to evaluate how the cooperation between various sciences and technologies can either promote or hinder progress. From there, we can come up with better, more effective ways of team management and use by identifying the most efficient methodologies in research, training, and communication on a larger scale. We should strive to improve the team dynamic until collaborative R&D groups are able to reach the level of progress and innovation achieved by individual researchers.

Currently, SciTS's major promoters are a number of complex systems scholars in the US. It is their belief that SciTS can be an important platform for further promoting and helping interdisciplinary cooperation in the 21st century. Scholars have recognized more than 180 SciTS related core documents that were nearly all published after 2001—17 articles were published between 1944–2000. These numbers show that although SciTS is still a fledgling field, it has fully burst into action.

A century ago, mankind experienced a veritable storm of scientific advancement, led by a few immensely talented individuals such as Max Planck and

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Albert Einstein. A century later, we might be at the eve of another such happening, this time led instead by groups of experts, and SciTS may be the lighthouse we need to weather the storm.

Generally speaking, the accumulation of knowledge can be divided into two categories: either continuous or by discrete, incremental leaps. A team of scholars reviewing 21 million articles worldwide published between 1945–2008 found a fundamental and universal shift in all branches of science. They found that high-impact, often-cited scientific discoveries were being achieved by groups rather than individual scientists. These groups have become increasingly larger, expanding beyond the boundaries of geography and discipline. A parallel study of technical patents worldwide showed similar results.

Scholars believe that this change comes because the problems we study in modern science are far more complex, requiring cross-disciplinary knowledge. Therefore, solutions can only be found by engaging many different scientific perspectives—the approach is at once multidisciplinary, interdisciplinary, and transdisciplinary.

With such increasing importance placed on a "team effort," there is a real need to establish methods with which to evaluate and determine how groups of people from differing backgrounds, both academic and social, can best work together toward a common goal. Web science and technology will be and have already been instrumental in SciTS.

VIVO and iPlant

Several examples can help illustrate the SciTS approach. VIVO, for example, is a Semantic Web application that originated at Cornell University (see http://vivo.cornell.edu). Developed as a means for faculty members to become aware of other research conducted at Cornell, it has been adopted by several organizations and is now an open source network that lets any user with a VIVO installation access information and profiles of researchers from participating programs. This network is populated with the collective profiles, research interests, and accomplishments of various scholars in diverse fields.

As of yet, VIVO consists of seven universities and institutions (120 members), but this past year has been a solid success and it is quickly building momentum. At its core, VIVO is a great example of how social computing and the Semantic Web can allow separate groups of people to share and propel scholarship. The prospect of a global network is exciting. (For more details, please refer to the VIVO website at http://vivoweb.org.)

The first step toward fully realizing the potential of team science applications requires a revolution in how we collect and distribute research intelligence.

While VIVO is a more generalized tool, the iPlant Collaborative is an example of team science specifically tailored to the needs of a more focused community. Led by the University of Arizona and five other organizations, iPlant aims to connect scientists, instructors, and students to help them apply social computational skills and thinking toward larger, big picture problems that appear in the study of plant biology. The initiative has identified four areas of focus: community interactions and synthesis activities, cyberinfrastructure development, education, and the social sciences. Project teams will lead investigations on how to create networking systems specified for the requirements of each focus area. This team science also involves developing better teaching and learner-centered methods for primary, secondary, and higher education. (For more detailed information, visit www.iplantcollaborative.org.)

Similar efforts are also underway in China. For example, the iCAN project (using an approach that combines those of VIVO and iPlant) specializes in integrating Chinese scholars, institutes, and research topics in the field of automation and control. Other projects include cPlant for agriculture and forestry research, and AI 3.0 for a real-time and more proactive, precise, and personalized academic intelligence.

Research Intelligence

Clearly, techniques and approaches such as Web science, social computing, computational thinking, and intelligent systems are essential to the success of projects such as VIVO, iPlant, iCAN, and cPlant. But in my opinion, intelligence sits right at the heart of the matter. The first step toward fully realizing the potential of such team science applications requires a revolution in how we collect and distribute research intelligence.

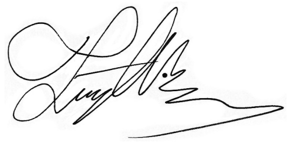
Examining the progression of military intelligence might shed some light on this area. That is, before and during WWI, military intelligence mainly consisted of human intelligence (HUMINT in espionage terminology). It then advanced to signal intelligence (SIGINT), and with the launch of satellites during the Cold War, it has become image intelligence (IMINT). After the collapse of the Soviet Union and the Eastern Bloc, military intelligence entered the age of open source intelligence (OSINT), with network intelligence (NETINT) forming its core component. Today, more than 80 percent of military intelligence is considered OSINT in many countries, and business intelligence is currently undergoing a similar evolution.

It seems that research or academic intelligence is going through parallel changes. We started with collecting academic information within books, then at libraries, and now on the global platform of the Internet. With the advent of Web 2.0 and social media, we once again embark on a new stage of knowledge creation, distribution, and application. All of this can be accomplished on a more integrated level, in real-time with great precision and effectiveness.

To this end, we must instigate an AI 3.0-type academic intelligence and establish related cyberinfrastructure and intelligent systems so that all scholars and students can automatically receive, classify, analyze, and archive research information on their topic of interest from all aspects—when, where, what, whom, why, and how. Only with open source and open access academic data can these goals be truly possible. Fortunately, for the most part, general scientific knowledge and information is essentially of this nature.

In the future, we might need more types of intelligence besides that of AI. There might appear a plethora of specialized intelligences for research, such as conference intelligence, journal intelligence, event intelligence, and topic intelligence. It is an intriguing direction to take and holds great promise for the future development and progression of academic discourse.

I am confident that these developments will lead to revolutions in the production, dissemination, acquisition, and impact of scientific knowledge. ■



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