Vincent Corruble
Masayuki Takeda
Einoshin Suzuki (Eds.)

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Preface

This volume contains the papers presented at DS-2007: The Tenth International Conference on Discovery Science held in Sendai, Japan, October 1–4, 2007.

The main objective of the Discovery Science (DS) conference series is to provide an open forum for intensive discussions and the exchange of new ideas and information among researchers working in the area of automating scientific discovery or working on tools for supporting the human process of discovery in science. It has been a successful arrangement in the past to co-locate the DS conference with the International Conference on Algorithmic Learning Theory (ALT). This combination of ALT and DS allows for a comprehensive treatment of the whole range, from theoretical investigations to practical applications. Continuing this tradition, DS 2007 was co-located with the 18th ALT conference (ALT 2007). The proceedings of ALT 2007 were published as a twin volume 4754 of the LNCS series.

The International Steering Committee of the Discovery Science conference series provided important advice on a number of issues during the planning of Discovery Science 2007. The members of the Steering Committee are Einoshin Suzuki (Kyushu University, Chair), Achim G. Hoffmann (University of New South Wales, Vice Chair), Setsuo Arikawa (Kyushu University), Hiroshi Motoda (Osaka University), Masahiko Sato (Kyoto University), Satoru Miyano (University of Tokyo), Thomas Zeugmann (Hokkaido University), Ayumi Shinohara (Tohoku University), Alberto Apostolico (Geogia Institute of Technology and University of Padova), Massimo Melucci (University of Padova), Tobias Scheffer (Max Planck Institute for Computer Science), Ken Satoh (National Institute of Informatics), Nada Lavrac (Jozef Stefan Institute), Ljupco Todorovski (University of Ljubljana), and Hiroki Arimura (Hokkaido University).

In response to the call for papers 55 manuscripts were submitted. The Program Committee selected for publication 17 submissions as long papers and 10 submissions as regular papers. Each submission was reviewed by at least two members of the Program Committee, which consisted of international experts in the field. The selection was made after careful evaluation of each paper based on clarity, significance, technical quality, and originality, as well as relevance to the field of discovery science. This volume consists of three parts. The first part contains the papers/abstracts of the invited talks, the second part contains the accepted long papers, and the third part contains the accepted regular papers.

We are deeply indebted to the Program Committee members as well as their subreferees who played the critically important role of reviewing the submitted papers and contributing to the intense discussions which resulted in the selection of the papers published in this volume. Without their enormous effort, ensuring the high quality of the work presented at Discovery Science 2007 would not have been possible. Furthermore, we would like to thank all individuals and institutions who contributed to the success of the conference: the authors for submitting papers, the invited speakers for their acceptance of the invitation and their stimulating contributions to the conference, the Steering Committee, and the sponsors for their support. In particular, we acknowledge the generous financial support from the Air Force Office of Scientific Research (AFOSR), Asian Office of Aerospace Research and Development (AOARD)[1]; the Graduate School of Information Sciences (GSIS), Tohoku University for providing secretarial assistance and equipment; the Research Institute of Electrical Communication (RIEC), Tohoku University; New Horizons in Computing, MEXT Grant-in-Aid for Scientific Research on Priority Areas; and the Semi-Structured Data Mining Project, MEXT Grant-in-Aid for Specially Promoted Research.

July 2007

Vincent Corruble
Masayuki Takeda
Einoshin Suzuki

[1] AFOSR/AOARD support is not intended to express or imply endorsement by the U. S. Federal Government.

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Challenge for Info-plosion

Masaru Kitsuregawa

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Abstract. Information created by people has increased rapidly since the year 2000, and now we are in a time which we could call the "information-explosion era." The project "Cyber Infrastructure for the Information-explosion Era" is a six-year project from 2005 to 2010 supported by Grant-in-Aid for Scientific Research on Priority Areas from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. The project aims to establish the following fundamental technologies in this information-explosion era: novel technologies for efficient and trustable information retrieval from explosively growing and heterogeneous information resources; stable, secure, and scalable information systems for managing rapid information growth; and information utilization by harmonized human-system interaction. It also aims to design a social system that cooperates with these technologies. Moreover, it maintains the synergy of cutting-edge technologies in informatics.

1 New IT Infrastructure for the Information Explosion Era

The volume of information generated by mankind has increased exponentially, i.e., "exploded" since 2000. The purpose of our research project, "Cyber Infrastructure for the Info-plosion Era" in the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Grand-in-Aid for Scientific Research on Priority Area, is to build advanced IT infrastructure technologies for this information explosion era [1]. According to the research by the University of California at Berkeley, the volume of information created by human is explosively increasing [2, 3]. Huge volume of data is also created by sensors and machines. We have considered that the most important theme for researchers in the field of computer science is the research on new IT infrastructure for the Information-explosion Era.

The project has three major research components (Research Groups) to achieve this goal: build technologies to search for needed information efficiently, without bias and without being at risk from the rapidly growing volume of information (A01); build new and sustainable technologies that can operate large-scale information systems managing enormous amounts of information safely and securely (A02), and build human-friendly technologies to enable flexible dialogue between men and machines and enable everyone to utilize information (A03).

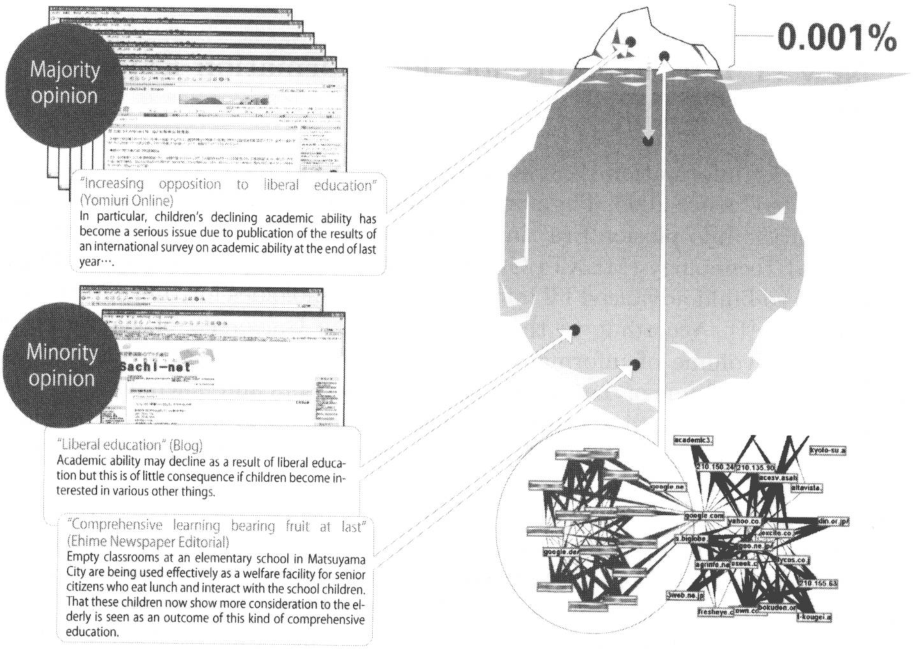
V. Corruble, M. Takeda, and E. Suzuki (Eds.): DS 2007, LNAI 4755, pp. 1–8, 2007.

Underlying these three components is the research into new social systems that can facilitate the use of advanced, information-based IT services (B01). In addition, Large-scale Info-plosion Platform (LIP) is implemented as the shared platforms used by all Research Groups. The project is interdisciplinary in its structure, bringing together advanced research methods in information-related areas. (Project leader: Masaru Kitsuregawa)

2 Infrastructure for Information Management, Fusion and Utilization in the Information Explosion Era (A01)

This Group focuses on the shortfalls of present internet searches and looks into new search methods, including better ranking systems (where minority opinions are not overlooked), interactive searches, reliability assessments and time-space searches. Currently, for knowledge workers, about 30% of their time on intellectual activities is spent just for retrieval information [4]. The Group will attempt to create a system of search platforms to search a massive volume of web page contents.

Another important issue for information retrieval is the dangers associated with information rankings. Search engines are extensively used in the web world. When a general word is given, it may hit millions of pages, and only about 10



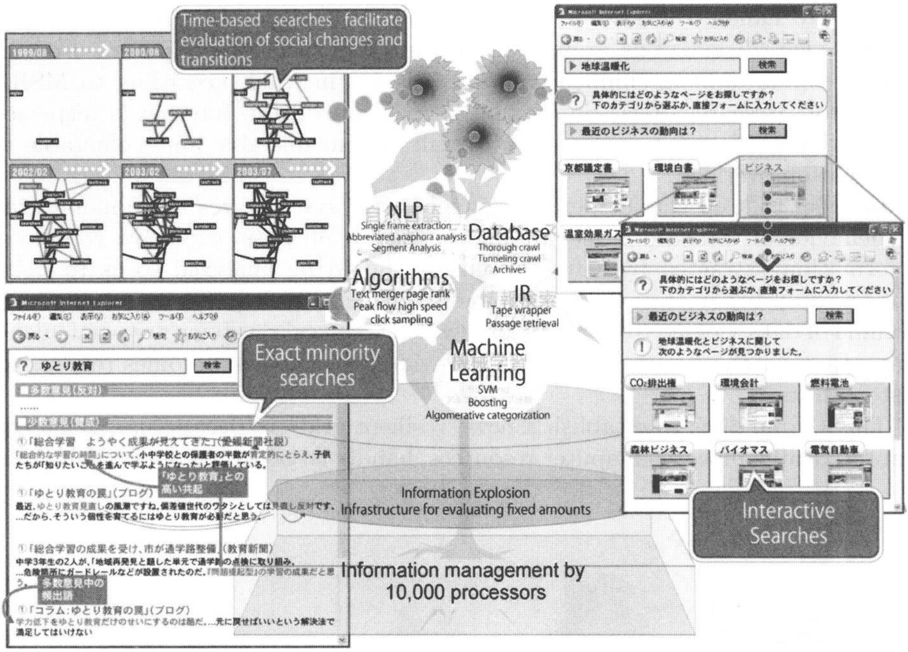
"Increasing opposition to liberal education" (Yomiuri Online)
In particular, children's declining academic ability has become a serious issue due to publication of the results of an international survey on academic ability at the end of last year⋯.

"Liberal education" (Blog)
Academic ability may decline as a result of liberal education but this is of little consequence if children become interested in various other things.

"Comprehensive learning bearing fruit at last" (Ehime Newspaper Editorial)
Empty classrooms at an elementary school in Matsuyama City are being used effectively as a welfare facility for senior citizens who eat lunch and interact with the school children. That these children now show more consideration to the elderly is seen as an outcome of this kind of comprehensive education.

Fig. 1. Dangers Associated with Information Rankings

probable candidates are listed as top rankers on the first page of the search result. Now, is this ranking really reasonable? Who guarantee the correctness of it? Actually, this is controlled by just a private company. There should be a possibility that the ranking is sold and bought. In addition, it is possible to control the ranking deliberately. We have found, as shown in the Fig.1, that the red island of links suddenly appear on February 2004, while only the black island of links is found in 2003. This is an example of a trick to raise their own rank by linking them to a well-known site.



? ゆとり教育

■多数意見(反対)

……

■少数意見(賛成)

①「総合学習　ようやく成果が見えてきた」(愛媛新聞社説)
「総合的な学習の時間」について、小中学校との保護者の半数が肯定的にとらえ、子供たちが「知りたいこと」を進んで学ぶようになった」と評価している。

①「ゆとり教育の罠」(ブログ)
最近、ゆとり教育見直しの風潮ですね。偏差値世代のワタシとしては見直し反対です。…だから、そういう個性を育てるにはゆとり教育が必要だと思う。

①「総合学習の成果を受け、市が通学路整備」(教育新聞)
中学3年生の2人が、「地域再発見と題した単元で通学路の点検に取り組み。…危険箇所にガードレールなどが設置されたのだ。『問題提起型』の学習の成果だと思う。

①「コラム：ゆとり教育の罠」(ブログ)
学力低下をゆとり教育だけのせいにするのは短絡だ。…元に戻せばいいという解決法で満足してはいけない

▶ 地球温暖化

? 具体的にはどのようなページをお探しですか？
下のカテゴリから選ぶか、直接フォームに入力してください

▶ 最近のビジネスの動向は？

! 地球温暖化とビジネスに関して
次のようなページが見つかりました。

Fig. 2. Next generation searches

Also, in the current ranking system, majority opinions are highlighted while minority opinions are buried. For example, when "Yutori Kyouiku" (liberal education) is searched, majority opinions are found easily like "increasing opposition to liberal education". Although there are minority opinions such as "comprehensive learning bearing fruit at last", they could be completely neglected.

Various technologies, including information searching, natural language processing, machine learning, artificial intelligence (AI) and database technology, are integrated into this system to enable quantitative analysis to be performed (Fig.2). We hope to enable a remarkable level of interdisciplinary synergy among different fields. It is better for human to understand by presenting relational information also than information itself. Several innovative researches are expected in this area, for example, presenting comparative information [5] and information on time sequence [6]. Research on the methods of management, integration and processing of "exploding" real-world information, including cyber information and information obtained from remote sensors, will also be conducted. (Group leader: Masaru Kitsuregawa, University of Tokyo)

3 Infrastructure for Information-Explosion-Proof IT Systems (A02)

The exponential increase in the amount of information requires far larger IT systems to handle the volume. According to [7], Google has now over 450,000 servers over 25 locations around the world. The ratio of computers used for search engines among shipped computers is 5% in total, according to MSRA (Microsoft Research Asia) Summit in 2006. Data on the Internet is dispersed over millions of nodes, making the overall system unstable and vulnerable to information overload.

In order to keep stable operation of such huge systems, real-time monitoring of behavior of software is inevitable. For such a purpose, explosive volume of information extracted by software sensors should be analyzed so as to point out anomaly behavior of the system and stabilize it. Researches on mining huge volume of data yielded from monitoring very-large-scale systems are particularly important for the age in which a nation-wide cyber attack becomes reality like Estonian case.

This Group aims to establish a new "resilient grid" infrastructure which can automatically allocate computer resources, handle large-scale system faults over

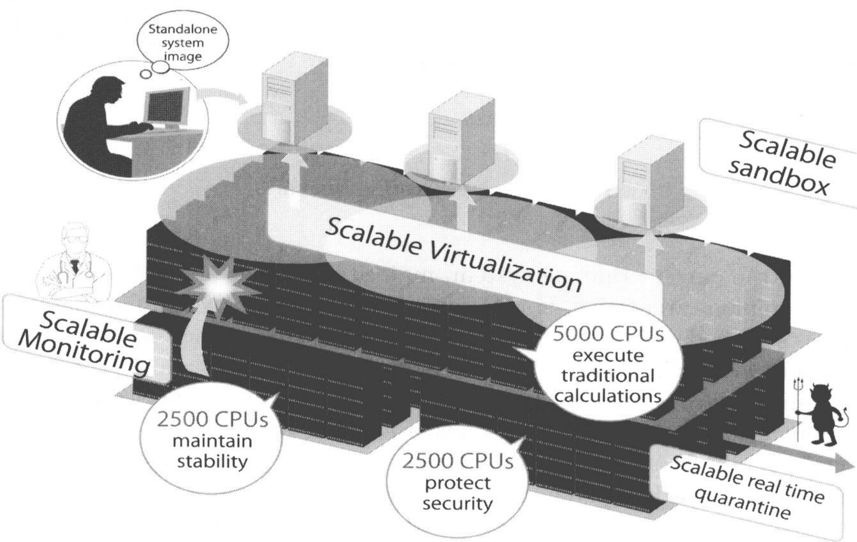

Standalone system image
Scalable sandbox
Scalable Virtualization
Scalable Monitoring
5000 CPUs execute traditional calculations
2500 CPUs maintain stability
2500 CPUs protect security
Scalable real time quarantine

Fig. 3. Infrastructure for large scale system

the network without human intervention and without the modern-day concerns of security breaches and intrusion (Fig.3). This is partially based on Autonomic Computing [8] and interesting research works performed by UC Berkeley and Stanford University [9]. The resilient grid will allow a high-performance virtual computing environment to be configured autonomously, on which applications can be deployed safely and securely. (Group leader: Satoshi Matsuoka, Tokyo Institute of Technology)

4 Infrastructure for Human Communication in the Information Explosion Era (A03)

The information explosion has two aspects: qualitative (volume) and quantitative (complexity). This Group proposes studies of the advancement of human communication to address the issues related to complexity. The underlying concept is a mutually adaptable multi-modal interaction that can fill the communication gaps between people and information systems. This is the key to overcoming the complexity resulting from highly functional and multi-functional information systems, and establishing a secure and user-friendly interactive environment (Fig.4).

Searching information from explosively huge size of information space still requires advanced skills, since existing tools for such a purpose is not necessarily easy to use for naive users. Human-friendly interfaces as well as communications

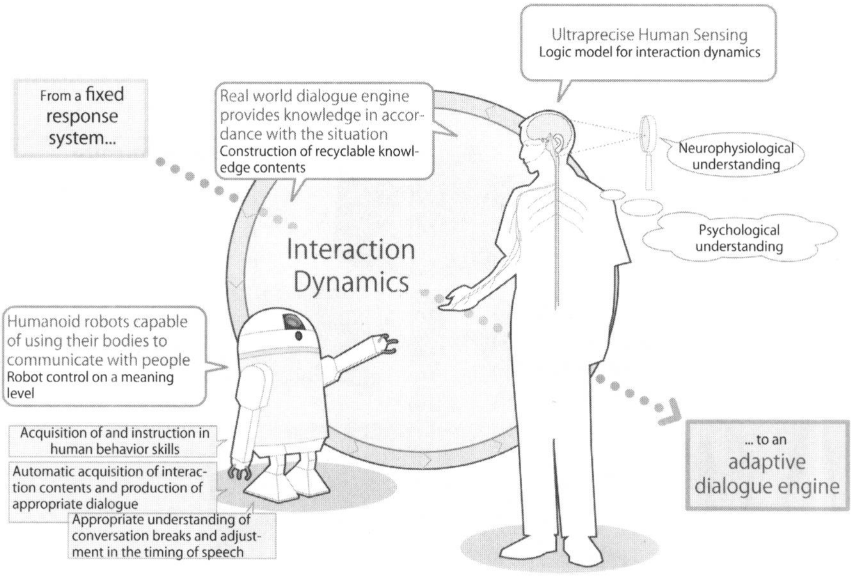

Ultraprecise Human Sensing
Logic model for interaction dynamics
From a fixed response system...
Real world dialogue engine provides knowledge in accordance with the situation
Construction of recyclable knowledge contents
Neurophysiological understanding
Psychological understanding
Interaction Dynamics
Humanoid robots capable of using their bodies to communicate with people
Robot control on a meaning level
Acquisition of and instruction in human behavior skills
Automatic acquisition of interaction contents and production of appropriate dialogue
Appropriate understanding of conversation breaks and adjustment in the timing of speech
... to an adaptive dialogue engine

Fig. 4. Infrastructure for human