

Database Systems Laboratory



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Information systems in transportation, welfare, health-care and public utility services depend on large scale data management systems. Research activity in Database Systems is focused on broadening their range of applicability. It is also focused on improving the performance of domain specific applications.

Large applications for e-governance and services use database systems as a basic part for web data resources. This year the laboratory organized an International Symposium with many invited distinguished researchers during 31 Oct. - 2 Nov. 2016.

The delivered lecture and manuscripts are being utilized to develop the state-of-the-art lectures on current research problems. These created a focused view on new research problems. Many current aspects of web related research activity were discussed at the symposium. The delivered lecture provided recent views on research problems.

Most of the advances in techniques concentrate on capturing more meaning within data. A number of researchers are actively developing improved data management strategies using Business Intelligence and data. This provides a challenging area for study. The domains of activity include:

- developing new user interfaces and query languages for skilled and semi-skilled users in health-care;
- developing infrastructures for computing facilities for cloud computing;
- supporting mobile computing applications, and
- designing new data models and asynchronous computation models for transaction and services.

In addition to complexity in features such as multiple attributed data, many new types of raw data are emerging that need to be captured by DBMSs for information extraction. Many research efforts are being made to make suitable Object-Relational architectures for spatial databases.

The Database Systems Laboratory has research activity concentrating on data modeling as well as transaction processing activity.

Data Modeling for Spatial Objects

Information Processing Systems of future will be a combination of integrated components. There will be components for intelligent problem solving, or decision making, components for specialized data processing and components for shared information management. The applications will utilize a shared base of information. Some examples are - business automation, industrial automation, computer-aided design and manufacture, and cartography.

Work-flow and Web Services

Traditional approaches to transaction management introduce elements of unpredictable delays during transaction processing. Thus, making these not suitable for adoption in new application environments. The techniques for time-critical transactions are applicable to Mobile databases and multimedia databases.

Healthcare Studies

The goal of this research is to study the Standardized Electronic Health Records (EHRs) databases. It is a temporal computational system with the ability to process large volume of information. Such system will prove useful in various areas of information technology such as online healthcare agencies. The modeling considers the complementary points of view:

1. EHRs data mining approach to address the epidemic studies,
2. An approach that involves the user in the modeling process.
3. Query Language with reference to user skills

Prototype systems to access dynamic contents through web based information systems are in progress. These emulate mobile e-commerce activity in banking and

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Geographic Information Systems, for test and studies. The test prototypes have been evolved based on research on new easy-to-use search and also new query language interfaces.

Refereed academic journal

[bhalla-307-008-01:2016] Subhash Bhalla Shinji Kikuchi. Evolution of distributed monitoring for scalable business process management in cloud-based databases. *International Journal of Computational Science and Engineering (IJCSE)*, 12(2/3):192–208, April 2016.

Embodying business process as a service (BPaaS) in cloud computing has been actively investigated by many research studies. There are many proposals to establish the scalable workflows, for instance, by adopting the multiple instances of workflow execute engine (WEE). However, it is difficult to track exactly the states of individual instances of the workflow running across multiple engines globally, by only applying the multiple WEE. It is necessary to implement an independent monitoring function from outside. This study considers making this monitoring function scalable in accordance with increasing the number of WEE. When designing the monitoring function and the maintenance protocol, the following important factors have been considered. First, to deliver the meta-data such as definitions of business processes among WEE for sharing. The second, to deliver the event instances asynchronously, by compensating inconsistent status for recoverable events. This study proposes architecture and a set of maintenance protocols to realise the scalable workflow management. It shows the critical requirements and selects a reasonable approach through qualitative evaluations.

[yutaka-307-008-01:2016] Wei-Hsun Liao Jianquan Liu Yutaka Watanobe Yi-Cheng Chen, Shih-Hao Chang. A cloud-based system for dynamically capturing appliance usage relations. *International Journal of Web and Grid Services*, 12(3), 2016.

Nowadays, owing to the great advent of sensor technology, data can be collected easily. Mining Internet of Things IoT data has attracted researchers' attention owing to its practicability. Mining smart home data is one significant application in the IoT domain. Generally, the usage data of appliances in a smart environment are generated progressively; visualising how appliances are used from huge amount of data is a challenging issue. Hence, an algorithm is needed to dynamically discover appliance usage patterns. Prior studies on usage pattern discovery are mainly focused on discovering patterns while ignoring the dynamic maintenance of mined results. In this paper, a cloud-based system, Dynamic Correlation Mining System DCMS, is developed to incrementally capture the usage correlations among appliances in a smart home environment. Further-

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more, several pruning strategies are proposed to effectively reduce the search space. Experimental results indicate that the developed system is efficient in execution time and possesses great scalability. Subsequent application of DCMS on a real data set also demonstrates the practicability of mining smart home data.

Refereed proceedings of an academic conference

[bhalla-307-008-02:2016] Subhash Bhalla Tanveen Singh Bharaj, Shelly Sachdeva. AsthmaCheck: Multi-Level Modeling Based Health Information System. In Gang Luo Fusheng Wang, Lixia Yao, editor, *Data Management and Analytics for Medicine and Healthcare - Second International Workshop, DMAH 2016*, volume 10186 of *Lecture Notes in Computer Science*, pages 139–154. VLDB Workshops, Springer, September 2016.

Every hospital uses their own format for creating their information system for storing patient's data. This does not allow hospitals to exchange patient data. Hence, there is requirement for standardized Hospital Information System (HIS). Also the HIS should be able to incorporate semantic interoperability. With technological advancement, clinicians and patients should get themselves involved in using the Electronic Health Records (EHRs). The current research provides roadmap for the introduction of domain specific clinical application following openEHR standards based on Multi-Level Modeling. Standardization will help in reducing cost and medical errors as well enhancing data quality. The current study focuses on (1) advantage of EHRs, (2) the need for standardization to improve quality of health records, thereby establishing interoperability among hospitals, (3) recognizing the use of archetypes for knowledge-based systems, (4) proposing framework for standardization, and (5) comparison of proposed approach with current HIS

[w-chu-307-008-01:2016] Yamin Li and Wanming Chu. Adjusting Parameters of K-Ary n-Cube to Achieve Better Cost Performance. In *Trust-Com/BigDataSE/ISPA 2016*, pages 1218–1225, Tianjin, China, August 2016. IEEE.

The k-ary n-cube, or k-ary n-dimensional torus, is widely used as the interconnection network for constructing commercial supercomputers. Compared to the hypercube, torus has the advantage of ease of implementation but its diameter increases rapidly as the network scales up. This paper investigates the configurations of the k-ary n-cube by adjusting the parameters k and n according

to the network size for achieving good cost performance tradeoffs. The node degree and diameter strongly affect the cost performance of the network. An interconnection network consists of routers and links which connect the ports of routers by following up an interconnect topology. The router is commonly implemented with a buffered crossbar switch whose cost increases non-linearly as the number of ports increases. The number of ports in a router is usually larger than the node degree because at least one port is needed to connect the compute node and this port is not counted as part of the node degree. The diameter determines the maximum communication delay between nodes which is a reciprocal proportion to the performance. This paper gives an analytical model for evaluating the relative cost performance (RCP) to hypercube. The model is parameterized with the node degree, the diameter, the router complexity, the number of compute nodes in a node, and the system size. The RCP function for a given n always has a minimum value at a certain system size. This is helpful for us to determine the values of k and n when we design a k -ary n -cube network. We also investigate the k -ary n -dimensional mesh and the unidirectional torus with different parameters. The unidirectional torus has a similar behavior to but better cost performance than the bidirectional torus.

[yutaka-307-008-02:2016] Wenxi Chen Kazuki Yamamoto, Yutaka Watanobe. Clustering Analysis of Vital Signs Measured During Kidney Dialysis. In *Lecture Notes in Computer Science, Trends in Applied Knowledge-Based Systems and Data Science*, pages 503–513, 2016.

Analysis of vital data of kidney dialysis patients is presented. The analysis is based on some vital signs of pulse rate (PR), respiration rate (RR) and body movement (BM) which were obtained by a sleep monitoring system. In a series of experiments, eight patients of different genders and ages were involved. For the analysis, a hierarchical clustering method was applied with multi-dimensional dynamic time warping distance to analyze the similarity between the vital signs. The hierarchical clustering uses Ward's method to calculate the distance between two clusters. The analysis results show that daily vital sign indicates a feature related to one of the clusters and physiological rhythms based on a series of the features vary depending on the season. Based on the hypothesis, some irregular vital signs which deviate from the physiological rhythms can be detected to predict abnormal health condition and discomfort of the patients.

[yutaka-307-008-03:2016] Alexander Vazhenin Mirai Watanabe, Yutaka Watanobe. Architecture for Hybrid Language Systems. In

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16th IEEE International Conference on Computer and Information Technology (IEEE CIT 2016), pages 134–139, 2016.

An architecture for hybrid language systems is presented. A hybrid language has features of both textual languages and visual languages. Textual languages are computer-oriented and are geared toward storage, syntax analysis, and editing. On the other hand, visual languages are human-oriented and are geared toward expressive power, understandability, direct manipulation, and learning cost. Although a hybrid language system has the advantages of both textual and visual languages, general architectures to develop the corresponding programming environment considering real-time processing, synchronization, and multiple platforms have not yet been proposed. In the present paper, an architecture for hybrid language systems that support the development of new hybrid languages and the corresponding programming environments is presented. Implementation methods based on this architecture is demonstrated, and a case study is presented.

[yutaka-307-008-04:2016] Mirai Watanabe Yutaka Watanobe, Nikolay Mirenkov. Adaptation Aspects of *AIDA programs. In *16th IEEE International Conference on Computer and Information Technology (IEEE CIT 2016)*, pages 34–41, 2016.

AIDA modeling/programming language and its environment support programming in algorithmic pictures which are used as super-characters for representing features of computational algorithms and data structures. *AIDA program is presented as a set of information resources oriented not only to the executable code generation, but also to the explanation of the problem, application algorithm, data features and other issues related. In general, *AIDA language and F-modeling environment are developed and promoted as a test-bed for various innovations in IT research and implementations. In this paper we consider how this test-bed can be applied for the BRASS problems of a DARPA initiative to create long-lived, survivable, and adaptive software systems.

Writing a textbook or technical book

[yutaka-307-008-05:2016] Yutaka Watanobe. *Algorithms and Data Structures for Programming Contests*. POST and TELECOM PRESS, 2016.

ISBN 978-7-115-43161-5

- [yutaka-307-008-06:2016] Yutaka Watanobe. *Algorithms and Data Structures for Programming Contests*. POST and TELECOM PRESS, 2016.
ISBN 978-7-115-43161-5

Advisor for undergraduate research and graduate research

- [w-chu-307-008-02:2016] Yuki Kanenari. Graduation Thesis: Open Spatial Data Search and Visualization with Google Map API and Spatial Database, University of Aizu, 2016.

Thesis Advisor: Wanming Chu

- [w-chu-307-008-03:2016] Takumi Baba. Graduation Thesis: Book Recommendation System Based on Customer Reviews, University of Aizu, 2016.

Thesis Advisor: Wanming Chu

- [w-chu-307-008-04:2016] Chihaya Saito. Graduation Thesis: Comparative Study of Document-based Databases for Medical Information System, University of Aizu, 2016.

Thesis Advisor: Wanming Chu

- [w-chu-307-008-05:2016] Yusuke Makiuchi. Graduation Thesis: An Intuitive Query Interface of Geographic Information using Openlayers and Post-GIS, University of Aizu, 2016.

Thesis Advisor: Wanming Chu

Advisor of a student club or circle

- [yutaka-307-008-07:2016] University of Aizu Competitive Programming Club (Coach/Proctor) ACM-ICPC World Finals 2016, 77 th place ACM-ICPC Asia Regional 2016, Daejeon, 8th place ACM-ICPC Asia Regional 2016, Tsukuba, 4th place (Advanced to ACM-ICPC World Finals 2017) ACM-ICPC Asia Regional 2016, Bangkok, 25 th place

Other significant contribution toward university planning, management, or administration

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[yutaka-307-008-08:2016] Judge and problem setter of programming contest for all Japanese high school students (PC Koshien)

[yutaka-307-008-09:2016] Judge and problem setter of programming contest for all Japanese high school students (PC Koshien)

[yutaka-307-008-10:2016] Judge and problem setter of programming contest for all Japanese high school students (PC Koshien)

Did you participate in Public Lectures, and/or Open Campus? (Yes or No) If yes, please describe what you did.

[yutaka-307-008-11:2016] Open Lab 2016 Development of online e-learning systems for programming as well as for IT engineers. Development of algorithms and applications for data mining. Development of visual programming/modeling languages and the corresponding environments for different domains.

[yutaka-307-008-12:2016] Special Lecture for Open Campus Let's Challenge Programming Contest