



Welcome to the Course of Web and Document Databases (7102-001)

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Birthplace: China

P.h..D: University of Kaiserslautern, Germany, in 1995

Post Doctor: University of Chemnitz, Germany, 1995/7 - 1997/8

Senior engineer: Germany Research Center for Information Technology,
1997/9 - 2000/2

Post Doctor.: University of Alberta, 2000/2 - 2000/6

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Associate Prof.: University of Winnipeg, 2004/7 – 2009/6

Full Prof.: University of Winnipeg, from 2009/7

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Meeting time: 2:30 – 3:45 pm, Monday and Wednesday

Meeting location: 3D03

Office hours: 4:00 pm - 5:00 pm Monday and Wednesday
11:00 – 16:00 Friday (except time for department
meeting)

Course Outline

Intro. to the design of Web and document databases, analysis, and applications

Introduction to relational database theory

Basic methods for designing relational databases, SQL and JDBC, Hashing, B+-trees, R-trees.

Web and XML documents

Web databases, Semistructured-data Model, Programming languages for XML, Web browser and search engines.

Evaluation of tree pattern queries in document databases

Tree searching and graph searching, unordered tree matching, ordered tree matching, XB-tree.

Graph databases and reachability query evaluation

Transitive closure, matrix multiplication, Warren algorithm, tree encoding, Permanent linked-list storage of graphs

Course Outline

Intro. to the design of Web and document databases, analysis, and applications

Data mining: find most popular packages

most popular packages, p -graphs, p^* -graphs, trie-like graphs, layered representation of a trie-like graph

Evaluation of extended reachability queries

Regular expressions, deterministic finite automata (DFA), non-deterministic finite automata (NDFFA), intersection graphs, restricted regular expression, general reachability query evaluation algorithm.

(A. O. Mendelzon, and P. T. Wood, Finding Regular Paths in Graph Databases, SIAM J. Comput. Vol. 24, No. 6, pp. 1235-1258, Dec. 1995)

Reference books:

- ***Database Systems (the complete book)***, 2nd Ed. by Carcia-Molina, Ullman, Widom, Pearson Prentice Hall, 2009.
- **Fundamentals of Database Systems**, 5th, 6th, 7th edition, Elmasri, Navathe, Addison-Wesley,
- ***Introduction to Algorithms***, 2nd Ed. by Cormen, Leiserson, Rivest, & Stein (CLRS), McGraw Hill, 2002.
- **Lecture slides online**
- **For evaluation of tree pattern queries:**
 - N. Bruno, N. Koudas, and D. Srivastava, Holistic Twig Joins: Optimal XML Pattern Matching, in *Proc. SIGMOD Int. Conf. on Management of Data*, Madison, Wisconsin, June 2002, pp. 310-321.
 - Y. Chen and L. Zou, Unordered tree matching: the evaluation of tree pattern queries, *Int. J. Information Technology, Communications and Convergence*, 2011.

Reference books:

• For evaluation of reachability queries

- Warren, “A Modification of Warshall’s Algorithm for the Transitive Closure of Binary Relations,” *Commun. ACM* 18, 4 (April 1975), 218 - 220.
- H. Wang, H. He, J. Yang, P.S. Yu, and J. X. Yu, Dual Labeling: Answering Graph Reachability Queries in Constant time, in *Proc. of Int. Conf. on Data Engineering*, Atlanta, USA, April 6-8, 2006.
- H. Yildirim, V. Chaoji, and M.J. Zaki, GRAIL: Scalable Reachability Index for Large Graphs, in *Proc. VLDB Endowment*, 3(1), 2010, pp. 276-284.
- Y. Chen and Y.B. Chen, Decomposing DAGs into spanning trees: A new way to compress transitive closures, in *Proc. 27th Int. Conf. on Data Engineering (ICDE 2011)*, IEEE, April 2011, pp. 1007-1018.
- Chen, Yangjun: General Spanning Trees and Reachability Query Evaluation, in *Proc. Canadian Conference on Computer Science and Software Engineering (C³S²E’09)*, Montreal, Canada, 2009, IEEE, pp. 243 – 252.

Reference books:

- **For evaluation of regular expressions**

- A. O. Mendelzon, and P. T. Wood, Finding Regular Paths in Graph Databases, SIAM J. Comput. Vol. 24, No. 6, pp. 1235-1258, Dec. 1995)

Course Roadmap

- Database basics
 - EER-diagrams, SQL and JDBC, Indexes:
Hashing, B⁺-tree, R-tree, kd-trees, Quad-trees, ...
- Web and document databases
 - Web databases: PHP, Node.js
 - Semistructured data model
 - Programming languages for XML
 - Searching engines
- Evaluation of tree pattern queries
 - Tree searching and graph searching
 - Unordered and ordered tree matching
 - XB-trees

Course Roadmap

- Graph databases and reachability query evaluation
 - Transitive closure
 - Matrix multiplication, Warren's algorithm
 - Methods based on tree encoding
 - Methods based on graph deduction and decomposition
 - permanent linked-list storage of graph databases
- Data mining: finding most popular packages
 - Questionnaire
 - p -graphs, p^* -graphs
 - trie-like graphs, layered representation of trie-like graphs

Course Roadmap

- Evaluation of extended reachability queries
 - Regular expressions, DFA (deterministic finite automata), NFA (non-deterministic finite automata)
 - Intersection graphs and restricted regular expressions
 - General reachability query evaluation algorithm

Database Basics

- Basic method for designing relational databases
 - Database system architecture, Enhanced entity-relationship diagram
 - Rules for mapping EERD to relational schema
- SQL, database application: JDBC
- Hashing, B⁺-tree, indexes over multi-dimensional data
 - Hashing and linear hashing
 - B⁺-tree, R-tree construction and maintenance
 - kd-trees, Quad-trees, Bit-map, inverted files
- **Goals**
 - Background knowledge on database systems

XML Document Databases

- Web databases: PHP, Node.js
- Semistructured-data model
- Programming languages for XML
- Databases over internet
- **Goals**
 - PHP, Node.js script languages
 - XML markup language
 - Data storage in document databases
 - Manipulation of data in document databases
 - Web browser and search engines

Evaluation of Tree Pattern Queries

- Tree searching and graph searching
- Tree encoding
- Ordered tree matching
- Unordered tree matching
- XB-trees
- **Goals**
 - Evaluation of queries against document databases
 - Indexing data to speed up query evaluation in document databases

Reachability Query Evaluation

- Transitive closures and reachability checking
 - matrix multiplication
 - Warren's algorithm
- Method based on tree encoding
 - Tree encoding
 - Extension of tree encoding to DAGs
- Method based on graph deduction and decomposition
- permanent linked-list storage of graph databases
- **Goals**
 - Efficient algorithm for checking reachability of nodes
 - Efficient storage of graphs on hard disk

FINDING MOST POPULAR PACKAGES

- Popular package according to a questionnaire
- p -graphs, p^* -graphs
- Trie-like graphs, and layered representation of a trie-like graph
- **Goals**
 - A kind of data mining to find customer patterns to enlarge sales
 - An efficient algorithm to find a most popular package according to a questionnaire

Evaluation of Extended Reachability Queries

- Regular expressions, DFA, NDFA
- Intersection graphs
- Restricted regular expressions
- General reachability query evaluation algorithm

Project

- Implementation of an algorithm for constructing an XB-tree
- Implementation of an algorithm for decomposing a DAG into a minimized set of chains
- Implementation of an algorithm for evaluating unordered tree pattern queries
- Implementing an algorithm for evaluating ordered tree pattern queries

Important dates:

Wednesday, Jan. 08, 2024

First class

Feb. 18 – 24

Reading break

Mon., March 04, 2024

Midterm examination

March 15, 2024

Final date to withdraw without academic penalty
from a course that begins in Jan. and ends in April
of the 2024 Winter term

April 05, 2024

Last class

Final examination

no (replaced by projects)

Course Evaluation:

3 assignments	24%
1 midterm examination	26%
1 project (or final exam.)	50%

- All assignments are handed in through email on the due date.
- All works must be prepared using a word processor (and placed in a folder).
- Late assignments are accepted (up to 1 day late) and receive a 25% penalty.
- Assignment sent to teaching assistant
(rasagnya53@gmail.com)

Academic dishonesty:

- Academic dishonesty is a very serious offense and will be dealt with in accordance with the University's discipline bylaw. Be sure that you have read and understood Regulations and Policies, #8 in the 2023-2024 UW Calendar.