DOMAIN STRUCTURED ARCHITECTURES

DBEXPO '90: NUCLEUS INTERNATIONAL

David McGoveran

March 26, 1990

LOGICAL ARCHITECTURES

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

A REVIEW AND CATEGORIZATION I

LOGICAL RELATIONAL DBMS STRUCTURES

- DISTINCT FROM THE USER VIEW OF DATA AS RELATIONS
- HOW LOGICAL DATA IS STORED
- HOW LOGICAL DATA IS RELATED
- TUPLE-ORIENTED
- ATTRIBUTE-ORIENTED
- DOMAIN-ORIENTED

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

A REVIEW AND CATEGORIZATION II

TUPLE-ORIENTED

- EACH BASE TABLE TUPLE IS STORED
- ATTRIBUTE VALUES ARE RELATED BY TUPLE
- OPERATIONS ARE TUPLE-ORIENTED
  - RELATIONAL ALGEBRA
  - RELATIONAL CALCULUS

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

A REVIEW AND CATEGORIZATION II

ATTRIBUTE-ORIENTED

- EACH ACTIVE ATTRIBUTE VALUE IS STORED
- TUPLES ARE COMPOSED FROM THE ATTRIBUTE VALUES
- BUT OPERATIONS MAY BE BASED ON EITHER...
  - TUPLES (HORIZONTAL OPERATIONS) OR...
  - ATTRIBUTE VALUES (VERTICAL OPERATIONS)
  - RELATIONAL ALGEBRA
  - DOMAIN ALGEBRA

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

A REVIEW AND CATEGORIZATION III

DOMAIN-ORIENTED

- EACH DOMAIN VALUE IS STORED
- ATTRIBUTE VALUES ARE RELATED TO DOMAIN VALUES
- TUPLES ARE COMPOSED OF LOGICAL ATTRIBUTE VALUES
- OPERATIONS ARE DOMAIN-ORIENTED

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

QUERY SYSTEMS

EQUIVALENCE OF....

- RELATIONAL ALGEBRA WITH COMPLEMENT

  .....IS EXPRESSIVELY EQUIVALENT TO....

- DOMAIN RELATIONAL CALCULUS WITH UNLIMITED EVALUATION

  ....IS EXPRESSIVELY EQUIVALENT TO....

- TUPLE RELATIONAL CALCULUS WITH UNLIMITED EVALUATION

- ALL ARE EQUIVALENT GIVEN LIMITED EVALUATION AND ALL ARE COMPLETE

  - IT MUST BE POSSIBLE TO EFFECTIVELY INTERPRET THE FORMULA EVEN IF THE DOMAIN IS INFINITE.

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN VERSUS TUPLE CALCULUS II

TUPLE RELATIONAL CALCULUS [CODD, 1971]

- EXAMPLE REPEATED

  "FIND ITEMS SOLD BY DEPARTMENTS ON THE SECOND FLOOR" ON SALES(DEPT, ITEM) and LOC(DEPT, FLOOR):

  - TUPLE RELATIONAL CALCULUS SYMBOLIC STATEMENT

    {s.ITEM | SALES(s) and ∃l ∈ LOC(l.DEPT = s.DEPT and l.FLOOR = 2)}

  - TRANSLATION

    Find the ITEM part of tuples s which is a tuple of SALES and whose DEPT part matches the DEPT part of tuple l in LOC, with the FLOOR part equal to 2.

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN VERSUS TUPLE CALCULUS I

DOMAIN RELATIONAL CALCULUS [PIROTTE, 1977]

- EXAMPLE

  "FIND ITEMS SOLD BY DEPARTMENTS ON THE SECOND FLOOR" ON SALES(DEPT, ITEM) and LOC(DEPT, FLOOR):

  - DOMAIN RELATIONAL CALCULUS SYMBOLIC STATEMENT

    {i|∃ d SALES (DEPT:d, ITEM:i) and LOC(DEPT:d, FLOOR:'2')}

  - TRANSLATION

    Find the ITEM i which is associated in SALES with some DEPT d which LOC gives on the second FLOOR.

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

SOME DOMAIN TERMINOLOGY I

- INFINITE

- FINITE

- ACTIVE DOMAIN

  THE DOMAIN RELATIVE TO A RELATION CONTAINING AN ATTRIBUTE DEFINED OVER THE DOMAIN SUCH THAT FOR EVERY MEMBER OF THE DOMAIN THERE IS A TUPLE IN THE RELATION WITH THAT ATTRIBUTE'S VALUE EQUAL TO THE DOMAIN MEMBER VALUE

- EXTENDED ACTIVE DOMAIN

  THE SET OF ACTIVE DOMAINS FOR ALL RELATIONS OR CONSTANTS MENTIONED IN A DOMAIN CALCULUS FORMULA.

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

SOME DOMAIN TERMINOLOGY II

- GENERALIZED EXTENDED ACTIVE DOMAIN

  THE GENERALIZED EXTENDED ACTIVE DOMAIN IS SOMETIMES CALLED THE EXTENDED ACTIVE DOMAIN AND IS THE EXTENDED ACTIVE DOMAINS FOR ALL WELL-FORMED DOMAIN CALCULUS FORMULA FOR A SCHEMA.

- INTENSIONAL DOMAIN DEFINITION

  A DECLARATIVE STATEMENT OF THE CONDITIONS WHICH AN ELEMENT MUST MEET FOR IT TO BE A MEMBER OF THE DOMAIN. NOTE: CONSIDER THE POSSIBLE DECIDABILITY ISSUES!

- EXTENSIONAL DOMAIN DEFINITION

  A LISTING OF ALL THE MEMBERS WHICH A DOMAIN MAY HAVE.

- ORDERED VERSUS UNORDERED DOMAINS

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN-STRUCTURED ARCHITECTURES I

SOME POTENTIAL PROPERTIES

- MINIMIZING STORAGE
- PERFORMANCE BENEFITS
  - AUTOMATIC INDEXING OF ATTRIBUTES BY DOMAIN VALUE
  - MULTIPAGING TO REDUCE SORTING REQUIREMENTS
  - PIPELINING OF SEQUENTIAL SCALAR OPERATIONS
  - CACHE EFFICIENCY

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN-STRUCTURED ARCHITECTURES II

SOME POTENTIAL PROPERTIES CONTINUED

- AUTOMATIC DOMAIN INTEGRITY ENFORCEMENT

- POTENTIAL USE OF A CONSTRAINT LANGUAGE

- EASY NORMALIZATION

  - DOMAIN KEY NORMAL FORM [FAGIN, 1981]

    ALL RELATION CONSTRAINTS ARE THE RESULT OF DOMAIN DEPENDENCES AND KEY DEPENDENCIES.

  - STRONGER THAN BOYCE-CODD NORMAL FORM

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN-STRUCTURED ARCHITECTURES III

SOME POTENTIAL PROBLEMS (IMPLEMENTATION DEPENDENT)

- IS CONCURRENCY CONTROL A BOTTLENECK?
- CAN ALL RELATIONAL OPERATORS BE IMPLEMENTED DIRECTLY?
- HOW IS REFERENTIAL INTEGRITY ENFORCED?
- HOW ARE INFINITE DOMAINS "STORED"?
- HOW IS DOMAIN INTEGRITY ENFORCED?

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859

DOMAIN-STRUCTURED ARCHITECTURES IV

SOME POTENTIAL PROBLEMS (IMPLEMENTATION DEPENDENT)

- HOW IS COLUMN INTEGRITY ENFORCED?
- HOW ARE LIKE AND BETWEEN PROCESSED?
- CAN UNORDERED DOMAINS BE HANDLED?
- ARE THERE SCHEMA RESTRUCTURING LIMITATIONS?
- HOW ARE DUPLICATES AND NULLS HANDLED?

C. 1990, David McGoveran ALL RIGHTS RESERVED 408/425-1859