Principles of Knowledge Discovery in Data

Fall 2004

Chapter 4: Data Mining Operations

Dr. Osmar R. Zaïane

University of Alberta

Source:
Dr. Jiawei Han

Summary of Last Chapter

- What is the motivation behind data preprocessing?
- What is data cleaning and what is it for?
- What is data integration and what is it for?
- What is data transformation and what is it for?
- What is data reduction and what is it for?
- What is data discretization?
- How do we generate concept hierarchies?

Course Content

- Introduction to Data Mining
- Data warehousing and OLAP
- Data cleaning
- **Data mining operations**
- Data summarization
- Association analysis
- Classification and prediction
- Clustering
- Web Mining
- Spatial and Multimedia Data Mining
- *Other topics if time permits*

Chapter 4 Objectives

Realize the difference between data mining operations and become aware of the process of specifying data mining tasks.

Get an brief introduction to a query language for data mining: DMQL.

Data Mining Operations Outline

- What is the motivation for ad-hoc mining process?
- What defines a data mining task?
- Can we define an ad-hoc mining language?

Motivation for ad-hoc Mining

- Data mining: an interactive process
  - user directs the mining to be performed
- Users must be provided with a set of **primitives** to be used to communicate with the data mining system.
- By incorporating these primitives in a **data mining query language**
  - User’s interaction with the system becomes more flexible
  - A foundation for the design of graphical user interface
  - Standardization of data mining industry and practice

Source:JH

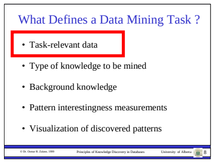
Data Mining Operations Outline

- What is the motivation for ad-hoc mining process?
- What defines a data mining task?
- Can we define an ad-hoc mining language?

What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

Task-Relevant Data

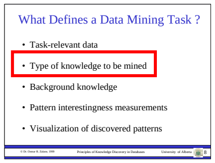

What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

- Database or data warehouse name
- Database tables or data warehouse cubes
- Condition for data selection
- Relevant attributes or dimensions
- Data grouping criteria

Source:JH

Types of Knowledge to Be Mined

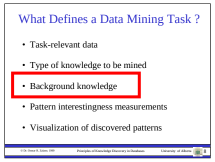

What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

- Characterization
- Discrimination
- Association
- Classification/prediction
- Clustering
- Outlier analysis
- and so on …

Source:JH

Background Knowledge

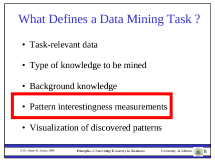

What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

- Concept hierarchies
  - – schema hierarchy
    - *Ex.* street < city < province_or_state < country
  - – set-grouping hierarchy
    - *Ex.* {20-39} = young, {40-59} = middle_aged
  - – operation-derived hierarchy
    - e-mail address, login-name < department < university < country
  - – rule-based hierarchy
    - low_profit (X) <= price(X, P1) and cost (X, P2) and (P1 - P2) < $50

Source:JH

Pattern Interestingness Measurements


What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

- Simplicity

  Ex. rule length
- Certainty

  Ex. confidence, P(A\B) = Card(A ∩ B)/ Card (B)
- Utility

  potential usefulness

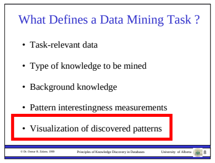
  Ex. Support, P(A∪B) = Card(A ∩ B) / # tuples
- Novelty

  not previously known, surprising

Source:JH

Visualization of Discovered Patterns

- Different background/purpose may require different form of representation
  - *Ex.*, rules, tables, crosstabs, pie/bar chart, etc.
- Concept hierarchies is also important
  - discovered knowledge might be more understandable when represented at high concept level.
  - Interactive drill up/down, pivoting, slicing and dicing provide different perspective to data.
- Different knowledge requires different representation.



What Defines a Data Mining Task ?

- Task-relevant data
- Type of knowledge to be mined
- Background knowledge
- Pattern interestingness measurements
- Visualization of discovered patterns

© Dr. Osmar R. Zaïane, 1999 Principles of Knowledge Discovery in Databases University of Alberta 8

Source:JH

Data Mining Operations Outline

- What is the motivation for ad-hoc mining process?
- What defines a data mining task?
- Can we define an ad-hoc mining language?

A Data Mining Query Language (DMQL)

- Motivation
  - A DMQL can provide the ability to support ad-hoc and interactive data mining.
  - By providing a standardized language like SQL, we hope to achieve the same effect that SQL have on relational database.
- Design
  - DMQL is designed with the primitives described earlier.

Source:JH

Syntax for DMQL

- ❖ Syntax for specification of
  - ▪ task-relevant data
  - ▪ the kind of knowledge to be mined
  - ▪ concept hierarchy specification
  - ▪ interestingness measure
  - ▪ pattern presentation and visualization
- ❖ Putting it all together — a DMQL query

Source:JH

Syntax for Task-relevant Data Specification

- ***use database*** database_name,

  or *use data warehouse* data_warehouse_name
- ***from relation***(s)/cube(s) [*where* condition]
- ***in relevance*** *to* att_or_dim_list
- ***order by*** order_list
- ***group by*** grouping_list
- ***having*** condition

Source:JH

Syntax for Specifying the Kind of Knowledge to be Mined

➢Characterization

mine characteristics **[*as* pattern_name]**
analyze **measure(s)**

➢Discrimination

mine comparison **[*as* pattern_name]**
for **target_class** ***where*** **target_condition**
{*versus* contrast_class_*i* *where*
contrast_condition_*i*}
analyze **measure(s)**

Source:JH

Syntax for Specifying the Kind of Knowledge to be Mined

➢Association

mine associations **[*as* pattern_name]**

Source:JH

Syntax for Specifying the Kind of Knowledge to be Mined (Cont.)

➢Classification

mine classification **[*as* pattern_name]**
analyze **classifying_attribute_or_dimension**

➢Prediction

mine prediction **[*as* pattern_name]**
analyze **prediction_attribute_or_dimension**
{*set* {attribute_or_dimension_*i*= value_*i*}}

Source:JH

Syntax for Concept Hierarchy Specification

- To specify what concept hierarchies to use

  use hierarchy <hierarchy> for <attribute_or_dimension>

- We use different syntax to define different type of hierarchies
  - schema hierarchies

    define hierarchy time_hierarchy on date as [date,month quarter,year]
  - set-grouping hierarchies

    define hierarchy age_hierarchy for age on customer as

    level1: {*young, middle_aged, senior*} < level0: all

    level2: {20, ..., 39} < level1: *young*

    level2: {40, ..., 59} < level1: *middle_aged*

    level2: {60, ..., 89} < level1: *senior*

Source:JH

Syntax for Concept Hierarchy Specification (Cont.)

- operation-derived hierarchies

  define hierarchy age_hierarchy for age on customer as

  {age_category(1), ..., age_category(5)} := cluster(default, age, 5) < all**(age)**

- rule-based hierarchies

  define hierarchy profit_margin_hierarchy on item as

  level_1: low_profit_margin < level_0: all

  if (price - cost) ≤ $50

  level_1: medium-profit_margin < level_0: all

  if ((price - cost) > $50) and ((price - cost) ≤ $250))

  level_1: high_profit_margin < level_0: all

  if (price - cost) > $250

Source:JH

Syntax for Interestingness Measure Specification

- Interestingness measures and thresholds can be specified by the user with the statement:

  with **<interest_measure_name>** threshold = **threshold_value**

- **Example:**

  with support threshold **= 0.05**

  with confidence threshold **= 0.7**

Source:JH

Syntax for Pattern Presentation and Visualization Specification

- We have syntax which allows users to specify the display of discovered patterns in one or more forms.

  display as **<result_form>**

- To facilitate interactive viewing at different concept levels, the following syntax is defined:

```
Multilevel_Manipulation  ::=   roll up on attribute_or_dimension
                               | drill down on attribute_or_dimension
                               | add attribute_or_dimension
                               | drop attribute_or_dimension
```

Source:JH

Putting It All Together: the Full Specification of a DMQL Query

use database **OurVideoStore_db**

use hierarchy **location_hierarchy for B.address**

mine characteristics as **customerRenting**

analyze **count%**

in relevance to **C.age, I.type, I.place_made**

from **customer C, item I, rentals R, items_rent S, works_at W, branch**

where **I.item_ID = S.item_ID and S.trans_ID = R.trans_ID**

and R.cust_ID = C.cust_ID and R.method_paid = ``Visa''

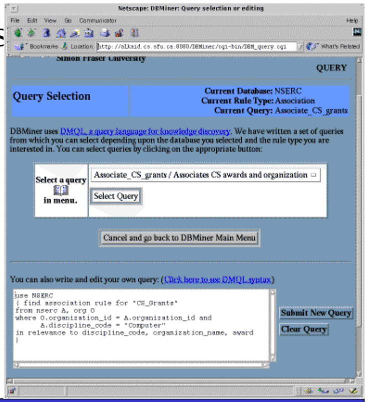
and R.empl_ID = W.empl_ID and W.branch_ID = B.branch_ID and B.address = ``Alberta'' and I.price >= 100

with **noise** threshold = **0.05**

display as **table**

Designing Graphical User Interfaces Based on a Data Mining Query Language

- ❖ Data collection and data mining query composition
- ❖ Presentation of discovered patterns
- ❖ Hierarchy specification and manipulation
- ❖ Manipulation of data mining primitives
- ❖ Interactive multi-level mining
- ❖ Other miscellaneous information


Netscape: DBMiner: Query selection or editing
File Edit View Go Communicator Help
Bookmarks Location: http://alkaid.cs.sfu.ca:8080/DBMiner/cgi-bin/DBM_query.cgi
What's Related
Simon Fraser University
QUERY

Query Selection

Current Database: NSERC
Current Rule Type: Association
Current Query: Associate_CS_grants

DBMiner uses DMQL, a query language for knowledge discovery. We have written a set of queries from which you can select depending upon the database you selected and the rule type you are interested in. You can select queries by clicking on the appropriate button:

Select a query in menu. Associate_CS_grants / Associates CS awards and organization

You can also write and edit your own query: (Click here to see DMQL syntax)

```
use NSERC
{ find association rule for "CS_Grants"
from nserc A, org O
where O.organization_id = A.organization_id and
      A.discipline_code = "Computer"
in relevance to discipline_code, organization_name, award
}
```

Summary: Five Primitives for Specifying a Data Mining Task

- task-relevant data
  - database/date warehouse, relation/cube, selection criteria, relevant dimension, data grouping
- kind of knowledge to be mined
  - characterization, discrimination, association...
- background knowledge
  - concept hierarchies,..
- interestingness measures
  - simplicity, certainty, utility, novelty
- knowledge presentation and visualization techniques to be used for displaying the discovered patterns
  - rules, table, reports, chart, graph, decision trees, cubes ...
  - drill-down, roll-up,....

Source:JH