Data Mining

Association Rules

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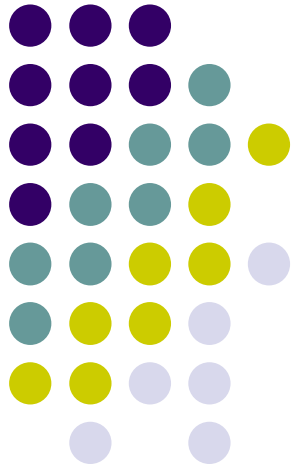
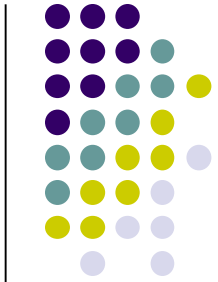
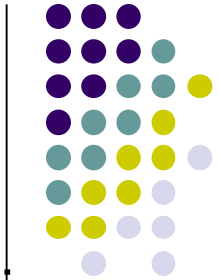


Association Rules



- Association rules are on of the major techniques of data mining and it is perhaps the most common form of local-pattern discovery in unsupervised learning systems



- Many business enterprises accumulate large quantities of data from their day-to-day operations

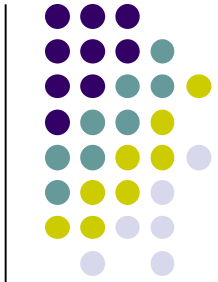
- For example, huge amounts of customer purchase data are collected daily at the checkout counters of grocery stores.

TID	Items
1	{Bread, Milk}
2	{Bread, Diapers, Beer, Egg}
3	{Milk, Diapers, Beer, Cola}
4	{Bread, Milk, Diapers, Beer}
5	{Bread, Milk, Diapers, Cola}

An example of market basket transaction

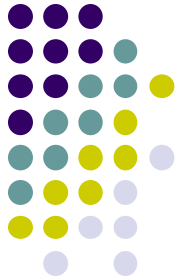
- It is a form of data mining that most closely resembles the process that most people think about when they try to understand the data mining process; namely, “mining” for gold through a vast database.
- The gold in this case would be a rule that is interesting, that tells you something about your database that you didn’t already know and probably weren’t explicitly articulate.

Market Basket Analysis



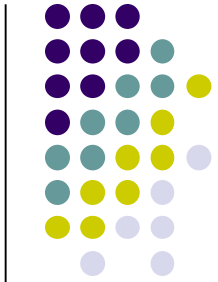
- A market basket is a collection of items purchased by a custumer in a single transaction, which is a well defined business activity.
- One common analysis run against a transactions database is to find sets of items, or itemsets, that appear together in many transactions.

Market Basket Analysis continuing



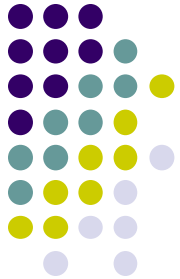
- A business can use knowledge of these patterns to improve the placemant of these items in the store or the layout of mail-order catalog pages and web pages.

Basic Concepts: Frequent Patterns



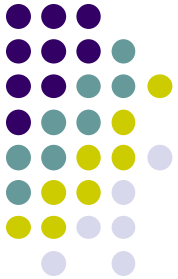
- An itemset containing i items is called an i-itemset.
- The percentage of transactions that contain an itemset is called the itemset's support.
- For an itemset to be interesting, its support must be higher than a user-specified minimum. Such itemsets are said to be frequent.

Basic Concepts: Frequent Patterns



- Let $I=\{i_1,i_2,\ldots,i_m\}$ be a set of literals, called items.
- Let DB be a set of transactions, where each transaction T is a set of items such that $T \subseteq I$.
- Note that the quantities of the items bought in a transaction are not considered, meaning that each item is a binary variable indicating whether an item was bought or not.

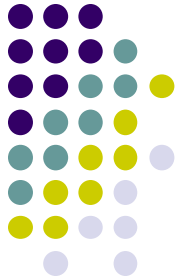
Basic Concepts: Frequent Patterns



- An example of the model for such a transaction database is given as follow;

Transaction-id	Items bought
10	A, C, D
20	B, C, E
30	A, B, C, E
40	B, E

Basic Concepts: Frequent Patterns

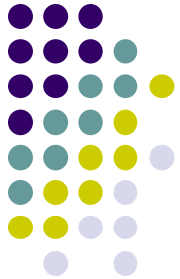


- Let X be a set of items. A transaction T is said to contain X if and only if $X \subseteq T$

- An association rule implies the form $X \Rightarrow Y$, where $X \subseteq I$, $Y \subseteq I$ and $X \cap Y = \varnothing$.

- The rule $X \Rightarrow Y$ holds in the transaction set DB with confidence c if c% of the transaction in D that contain X also contain Y.

Basic Concepts: Frequent Patterns



- The rule $X \Rightarrow Y$ holds in the transaction set DB with confidence c if c% of the transaction in D that contain X also contain Y.

- The rule $X \Rightarrow Y$ has support s in the transaction set D if s% of the transaction in DB that contain $X \cup Y$.

$$\text{Support } (X \Rightarrow Y) = P(X \cup Y)$$

$$\text{Confidence}(X \Rightarrow Y) = P(Y|X)$$

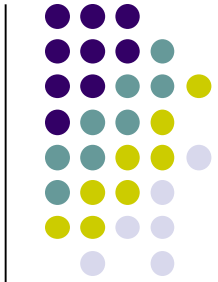
Transaction ID	Items Bought
1	{Shoes, Trousers, Shirt, Belt}
2	{Shoes, Trousers, Shirt, Hat, Belt, Scarf}
3	{Shoes, Shirt}
4	{Shoes, Trousers, Belt}

Transaction ID	Shoes	Trousers	Shirt	Belt	Hat	Scarf
1	1	1	1	1	0	0
2	1	1	1	1	1	1
3	1	0	1	0	0	0
4	1	1	0	1	0	0

Support(Trousers $\Rightarrow$Shirt)=2/4

Confidence(Trousers $\Rightarrow$Shirt)=2/3

Basic Concepts: Strong Rules

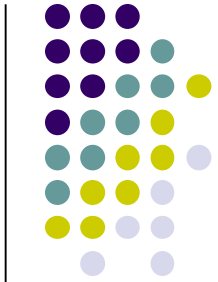


- Confidence denote strength of implication and support indicates the frequency of the patterns occuring in the rule.
- It is often desireable to pay attention to only those rules that may have a reasonable large support.
- Such rules with high confidence and strong support are referred to as strong rules.
- The task of mining association rules is essentially to discover strong association rules in large databases.

Mining Association Rules

- The problem of mining association rules may be decomposed into two phases:
  - Discover the large itemsets, i.e. the sets of items that have transaction supports above predetermined minimum threshold
  - Use the large itemsets to generate the association rules for the database that have confidence c above a predetermined mining threshold

ALGORITHM APRIORI



- The algorithm Apriori computes the frequent itemsets in the database through several iterations.
- Iteration i computes all frequent i-itemsets (itemsets with i elements)
- Each iteration has two steps:
  - Candidate generation
  - Candidate counting and selection

ALGORITHM APRIORI

- In the first phase of the first iteration, the generated set of candidate itemsets contains all 1-itemsets (i.e. All items in the database)
- In the counting phase, the algorithm counts their support searching again through the whole database. Finally, only 1-itemsets (items) with s above required threshold will be selected as frequent.
- Thus, after the first iteration, all frequent 1-itemsets will be known.

The Apriori Algorithm—An Example

Database TDB

Tid	Items
10	A, C, D
20	B, C, E
30	A, B, C, E
40	B, E

$Sup_{min} = 2$

C_1 — 1st scan

Itemset	sup
{A}	2
{B}	3
{C}	3
{D}	1
{E}	3

L_1

Itemset	sup
{A}	2
{B}	3
{C}	3
{E}	3

C_2

Itemset
{A, B}
{A, C}
{A, E}
{B, C}
{B, E}
{C, E}

2nd scan

C_2

Itemset	sup
{A, B}	1
{A, C}	2
{A, E}	1
{B, C}	2
{B, E}	3
{C, E}	2

L_2

Itemset	sup
{A, C}	2
{B, C}	2
{B, E}	3
{C, E}	2

C_3

Itemset
{B, C, E}

3rd scan

L_3

Itemset	sup
{B, C, E}	2

An itemset lattice diagram