Mining Relationships Among Records

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Outline

- Basic Concepts
- Performing Association Rule Mining

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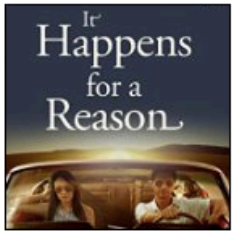

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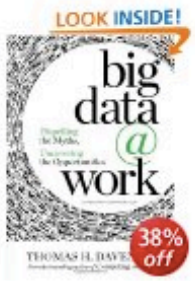

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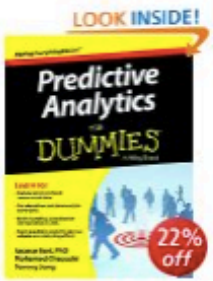

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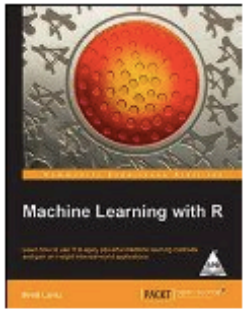

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Basic Concepts: Example

Bound Away
Last Train Home

Share your own customer images

List Price: $16.98
Price: **$16.98** and eligible for **FREE Super Saver Shipping** on orders over $25. See details.

Availability: Usually ships within 24 hours

Want it delivered Tomorrow? Order it in the next 4 hours and 9 minutes, and choose **One-Day S** checkout. See details.

41 used & new from $6.99

See more product details

Based on customer purchases, this is the #82 Early Adopter Product in Alternative Rock.

801x612

Buy this title for only $.01 when you get a new Amazon Visa® Card

Apply now and if you're approved instantly, **save $30** off your first purchase, earn **3% rewards**, get a **0% APR**,* and pay **no**

Amazon Visa discount: $30.00
Applied to this item: - $16.97
Discount remaining: $13.03
Find out how
(Don't show again)

Customers who bought this title also bought:

- Time and Water ~ Last Train Home (Why?)
- Cold Roses ~ Ryan Adams & the Cardinals (Why?)
- Tambourine ~ Tift Merritt (Why?)
- Last Train Home ~ Last Train Home (Why?)
- True North ~ Last Train Home (Why?)
- Universal United House of Prayer ~ Buddy Miller (Why?)
- Wicked Twisted Road [ENHANCED] ~ Reckless Kelly (Why?)
- Hacienda Brothers ~ Hacienda Brothers (Why?)

Basic Concepts

- Proposed by Agrawal et al in 1993.
- It is an important data mining model studied extensively by the database and data mining community.
- Assume all data are categorical.
- No good algorithm for numeric data.
- Initially used for Market Basket Analysis to find how items purchased by customers are related.

$$\text{Bread} \rightarrow \text{Milk} \qquad [\text{sup} = 5\%, \text{conf} = 100\%]$$

Basic Concepts

- What are Association Rules?
  - Study of "what goes with what"
    - "Customers who bought X also bought Y"
    - What symptoms go with what diagnosis
  - Transaction-based or event-based
  - Also called "market basket analysis" and "affinity analysis"
  - Originated with study of customer transactions databases to determine associations among items purchased

Basic Concepts: Association Rules

"IF" part = **antecedent** "THEN" part = **consequent**

"Item set" = the items (e.g., products) comprising the antecedent or consequent

- Antecedent and consequent are *disjoint* (i.e., have no items in common)
  - An association rule is an implication of the form:
    $X \rightarrow Y$, where $X, Y \subset I$, *and* $X \cap Y = \varnothing$
  - An itemset is a set of items.
    - E.g., X = {milk, bread, cereal} is an itemset.
  - A *k*-itemset is an itemset with *k* items.
    - E.g., {milk, bread, cereal} is a 3-itemset

Basic Concepts: Association Rules

Transaction	Faceplate Colors Purchased			
1	red	white	green	
2	white	orange		
3	white	blue		
4	red	white	orange	
5	red	blue		
6	white	blue		
7	white	orange		
8	red	white	blue	green
9	red	white	blue	
10	yellow			

Basic Concepts: Association Rules

For example: Transaction 1 supports several rules, such as

- "If red, then white" ("If a red faceplate is purchased, then so is a white one")
- "If white, then red"
- "If red and white, then green"
- + several more

Basic Concepts: Association Rules

Transaction	Red	White	Blue	Orange	Green	Yellow
1	1	1	0	0	1	0
2	0	1	0	1	0	0
3	0	1	1	0	0	0
4	1	1	0	1	0	0
5	1	0	1	0	0	0
6	0	1	1	0	0	0
7	1	0	1	0	0	0
8	1	1	1	0	1	0
9	1	1	1	0	0	0
10	0	0	0	0	0	1

An example

t1:	Butter, Bread, Milk
t2:	Butter, Cheese
t3:	Cheese, Boots
t4:	Butter, Bread, Cheese
t5:	Butter, Bread, Clothes, Cheese, Milk
t6:	Bread, Clothes, Milk
t7:	Bread, Milk, Clothes

- Transaction data
- Assume:
  minsup = 30%
  minconf = 80%

- An example frequent *itemset*:
  {Bread, Clothes, Milk} [sup = 3/7]

- Association rules from the itemset:
  Clothes → Milk, Bread [sup = 3/7, conf = 3/3]
  …
  Clothes, Bread → Milk, [sup = 3/7, conf = 3/3]

Basic Concepts: Objective

- Ideally, we want to create all possible combinations of items
- Problem: computation time grows exponentially as # items increases
- Solution: consider only "frequent item sets"
- Criterion for frequent: support

=> Apriori Algorithm

Basic Concepts: Rule Strengths

- Support: The rule holds with support *sup* in *T* (the transaction data set) if sup% of transactions contain $X \cup Y$.
  - $sup = \Pr(X \cup Y)$.
- Confidence: The rule holds in *T* with confidence *conf* if *conf*% of transactions that contain *X* also contain *Y*.
  - $conf = \Pr(Y \mid X)$
- **Lift** = *confidence*/(*benchmark confidence*)
  - *Benchmark confidence* = transactions with consequent as % of all transactions
  - Lift > 1 indicates a rule that is useful in finding consequent items sets (i.e., more useful than just selecting transactions randomly)

Basic Concepts: Rule Strengths

- Support count: The support count of an itemset X, denoted by $X.count$, in a data set T is the number of transactions in T that contain X. Assume T has n transactions.
- Then,

$$support = \frac{(X \quad Y).count}{n}$$

$$confidence = \frac{(X \quad Y).count}{X.count}$$

Apriori Algorithm

Goal: Find all rules that satisfy the user-specified *minimum support* (minsup) and *minimum confidence* (minconf).

For *k* products…

1. User sets a minimum support criterion
2. Next, generate list of one-item sets that meet the support criterion
3. Use the list of one-item sets to generate list of two-item sets that meet the support criterion
4. Use list of two-item sets to generate list of three-item sets
5. Continue up through *k*-item sets

Apriori Algorithm
Interpretation

- *Lift ratio* shows how effective the rule is in finding consequents (useful if finding particular consequents is important)
- *Confidence* shows the rate at which consequents will be found (useful in learning costs of promotion)
- *Support* measures overall impact

Apriori Algorithm
Caution: The Role of Chance

Random data can generate apparently interesting association rules

The more rules you produce, the greater this danger

Rules based on large numbers of records are less subject to this danger

Summary

- Association rules (or *affinity analysis,* or *market basket analysis*) produce rules on associations between items from a database of transactions
- Widely used in **recommender systems**
- Most popular method is **Apriori algorithm**
- To reduce computation, we consider only "frequent" item sets (=support)
- Performance is measured by *confidence* and *lift*
- Can produce a profusion of rules; review is required to identify useful rules and to reduce redundancy

Thank You