Association Rules

Universitat Pompeu Fabra Barcelona

Mining Massive Datasets

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Sources

- Data Mining, The Textbook (2015) by Charu Aggarwal (Chapters 4, 5) – slides by Lijun Zhang
- Mining of Massive Datasets 2nd edition (2014) by Leskovec et al. (Chapter 6) - slides
- Data Mining Concepts and Techniques, 3rd edition (2011) by Han et al. (Chapter 6)
- Introduction to Data Mining 2nd edition (2019) by Tan et al. (Chapters 5, 6) – slides ch5, slides ch6

What is a rule

- A rule is of the form X⇒Y
  - X and Y are itemsets
- X is the antecedent, Y is the consequent
- The **confidence** of the rule is:

$$\mathrm{conf}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)}$$

Confidence of a rule

- The **confidence** of the rule $X \Rightarrow Y$ is:

$$\mathrm{conf}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)}$$

- This is the conditional probability of $X \cup Y$ occurring in a transaction, given that X occurs in the transaction

Confidence of a rule (cont.)

tid	Set of items
1	Bread, Jam, Juice
2	Tofu, Juice, Tomatoes
3	Bread, Strawberries, Tofu, Juice
4	Tofu, Juice, Tomatoes
5	Strawberries, Juice, Tomatoes

$$\text{conf}(\{\text{tofu}, \text{juice}\} \Rightarrow \{\text{tomatoes}\}) = ?$$

Confidence of a rule (cont.)

tid	Set of items
1	Bread, Jam, Juice
2	Tofu, Juice, Tomatoes
3	Bread, Strawberries, Tofu, Juice
4	Tofu, Juice, Tomatoes
5	Strawberries, Juice, Tomatoes

$$\text{conf}(\{\text{tofu}, \text{juice}\} \Rightarrow \{\text{tomatoes}\}) = \frac{\sup(\{\text{tofu}, \text{juice}, \text{tomatoes}\})}{\sup(\{\text{tofu}, \text{juice}\})}$$

$$= \frac{0.4}{0.6} = \frac{2}{3}$$

X and Y are sets of items

$$\mathrm{conf}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)}$$

- The “union” in the above definition is confusing for some people, because conditional probability definitions use “intersection”
- Remember that that the set of transactions containing X ∪ Y is the set of transactions containing X intersected with the set of transactions containing Y
- The set of transactions containing “X ∩ Y” is **irrelevant** for the purposes of computing confidence, e.g., **in the previous exercise, {tofu, juice} ∩ {tomato} is an empty set**

Lift of a rule

- The **lift** of the rule $X \Rightarrow Y$ is:

$$\text{lift}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)\sup(Y)}$$

- This is the ratio between the observed support and the expected support if X and Y were independent

Exercise

$$\text{conf}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)}$$

$$\text{lift}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)\sup(Y)}$$

Rule	Support $\sup(X \cup Y)$	Confidence	Lift
$A \Rightarrow D$			
$C \Rightarrow A$			
$A \Rightarrow C$			
$B \,\&\, C \Rightarrow D$			

https://www.saedsayad.com/association_rules.htm

Answers

$$\text{conf}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)}$$

$$\text{lift}(X \Rightarrow Y) = \frac{\sup(X \cup Y)}{\sup(X)\sup(Y)}$$

Rule	Support	Confidence	Lift
$A \Rightarrow D$	2/5	2/3	10/9
$C \Rightarrow A$	2/5	2/4	5/6
$A \Rightarrow C$	2/5	2/3	5/6
$B \,\&\, C \Rightarrow D$	1/5	1/3	5/9

https://www.saedsayad.com/association_rules.htm

Association rule (minsup, minconf)

- Let X, Y be two itemsets; the rule $X \Rightarrow Y$ is an **association rule** of minimum support **minsup** and minimum confidence **minconf** if:

$$sup(X \Rightarrow Y) \geq minsup$$

and

$$conf(X \Rightarrow Y) \geq minconf$$

Summary

Things to remember

- Association rule of minsup and minconf
- The concepts of **confidence** and **lift**

Exercises for TT11-TT12

- Data Mining, The Textbook (2015) by Charu Aggarwal
  - Exercises 4.9 → 1-3, 5, 7-8
  - Exercises 5.7 → 1-5
- Mining of Massive Datasets 2nd edition (2014) by Leskovec et al.
  - Exercises 6.1.5 → 6.1.1-6.1.7
- Introduction to Data Mining 2nd edition (2019) by Tan et al.
  - Exercises 5.10 → 2-7