

CSC 8740 - Advanced Data Mining

Homework Assignment 2

Objective measures are often used for understanding the interestingness of patterns and association rules. These interestingness measures play an important role in data mining tasks as they are intended for selecting and ranking patterns according to their potential interest to the user. Good measures also allow the time and space complexity of the mining process to be reduced.

Tan et al. (2004)¹ presents 21 measures for pattern interestingness. These are listed in Table 5 of the paper. For your reference, they are also added below. In this assignment you will be exploring the implementations for these measures.

#	Measure	Definition
1	ϕ -coefficient	$\frac{P(A,B) - P(A)P(B)}{\sqrt{P(A)P(B)(1-P(A))(1-P(B))}}$
2	Goodman-Kruskal's (λ)	$\frac{\sum_j \max_k P(A_j, B_k) + \sum_k \max_j P(A_j, B_k) - \max_j P(A_j) - \max_k P(B_k)}{2 - \max_j P(A_j) - \max_k P(B_k)}$
3	Odds ratio (α)	$\frac{P(A,B)P(\bar{A},\bar{B})}{P(A,\bar{B})P(\bar{A},B)}$
4	Yule's Q	$\frac{P(A,B)P(\bar{A}\bar{B}) - P(A,\bar{B})P(\bar{A},B)}{P(A,B)P(\bar{A}\bar{B}) + P(A,\bar{B})P(\bar{A},B)} = \frac{\alpha - 1}{\alpha + 1}$
5	Yule's Y	$\frac{\sqrt{P(A,B)P(\bar{A}\bar{B})} - \sqrt{P(A,\bar{B})P(\bar{A},B)}}{\sqrt{P(A,B)P(\bar{A}\bar{B})} + \sqrt{P(A,\bar{B})P(\bar{A},B)}} = \frac{\sqrt{\alpha} - 1}{\sqrt{\alpha} + 1}$
6	Kappa (κ)	$\frac{P(A,B) + P(\bar{A},\bar{B}) - P(A)P(B) - P(\bar{A})P(\bar{B})}{1 - P(A)P(B) - P(\bar{A})P(\bar{B})}$
7	Mutual Information (M)	$\frac{\sum_i \sum_j P(A_i, B_j) \log \frac{P(A_i, B_j)}{P(A_i)P(B_j)}}{\min(-\sum_i P(A_i) \log P(A_i), -\sum_j P(B_j) \log P(B_j))}$
8	J-Measure (J)	$\max \left(P(A, B) \log \left(\frac{P(B A)}{P(B)} \right) + P(\bar{A}\bar{B}) \log \left(\frac{P(\bar{B} \bar{A})}{P(\bar{B})} \right), \right. \\ \left. P(A, \bar{B}) \log \left(\frac{P(\bar{B} A)}{P(\bar{B})} \right) + P(\bar{A}B) \log \left(\frac{P(B \bar{A})}{P(B)} \right) \right)$
9	Gini index (G)	$\max \left(P(A)[P(B A)^2 + P(\bar{B} A)^2] + P(\bar{A})[P(B \bar{A})^2 + P(\bar{B} \bar{A})^2] \right. \\ \left. - P(B)^2 - P(\bar{B})^2, \right. \\ \left. P(B)[P(A B)^2 + P(\bar{A} B)^2] + P(\bar{B})[P(A \bar{B})^2 + P(\bar{A} \bar{B})^2] \right. \\ \left. - P(A)^2 - P(\bar{A})^2 \right)$
10	Support (s)	$P(A, B)$
11	Confidence (c)	$\max(P(B A), P(A B))$
12	Laplace (L)	$\max \left(\frac{NP(A,B)+1}{NP(A)+2}, \frac{NP(A,B)+1}{NP(B)+2} \right)$
13	Conviction (V)	$\max \left(\frac{P(A)P(\bar{B})}{P(\bar{A}\bar{B})}, \frac{P(B)P(\bar{A})}{P(\bar{B}\bar{A})} \right)$
14	Interest (I)	$\frac{P(A,B)}{P(A)P(B)}$
15	cosine (IS)	$\frac{P(A,B)}{\sqrt{P(A)P(B)}}$
16	Piatetsky-Shapiro's (PS)	$P(A, B) - P(A)P(B)$
17	Certainty factor (F)	$\max \left(\frac{P(B A) - P(B)}{1 - P(B)}, \frac{P(A B) - P(A)}{1 - P(A)} \right)$
18	Added Value (AV)	$\max(P(B A) - P(B), P(A B) - P(A))$
19	Collective strength (S)	$\frac{P(A,B) + P(\bar{A}\bar{B})}{P(A)P(B) + P(\bar{A})P(\bar{B})} \times \frac{1 - P(A)P(B) - P(\bar{A})P(\bar{B})}{1 - P(A,B) - P(\bar{A}\bar{B})}$
20	Jaccard (ζ)	$\frac{P(A,B)}{P(A) + P(B) - P(A,B)}$
21	Klosgen (K)	$\sqrt{P(A, B) \max(P(B A) - P(B), P(A B) - P(A))}$

¹P. Tan, V. Kumar, J. Srivastava, Selecting the right objective measure for association analysis, Information Systems, Volume 29, Issue 4, 2004, pp. 293-313, [https://doi.org/10.1016/S0306-4379\(03\)00072-3](https://doi.org/10.1016/S0306-4379(03)00072-3)

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Task 1: Read the Tan et al. (2004) paper. (repeat this step until you understand)

Task 2: Create a test dataset for yourself using Table 2 in the paper.

Task 3: Using the definitions in Table 1 and 5 (and if needed references within the paper) implement the measures of interestingness. Discover which ones you would not be able to calculate with only contingency tables and discuss why.

Task 4: Compare your results with the rankings that are presented in Table 3.

Notes:

- You are expected to use the Python programming language and implement these measures from scratch (please do not use libraries as the point of this exercise is to have you understand the behavior of interestingness measures).
- You can assume that all the implemented measures take a contingency matrix as input.
- You can implement the measures in a separate Python file (e.g., as utility functions) or within a jupyter notebook. Please use jupyter notebooks to show the comparisons.