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Discriminative Pattern Identification using Rule Based Approach

Bhushan Mahajan*[1], S. S. Nandgaonkar[2]
*[1] Department of Computer Engineering, Vidya Pratishthan College of Engineering, Baramati,413 133,University of Pune, Maharashtra, India
[2] Department of Computer Engineering, Vidya Pratishthan College of Engineering, Baramati,413 133, ,University of Pune, Maharashtra, India
hbhushan10@gmail.com

Abstract

Discrimination is bias behavior of people in society; particularly discrimination is based on race, sex, age and cast. Discrimination observed in many areas like labour market, education credit, mortgage and medical. Most of scientist found it in many subject like social sciences economics and law. Discrimination system relies on historical data for making decisions in socially sensitive actions. The technique of Discrimination identification uses information systems based on data mining technology for decision making. Decision making systems and data mining techniques such as association rule mining have been designed and are now used for making automated decisions, like loan granting or denial. Discrimination situations found in dataset in direct and indirect ways. Rules are formed from the dataset using Apriori algorithm and certain parameters such as number of rules, minimum support and confidence. Power of discrimination within rules are calculated by an elift and glift on a classification rule using Alpha and strong Alpha protection. In direct discrimination, the rules are directly extracted from dataset and searched for discriminatory pattern. In indirect discrimination, system needs some background knowledge as a further input and it is used to find unfair treatments. Inference model required for integration of classification rules with background rules. Inference model is a mathematic model. Direct and Indirect Discrimination tested over German credit dataset.

Keywords: Rule, Inference Model. Direct Discrimination, Indirect Discrimination.

Introduction

Discrimination word is born from latin word "discriminare". It means distinguishing objects on the basis of their attributes. In the social sense, discrimination means unfair or unequal treatment of people based on membership to specific group without regard of individual merit or score. In discrimination identification system relies on collection of real time data and analysis of data for the fighting against discrimination. Getting historical data for decision making system for socially-sensitive actions is starting point for identification of discriminatory pattern. The traditional decision making system is improved using intelligent decision support systems and it is capable to assist the decision process using data mining technique. But the actual identification of discriminatory situations and practices are extremely difficult task. Decision model may show unlawfully predefined behavior because decision making system relies on only historical data.

There are two type of difficulty found in identification discriminatory pattern in decision making system
1) Personal data is highly dimensional, so multi-valued attributes as a result in to a huge number of possible contexts.
2) The second source of complexity is indirect discrimination.

The actual goal of this research is to find discriminatory pattern in historical decision records using data mining techniques. Data mining approach is used to distinguish object based on their properties. But data mining can also be fruitfully put at work on a powerful side to the anti-discrimination analyst, and make it able to discover the patterns of discrimination that are derived from the available data with stronger proof.

Literature Survey

Discrimination found in many areas mostly in credit, mortgage, insurance, labor market, and

education. Discrimination has been studied over the last few decades and antidiscrimination laws have been adopted by many democratic governments like India, Australia. Some examples are the UK Sex Discrimination Act (Parliament of the United Kingdom 1975), the UK Race Relations Act (Parliament of the United Kingdom 1976) and US Employment Non-Discrimination Act (United States Congress 1994).

U.S. federal laws exhibits their discrimination by nationality, sex, race, color, religion, marital status, age and pregnancy, Fair Housing Act shows their discrimination on the basis personnel selection and wages [2]. Other U.S. federal laws exist for discrimination in public programs or activities, such as nursing homes, adoptions, senior citizens centers, public accommodations, education, health care, academic programs, student services, hospitals, transportation. Several authorities perform analysis of discrimination with the help of automatic decision support systems, such as credit scoring systems in early period of 1990. Later development in decision making system makes it is easy for collection of information but it has opens several challenges to data analysts for the fight against discrimination. Despite the wide deployment of information systems based on data mining technology in decision making, the issue of anti-discrimination in data mining did not receive much attention until 2008.

In 1957 Becker's launched book on "The Economics of Discrimination" it focuses on analysis of labor market discrimination among economists. Becker's analysis was focused on the relationship between racial prejudice among whites and discrimination against racial minorities. Racial prejudice causes some employers to regard black workers as more expensive than they truly are.

Discrimination prevention technique in [7] consists of inducing a classifier like Naive Bayes in which classification is done without any sensitive attribute. In this technique prevention need to modify probability of decision records. That does not lead to discriminatory decisions even if trained from a dataset containing these itemset. Training model consist unwanted dependencies between attributes.

Advantage
- It is Discrimination prevention technique.
- It Balances modified Probability such that minimum loss of original meaning.
- Find dependencies between the Sensitive and attributes training data.

Disadvantage
- Not fruitful for indirect Discrimination.

- No measures are available for finding how much discrimination occurs or how much removed from dataset.
- Low accuracy.
- Some Discrimination free attribute are not observed further more for discrimination prevention.

In [8] anti discrimination techniques including discrimination discovery and prevention have been introduced using data mining. Discovering discriminatory situation and eliminating them from training data should be harmless for decision making also there should be no loss of real meaning of records. Clean training data sets and modified data sets in such a way that direct and indirect discriminatory decision rules are converted in to legitimate (non discriminatory) classification rules.

There are three approaches for discrimination prevention 1) pre-processing 2) In processing 3) Post processing.

Advantage
- Prevention technique, better than previous one.
- Applicable to Indirect Discrimination.
- Utility measures for both direct and indirect discrimination and can deal with several discriminatory items.

Disadvantage
- Even if it is prevention technique it requires identification technique for finding how much discrimination is remaining in dataset.
- Prevention technique some time lead to change meaning of records or rules.
- High time and space complexity.
- Cannot handle continuous value.
- Does not find specific attribute that are responsible for Discrimination.

Basic Terminology
A. Potential Discriminatory Itemset (ID Set)
ID Set is set of attributes which can influence decision-making. In other word it is a collection of sensitive attributes that may be going across law and might be potentially leads to discrimination. For example attributes sex=female, race=black, specific age range can be considered as Potentially Discriminated Item set.

B. PD and PND Rule
Direct discrimination is detected by rules in which ID Set is part of rule. This rule is called as Potential Discriminatory rule (PD Rule). Indirect

discrimination consists of rules or procedures that do not explicitly specify discriminatory attributes (ID Set) in rules this rule is called as Potential Non-Discriminatory rule (PND rule).

C. Elift and Glift

The Elift and Glift express the diversion in confidence of base rule due to the present of the item set A in the premise of the base rule. Where A is subset of ID set.

Elift or Glift=conf(A,B->C)/conf(B->C)

D. α-Protection and Strong α-Protection

α-Protection and Strong α-Protection are measure technique for discrimination power within rule. Let c = A,B -> C be a PD classification rule, where A is subset of ID-set attributes and B is a PND item sets, and let ~c = A,B ->~C be a negated form of rule c.

For a given threshold α>=0, c is α-protective if its extended lift with respect to B is lower than α. Otherwise, c is α-discriminatory [1].

For a given threshold α>= 1, we say that c is strongly α -protective if both the glifts of c and ~c with respect to B are lower than α. Otherwise, C is strongly α-discriminatory [1].

Project Modules

Discrimination identification system divided into four different modules. In first module Apriori algorithm generate association rules with support and generate association rules with confidence by using index Hashing technique. Then in second module classification is preformed on the basis of ID set. Association rules are categorized into three different groups 1.PD classification rules 2.PND classification rules and 3.BK (Background) Association Rules. After classifying rules, a PD rules are applied to Third module of Direct Discrimination and PND applied to Fourth module of Indirect Discrimination. Indirect Discrimination depends on additional background knowledge (BK Rules) for further processing, which requires inference model. It is needed for combining PND rules with BK rules. Every modules uses hashing technique for reducing searching time of algorithm. Also Direct and Indirect Discrimination algorithm detect which attributes are responsible for making rule Discriminative. Last Section contains Inference model.

A. Apriori

Apriori uses a "bottom to up" approach, where frequent subsets are extended one item at a time. Most important things about apriori algorithm is confidence of the rule can be computed by looking only at itemsets of length k-1 by using hashing technique. Here apriori use mapped value like if Attribute 9 is sex and it have 2 values male and female so that their mapped value is 91 for male, 92 for female and so on. In apriori algorithm analyst can restrict number of association rules. Hash table is prepared while calculating confidence of rule [3].

B. Classify Rule

Association of rule are generated from Apriori Algorithm and separate out into three groups, named as PD classification rules, PND classification rules and BK association rules by a single scan over the classification rules ordered by the item set of size k. For k-frequent item sets that include a class item and non class item in result field. The rules in output are distinguished between PD and PND rules, based on the presence of discriminatory items(ID Set) in their premises, if rule have class attribute into result field otherwise rule is classified into BK rules.
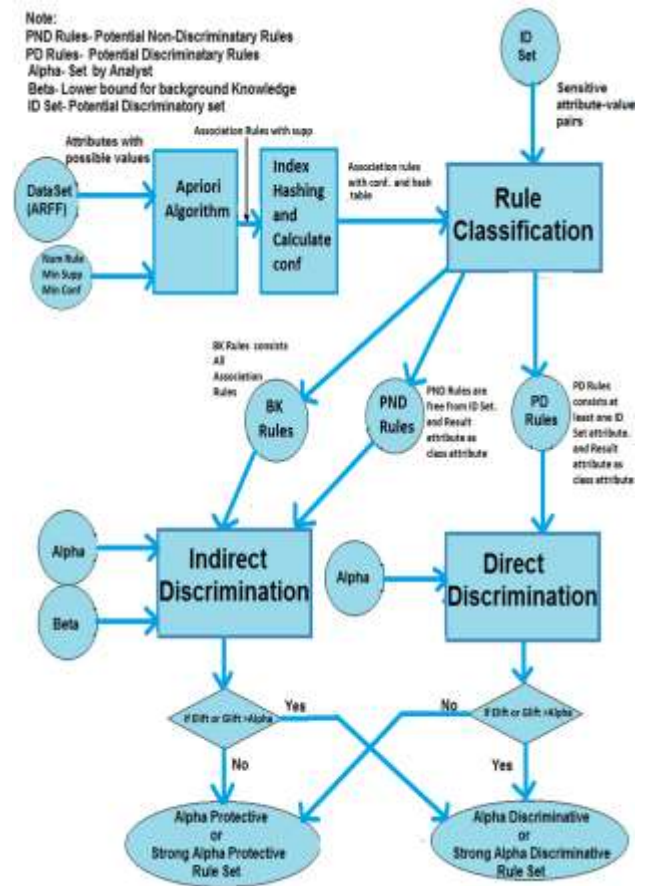

Fig 1. System Architecture

C. Direct Discrimination

Discrimination has been discovered by literature as either direct or indirect in law or society. Direct discrimination consists of rules or procedures that explicitly impose disproportionate burdens on low level society or disadvantaged groups. Direct Discrimination performed over PD rules from dataset. potentially discriminatory (PD) rules defined as classification rules A,B->C that contain potentially discriminatory item sets A in their premises. A PD rule is does not necessarily result in the discriminatory actions. We use some notion for measuring effect of rule imposes on law or society, the alpha-protection and Strong alpha protections are introduced as a measure of the discrimination effect of a PD classification rule. Proposed method measures relative confidence and support of the rule. The alpha is user defined value set by analyst, in other words it is used for stating the boundary between anti discrimination and discrimination. PD classification rules are taken from dataset[8]

Algorithm (α Protection)
ForEach *PD rule* s.t. *PD* ≠θ*;*
 ForEach X -> C ϵ *PD*
 A = largest subset of X in *Id*
 B = X / A
  γ= *conf*(X -> C)
  β= conf(B -> C) // found in *PND*
  If *elift(γ; β)>α* // *glift(γ; β)>α* for Strong α protection
     output A,B -> C // rule is discriminative
   else
    output A,B -> C // rule is protective
   EndIf
  EndForEach
EndForEach [1]

D. Indirect Discrimination

Indirect discrimination consists of rules or records that do not explicitly show discriminatory item or discriminatory action on society or law. So that inference model is used for combining background knowledge with association rule with minimum confidence (β1, β2) for background knowledge. Where the sensitive attribute does not work it means that there may be other attributes that are highly concern with it. In such a situation the system will use these correlated attributes to indirect discrimination. This is called as red-lining effect. PND Rules are formed from a dataset which should not consist PD item sets. But PND rules may lead to discrimination action. We can find out such situation with the help of additional historical data. In order to measure the disproportionate burdens imposes by

PND rule on law or society, the alpha-protection and strong alpha-protection is introduced as a measure of the discrimination level of a PND classification rule.[8]

Algorithm (α Protection)
 ForEach PND rule s.t. PND≠θ
  ForEach X ->C ϵ PND | there exist X -> A ϵ BK
   γ = conf(X -> C)
    ForEach X -> A ϵ BK order by conf(X -> A) descending
      β2 = conf(X -> A)
      s = supp(X -> A)
   If β2 > 1 -γ or β2 > γ
     ForEach B subset of X s. t B -> C ϵ X->C
        δ= conf(B -> C)
     If β2(1 - αδ) ˏ>=1-γ or β2(1 - α(1 –β2)) >=γ
        V = V [(B; δ)]
       EndIf
     EndForEach
    EndIf
    ForEach (B; δ) ϵ V
    If β2(1 - αδ) >= 1-γ or β2(1 - α(1 -δ)) >=γ
     β1 = s/supp(B -> A)
     If elift(γ;δ)>=α // glift(γ;δ)>=α
      output A,B -> C // is α Discriminative
     Else
      output A,B -> C // is α Protective
     EndIf
    Else
      V = V n f(B; δ) // no need to check it anymore
    EndForEach
   EndIf
  EndForEach
EndForEach [1]

E. Inference Model

Inference model is mathematical model which used for indirect discrimination. In inference model background knowledge used for further processing over PND rules. Because of PND classification rules does not explicitly mention ID item sets. PND rule need to uncover most concened rules that are extracted from background knowledge with the help of inference model. Generally, For PND rules value of alpha is 1 or greater than 1. Indirect discrimination, as modeled in Figure 1 left, required inference model for combining background knowledge with PND classification rules extracted from Dataset [1]

Let D,B -> C be the PND rule
x=γ= conf(D,B -> C) and y=δ= conf(B -> C) > 0
Let A be the PD itemset and let β1, β2 are lower bound such that

conf(A,B -> D) >= β1 and conf(D,B ->A) >= β2 > 0
called :
f(x)= β1/ β2(β2+x-1)

For α Protection

Elift(γ,δ)= { f(x)/y if f(x)>0

0 Otherwise

For Strong α Protection

Glift(γ,δ)= { f(x)/y if f(x)>0
f(1-x)/1-y if f(1-x)>1-y
1 otherwise

We have:
1) For α>= 0, if elift (γ,δ)>=α, then the PD classification rule A,B -> C is α discrimination.
2) For α>=1, if elb (γ,δ) >=δ, then the PD classification rule A,B -> C is Strong α discrimination.[1]

Results

Result of this paper is tested over German credit dataset which consist one thousand transactional data [12]. A Result is generated by proper adjustment of Alpha, minimum support and minimum confidence. From results we observe that, whenever we increase the value of alpha, then number of rules coming under discrimination decreases.
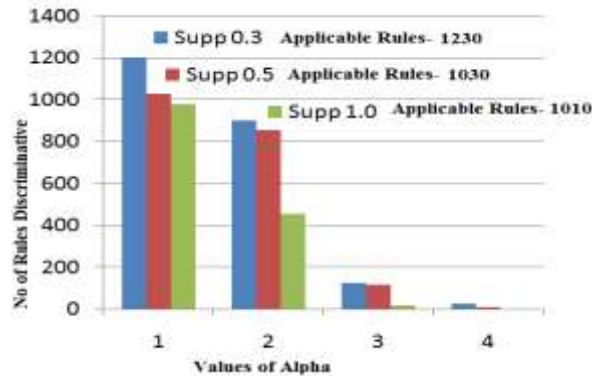

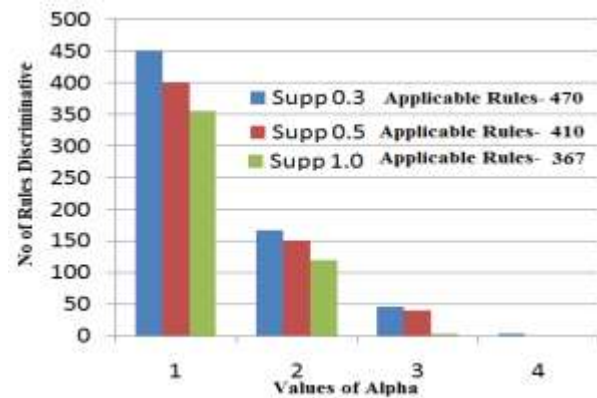**Fig 2. Direct Discrimination for Alpha Protection**

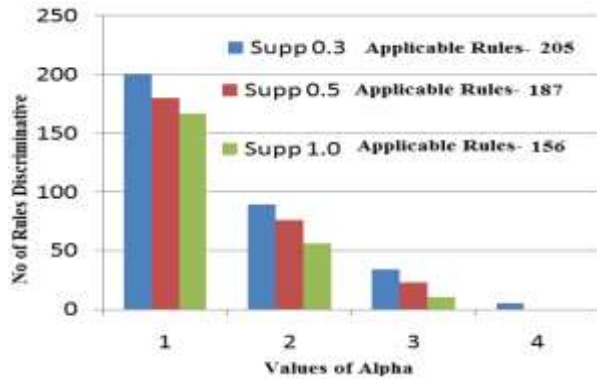**Fig 3. Direct Discrimination for Strong Alpha Protection**

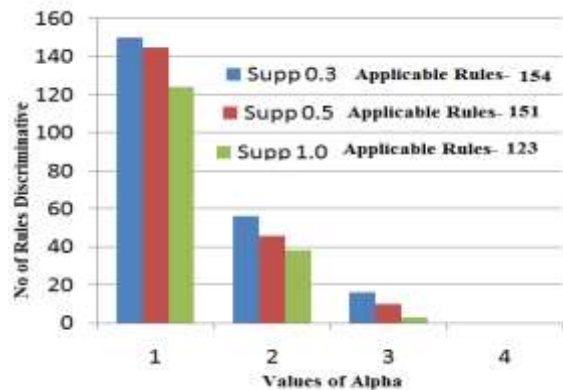**Fig 4. Indirect Discrimination(Alpha Protection)**

Fig 5. Indirect Discrimination(Strong Alpha Protection)

Conclusion And Future Scope

Discrimination identification is very troubled and complex task in social science whenever analyst works over real time dataset. The proposed system introduced here an approach for identification the contexts of discriminatory situations. It provides a knowledge discovery technique for solving Discrimination problem like direct and indirect Discrimination. System makes used of a concept of Potentially Discriminated Item set. System uses parameters such as alpha and beta, and background

knowledge to find direct or indirect discrimination. From result we conclude that whenever increase value of alpha, number of rule susceptible to discrimination decrease. When value of alpha is one then almost all rules are coming under Discrimination. Also hashing technique and Mapped Value in dataset makes algorithm as space and time efficient. Many issue from current context of discrimination-aware data mining open for study in future investigation, both on the technical and on the interdisciplinary side.

Acknowledgment

References

[1] S Salvatore Ruggieri, Dino Perdreschi, Franco Turini, Data Mining for Discrimination Discovery, www.di.unipi.it/ ruggieri/Papers.

[2] E European Union Legislation. 2009, (a) Racial Equality Directive, (b) Employment Equality Directive, http://ec.europa.eu/employmentsocial/ fundamentalrights.

[3] G Goethals, B. 2009, Frequent itemset mining implementations repository, http:// mi.cs.helsink Hunter, R. 1992, Indirect Discrimination in the Workplace, The Federation Press. no. 4, pp. 491?502, Apr. 2005.

[4] K Knop, R. 1986, On proving discrimination: Statistical methods and unfolding policy logics,"Canadian Public Policy 12, [6] P Pedreschi, D., Ruggieri, S., and Turini, F. 2009, Measuring discrimination in socially-sensitive decision records, ,In Proc. of SIAM DM 2009. SIAM, 581592.

[5] T Toon Calders ,Sicco, Three naive Bayes approaches for discrimination- freec lassification,In Proc. of SIAM DM 2009

[6] S Sara Hajian and Josep Domingo-Ferrer, A Methodology for Direct and Indirect Dis-crimination Prevention in Data Mining,2013.

[7] P Pedreschi, D., Ruggieri, S., and Turini, F. 2008, Discrimination-aware data mining,In Proc. of KDD 2008. ACM, 560-568.

[8] S Sara Hajian, Josep Domingo-Ferrer and Antoni Martnez-Ballestei, Discrimination Prevention in Data Mining for Intrusion and Crime Detection,Av. Paisos Catalans 26 - E-43007 IEEE 978-1-4244-9906-9

[9] R R. Agrawal and R. Srikant, Fast Algorithms for Mining Association Rules in Large Databases, Proc. 20th Intl Conf. Very Large Data Bases, pp. 487-499, 1994.

[10]R Hans Hofmann, German Credit Dataset http://archive.ics.uci.edu/ml/datasets/Statlog +.O. A. Mohamed Jafar and R. Sivakumar R.