

The Impact of Data Protection Laws on Credit Granting: A Systematic Literature Review

Abstract

Enforcement of Data Protection Laws ensures financial decisions are taken more fairly and requires institutions to be transparent about their clients' data processing. The objective of this paper is to identify studies that bring evidence of how consumers' personal data has been used in the process of granting credit using Artificial Intelligence (AI) as decision support. Also, whether there is compliance with Data Protection Laws during this process. A Systematic Literature Review was conducted to achieve the objective proposed by this paper. Based on the inclusion and exclusion criteria established, eight studies were relevant. As evidence from selected studies, there is little, or no attention on the demographic aspects of credit applicants, which means the samples used to training AI algorithms may not be well balanced. As a conclusion, we identify the poor compliance with data protection laws may lead to unfavorable outcomes for population minorities.

Keywords— Data Protection Laws; Credit Granting; Discriminatory Algorithm Bias; Artificial Intelligence; Financial Decision support.

I. INTRODUCTION

The current conjuncture that society is facing has been generating a volume of data never seen by mankind. This event brought to everyday life terms such as “big data”, “data processing”, “data privacy” among others. Bringing in concern how personal data are being handled by the institutions that retain them (Executive Office of the President, 2014) (Linner, 2018).

Data Protection Laws are intended to protect the fundamental rights of freedom, privacy and free development of the personality of every human individual in our society. Enforcement of these laws covers all sectors that somehow involve a human being (Brasil, 2018).

The issue concerning the discriminatory bias present in big data processing results has become increasingly evident. Discriminatory algorithmic bias is observed in software from several domains, e.g., face recognition apps, criminal enforcement systems, custody systems (Maddalena Favaretto, Eva De Clercq & Bernice Simone Elger, 2019).

The United States government expresses concern about the harmful treatment of personal data to minorities in sectors that have a major impact on citizens' lives. Industries using Artificial Intelligence (AI) methods as decision support should be transparent about how predictions are made and what data is used to arrive at a decision (Executive Office of the President, 2014).

This paper aims to identify the cadastral demographic attributes used as input variables in AI methods used to support the decision to grant credit to individuals. As well, what resources are used to mitigate discriminatory algorithmic bias.

The methodology chosen to conduct this study was a systematic review of the literature (David Budgen & Pearl Brereton, 2006) supplemented by the snowball method (Skoglund, M. & Runeson, P., 2009), for the correct identification of the demographic attributes contained in the client register.

This paper is organized as follows: Section II describes the research methodology. Section III shows results and discussions. Finally, in Section IV, conclusion and future works are debated.

II. RESEARCH METHODOLOGY

This section aims to describe the methodology applied in the planning, execution and how the results of this Systematic Literature Review were obtained. Following an accurate and rigorous sequence of methodological steps to review the scope literature proposed in this paper. The SRL have well-defined protocols in order to extract, 2 analyze and document results obtained by the steps described below.

Step 1: Identification of studies in libraries.

Step 2: Screening.

Step 3: Eligibility and Inclusion.

A. Identifying the Need for Literature Review

This paper aims to identify in the literature the cadastral demographic attributes used as input variables in AI methods used to support the decision to grant credit to individuals. And if the application of general data protection laws has been used as a resource for processing the registration data of these customers.

The current scenario shows widespread concern about the ability of AI algorithms to be fair when it comes to minorities.

Given this, the search in the literature for evidence that indicate which aspects contribute to the results of applying AI methods to present discriminatory bias is necessary to minimize the damage that such bias may cause to customers of credit concessionaires (Executive Office of the President, 2014).

B. Specifying Research Questions

The search to answer the research questions specified below leads to a methodological review of existing research in the area of Artificial Intelligence as a support to the decision to grant credit to individuals.

Research Question 1 (RQ1): What aspects in the customer record can mislead the AI method, thus causing a discriminatory algorithmic bias? Knowledge about which demographic aspects are used as input variables and how these aspects are treated before to applying an AI method can influence a better sampling of data used in the AI algorithms training process.

Research Question 2 (RQ2): What resources, tools, and techniques the researchers are using to address discriminatory algorithmic bias? Knowledge of the techniques they are using can influence the way lenders deal with discriminatory algorithmic bias.

Research Question 3 (RQ3): How enforcement of Data Protection Laws influences the quality of sampling and the results obtained after applying AI methods?

C. Search Sources

A selection of keywords was made based on research questions above. The keywords were used to form the search strings that were entered in the chosen repositories.

Studies published in Journals, conferences and magazines from 2014 to 2019 were used as source. It was decided to use the period of the last 5 years due to the large amount of work in the area of AI applied to the credit granting to individuals.

This paper focus on costumer's data and how they are treated. That's why terms related to algorithms are not included on research strings, e.g., Algorithm fairness.

To build research strings keywords were identified when the paper theme was analyzed, e.g., credit, bias, artificial intelligence, Data Protection Laws.

The research strings below have been inserted into the following digital repositories: IEEE, ACM, Scopus and Springer.

‘Credit analysis and artificial intelligence’,

‘Credit granting decision and artificial intelligence’,

‘Credit risk analysis’,

‘Data laws and credit risk’,

‘Credit risk analysis and algorithm bias and artificial intelligence’,

‘Algorithm bias and credit’,

‘Discrimination prevention and credit’,

‘Discriminatory algorithm bias’,

‘Discriminatory algorithm bias and credit’,

‘Discriminatory algorithm bias and data protection laws’,

‘Discriminatory algorithm bias and data protection laws and credit’.

D. Selection of primary studies

To select the appropriate studies, the following steps were performed.

Step 1 - Search strings results applied to digital libraries. Three digital libraries were selected - IEEE Xplore Digital Library, ACM Digital Library, Scopus Library and Springer. They were selected because of their multidisciplinary relevance. The search string syntax was the same for all three libraries.

Results included only the title, keywords and abstract of the studies. The automatic search was complemented by the snowball method for the selection of works related to the research questions.

Step 2 - Read titles and abstracts to identify potentially relevant studies. The studies were identified based on the analysis of their titles and abstracts, discarding studies that were clearly irrelevant to the research. When there was any doubt about the inclusion of a study, it was included for further consideration.

Step 3 - Apply Inclusion and Exclusion Criteria: After the previous steps, the sections on introduction, methods, and conclusion were read, and the inclusion and exclusion criteria were applied. If in doubt about the classification, a more complete reading was taken.

Inclusion Criteria's. IC1: Publications must be "journal", "conference" or "magazine." IC2: To be eligible, papers must present studies of AI methods to support the decision to grant credit to individuals. IC3: Studies should contain the description of the data contained in the client records. IC4: If multiple journal articles report the same study, the most recent article should be included.

Exclusion Criteria's. EC1: Studies that do not answer research questions. EC2: Studies that do not present the statements of customer registration attributes. EC3: Previous Publications 2014 (Publications after September 2019 are not included in this SLR because this was the month in which the collection was finalized). EC4: Studies that are in other languages than English or Portuguese and paid access.

E. The automatic search

An automatic search was performed targeting three digital libraries based on a sequence of keywords derived from the search questions.

The review was started with automatic search and as a complement the snowball method was used to identify potentially relevant studies. Snowball consists of following references from one article to another to find other relevant articles (David Budgen & Pearl Brereton, 2006). This was done in the back and forth directions. Snowball back means following the reference list and direct snowball refers to looking at documents that cite what was considered relevant. The apply inclusion and exclusion criteria to all articles founded using this method.

The first results with the automatic search were obtained in January 2019. The studies obtained from snowball were also analyzed for their titles and abstracts. The table 1 presents the results obtained in each digital library and snowball used in the search.

Table 1. Research Sources

Public data source	Search results	Relevant studies
IEEE	325	39
ACM	2.640.640	16
Scopus	0	0
Springer	20.956	0
Snowball	3	0

F. Data Extraction

Based on results of the selection process described in section II.D, the selected primary studies were listed and classified. So that a clear understanding of the objectives, methodologies and results were identified.

Organizing the selected studies as follows: (i) year of publication; (ii) title; (iii) statement of demographic attributes in the client register.

G. Potentially relevant studies

The results obtained in the automatic search and snowball method were included in a dataset. Articles with identical titles, authors, years, and abstracts were considered duplicate and therefore discarded. Articles in other languages than English and Portuguese were discarded. Articles without 4 demonstrations of cadastral attributes were discarded. Paid items have been dropped.

The automatic search in the chosen digital libraries returned a total of 2,640,965 references related to the 11 search strings. The strings were constructed from the keywords referring to the research questions. 8 articles were found by the snowball method, totaling 2,640,973 studies. Among these 2,640,973 results, only 198 articles were really related to the subject of credit granting.

After reading their titles and abstracts, 58 relevant documents were considered. Then read the methodology sections, research questions and the corresponding results. 8 articles were considered relevant for this Systematic Literature Review.

III. RESULTS AND DISCUSSION

This section presents the results founded by this SLR in order to answer the RQ1, RQ2 and RQ3 research questions.

Through the chosen methodology fifty-five studies were found through the automatic search in the libraries IEEE, ACM, Scopus and Springer.

After applying the inclusion and exclusion criteria eight studies were used in this Systematic Literature Review (SLR) table 2.

Table 2. Authors – Title – Year

Related Works	Author, Title	Year
Ramya et al.	R.S.Ramya, S.Kumaresan. ANALYSIS OF FEATURE SELECTION TECHNIQUES IN CREDIT RISK ASSESSMENT	2015
Silval et al.	Cesar Silval, Germano Vasconcelos, Hadautho Barros, Gabriel França. Case-based Reasoning Combined with Neural Networks for Credit Risk Analysis	2015

Gorzalcnazy et al.	Marian B. Gorzalczany, Filip Rudzinski. An improved multi-objective evolutionary optimization of data-mining-based fuzzy decision support systems	2016
Chen et al.	Haojie Chen, Minghui Jiang, Xue Wang. Bayesian Ensemble Assessment for Credit Scoring	2017
Byanjankar at al.	Ajay Byanjankar. Predicting Credit Risk in Peer-to-Peer Lending with Survival Analysis	2017
Okesola et al.	Olatunji J. Okesola, Kennedy O. Okokpujie, Adeyinka A. Adewale, Samuel N. John, Osemwegie Omoruyi. An improved Bank Credit Scoring Model A Naïve Bayesian Approach	2017
Saia at al.	Roberto Saia and Salvatore Carta. A Fourier Spectral Pattern Analysis to Design Credit Scoring Models	2017
Zhang at al.	Han Zhang, Kuisheng Wang. Research on Customer Credit Demand Forecasting Based on Big Data Analysis	2018

Through the snowball were identified 3 papers, but after inclusion and exclusion criteria were applied none of the papers was relevant for this literature review.

Many of these studies discuss the AI algorithms used in the context of credit granting to individuals and how to improve them. Although there are many studies addressing AI methods, none of studies founded focus on the dataset or how the data were treated.

Thus, the contributions of this work are the identification of the lack of proper treatment in the datasets used in the studies founded, standardization of the input variables that serve as a basis for credit 5 grant analysis and inadequacy regarding the Data Protection Laws. Few papers have talked about the demographic attributes used and no papers use Data Protection Laws as a resource in the credit granting process.

In the following we presents the results founded by this SLR in order to answer the RQ1, RQ2 and RQ3 research questions.

A. Demographic Attributes in Customer Registration

In this item we use the founded studies to respond to RQ1. Which aspects in the client register can lead the AI method to error, thus causing a discriminatory algorithmic bias?

The eight studies selected do not completely present the demographic attributes contained in the client register. On the other hand, they discuss some input variables used in AI methods.

There is no standard as to which attributes are used as the basis for credit grant analysis. This way each institution uses different criteria in the customer analysis.

B. Tools and Resources Used

In this item we use the studies founded to respond to RQ2. Which resources, tools, and techniques researchers are using to address discriminatory algorithmic bias?

This SLR demonstrated that the founded studies focus on algorithms and how to improve them to make them more accurate and thus more mathematically fair. The only treatment studies describe is the applies of separation to sampling in two groups: "Good Payers" and "Bad Payers". However, no treatment is observed that guarantees fair sampling for minority populations. Thus, the datasets are full of discriminatory bias even before applying the AI method to these datasets.

C. Data Protection Laws

In this item the studies found are analyzed to respond to RQ3. How enforcement of Data Protection Laws influences the quality of the samples and the results obtained after the application of AI methods?

Among the eight studies addressed by this SLR none apply the Data Protection Laws in their methodologies. From the dataset to the results there is no compliance with the data processing that Data Protection Laws require.

In all eight studies datasets were obtained from online repositories and do not discuss which personal data are contained in the datasets and whether they are in accordance with legislative requirements.

IV. CONCLUSION AND FUTURE WORK

This study provides a detailed overview of the state-of-the-art in credit grant to individuals. It also brings the discussion about the importance of compliance with Data Protection Laws at all stages of the credit granting process.

To achieve these objectives a Systematic Literature Review was performed by investigating the most recent studies present in some of the most expressive virtual libraries today.

The results of this study indicate that:

- There is a normalization lack in the attributes that serve as the basis for the credit granting to individuals' analysis.

- There is no compliance with the Data Protection Laws in the credit grant analysis process.

- There is no indication that the datasets used for AI methods training are standardized on client demographic aspects. Nor should sampling be treated in a such way that there is a correct representation of population minorities.

We considered the evidence provided by the eight studies published in digital libraries that allowed this study to answer the proposed research questions.

The three research questions were answered partially. This shows that the theme proposed by this SLR needs to be explored and demonstrates a lack of studies addressing the discriminatory algorithmic bias in the credit granting sector.

In addition, the non-compliance with Data Protection Laws in the eight studies addressed by this SLR corroborates the concern that the way citizens' personal data has been manipulated is a factor in the existence of the discriminatory algorithm bias arising from the use of AI methods as decision support.

Foments as future works:

- Enforcement of General Data Protection Laws in datasets containing the demographic attributes of financial institution customers.

- Creation of a taxonomy that standardizes the criteria that serve as the basis for the analysis of credit granting to individuals.

References

Ajay Byanjankar (2017). Predicting Credit Risk in Peer-to-Peer Lending with Survival Analysis. Available at: <https://ieeexplore.ieee.org/document/8280927> [Accessed 6/09/2019].

Brasil (2018). Lei 13709. Available at: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/L13709.htm [Accessed 07/05/2019].

Cesar Silva, Germano Vasconcelos, Hadautho Barros, Gabriel França (2015) Case-based Reasoning Combined with Neural Networks for Credit Risk Analysis. Available at: <https://ieeexplore.ieee.org/document/7280738> [Accessed 6/3/2019].

David Budgen and Pearl Brereton. 2006. Performing systematic literature reviews in software engineering. In Proceedings of the 28th international conference on Software engineering (ICSE '06). ACM, New York, NY, USA, 1051-1052. DOI: <https://doi.org/10.1145/1134285.1134500>.

Executive Office of the President. BIG DATA: SEIZING OPPORTUNITIES, PRESERVING VALUES. Available at: https://obamawhitehouse.archives.gov/sites/default/files/docs/big_data_privacy_report_may_1_2014.pdf [Accessed 25/05/2019].

Han Zhang, Kuisheng Wang (2018). Research on Customer Credit Demand Forecasting Based on Big Data Analysis. Available at: <https://dl.acm.org/doi/abs/10.1145/3207677.3277994> [Accessed 6/10/2019].

Haojie Chen, Minghui Jiang, Xue Wang (2017). Bayesian Ensemble Assessment for Credit Scoring. Available at: <https://ieeexplore.ieee.org/document/8078596> [Accessed 1/07/2019].

Maddalena Favaretto, Eva De Clercq and Bernice Simone Elger. Big Data and discrimination: perils, promises and solutions. A systematic review (2019). Available at: <https://journalofbigdata.springeropen.com/articles/10.1186/s40537-019-0177-4> [Accessed 9/05/2019].

Marian B. Gorzalczany, Filip Rudzinski (2016). An improved multi-objective evolutionary optimization of data-mining-based fuzzy decision support systems. Available at: <https://ieeexplore.ieee.org/document/7737970> [Accessed 20/05/2019].

Olatunji J. Okesola, Kennedy O. Okokpujie, Adeyinka A. Adewale, Samuel N. John, Osemwegie Omoruyi (2017). An improved Bank Credit Scoring Model A Naïve Bayesian Approach. Available at: <https://ieeexplore.ieee.org/document/8560791> [Accessed 6/09/2019].

Rachelle Linner. Algorithms of Oppression: How Search Engines Reinforce Racism by Safiya Umoja Noble. New York, NY: New York University Press, 2018, 256 pp. Available at: <https://ieeexplore.ieee.org/document/8664549> [Accessed 12/02/2019].

Roberto Saia, Salvatore Carta (2017). A Fourier Spectral Pattern Analysis to Design Credit Scoring Models. Available at: <https://dl.acm.org/doi/abs/10.1145/3109761.3109779> [Accessed 6/10/2019].

R.S.Ramya, S.Kumaresan (2015) ANALYSIS OF FEATURE SELECTION TECHNIQUES IN CREDIT RISK ASSESSMENT. Available at: <https://ieeexplore.ieee.org/document/7324139> [Accessed 3/04/2019].

Skoglund, M.; Runeson, P. Reference-based search strategies in systematic reviews. In Proceedings of the 13th international conference on Evaluation and Assessment in Software Engineering, Swindon, UK, 20– 21 April 2009.