Exploration of Artificial Intelligence & Machine Learning Algorithm Bias, Legal and Ethical Topics in Online Classes

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ABSTRACT
Artificial intelligence (AI) and machine learning (ML) has seen a substantial increase in corporate investment and interest. With this interest has come an increase in AI related course material. The use of AI algorithms and potential bias comes with the prospective for legal and ethical issues. This paper explores the available course material in the massive open online courses (MOOC) format for education in AI/ML algorithm bias, legal and ethical issues. A survey targeting the OMSCS community gathered information on available education in the topics along with corporate interest. Education in these topics should be available as the technology continues to be used to make key decisions within public and private institutions.

Author Keywords
Artificial intelligence; machine learning; algorithm bias; algorithm legal issues; algorithm ethical issues; Massive Open Online Courses; MOOC; online learning

ACM Classification Keywords
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INTRODUCTION

Artificial intelligence (AI) and machine learning (ML) has seen an increase in investment from industries worldwide. In 2018, there will be an estimated $19.1 billion invested in AI systems. That is a 54.2% increase from 2017. IDC predicts AI spending to increase to $52.2 billion by 2021 [1]. This investment and interest in AI is increasing at a phenomenal pace with little indication it is going to slow down in the short term. Deloitte anticipates the number of AI/ML projects coming from industry to double in the next year [2].

The number of AI/ML courses has increased along with interest in current offerings [3]. The investment in AI/ML from industry would appear to correlate with the increase in interest in AI/ML related courses. The need to train and find employees with the skills necessary to create the AI/ML projects may have helped drive the increased interest in related courses.

There is risk in those creating and interpreting AI/ML algorithms not understanding algorithm bias. Bias in this context is the bias found in datasets and how the algorithms results are interpreted as part of the decision processes that utilize those results. These algorithms are making decisions, biased in some cases, which have a large and lasting impact on people's lives financially through loan applications [4] and criminal sentencing [5]. There is a rapid industry investment in AI/ML along with courses teaching the subject matter; however, Is AI/ML algorithm bias along with legal and ethical issues of their use being taught to bring awareness of the potential dangers? Are employers asking candidates in AI/ML related jobs their knowledge of these topics when screening potential hires?

Bias in algorithms can be found in various forms and contain subtle differences in definition. AI/ML algorithms require data to be modeled from in the form of datasets. Bias in the datasets can come from the type (images, language, etc.), how the dataset was sampled, features of the dataset used in the algorithm modeling, and correlations of the features. Another form of bias is in how the models fit the underlying datasets they are modeled from. The last form of bias to be explored is in the cognitive interpretation of the results of the algorithms.

Input Data Bias

Recognition

Here we are defining recognition datasets as image data used for recognition algorithms. Image data can suffer from various forms of bias such as: selection, capture, category/label, and negative set biases. A method to detect and measure recognition data bias is to perform cross-dataset generalization. This technique trains the recognition algorithm on one dataset but tests on another one. This isn't the same as slicing up a homogenous dataset into training, verification, testing sets. This measuring technique helps to detect how well the dataset allows for generalization of the target image data [6]. An example of biased image datasets can be seen in some facial recognition software that can't classify certain races correctly due to the algorithm being trained on a dataset that disproportionally represents a certain race [7].

Sample

AI/ML datasets can be created with sampling selection bias due to the dataset not correctly representing the underlying populations [8]. This form of bias can be a result of non-randomized sample selection from an underlying dataset caused by a defect in the sample selection process. Sample selection bias is often detected using bivariate and multiple regression methods [9].

Features

Bias can be introduced from features of the dataset that should be omitted prior to the algorithms modeling the data. An example of bias introduced from features can be discrimination of certain minority or disadvantaged groups. Direct discrimination can be features explicitly mentioning those groups (i.e. race, gender, sexual orientation). Indirection discrimination can be features that may not explicitly mentioned those groups but produce results that do produce discriminatory decisions. Direct and indirect bias detection and measurement can be done through identifying a set of α-discriminatory (direct) and redlining (indirect) rules. Proposed processes also exist to measure the success of removal of direct and/or indirect discriminatory bias for a dataset. Four metrics used to make these measurements are direct discrimination prevention degree (DDPD), direct discrimination protection preservation (DDPP), indirect discrimination prevention degree (IDPD), and indirect discrimination protection preservation (IDPP) [10].

Word Embedding

There can be bias introduced into an algorithm through word embedding. Word embedding encode words into a low dimensional continuous space to preserve semantic and syntactic information [11]. For example, gender bias is often undesirable and can be introduced through word embedding. Identifying the gender subspace is a technique that can help identify direct and indirect gender bias. Measuring the direct bias in gender takes the identification of words considered gender-neutral and comparing those against the formulated gender subspace; however, this does not capture indirect gender bias. Indirect gender bias detection requires more subtle relationships between words to be identified and more vector comparisons to the gender subspace. These methods may be able to be expanded to other types of bias such as racial, ethnic and cultural stereotypes [12].

Algorithm Design Bias

Bias defined in algorithmic design is the error from flawed assumptions of the algorithm itself. AI/ML algorithms are generally trained, verified and tested with datasets. The algorithms are modeled from a training set that is a subset generated from the dataset. These models are then verified and tested from other subsets of the total dataset. The sizes of these various datasets are not always predetermined and depend on the model, dataset size, and other factors [13]. When bias in this context is considered high the algorithm can miss applicable associations and is considered to underfit the data. Bias and its counterpart variance can be interpreted graphically or automatically through software packages to find a tradeoff between the two metrics that allows for a model complexity of acceptable accuracy [14]. Measuring and detecting potential bias in the sampling of the training, verification, and testing subsets can be done by calculating various metrics of the resulting model. Those metrics can include accuracy, precision, recall, F1 score, ROC curves [15].

This form of bias is typically taught in AI/ML courses, but it is not the form of bias the paper wishes to identify as being taught. The bias-variance tradeoff does not focus on the appropriateness of the input features or how the results of the algorithm are used. The definition is added to provide context to the typically taught term of bias in AI/ML courses.

Result Interpretation Bias

Biased interpreted results from AI/ML algorithms can be caused by the datasets and algorithm design; however, even with correct data and proper algorithms their interpretation can be cognitively biased. This form of bias of the results can be classified into different forms that distort the interpretation of the algorithm's results. There is no generally accepted measure of interpretability of AI/ML model results; however, there is research into the concept of plausibility to measure interpretability [16].

There can be difficulties in measuring bias by those who didn't train and create the algorithms. Discovering bias in algorithms for these cases can be difficult due to many of the algorithms being proprietary and black boxes (Savage, 2016). There are some proposed methods on measuring bias in algorithms where the algorithm is a black box and the only way to measure it is by feeding the algorithm data and interpreting the results. Pitoura distinguishes bias as two types: user or content. User bias is defined as bias against users receiving the information while content bias refers to bias in the information sent to the users. His team's bias measuring system claims bias if the measurements exceed a small threshold error value [17].

PROBLEM STATEMENT

The research hypothesis assets AI/ML algorithm bias, legal and ethical issues are not being taught by MOOC educational vehicles and employers are not anticipating new hires to have this knowledge.

The research is also looking to identify any correlation between questioning new hires on AI/ML algorithm bias, legal and/or ethical knowledge and if the topics are being presented to students. If those topics are not being taught, then there might be a correlation to why job candidates are not being asked by employers. This correlation may stem from those undertaking the hiring not understanding the topics themselves as they have no or limited knowledge in the topics. This could produce a feedback loop that is preventing educational opportunities from happening. If employers are not demanding employees to be educated on these topics, then this may cause educational institutions to omit topics in their curriculum as no demand has been expressed.

Finally, the research would like to identify any desire to include AI/ML algorithm bias, legal and ethical education into a MOOC course. If there proves to be a lack of education in the topics from current course offerings and there is a demand for it, this could provide proof that new courses could should be created to fill this demand.

MOOC RESEARCH FOR EXISTING COURSES IN AI/ML ALGORITHM BIAS, LEGAL OR ETHICAL TOPICS

Information gathered from a list of MOOC course providers including the George Institute of Technology's Online Master of Science in Computer Science (OMSCS) program (see Appendix) provided a minimal amount of information regarding algorithm bias, legal and ethical issue education. The following table shows the total courses for each provider and the number of classes that could be determined through publicly available information to provide education in bias, ethical and legal issues.

MOOC Provider	Total Courses	Bias, Legal or Ethical Education Found in Course Description
EDX	42	2
OMSCS	9	0
Coursera	76	0
Udemy	66	0
TOTALS	**193**	**2**

Table 1. Number of AI/ML related courses researched, and number found to contain a reference to algorithm bias, legal or ethical issues.

There were only 2 courses that demonstrated they taught algorithm bias, legal or ethical issues out of 193 total courses. A major limitation to this research was a cursory overview of each course could only be obtained from publicly available syllabi and course descriptions. To provide an accurate evaluation one would have to enroll in each course to view the content. Many of these require a fee to do so and time limitations also made this restrictive. The survey was created to help identify if the content of MOOCs were providing algorithm bias, legal and ethical education.

OMSCS SURVEY RESEARCH

The survey served the purpose of helping to determine if AI/ML algorithm bias, legal and ethical topics are being taught in various MOOCS. The research separated MOOCs and the OMSCS program by asking about both separately in the survey. The questions regarding employers look to find some correlation between employer inquiry and education in the topics.

Target Audience

The target audience of the survey was the OMSCS student body. The rational for using the OMSCS student body was based on these assumptions:

1. Easy access through available technologies: Piazza and Slack.
2. Currently taking OMSCS classes or have graduated
3. Have a higher than average likelihood of previously taking traditional AI/ML courses (undergraduate, graduates degrees)
4. Have a high likelihood of taking AI/ML MOOC courses outside of OMSCS (Udacity, Coursera, EDX, Udemy)
5. Have a higher than average likelihood of being in a AI/ML occupational field

Survey Results

The survey description stated:

> Bias in this survey is not defined as the bias-variance trade-off that is typically taught in Artificial Intelligence (AI) / Machine Learning (ML) algorithmic design. Bias in the input to the algorithm (data sets in most cases) is defined as using certain features of the input data that can introduce bias into the algorithmic model. For example, using gender, race, or age to train a model where using those features can introduce legal or ethical issues. Bias in the algorithmic results interpretation is defined as cognitive biases by the interpreter.
>
> Legal and ethical issues in algorithmic bias encompasses any legal or ethical ramifications to the individual or company that creates, deploys, or interprets the results of the algorithms. This also includes any discussions on laws or policies that can govern the creation or use of AI/ML algorithms.

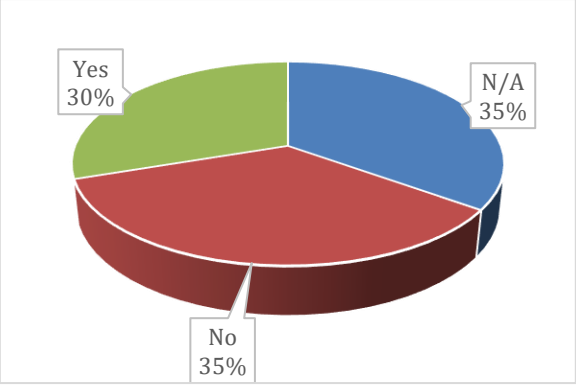

Figure 1. Question 1: If you have taken any AI/ML MOOC courses outside of OMSCS have any discussed how to identify features in the input data that could introduce bias?

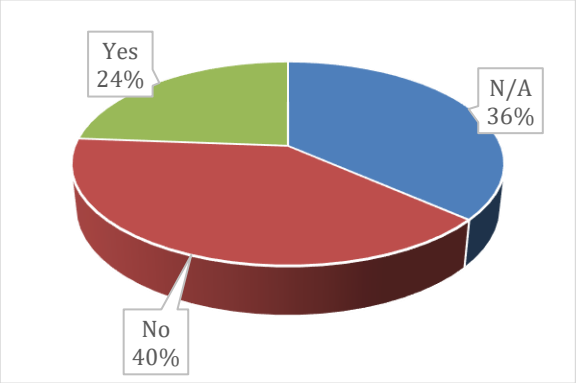

Figure 2. Question 2: If you have taken any AI/ML MOOC courses outside of OMSCS have any discussed how to identify bias when interpreting the AI/ML algorithm's results?

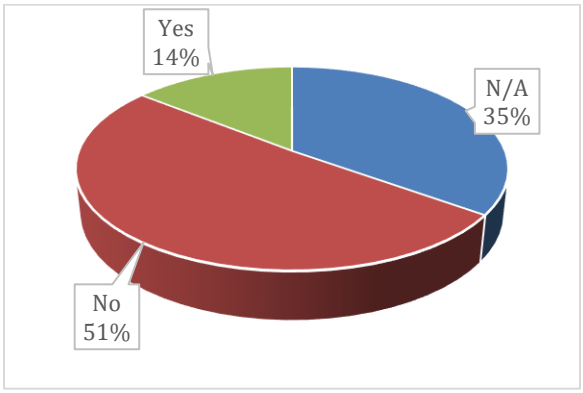

Figure 3. Question 3: If you have taken any AI/ML MOOC courses outside of OMSCS have any discussed legal or ethical implications of algorithm bias?

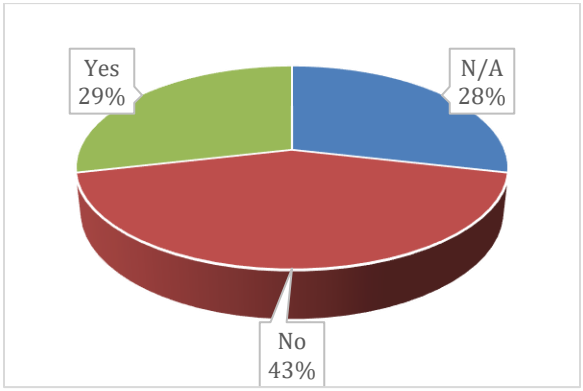

Figure 4. Question 4: If you have taken any AI/ML OMSCS courses have any discussed how to identify features in the input data that could introduce bias?

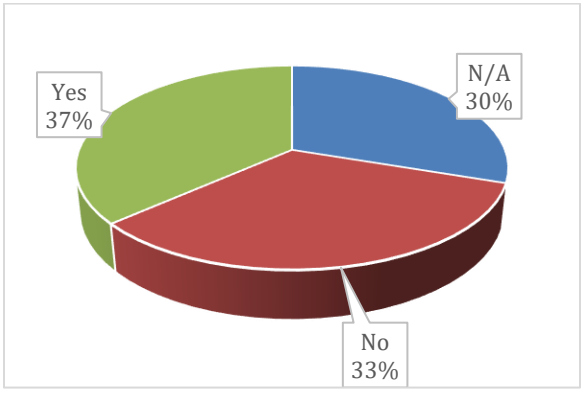

Figure 5. Question 5: AI/ML OMSCS courses have any discussed how to identify bias when interpreting the AI/ML algorithm's results?

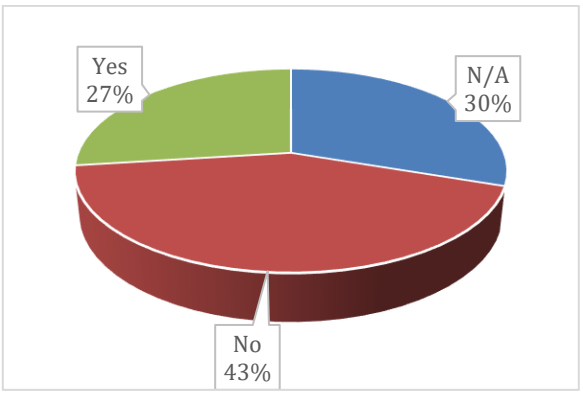

Figure 6. Question 6: If you have taken any AI/ML OMSCS courses have any discussed legal or ethical implications of algorithm bias?

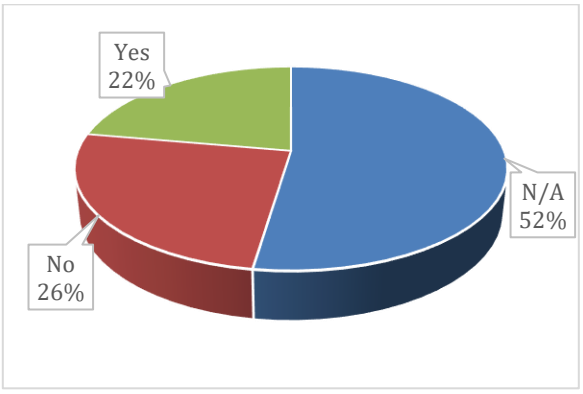

Figure 7. Question 7: If you have been interviewed for an AI/ML related position, were you asked any questions associated with algorithm bias (input data or results interpretation)?

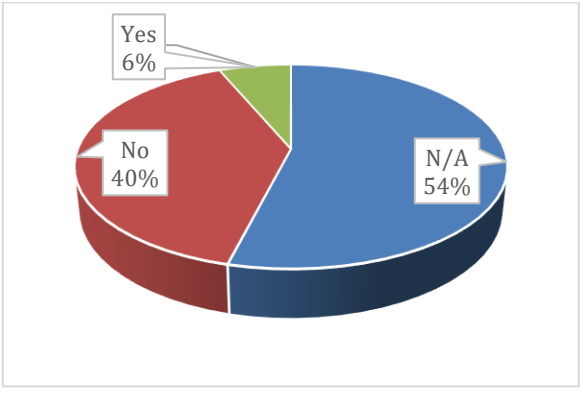

Figure 8. Question 8: If you have been interviewed for an AI/ML related position, were you asked any questions associated with legal or ethical issues regarding AI/ML algorithms?

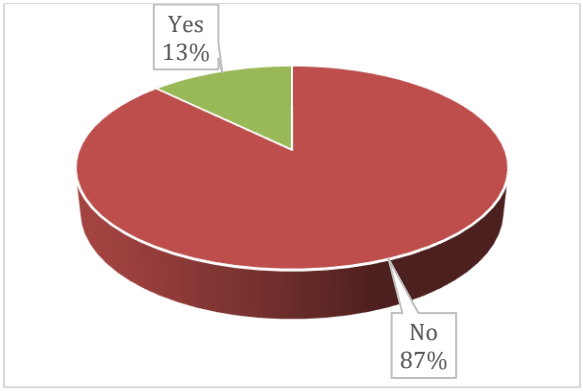

Figure 9. Question 9: Has any employer provided training regarding AI/ML algorithm bias?

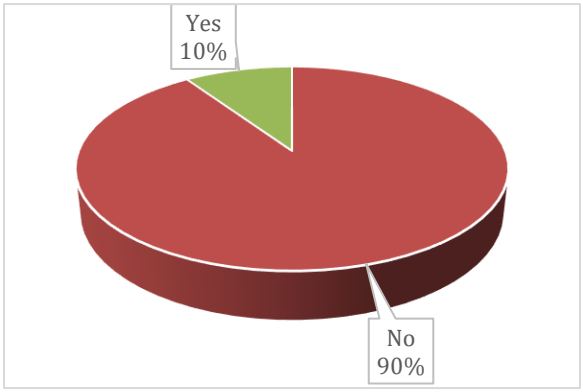

Figure 10. Question 10: Has any employer provided training regarding legal or ethical implications of AI/ML algorithms?

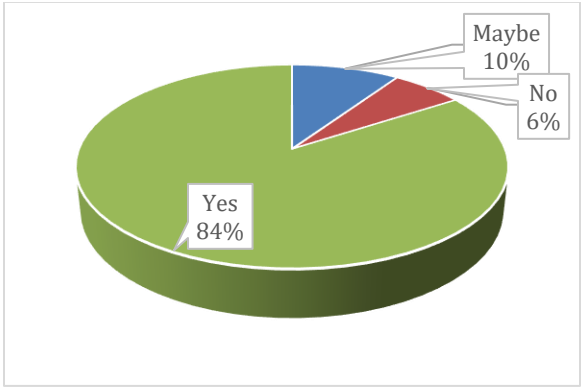

Figure 11. Question 11: Would you be interested in taking a course that teaches bias in AI/ML algorithm input data and results interpretation?

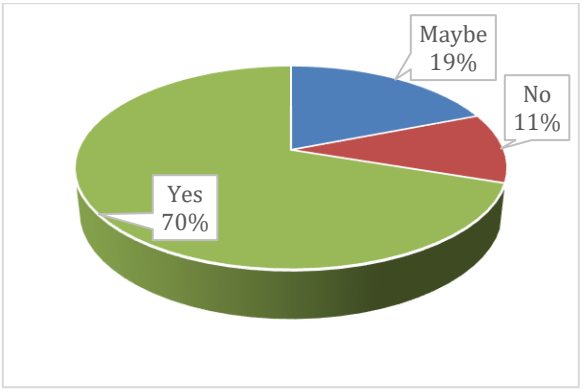

Figure 12. Question 12: Would you be interested in taking a course that teaches AI/ML algorithm legal and ethical issues?

Key Takeaways

There were 63 respondents to the survey from the OMSCS community. The survey results displayed the N/A answers for completeness and demonstrating the proportion of respondents with either yes or no answers to the overall total.

The responses appear to support the following assertions:

1. Respondents are seeing AI/ML algorithm bias in the input data being discussed in both OMSCS and other MOOC programs.
2. Respondents are seeing AI/ML algorithm bias in the interpreted results being discussed in both OMSCS and other MOOC programs.
3. Respondents are seeing AI/ML algorithm bias ethical and legal issues being discussed in both OMSCS and other MOOC programs; however, to a lesser degree than the previous two points.
4. Employers have been asking about algorithm bias topics in interviews and providing some level of training to a subset of the respondents.
5. There is a substantial interest in courses that teach AI algorithm bias, legal and ethical topics.

In the questions involving algorithm input data bias and results interpretation there was a higher percentage of responses stating that they have experienced the topics in courses, employer engagement (interviews and corporate training) than those that involved algorithm bias legal and ethical topics. Less education in legal and ethical issues may stem from these possible suppositions:

- Bias, ethical and legal education can fall into the realm of philosophy. Considering these courses, OMSCS in particular, are computer science focused, topics that drift into philosophical discussions might be out of course scope.
- A lack of interest from employers in the topic has an influence on the creation of course content due to low demand.

- A lack of course content in ethical and legal bias issues has a trickle-down effect. If individuals are not educated in a topic then they would not know to ask those questions of people, they may subsequently hire and develop corporate training for.
- The content may be present, but individuals may be avoiding taking those courses due to lack of interest.
- Asking questions about them due to lack of interest or a sense of being removed from the consequences of the legal and ethical implications.

SUPPLEMENTAL SURVEY

A second survey was conducted with the intent of finding specific examples of MOOCs that had taught algorithmic bias, legal and/or ethical issues based on the respondent's experience. The survey description was that same as the previous survey for clarification.

The survey asked the following questions:

1. If you have taken any AI/ML courses (in OMSCS or another MOOC provider) and they have discussed algorithm bias in the input data or results interpretation please list the provider and course name (For example, OMSCS - Machine Learning, OMSCS - Artificial Intelligence, EDX - Python for Machine Learning, etc.)
2. If you have taken any AI/ML courses (in OMSCS or another MOOC provider) and they have discussed algorithm bias legal or ethical issues please list the provider and course name (For example, OMSCS - Machine Learning, OMSCS - Artificial Intelligence, EDX - Python for Machine Learning, etc.)

MOOC Provider	Course Title	Bias	Ethical / Legal
Coursera	Machine Learning	3	2
EDX	Python for Machine Learning	1	1
Google	Introduction to Machine Learning		
OMSCS	Artificial Intelligence	1	1
OMSCS	Machine Learning	11	8
OMSCS	Knowledge-Based Artificial Intelligence: Cognitive Systems	6	9
OMSCS	Big Data for Health	1	1
OMSCS	Reinforcement Learning	3	2
OMSCS	Machine Learning for Trading	4	3
OMSCS	AI for Robotics	3	2
Udacity	Deep Learning	1	1
Udacity	AI Foundations	1	1

Table 2. Survey respondents asked for specific courses that taught AI/ML algorithm bias, legal and/or ethical topics

The results from the survey, Table 2, display twelve course that either taught AI/ML algorithm bias and/or ethical legal issues with the algorithms. The majority were from the OMSCS program which would be expected as the survey was conducted against the OMSCS student body. The results showed some discrepancies where some respondents stated a class discussed algorithm bias but did not discuss legal and ethical issues. The reverse was also true. This can be seen most clearly in the Machine Learning and Knowledge-Based Artificial Intelligence: Cognitive Systems OMSCS courses. The cause for the discrepancies could be a lack of understanding of what the survey was asking. It also could have been an issue of when the respondent took the course. Courses can change content over time, so these topics could have been added or dropped based on when the student took the course. From the author's experience in taking eight of the above courses, none of the topics were taught; however, like previously stated the courses could have been updated since then.

SURVEY LIMITATIONS & ISSUES

The disjointed nature of the two surveys did not provide as much clarity into the research as it was hoped. The initial survey could have been more accurate if it originally included the content from the supplemental survey. This would have potentially allowed better analysis of the results.

Bias defined in the bias-variance tradeoff that is prevalent in AI/ML courses might be causing respondent confusion and inflating the respondent answer for the affirmative for bias, legal and ethical education. A more accurate assessment would have been contacting the instructors of the courses or acquiring transcripts of videos and course material from those course instructors or institutions willing to provide that information.

The survey may be misleading with respect to employer engagement in the topics. The survey may be skewed due to a low number of respondents interviewing for or being employed in an AI/ML related occupation. A better approach to answer this question would have been to acquire a larger sample from respondents who fall into that category.

OPPORTUNITIES FOR ADDITIONAL RESEARCH

The respondents stated they would like to see courses in AI/ML algorithm bias (Figure 11) and legal and ethical issues (Figure 12). If the assumption is the respondents understood the context and definition of AI/ML algorithmic bias as defined in the survey description there is an opportunity for MOOC course creation to teach these topics. There could also be an opportunity for corporate training on the topics to better educate employees. This may result in legal exposure to companies by ensuring their employees understand the legal implications of AI/ML algorithm creation.

CONCLUSION

The survey results imply that AI/ML algorithm bias, legal and ethical issues are being covered in some courses. This is an encouraging sign that educators are providing some coverage of the topics as the interest for the technology has swiftly grown. This conclusion presupposes the respondents accurately understood AI/ML algorithm bias, legal and ethical issues as defined in the paper and survey.

The survey does provide some insights into employer interest in the topics. There was not a large percentage of acknowledgement that employers are actively seeking out employees with knowledge of algorithm bias. There was also not a substantial number of employers providing that form of training to employees.

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APPENDIX

This lists all the MOOCs that were looked at to determine if they teach algorithm bias, legal and/or ethical issues. The extent that they were looked at did not progress past the description of the course that was publicly available. The MOOC providers that were researched were EDX, Coursera, Udacity, Udemy and the OMSCS program.

Provider	Course Title	URL
EDX	Reinforcement Learning Explained	https://www.edx.org/course/reinforcement-learning-explained-2
EDX	Natural Language Processing	https://www.edx.org/course/natural-language-processing-1
EDX	Computer Vision and Image Analysis	https://www.edx.org/course/computer-vision-image-analysis-1
EDX	Ethics, Law and Data Analytics	https://www.edx.org/course/ethics-law-data-analytics-1
EDX	Microsoft Professional Capstone: Artificial Intelligence	https://www.edx.org/course/microsoft-capstone-artificial-intelligence
EDX	Introduction to Data Science	https://www.edx.org/course/introduction-to-data-science-3
EDX	Implementing Predictive Analytics with Spark in Azure HDInsight	https://www.edx.org/course/implementing-predictive-analytics-spark-azure-hd-insights-2
EDX	Dynamic Programming: Applications In Machine Learning and Genomics	https://www.edx.org/course/dynamic-programming-applications-machine-uc-san-diegox-algs205x
EDX	Essential Math for Machine Learning: Python Edition	https://www.edx.org/course/essential-math-for-machine-learning-python-edition
EDX	Essential Math for Machine Learning: R Edition	https://www.edx.org/course/essential-math-machine-learning-r-1
EDX	Deep Learning with Python and PyTorch	https://www.edx.org/course/deep-learning-with-python-and-pytorch
EDX	Deep Learning Fundamentals with Keras	https://www.edx.org/course/deep-learning-fundamentals-with-keras
EDX	Machine Learning with Python: A Practical Introduction	https://www.edx.org/course/machine-learning-with-python
EDX	Artificial Intelligence (AI)	https://www.edx.org/course/artificial-intelligence-ai-columbiax-csmm-101x-4
EDX	Machine Learning	https://www.edx.org/course/machine-learning-columbiax-csmm-102x-4
EDX	Data Science: R Basics	https://www.edx.org/course/data-science-r-basics
EDX	Statistical Thinking for Data Science and Analytics	https://www.edx.org/course/statistical-thinking-for-data-science-and-analytics
EDX	Machine Learning for Data Science and Analytics	https://www.edx.org/course/machine-learning-for-data-science-and-analytics
EDX	Big Data Analytics	https://www.edx.org/course/big-data-analytics-adelaidex-analyticsx

EDX	Big Data Fundamentals	https://www.edx.org/course/big-data-fundamentals-adelaidex-bigdatax
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EDX	Applied Deep Learning Capstone Project	https://www.edx.org/course/applied-deep-learning-capstone-project
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EDX	Data Science: Machine Learning	https://www.edx.org/course/data-science-machine-learning

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OMSCS	CS 6476: Computer Vision	http://www.omscs.gatech.edu/cs-6476-computer-vision
OMSCS	CS 6601: Artificial Intelligence	http://www.omscs.gatech.edu/cs-6601-artificial-intelligence
OMSCS	CS 7637: Knowledge-Based Artificial Intelligence: Cognitive Systems	http://www.omscs.gatech.edu/cs-7637-knowledge-based-artificial-intelligence-cognitive-systems
OMSCS	CS 7641: Machine Learning	http://www.omscs.gatech.edu/cs-7641-machine-learning
OMSCS	CS 8803-003 Special Topics: Reinforcement Learning	http://www.omscs.gatech.edu/cs-8803-special-topics-reinforcement-learning
OMSCS	CS 7646: Machine Learning for Trading	http://www.omscs.gatech.edu/cs-7646-machine-learning-trading
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OMSCS	CSE 8803 Special Topics: Big Data for Health Informatics	http://www.omscs.gatech.edu/cse-8803-special-topics-big-data-for-health-informatics
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