Prospectus

Automated Machine Learning Technique to Detect Cobb Angle Among Scoliosis Patients

(Technical Paper)

Reskilling Programs: Giving Lower-Income Adults the Opportunity to Thrive in an Ever-Increasing Digital Skills market

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

In my technical report I will take a look at the detection of Adolescent Idiopathic Scoliosis (AIS). Scoliosis among adolescents is diagnosed by measuring the spine's Cobb Angle. Current methods involve physicians manually tracing the angle, a procedure that is time consuming and can lead to human error. My team is devising a convolutional neural network machine learning algorithm that will train based upon a set of spinal x-ray images with known Cobb Angles. This algorithm will be able to detect spinal Cobb angle faster and with more accuracy, ultimately increasing patient throughput within hospitals.

In my STS Thesis, I will explore technology's increasing presence in the economy of Boston, Massachusetts, and the threats that this poses for lower-income American workers. I will analyze how corporations, government systems, and educational institutions can play a part in creating job reskilling programs that will allow these workers to regain a competitive edge in today's economy.

Technical Report

Automated Machine Learning Technique to Detect Cobb Angle Among Scoliosis Patients

Adolescent Idiopathic Scoliosis (AIS) affects up to 3% of children in the U.S., and it is the most common form of spinal deformation (Genetics Home Reference, n.d.). This disease develops in late childhood and results in abnormal curvature of the spine. The cause of this disease is unknown, so, Minimally Invasive Spinal Technologies (MIST), LLC is looking to correct the spine once the disease presents itself (Genetics Home Reference, n.d.). Currently, scoliosis is defined for spines with at least a 10_o Cobb angle (Bunnell, 2005). The Cobb angle is measured by hand from an X-ray of the patient's spine, as shown in Figure 2 from Safari et. al (Safari, Parsaei, Zamani, & Pourabbas, 2019). Currently the process is prone to error as the doctor will use a ruler, pencil, and protractor to make the measurement. This process also takes up time that the doctor could be using to tend to other patients (Safari et al., 2019).

MIST, LLC has identified a need for an automated way for doctors to calculate Cobb angle from a spinal X-ray image. Thus, **we plan to build a Convolutional Neural Network algorithm that uses machine learning techniques to recognize spinal X-ray image patterns to automatically determine Cobb angle among patients at risk for Adolescent Idiopathic Scoliosis.** Machine learning will allow the program to recognize patterns amongst large sets of data without being explicitly programmed to do a certain task ("Machine Learning," n.d.), avoiding the innate human error present in current methods. By giving our program multiple images and their correlated Cobb angles, the program will become iteratively more accurate (SHARMA, 2019), ultimately yielding at least 80% angle detection accuracy.

Aim 1: Build Machine Learning Algorithm to Find Cobb angle

- **(A)** Use MATLAB in conjunction with Python libraries Keras and TensorFlow to build out framework for Convolutional Neural Network (CNN), which will identify and weigh specific features of X-ray input images (Agarwal, 2019). Said algorithm will include several propagations through the following layers: **1)** at least one convolution operation on the original image pixel matrix, **2)** creation of an application layer to reduce image linearity, **3)** a pooling layer to reduce image resolution, thus reducing requirements needed to ultimately determine accurate weighting, and **4)** a fully-connected layer which links all neurons in subsequent image layers, and classifies output to be compared to the test set (ujjwalkarn, 2016).
- **(B)** Research common feature detector masks used in current machine learning image analysis studies. Adjust 3 primary parameters (filter depth, pixel stride, and zero-padding) to minimize error during algorithm training.

Aim 2: Manually determine Cobb angles of X-ray test set and input images and angles into Convolutional Neural Network algorithm

- **(A)** Input X-ray images and corresponding "known" Cobb angles into Convolutional Neural Network algorithm in order to accurately calculate sum of squared errors for each propagation step.

(B) For each X-ray image: **1)** initialize determined filter detector with weighted values, **2)** calculate the total error from the output layer, comparing algorithm output to the manually pre-determined Cobb angle measurement, and **3)** use backpropagation to calculate gradients of error for all network nodes; this allows the network to "learn" to classify Cobb angle for the inputted images. Ultimately achieve at least 80% angle detection accuracy.

This technology will benefit the 6 to 9 million people in the U.S. who undergo imaging for scoliosis by automating this Cobb Angle detection process. Additionally, this new program will reduce the time doctors will need to spend on each patient, thereby increasing their total patient throughput ("Patient throughput," 2019). This product is also crucial for MIST's business strategy. In addition to this project MIST has also developed a new long-term implant, that could fix scoliosis. Unfortunately, it will take multiple years to gain FDA approval. As such, MIST will use our product to increase income while trying to gain FDA approval. Though completion of the previously stated aims, we can accurately identify scoliosis among adolescents, increase patient throughput among doctors by automating Cobb angle detection, and strengthen MIST's scope in proactively identifying AIS cases throughout the U.S.

STS Thesis

Reskilling Programs: Giving Lower-Income Adults the Opportunity to Thrive in an Ever-Increasing Digital Skills market

Introduction

As technology in the twenty-first century becomes increasingly advanced, it is beginning to pervade the modern economy as a labor market alternative to improve efficiencies. As technology is implemented to perform the jobs previously done by humans, American working-class citizens run the risk of losing a competitive edge in their marketable skillsets. This technological revolution poses greater risks to lower-income workers, as the threat of unemployment could leave them without means of sustaining themselves in the modern economy. In my class blueprint project, my team has begun to investigate some of these labor issues within our local Charlottesville community. I will expand upon this work to explore how lower-income adults can gain the skills needed to compete in an ever-increasing digital skills job market.

Literary Review

The journal article titled, *The Role of Skills and Jobs in Transforming Communities*, by Harry J. Holzer, discusses obstacles and potential solutions to achieving widely shared prosperity in the labor markets of lower-income communities in the United States (Holzer, 2017). The method it does so is threefold: first the demand of the labor market is investigated. Holzer talks about how corporations will partner with community colleges and universities to increase job opportunities by fostering a stream of newly skilled workers. He also touches upon on-the job training of workers to improve quality of the workers' skills. Secondly, the supply side of the labor market is analyzed by investigating the shortcomings of associate degree programs in translating education into actual labor market skills that can lead to success for graduating students. The author here also discusses the potential to improve vocational education and apprenticeship programs to provide valuable labor market training and skills to students who do not attend college. Finally, the article discusses how access to the aforementioned jobs and skill-building opportunities is far more difficult for lower-income and disadvantaged students and workers, due to factors such as racial segregation, geographical location, and lack of access to good public-school systems. Holzer's article describes some of the key reasons why lower-income people frequently lack access to the skills necessary to participate in the labor market of today's modern economy.

While Holzer focuses on how lower-income workers can overcome innate disadvantages, the book *Facing the Challenges of a Multi-Age Workforce: A Use-Inspired Approach* explores the use of retraining programs as a means to combat similar labor market disadvantages for aging workers (Finkelstein, Truxillo, Fraccaroli, & Kanfer, 2015). In the section, "Implications of Workplace Changes for Older Workers," Finkelstein et al. highlight the effects of rapidly changing technology on adult workers. As new technologies are implemented to increase efficiency within companies, adult workers – who may not have been introduced to these modern technologies during their education – face a severe disadvantage. This technology creates a need for these workers to be retrained in order to remain relevant in the modern labor market and avoid unemployment. The book focuses on government sponsored programs, community college initiatives, and the development of skilled retraining advisors as a framework for how to provide

long-term skill retraining allowing older workers to remain competent among the modern digital labor force. Both aforementioned articles highlight major disadvantages faced among lower-income and aging populations to maintain relevant job market skills in a rapidly advancing technological economy.

Framework

As technology continues to innovate, the skills demanded of the labor market are conjointly evolving. Laborers are resultingly threatened by inadaptability and the risk of layoffs due to their inability to keep up with labor market demand. This change exposes a dire need for modern retraining programs that can provide long-term skill competency to allow lower-income workers to succeed in a technologically advancing job space. Focusing on Boston, Massachusetts, a diverse city with a rapidly growing technical economy ("4 emerging, 'techified' industries defining Boston's economy," n.d.), I plan to explore what entities create reskilling programs, whom these programs serve, and how these skills actually get translated to job opportunities that ultimately benefit lower-income adults.

Methods

I will first consult current literary research as to how the public and private sector create and justify job reskilling in Boston. Through analyzing the various stakeholders, I will explore the content of education systems, identifying what they teach and how that prepares people to enter the job market. I anticipate focusing on high schools, community colleges, and vocational schools, three entities responsible for providing skills that will make their graduates immediately marketable in the real world. I will also explore how corporations approach retraining their employees, as well as the role of government programs to promote modern technical skill training.

Secondly, through market research and personal interviews, I will examine what specific jobs are at the forefront of this reskilling process, and what skills should be prioritized for one to be defined as marketable within the Boston economy.

Staying attune to Holzer's emphasis of achieving "widely shared prosperity" despite systemic disadvantages, I plan to investigate opportunities and obstacles that lower-income communities have to get involved in these programs. Through research of Boston's demographics, I will investigate workers' geographical, educational and racial backgrounds to pinpoint any bias that may prevent the inclusion of lower-income workers in a proposed reskilling program. Through surveys, I will also more qualitatively explore peoples' actual desire to participate in such a program, shedding light on how skill retraining can be implemented to coexist with cultures among the lower-income communities for whom it is intended to serve.

Finally, I will research empirical evidence pertaining to the substantive outcomes of existent retraining programs, investigating the long-term benefits reaped by participants. Analyzing how newly-learned skills have translated to direct job proficiency in previous reskilling programs will allow for the framing of a pipeline defining the concrete steps needed to be taken by stakeholder entities to maximize the success of their proposed retraining.

Discussion and Next Steps

By exploring how aspects like skills training, labor force education, career motivation, and mentorship combine to create sustainable job outcomes for low-income workers, a retraining program can be proposed to successfully achieve widely shared prosperity for low-income workers in today's technologically evolving workplace. While the concept of reskilling has been approached in several different facets, I want to propose a method by which corporations, government programs and educational institutions can collaborate to implement a cohesive reskilling program that will allow lower-income workers to remain competitive in today's ever-increasing digital skills job market.

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