PROGRESS OUTCOME 8

Can algorithms be biased?

Context

Erana has been working on a project in her digital technologies class. Through it she has developed a strong interest in programming and algorithms.

Insight 1: A digital concept in practice

This year I began researching the concept of the social impacts of algorithms after reading articles about how algorithms affect human behaviour. Headlines included “Algorithmic Discrimination”, “Algorithms for Design” and “Algorithmic Personality Detection”. Just reading the headlines was disturbing, so I wanted to find out more. I decided to investigate policing, as it would be scary if computers started policing … or would it?

Insight 2: Heat-map algorithms

I did some research into how ‘heat-map’ algorithms work. In policing, a heat-map algorithm tells the police where to look for criminals, based on the locations in which people have been arrested in the past. The police claim it helps allocate resources more effectively. But I discovered that data is only useful for predictive processing if you are working with a large sample or big data.

The data that police collect is like a tally: they count all the arrests they’ve made and display the most common locations. While most algorithms might appear to be just programs, some are designed to find trends. This is how an algorithm that identifies dominant trends could be discriminatory.

To test this, I conducted some experiments on a small scale. I looked at Google™ predictive searching and how it works. I then wrote a simple program that searched for common words to show how this might work on a large scale.

Insight 3: The key problem

After I tested my simple program to show how data can be gathered and analysed, I looked at how this could be improved. I examined the concept of "sample size disparity" and discovered that if you want to make a prediction, you need to be careful about how your algorithm treats outlying data.

For example, if a disproportionate number of people in a specific ethnic group behave in a particular way, an algorithm may connect all people from that group with that behaviour. This is like saying everyone from the "rough side of town" is a criminal.

To test this, I built a data set of different ethnicities and included their street addresses and their favourite fruit. I put in a disproportionate number of English people liking bananas, and when I created a simple query, my program predicted that English people ate bananas.

Insight 4: Applying algorithmic predictions in society

I wanted to use the results from my research and experiments to find out the wider applications. As a society, we want to reduce crime and better resource police to deal with crime. It would be great if we could predict where crimes are likely to occur, but I found that algorithms are not unbiased lines of code – an algorithm designed to pick up statistical patterns in data will report back what it is exposed to.

This means that if data includes a social bias against a minority, an algorithm is likely to incorporate this bias. This can lead to unfair or bad decisions by police or the government for members of the minority.

Insight 5: Critical evaluation of the concept and its future use

I was amazed at what I found out from my project. Nobody can agree on how an algorithm can be 'fair'. I thought algorithms were immune from bias, but they may not be because they try to make meaning of data and will predict outcomes as they process it.

There are many problems associated with this and no easy solutions, particularly because it's difficult to know how some algorithms are used. Many companies keep their algorithms secret in case they are accused of being biased or to prevent their algorithm being stolen. I think that algorithms need to be carefully developed to consider the range of social conditions that may influence their predictions.

We all want less crime and to be able to prevent crime, but we don't want to unfairly target specific groups. As computer science progresses, I think we will continue to use algorithms in fighting crime. If we keep checking the results and keep the public informed, the algorithms will become more refined.

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PROGRESS OUTCOME 8

Communicating online successfully

Context

Ravi's digital technologies class has been learning about the use of data on the internet at home and school. He has developed a real interest in how data is organised, manipulated and used in computers.

Insight 1: Key concepts

A key aspect of society today is communication. Even the most basic (short distance) and complex (long distance) aspects of communication can be done using technology. People rely on technology for communication and expect it to function well, so they don't tend to think about the mechanisms that enable this.

I started researching the concept of network protocols, as I like using the internet and wanted to find out more. Transferring files around the world is a complex and difficult task, so it's not surprising that data can be corrupted, delayed or lost in transit. To address this problem, transport protocols are created to send intact data from one location to another.

On a conceptual level, a protocol is an established process for accomplishing a task. When applied to networking, a protocol is a formal set of rules that ensures a successful communication between two parties. The presence of protocols across a network enables data to be transferred efficiently and means that users don't have to worry about the reliability of online communication.

Insight 2: How transport protocols work

I posed the question "Can a protocol ever reach 100 percent efficiency?" To test different transport protocols and their efficiency in transferring data across a network, I conducted an experiment with Skype. Skype uses the protocols TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). By carrying out a long-distance video call and chat (messages) with my family back in Sri Lanka, I could see the application of these two different transport protocols and their results.

Skype's use of two protocols means that data being sent from New Zealand to Sri Lanka can travel through different routers. When data is sent, large amounts of data are broken up into transportable segments called packets, which later combine to form the original set of data. Data packets can be traced by an application called Wireshark. Using this application allowed me to see the packets that I was sending through each router and enabled me to identify one of the causes of the fluctuating quality in our Skype calls.

Insight 3: Network protocols in today's world

TCP has built-in calculating algorithms it so that it can obtain the most suitable window size for efficient transport of a file. This size is chosen once the first couple of packets are received so an efficient data transfer rate is achieved early in the transfer. This mechanism also helps to control congestion by constantly adapting to the fluctuating network. Due to all these safety mechanisms, TCP is known for prioritising accurate data transmission over speed, while UDP prioritises speed over accuracy.

Our school network is large due to our BYOD policy. It uses both TCP and UDP transport protocols for several applications run by the school. The centre of our school's online learning experience is our e-learning website. It contains subject resources, external links and daily updates on school notices. It's accessible in and out of school and is linked to the school database from which it retrieves information.

The website, however, is run by an external company, so the servers for e-learning aren't located in the school. The company uses TCP to manage the website because all the information must be displayed accurately. Because data needs to be received intact and doesn't require simultaneous delivery, TCP is ideal.

Insight 4: How network protocols affect me and others

My family in Sri Lanka and I often experience poor video reception when talking to one another on Skype. I think this is because bandwidth capacity is much smaller in Sri Lanka than in New Zealand. Using Wireshark, I could see statistics for the data packets sent and received – the amount of data being sent was much greater than the amount I was receiving. I concluded that some of the data was getting lost due to poor bandwidth and not being recovered due to UDP protocols.

The expression "You can't build a strong building on a weak foundation" applies to network protocols. I think Sri Lanka's network layer with its poor bandwidth is a weak foundation. It's almost impossible for a protocol to be 100 percent efficient when built on top of this layer. The most an efficient protocol can do is reduce the impact of the weak foundation.

Insight 5: Wider impacts and scenarios

UDP has speed but lacks reliability; TCP has reliability but lacks speed. For our school's e-learning website, it's clear that TCP is better; for video calls, UDP is better. Both protocols have their pros and cons. When used together, they can create reliable and speedy data transfers.

Skype uses TCP for instant messaging to establish trustworthy communication and UDP in video and voice calls for speed and synchronisation. As a result, Skype incorporates the advantages of both protocols, maximising their usefulness and helping to make Skype one of the most popular long-distance communication applications.

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PROGRESS OUTCOME 8

An Agile approach to game design

Context

Lily's class has been working on a collaborative project that involves using a software engineering approach to design a game in Unity® software. She was learning a lot from developing the game and wanted to learn more about the ways to make good software.

Insight 1: Key aspects in developing software

I did some research into software engineering to understand why it is so important. I learnt that for a software project to be successful, it must be delivered on time, within budget and with few or no errors. Failure in any one of these three requirements can cause failures in the others and can compound into the overall failure of the project. Meeting these three requirements is often difficult in reality, due to the complexity and sheer size of many projects. When a project fails, it can be very costly, and not just in monetary terms.

For example, NASA's Mars Climate Orbiter was sent into space in 1998 to orbit Mars and observe its climate. Before the satellite managed to achieve a stable orbit, it burnt up in the Martian atmosphere. On review, it was discovered that within the software controlling the satellite's thrusters, the force required to be exerted had been calculated using English pounds rather than the industry-standard newtons.

Insight 2: Wider implications of the NASA debacle

The cost of the Climate Orbiter's software failure was far greater than the $125 million dollars it cost to build. Although NASA had a working blueprint for the satellite, producing the satellite a second time with the error corrected would be pointless, as technology had developed considerably since the initial development.

Therefore, development of a new satellite would have had to begin from scratch, which would take many years and a lot more money. Also, a costly failure such as the Mars Climate Orbiter can cause a government to lose confidence, cut funding and reduce support for similar projects in the future.

Insight 3: Comparing different project methodologies

I wanted my game development to be successful, so I decided to take on board what I had learnt from the software disasters I had researched and find a good strategy for my game design project.

Projects are usually described as a series of stages, such as analysis, design, and implementation. I was currently using a basic Waterfall process to develop outcomes – this is a linear, sequential method of working through a project with five stages: analysis, design, implementation, testing and release. Each stage is visited once and completed before moving on to the next stage.

I looked at the Agile methodology and compared its more flexible, iterative approach with the Waterfall process.

Insight 4: Using the Agile approach

I decided to use an iterative Agile approach with my team to deliver the game. We wanted to make sure we delivered the project on time and within cost (we agreed that the 'cost' would be the impact of the project on our other subjects). It was also important that the game would be playable, that it would work as intended without any major errors.

We decided to focus on short iterations – rather than conducting the whole project from start to finish, we would make small features in short periods of time. In this way, the results of each iteration could be used to adjust the overall project plan. Each iteration was like a short project in itself, which was awesome, as it meant we could work together but be assessed separately. It also allowed us to adjust goals and measure progress regularly.

Insight 5: The Scrum process

We had a large team on this project – nearly half the class! We decided to use a Scrum process and set up team responsibilities accordingly. I was the Product Owner – my role was to prioritise and define the features of the project. We also had a Scrum Master, who had to ensure that the team was fully functional and productive and followed our agreed process. We had a large Development Team, which selected the sprint backlog, organised themselves and demonstrated work results to me as the product owner.

As we worked through the process, we found out which members of the team could handle particular jobs and so we were able to better allocate tasks. Also we made sure we were always working towards a realistic goal.

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