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Practical Work Portal

Report Year 2024

- ★ Student Report Progress
- ☑ Student Hours Completed
- 👤 Student Assigned Markers
- 📄 Marker Payment Tracking
- 📁 Work Registration Expenses
- ⚙️ System Configuration

📍 Employment at Douglas Pharmaceuticals

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Report Submitted : 2024-02-19

PASSED

Assigned Marks : 25 / 25 (Grade : A)

Marker : [REDACTED]

Hours Verified : 400

Student : [REDACTED]
Specialisation : Computer System Engineering
Student Group : [REDACTED]

Uploaded Report
[REDACTED]

Scoring Rubric

Section One	Passed Section If you pass Section One you still need to pass Section Two.			Failed Section If you fail Section One you will be asked to resubmit the report.			5/5
Section Two	Passed Section If you pass Section Two you will still need to pass Section Three			Failed Section If you fail Section Two you will be asked to revise and resubmit the report.			5/5
Section Three Part A : Structure of the Report	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5
Section Three Part B : Quality of the Report	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5
Section Three Part C : Presentation of the Report.	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5

Existing Admin Verified hours

400 General Hours added [REDACTED]

Administrator Add Verified Hours

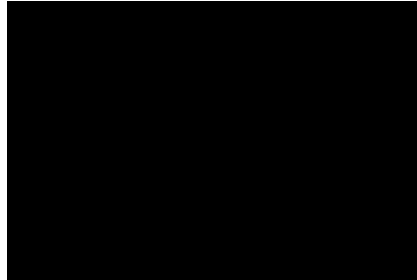
Administrator Details

👤	[REDACTED]
☎	[REDACTED]
✉	[REDACTED]

Verified Hours Hours Type

ENGGEN 499

Practical Work Experience Report



The Department of Electrical, Computer & Software
Engineering (ECSE)

13 February 2024

Douglas Pharmaceuticals



Work Period: 20/11/23 to 16/02/24

Summary

Douglas Pharmaceuticals, a New Zealand family-owned pharmaceutical company, is renowned for its commitment to high manufacturing standards, quality products, and exceptional client service, all aimed at improving people's lives. Engaging in world-class research, development, manufacturing, and global distribution of pharmaceutical and nutraceutical products, the company also provides automated dispensing machines to New Zealand pharmacies and manufactures consumer healthcare products. Notably, in 2022, they ranked second on the TIN200 Healthtech Companies list and received the HR Team of the Year award in 2023.

During my internship with Douglas, I worked with the operational technology/digital team, focusing on implementing artificial intelligence (AI) and machine learning (ML) for lab data analysis. This involved mostly coding in Python, utilising various libraries for data extraction from diverse sources, and integrating AI and ML for predictive modeling. The experience sharpened my Python coding skills, AI concepts, ML techniques, and data analysis.

In the real-life engineering environment at Douglas, I learned communication skills through Microsoft Teams, improved networking by engaging with diverse professionals, enhanced punctuality and time management due to meetings and deadlines, and developed independence by structuring my own workdays. I was tasked with solving or improving challenges faced by multiple departments by implementing AI, further developing my critical thinking and problem-solving skills.

My internship at Douglas Pharmaceuticals provided a valuable combination of technical and soft skills. It improved my engineering knowledge and prepared me for a permanent engineering role, motivating a continuous learning and growth mindset. I found a lot of personal growth within the dynamic work environment, finding fulfillment in both personal development and the completion of projects.

Acknowledgements

I would like to thank [REDACTED]. I would also like to thank [REDACTED].

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Introduction

This report explains my journey through an internship where I worked on tasks such as data extraction, machine learning, and artificial intelligence. Throughout my period of work, I was involved in a diverse range of meetings, from intern catch-ups to high-level discussions with heads of departments and clients. The focus points include the application of AI to data analytics, handwritten text recognition, and the development of machine learning models for time-series forecasting.

Douglas Pharmaceuticals is the company at which I interned throughout this period. Douglas is a progressive and innovative pharmaceutical company that is trying to make technology converge deeper within pharmaceutical processes. The company is now interested in harnessing the potential of AI and machine learning to enhance data analytics, automate processes, and improve efficiency in new product development.

Throughout the internship, I actively contributed to the organisation's technological advancements in artificial intelligence. I became part of the digital team, specifically the operational technology (OT) team. The focus of my role was to leverage AI tools and drive efficiency within the company. They wanted me to focus on data analytics, such as forecasting future predictions, where we could implement generative AI or even use AI to extract handwritten text from PDFs.

I ended up taking on many different projects throughout my time interning at Douglas, but the three main projects I worked on were handwritten text recognition, time series forecasting, and generative AI chatbots for personal data. This included many subtasks, such as exploring AI applications for data extraction, developing machine learning models, researching handwritten text recognition, and integrating large language models (LLM) for efficient data querying. Lots of research led me to engage with Microsoft Azure services to produce efficient solutions to all the AI challenges the company faced.

Throughout this journey, I learned many skills, including problem-solving, independence, and being proactive. Being given an idea of some challenges and what inputs we had available, I was forced to think outside the box and come up with feasible solutions I could achieve within the time I had. This led to thoughts of innovation, collaboration with diverse teams, and improved communication. My progress helped contribute to the growth and further technological advancement within Douglas Pharmaceuticals.

Company Information

Layout of Workplace

Douglas Pharmaceuticals is located [REDACTED]. It has two large buildings, one is the head office where I am located, and the other is the manufacturing lab which is just opposite the office on the other side of the road. The sites are named Douglas Pharmaceuticals Limited (DPL) and Douglas Manufacturing Limited (DML), respectively. There is also a new section built behind the head office (DPL) called Douglas Innovation Limited (DIL), and this site contains labs dedicated to new product development (NPD). DIL is connected to the main DPL building through a bridge on level 1. DPL and DML both contain staff car parking lots pre-allocated to employees. New staff can also use the car parks through an online booking system, subject to availability. There are just over 200 car parks at DPL. I am in the digital team on the second floor of DPL. DPL is two stories tall where as DIL is three.

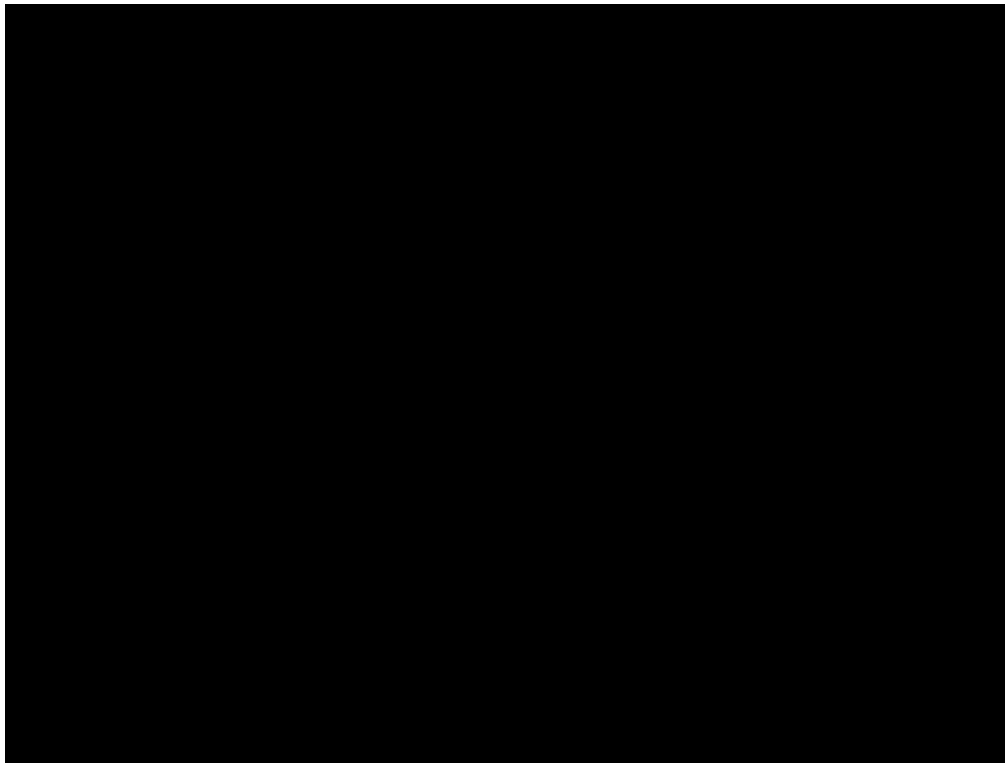


Figure 1: Layout of my floor

There is a large office space with rows of 3 desk spaces on either side of the middle walkway. In the centre of our floor is the kitchen area with a fridge, coffee station, sink, lunch table with stools, and two booths to sit in. The filtered water tap includes cold, boiling, and sparkling water alongside the coffee machine. Each desk has a power supply with two outlets, two USB ports, and two monitor screens that connect to every work laptop through a USB-C cable. Staff are free to sit and work wherever they please as long as the desk is free for the day, but I preferred to sit at the same desk next to my team throughout my whole work experience.

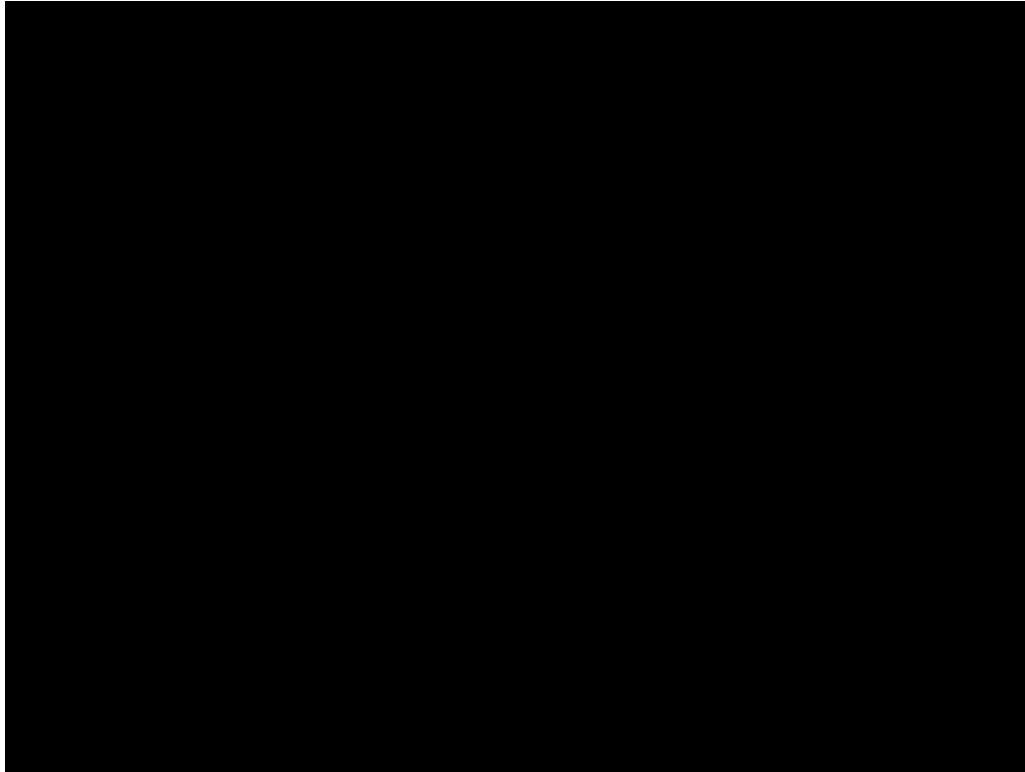


Figure 2: My Desk Set-Up

Amenities

The second floor of DPL primarily consists of desks/workspaces and meeting rooms. On the bottom floor is the reception and a large cafe where fresh meals and snacks are made by our in-house chef every day. Cafe food is subsidised for our staff. People can purchase food, snacks, and sweets there or simply sit and enjoy lunch with their colleagues. There are also cafes/lunch rooms in DML and on level 3 in DIL. Every cafe consists of a coffee station, microwaves, dishes, and cutlery at the minimum. There are also alternative milk options, including oat and soy milk. The cafe in DIL also contains a foosball table for staff to play during breaks. The main DPL building has an outdoor courtyard in front of the cafe with outdoor seating and umbrellas so that staff can enjoy sitting outside in good weather.

DML contains mostly manufacturing rooms with industrial equipment and some offices around the edges of the entrance for people to work. Similarly, DIL is mainly filled with laboratory rooms and equipment, with some offices and desks at the outer sides of the entrance. Permanent staff members are entitled to the team purchase portal, where they can buy Douglas Pharmaceutical products at a discounted price. I am not entitled to the discount as I am an intern only contracted for three months and therefore not under a permanent contract.

Staff organisation structure

In my immediate operational technology (OT) team, there are five other team members. This includes two operational technology engineers, two data admins, and one operational technology manager. This OT team is a part of the overall digital team, which handles everything to do with digital and information technology within the company. The overall digital team consists of about 24 employees and is managed by the general manager of digital technology. A chief operating officer manages eight other general managers throughout the company. Eight other chief officers are responsible for different departments such as finance, people, science, legal, etc. These officers are directly under the managing director, [REDACTED], [REDACTED], [REDACTED], the founder of Douglas Pharmaceuticals. The company has just under 800 employees, with 600 or so based in New Zealand. The remaining employees are mostly based in Fiji, with a few scattered throughout America and Australia. Other departments at Douglas include quality control, quality assurance, production, engineering, new product development, regulatory affairs, supply chain, marketing, and more.

Work Experience

Intern Group Trainings

Generally, every other week, there were group training workshops for all interns where we would be taught important skills and concepts in a corporate workplace. They were one to three hours long and involved many fun and engaging group activities.

Induction

Our internship journey began with a comprehensive induction presentation on the first day. This session explained the company's core values, goals, insights, and history. Before interacting with senior leaders and people partners, we engaged in various group activities with team-building exercises. This helped us to get to know our fellow interns, which was helpful as we started building our own network of people to relate to. Exploring emotions in the workplace, we identified feelings to avoid, such as anxiety, and discussed how to notice and address these emotions. Additionally, we also discussed the positive emotions we desired, such as feeling included and motivated, outlining how the company could promote these emotions. The induction also included setting SMART goals for our internship journey. After a round of introductions with fellow interns, I met my direct leader, toured my department, and received an overview of my responsibilities. A more detailed meeting was scheduled for the next morning.

Powerful Conversations - Feedback and Feedforward

Our second training was a two-hour intern training session focused on the principles of feedback and feedforward. This training equipped us interns with valuable insights on effective communication strategies. We learned the best ways of giving feedback to others without sugarcoating it so that the main points are delivered effectively. We also learned how important it is to provide feedforward and communicate well with others.

Critical Thinking

We engaged in a two-hour intern training workshop focused on critical thinking. Collaboratively, we explored how to promote critical thinking amongst ourselves and identified barriers like single-mindedness. We strengthened our critical thinking skills through practical scenarios, such as addressing tardiness caused by morning routines. We learned how significant it is to be able to think critically, especially in a corporate work environment, doing the jobs we are currently doing as interns.

Business Awareness

This workshop taught us about business processes specific to our company. We gained a comprehensive understanding of how products progress from concept to shelf. We explored the complications of securing patents, ensuring safety, market demand, and navigating regulatory compliance. It helped us understand what the company is about and how all of us interns from different departments tie in to help the business move efficiently.

DiSC Workshop - Personality and Behavioral

This was a larger three-hour workshop introducing us to the DiSC personality profiling tool. The tool evaluates individuals based on four personality traits: dominance, influence, steadiness, and conscientiousness. We learned that it helps to understand how individuals approach tasks, communicate, and collaborate in a work environment. Understanding this concept helped us to better navigate team dynamics, leadership, and communication by identifying and leveraging each person's unique behavioral style. The workshop training session emphasised the importance of understanding different personality types for effective communication and taught us how to tailor our approaches for every unique individual.

Job Skills Workshop

This was a comprehensive intern training session that began early in the morning, focusing on job skills. We received guidance on structuring resumes using templates on Canvas, emphasising simplicity and clarity. Resumes should be no longer than two pages and not be full of paragraphs of writing. The hiring team mentioned that they prefer more attractive and simple-looking CVs. Additionally, we learned the significance of maintaining private social media accounts and received insights on creating effective LinkedIn profiles. For example, some previous job candidates did outstanding in the interviews, but since they did not have a private Facebook or

Instagram account, they could not be hired because of the content they publicly shared about themselves. The workshop also provided valuable interview tips for our future career journey.

Intern Graduation

To mark the end of our internships, each intern presented a PechaKucha-style presentation, presenting their intern work experience into ten slides, each lasting 20 seconds. This format allowed us to reflect on our collective experiences and share the impactful work undertaken during the three-month internship. It was very interesting to see the other interns' work within the different departments throughout Douglas. It also felt great to get a chance and finally show everyone what I had achieved as an intern. All my co-workers and fellow interns were surprised at the work I had achieved and told me that they were very interested in it.

Meetings

First meeting & general info

On the first real working day of my internship, I joined the Operational Technology (OT) team, starting the day with a meeting that set the expectations for my experience. I met each team member during introductions, providing a brief overview of my background. This meeting helped me gain insights into the overall plan and tasks I would work on throughout my internship. My supervisor presented and explained to me all our different types and formats of data, including digital, non-digital, and hybrid records. Hybrid records were originally in paper form but were manually copied into digital form, having two versions of the same data. This creates the issue of human error during the manual handling and transfer of data. The first task was leveraging AI, automation, and machine learning to enhance efficiency throughout our data-driven environments. I initially thought of using Robotic Process Automation (RPA) to extract and process data, as I have prior experience with UiPath. Initially, it seemed a viable solution for extracting information from PDFs, but potential disadvantages include faded pen ink and illegible handwriting. This led me to explore further machine-learning techniques such as OCR and HTR. I was provided a work phone, laptop, and headset, which I used to dive into the company's digital policy on AI tools. As a first task given by my supervisor, I read "From Industry 4.0 to Pharma 4.0" to better understand the regulations surrounding AI in the pharmaceutical industry. After lunch, I was taken for another tour of the manufacturing facility by my supervisor, but this time, it was much more in-depth as he explained where the data came from and how my work was relevant to everything in the plant. While engaging with various departments, I discussed data extraction, process automation, and the challenges of their data utilisation. This research revealed many opportunities for automation in lab work, such as production processes that rely heavily on manual handling. Focused on historical, current, and future data, it was ideal to begin extracting and analysing it to uncover trends and identify potential issues or outliers. This initial meeting and introduction day laid the foundations for the challenges the company is facing and how I could come up with innovative solutions to contribute meaningfully to the company.

Intern Meetings

Every week, I engaged in a scheduled meeting session with technology-oriented colleagues [REDACTED], and [REDACTED], showcasing my progress. [REDACTED] is mainly responsible for our web and database services and was a good reference for my work. He provided lots of strategic insight, which helped keep me on the right track. He initially recommended exploring the extraction of raw data instead of PDFs, as this aimed to enhance efficiency in our processes. Building on this, [REDACTED] suggested that I request some data samples from [REDACTED], encouraging experimentation to refine extraction techniques. [REDACTED] further guided my data analysis by suggesting the investigation of ODBC libraries for Python, offering direct access to databases. I could combine my Python code with SQL data queries for our LIMS database. I also arranged many extra meetings with [REDACTED] to continue further developments on data extraction and visualisation. Throughout my weekly intern catch-up meetings, I presented advancements on all the projects I was working on. The meetings allowed me to collaborate with the team and exchange ideas. It helped me progress because I always got new ideas, fresh trains of thought, and different perspectives on how to go about my work. Since everyone was much more experienced than me, having some guidance and backup was nice. As the team reviewed my progress, they helped me refine strategies, explore innovative ideas, and develop plans to succeed.

Weekly Catch-ups

In our weekly catch-up sessions, I maintained an open line of communication with my supervisor, [REDACTED], who helped keep me updated with comprehensive ideas throughout the journey. During one session, we discussed my involvement in other meetings, knowledge gained, and ongoing research initiatives. In another meeting with [REDACTED] I showed my progress in extracting data from SQL into Python and leveraging data frames for plotting and running models. Our discussions dived into the implementation of AI, with considerations for writing a model to validate handwritten batch records. Exploring the potential of external parties like Microsoft Azure for model implementation, we considered data security, contemplating whether to utilise a local model or send data to external services. The current strategy involves personally implementing a validation model, with the option to explore alternative services if needed. Acknowledging the importance of interdepartmental collaboration, we had created plans to meet with other departments and understand their priorities regarding batch records. [REDACTED] provided insights throughout every meeting with new updates to keep me going. For example, sometimes, I would be provided with a new challenge to look into and solve using AI. Other times, I would be provided feedback on work, new data to look into, or new ideas or perspectives that would allow me to improve my progress. During one of the catch-up sessions, I struggled with some challenges and voiced all of them to [REDACTED]. He calmly provided some insight on how I could solve them and helped me find a way to work through them. Within a couple of days, I had solved the issues and was back on track to making good progress. These weekly catch-ups were

significant in aligning objectives, addressing challenges, and refining strategies for successful project outcomes.

Operational Technology (OT) team meetings

Throughout our Operational Technology (OT) team meetings, we would begin with each member providing updates on their projects and tasks. This would help each member better understand what work is going on amongst our team overall. Others could help to pitch ideas or add any information they feel is relevant as a way of helping team members with any issues or challenges they may have. These meetings offered me valuable insights into the diverse range of work within the team. During these sessions, I presented my weekly achievements, providing an overview of my progress and outlining my goals. This helped me align better with the team and also allowed me to gain valuable feedback and insights from peers. These OT team meetings helped me continuously improve my perspective, share knowledge, and solve problems collaboratively.

Cross-Departmental Challenges

Engaging with heads of various departments helped me gain deeper insight into all the challenges surrounding artificial intelligence (AI) implementation within the company. In a meeting with [REDACTED] from Metrology, our discussion was based on various issues and future considerations, looking into critical aspects such as data integrity and the challenges posed by manual handling. Maintaining data integrity within the Metrology department is a major challenge as there are many different data locations, data can be modified through its life cycle with no record, and many people tamper with the same data due to the manual handling aspects.

In another discussion in a meeting with [REDACTED] the Quality Process Manager, he shared his insights into how data integrity affects business processes. He shared a new perspective on the challenges we face implementing AI, which gave me ideas on tackling some of these challenges. He mainly focused his concerns on data integrity and whether or not automation could solve this problem.

A meeting with the Head of Quality Control further improved my understanding of the practical applications of AI. Specifics regarding lab data extraction were discussed, clarifying the challenges faced by the Quality Control department. This allowed me to start considering how I could automate the data extraction from the labs and begin processing it so that it could be visualised in a useful manner.

Additionally, a meeting with [REDACTED] about the extraction of BMS data demonstrated a simpler technique to extract BMS data and save it in any desired file format. This session helped clarify some questions about the data extraction side of things and eliminate the need for guesswork when working with PDF files.

The meetings with department heads had been incredibly valuable. I learned about what aspects of AI would interest each person, what challenges they face, and how I could implement a feasible solution.

Practical meetings with [REDACTED]

I had a lot of meetings with a digital team senior, [REDACTED], who helped advance my knowledge of the software and databases used throughout Douglas. This includes Laboratory Information Management Systems (LIMS), Chromatography Data Systems (CDS), Power BI, and many more. [REDACTED] took the time to explain each relevant system to me when I crossed its relevance during my project work. For example, with LIMS, he explained the base foundation of it and showed an example query to integrate with my program. From there, I explored on my own and started pulling together some results that seemed of good use/context. Similarly, [REDACTED] offered technical help throughout my journey whenever required.

Monthly digital team meetings

Every month, there were digital team meetings in which every member of the digital team would participate. Even the relevant team members from Fjij would join remotely. These meetings provided a comprehensive overview of ongoing projects, shedding light on the combined efforts within the team. The meeting was run by our general manager for the digital department, and the discussions ranged from the major current projects and challenges to the success rate of phishing emails within our company. Overall, the monthly digital team meetings were an insightful and informative way to share knowledge and discuss issues within the digital landscape.

CAB - change request approval

Participating in two Change Advisory Board (CAB) digital meetings provided a firsthand experience of the team's decision-making process. The CAB meetings involved evaluating and discussing requested changes, where three senior digital managers would determine whether they should be approved. Without all of their sign-offs, no changes could be approved. Each change was briefly discussed amongst the team with a short explanation from the person who requested it, and then generally, it was accepted immediately. The CAB digital meetings were interesting to be involved in as they demonstrated the team's communication and democratic approach to approving changes that should positively impact the company.

[REDACTED] & Data Scraping

In a meeting with [REDACTED] the Quality Process Manager, I received valuable insights into the issues with my data extraction query. He helped to clarify the issues that led to results that did not quite make sense. [REDACTED] guidance was very helpful and helped me understand how to provide more context to the data in my approach.

█ also assisted in this and provided me with an updated query with more context to the data, as █ suggested. This resulted in more specific results. █ emphasised the importance of grouping results around assay results, suggesting a shift from using 'Numres' to final results for improved accuracy.

After I had more time to work on the project, a follow-up meeting with █ in DML was arranged by my supervisor. Here, I demonstrated my progress, and █ was happy to see how far the work had come. He offered some useful feedback, which included plotting material data results in conjunction with more contextual information, such as the specific machine used, the analyst involved, and the potency of standards. This would help us dig deep into any outliers and provide a specific response for any historical issues.

Microsoft Azure Meeting

Engaging with █, our Microsoft representative, helped me to better understand the possibilities of leveraging Azure AI services for our specific tasks and use cases. I provided an overview of my responsibilities and task objectives in our meeting. █ took these notes and recommended some services they had to offer that would satisfy our use cases. After a productive discussion, a follow-up meeting was scheduled with more technical members from both sides, including a demonstration from the Microsoft team on their relevant services.

Key takeaways from the initial discussion included explaining how our data will be securely stored in our subscription cloud, which service would be best for time series forecasting, and how we could create our generative AI model for natural language queries. Emphasising the importance of access control and security, Microsoft also had plans to organise a workshop for our specific use cases, collaborating with another partner to see the readiness of our data. █ suggestion allowed me to research Microsoft Fabric, where I discovered that it offers a range of features and services for Machine Learning and data science. These are easily integrated with Power BI and are widely used throughout our company.

The follow-up meeting with Microsoft included a technical assistant from their company who provided detailed information on relevant Fabric and Azure services. A demonstration of a chatbot using their OpenAI LLM demonstrated the service's capabilities without the need for training and ensured data security within our organisation. Additionally, it was identified that Data Engineering & Synapse can be used to provide real-time, time series reports and forecasting. Microsoft Azure is also used by many reputable companies such as Siemens, AT&T, Mercedes, and KPMG, making a good case of reassurance for Douglas. These meetings with Microsoft have opened up a new path to implementing AI and machine learning.

Client meetings - Databricks & Adaptiv

Conducting a client meeting with representatives from Adaptiv and Databricks was an interesting meeting to be engaged in, exploring integrating Artificial Intelligence (AI) and Machine Learning (ML) techniques into our data analytics framework. The meeting was a good opportunity to discuss the potential collaboration and the specifics of implementing advanced analytical solutions for data insights. The clients explained their capabilities and services in AI and ML. Topics ranged from understanding their technological offerings to exploring how their solutions could be easily integrated with our existing infrastructure.

Artificial Intelligence & Machine Learning Projects

Exploratory Analysis

During the exploratory analysis phase, I researched the application of Artificial Intelligence (AI) to data extraction, processing, and visualisation. I started my research by exploring various AI techniques to observe trends in data while documenting helpful information for future reference. Regarding AI implementation, Microsoft Azure AI services emerged as a promising solution to our challenges. Given our existing license with Microsoft, I thought it would make sense to continue using their services over other companies such as Google or Amazon. After conducting some research and coming up with some concepts to be developed, my supervisor suggested that I create an introductory AI presentation for less technical staff members to give them a better understanding of the advantages to be gained from it. I submitted it to him, and he provided some feedback to refine and improve its effectiveness.

Extracting Data in Python

I began the first stage of this project by extracting data from PDFs in Python. I was given a handful of PDF files from our BMS that contained time series data in tables on room temperatures. Further refinement involved setting up if statements for varying conditions and adapting the code to extract specific column headings based on the PDF title. This ensured the code could work on different formats and have the data ready for visualisation. To extract many PDFs simultaneously, I incorporated Tkinter to create a GUI popup window. This lets users conveniently select one or multiple files simultaneously, allowing the program to extract and plot them consecutively. The code was then extended to handle PDFs and CSVs as the time series data was ultimately saved to a pandas dataframe.

As previously mentioned, another stage of extracting data was connecting our SQL data warehouse, guided by [REDACTED] in a meeting. He helped set up Azure Data Studio on my computer, which enabled me to experiment with SQL queries in Python, converting the obtained data into a usable dataframe and preparing it for visualisation. Throughout the journey, [REDACTED] assisted in providing additional SQL code to incorporate potency data for an Assay test standard. Though faced with initial errors, I successfully resolved them, resulting in a useful query with the context we can visualise.

Visualising Extracted Data

After extracting data from various sources, the next stage was to visualise it in a way that can be easily interpreted and provide some value with context. I began by simply using a matplotlib library in Python to display time series data as a line chart. Even this much so far was interesting for my supervisor as all old unused data had never been looked at. They only consider the immediate values, but we were interested in taking a step back and looking at the trends over time. Below is an example of some BMS data I extracted and plotted. As you can see, there is a clear trend of oscillation, which would never have been flagged up because the values are within spec. We can now begin investigating the reasons for this trend.

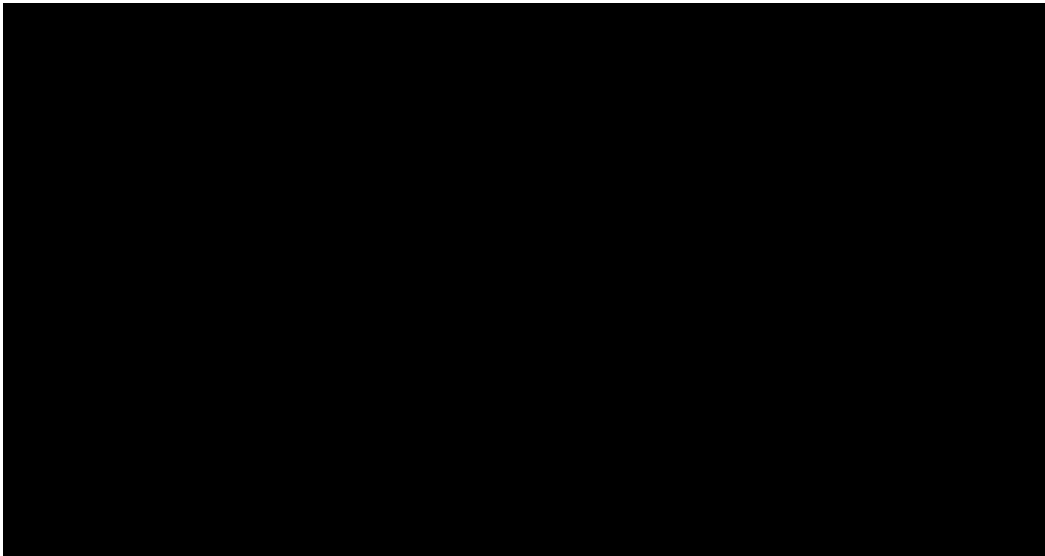


Figure 3: BMS data visualised

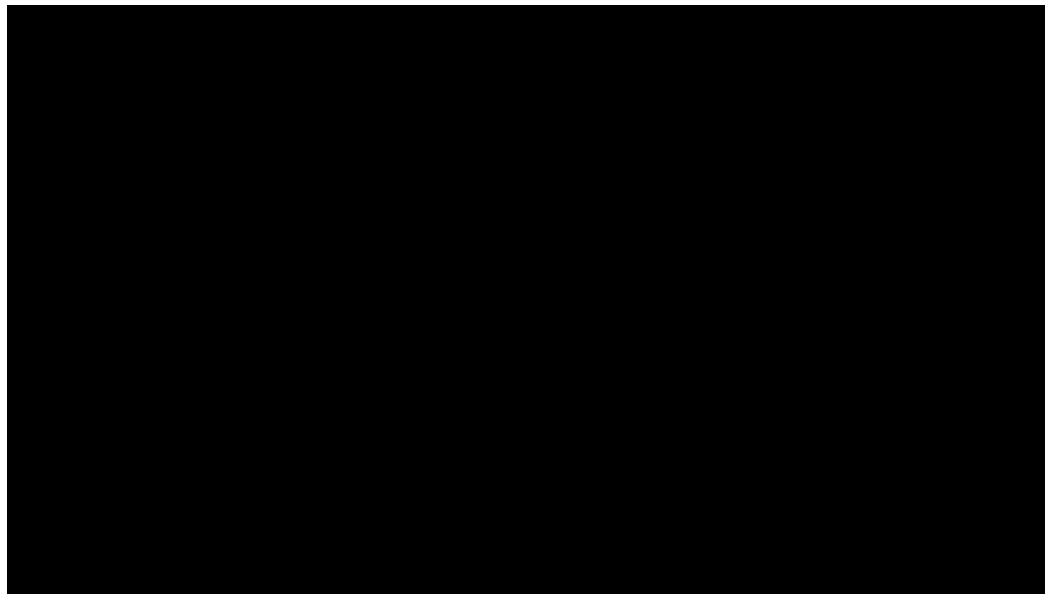


Figure 4: SQL query for material results visualised

Machine Learning Data Forecasting

Since I could easily visualise data from all different sources, I began working on incorporating machine learning techniques to forecast our time series data. My initial attempt involved training and testing a linear regression model, which was very inaccurate. After doing some more research, I decided to try the ARIMA model. Although this model displayed some deviation in a small portion of the prediction, it regressed to a straight line for approximately 95% of the dataset. Similarly, I tried training and testing many different ML models to forecast data, including the Pyramid, AutoTS, prophet, SARIMAX libraries, and more. They all came out quite inaccurate, apart from the LSTM model in TensorFlow.

I started working with TensorFlow and initiated the development of an LSTM model. While encountering data normalisation and model accuracy challenges, I adjusted the hyperparameters by experimenting with different batch sizes, epochs, and neuron configurations to improve the training process. Adjustments to these parameters showed positive results with improving accuracy. Recognising the uniqueness of hyperparameter tuning to specific matcodes/testcodes, I worked on refining the LSTM model for a specific product, which is a significant contributor to the company's profit. After some trial and error, I got a relatively accurate time series forecast for the material. As shown below, the orange line is the test data attempting to predict the real original data (blue line). The green line is the future forecast, which seems somewhat realistic. (Plot title removed for privacy reasons)

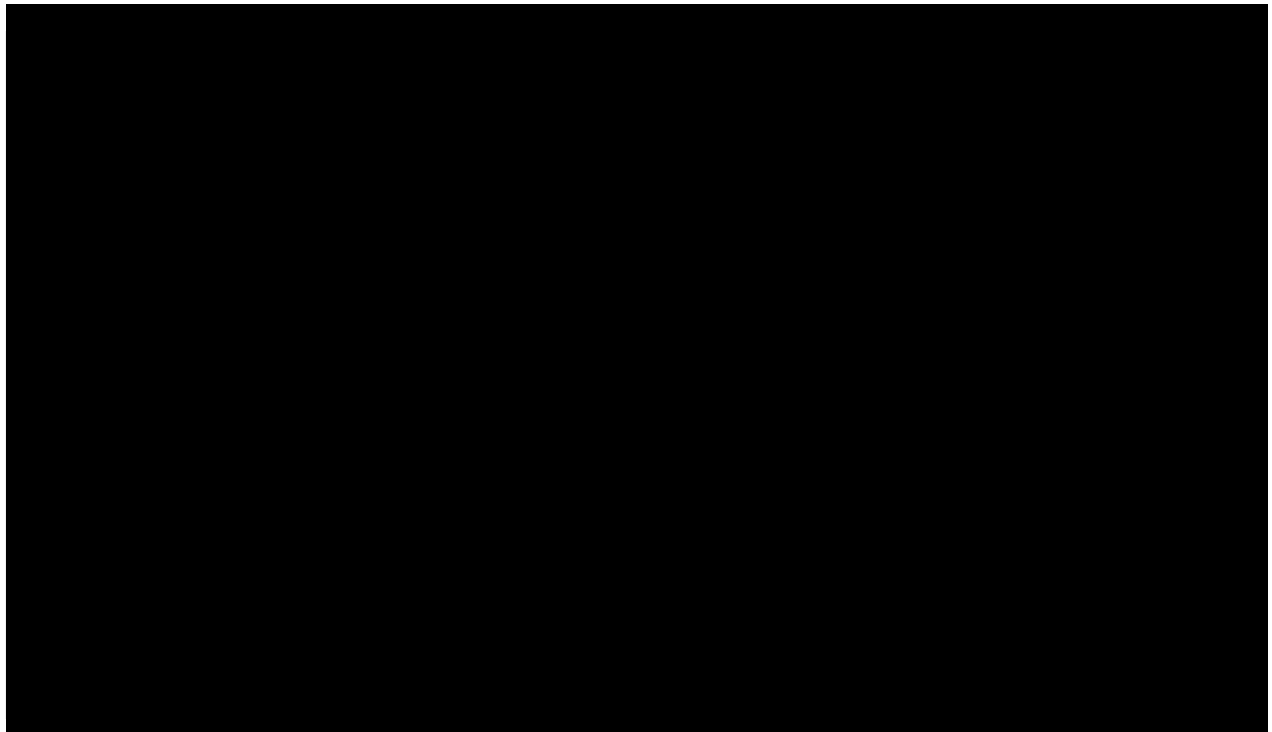


Figure 5: LSTM model forecasting product data

After success with machine learning models and time series forecasting, I explored the potential of Azure Machine Learning for large-scale BMS data prediction. The challenge of forecasting the data locally was using a dataset with 25,000 data points. A large dataset would take incredibly long to train locally, leading to the consideration of Microsoft's ML services. Microsoft Fabric's Data Science Service offers time series forecasting, but I encountered challenges uploading data to the SARIMAX model. I started trying to refine a new method of time-series forecasting using Python notebooks and the AutoTS model in the Microsoft Fabric service. There were too many errors to achieve what we wanted without the full-service license, so I focused on other objectives.

Handwritten Text Recognition

The most valuable and successful project I worked on throughout my internship was developing an effective solution for handwritten text recognition in old batch records with handwritten data. The journey began with a few examples of handwritten batch records from my supervisor, Barry. The initial stages were challenging as I encountered issues extracting the data from PDFs. There were many limitations in accessing the required packages, which led me to explore alternative options. To better understand the task, I researched types of neural networks, identified the relevant information to extract, and considered between creating a custom model or utilising a third-party service. After understanding the true complexity of the task and the resource constraints, I opted for a closed-source service, with Microsoft Azure AI Vision as the preferred choice. It also, fortunately, had one of the highest accuracies in recognising handwriting. I started by creating a custom recognition model in the Azure service. I trained the model to recognise data sections we were most interested in finding over a few example documents. Since we did not have the full license, I could only use the first two pages of the document, but this was enough for a proof of concept to convince the company to purchase a license in the future. After training and testing, a significant breakthrough was achieved by successfully reading handwritten data by calling the model from an API in my local Python code. The focus shifted towards extracting data in tables or sections rather than per line for improved readability. I could separate each section of relevant data into sections in an Excel spreadsheet, which proved to be a great success. In the images below, the left shows the original handwritten batch record, and the right image shows the extracted data in a spreadsheet.

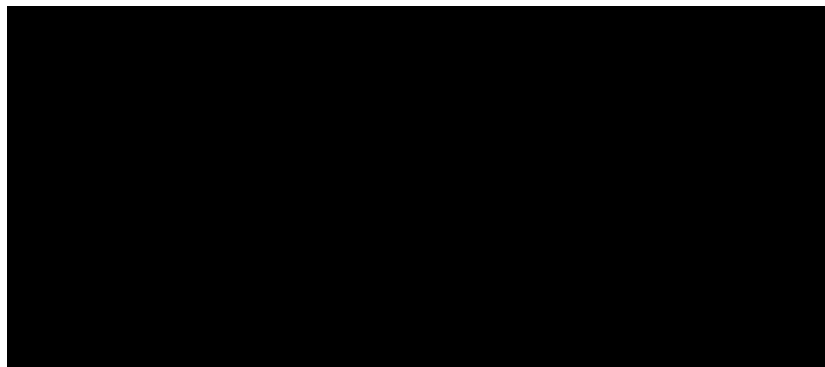


Figure 6: Handwritten Batch Record Text Extraction

Generative AI Data Query

A new project idea introduced to me by my supervisor was being able to query large amounts of data using an LLM (Large Language Model). I was provided an example spreadsheet that contained hundreds of lines of data used by NPD (New Product Development). They spend lots of time manually searching through the data when they have many spreadsheets containing large amounts. The idea was to create a chatbot that would allow for natural language queries and then extract data from various sources. It would then return a result of what the user was looking for.

My progress included the creation of a custom tkinter interface, allowing users to extract and filter data from selected data sources using a "filter" query. The initial interface had good functionality, but I spent more time improving the visibility of information and adding sorting functions. After a few interface iterations, I presented the demo at a catch-up meeting with Barry to ensure its alignment with the project goals. Below is an example of a query in the GUI.

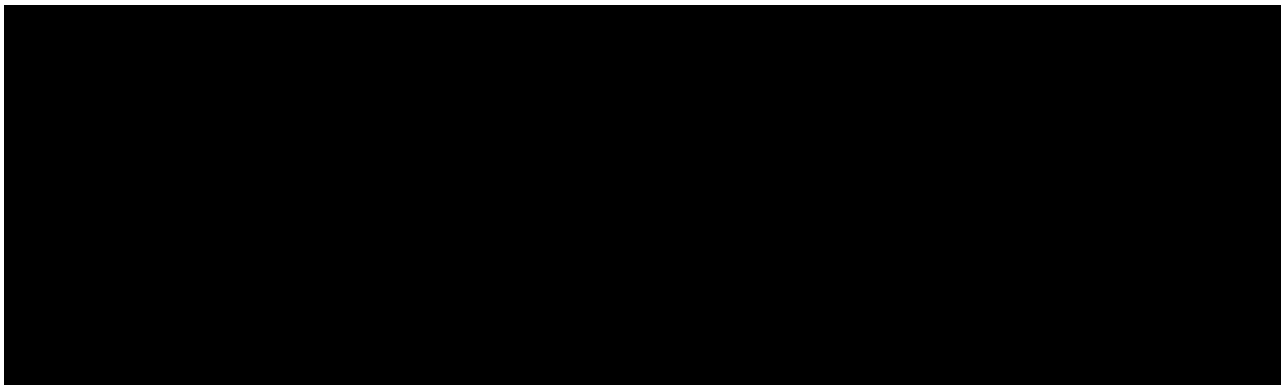


Figure 7: Database Query and Filtering

I faced many challenges when displaying a combined dataframe of multiple spreadsheets. For example, one issue was the query logic was not functioning when concatenating multiple spreadsheets. Ultimately, the challenge was overcome, and the interface successfully allowed the application of a search filter to a combined dataframe comprising data from multiple spreadsheets. Additional functionality included sorting columns in ascending and descending order with alternating clicks. After achieving this, I began exploring generative AI and LLM for querying a data pool, such as the example spreadsheets I was given. Once again, there were access limitations to Azure OpenAI services due to not having a full license. Although we could not begin practically developing our solution, we were shown a demonstration by the Microsoft technical team that our data can be uploaded to a model on the Azure OpenAI service and used to query a pool of data. The concept of our solution was proved, and I started considering future options, such as applying this generative AI concept to data such as the handwritten batch records being extracted. This process automation would make many people's lives easier, allowing them to do work of a higher value and help Douglas develop their use of modern technology.

Company Events

Throughout my internship, I was fortunate to be involved with many team events. The first event was an OT team Christmas lunch. Although I had just started a few weeks prior, I got to join the team for lunch at a local pub. It was a great team bonding event, especially since I was very new, and I got a chance to chat openly with my co-workers.

Another event was a BBQ for the digital team, courtesy of one of our technology service-based clients. They came over to our site with meat, snacks, juice, and alcoholic beverages for all to enjoy. Douglas was their first customer, and to show appreciation, they come over every year and celebrate with us. This was another chance to mingle and get to know others throughout the digital team.

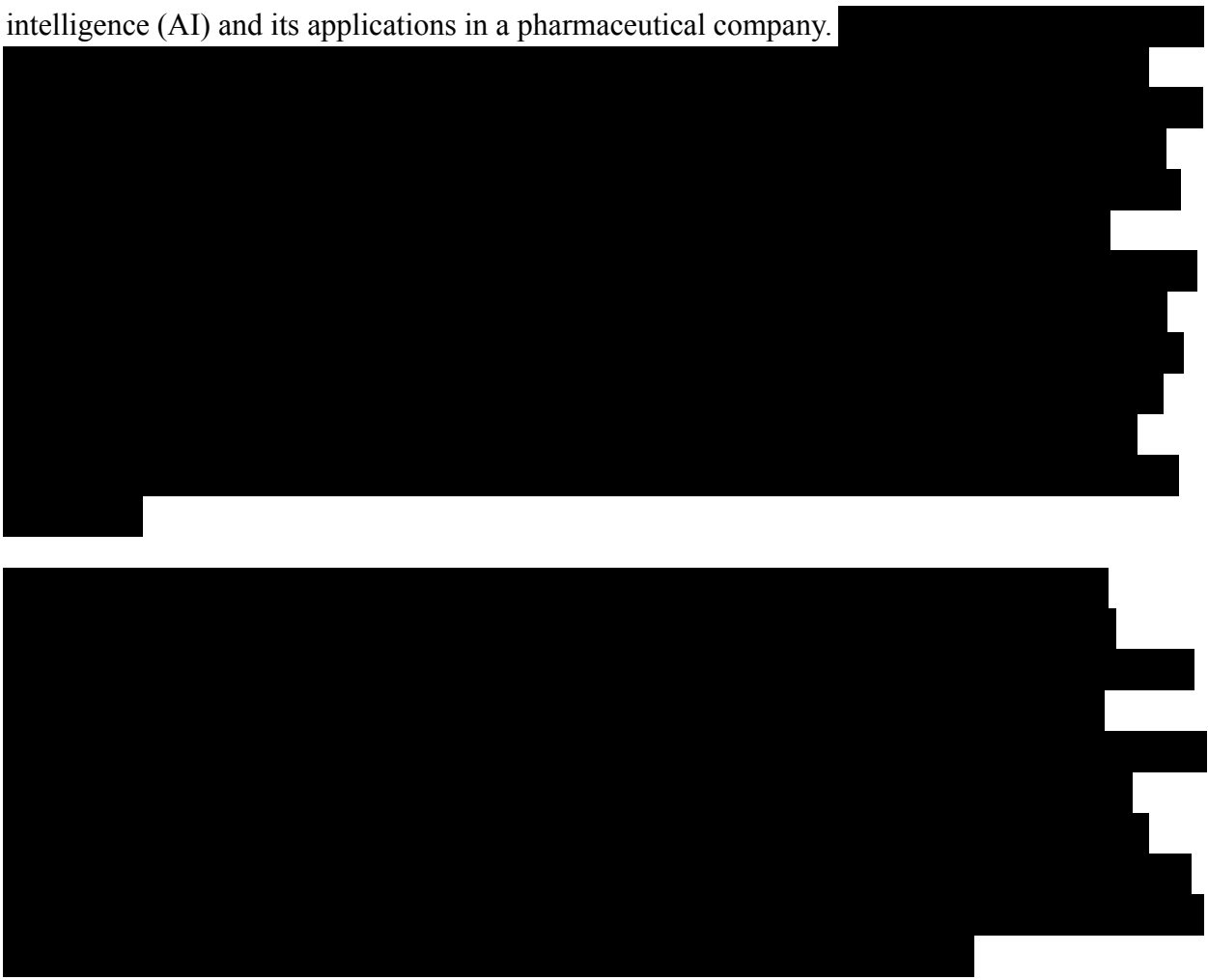
For Christmas, the digital team had their function: a day out to the beach where we played games, had a shared lunch and shared some drinks. Everyone spent time chatting, and a few swam in the water. Once again, it was a great opportunity to get to know the team better.

The company-wide function was large on-site for all staff across all departments and facilities. It was a large Mexican-themed party with almost ten food trucks, drink stations, and ice cream stands. I spent most of the time getting to know the other interns better while mingling over food and drink.

On Chinese New Year, the company held a special function over lunchtime with a Chinese dance performance to enjoy alongside some complimentary dumplings. We were all motivated to wear red in celebration of the occasion.

Reflective appraisal

During my practical work experience as an intern, I had the opportunity to explore artificial intelligence (AI) and its applications in a pharmaceutical company.



I learned a great deal throughout my work experience. For example, I had never previously used SQL, Microsoft Azure, and other software I learned at Douglas. Almost every day was a new learning experience for me, and I believe they are all great lessons that I can apply in any future engineering environment. I can now perform SQL queries, extract unique data, perform machine learning analytics, and use other AI techniques accurately. It was also very interesting to learn how these aspects are applied in a real-world concept (outside of university). Projects given in university are very controlled with fewer variables as they are designed to be completed. Doing work for a company is different as you have to create a solution from scratch and have no idea if it will work exactly as expected. I had lots of fun and enjoyed experimenting with different methods of developing a solution.

Some of the main skills I learned and developed during this experience were problem-solving, being proactive, and communicating. From the first day, I was given some project concepts and ideas with the incentive to come up with solutions since I was a fresh pair of eyes just having finished university. I was never explicitly told what to do. This pushed me to start thinking outside the box and come up with solutions to problems that also were realistic. I had to come up with solutions that I would be able to develop or at least prove the concept within my time as an intern. This led me to become more proactive because I knew I had to achieve some results, and I was implementing these projects alone. I could not procrastinate because it would waste the company's time, money, and resources. I also had to proactively chase people up when I needed help or more information from them. This worked hand in hand with further developing my communication skills. I was newly introduced to Microsoft Teams, a platform I could use to reach out to anybody in the company. I thought it would be best to take ownership and communicate with all relevant teams by sending updates and progress reports or following up if I did not get a response after a while. I also had to use research, project management, and software development skills throughout. I believe that overall, I was able to develop these skills further together as they worked well in conjunction and prepared me for any future engineering environments.

Conclusions

Completing this internship at Douglas Pharmaceuticals has been a great learning and personal development experience that allowed me to explore artificial intelligence and machine learning in the pharmaceutical industry. My work days were filled with diverse tasks, from meetings and workshops to developing code for machine learning models. My role within the operational technology (OT) team aimed to integrate AI tools into pharmaceutical processes, focusing on data analytics, machine learning, and AI applications for efficiency. Douglas Pharmaceuticals is an innovative company actively trying to improve the utilisation of modern technology within its daily operations. This experience has been a great turning point in my professional growth, adjusting my perspective on the industry and technology's crucial role in improving efficiency. I also learned how important it is to adapt to change; otherwise, there is a chance of getting caught in technical debt.

Despite the challenges, I am grateful for the exposure to diverse projects, the friendly environment that aided my skill development, and the invaluable lessons learned in navigating a corporate company for the first time. The lessons learned from struggles and challenges were significant parts of the journey. In conclusion, this internship has expanded my technical expertise and equipped me with crucial skills in research, project management, and communication. I believe I have improved my skills, from problem-solving and independence to proactivity. As I move forward, the experiences gained during this internship will undoubtedly shape my approach to professional engineering, emphasising the important integration of modern technology with the world.