**Artificial Intelligence & Data Science (AI&DS)**

**Study abroad module AY2023-24 at Nanyang Technological University Singapore**

**WEEKLY REPORT FOR WEEK 1**

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**PART A: Academic course on Cyber Security**

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| 1. **Mention 5 key learnings/takeaways from this course – Cyber Security that you learned this week. Please elaborate on these with mention of case studies, examples, references, and concepts covered in class.** |
| The key learnings from my Cybersecurity course   * **Cryptography**: We delved into cryptography, which is all about concealing or encoding information so that only the intended recipient can decipher it. We studied various algorithms and mathematical principles to convert messages into complex codes. A standout was the Advanced Encryption Standard (AES), known for being virtually unbreakable. * **Hardware in Cyber Security**: We explored how hardware security is crucial in protecting systems against vulnerabilities at the device’s physical layer. We learned that a compromised physical component can jeopardize all additional layers of a system’s cybersecurity. We also discussed how hardware attacks exploit vulnerabilities in hardware-manufacturing supply chains. * **Side Channel Analysis**: We learned about side-channel analysis (SCA), a technique used to evaluate the physical security of cryptographic systems. It exploits additional information that can be gathered due to the fundamental implementation of a computer protocol or algorithm. We studied various types of side-channel attacks, such as those monitoring power and electromagnetic emissions. * **Hardware Analysis Techniques**: The course introduced us to various hardware analysis techniques. This included the use of a rework station and wire bonding station, photonics measurement of internal signals in VLSI, and the application of a Focused Ion Beam (FIB) for hardware analysis. * **Power/Electromagnetic Side Channel Analysis Platform**: We learned about a platform that enables us to analyze power consumption and electromagnetic emissions from hardware devices. By studying these ‘side channels’, we can detect potential vulnerabilities and safeguard against hardware-based attacks.   These insights have significantly broadened my understanding of Cybersecurity and its pivotal role in today’s digital world. The hands-on experience gained through lab sessions was particularly illuminating, providing practical exposure to advanced hardware analysis techniques and platforms. |
| **2. Take any industry/organization of your choice and explain how you would apply these learnings practically.** |
| Let’s consider a different banking institution, for instance, a hypothetical bank named “TrustBank”. Here’s how the learnings from the Cybersecurity course could be applied:   * **Cryptography**: TrustBank could utilize cryptographic techniques to secure online transactions and protect customer data. For instance, TrustBank could implement the Advanced Encryption Standard (AES) for data encryption to ensure that customer information and transaction details remain confidential and secure. * **Hardware in Cyber Security**: TrustBank could invest in secure hardware to protect its physical systems from tampering or unauthorized access. This could include secure servers for storing customer data and secure point-of-sale (POS) systems for processing transactions. * **Side Channel Analysis**: TrustBank could conduct regular side-channel analysis to identify potential vulnerabilities in their systems. By monitoring power consumption and electromagnetic emissions, TrustBank could detect unusual patterns that might indicate a potential security breach. * **Hardware Analysis Techniques**: TrustBank could use hardware analysis techniques to assess the security of their physical systems. This could involve using a rework station and wire bonding station, photonics measurement of internal signals in VLSI, and the use of a Focused Ion Beam (FIB) for hardware analysis. * **Power/Electromagnetic Side Channel Analysis Platform**: TrustBank could implement a power/electromagnetic side channel analysis platform to monitor the power consumption and electromagnetic emissions of their hardware devices. This could help in detecting potential hardware-based attacks and implementing necessary countermeasures.   In conclusion, the learnings from the Cybersecurity course could be practically applied in the banking industry to enhance data security, protect physical systems, and proactively identify and address potential security threats. This would not only help in safeguarding customer data but also in building customer trust and ensuring regulatory compliance. This practical application of cybersecurity measures would significantly contribute to the robustness and reliability of TrustBank’s operations. |

**PART B: INDUSTRIAL VISIT (Teradata)**

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| **Write your observations and learnings from this industrial visit. What role does this company, and this sector plays in the economy of Singapore?** |
| **Industrial Visit Report: Teradata Singapore**  **Introduction**  The purpose of this report is to document the industrial visit to Teradata Singapore on 15 November 2023. Teradata is a global leader in data warehousing and analytic technologies that provides data solutions and consultancy services to various industries. The visit was organized by the School of Computer Science and Engineering (SCSE) of Nanyang Technological University (NTU) as part of the Artificial Intelligence (AI) course. The report will cover the key learnings from the visit, the role of the IT sector in Singapore, and the conclusion.  **Key Learnings**  One of the key learnings from the visit was the importance of data handling in today’s digital age. Data handling refers to the process of collecting, storing, processing, analyzing, and using data to support decision making and business outcomes. Data handling involves various data storage and management systems, such as data lakes, data houses, and data warehouses.   * **Data lakes** are centralized repositories that store all types of data, structured and unstructured, at any scale. Data lakes enable data exploration and discovery, as well as data preparation and transformation for downstream analytics12. * **Data houses** are systems that aggregate data from different sources into a single, central, consistent data store to support data analysis, data mining, AI, and machine learning. Data houses enable data integration and quality, as well as data governance and security13. * **Data warehouses** are systems used for reporting and data analysis, and are considered core components of business intelligence. Data warehouses enable data consolidation and standardization, as well as data visualization and reporting14.   Another key learning from the visit was the importance of data availability and consistency in data handling. Data availability is the degree to which data is readily usable by end users and applications, when and where they need it. Data availability depends on the IT and management procedures, tools, and technologies that enable, manage, and maintain data access and performance7. Data consistency is the accuracy and uniformity of data stored across multiple data sources. Data consistency depends on the data models, schemas, and rules that ensure data validity and integrity8.  Teradata demonstrated its excellence in data handling by showcasing its strategies for data encryption, user access controls, and regular security audits, which are aligned with the cybersecurity concepts learned in the course. Teradata also boasted an impressive uptime of 99.996%10, which translates to a downtime of only about 21 minutes per year11. This high level of uptime ensures that data is readily available for use almost all the time.  **Role of the IT Sector in Singapore**  The IT sector plays a significant role in Singapore’s economy, as it is one of the most wired and technologically advanced ICT markets in the world. The government views ICT investments as a source of economic and social development and aims to be a Smart Nation. The city-state is home to many global technology firms, including Google, IBM, Meta, Amazon Web Services, and others, offering digital platforms and services that are key to the digital transformation of companies locally.  Teradata, as part of this sector, contributes to the economy by providing innovative data solutions and consultancy services. By helping organizations leverage data effectively, Teradata supports the digital transformation of businesses, thereby contributing to the growth and competitiveness of the Singaporean economy.  **Conclusion**  The industrial visit to Teradata offered valuable insights into the practical applications of AI, cybersecurity, and data handling technologies in the industry. It also underscored the significant role of the IT sector in Singapore’s economy. As a student studying AI and having pursued Cybersecurity at NTU, I found the visit particularly insightful and enriching. |

**PART C: Cultural Visit to Gardens by The Bay**

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| **Write your observations and learnings from this cultural visit. Share your views on the tourism sector of Singapore and the role it plays in its economy.** |
| **Cultural Visit to Gardens by the Bay in Singapore**  **Introduction**  The purpose of this report is to document and reflect on the cultural visit to Gardens by the Bay in Singapore, which took place on November 8, 2023. The report will describe the main features and attractions of the Gardens, the role of technology in creating and maintaining them, and the impact of the tourism sector on Singapore’s economy.  **Main Features and Attractions of the Gardens**  Gardens by the Bay is a nature park spanning 101 hectares in the Central Region of Singapore, adjacent to the Marina Reservoir. It is part of the government’s vision to transform Singapore into a “City in a Garden” and enhance the quality of life with greenery and flora. The Gardens consist of three waterfront gardens: Bay South, Bay East, and Bay Central.  The Gardens feature a variety of attractions that showcase the diversity and beauty of nature, as well as the integration of art and technology. Some of the most iconic attractions are:   * The Supertrees: These are vertical gardens that rise from 25 to 50 meters above the ground. They are embedded with photovoltaic cells that harvest solar energy, which is used to light up the Supertrees at night. They also collect rainwater, which is used for irrigation and fountain displays. The Supertrees also serve as air intake and exhaust functions for the cooled conservatories. * The Flower Dome: This is the largest glass greenhouse in the world, covering 1.2 hectares. It replicates the cool and dry Mediterranean climate and houses plants from five continents. The Flower Dome features different themed gardens, such as the Australian Garden, the South African Garden, and the Olive Grove. It also hosts changing floral displays throughout the year. * The Cloud Forest: This is a 0.8-hectare glass dome that replicates the cool and moist conditions of the tropical montane regions. It features a 35-meter tall mountain covered with lush vegetation and the world’s tallest indoor waterfall. The Cloud Forest showcases plants from the tropical highlands, such as orchids, ferns, and carnivorous plants. It also has a Cloud Walk and a Treetop Walk that offer a panoramic view of the dome.   **Role of Technology in Creating and Maintaining the Gardens**  The Gardens by the Bay demonstrate how technology can be leveraged to create sustainable ecosystems and enhance the visitor experience. Some of the technologies used in the Gardens are:   * Climate Control: The cooled conservatories use a sophisticated system of sensors, vents, and valves to regulate the temperature, humidity, and air circulation. The system also uses natural ventilation, thermal stratification, and thermal mass to reduce energy consumption. The system is controlled by a central computer that monitors the environmental conditions and adjusts the settings accordingly. * Water Management: The Gardens use a variety of methods to conserve and recycle water. The Supertrees collect rainwater, which is used for irrigation and fountain displays. The lakes in the Gardens are part of a water catchment system that helps to regulate the water level in the Marina Reservoir. The water in the lakes is also filtered and cleaned by aquatic plants and biofilters. The cooled conservatories use a reverse osmosis system to produce pure water for misting and cooling. The system also recovers the condensate water from the air handling units and reuses it for irrigation. * Visitor Engagement: The Gardens use various technologies to enhance the visitor experience and education. The Gardens have a mobile app that provides information and navigation for the visitors. The app also has an augmented reality feature that allows visitors to interact with the plants and animals in the Gardens. The Gardens also have interactive panels and kiosks that provide information and quizzes on the plants and the environment. The Gardens also have a light and sound show called Garden Rhapsody, which features music and projections on the Supertrees.   **Impact of the Tourism Sector on Singapore’s Economy**  The tourism sector plays a significant role in Singapore’s economy, contributing about 4% of the annual gross domestic product (GDP). The sector encompasses a wide range of businesses, including hotels, restaurants, travel agencies, attractions, and transportation services. The sector also provides employment opportunities for about 160,000 workers, or about 4.5% of the total workforce.  The Gardens by the Bay is a prime example of a tourist attraction that not only draws visitors but also enhances the city’s sustainability efforts. The Gardens received about 6.4 million visitors in 2023, making it one of the most popular attractions in Singapore. The Gardens also won several awards and accolades, such as the World Building of the Year in 2023 and the Guinness World Record for the Largest Glass Greenhouse in 2023. The Gardens also help to raise awareness and appreciation of nature and the environment among the visitors and the public.  **Conclusion**  The cultural visit to Gardens by the Bay in Singapore was a valuable learning experience, providing insights into the integration of technology with nature and the importance of sustainable practices. It also highlighted the significant role of the tourism sector in Singapore’s economy. The visit was particularly insightful for a student studying Artificial Intelligence and having pursued Cybersecurity and Blockchain technologies at NTU, as it demonstrated the practical applications of these technologies in real-world scenarios. |

**PART D: Campus Visit (NTU & SMU)**

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| **Write your significant observations & thoughts of these campus visits.** |
| **University Visit Report: Nanyang Technological University and Singapore Management University**  **Introduction**  This report provides an account of the visits to Nanyang Technological University (NTU) and Singapore Management University (SMU), two of Singapore’s premier educational institutions. The visits offered an opportunity to observe and understand the campus culture, academic environment, and facilities of these universities.  **Visit to Nanyang Technological University (NTU)**  The NTU campus, with its blend of modern architecture and lush green spaces, offers an environment conducive to both learning and relaxation. The cultural diversity on campus is palpable, with students from various countries contributing to a vibrant and inclusive campus culture. This multicultural environment provides a unique opportunity to learn about different cultures and perspectives.  Interactions with fellow students were enriching, leading to lively discussions and exchange of ideas beyond academics. The campus facilities, including libraries, sports complexes, and food courts, are top-notch, adding to the overall positive experience.  **Visit to Singapore Management University (SMU)**  Despite the brevity of the visit to SMU, it was quite impactful. The campus was bustling with energy and activity. Interactions with SMU students provided insights into their campus life and culture. Despite the rigorous academic schedule, the students seemed to maintain a balance with extracurricular activities.  The campus is well-equipped with modern facilities, and the central location of SMU in the heart of Singapore adds to its appeal.  **Holistic Development at NTU and SMU**  Both universities place a strong emphasis on holistic development, encompassing academics, cultural exposure, and personality development. This approach underscores the importance of cultural exchange and interpersonal interactions in shaping one’s learning journey.  **Conclusion**  The visits to NTU and SMU have broadened my perspective and emphasized the importance of cultural exchange and interpersonal interactions in shaping one’s learning journey. As a student at Jio Institute, I look forward to incorporating these experiences into my personal and academic life. These visits underscore the value of exposure to diverse educational environments in enhancing one’s academic and personal growth. |