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CYBERSECURITY & DATA PROTECTION IN THE CONTEXT OF ARTIFICIAL INTELLIGENCE

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Abstract

As cyber threats grow more complex and widespread, AI is increasingly deployed to strengthen cyber security and data protection. This paper examines how AI techniques, particularly machine learning and deep learning, which can improve the detection, containment and eradication of cyber threats, and the ethical issues that arise from their use. The findings indicate that AI tools are highly effective at automating threat detection and response. Key benefits include predictive analytics, automated threat detection and real-time adaptive changes to cyber defences. However, emerging risks such as Adversarial AI exist, alongside significant ethical and regulatory issues, including privacy breaches, algorithmic bias and the lack of governance frameworks. Practitioners generally consider the tools practical, though there was strong consensus that a human in the loop is essential and that full automation should be avoided. The paper also argues that the AI cyber security operational model, which also requires massive volumes of data collected continuously to enable predictive risk profiling, fundamental conflicts with GDPR principles, particularly on data minimisation and the prohibition on automated decision making. AI has enormous potential to improve cyber security, but its use must be carefully balanced against privacy, fairness and legal compliance. The study concludes, Artificial Intelligence requires strong governance, GDPR-compliant data handling and human oversight.

Keywords: artificial intelligence, cyber security, data protection, GDPR, machine learning, ethical governance framework.

Introduction:

Cyber security and data protection have become very important in the world. The fast growth of devices that connect to the internet, cloud services and ways of doing business that depend on data have made it easier for bad people to attack. The dangers are getting complicated more common and harder to find out who is behind them. Companies can no longer depend on old ways of protecting themselves. There is a need for security methods that can learn, change and react as fast and as much as modern attacks happen. Artificial Intelligence (AI) machine learning and deep learning has become one of the best ways to deal with this problem. By looking at a lot of data from networks and users AI systems can find patterns, spot things that are not normal and help find, stop and

remove cyber threats usually right away. Features like predicting what might happen finding threats automatically and changing security measures help security teams act before a problem causes damage. Using AI in cyber security comes with some dangers. Adversarial AI, where bad people trick the models that companies rely on creates types of weaknesses. In addition to the dangers using AI brings up big questions about ethics and rules like losing privacy unfair decisions by machines and not having good systems to manage it all. These worries are very important because AI-based security systems need to collect a lot of data all the time to make predictions. This way of working is not always in line with the rules of the General Data Protection Regulation (GDPR) especially when it comes to not collecting much data and not making decisions only by machines. The question is not just if AI can make security better. Under what conditions it can do that in a responsible way. This study looks at how AI methods can make it easier to find and respond to cyber threats and the ethical and legal problems that come with using them. It also looks at what people who work in the field think about these tools, including how much humans should be involved and how much can be done automatically. The paper says that AI has a lot of potential to make cyber security better. That using it must be balanced with keeping privacy being fair and following the law. The rest of this paper is laid out like this. Section 2 explains the research method. Section 3 looks at the work about AI in cyber security the dangers involved and the rules that apply. Section 4 shows what was found. Section 5 ends by talking about the need, for good control following GDPR rules when handling data and having humans watch over the process. The important thing now is to make sure that security and privacy are protected. The field of cyber security is being changed a lot by intelligence, which is known for being able to learn from information and make good decisions.

Future Trends in Data Leakage Attacks:

Data leakage attacks take advantage of the fact that artificial intelligence models create parameters, predictions and output vectors based on training data. Because these results come from the data set they can accidentally show private information about the data used when the model was trained. Because of this no AI model can be seen as safe from data leakage attacks. Future changes in this area are expected to aim at two goals. First scientists will keep making advanced attack methods that can get more details from model results. Second data leakage attacks will be used with learning ways like transfer learning and reinforcement learning which means they will cover more areas and be more useful. A big problem with privacy theft attacks is the number of times someone has to interact with the target model. For instance model extraction attacks often need queries to create a good model that acts like the original. This need is because deep neural networks have a space with dimensions, nonlinear behaviour and complicated ways to optimize. Many queries make the cost of computing higher and also make it more likely that the attack will be found. Because of this making attacks faster has become a topic for research. Many methods have been suggested to use queries but still do the job well. Most of these methods

use ways to pick the best samples that give the most useful information. Methods like learning and natural evolution strategies have shown good results in making privacy theft attacks work better. Even though these attacks are harmful research, on data leakage attacks helps make AI security better. By finding spots and learning how attacks work scientists can create better ways to protect privacy and build AI systems that are more secure andreliable.

Artificial Intelligence and Privacy:

Artificial Intelligence or AI is an area that covers machine learning and cognitive computing. These technologies allow computers to do things that are similar to how humans think. For example computers can learn from data understand language and solve problems. In situations computers can do these tasks faster and with fewer mistakes than people. Today AI is used in different fields. It helps with things like recognizing voices and faces diagnosing health conditions predicting trends and tracking disease outbreaks. AI systems take in information analyse it and then make choices or take actions to reach goals.

AI tools can also help keep data safe and protect privacy. When AI is used together with block chain technology organizations can use data to learn and improve without owning the data or having full control over it. This way the risks for both the organizations and the people sharing their information I reduced. By including privacy protections, on, when designing block chain systems and procedures both the people involved and the organizations managing the system can benefit. This helps build trust and keeps information more secure from the start. Tension with the GDPR. I see that the GDPR does not forbid AI-based security yet two rules in the GDPR limit how these AI-based security systems are made and used.

Data Minimisation:-

GDPR requires personal data to be adequate, relevant, and limited to what is necessary for a specific purpose. This creates challenges for AI-based security systems, as predictive risk profiling often relies on large volumes of diverse data that may be stored for long periods. While GDPR recognises security as a legitimate objective, it only permits processing that is necessary and proportionate to achieving that goal. Therefore, the key issue is not whether security monitoring is allowed, but whether the amount of data collected, the retention period, and the scope of processing are justified. Purpose limitation and storage limitation further restrict excessive data use. GDPR also protects individuals from decisions based solely on automated processing, including profiling, when

such decisions have legal or similarly significant effects. Exceptions apply when the decision is necessary for a contract, authorised by law with appropriate safeguards, or based on explicit consent. In these cases, individuals must be able to seek human review and challenge the outcome. The use of special-category data is subject to even stricter safeguards and limitations.

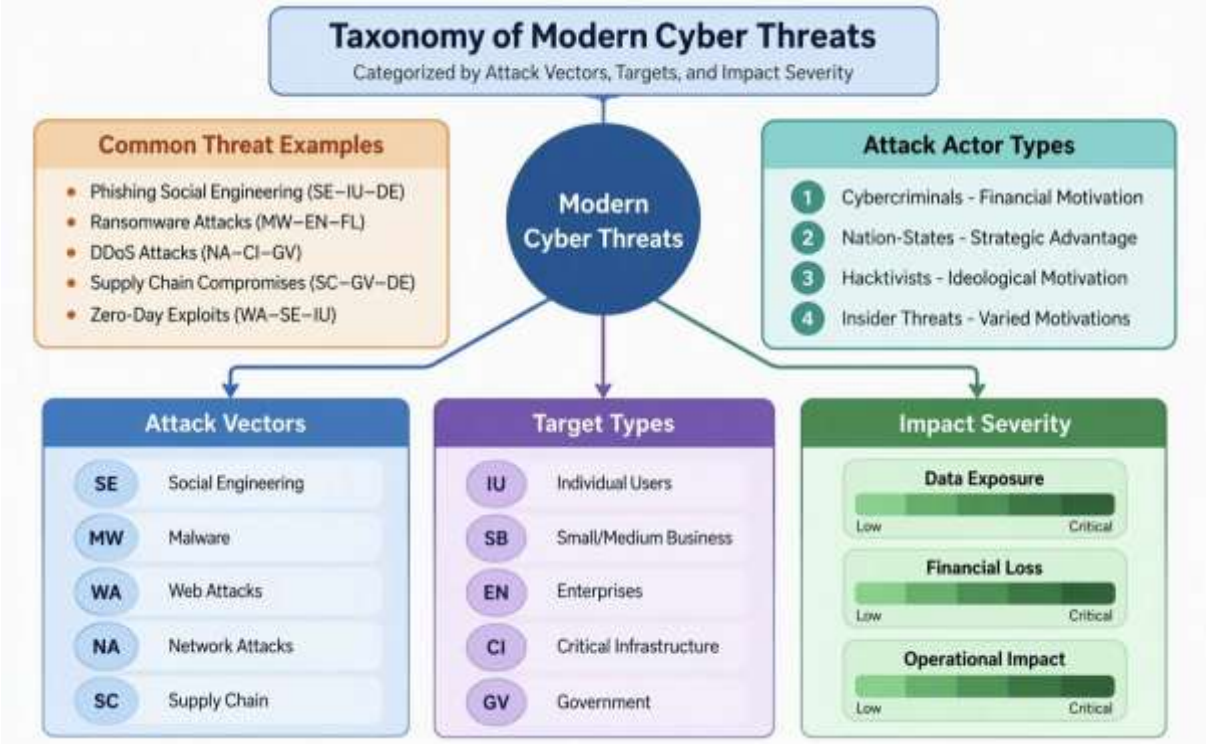


Figure 4.1 : Taxonomy of Modern Cyber Threats

Applications of AI in Cyber security:

As cyber threats become more sophisticated, organisations in both the public and private sectors are increasingly adopting artificial intelligence (AI) and machine learning to enhance their cybersecurity capabilities. Modern security teams face persistent threats from hackers, cybercriminal groups, and state-sponsored cyber operations. AI helps address these challenges by analysing vast amounts of network data, identifying unusual patterns, detecting potential threats in real time, and enabling faster responses to security incidents. This improves the protection of critical systems, sensitive information, and digital infrastructure.

However, the growing use of AI also introduces new risks. The same technologies that strengthen cyber defences can be misused to develop more advanced and difficult-to-detect attacks. Malicious users can leverage AI to automate cyberattacks, exploit vulnerabilities more efficiently, and evade traditional security measures. Additionally, AI systems themselves may be susceptible to manipulation, potentially weakening the security mechanisms that rely on them.

Consequently, cybersecurity has evolved into a continuous technological contest in which AI serves both defensive and offensive purposes. To ensure that its benefits outweigh its risks, organisations must implement AI responsibly, supported by appropriate governance, oversight, and security safeguards.

Types of Cyber Threats:

Cyber threats are growing in number and complexity every year. Privacy and data security are under attack. Cyber security professionals must stay alert to the ways systems can be compromised. Hackers are no longer just trying to break into systems—they are using tools to steal information, disrupt services and influence decisions. These attacks can happen for money, power or even political goals.

As technology moves forward with the rise of AI new threats are emerging. Attackers can now use machine learning to automate attacks craft convincing phishing messages or find weaknesses in software. They can even use AI to test systems and learn how to exploit them. This means that old defences are not enough. Security systems need to evolve as fast as the threats do.

The goal of this research is to understand how AI changes the game in cyber security. On one hand AI can help organizations detect and stop threats before they cause harm. On the hand it can also make threats more powerful and harder to control. The challenge is to use AI to protect systems while preventing misuse. AI-driven security is not a solution. It's a tool that must be used carefully, with oversight and ongoing updates.

Machine Learning for Attack Mitigation:

Machine Learning and its uses are still developing, among small and medium-sized enterprises. The study identified three types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning and the algorithms that support each type. Examples of Supervised Learning are text on Twitter, analysis

of product reviews on Amazon and eBay and predictive modelling tasks such as forecasting temperature calculating insurance premiums setting product prices and planning workforce based on company revenue. Unsupervised Learning is used for tasks such as detecting news, filtering spam spotting fraud or criminal activity online and optimizing marketing campaigns. Reinforcement Learning is often shown in video game settings, where algorithms learn by receiving rewards or penalties for the actions they perform. Every type of Machine Learning uses algorithms and data sets to perform calculations create predictions and make better decisions. The study also noted that awareness of Machine Learning among SMEs is increasing and showed its business uses. Building on this knowledge this study aims to raise SME awareness of the Machine Learning algorithms that are already part of their cyber security software. Analysis showed that advanced Machine Learning algorithms like Neural Networks, Support Vector Machines, Deep Neural Networks and Bayesian Models are present. Often these algorithms run in the background. Are smoothly integrated into cyber security tools so their function is largely hidden from users. Using Intrusion Detection and Prevention Systems, both commercial and open-source has become more important for protecting SME data. As cybercriminals use advanced attacks and automated bots organisations rely more on Artificial Intelligence and Machine Learning to strengthen cyber security defences. Machine Learning enabled IDPS can examine network traffic patterns tell apart legitimate from actions and keep improving detection through learning. Of all the Machine Learning methods used in cyber security anomaly detection is more effective at spotting zero-day attacks than traditional signature-based methods. This ability makes Machine Learning powered cyber security especially useful for SMEs that want protection from new threats. So a big gap still exists in adopting and developing these technologies. Exploring cyber security solutions, such as open-source platforms and community projects could help SMEs build stronger defences against future cyber threats and keep their security systems working well.

Balancing Privacy and Security:

Finding the balance between privacy and security is very important when using AI in cyber security. One of the ways to do this is through data minimization. This means collecting the data that is really needed for a specific task and keeping it only as long as necessary. By doing this organizations reduce the amount of information they store. It also lowers the risk of privacy breaches while still allowing them to use AI effectively. Another key strategy is using anonymization and encryption. Anonymization removes details from data so that individuals cannot be identified. Pseudonymization replaces identifiers with fake names or numbers making it harder to connect data back to a person. Encryption protects data while it is being sent and while it is stored. This helps prevent hackers from accessing information and keeps the data safe and intact . Transparency and user consent are also very important. Organizations must clearly explain what data is collected how it is used and how it is

protected. Users should be able to understand these practices and have real control over their personal information. Providing consent forms and allowing users to check and change their data settings builds trust. It also helps organizations meet privacy laws and regulations. Regular audits and assessments help keep privacy and security strong. Checking AI systems and data processes often helps organizations find risks early. These checks make sure that security controls and data policies are still working well. They also help organizations stay up to date with technology and new laws.

In summary organizations can balance privacy and security by using data minimization applying anonymization and encryption being open with users getting consent and doing ongoing checks of their AI and data systems. These steps support both security and respect, for personal privacy. Development of Effective Defences Techniques against Data Leakage Attacks Data leakage attacks happen when a machine-learning model accidentally shows information in its design, training or answers. Because people can guess private data from the model's settings or its predictions, defence mechanisms for data leakage attacks normally concentrate on three ideas:

- Output Obfuscation: Lowering the share of private data that appears in the model's answer vectors so that data leakage attacks see less useful information.
- Data Obfuscation: Adding deliberate changes to private data before training which makes it harder for data leakage attacks to pull out sensitive details from the model's predictions.
- Model Parameter Obfuscation: Using privacy-protecting methods that hide model settings, middle calculations and answer vectors by encryption or other safety tools so data leakage attacks cannot easily steal information. Although these defence strategies can boost privacy protection a lot picking the amount of obfuscation is very important. If obfuscation is not strong enough, data leakage attacks can still break the model. Steal private data. If obfuscation is too strong, the model's performance drops the answers become weaker. The main job of the model gets hurt. A similar problem shows up in privacy-preserving tools, like query control defences. Tight limits on queries can stop data leakage attacks from getting data but they can also make the user experience bad by forcing real users to work harder or by flagging honest users as attackers by mistake.

Thus, good privacy protection needs a trade-off between security and usability. Defences mechanisms for data leakage attacks must give safety while keeping the model's accuracy, reliability and overall service quality intact. Finding this balance is still a research hurdle and a key issue when putting privacy-preserving machine learning systems into real use and, for their future growth.

Improving Public Awareness and Data Literacy

In today's data-driven world, the volume of data generated, collected, and shared is increasing at an unprecedented rate. As organisations become more reliant on data for decision-making and innovation, the ability to understand, manage, and protect information has become a critical skill. This highlights the importance of both data literacy and data awareness.

Data literacy is particularly important for professionals who regularly work with information, including researchers, data analysts, and public-sector employees. These individuals must understand how data is collected, processed, stored, and governed. They are responsible for implementing appropriate security controls, ensuring data integrity, and complying with privacy and data protection regulations. Effective data management helps reduce the risk of unauthorised access, data breaches, and misuse of personal information.

At the same time, data awareness is essential for all individuals. People should recognise the value of their personal data and understand the potential risks associated with oversharing information online. Sensitive details such as passwords, financial information, and home addresses should be protected, while the privacy of others should also be respected. A lack of awareness can lead to identity theft, fraud, privacy violations, etc.,

Together, data literacy and data awareness promote responsible digital behaviour, strengthen privacy protection, and contribute to a safer and more trustworthy digital environment for everyone.

Conclusion:

Artificial Intelligence (AI) is transforming cybersecurity and data protection by improving threat detection, risk analysis, and incident response. Using machine learning, behavioural analytics, and predictive modelling, AI can analyse large volumes of security data in real time, enabling organisations to identify vulnerabilities and respond to cyber threats more effectively. Generative AI also enhances threat intelligence and security automation, strengthening overall cyber resilience. However, AI presents significant security and ethical challenges. The same technologies that support cyber defence can be exploited to create sophisticated attacks, including deepfakes, AI-generated phishing campaigns, and adaptive malware. In addition, AI implementation often requires substantial computational resources, high-quality datasets, and specialised expertise. Concerns regarding algorithmic bias, privacy infringements, and autonomous decision-making further highlight the need for responsible AI governance. Effective deployment requires strong data governance frameworks, privacy-preserving measures, explainable AI (XAI), and continuous human oversight to ensure transparency and accountability. These issues

have important implications for both policymakers and cybersecurity professionals. Regulators must develop balanced frameworks that encourage innovation while protecting privacy and security, whereas organisations must integrate AI responsibly into their cybersecurity strategies. Although AI has the potential to revolutionise cybersecurity, challenges relating to security, ethics, and governance remain. Future research should focus on explainable AI, adversarial robustness, scalable AI solutions, and emerging technologies such as quantum machine learning and neuro-symbolic AI. Ultimately, achieving the full benefits of AI will depend on balancing technological advancement with robust governance and ethical safeguards

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