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NEURAL NETWORKS INTEGRATION INTO LEGAL RESOURCES FOR ANTI-CORRUPTION MEASURES IN INTERNATIONAL ECONOMIC CO-OPERATION

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Abstract. The article under discussion highlights that appropriate evaluation procedures are of crucial importance for anti-corruption and other compliance assessments in international commercial transactions, national physical security guarantee agreements, their combinations, and other related deals. It is imperative that legal standards of higher civilisations neutralise the corruptive barriers posed by lower civilisations, which they integrate with through economic, defence, and other alliances. The primacy of natural law is emphasised as being balanced rather than opportunistic, both at the level of individual legal relations and in inter-nation interactions. The attainment of public goods by a nation is the result of human virtues being released from the pressure of human vices. This issue is further exacerbated by the capabilities of non-anthropogenic neural networks at the current stage of human development. The study establishes that interstate corruption exhibits all the characteristics of national corruption while additionally incorporating a scaling effect, which manifests in the preservation and expansion of material benefits through the economic exploitation of other nations and/or the use of their legal systems. In contrast to the typical, long-term, and easily sustained nature of national administrative corruption, the practice of abusing power within multinational organisations is neither typical nor easily sustained. The corrupt dimension of international communication is a constant variable, with a variable volume. The presence of virtuous individuals in top public positions within the world's most powerful nations has been demonstrated to reduce the level of global corruption-driven perversion and vice versa. The study concludes that transnational corruption constitutes organised crime, with both phenomena forming complex networks involving extremely high sums of criminally acquired assets. A deep neural network has been posited as a potential analytical and predictive model with the potential to empower stakeholders engaged in anti-corruption activities and enhance national security by providing accurate data for informed decision-making. The capabilities of non-anthropic neural networks have the potential to eliminate human error and bias in analysing the expenditure of public funds by organisations, both domestically and in international relations within foreign jurisdictions. In this context, the composition, adequacy, classification, and other characteristics of financial data, as well as access rights and regulations governing the use of neural network analysis results, play a crucial role. The overarching objective of digital networks is to ensure accurate assessment of all financial and accounting documents related to public funds and other national material resources in international economic transactions. The primary anti-corruption knowledge generated by digital neural networks consists of reliable insights into interconnections, patterns, and behavioural trends concerning material assets beyond national borders. The prevention of corruption and its associated forms of organised crime is achieved through the analytical capabilities of multimodal AI models such as Gemini, GPT-4o, and other deeply trained neural networks. In addressing the challenges posed by corruption in the context of international economic relations, the efficacy of any neural network with extensive training is noteworthy. This could be a LipNet neural network, which is trained for audio-visual recognition of human speech, or another recurrent neural network, as well as convolutional neural networks, deep contrastive neural networks, residual neural networks, and others.

Keywords: agreement, criminal assets, data, deep learning, finances, cronyism, kleptocracy, neural networks, cyberspace.

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1. Introduction

Corruption has been demonstrated to circumvent democratic decisions, dampen economic growth, impede the redistribution of resources and wealth to the detriment of the less well-off, and, more generally, reduce trust in society (Pedersen, 2023, p. 1261). The phenomenon of systemic corruption, along with the limitations it imposes on state capacity, has been identified as a "characteristic problem for countries with transitional economies" (Revkin, 2024, p. 1596). For instance, Ukraine achieved its highest score in the Corruption Perceptions Index (CPI) since the index's inception in 1995, receiving 34 out of 100 possible points and ranking 104th out of 180 countries in the most recent assessment in 2024. Denmark was the leading country with 90 points (CPI 2024). However, the momentum of Ukraine's anti-corruption legislative innovations, which had begun to become relatively systematic in 2021, was halted by the onset of large-scale external military aggression. One of the significant legislative developments of that period was the ambitious Law of Ukraine "On Preventing Threats to National Security Related to the Excessive Influence of Persons with Significant Economic and Political Weight in Public Life (Oligarchs)" dated September 23, 2021, No. 1780-IX, aimed at countering kleptocracy and political corruption. The introduction of lobbying regulation can be regarded as an innovation intended to neutralise such threats. In the context of Ukraine, the pursuit of rule of law is substantially encumbered by the dual challenges of combating corruption and defending against external military aggression. "As the meaning of historical struggle becomes clear through the course of societal development, only then can society truly recognize the moral significance of acknowledging it." (Grigore, 2025, p. 108)

2. Analysis of Recent Topical Resources

Together, the studies shed light on the intersection between artificial intelligence, governance, anti-corruption efforts and economic regulation. They highlight the challenges and opportunities that have emerged in the digital era. K. Alhosani and S. Alhashmi examined the challenges and advantages of AI-driven innovations in public services. Conversely, S. Carcelli analysed the relationship between bureaucratic structures and compliance with international agreements. S. Chayes emphasised the threats that corruption poses to global security. By contrast, M. Dang and T. Vu examined the importance of good governance and anti-corruption initiatives in the digital era. Furthermore, Djenna, E. Barka, A. Benchikh and K. Khadir examined AI-powered cybersecurity analytics for the detection of cybercrime. W. Dong and S. Sun proposed the utilisation of multi-view deep Gaussian processes for the purpose of supervised learning. In a similar vein, J. Echenausía-Monroy, D. Magallón-García, L. Ontañón-García, R. Rodriguez, J. Ramirez, and J. Álvarez made significant contributions to the domain of machine learning through the development of recurrent neural network applications. H. Lee, C. Jang, D. Bok Lee, J. Lee introduced agnostic neural processes, while K. Miller, C. Hettinger, J. Humpherys, T. Jarvis, D. Kartchner applied deep random forest methodologies for training neural networks. In addition, H. Peng and J. Wang investigated advanced spiking neural systems, while J. Jiao, X. Zhang, Z. Liu, L. Zhang, H. Wu, M. Gao, T. Li, and J. Wu developed deep contrastive structures for unsupervised forecasting in dynamic networks. M. In his discourse on the future of European competitiveness, Draghi explored the impact of digital administration on political rationality and governance, a topic subsequently explored by A. Khaldi. Despite the extensive corpus of scientific works relevant to the subject of the research, this study proposes a hypothesis concerning the capacity of non-anthropomorphic neural networks to eradicate interstate corruption in economic relations, a pernicious threat to the security of nations.

3. The Distinctive Attributes of Corruptive Erosion in Inter-state Economic Synergies

In accordance with the United Nations' Sustainable Development Goals (SDGs) for 2030, digital technologies have the capacity to facilitate access to relevant information, monitor the implementation of reforms, promote transparency in public institutions, strengthen the rule of law, improve anti-corruption mechanisms, and provide better protection of citizens' fundamental rights (SDG 16, UN, 2015). The most recent changes are set against the backdrop of globalisation, technological advancement, the expansion of intergovernmental organisations, international economic co-operation, and the increasing roles of non-state actors such as multinational corporations (Olaniyan, 2023, p. 43). It is widely accepted that the attainment of long-term development by enterprises is a prerequisite for ensuring national security and attaining economic prosperity. In the EU and the Asia-Pacific region, enterprises are regarded as the fundamental driving force of the economy. The prevailing belief is that the effective mobilisation of enterprise capabilities is pivotal for enhancing national competitiveness and fostering economic dynamism (Zhang, 2023, p. 25144).

The pervasiveness of corruption on a global scale serves as an indication that the implementation of various policy initiatives has not yielded the desired outcomes, underscoring the necessity for additional

policy directives (Zhang & Goel, 2023, p. 2479). The contemporary transformation of humanity is characterised by the remarkable convergence of emerging technological breakthroughs encompassing artificial intelligence (AI), robotics, the Internet of Things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, quantum computing, and numerous others. For instance, the global cybersecurity market, which has exhibited consistent annual growth, is projected to reach 562.72 billion USD by 2032 (Schwab, 2016, p. 7, 59; Cybersecurity, 2025). The EU and NATO are both active in a broad range of security and defence activities, including crisis management, cybersecurity and resilience. These activities entail the coordination and sharing of material resources, personnel and expertise (Hoeffler, 2024, p. 1265).

Political corruption and kleptocracy act as persistent impediments to the transition from a totalitarian to an anthropocentric socio-legal regime, from violence against individuals by criminal justice bodies to the protection of human rights by those same bodies. Funds stolen from national treasuries around the world (resources that should be spent on health care, education and sanitation) continue to flow into real estate and other investments in Western financial centres (Keatinge, 2024, p. 1). According to Lizundia (2024, p. 6), kleptocratic governance is associated with authoritarian regimes that use state resources for personal enrichment and the consolidation of political power. It is also associated with countries where political elites are intertwined with transnational criminal networks and where large-scale corruption undermines democratic processes. Misra (2022, p. 12) suggests that loyalty to corruption can stem from its widespread perception as a cultural norm rather than a hindrance to development. The systemic, long-term, and widespread nature of large-scale corruption distortions leads to the formation of transnational connections, as well as the deepening of organised crime involving money laundering, foreign intelligence bribery, espionage, terrorism, and a range of other crimes against the constitutional order, the lives and inviolability of citizens, and other national legal values. "Corruption and money laundering are interrelated and self-reinforcing phenomenon, because corruption proceeds are disguised and laundered by corrupt officials to be able to spend or invest such proceeds." (Zhu, 2022, p. 994) The threat posed by this entrenched criminal system to the violation of human rights and other constitutional values in Ukraine is analogous to the challenges faced by Italy and the EU in countering the mafia. "Italian organized crime of the mafia type is a clear and present danger to the EU. The foundation of mafia power lies in its control and exploitation of territory and community. Contextual concepts of family, power, respect, and territory are fundamental to understanding mafia dynamics. The mafia is capable of manipulating elections and placing its people in administrative roles even far from the territories they control. In this sense, the threat they pose is unmatched by any other European organized criminal group." (Europol 2013, p. 3) Kleptocratic tactics, when combined into strategies, enable corrupt elites to target and capture public finances, commodities, natural resources, development and security assistance, the private sector and strategic assets. Kleptocrats aim to accumulate significant wealth for personal gain, and to consolidate and entrench political power in their home countries, and occasionally in foreign countries over which they wish to exert their influence (Kleptocrat's, 2021, p. 1).

Corrupt fugitives are able to evade domestic prosecution and launder their illicit funds worldwide by taking advantage of the international financial system, networks, and immigration policies of foreign jurisdictions. Seizing these fugitives requires international co-operation, but this often encounters roadblocks caused by legal and political differences between countries, which make extradition and mutual legal assistance exceptionally difficult, if not impossible, to achieve. For instance, numerous endeavours by the Chinese government to extradite corrupt fugitives in the past, including the notable Lai Changxing (赖昌星) of the Yuanhua (远华) smuggling case, have resulted in protracted impasses (Zhu, 2022, p. 994). In the field of international relations, crimes within the remit of Interpol and Europol, including corruption, increase in scale but retain their defining features. "The majority of imports into the EU depend on countries with low governance ratings – governance includes aspects of political stability, government effectiveness, rule of law, control of corruption, as well as voice and accountability." (Draghi, 2024, p. 47) A failure to manage mineral resources, finances and other material assets of the nation effectively at all stages of the investment process, as well as distortions in the essence of internal financial control, can lead to unsatisfactory results in economic growth and social welfare of citizens. This is often accompanied by a range of economic and official crimes, which are typical of corruption-prone countries. "Financial control enables the elimination of abuse in the financial sphere, corruption among officials, misuse and inefficiency in the allocation of financial and budgetary resources." (Ivaskevych, 2019, pp. 188, 43) Ensuring the legal framework for quality personnel policy, elimination of inter-official cronyism, corruption in the form of service exchanges, use of publicly funded labour of others for private gain instead of satisfying public interests, falsification of results and authorship, corrupt earnings, and similar distortions guarantees economic integration into highly civilised

communities on equal terms (Makarenkov, 2023), "so that democracy would have a chance to consolidate, and peace an opportunity to take root" (Nalepa, 2022, p. 12).

Many international agreements on diverse issues such as human rights, the environment, trade and security provide little monitoring or enforcement. Yet many states expend considerable resources and effort complying with these seemingly ineffective agreements. Equally puzzling is the fact that many states fail to comply with international agreements that they joined voluntarily. Clearly, domestic institutions play a role in state compliance. Consolidated democracies are significantly more likely to adhere to their international commitments thanks to their robust domestic institutions. The presence of several distinct agencies can protect parts of the bureaucracy from the impact of international agreements. This creates a "loor effect", whereby even highly motivated bureaucrats are unable to influence the policies of other bureaucracies over which they have little control. The more fragmented the bureaucracy, the less effective international agreements will be, and the less compliant a state will be (Carcelli, 2024, p. 183).

4. Input Data for Deep Learning Neural Networks Addressing Anti-corruption Issues in Transnational Economic Relations

Operational data gathered within criminal proceedings against corrupt actors at the intersection of different legal systems now allows authorities to overcome resistance from foreign governments and equalise the jurisdictional capabilities of anti-corruption infrastructure, even amid the absence of economic, military, or spiritual-cultural parity between countries. These countries often dominate the centres of integrity and economic power, overshadowing the innovative development and rule of law of the peripheries. Nigeria, for example, is the second-largest economy in Africa but faces corruption, militancy, oil bunkering, insurgency, terrorism, kidnapping and armed robbery, all of which have an adverse impact on the population (Misra, 2022, p. 12).

In order to preserve healthy competition among nations, it is necessary to eliminate unethical practices in international relations. These practices can be evaluated and addressed impartially using neural networks that analyse data on how nations behave towards one another. It is imperative that the regulations governing this matter be formally codified in conventions, treaties and other sources of international anti-corruption law. Consequently, technology-based governance establishes a level playing field between the state and its citizens, particularly with regard to access to information and public oversight. The majority of contemporary approaches to governance emphasise the significance of comprehending, implementing, promoting and further developing technologies. The expansion and facilitation of openness and transparency through digital programmes also introduces challenges when personal data and core societal values require protection (Dang, 2024, p. 133, 150–151).

The development trends outlined above require public authorities to utilise legal tools that keep pace with social change. This includes tools created with the help of AI neural networks and other digital tools. Artificial neural networks significantly outperform human capabilities when it comes to searching data networks and languages, "enhancing useful functions and reducing the influence of unwanted functions, such as noise" (Zhang, 2023, p. 25143). A comprehensive approach is required to address street-level, administrative and political corruption, since, as with many topics in criminology and sociology, they are affected by the "dark figure" of crime, which involves underreporting and undiscovered cases (Pedersen, 2023, p. 1275). Unlike public officials responsible for anti-corruption policies, who may be involved in corruption themselves or unable to detect it, neural networks reach unbiased conclusions about whether a person's actions contain elements of a corruption offence, whether their standard of living shows signs of illicit enrichment or whether negligence in their job indicates a bribe paid to their supervisor in exchange for their appointment. Provided there is sufficient data, accurate classification and processing algorithms, and quality control of input data, neural networks show a growing tendency toward objectivity (Figure 1).

The propagation of big data through digital formats and cyberspace has engendered a series of innovations for anti-corruption and other constructive interferences in legal relations, as it has reshaped the landscape of policy adoption, creating the potential for more reasoned and rational policymaking. The dominance of cyberspace over the circulation of physical information is evident in the use of deep machine learning by neural networks. These networks' databases reside in the memory domains of laptops, smartphones, tablets, sensors and other ICT-based devices, as well as digitised paper media, images and statistical agency data. In order to combat the proliferation of corruption-related and other criminal funds at the transnational level, it is imperative to undertake an audit-based assessment of the performance of cryptocurrency exchanges, transaction databases, and other data pertaining to business operations conducted on these platforms. Examples of such platforms include Zengo, Kraken, Robinhood, Trezor, Hardware Wallets, Trezor, Coinbase, Binance. US, Binance, Matcha, and Ledger, amongst others.

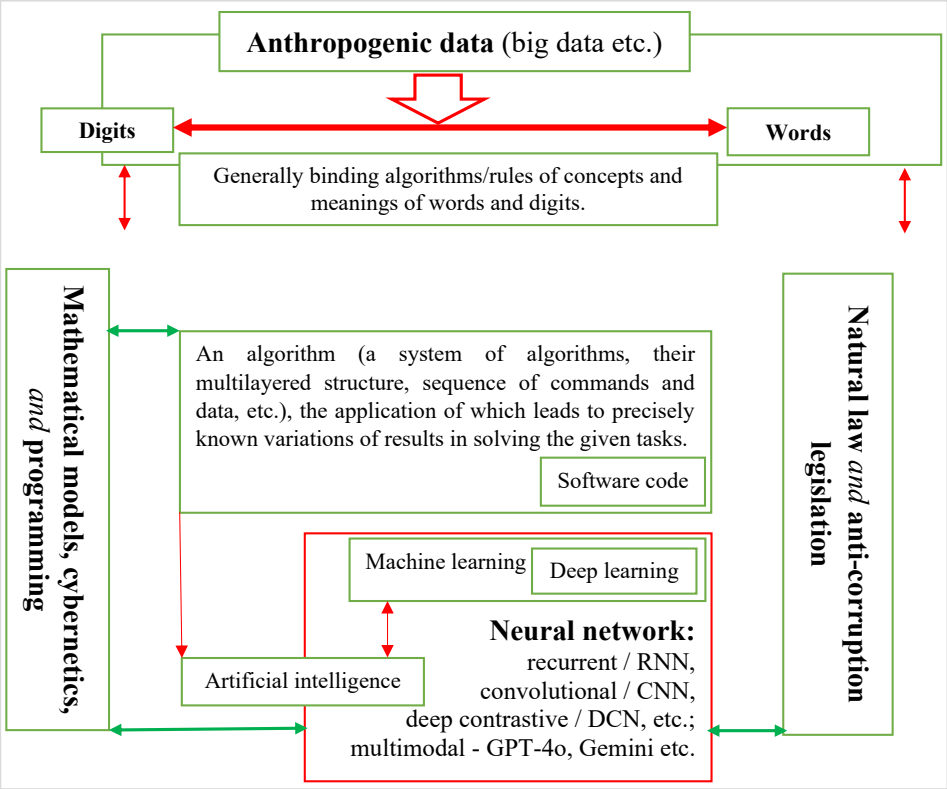

Figure 1. Correlations and data transformations for anti-corruption policy in digital neural networks

In the context of corruption cases, digital sources have been identified as a vital tool for investigators, facilitating the estimation of "informal costs", which encompass illicit activities such as corruption, bribery, and informal taxation. Informal costs represent a significant global problem, impacting all countries irrespective of their level of social development. In the case of Myanmar, informal taxation encompasses several forms, including local informal payments, forced taxation, revenue raised from individuals and businesses through the informal conduct of the formal taxation system, and payments made to government officials. In the context of Vietnam, the distinction between bribes and gifts is often indistinct, with cash payments frequently characterised as "gifts" by both parties involved in the transaction (Nguyen, 2024, p. 382, 383). "Some anti-graft measures may include road-walk campaigns, the establishment of anti-corruption clubs in schools, etc." (Misra, 2022, p. 12)

In recent years, anti-corruption provisions have implicitly or explicitly become part of trade agreements, as nations attempt to establish fair trading conditions (Zhang & Goel, 2023, p. 2502). A significant proportion of interstate economic co-operation is represented by trade agreements. Regional trade agreements (RTAs) provide a means of creating international public goods based on transparency and good governance. These kinds of instruments help to alleviate a wide range of information asymmetries that hinder trade when they are more transparent and predictable. They also improve the design and administration of these measures, reducing uncertainty and the scope for discretion in their application. Therefore, transparency itself reduces trading costs and enhances economic integration. Contemporary RTAs encompass regulatory domains such as transparency and anti-corruption provisions, in addition to environmental and labour standards. Furthermore, a significant number of provisions within the RTAs incorporated anti-corruption and anti-bribery commitments, a development which has no precedent under the WTO (World Trade Organisation) regime. Moreover, comprehensive Free Trade Agreements (FTAs) frequently enable the establishment of more profound collaborative relationships among the signatories in a multitude of domains, which may in turn contribute to the efforts to combat corruption. Nevertheless, the utilisation of the WTO system to combat corruption would be both superfluous and ineffective, as well as being prohibitively expensive. However, due to the limitations of WTO schemes, bilateral and regional trade agreements are supplementing them with good governance provisions and incorporating explicit anti-corruption provisions into their agreements (Zhang, Goel 2023, p. 2479, 2481, 2482).

In addition to RTAs, any agreement that defines the obligations of its parties becomes a source of data

in international economic relations. For instance, this encompasses EU treaties, WTO agreements, multilateral and bilateral treaties, and grant agreements. It is imperative to undertake meticulous due diligence and implement rigorous evaluation procedures to accurately assess the impact of international commercial and other deals. The World Bank Group Data Catalog provides valuable development data for this purpose (World Bank, 2025). "In current reality, international law has not yet matured into an effective, fair, and just legal system." (Olaniyan, 2023, p. 43) When international law is unable to protect nations from external armed aggression and hybrid warfare, the economic component of national security, along with effective, corruption-free mechanisms to ensure it, must be embedded within physical security agreements through the armed forces of partner countries. A compelling example is Ukraine's case. It gave up its nuclear weapons and delivery systems in compliance with a demand made by the USA, the UK and the Russian Federation at the end of 1994. However, Ukraine did not receive any mechanisms for preventing or defending against external armed aggression. This left it highly vulnerable to attacks by Russia and its allies in 2014 and from 2022 onwards. This experience has enabled Ukraine to apply due diligence and the principle of international law when assessing the agreement offered by the USA regarding the use of natural resources. The two versions of the agreement not being in compliance with each other prevented President V. Zelenskyy from signing them on February 12th and 28th, 2025. Accordingly, audit (expert) conclusions on economic and, at the same time, military security issues, drawn up prior to the signing of property agreements in international economic relations, during their implementation and after their completion, become a key source for compliance with anti-corruption and security requirements in the military sector.

"A model of democratic participation that uses digital technologies enables more flexible and adaptive forms of representation, which could potentially bridge the gap between different political structures." (Khaldi, 2024, p. 117) The secrecy with which corruption takes place makes it difficult to detect, and obtaining sufficient evidence to meet the universal standard of proof beyond reasonable doubt for criminal prosecution is challenging (Chayes, 2015, p. 209). Today, technological advances and sophisticated investigative techniques are making it easier to gather evidence (Olaniyan, 2023, pp. 222–101). Therefore, deep neural networks hold the greatest potential to support objective data processing and the implementation of public authority decisions. This renders the classification of data increasingly pertinent, particularly with regard to the subjects of corruption crimes (nepotism, bribery, embezzlement of public funds, etc.), money laundering, and other corruption-derived offences; by the characteristics of corruption actors and their accomplices; and by their transnational connections in economic, political and military spheres. The utilisation of neural network decoding in cyberspace to interpret the verbal and behavioural expressions of individuals has the potential to liberate resources, thereby facilitating timely and comprehensive actions by others.

The data analytics method is useful for generating new insights, predictive modelling and identifying behaviour patterns of public officials that hinder economic or spiritual-cultural development, military security and other achievements. It can also be used to substantiate decisions aimed at resolving such problems. This primarily concerns data on public spending, at both the planning stage (procurement, investment, and other projects) and during implementation. The process of data analysis and machine learning by non-anthropocentric neural networks involves the standardisation of data for programming languages such as Java and Python (and its open-source machine learning libraries). NumPy, Pandas, Scikit-learn, TensorFlow, PyTorch), R, Julia, LISP and others. Optimisation techniques such as SGD, Adadelta, Adam, and other stochastic gradient descent algorithms are used for data iteration – repeated, sequential evaluations to identify hierarchical task classes and the data segments corresponding to those tasks.

Data scaling involves accounting for new information relating to the actions of officials and their close relatives concerning their assets, as well as their interactions with these individuals, such as movement across foreign jurisdictions, visits to financial institutions and intermediaries, and participation in jurisdictional processes. The epistemological principle reveals differences in the connections between corruption metrics and anti-corruption policy. While AI operates through numerical logic, humans still use words, the mathematically consistent nature of which they can distort while insisting that no distortion has occurred. Such a distortion of numbers is impossible.

5. Non-anthropic Neural Networks with Deep Learning Architectures for Anti-corruption Compliance in Economic Relations

AI is a mathematical derivation of the operational principle of human (anthropic) neurons. At present, numerical data created by humans that is well-structured only simulates one-hundredth of the one hundred trillion neural connections involved in thought. At the present time, there are two principal approaches that are currently being pursued. The first

of these approaches is the development of parallel processing technology for computers based on advanced semiconductor integrated circuit processes. The second approach is the development of new computing technologies that are not based on von Neumann architectures, including quantum computing, bio-computing, and so forth. The field of artificial neural networks (ANNs) and spiking neural networks (SNNs) has been influenced by the study of the brain and biological nervous systems, leading to the development of third-generation neural network models. These systems have effectively simulated some of the working mechanisms of biological neurons, possess a good distributed structure and high parallelism, and can exhibit rich dynamics, making them suitable for processing time series forecasting tasks, among others (Peng, 2024, p. 4, 5, 154).

It is obvious that the vast majority of phenomena surrounding people can be described by a system of differential equations, a method that facilitates the generalisation of temporal changes. Neural network models are capable of reproducing non-linear behaviour through the implementation of discontinuous activation functions. They are also able to process multiple inputs and outputs concurrently, and automatically adjust synaptic weights through the utilisation of learning algorithms (Echenausía-Monroy, 2024, p. 2). Deep neural network-based (DNN) language modelling has precipitated significant advances in numerous data-driven AI technologies. The increasing scale of data repositories has resulted in a concomitant increase in the usage of language models in various data-driven AI applications. In the context of the emerging paradigm of Language-Model-as-a-Service, language models that have been trained on substantial web data are now made available as cloud platforms. They facilitate the development of natural language interfaces for various AI applications and offer a range of features for a variety of downstream uses by criminal justice bodies. These include verifying illicit assets, recovering stolen and corrupted assets, preventing money laundering and addressing other crimes (Naik, 2022, p. 1). Predictive models such as deep learning facilitate decision-making in sustainable development domains by extracting knowledge from raw data using algorithms rather than the outlined features of domain experts. This is achieved by using many layers of nonlinear processing units to make predictions or take actions that align with the defined target objective. Generally, a neural network is categorised as a "deep" model if it has more than one hidden layer (Misra, 2022, p. 5).

The utilisation of data mining techniques, which have been shown to enhance classification and prediction capabilities, has the potential to assist auditors in the identification of public management fraud (Nguyen, 2024, p. 400). Among digital solutions aimed at balancing private and public interests, the following AI-based innovations in legal communication stand out as particularly advanced: 1) predictive algorithms that can analyse and forecast societal trends in order to make effective decisions regarding counterintelligence, anti-corruption measures, the prevention of terrorism, responses to external military threats and the more efficient allocation of resources for law enforcement activities; 2) real-time administrative monitoring of digitised data allows movement, economic transactions and other societal indicators to be tracked, enabling faster responses and adaptive governance; 3) e-platforms to promote transparency regarding lobbying activities, financial benefits, terms of participation in public procurement and other potential conflicts of interest in public office. A notable example is the EU Transparency Register, which is adatabaselisting"interestrepresentatives"(organisations, associations, groups and self-employed individuals) who seek to influence EU policy and decision-making processes (EU, 2021; Transparency, 2025); 4) digital dashboards of institutional performance on public authority websites, reflecting key effectiveness indicators; 5) digital platforms enabling citizen participation in governance, from consultation processes to collaborative policymaking. Examples include e-consultation platforms, participatory budgeting tools, crowdsourcing platforms (Makarenkov, 2016) and civic tech apps. One example is the digital democratic participation platform decidim.barcelona (Barcelona, 2024). Another example is open data initiatives, which provide public access to government data (Khaldi, 2024, p. 121–124).

The public blockchain remains a promising tool for neutralising corruption threats to national security in the information sphere. A distributed ledger enables the creation, transfer and storage of data within a decentralised, horizontal, peer-to-peer network of computers and other devices. Users connect to this network securely via cryptographic protocols, or algorithms, and can add new blocks of transactions to the data chain through consensus algorithms, which are agreed mathematical rules and functions involving complex equations. This blockchain system is immune to the flaws typically found in centralised databases with a single administrator. Namely: 1) it is impervious to data distortion caused by corrupt administrator intentions; and 2) it offers 100% protection against hacking and other cybercrimes involving binary data units ("0" or "1"). However, it is conceivable that future computing units may be capable of decoding contemporary blockchain encryption with minimal effort, potentially through the utilisation of quantum computers, wherein data units (qubits) exist in a state of superposition between "0" and "1" (or their fractions). The primary

function of blockchain is to protect the information component of national security from the threat of cybercrime, including external military aggression. For instance, it could mitigate losses incurred during large-scale cyberattacks perpetrated by the Russian Federation, such as those that occurred on December 19, 2024 (against Ukrainian state registers) and on June 27, 2017, which targeted financial institutions, critical infrastructure, and numerous enterprises in Ukraine. The 2017 attack involved the propagation of a virus based on the 2016 malware "Petya" during an update of the M.E.Doc accounting software.

Natural language variables are defined as linguistic variables, and their qualifiers are hedges (a word or phrase used in a sentence to express ambiguity, probability, caution, or indecisiveness about the remainder of the sentence, rather than full accuracy, certainty, confidence, or decisiveness). Linguistic hedges function within the domain of fuzzy sets and play a pivotal role in experts' qualitative descriptions of variables, superseding numerical values (Rafiei, 2024, p. 4929). NN benefit not only from aspect information, but also from an attention mechanism that captures important words associated with aspect words. Due to the flexibility of linguistic terms that incorporate uncertainty to a certain extent, rather than probability values, the interval-valued fuzzy numbers corresponding to these terms offer a more intuitive means for experts and dispatchers to comprehend the diagnostic results (Peng, 2024, p. 293).

Recurrent Neural Networks (RNNs) are trained to process and transform sequential input data into sequential output data, rendering them effective for time-series analysis and language processing. RNN models facilitate data processing through the calculation of unknown data units according to algorithms (rules, formulas) derived from known preceding data units in a sequence. The information pattern of this type of neural network is analogous to a perceptron – the basic unit of a mathematical (computer, cybernetic) model of human brain information perception ("first proposed by Frank Rosenblatt" in 1957). The system of these units determines the computational capabilities of the neural network and the cognitive abilities of humans, respectively. "These networks consist of interconnected neurons arranged in layers, with recurrent connections enabling the detection of temporal dependencies in the input data. Recurrent Wavelet First-Order Neural Networks (RWFONN) have found applications in various fields, such as unmanned aerial vehicles, to name a few. The architecture and parameters of the network remain consistent across these systems, and the authors achieve a practically negligible mean square error between the time series. The main advantage of this technique lies in its ability to recognize complex trajectories as systems evolve, achieved by a good balance between accuracy and complexity after the training, which is performed only once." (Echenausía-Monroy, 2024, p. 2) For instance, the LipNet RNN with an LSTM (long short-term memory) deep learning architecture has been employed for the audio-visual recognition of human speech. This technology has been effectively utilised in pre-trial work to record the crimes of corrupt officials, their accomplices, and others.

Convolutional neural networks (CNNs) are valuable for recognising patterns in images and spatial data, and for converting verbal language, signals and other data into text or digital formats, and vice versa. These networks are widely used in digital image, web, and IoT forensics. Forensic analysis techniques can be used to extract hidden and encrypted information through voiceprint analysis, darknet analysis, cryptanalysis and cybersecurity analytics. CNN is widely recognised as one of the most successful deep learning methods. Its deep learning architecture comprises four key layers: the input layer, the convolutional layer, the pooling layer and the fully connected layer. This is used for visual data analysis tasks. It is particularly effective at capturing spatial relationships and extracting meaningful features (Djenna, 2023, p. 2–5; Makarenkov, 2025).

Deep contrastive networks (DCNs) are essential for identifying even the slightest differences or similarities between paired data samples. These models are trained by optimising the contrastive loss between positive and negative examples. "Two-layer framework capable of extracting the nonlinear spatial–temporal features in dynamic networks. Specifically, the network structure information at each timestamp is extracted by a structure encoder, and then the network evolution pattern is obtained through another sequence model. In these networks, each node signifies an entity, while links denote the dependency relationships between pairs of nodes, representing collaborations or interactions in the real systems." (Jiao, 2024, p. 1-2) This type of neural network is useful for analysing the financial networks of organised crime and information from social networks such as LinkedIn, Instagram, TikTok, Meta (formerly Facebook) and X (formerly Twitter). Consequently, it can be used to verify hidden connections between criminals, predict the formation of new connections and the development of existing ones within such networks, and analyse the joint actions of their participants. It can also be used to extract other informative patterns.

"Overall, vision models are slower and often more expensive to run than text-only models, especially the GPT-4 versions. Current implementations of visual reasoning models may not be as scalable as text-based models. However, runtime is significantly

more efficient for GPT-4o, and this efficiency is expected to continue improving as the technology advances." (Ogg, 2024, p. 30) Versions of neural networks that use multiple modalities, such as GPT-4o, Gemini, VGGNet, ResNet and GPipe, are becoming increasingly applicable to anti-corruption auditing and compliance in international economic relations. The Generative Pre-trained Transformer has been demonstrated to exhibit one of the highest levels of human-like performance, especially in text processing tasks, regardless of the modality of the input data. However, it is evident that no contemporary model has adequately accounted for inter-individual variability among human participants, and only moderately aligns with the responses of any single individual (Ogg, 2024, p. 1).

The field of deep machine learning of neural networks is evolving within the context of complex technological architectures, employing specialised algorithms to construct representations for specific tasks. These include the analysis of financial statements and accounting data in the context of international economic relations and transactions in foreign jurisdictions. "The ability to adaptively deepen the network as needed to improve results is done by training one layer at a time, and once a layer is trained, the input data are mapped forward through the layer to create a new learning problem. The process is then repeated, transforming the data through multiple layers, one at a time, rendering a new dataset, which is expected to be better behaved, and on which a final output layer can achieve good performance." (Miller, 2017, p. 1)

The most well-known training algorithm for neural networks is backpropagation, which calculates a gradient vector of the error surface. This indicates the direction of the steepest descent from a given point, so gradually moving in this direction reduces the error. A sequence of such steps, each decreasing in size over time, eventually leads to the required minimum (Yermolaev, 2021, p. 10). The objective of the general gradient descent optimisation algorithm, when applied to a problem solved by a neural network, is to ascertain the optimal parameter values that minimise the error between the predicted and actual values, with initial parameter estimates being used as a starting point. The stages of gradient-based optimisation include: a) initialising weights with random values and calculating the initial error; b) calculation of the gradient, which determines the direction of weight adjustment to minimise the error; c) updating weights using gradients; d) usage of updated weights to generate predictions and calculate new errors; e) repeating the process of calculating the gradient and updating the weights until the adjustments result in a significant reduction in error (Misra, 2022, p. 5). The attention mechanism is a technique used to improve model performance by focusing on relevant information.

The classification and regression trees have been shown to be well-suited as predictive models for drawing conclusions about a set of observations in the legal sphere of interest, particularly in the redistribution of material resources among nations through contracts and as a result of various financial transactions. The Extreme Gradient Boosted Trees (XGBoost) library is a scalable, distributed machine learning library for anti-corruption neural networks. It is based on gradient boosted decision trees. It provides parallel tree boosting and is the leading machine learning library for regression, classification and ranking problems. Conditional inference trees are much better at determining the true effect of a predictor if it is significant, i.e., if it is necessary. The construction of random forests bears similarity to the construction of DNNs, meaning that random forests can be transformed into neural networks and vice versa. The mathematical dependencies between DNN nodes are analogous to the dependencies between decision tree leaf nodes in random forests. As Miller (2017, p. 1, 7) have demonstrated, decision trees can be assembled into layers that resemble a DNN architecture.

The objective of meta-learning is to develop models capable of generalising to novel tasks with limited labelled data by extracting shared features across diverse task datasets. Furthermore, it accounts for prediction uncertainty during both training and evaluation, a concept known as uncertainty-aware meta-learning. Neural process (NP) is a well-known, uncertainty-aware meta-learning method which uses parametric neural networks to construct implicit stochastic processes, enabling rapid adaptation to new tasks. However, existing NP methods struggle to accommodate diverse input dimensions and learned features, which limits their applicability to a range of regression tasks (Lee, 2025, p. 1).

Gaussian process (GP) is highly adaptable and able to generalise well when dealing with complex problems such as high dimensions, nonlinearity, and small sample sizes. Unlike other machine learning methods, GPs can not only obtain better learning properties, but also estimate the uncertainty of the predicted value, which is highly significant for actual predictions. However, GP is essentially an approximate single-layer neural network with an infinite number of neurons. Therefore, compared with deep learning models, its ability to express features is limited. Deep Gaussian processes (DGPs) are a type of deep belief network based on Gaussian process mappings. DGPs offer a Bayesian non-parametric alternative to standard parametric deep learning models. DGPs have successfully learned the hierarchical features of human natural motions and handwritten

digits. DGPs are powerful tools that can encode and extract data, even from small data sets. DGPs can also provide uncertainty estimates that alternative deep models cannot, improving the model's interpretability. It is crucial for deep learning to model uncertainty and enable models to recognise their own limitations, specifically what they do not know. This is particularly important for high-risk applications, such as preventing losses to national security caused by corrupt individuals and organised crime groups (Dong, 2023, p. 15138).

Representational Similarity Analysis (RSA) is a method that is rooted in cognitive neurobiology. It enables the comparison of representations from two different data sources. This method can be used to assess the extent to which anthropomorphic understanding of diverse tasks from legal reality is reflected within non-anthropic neural systems operating in cyberspace. "Large language models best align with human evaluations in text and image input tasks, but none of the models have precisely reproduced the individual variability observed in human cohorts." (Ogg, 2024, p. 15) For instance, as Naik (2022, p. 1) argue, "using bimodal inputs (code and natural language) over unimodal inputs (only code) gives better semantic grounding and sample efficiency during semantic fine-tuning".

Beyond verifying the quality of information about transnational corruption networks through neural models, "the use or delegation of decision-making to AI requires legal frameworks that ensure the fairness of AI's impact on human lives, its alignment with anthropocentric values, and the elimination of any threats to those values. Otherwise, in the absence of clearly defined roles, such threats and related challenges inevitably arise. These problems are not characteristic of societies with robust legal systems that precisely define improper conduct and impose appropriate sanctions." (Alhosani, 2024, p. 10) Countries that hold dominant positions in the DNN are likely to perform better in terms of fighting inter-official cronyism, recovering assets and tackling other forms of corruption within the context of international co-operation (Zhang & Goel, 2023, p. 2498, 2502). In this field, an agreement (such as a covenant or protocol) could provide the necessary level of coordination and harmonisation with key players from developing countries. This would ensure that Western countries' resources, technical ability and technology contribute much-needed support in asset recovery matters (Olaniyan, 2023, p. 310).

6. Conclusions

Thus, social progress requires the elimination of corruption-related distortions within the framework of the rule of law, as well as in the legal reality of relations between nations. Due diligence and other appropriate evaluation procedures are essential for anti-corruption and compliance assessments of international commercial transactions, national physical security guarantee agreements and combinations thereof, as well as other deals.

The legal standards of higher civilisations must neutralise the corrupting influences of lower civilisations within economic, defence and other alliances. If the world's economic and/or military centres, particularly those with nuclear weapons, thrive at the expense of peripheral nations in these areas by oppressing and/or knowingly placing them in dire conditions, this is a manifestation of human flaws on a transnational scale. Such flaws are historically situational and act as a form of violence against the nation affected. They will in no way strengthen the nation expressing such flaws. Natural law is balanced rather than opportunistic, both in legal relations between individuals and in relations between nations. National well-being is achieved by releasing the energy of human virtues from the constraints imposed by human flaws, a process that may be exacerbated by the current level of human development and the resources of non-anthropic neural networks.

Endemic intergovernmental corruption exhibits all the characteristics of national corruption, while also featuring a scaling element: the preservation and amplification of material gains at the expense of other nations' economic exploitation and/or through the use of legal instruments. Image-based corruption (inter-official cronyism in international co-operation), such as holding positions for prestige despite lacking the relevant abilities, nepotism and similar behaviour, is eliminated from intergovernmental relations through national reactions. In any case, the corrupt occupation of positions within international organisations is neither typical nor long-term, nor as easy as comparable levels of administrative corruption at the national level. At the international level, neural networks are indispensable for anti-corruption policy. Firstly, nations compete with one another and this interaction is often driven by flaws rather than virtues, affecting both the collective of people within a nation and its public authorities, entrepreneurs and other representatives. Secondly, corruption is a constant feature of international communication, albeit one that fluctuates in volume. The presence of virtuous individuals in top public positions in the most powerful nations reduces the level of global corruption, and vice versa.

Transnational corruption is considered to be a form of organised crime. Both of these criminological phenomena are complex networks involving significant quantities of criminally obtained money. The success of neutralising such networks is contingent

upon the utilisation of digital neural network data, which are employed extensively by the criminal justice network. In this regard, the set sufficiency, classification, and other characteristics of financial data, as well as the rules for using neural network analysis results, are crucial. The primary function of digital networks is to accurately evaluate the input data of financial and accounting documents pertaining to public funds and other material resources of the nation in the context of international economic transactions, along with associated information, including from the Internet. Such knowledge allows for the adoption of adequate measures. These measures ensure compliance with targeted use. They also ensure economic justification of volumes. This is based on the prices of goods, works, and services. Furthermore, they ensure the expenses of financial resources. These resources are defined by law for the reproduction and development of society. This is done regardless of any dishonest motives. This applies both within the country and in transnational communication. The sources of data on mutually beneficial economic equality between countries are the terms of intergovernmental agreements, such as regional trade, financial, investment, foreign economic and other property agreements. Assessments of the benefits to each party, cash flows, accounting, and details of other financial conditions are contained in expert and audit opinions on the parameters, process, and results of the fulfilment of contractual obligations. Primary anti-corruption knowledge from digital neural networks consists of reliable information about the interconnections, patterns and behavioural trends of individuals with regard to material goods outside their own country. This includes hardware and paper data, statistical information, and data on the synergy of cause-and-effect relationships in international economic obligations.

Data obtained from anti-corruption neural networks enables the timely and confident implementation of active measures aimed at preventing national security losses resulting from corruption and related organised crime with economic and/or unconstitutional implications. These networks guide clear criminal proceedings to recover corrupt and other criminal assets located outside the jurisdiction of their origin. This data serves as a foundation for the delineation of anti-corruption requirements, particularly in regard to national-level public officials, the establishment of codes of conduct for individuals wielding significant economic and political influence (i.e., oligarchs), and the formulation of national legal standards for the exercise of public authority. The infrastructure of cyberspace is primarily geared towards solving legal issues, particularly the prevention and investigation of transnational financial transactions involving corrupt proceeds, money laundering, and the storage of criminal funds in foreign jurisdictions. These funds are often used to finance terrorism and war. Such crimes are prevented using the analytical capabilities of multimodal neural networks, such as Gemini and GPT-4o. It is asserted that any versions of neural networks trained using technological architectures such as recurrent neural networks (e.g., LipNet), convolutional neural networks, deep contrastive networks, residual networks, and others will be effective in solving anti-corruption tasks in international economic relations. The training methods employed for such networks include backpropagation of error, gradient descent optimisation, classification and regression trees, extreme gradient boosted trees, conditional inference trees, neural processes, deep Gaussian processes, and numerous others. Achieving these objectives through non-anthropic neural networks in cyberspace will necessitate the implementation of representational similarity analysis and other methodologies for the regular verification of the accuracy of the data they generate, their compliance with anthropic knowledge, cognitive mechanisms, and so forth. The combination of the rapid processing capabilities of neural networks and the shifts in legal consciousness that they have precipitated necessitates the establishment of timeframes within which anti-corruption legislation must be revised, as is already the case in the EU.

International and regional anti-corruption bodies form a unified whole within the global AI network. Therefore, their organisational structures must be transformed into a single structure with a shared database, meeting schedules, and directives for operational co-operation in investigating international crimes, especially transnational corruption. A comprehensive understanding of transdisciplinary knowledge regarding the efficacy of deep neural networks in preventive and punitive anti-corruption activities of criminal justice bodies is imperative to establish a trend for domain experts skilled in both jurisprudence and the operations and architecture variations of digital neural networks, including machine learning capabilities and programmer competencies. This allows such experts to formulate assignments for programmers efficiently. The ontological basis of legal training is rooted in the fact that the neuron/perceptron, as a fundamental component, and the principle of interaction between input data and output formulation, are common to anthropic neural networks in both the physical and cybernetic realms.

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