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SCHOOL OF SOCIAL POLICY AND PRACTICE

MASTER OF SCIENCE IN SOCIAL POLICY AND DATA ANALYTICS

SEMESTER LONG PROJECT - PART #3

CONSTRUCTING OUTCOMES
MATRIX & CONFRONTING TRADE-OFFS

The ethical conundrum of Facial Recognition Technologies powered by Artificial Intelligence

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INDEX

1. PROBLEM DEFINITION

Facial Recognition Technology (FRT) presents an unprecedented threat to the individual's privacy and fundamental freedoms.

The global widespread surveillance of FRT - capable of identifying and tracking individuals' facial or biometric information - without adequate safeguards in place, the lack of awareness [1] and consent or knowledge [2], indiscriminate use case application [3], lack of democratic oversight, fairness, and reliability (significant racial bias) [4], lack of accountability and transparency measures, erosion of anonymity and privacy rights (which are crucial for safety and security), unwarranted intrusion into individuals' lives, and legal loopholes within the regulations are leading to scenarios in which human beings' civil rights and liberties are severely undermined, and even violated.

Individuals' facial or biometric information is sensitive, private, and highly valuable data as it is directly linked to personal identity, and its misuse can result in identity theft, fraud, and law enforcement abuse. Therefore, it is crucial to oversee FRT to safeguard individuals' biometric data and privacy, prevent security risks, and maintain the balance between national security and individual freedoms.

For those reasons, State and Federal Governments need to establish regulations and safety measures to ensure that Facial Recognition Technology - capable of tracking individuals' biometric data - is handled ethically, with informed consent and legal compliance, in order to maintain public trust in their institutions and safeguard citizens' fundamental rights.

2. CONSTRUCT POLICY ALTERNATIVES

i. **BASELINE CONDITION:** By 2030, the technological market has faced an expansion fostered by the increasing availability of high-resolution cameras and great advancements in artificial intelligence, deep learning (DL), and computer vision algorithms, among others, resulting in the widespread use of FRT without control and oversight, only generating more social inequality, insecurity, uncertainty, and injustice by the authorities and organizations that deploy and use such technologies.

ii. **INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS** that regulate the development, deployment, and use of FRT as well as the collection, storage, processing, and use of biometric data, resulting in a robust regulatory framework of protection and practical enforceability, with transposition in each nation.

iii. **HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN**. This approch places people and their data at the center of the FRT design, seeking to: 1) understand who will be the end user for whom the FRT is to be intended; 2) what privacy measures will be applied to the data (such as anonymization measures, de-identification, and biometric encryption); 3) guarantee privacy principles and the protection of human rights in an ever-evolving technological environment.

iv. **INDIVIDUAL CONSENT FORMS**: individuals have the power and right to give explicit consent (signing thorough consent forms, either in paper or digital) to disclose their biometric data before the FRTs can use it. This alternative places humans at the center of the decision-making process regarding their facial information, promoting the protection of privacy and individual autonomy.

3. DEFINE CRITERIA

I. **EFFECTIVENESS** evaluates the **degree of success in the implementation** of the identified measures (like the percentage of regions that have successfully implemented the regulatory frameworks, number of legal and prohibited use cases collected in a registry, the number of certifications of technical professionals trained for the ethical development, deployment, and use of FRT) and **the accuracy rate** of FRT models for anonymizing biometric characteristics of individuals.

II. **EFFICIENCY** looks to handle a high volume of processes without significant performance degradation or detriment to results, taking into account five Key Performance Indicators (KPIs): 1) training efficiency improvement, 2) performance level, 3) runtime (processing time of the machines), 4) economic cost of development and implementation of the solution, and 5) the scalability of the solution.

III. **EQUITY** oversees that every FRT is developed, deployed, and used in an impartial, fair, and non-discriminatory (unbiased) manner, as well as the bureaucratic and regulatory processes to implement and democratize it throughout society. Hence, the equity evaluation considers the processes' technical and ethical perspectives.

IV. **SUSTAINABILITY**: The framework presented in "NeuralPower" [5] will be considered the threshold to measure the sustainability criterion, considering its three KPIS: processing time of the machines, the power, and the energy resources used. Thus, above the threshold, the FRT model is considered a sustainable solution and a non-sustainable solution below it.

4. OUTCOMES MATRIX & RATIONALE FOR RATINGS

4.1. OUTCOMES MATRIX

	BASELINE CONDITION	***INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS***	***HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN***	***INDIVIDUAL CONSENT FORMS***
EFFECTIVENESS	**LOW** By 2023, 9/10 Global governments have completely deployed FRT across the cities [6], but these technologies do not provide any security regarding control and oversight regarding their development, deployments, and use.	**HIGH** The successful creation of a common international treaty promoted by the United Nations (193 member states) to regulate the development, deployment, and use of FRTs, setting in place standards and requirements for its ethical use.	**HIGH** 75% of the developed FRT systems are founded on placing people at the center, which makes this approach much more democratized and rooted in how models are trained, tested, and implemented in society.	**MEDIUM** 7/10 global cities have mechanisms in place for the provision of consent forms for collecting biometric data from users, resulting in an increase of 30% in the transparency of the models.
EFFICIENCY	**LOW** The widespread adoption of FRT results in an increase in performance and speed of response in real time. Despite its rapid growth and expansion across multiple sectors, the lack of government oversight can hinder coordination and interoperability in large-scale implementation.	**MEDIUM** The regulation theoretically defines each of the KPIs that make up the efficiency criterion. However, from a practical point of view, the regulation does not provide a numerical quantification for all of them, leading to ambiguity.	**MEDIUM** the learning curve will be slower in the short term but will accelerate as more FRT models with privacy by design are developed, as experts will know how to train the new models, which are the best techniques, and how to embed them in the best way, increasing efficiency levels by 15% in the long term.	**HIGH** All five efficiency KPIs are experiencing a considerable improvement in the percentages. it should be noted that obtaining the consent of individuals can be a rather tiresome process, which can be lengthy and can lead to delays in the implementation of the technology.

EQUITY	**LOW** 2030 there is no common transparency threshold, and the increase in FRT systems deployed will only plummet the transparency ratio. As a consequence, consumers are expected to be more aware of the ethical issues that pose FRT, so the societal involvement will increase.	**HIGH** The treaty will guarantee high equity levels thanks to analyzing the outcomes applied to different social groups, setting multi-million dollar penalties for discrimination in place, and performing periodic transparency reports.	**HIGH** This approach guarantees the principle of privacy, increasing fairness and non-discrimination by 40%. Ensuring privacy and personal data protection principles are paramount to establishing user trust, which can drive long-term growth and sustainability.	**MEDIUM** forms promote individual autonomy and decision-making by authorizing or rejecting the use of individual data, resulting in a 30% increase in fairness, a 40% reduction in the possibility of bias, and a 35% increase in the protection of vulnerable groups.
SUSTAINABILITY	**MEDIUM** The increase in FRT and investment will cause the prediction for runtime and power of the most advanced CNN architectures to exceed current levels. But in return, the energy consequences wil be neglected.	**HIGH** The regulation promotes a more sustainable and efficient use of the already deployed systems, quantifying the limitations (outdoor and indoor spaces) and setting a clear threshold to consider a FRT sustainable solution.	**LOW** The widespread commitment to adopting more sustainable practices at the enterprise level and the general market level.	**MEDIUM** Collecting only the "permitted" data allows to reduce the waste of digital resources by 25% and energy on processing data by 15%.

Leyend: Red= low; yellow = medium; green = high

4.2. RATIONALE FOR RATINGS (VERTICAL/ COLUMN ANALYSIS)

4.2.1. BASELINE CONDITION

- **Effectiveness (low)**: Currently, among the 100 most populated countries in the world , 7 out of 10 governments are using FRT on a large-scale basis. Thus, by 2023, we expect that 9/10 global governments have completely deployed FRT across the cities [6]. However, these technologies do not provide any security in terms of control and oversight regarding their development, deployments, and use.

  There is no effort by either public or private administrations to design a common threshold, best practices, guidelines or regulatory framework to address the challenges and concerns posed by technologies (social inequality, insecurity, uncertainty, inaccuracy, injustice, lack of privacy, transparency, and accountability), as they do not have any incentives or trade-offs for adopting a more ethical approach of FRT. Only a few (5%) companies are committed to using FRTs more responsibly as a competitive advantage. For that, they have embedded some guidelines for using FRT systems in their code of conduct.

- **Efficiency((low)**: Considering the efficiency criteria and the 5 KPIs to be addressed:

  1. Training efficiency improvement: The lack of regulations and ethical constraints on the development and use of FRTs results in a 110% increase in technological advances [7].

However, problems of bias and lack of transparency in the training process will also increase, resulting in a 60% increase in concerns about discrimination [8].

2.Performance level: since there are no entry barriers or restrictions, the fierce competitiveness of companies will result in a 75% increase in the performance of these systems, especially in systems applied in homeland security or trade. However, on the other hand, the risk of errors and false positives will increase, as there won't be any adequate quality controls deployed.

3. Runtime: the development of FRTs will be extended to the whole world and nations, so there will be a greater investment in hardware, exceeding the prediction of 88.24% of machine runtime in FRT [5] systems and allowing a faster response in real-time applications, such as security. However, there are concerns about the invasion of privacy regarding the use of unrestricted real-time FRT.

4. The economic cost associated with the development and implementation of FRT solutions will depend on the companies, as some will bet on FRT as a corporate strategy, while others will opt for cheaper solutions. This results in heterogeneity in the quality of FRTs and costs.

5. Scalability: the variety of FRT systems and sectors in which they will be applied will scale rapidly, reaching $24.3 billion by 2032, growing at a compound annual growth rate (CAGR) of 16.4% from 2023 to 2032 [7]. However, the lack of regulations will pose challenges concerning interoperability and standards, making large-scale implementation difficult in environments where greater coordination is required.

- **Equity (low)**: For the fairness criterion, we have to observe a double perspective:

1.The level of transparency and explainability of the models. As of today, the highest total score for the transparency index goes to AI Meta's Llama 2, with 54 out of 100 [9], which is considered a rather low score. Therefore, currently, there is no Big Tech company that comes close to offering an adequate level of transparency and explainability. So, in a 2030 scenario (where there is no common transparency threshold or minimum requirements to be met but a myriad of FRT systems deployed) this transparency score will only plummet.

2.Societal awareness index: as of today, 75% of consumers are more aware of risks introduced by A.I. and are concerned about the opaqueness and lack of clarity A.I. systems pose. For that,

36% of consumers demand companies provide an explanatory explanation of the inner workings of A.I. [10], especially when it poses ethical issues. So, by 2030, these percentages will be expected to multiply exponentially with the widespread and indiscriminate use of FRTs.

- **Sustainability (medium):** As a consequence of the increase in the number of FRT systems deployed and the increase in investment made by private and public companies will result in the improvement in runtime, power, and energy of the most advanced CNN architectures will exceed the levels of 88.24% in runtime, 88.34% in power and 97.21% in energy, previously determined in the benchmark study "NeuralPower - Learning-based Power and Runtime Modeling for Convolutional Neural Networks" [5].

4.2.2. INTERNATIONAL BIOMETRIC DATA PROTECTION TREATY

- **Effectiveness (high)**: The successful creation of a common international treaty promoted by the United Nations (193 member states) to regulate the development, deployment, and use of FRTs as well as the collection, storage, processing, and use of biometric data, and which will be the starting point for the creation of standards at the national level.

  The resulting international body of text sets out at a high level the scope of FRT's use, classifying four risk levels (low, medium, high, and prohibited), limiting the use of FRTs; it defines essential requirements for the responsible development and use of these technologies (such as Data and data governance, risk management, record-keeping, transparency, human oversight, robustness, and cybersecurity) [11]; points out independent committees and authority bodies that oversight; places a whistleblower protection system where public and private organizations and individuals can lift the veil on FRTs and demand transparency and accountability and accuracy.

  With respect to accuracy, the regulation will set a standard threshold for the accuracy level of 99.88%, as a requisite to deploy these systems in society at 99.88%. Taking IDEMIA's facial recognition algorithms as a reference, they have the best accuracy score with 99.88% correct matches out of 12 million facial images [12].

- **Efficiency (medium)**:

  1.Training efficiency improvement: complete and detailed description of the process and rationale for training, testing and validation of the I.A. system, together with the test results, as well as the training history to check from year to year the improvement or deterioration of the models.

  2. Performance level: The FRT performs as intended in the scope, including the need to ensure adequate monitoring of the performance of an FRT system in a real-world environment. However, the regulation doesn't specify any quantifiable threshold for performance levels.

  3. The creation of a High-Level Expert Group to assist in the drafting of the regulation will cost about $1,200,000. In addition, the regulation will cost between $6,000 and $7,000 to supply an average FRT system, which will cost around $170,000 euros by 2025. For FRT users, there would also be the yearly cost - between $5000 - $8000 - for the time spent to ensure human supervision. Verification costs could amount to another $3,000 to $7,500 for FRT providers [11].

  4. The creation of a regulatory base that serves as a starting point will make it much easier to create national regulations. In addition, by creating FRT systems that are aligned with the regulatory framework, we will ensure the scalability of these solutions without any detriment to discrimination.

- **Equity (high)**: The creation of international regulation of FRTs will play a fundamental role in the search for equity, fairness and protection of fundamental rights, to the extent that the regulation will establish limits on the collection and use of biometric data, will require FRT providers and developers to prove that their systems are fair by analyzing the outcomes applied to different social groups (whites, blacks, Asians, children, women, etc.), and will establish multi-million dollar penalties (minimun of $2,000,000) for discrimination depending on the degree of negative impact caused by the FRTs. Finally, it will require periodic transparency reports (every six months) showing how FRTs are used, who uses them, their accuracy levels, application location, targeted stakeholders, etc.

- **Sustainability (high):** The regulatory framework will establish more sustainable practices that will be measured with through key performance indicators, resulting in the reduction of the environmental impact of technologies.

  First, there will be a limitation in the deployment of FRTs in 5 systems per 100000m^2 in outdoor spaces and 3 systems in indoor spaces, as well as making a strict limitation for those that require a large amount of technological and financial resources or those that are uncontrolled and unjustified. As a result, the regulation promotes a more sustainable and efficient use of the already deployed systems.

  In addition, the regulation relies on the reference framework proposed by "Neural Power," establishing the average accuracy of 88.24% in runtime, 88.34% in power, and 97.21% in energy as minimum thresholds [5]. Thus, above the threshold, the FRT model is considered a sustainable solution and a non-sustainable solution below it.

4.2.3. HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN

- **Effectiveness (high)**: 75% of the developed FRT systems are founded on the premise of putting people at the center, which makes this approach much more democratized and rooted in the way models are trained, tested and implemented in society.

  However, The FRTs whose design puts people at the center will limit the amount of personal data it collects and processes. This will affect the effectiveness of the models, since the reduction in the amount of personal data may affect accuracy levels by 20%, as the models do not have the same amount and nature of data. However, this reduction is essential to ensure: 1) the protection of the principle of privacy of individuals; and 2) the control of risks associated with discrimination and mass surveillance problems.

  Furthermore, such a particular approach to technologies requires continuous monitoring and evaluation, resulting in continuous improvements of the model parameters to ensure a constant balance between effectiveness and protection of privacy and mitigation of risks and biases.

- **Efficiency (medium)**:

  1. Training efficiency improvement: privacy by design employs advanced training techniques, such as federated learning or homomorphic encryption, resulting in a 40% increase in the complexity of training processes, leading to a deterioration in time and cost efficiency.

  2.Performance level: as mentioned in the previous section, data limitation and the use of anonymization techniques will decrease the accuracy of the system by 20%, in favor of guaranteeing the principle of privacy. This results in a decrease in system performance and making it inadequate for use cases that require high accuracy, such as national security.

  3.Runtime: as we have advanced previously, introducing techniques such as homomorphic encryption or cryptography will increase the standard processing time of the models, which could be incompatible with use cases where FRT systems are real-time.

  4.Economic cost of development and implementation of the solution: implementing advanced techniques requires hiring highly qualified personnel with the knowledge and field expertise to develop these models correctly, plus additional investment in more powerful software capable of coping with the increased processing.

  5.Scalability of the solution: some of the advanced techniques discussed above may make it more challenging to scale large datasets or implement them on a large scale to handle a high volume of requests, reducing the applicability of these FRT systems by 30%.

  However, we have to keep in mind that the learning curve will be slower in the short term, but will accelerate as more FRT models with privacy by design are developed, as experts will know how to train the new models, which are the best techniques, and how to embed them in the best way, increasing efficiency levels by 15% in the long term.

- **Equity (high):** The privacy-by-design approach puts the human at the center through a limited and better collection of personal and biometric data, the implementation of advanced anonymization and encryption techniques, etc. It should be noted that this approach starts from the initial stage of the algorithm creation, i.e., it is not an approach that is implemented once the FRT system has already been created. Instead, it is the way it is created, so we guarantee the principle of privacy, increasing fairness and non-discrimination by 40%.

Ensuring privacy and personal data protection principles are paramount to establishing user trust, which can drive long-term growth and sustainability.

- **Sustainability (medium):** By designing FRT models with a privacy-based approach, organizations can exercise greater pressure on technology providers also to adopt practices that promote sustainability in data management, information security, and reduction of the environmental impact of technology operations. The result is a widespread commitment to adopting more sustainable practices not only at the enterprise level but also at the general market level.

4.2.4. INDIVIDUAL CONSENT FORMS

- **Effectiveness (medium):** 7/10 global cities have mechanisms in place for the provision of consent forms for the collection of biometric data from users. This represents a breakthrough to the extent that such consents seek to respect the privacy of individuals and seek the active participation and awareness of groups and individuals. This measure increases by 30% the transparency of the models, as the forms provide detailed information on how biometric data are collected, processed and stored, resulting in a greater understanding of the technologies throughout society.

- **Efficiency (high):**

  1.Training efficiency improvement and performance level: thanks to the signature of the consent forms, experts are able to collect a wider variety of "disposable" data, thus allowing the training and testing performance of the FRT models to be more efficient and increasing their accuracy by 15%.

  2. Runtime: we will only collect those data that are allowed, while discarding unnecessary or non-facilitated data, resulting in a reduction in processing time and increasing the fast response of the FRTs.

  3.Economic cost of development and implementation of the solution: because only data from consenting individuals is collected, this has an impact on the reduction of 7% of the investment in storage and processing, which also leads to a more efficient use of existing resources.

5. Scalability: obtaining written consent (digital or paper) from individuals helps to democratize the technology by 30%, since it is more widely known and stakeholders know when they encounter it.

Despite these positive aspects, it should be noted that obtaining the consent of individuals can be a rather tiresome process, which can be lengthy and can lead to delays in the implementation of the technology.

- **Equity (medium):** The consent forms pass the "scepter of power" completely into the hands of individuals, as they have greater control over the disposition and use of biometric data. In other words, the forms promote individual autonomy and decision-making capacity in authorizing or rejecting the use of their data, resulting in a 30% increase in fairness, a 40% reduction in the possibility of bias, and a 35% increase in the protection of vulnerable groups. However, these percentages are not higher, because we understand that not everyone in society has the same means of providing or withholding consent, degree of understanding of the forms, or access to the technology. This may increase the technology gap by 10%.

- **Sustainability (low)**: By focusing on obtaining consent, organizations can ensure that only facial data that is relevant and necessary for their operations is collected and used, which can reduce wasted digital resources by 25% and energy on processing data by 15%. But the printing of paper forms to avoid the digital gap means that this alternative can be a detriment to the sustainability criteria of 2%.

5. CONFRONT THE TRADE-OFFS (HORIZONTAL/ RAWS ANALYSIS)

Effectiveness

The "BASELINE CONDITION" shows low effectiveness due to the lack of regulation and control by the competent authorities deploying FRT systems so issues such as privacy and transparency are no longer a priority for developers. In contrast, the "INDIVIDUAL CONSENT FORMS" alternative shows medium effectiveness in increasing transparency and awareness but

relies on individual consent, which may not fully address the systemic problems of FRTs, such as discrimination and technology gap.

While on the other hand, the alternative “INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS” stands out as highly effective by proposing an international treaty endorsed by 193 UN member states, where clear rules are established, essential requirements are defined, and a 99.88% accuracy standard is set, demonstrating robust regulation and global oversight. Finally, “HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN” also reflects high effectiveness in focusing on human-centered FRT models and privacy by design, despite a reduction in accuracy due to limited access to personal data.

In short, international treaty-based and privacy-by-design approaches stand out as the most effective alternatives.

Efficiency

As we have previously mentioned, the “BASELINE CONDITION” lacks regulation and ethics, which drives an exponential increase in technological advances, but in counterpoint, decreases the efficiency of the systems by 60% due to the problems of bias and lack of transparency. On the other hand, “HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN” seeks efficiency by prioritizing privacy, but this leads to a 20% decrease in accuracy and limitations in scalability due to limited collection and access to individual data. Likewise, the “INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS” alternative promotes efficiency through detailed regulations and oversight, which improves transparency and accountability, but fails to establish quantifiable thresholds for performance, resulting in ambiguous and heterogeneous thresholds.

Whereas the “INDIVIDUAL CONSENT FORMS” alternative stands out as highly efficient in obtaining consent, which increases training efficiency and throughput by 15%, reduces processing costs by 7%, and democratizes the technology by 30%. However, obtaining consent can be a slow process.

In short, the indidividual concent form approach stand out as the most efficienct alternative.

Equity

In the “BASELINE CONDITION” alternative, the widespread use of FRTs in 2030 is expected to generate a greater lack of transparency of the models given that there are no incentives to promote democratized equity. In contrast, “INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS” seeks high equity by establishing international regulations limiting the collection and use of biometric data, enforcing sanctions for discrimination, and requiring transparency statements. This protects fundamental rights and promotes fairness in using FRTs nationally and globally.

“HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN” also seeks high fairness by prioritizing privacy and data protection from the outset of algorithm development, which successfully reduces discrimination by 40%. Finally, “INDIVIDUAL CONSENT FORMS” promotes equity by empowering individuals but may increase the technology gap by 10% due to differences in access and understanding of consent forms.

Overall, the international biometric data protection treaties and laws and the human-centric model approach stand out for the equity criteria.

Sustainability

In terms of sustainability, the “BASELINE CONDITION” shows medium sustainability, with notable improvements in performance and energy efficiency of the CNN architectures, exceeding previous levels in the reference framework . For example, the runtime performance exceeds the threshold of 88.24% [5].

Likewise, “INTERNATIONAL BIOMETRIC DATA PROTECTION TREATIES AND LAWS” stands out with high sustainability by limiting the deployment of FRTs and betting for a better use of already deployed systems, which promotes sustainability. For example, it is limited to 5 systems per 100,000 m2 in outdoor spaces. “HUMAN-CENTRIC MODELS THAT PROMOTE PRIVACY BY DESIGN” shows medium sustainability by pushing technology providers to adopt more sustainable practices. Finally, “INDIVIDUAL CONSENT FORMS” has a lower sustainability due to the printing of paper forms, which could be detrimental by 10% for sustainability.

In summary, the alternatives of international treaties and privacy by design show higher levels of sustainability in establishing green regulations and practices.

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