Cryptographic Authentication: EEG-Based Biometrics

(Technical Paper)

The Competition to Shape Data Policy in the EU

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree

Bachelor of Science, School of Engineering

Thomas Cedeno

Fall, 2020

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature  Date *5/6/2021*

Thomas Cedeno

Vicente Ordonez-Roman, Department of Computer Science

Kathryn A. Neeley, Associate Professor of STS, Department of Engineering and Society

General Research Problem

How can people protect data in a digital environment?

Hosting large collections of data comes with some advantages and risks. Facebook recently proposed a cryptocurrency, Libra. Yves Mersch, a Member of the Executive Board of the European Central Bank, described it as "highly centralised, with Facebook and its partners acting as quasi-sovereign issuers of currency" (Mersch, 2019). However, Yves (2020) warns that "centralisation is only a virtue in the right institutional environment." A centralized currency leaves data policy to a company with a fiduciary duty to produce a profit for stakeholders. For users, the tradeoff is between integrated online commerce and privacy. Foregoing some privacy offers advantages. According to the National Institutes of Health, centralized health data offer benefits for "patients, families, ... and health agencies" (Donaldson & Lohr, 1994). Accessible data can also help people get a loan, insurance, or even a job.

Cryptographic Authentication: EEG-Based Biometrics

How can an EEG-based biometric system supplant or augment conventional security protocols?

Biometric security, such as face detection, fingerprints and voice identification, have poor cancellability: An exposed fingerprint can't be modified after a leak.

By recording brain activity, humans can be identified by how their brain reacts to certain active tasks (Gui, Ruiz-Blondet, & Laszlo, 2019). Working with the Computer Science department and Aaron Bloomfield, my capstone project involves this biometric, discarding the drawbacks from traditional approaches. By implementing this biometric with reasonable accuracy, we can show a proof of concept for mutable biometrics and present their case as a replacement for more traditional password based systems. In their research, Gui, Ruiz-Blondet

and Laszlo have seen a general acceptance rate of up to 94.04%, with some models reaching higher performance (Gui, Ruiz-Blondet, & Laszlo, 2019). This performance could be pushed higher by using a neural net classifier that takes time into account, i.e. Long short-term memory or recurrent neural net, instead of the conventional memoryless classifiers being used in today's state of the art.

I would expand on existing research, looking for a viable software system capable of accurate and practical use cases. Sources of data will range from publicly established databases to live participants, if conditions permit. By the end of this project, we will have a software model and system to analyze these EEG signals.

The Competition to Shape Data Policy in the EU

How are groups in the EU pursuing their agendas of data collection and protection?

In Europe as elsewhere, proliferating algorithms in healthcare, ecommerce, social media, and public policy bear vast social implications.

Cambridge Analytica (CA) harvested data from more than 87 million Facebook accounts, combining it with state and local data sources to produce a comprehensive voter database (Wylie, 2019). According to Wylie (2019), who once worked for the firm, CA sought "to provoke people, to get them to engage" and thereby to find means of influencing voters. With this comprehensive database, CA could determine an individual's home location, preferences, and votes. Many companies and nonprofit advocacies have much at stake in data policy, and they therefore compete to influence the rules governing how data is collected and used.

CA violated such rules by gathering and using personal data without consent or constraint. Privacy advocates have been fighting back by demanding better legal protections.

In 2018 the EU implemented the General Data Protection Regulation (GDPR), a controversial data privacy law. Widely regarded as a win for consumers, it "limits what kinds of data companies are allowed to collect and the manner in which they can do so" (Chorpash, 2020). According to Chorpash (2020), small businesses have found compliance with the GDPR burdensome.

By using statistics to anonymize databases and by separating personal identifiers from the data, companies can protect personal privacy. Through statistical techniques such as differential privacy and statistical disclosure limitation, researchers hope "to prevent identification" (Oberski & Kreuter, 2020). Some privacy protection techniques may limit the utility of the database.

In the European Parliament, Liberal Democrats (ALDE), Social Democrats, and the European Green Party have defended personal privacy as a human right. Responding to a Human Rights Watch questionnaire, ALDE asserted that "Privacy should not be sacrificed or suspended in order to fulfil a temporary and questionable goal" (HRW, 2020).

In contrast, the European People's Party contends that the EU "must strike the right balance between security and privacy," without impeding law enforcement (HRW, 2020). The European Commission has faulted international law, finding it too hard for consumers to understand and too hard for regulators in member states to apply (EC, 2020).

The commission reports that consumers are now more aware of their data privacy rights; for example: "71% of people heard about their national data protection authority" (EC, 2020). Yet some consumers report "consent fatigue," or find that "exactly what they need to do" is unclear (Fazzini, 2019).

Google and Facebook, both enormous data collectors, have defended GDPR, despite their business models. Both companies' targeted advertising practices and facial recognition

technology have been criticized as privacy threats. “They’re supposed to be transparent about what they're using the data for, but we don't really know.” said Jason Kint, chief executive of Digital Content Next (Scott, 2019).

References

Chorpash, J. (2020). Do You Accept These Cookies? How the General Data Protection Regulation Keeps Consumer Information Safe. *Northwestern Journal of International Law & Business, 40(2), 227–249.*

Donaldson, M. S., Lohr, K. N., & Institute of Medicine (US) Committee on Regional Health Data Networks. (1994, January 01). Health Databases and Health Database Organizations: Uses, Benefits, and Concerns. *National Center for Biotechnology Information.* https://www.ncbi.nlm.nih.gov/books/NBK236556/

EC (2020, June 24). European Commission. Commission report: EU data protection rules empower citizens and are fit for the digital age. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1163

HRW (2020, Oct. 28). *Human Rights Watch.* EU: Parliamentary Candidates’ Views on Rights. https://www.hrw.org/news/2019/05/16/eu-parliamentary-candidates-views-rights

Fazzini, K. (2019, May 5). Europe’s sweeping privacy rule was supposed to change the internet, but so far it’s mostly created frustration for users, companies, and regulators. *CNBC.* https://www.cnbc.com/2019/05/04/gdpr-has-frustrated-users-and-regulators.html

Gui, Q., Ruiz-Blondet, M. V., & Laszlo, S. (2019). A Survey on Brain Biometrics. NY: University at Buffalo, State University of New York.

Mersch, Y. (2019, September 02). Yves Mersch: Money and private currencies - reflections on Libra. Bank for International Settlements. https://www.bis.org/review/r190902a.htm

Oberski, D. L., & Kreuter, F. (2020). Differential Privacy and Social Science: An Urgent Puzzle. *Harvard Data Science Review, 2(1).* https://doi.org/10.1162/99608f92.63a22079

Scott, M. (2019, May 22). How Silicon Valley gamed Europe’s privacy rules. *POLITICO.* https://www.politico.eu/article/europe-data-protection-gdpr-general-data-protection-regulation-facebook-google/

Wylie, C. (2019, October 4). How I Helped Hack Democracy. *New York Magazine Intelligencer.*

https://nymag.com/intelligencer/2019/10/book-excerpt-mindf-ck-by-christopher-wylie.html