Homework 1:
Semantic Network Construction & Implications of GDPR on AI Applications

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1 INTRODUCTION TO THE PROBLEM

In the following sections, this paper will cover two main problems. The first part of the paper (section 2) will illustrate the long hand construction of a semantic network and its application to the problem of transporting 3 objects (Kylo, Rey & Snoke) from one side (the planet Quesh) to another side (an orbital ship) where there is already an object present (Leia). The first problem is governed by the following rules and constraints: (1) There is only one shuttle to move objects from one side to another, (2) The Shuttle can only take one object or no one at all at a time, (3) Rey Can't be alone with Snoke (without Kylo), (4) Kylo can't be along with Rey (without Rey), and (5) The generator cannot rule out invalid or non-productive states. The second problem this paper covers is the exploration of (General Data Protection Regulation (GDPR), products or business that are critically dependent upon using personal data and the impact of GDPR on AI.

2 SEMANTIC NETWORK CONSTRUCTION & APPLICATION

2.1 Construct Semantic Network

Semantic networks at a minimum must define each node or state, and the links between those nodes. States are made of objects which also need to be defined along with a way to show the relationship between objects in a state. Icons were chosen to represent a given state and the links between those states. Additionally, the semantic network needed a way to identify the goal state (green state), previous states (yellow states) and invalid states (red states), which are defined within the tester and the links connected to the tester. Any state determined valid but not the goal state was left unshaded. The diagram below explains the constructed semantic network along with a legend.
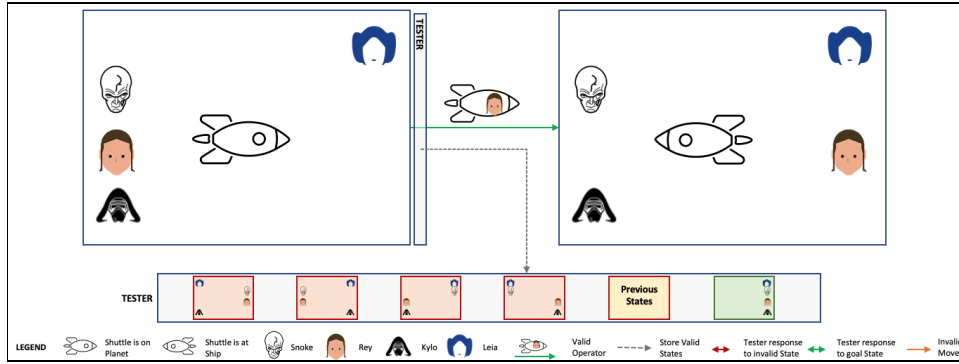
Figure 1—Base constructed Semantic Network.

2.2 Apply Semantic Network using Generate and Test

To solve the problem, in addition to building a semantic network and language, some logic is needed to apply a problem solving method to the problem. In this instance, we are using the Generate and Test method with the semantic network to solve the problem. The logic chart below describes the logic chosen to solve this problem while staying within the constraints and rules provided.
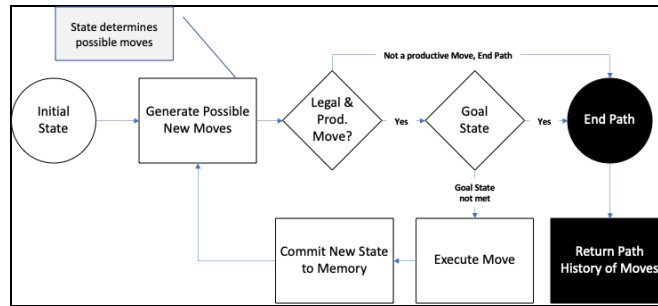

Figure 2— Semantic Network using Generate & Test High-Level Logic Flow

With logic determined, we can now apply it with the semantic network to move all three objects from the planet to the orbital ship. Once applied, four legal paths were found, with two being equally optimal taking two less steps to reach the goal state than the remaining two paths.
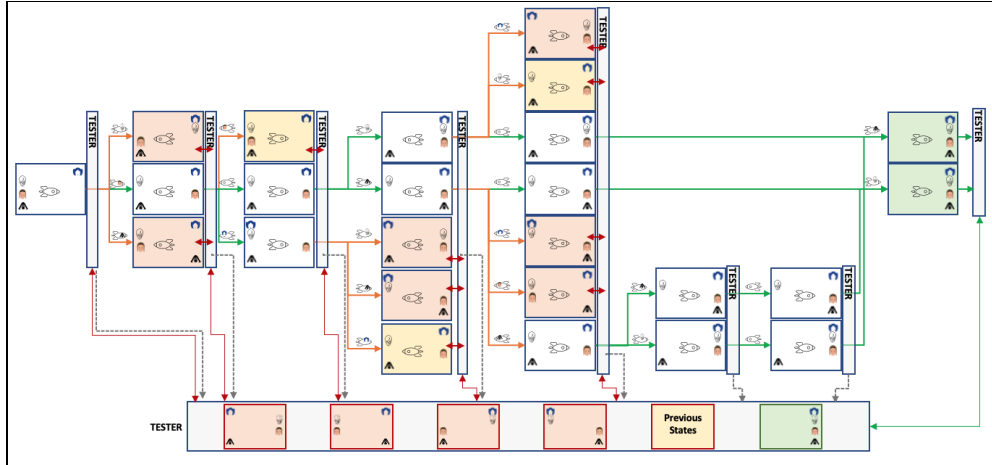
Figure 3—Applied Semantic Network - Generate & Test.

Admittedly, it was difficult to graphically depict the generator in a semantic network. A generator could be represented similarly to the tester but would need to have a set of logic represented to output the possible states. A generator would look something like the following at a minimum:
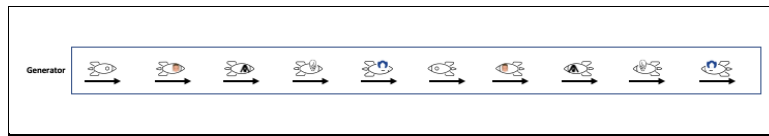

Figure 4 —Applied Semantic Network - Notional Generator.

3 IMPLICATIONS OF GDPR ON AI APPLICATIONS

3.1 GDPR Overview and Guidance for Usage of Personal Data

Nearly every part of our lives is now able to be digitized, tracked and used, an outcome of both innovating business and also responding to consumer demands. However, the digital sprawl grew for nearly two decades without any checks and balances beyond outdated policies around Public Health Information (PHI) and Personal Identifiable Information(PII). As a result, the EU started drafting legislation and ultimately passed the General Data Protection Regulation (GDPR) in 2016 and began enforcing it in may of 2018.

At a high-level, the GDPR aims to protect people from the improper or negligent use of any data that can identify a person. The regulation makes any company that interacts with EU citizens justify why it needs PII and other data points, and prove that it is properly protecting the data. A critical component of this

3

regulation is proving that each person has given consent for a company to collect data. Additionally, a person can both request to see the data that has been stored on them and request it be deleted. There are exemptions for some entities such as hospitals, journalists and government agencies, but the regulation has brought major changes to how data is captured, stored, protected and used across the world in every industry. The GDPR is wide in range and scope and even has specific articles that apply to Artificial Intelligence (AI) applications. The table below outlines some of the most impactful articles of GDPR as it pertains to AI products and companies:

Table 1—GDPR Articles that impacts the AI industry.

Article #	Article Name	Summary of Impact to AI Industry
5	*Principles relating to processing of personal data*	Companies will need to transparently process personal data, resulting in additional cost, delay and releasing trade secrets. Companies will also need to justify what data is adequate, relevant and limit their data processing only to that data, which could impact discovering data that improves algorithm performance.
6	*Lawfulness of processing*	Companies may need to disclose conclusions made about a person to that person, since aggregated data is the result of data processing.
13	*Information to be provided where personal data are collected from the data subject*	Companies may need to disclose that they are collecting data to create algorithms, classifications and predictions, explain the logic and the use of the decisions made by that algorithm that the person may not like and can as a result request not to happen.
17	*Right to Erasure ('Right to be forgotten')*	Companies will have to erase a person's data as quickly as possible, which may impact the integrity, efficiency and performance of prediction models.
22	*Automated individual decision-making, including profiling*	Companies will have to make significant measures to be able to produce profiling and decisions based on automated processing, especially decisions based on special categories of personal data.
All	*General Summary of Impact*	GDPR requires significant measures that result in additional costs, slower pace of innovation, limited prediction value and the integrity, efficiency and performance of prediction models.

3.2 Example of Personalization (device, company, industry)

While companies and services like amazon, spotify and google comes to mind when we think of personalization, it's arguable that each of these companies would still go on, albeit not as fast and successful, without their personalization capabilities in their product recommendation, song recommendation and search engine personalization capabilities. Despite the race to personalize digital experiences, there are still only a few devices, companies, or industries that

would not succeed without the ability to leverage personalization. For the sake of brevity, here are a few that would not be able to continue without the ability to leverage personal data for personalization:

1. **Digital Ad Serving platforms** - leverages significant amounts of 1st party and 3rd party data to identify the right people to serve the right ads to, optimizing for accuracy from serve-to-click. Without data on a person to personalize, it would not know which ads to serve.
2. **Digital Personal Styling (e.g. StichFix)** - Gathers data such as date of birth, size, preferences, pictures and more to determine the style and size to send a consumer. Without data on a person to personalize, it would not efficiently provide styling and products to buy.[3]
3. **Personalized Healthcare** - Consists of companies that create new medicine or care plans by combining personal data, prediction services and their new product or service. Without data on a person to personalize, these companies would be the same as other larger pharmaceuticals and services.

3.2 The European Economic Area (EEA) and GDPR Impacts on Personalization Company Examples

While the GDPR applies to the EU, it is expanded in scope due to the existence of the European Economic Area (EEA). The EEA, created in 1992, encourages free commerce between the EU and EFTA (except Switzerland) by establishing a single market. The EEA includes 30 countries as of 2021 and the GDPR extends to those countries as well. Furthermore, this means that companies world wide will have to adhere to GDPR if the person that it is collecting data on resides within the EEA.

Given this large scope, there are a lot of considerations for any company looking to implement AI applications as a core part of their devices, services or core business model. At a glance, here is how GDPR and EEA impacts the above given examples of personalized companies:

1. **Digital Ad Serving platforms** - These companies and services will need to not only get consent, but also disclose that it will sell the exact or derivative of the person's data according to GDPR Article 5. These companies will need to disclose upfront that they are using the data to create algorithms, classifications and predictions, according to Article 13.

Articles 6 and 22 may limit their ability to complete profiling and classification and Article 17 may severely inhibit their ability to make good ad selections if large amounts of personal data is consistently erased from their platforms. These articles extend through their entire businesses unless they bifurcate sources and servicing into two platforms - (1) EEA platforms and (2) Non-EEA platforms which will add significant costs.

2. **Digital Personal Styling (e.g. StichFix)** - As a result of article 22 protecting special categories of data, these companies would need to put measures in address article 9, including measures that would make the company HIPAA compliant. The EEA impacts this further by making companies like these store their data in GDPR compliant countries, which may impact their supply chain planning and selection of vendors.

3. **Personalized Healthcare** - These companies should already have measures in place like the ones that would make it HIPAA compliant to become compliant with Article 9, and will have to take additional precautions to either limit their products and services to countries outside of the EEA to become compliant with most of the GDPR. These companies may be most impacted by Articles 5 and 13, as they may give away trade secrets, which is a huge factor in pharmaceuticals.

For all of the examples given, it is plausible for these kinds of companies to operate within or collect data from persons within the EEA. While the EEA and GDPR introduces significant obstacles, these obstacles are being met by many global companies, and there are other levers within the business model that can offset the additional burden of complying with the GDPR. Additionally, it's reasonable to believe that companies that comply will eventually develop a competitive advantage that will later offset the upfront cost.

4 REFERENCES

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3. Stichfix. (2021) US Privacy Policy. Retrieved from https://www.stitchfix.com/privacy