CS7637 Knowledge-Based AI
Homework 1: Star Wars and GDPR

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1 THE STAR WARS PROBLEM

Snoke and Kylo have been captured by Rey on planet Quesh. All 3 must be transported to an orbiting ship using a shuttle. However, 1) the shuttle can either travel empty or take 1 person and 2) Rey and Kylo or Rey and Snoke can never be alone together unless the shuttle is with them. One of them must depart on it.

1.1 Semantic Network

Figure 1 represents the problem as a semantic network. Each state is represented in a box. The planet and ship are represented as boxes within each state, characters are represented by their name on the planet or the ship. The shuttle is represented as an asterisk (*) on the side it is currently on, and the arrow represents a directional move from one state to another.

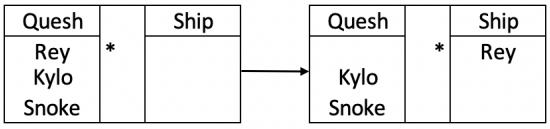

Figure 1 — Knowledge representation using a Semantic Network

The figure represents an initial state on the left, where all characters and the shuttle are on Quesh. The arrow represents the transition of Rey taking the shuttle from Quesh to the ship. The transition results in a state where Kylo & Snoke are on Quesh together, while Rey and the shuttle are on the ship.

1.2 Applying Generate & Test

We can now apply Generate & Test, a problem-solving method, to this semantic network. The generator generates all possible valid moves, while the tester checks each move's efficiency in solving the problem, including validity of states and duplicate states. *Figure 2* shows the result of applying generate & test to the semantic network for one iteration, while *Figure 3* displays the entire network.

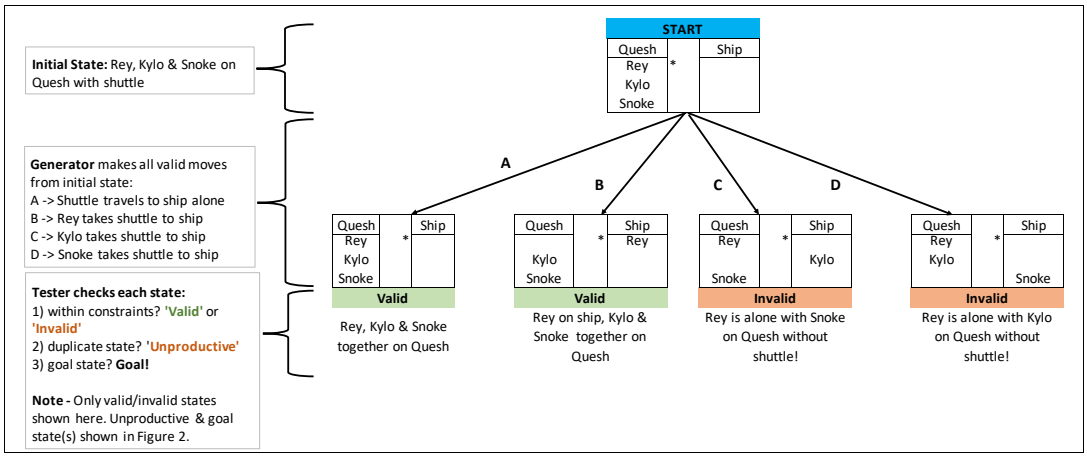

Figure 2 — One iteration of Generate and Test

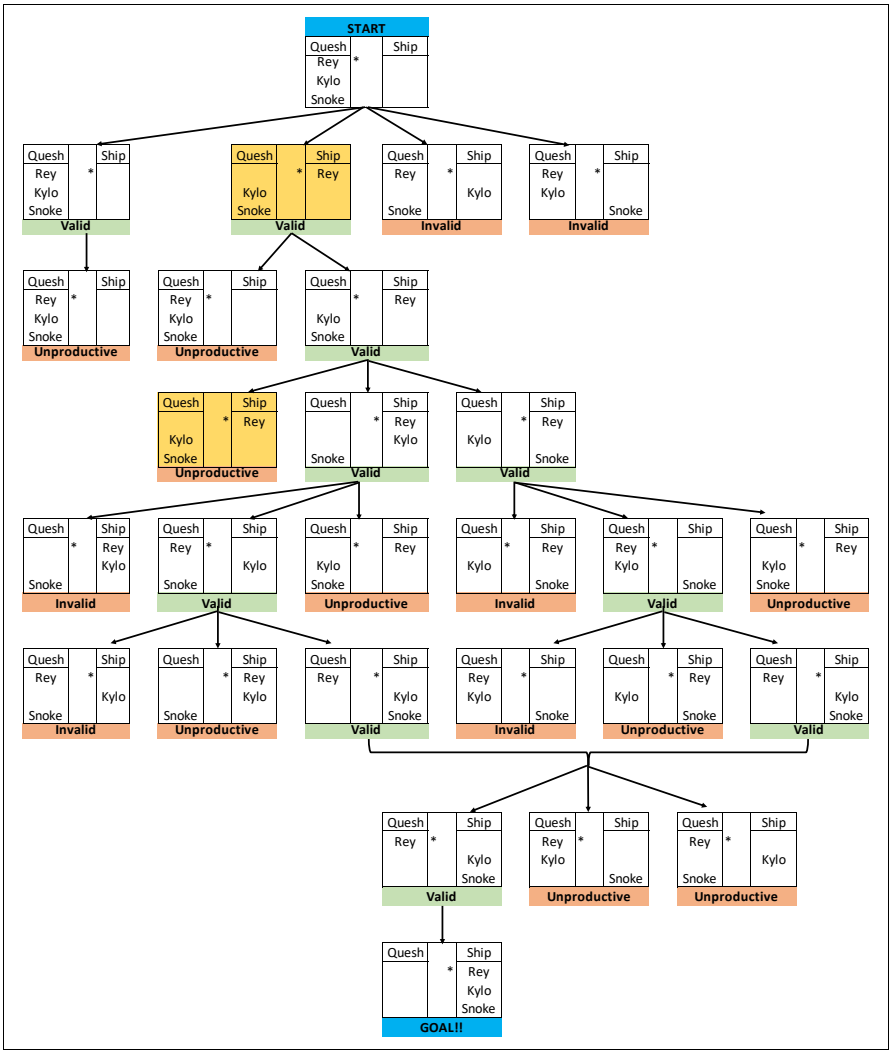

Figure 3 — Applying Generate and Test to the Semantic Network.
One example of duplicated state + prior state in yellow.

2 GENERAL DATA PROTECTION REGULATION (GDPR, 2016)

2.1 Overview

The General Data Protection Regulation was put in place in 2016 and covers a wide variety of issues surrounding data protection and privacy in the European Union (EU) as well as the European Economic Area (EEA). It applies to entities in the region that collect or use personal data for commercial purposes, as well as those outside the region who may collect and/or process data of individuals residing within the region.

To understand what GDPR says about the usage of personal data to personalize user experiences online, we must start with reviewing defines personal data:

> "'personal data' means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person;" (Art. 4 GDPR 2016)

The regulation includes quite a wide variety of data points, and it isn't hard to think about the umpteen numbers of products and services we use daily that collect and use our personal data in some form.

With an understanding of how personal data is defined, we can dive further into how this data can be used. Article 6 (GDPR 2016) lays out six principles, at least one of which must be applicable for data use to be legal (excluding data processing by public authorities). These principles emphasize legitimacy or an absolute need to process personal data but also give leeway on consent i.e., an entity may use your personal data if you provide consent for them to do so for a single or multiple purposes. In addition, unless given consent, "Processing of personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation shall be prohibited" (Art. 9 GDPR 2016)

2.2 Usage of data for personalizing user experiences online

Having laid the groundwork for GDPR, we can now tackle the impact it has had and continues to have in various areas of AI, and more generally the tech industry. The last decade has seen a significant increase in personalization – Meta (Facebook, Instagram, Whatsapp etc.), Amazon, Netflix, Spotify, TikTok and many more companies use personal data to customize their online experiences. This includes recommending movies to watch, songs to listen to, or even customizing which of your friends' updates show up first on your social media feed. However, up until GDPR, none of these services were required to ask their users for consent when collecting, storing & processing their data including their name, location, gender, age, ethnicity etc. The introduction of GDPR essentially limits, at least in spirit, the usage of all these data points and hence limits how much they can personalize individual user experiences.

Although companies may be restricted in collecting personal data from their users, they are still free to provide services such as selling products or providing the ability to post and share pictures with friends.

2.3 How GDPR impacts the use of AI

There are many aspects to personalization of a user's experience online. It starts with some identifiable information specific to a user – such as a unique identifier, perhaps some demographic data such as age, sex, gender, location, and a sprinkle of other information like the user's IP address, device's IMEI number, usage patterns and behavior online (purchase history, viewing habits etc.). This is an oversimplification of course, because the data collected by these companies gets down to some very personal details as well. Then, with this robust dataset made up of all their users, companies deploy various machine learning and/or other relevant algorithms that ultimately fuel their recommendation systems. It is these recommendation systems that live at the heart of personalized experiences.

While articles 4, 6 and 9 are all relevant to these systems, Articles 15 and 22 also explicitly state that users have the right to know how their data is being used including where there is "the existence of automated decision-making, including profiling". Overall, GDPR outright prohibits these activities unless users provide consent or companies can prove legitimate need-based reasons for collecting and using this data. And even where present, at a minimum the regulation can create

a headache for entities where the use of AI is integral to their business. The GDPR, although detailed, isn't always as explicit and one can imagine how limiting this can be for those with tight budgets (such as startups) who may not have legal teams to help navigate the lengthy documentation.

2.4 Netflix – do you really need that recommendation?

Netflix has been around since 1997 and was originally started as mail-based rental service for movie DVDs. Within the next decade, Netflix launched its streaming business and slowly over time, the company amassed significant amounts of user data. Today, personalization is core to its business – from recommending which movies you should watch next to a personalized homepage, even personalizing the artwork you see (Artwork Personalization at Netflix, 2017)! Although the product has significantly improved user experience with personalization, it isn't hard to imagine Netflix continuing to offer a viable product should a user choose not to provide them their data and/or opt out of recommendations altogether. After all, that is how Netflix started, and the ability to log on and watch any movie you want at any time, continues to be a big selling point.

2.5 Oura Ring – personalization runs deep

While Netflix may well be a strong product without its recommendation system, there are some products, companies or industries that may cease to exist entirely if they're unable to collect and use personal data. One such example is the Oura Ring, a 'smart' ring that allows users to keep track of their physical activities (including sleep). The ring measures a user's heart rate, movement, and other metrics 24/7, and by doing so, it can provide deeply personalized insights into the user's well-being. The product learns a user's 'baseline' over time and can alert the user of significant deviations from their personalized norm.

In some sense, the Oura Ring is comparable to the Apple Watch, as the device uses health data to personalize an experience. However, one could argue that an Apple Watch could theoretically be used as, well, just a watch. The Oura Ring on the other hand, would cease to exist as a viable product if it was unable to personalize its user's experience.

2.6 European Economic Area (EEA)

The European Economic Area (EEA) includes all 27 member states of the EU as well as Norway, Iceland, and Liechtenstein, making it a total of 30 member states. The GDPR applies to all members of the EEA, and hence both examples cited in this paper must comply with the GDPR in this region.

Articles 4, 6, 9, 15 and 22 are all relevant to both Netflix and Oura Ring. As mentioned in prior sections, Article 4 defines what constitutes personal data – collected both by Netflix and Oura (neither is anonymized). Article 6, particularly part 1(a) only makes data processing by these companies lawful if the user "... has given consent to the processing of his or her personal data for one or more specific purposes;". Article 9, quoted in section 2.1, is relevant for Netflix as viewing habits could be determined as capturing data on "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs" whereas for Oura, the areas of "data concerning health" are particularly relevant. Finally, Articles 15 and 22 relate to automated processing and logic, which would be relevant for both Netflix's recommendation systems as well as Oura Ring's 'sleep staging algorithm', a system that utilizes machine learning.

2.7 Can EEA users watch movies and stay fit with GDPR?

The short answer is yes, they can.

Since GDPR was put in place more than 5 years ago, Netflix has since adapted by providing users in the EEA with various options that maintain compliance. The company's Privacy and Security help page has a dedicated GDPR section (https://help.netflix.com/en/node/100629) where users can learn about their right to access, update or even delete their data, right to receive a copy of their data as well as withdraw consent from usage of their data – all of which allow Netflix to continue serving the EEA.

Similarly, the Oura Ring is GDPR compliant as it has an integrated consent mechanism for users which includes giving users the ability to understand how their data is managed.

Both companies have relied heavily on Article 6 (user consent) among other principles of the GDPR to remain compliant in the EEA.

3 REFERENCES

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