Assignment 2

Part A. Solving a "Kind" Decision Making Problem

The following data is given:

The general chance of cat allergy is 1%.

For people who are allergic to cats, the probability that they test positive is 85%.

For people who are not allergic to cats, the probability that they test positive is 10%.

1. In this scenario, a "hit" is when a student is in fact allergic to cats, while also testing positive for cat allergy. A "false alarm" is when a student is not allergic to cats, but nevertheless tests positive for cat allergy anyways.

2. If this student tests positive, the probability that they have a cat allergy can be calculated using the Bayes' Theorem:

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B \mid A)P(A) + P(B \mid A')P(A')}$$

- The general chance of cat allergy (event A) is 1% ("prevalence"): $P(A) = 0.01$, so $P(A') = 0.99$.

- If this student has a cat allergy (event A), the probability that they test positive (event B) is 85% ("hit/true positive of the test"), $P(B \mid A) = 0.85$.

- If this student does not have a cat allergy, the probability that they nevertheless test positive anyways is 10% ("false alarm rate of the test"), $P(B \mid A') = 0.1$.

Given this student has a positive test result, the probability that they actually have a cat allergy is:

$$P(A \mid B) = \frac{0.85 \times 0.01}{0.85 \times 0.01 + 0.1 \times 0.99} = 0.0791 = 7.91\%$$

Therefore, the probability that this student actually has a cat allergy is 7.91%.

3. There are many factors that could contribute to overestimating or underestimating the probability that a positive test is true. Dan Airely brings up some great points from his TED Talk on decision making to help explain this [1]. He states that intuition fools people in repeatable, predictable, consistent ways, and there is almost nothing that can be done about it, aside from taking a ruler and starting to measure it. Without training in Bayes' Theorem, there is really no other mathematical way to validate how trustworthy

Paolo Torres

Assignment 2

the test really is. In addition, some people may tend to challenge results of a test, where they are skeptical of the results until they have enough sufficient evidence for them. People may overestimate that a positive test is true if they experience severe symptoms around cats, as their personal experience backs up the result, whereas they could underestimate the test if they do not experience many symptoms, as their personal experience contrasts that of the test results.

Furthermore, points from Daniel Kahneman and Gary Klein's paper on intuitive expertise brings in some more insight on this topic [2]. People may have heuristics, which are mental shortcuts to make decisions quickly, that could lead them to overestimating or underestimating the results. They could have a skeptical attitude toward the results and may err on the side of doubt due to inconsistencies in testing and personal experience. They may have an illusion of validity, an unjustified sense of confidence that often comes with clinical judgement, that impacts their trust in the test. Lastly, loss aversion could be at play here, where people react to incorrect testing more strongly than correct testing. The true positive probability is 85%, whereas the false alarm probability is only 10%, so depending on their level of confidence in the tests, their ability to gauge a true positive test will vary from person to person.

Paolo Torres

Assignment 2

Part B. Drafting a "Wicked" Decision Making Task

4. **Decision Makers of Interest**

a. The project for this assignment will pertain to a feature I worked on during my internship at Microsoft a couple of years ago. This feature was a part of C++ productivity improvements for the Visual Studio integrated development environment (IDE) which got released to the public in 2019 [3]. More specifically, the feature that was implemented was the one titled "Go to Document on $#include$", which allows users to use the go to definition shortcut ($F12$) on $#include$ directives to open the corresponding file. In relation to this assignment, this feature helps users navigate to files in a more fluid and natural way and works alongside other navigation features to get the user to where they need to get to. In particular, there became four ways to navigate to files within Visual Studio: using the project explorer, using a file search bar, via right-click, and then now through this new feature through the $F12$ shortcut. With all these options available for file navigation, the human decision makers (i.e., developers, students, general users of the product) must utilize one of these four methods to achieve their task.

Paolo Torres

Assignment 2

5. **Heuristics and Biases**

a. The chosen bias for this section will be the default effect.

b. People go with the default because it is the path of least resistance. In other words, going with the default does not require as much of an investment in decision making as going against the default does. This is a very important bias to consider for this feature because the intent of my implementation was to blend together what was already a default action across the IDE and standardize the navigation of files altogether. The motivation behind this feature in the first place was that users had trouble navigating to files quickly, so this feature was looking to tackle that problem. Since the $F12$ shortcut was already used in many other parts of the IDE for navigation, it made sense to incorporate this action with another instance of navigation. By setting a popular and well-known shortcut to a related action, the goal was to harmonize and simplify the user experience of file navigation. Part of my internship there was to analyze and see the results of my implementation, and whether or not the feature actually tackled the problem. After it went live for millions of people to start using, the feedback was entirely positive. Many people praised the change, saying how easier and more convenient it was to navigate to files. Connecting back to the chosen bias, this success was largely due to incorporating the well-known default action, which was that $F12$ shortcut, to this pain point of the product. For more veteran users of the product, it took a longer time for them to get used to this change, which could have backfired, however, this concern was largely outweighed by the benefits gained in the simplification of file navigation. Lastly, although this now became the prominent default action, there are still those other ways to perform the same thing, which will satisfy the users who may not have liked the changes, thereby keeping them happy.

Paolo Torres

Assignment 2

6. Skill

a. Skill-based decision making is the making of decisions based not only on inherited abilities, but also conditioned through experience. This type of decision-making acts like automated routines requiring little conscious attention [4].

b. The best example of skill-based decision making related to the Visual Studio file navigation feature relates to the user's level of experience. If the user is a relatively new user, for instance a university student or junior software developer, it may be easier for them to be accustomed to the changes and add it to their arsenal of default actions without any issues. However, if they are a long-standing user or senior developer using the product for many years, it may go one of two ways. Either they praise the change and quickly assimilate into regular usage of this new feature, or they struggle with it at first, perhaps even straying to other navigation methods. This almost entirely depends on their experience, and whether or not they have been using the $F12$ shortcut regularly throughout their development before the changes. If they have been using it consistently, it will be easy for them to pick it up, however if they have been using other methods such as the project explorer or file search bar, it may take some time for them to change or they may not even use it and continue to use alternate methods they are already used to.

Paolo Torres

Assignment 2

7. **Rule**

a. Rule-based decision making is the making of decisions that are conditioned and codified by experience in the brain or in external references. They are like pre-packaged units of behaviour released and can be related to how computer programs make decisions with conditionals ($IF, THEN, ELSE$).

b. The closest example of rule-based decision making related to this feature is with respect to what action the user is currently doing immediately prior to performing a file navigation. Recall the four ways to navigate to a file within the IDE: using the project explorer, using a file search bar, via right-click, and this new feature through the $F12$ shortcut. Assuming the user in question is neutral towards all options, i.e., is not biased towards one of the four ways, then the option chosen for the file navigation can be described like rule-based decision making. If the user has been actively interacting within the project explorer, then most likely they would also navigate to their desired file using the explorer. Else, if they used the right-click feature recently on actions like syntax correction or code suggestions, they would be inclined to perform the file navigation the same way. Else, the desired default option would be invoked, where users would gravitate toward use of $F12$ to perform the action.

Paolo Torres

Assignment 2

8. Knowledge

a. Knowledge-based decision making is the making of decisions that are for the most part, based on the mysterious process inherent in creative decisions and acts. This type of decision-making is like improvisation in unfamiliar environments, where there are no routines or rules available.

b. The best example of knowledge-based decision making for this feature is when users navigate to the files in ways in which they learn the corresponding method through documentation or instruction. This changes the mentality when making the decision to perform the desired action, as it turns from discovering the methods to learning the methods. Given the documentation, it would allow users to assess the different methods and make informed decisions for any situation they are in. Although the $F12$ shortcut method is generally the easiest way, it is also dependent on the user and how their project is setup. It may be that using the project explorer is quicker, if for instance their project has a small number of files or they have specific configurations and settings to allow this. As such, rather than performing an action based on skill (experience) or rule (a set of conditionals), the users can make informed decisions through documentation to ensure the optimal outcome for their specific needs.

Paolo Torres

Assignment 2

9. References

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[4]   T. B. Sheridan, "Musings on Models and the Genius of Jens Rasmussen," Elsevier, 26 October 2015. [Online]. Available: https://learn.uwaterloo.ca/content/enforced/635025-SYDE543_y457li_1211/Wk5.%20Decision%20Making%20Part%202/Musings%20on%20Models%20and%20the%20Genius%20of%20Jens%20Rasmussen.pdf?_&d2lSessionVal=fixXHc2WhT1BGLssj2UykUfFO&ou=635025. [Accessed 15 February 2021].

Paolo Torres