

## Information Fusion (IFU), Summer Semester 2023

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### Exercise 1: Information and Uncertainty

The main aim of this exercise is to help you develop a deeper understanding of the topics covered in the first lecture (L\_IFU\_1). For this exercise you will need to form groups of 3-4 students. Your group will need to choose an example scenario to use as a setting for this exercise. You can choose a scenario of your own choice or you can choose one of the following examples:

- autonomous driving,
- condition monitoring of production lines,
- medical health monitoring,
- dinner preparation,
- space exploration.

Please complete this exercise by **13.04.2023** and be prepared to share and present your ideas, examples and opinions.

We recommend that you spend ample time playing around with the scenarios and engaging in thoughtful discussions with other students. We also encourage you to use modern tools such as ChatGPT<sup>1</sup> to help you with this exercise. It is important to remember that the ultimate goal is to develop your critical thinking skills and demonstrate your understanding of the lecture topics. Therefore, we urge you to take your time and carefully evaluate the answers you receive. Use your own creativity and analytical skills to support and develop your answers.

#### 1.1 Data – Information – Knowledge

In the lecture, it is mentioned that *data*, *information*, and *knowledge* are three very distinct concepts. Please use your example scenario to work through the following points:

1. Brainstorm examples of data that could be collected from sensors or other sources. Describe the format, type, and frequency of the data.
2. Identify examples of information that could be derived from the collected data. Describe how the data could be analysed and processed to generate meaningful information.
3. Discuss examples of knowledge that could be gained from analysing the information. Describe the expertise, experience, or values that could be achieved.
4. Analyse the role of context in your scenario. Discuss how factors such as time, location, industry, culture, or language could impact the interpretation of data, information, and knowledge.
5. Summarise your findings with key takeaways.
6. (Optional) Tell a story! Embellish your example scenario with a story of your own. Tell a gripping narrative of how your main character gains crucial knowledge from data to triumph against almost insurmountable odds. (This is a good opportunity to play around with ChatGPT).

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<sup>1</sup>but you don't need to!

## 1.2 Uncertainties

The lecture introduces the concepts of *aleatoric* and *epistemic* uncertainties. These two types of uncertainty are fundamentally different. It is important for the success of an application - whether in machine monitoring [1], technical systems [2], engineering [3, p.56 ff.], or machine learning [4] - to be able to distinguish between aleatoric and epistemic uncertainty.

1. What are the characteristics of these types of uncertainty? Describe strategies on how to cope with these uncertainties.
2. What is the goal of information fusion concerning uncertainties in multi-sensor systems?
3. Examine your example and identify where you can find instances of these types of uncertainties. Provide specific examples of each.

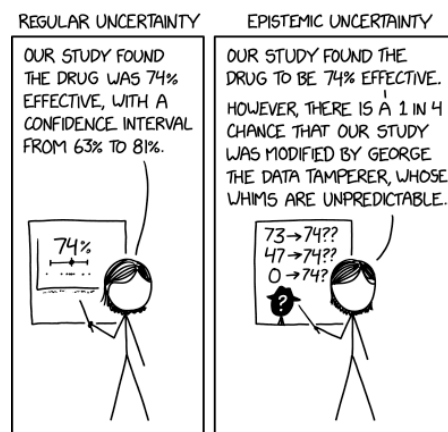


Figure 1: Relevant xkcd

We hope that this exercise will help you develop a deeper understanding and that you will be able to apply this knowledge in your future studies and careers.

Good luck and have fun!

## References

- [1] Volker Lohweg, Karl Voth, and Stefan Glock. A Possibilistic Framework for Sensor Fusion with Monitoring of Sensor Reliability. In Ciza Thomas, editor, *Sensor Fusion*, chapter 11. IntechOpen, Rijeka, 2011.
- [2] Christoph-Alexander Holst and Volker Lohweg. Scarce Data in Intelligent Technical Systems: Causes, Characteristics, and Implications. *Sci*, 4(4), 2022.
- [3] Bilal M. Ayyub and George Jiri Klir. *Uncertainty Modeling and Analysis in Engineering and the Sciences*. Chapman & Hall/CRC, Boca Raton, FL, USA, 2006.
- [4] Eyke Hüllermeier and Willem Waegeman. Aleatoric and epistemic uncertainty in machine learning: an introduction to concepts and methods. *Machine Learning*, 110(3):457–506, 2021.