Weekly Exercise 1

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Probability theory

Exercise 1 (**Consequences of the axioms**). Let P be a probability measure, and assume that A and B are events. Prove the following statements

1. If $A \subseteq B$, then $P(A) \leq P(B)$,

2. $P(A \setminus B) = P(A) - P(A \cap B)$,

3. $P(A \cup B) = P(A) + P(B) - P(A \cap B)$,

4. $P(A \cup B) \leq P(A) + P(B)$.

Solution. Let us apply the axioms.

1. Assume that $A \subseteq B$. Then we have
$$P(B) = P(A \cup (B \setminus A)) = P(A) + P(B \setminus A) \leq P(A) .$$

2. $P(A) = P((A \setminus B) \cup (A \cap B)) = P(A \setminus B) + P(A \cap B)$, which means that
$$P(A \setminus B) = P(A) - P(A \cap B)) .$$

3. $P(A \cup B) = P((A \setminus B) \cup B) = P((A \setminus B) + P(B) = P(A) + P(B) - P(A \cap B)$, where Statement 2. has been applied.

4. Based on Statement 3., we have that
$$P(A \cup B) = P(A) + P(B) - P(A \cap B) \leq P(A) + P(B) .$$

Programming

General Information. In this lecture, you are free to choose your preferred programming language, e.g., `C/C++`, `Python`, `Matlab`. However, please note that, we mainly provide support for `C++` and `Matlab`. We suggest you to use `OpenCV library` for image processing for both C++.

Exercise 2. Load, modify and save an image. This exercise is intended to get you familiar with the programming interface to process images. Your task is to load a color image, **write your own function** to convert the image to grayscale with the following formular,
$$g = 0.299 \cdot R + 0.587 \cdot G + 0.114 \cdot B$$
and then save the grayscale image.