Department of Systems Innovation

Online Written Examination: Problems Designed to Test Ability of Logical Thinking #2

Question P1 (Choose one question from P1-P3)

Vortex is one of the phenomena that occur in fluids. Humans have used the benefits of vortices but also suffered from them; thus, we must understand the nature of vortices and efficiently utilize them.

(1) Consider an object placed in a uniform flow in the air, which can generate vortices behind it. In the case that the object is of a cylindrical shape, describe the state of the flow behind the object by considering the relation between inertial force and viscosity of the flow.

(2) Give an example of vortex phenomena behind object(s) which caused or can lead to accidents of mechanical products or structures. Also, describe the possible measures to prevent accidents.

(3) Describe the relation between accidents caused by vortices and the human society (e.g. impacts of accidents on society, or how society and technology have been advanced and developed after accidents). You may refer to the accidents answered in (2), or you can describe other accidents that are not related to (1) or (2).

(4) Give an example of the effective use of vortex phenomena and describe its mechanism. Note that the example is neither limited to mechanical products or structures, nor to the vortices mentioned in (1).

Question P2 (Choose one question from P1-P3)

There are $m+n$ data points $\{\boldsymbol{x_1}, \ldots, \boldsymbol{x_{m+n}}\}$, which consist of d -dimensional real values ($d \geq 3$). Note that $\{\boldsymbol{x}_1, \ldots, \boldsymbol{x}_m\}$ belong to the class C_1 , and $\{\boldsymbol{x}_{m+1}, \ldots, \boldsymbol{x}_{m+n}\}$ belong to the other class C_2 . Assuming $m \gg 1$ and $n \gg 1$, answer the following questions regarding the method for determining the class of a new data point $\boldsymbol{x}_0$. If needed, you can draw figures.

(1) Give two or more examples of the methods for determining the class of data points and describe the features of the methods.

(2) Choose one method from your examples given in (1) and describe its algorithm using such as equations, pseudo-codes*, or flow-charts.

(3) Explain how to evaluate the accuracy of the method described in (2).

*Pseudo-code is an informal description of the operating principle of a computer program or algorithm. Below is an example pseudo-code to give an order to study unless being sleepy.

```
if isSleepy == true:
    Go to bed
else:
    Study
```

Question P3 (Choose one question from P1-P3)

Due to the COVID-19 pandemic, global daily CO_2 emissions in April 2020 were estimated to be 17% lower than the average in the previous year[1]. The figure shows the global daily fossil CO_2 emissions (10^6 t-C/day; carbon equivalent) from 1960[1,2]. In the figure, the value of each year from 1960 to 2019 corresponds to the annual average. On the other hand, the data for 2020 is that of April 7th, which is the estimated minimum value between January and April. The green area shows an uncertainty range.

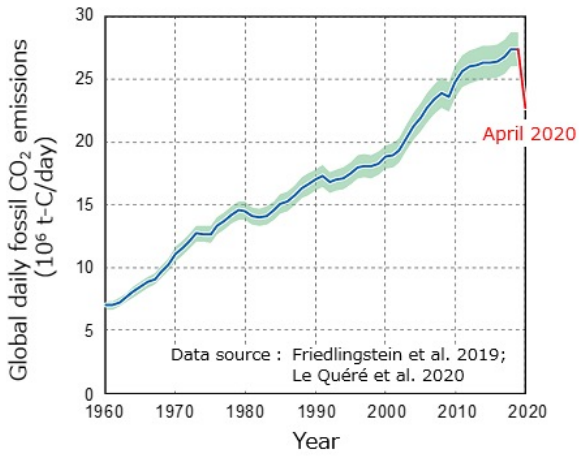

Figure Global daily fossil CO_2 emissions

(1) The estimated daily fossil CO_2 emissions in 2020 decreased at a rate unseen in the past 60 years. However, the emissions seem to return only to the level of 2006. Based on this fact, describe issues regarding the trend of global fossil CO_2 emissions.

(2) Based on the issues described in (1), describe what you think are appropriate measures to be taken against the global fossil CO_2 emissions in the future.

1. Le Quéré, C. et al. Nature Climate Change 10, 647-653 (2020).
2. Friedlingstein, P. et al. Earth System Science Data 11, 1783-1838 (2019).