

In computer science robustness is used to describe the ability of a system to handle errors, exceptions and keep the system running stably in this situation. As a student studying computer science, I migrated this concept into the biological sciences. So, I think the robustness for biology is that the ability of a biological system to maintain its specific or core functions regardless of the influence of external or internal factors. Robustness does not mean that a biological system should maintain the status under all circumstances, but rather that robustness means that a biological system should be able to guarantee at least its core functions or some specific functions, regardless of the influence of external factors. The robustness allow system changed in structures and components, but some specific or core functions should be maintained (Kitano, 2004). But fragility, from my point of views, I think fragility is a concept that corresponds to robustness, fragility describes the component of a biological system that is susceptible to external or internal influences that change the core or specific functions of the system. For humans, I believe that the homeostasis of the human beings reflects the system's robustness as an organism.

For biological robustness and fragility, I believe that these characteristics are specific to multiple levels, from DNA and protein structure to ecosystems.

From my personal perspective, I believe that the biological representation of robustness is the human beings. I believe that within a certain external environment, the human body, through the collaboration of various organs and various body fluids regulation, finally maintains the relative stability of the internal environment, and finally achieves a dynamic equilibrium, and in this way, it achieves robustness. The human body needs to maintain biological homeostasis to keep its organs working properly and to maintain its health. For example, the human body temperature is normally maintained at around 37 degrees Celsius, which does not change significantly when you are in Russia or Singapore. Similarly, in the case of normal physiological indicators of the human body, regardless of whether the external environment is hot or cold, the pH value of body fluids in the human body is probably still stable between 7.35 and 7.45. When external conditions change, the body may generate some negative feedback mechanisms to maintain homeostasis. For example, when the weather is hot, people will sweat to lower

their body temperature; after eating, blood glucose will rise and human glucose concentration will be higher than normal, then the body will secrete insulin to lower the glucose concentration in human blood. Therefore, I believe that through the above mechanism, the body maintains homeostasis, and the body ensures the stable working of its own vital functions in this way, thus achieving robustness.

From my point of view, biological fragility can be similarly illustrated by the homeostasis of the human body. For example, in extremely hot weather, heat stroke may occur if the body's thermoregulatory function is impaired, and the body absorbs more heat from the environment. The body may develop many symptoms in this situation and the homeostasis of the body is disrupted. In this case, if the situation is serious and not timely treatment, the entire biological system will be seriously affected, for the human body is to produce a variety of diseases, in serious cases will lead to the collapse of the entire biological system, that is, death. Therefore, I believe that extreme environments are fragility for the human body as a biological system, and that the body's robustness is susceptible to extreme environments, which leads to changes in some specific functions of the body.

As I mentioned above, since the environment is in constant change, biological robustness for the individual ensures the stability of its specific functions, and for the individual robustness ensures that the core functions are unchanged, and these core functions are needed for the individual to maintain survival, so biological robustness for the individual is part of survival.

Similarly, as mentioned above, for individuals, fragility may lead to the death of the individual; for ecosystems, it may lead to the complete change of the whole ecosystem, such as the problem of soil erosion in northwest China due to the drastic reduction of biological species and low forest cover, which eventually leads to the desertification of the soil and the change of the whole ecosystem.

I think this fragility needs to be avoided by external intervention in advance of external intervention. For example, for the prevention of many cancers, people will undergo annual physical examinations to check the indicators of their bodies, and based on the data of their bodies, they can determine the potential risks of some diseases in advance,

and intervention at this time may be able to avoid the emergence of cancer, thus avoiding fragility

The above is my understanding of the robustness and fragility of biology, which is why I think biological data science is so important. I believe that biological data science can analyse the robustness and fragility of both systems and individuals through data, so that early prevention can be achieved.

References

- [1] Kitano, H. (2004). Biological robustness. *Nature Reviews Genetics*, 5(11), 826-837.
- [2] Sole, R. V., & Montoya, M. (2001). Complexity and fragility in ecological networks. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 268(1480), 2039-2045.
- [3] 杨映红, & 洪子江. (2005). 我国西北地区土壤沙漠化和水土流失的原因及对策. *甘肃农业*, 5, 39.