Design of Complex Mechanical Systems

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Analysis of Complex System

Complex system, as the contrary of simple system, consists of tremendous elements and a complex relation among these elements. And its complexity is represented by followed characteristics: 1) numerosity, which implies the large numbers of its inner elements emerging into different scales with local interaction and self-organization; 2) interdependence and nonlinearity, such as a sensitivity to initial condition with a characteristic in chaos; 3) connectivity, where some basic elements orderly or unorderly emerge into a system and those systems can also connect with each other to form a more complex network; 4) adaption, that shows even without centralized coordination or control, the system can autonomously adapt to environmental change by interacting with each inner elements.

Here is an example of complex system in food web.

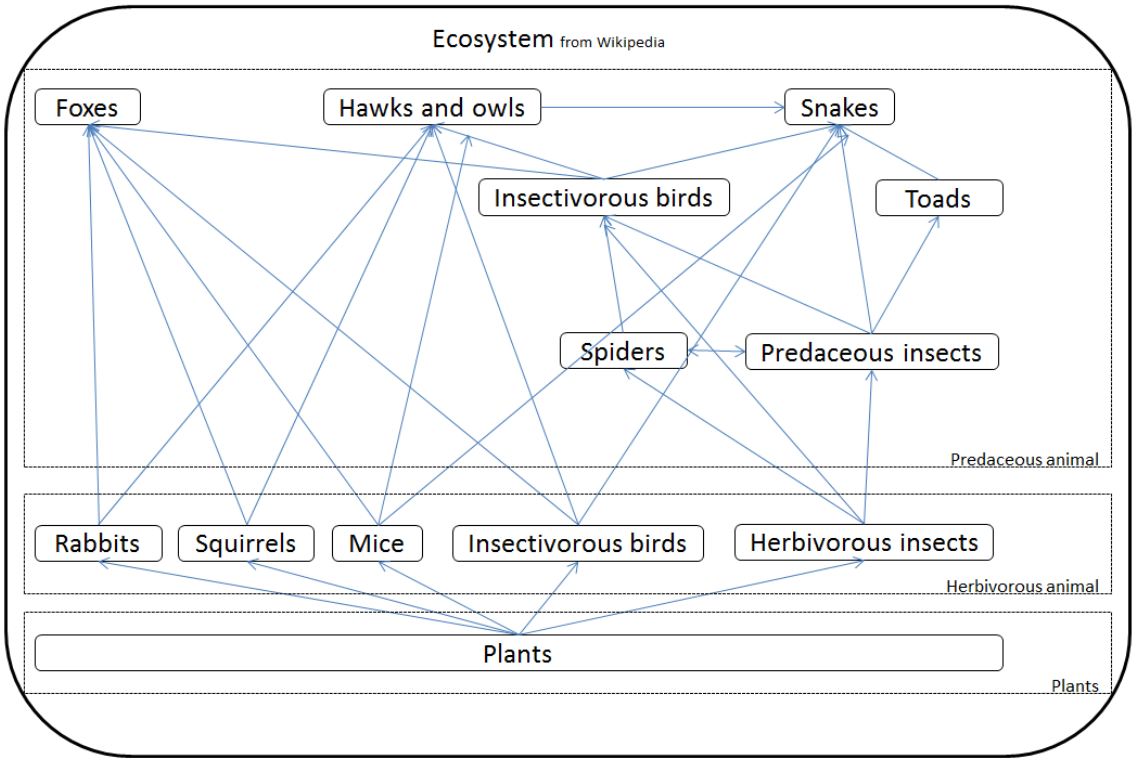

Fig. 1 an example of complex systems

1. Elements: Plants (plants), Herbivorous animals (rabbits, squirrels, mice, insectivorous birds, herbivorous insects), and Predaceous animals (spider, predaceous insects, toads, insectivorous birds, snakes, hawks and owls, foxes)
2. Interaction: Global (Predaceous animals eat Herbivorous animals and Herbivorous animals eat Plants), Local (for example, a food sub-web among herbivorous insects,

spider, predaceous insects, toads, insectivorous birds and snakes)

3. Take cereals within the class of Plants as the target elements. Its yield depends on not only the environmental condition such as sun rise and rain (external factors) but also the consuming by the Herbivorous animals and the indirect influence by those Predaceous animals (internal factors). Noted that the relations between different hierarchies are not negative only, such as the discharge of animals makes a positive effect to the growth of plants.
4. Along with above model, the increasing of the yield of cereals is determined by the quantities of other elements such as Herbivorous animals and Predaceous animals. First of all, the space and nourish for other plants will decrease with the increasing in cereals as a simple competitive relationship. Since that, the quantities reduce of animals will happen as follow, which lead to a higher probability in their choice to consume cereals or a species vanishing.
5. There are two ways to control or affect this food web in order to increase the quantity of cereals. One is to increase external positive factors such as fertilization, and the other is control the negative effect from internal elements within this food web. In other words, the combination of increase the input nourish and control the output consuming can help to reach the goal.