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GPS 1010-010

29 August 2018

In my mind, a complex system is a system made up of simple components performing

relatively straightforward tasks that, through various interactions and building upon each other,

lead to more complex patterns of behavior. These patterns are also dynamic and unpredictable,

with changes in variables of the situation leading to different behaviors; the system and its

components adapt to changing circumstances. Rather than simply being a network of smaller

components, the actions of these components must lead to the larger, unpredictable patterns of

complex behavior.

This definition appeals to me because you can think of a nearly infinite variety of

examples that fit it, and therefore you can think of many examples of complex systems in the

real world: ecosystems, cities, living cells, airports, schools, and more. It's fascinating that so

many of the networks we're made up of or that we are part of are complex systems, because it

means that many things in our life are unpredictable. As much as many of us would like to know

exactly how the world around us will act and how our lives will unfold, the study of complex

systems and the many complex systems we see in our lives proves that we can't really know what

will happen in the future. This may seem like an intimidating prospect, but it also means that almost anything can happen, just like when life miraculously arose out of matter billions of years ago.

I'm currently majoring in biology and I've always been very interested in the subject, so I was especially intrigued by the brain and an insect colony being described as examples of complex systems in Mitchell's book. Previously, I defined a complex system as a network of simpler components whose actions interact to lead to complex, unpredictable patterns of behavior; both of these biological examples of complex systems fit this definition very well. The brain is made up of relatively simple, very small components in the form of neurons, which communicate with each other by receiving and transmitting electrical pulses that translate into chemical neurotransmitters. Although this simple passing of messages may seem like it could never lead to anything complicated or original, the human brain is incredibly complex, able to process large amounts of information and stimuli and adapt to changing situations better than any artificial intelligence we've seen so far. Insect colonies—ants, bees, wasps, termites—are also a fascinating example of a complex system found in nature. Individually, all these insects are inarguably simple organisms performing straightforward, predictable tasks. But working together, colonies can do incredible things—termites build mounds reaching up to 17 feet or

even higher; bees create honey, a delicious food source that can also be used for healing and never goes bad, and they also pollinate one third of all of our food crops; wasps eat pest insects that harm crops and build intricate nests out of paper; ants can work together to build living rafts of ants that can float on water. Insect colonies can also adapt to changing situations; if a nest or hive is destroyed, the colony will build another one, moving astonishing amounts of material to do so.

From the beginning of summer 2017 to the end of summer 2018, I worked at a veterinary center and boarding kennel, where my job was to exercise the dogs being boarded there. Although this job may not seem very complex at first glance-- going to work, taking the dogs out of their kennels into a play yard, repeating the same thing day after day, week after week—no day was ever the same and things were always changing.

My job at the kennel can be framed as a complex system because it is a network—though admittedly, not a very large one—of simpler components whose actions lead to a more complex pattern of overall behavior. These simpler components range from the other staff members-- secretaries, kennel technicians, the veterinarians and vet technicians that worked in the veterinary center that also operated out of the same building—to the number and type of dogs being boarded and me. Each one of these components had a different, straightforward function.

The kennel technicians cleaned out the dogs' runs and fed and watered them; I took the dogs outside one by one to play yards, so they could spend time outside and play fetch or get pet. Although this simple routine may seem like it would lead to uneventful, predictable days, such was not the case. No day was the same; my hours were flexible, so I would arrive at work after the kennel techs finished power washing the kennel anywhere between 11:00 and 2:00; there was never the exact same group of dogs there from one day to the next; the weather would change from day to day and from season to season. Some dogs would be perfectly calm when walking past other dogs down the hallway of the kennel, while others would get excited and bark at other dogs, requiring a shorter leash and much more effort to get out. Some dogs could be left in the play yard for a few minutes while I spent time with another dog in the second play yard, while others had to be paid constant attention to or they would try to get through the fence. Occasionally a dog would be too stressed and nervous to get let out of its kennel. Owners could also pay extra for their dogs to get let out multiple times a day. Some dogs had stayed at the kennel multiple times, and I was familiar enough with their behavior that I knew whether to trust them or to be watchful with them. Some dogs would have to go back inside early if it was a very hot summer day and they had long coats, or if it was snowing and they had short coats and were small or thin. All these factors, plus many more that varied day to day, meant that there

was constant variation in my job, but also that larger patterns developed over time: in what

order I would let dogs out (extra walks first, then alternating between large and small dogs, etc.),

when I would arrive to work (early enough to leave before the dogs' dinnertime, late enough not

to get there while the kennel techs were power washing), even how I would open the run doors

for different numbers and types of dogs and what runs I would put different dogs in. My job at a

boarding kennel is an example of a complex system in my own life because all the smaller

components interact to create larger patterns of more complex, dynamic behavior.

Because of the unpredictability of my job, I often ran into problems that I had to adapt to

and solve quickly; past patterns often helped me solve these problems. The first time I let out a

dog, I'd never know exactly what to expect, but the more times I'd let that dog out the better I

could handle any problems. I'd learn the best way to handle the dog if he or she wanted to lunge

at and bark at other dogs walking down the hallway, whether to watch the dog constantly while

he or she was outside or if I could have a dog in the other play yard at the same time, and if and

how the dog liked to play or get petted. Establishing patterns over time by learning from past

mistakes and successes meant I developed specific methods for approaching different situations

while doing my job.