Spring example: blackbox diagram

Vaibhav Sherkar (BS2041)

Linear Statistical Models deal with the problem of solving approximate linear equations. Now, we shall look at a source of such approximate linear equations. Consider a spring in vertical plane with one end attached to ceiling and a weight attached to another end of the spring. As we change the weight attached to spring, naturally, the length of the spring changes. Figure 1 shows the experimental setup we are discussing about. We are now interested in investigation of relationship between the weight attached to the spring and length of the spring. Note that we are not interested in the reasoning of the relationship between the weight attached and length of the spring.

We now consider a more general setup known as 'Black box'. In the example considered, the spring is a 'Black box' the weight attached to the spring is 'Input' and the length of the spring is 'Output'. We do change the values of inputs (weights) and observe the effects on output (Length of the spring). We use this information to infer about the behaviour of the black box (spring). The black box diagram corresponding to our experimental setup is shown in figure 2.

In general, we consider a Black Box system with one or more inputs and one or more outputs. However, we will be considering the systems having only one output. Figure 3 is pictorial representation of Black box system with 4 inputs and 1 outputs. We shall now see some more examples of Black box systems.

We now consider an example in the field of Clinical Studies. Suppose we have to study the effect of the drugs on the blood pressure of the patient. Suppose this effect also depends upon age and gender of the patient. Then in this case,

(a) Spring Diagram 1

(b) Spring Diagram 2

Figure 1: Experimental Setup

.

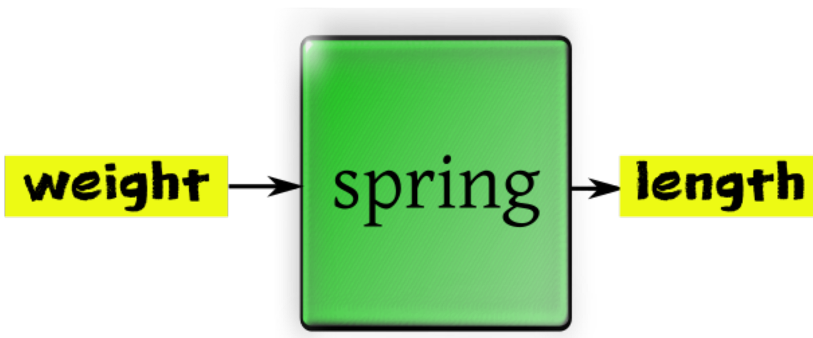

Figure 2: Black Box System corresponding to the Spring System

.

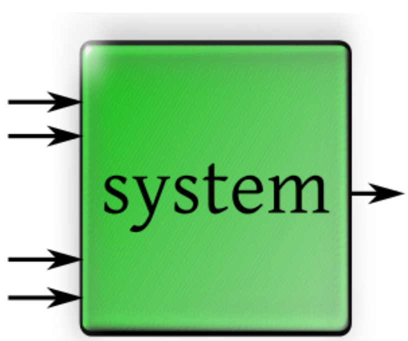

Figure 3: A general Black Box System

.

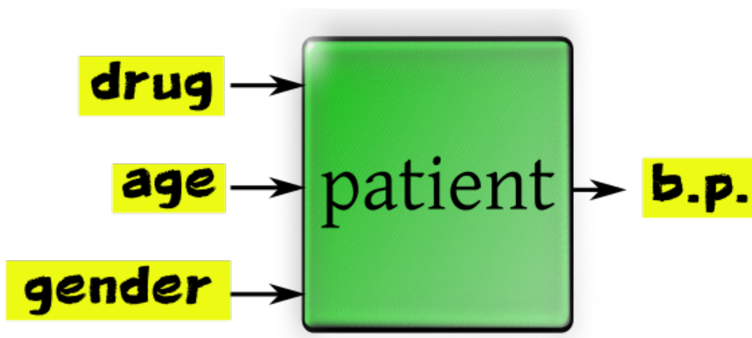

Figure 4: Example 1

Patient is the system, the drug, age of the patient and gender of the patient are inputs of the system and Blood Pressure is output of the system. This example has been pictorially represented in figure 4.

We now consider an example in the field of Agricultural Studies. We now consider plot of agricultural land as our system. Suppose, we have to study how the yield of the crop changes as we change the crop cultivated on the plot and manure used for cultivation. In this example, plot of land is our system , crop and manure are our inputs and yield of the crop is the output of the system. Figure 5 is a pictorial representation of the black box system constructed in this example.

Suppose, we use two identical plots of land for cultivation of same crops using the same manures. Even in this case, we cannot expect the yield of the crop to be be exactly same for both the plots. Hence, even if we consider two systems which are as identical as possible and all the inputs are maintained at the same level, the output cannot be expected to be exactly same. Hence, some amount of random error is inevitable in the output. Hence, it cannot be concluded that there exists some mathematical relationship between output and inputs.

In practical, there are many factors which affect the output and all of them cannot be taken into account. We consider the effect all such factors by addition of random error into the system. Note that this random error is being considered as a random input of the system. Hence, all the randomness in the output is being attributed to this random input. Figure 6 represents the black

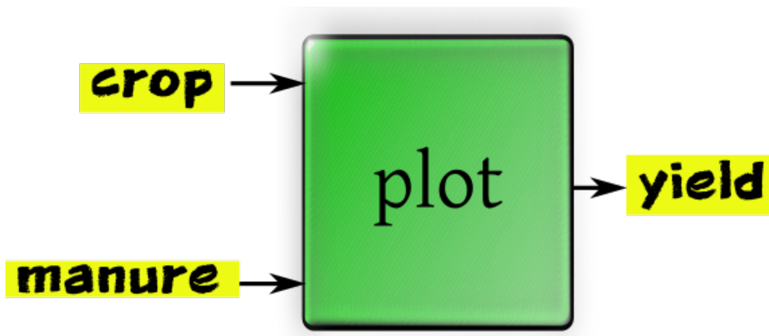

Figure 5: Example 2

box system of agricultural example after addition of random error to the system. Now, we assume that there exists some precise mathematical relationship (Possibly involving unknown parameters) between output and inputs(including the random input 'Random error'). This mathematical relationship can be used to determine the output.

.

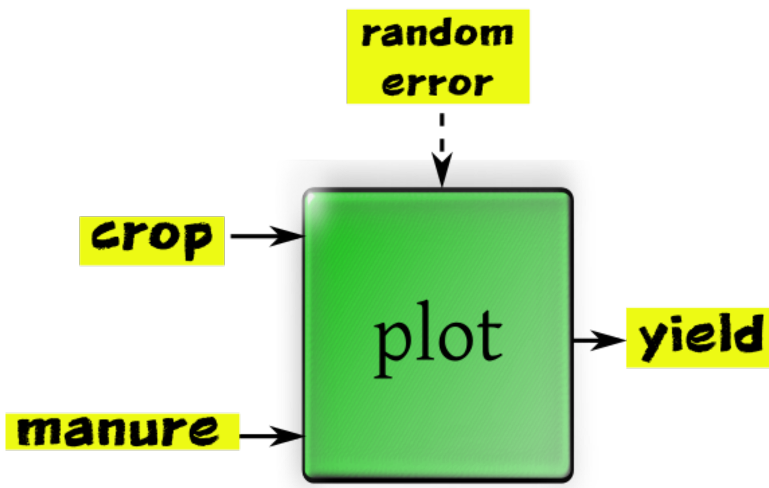

Figure 6: Introduction of random error