Structural Reliability
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Lecture –11
Review of Probability Theory (Part -03)

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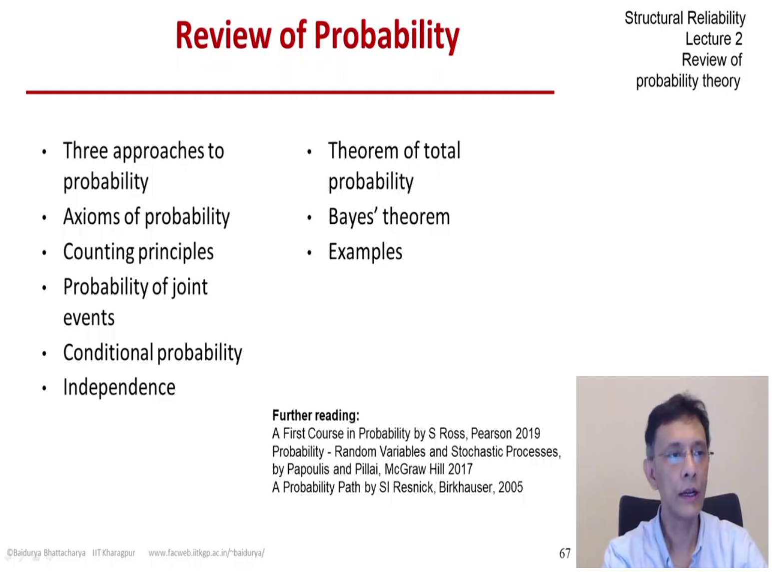

In this review of the basic concepts of probability we would like to cover the 3 approaches to defining the concept the 3 axioms of probability some applications of the counting principles probability of joint events the concepts of conditional probability and statistical independence the theorem of total probability and base theorem and as we will usually do solve examples during the lecture. These three texts will serve as further reading the book by Sheldon Ross, the book by Papulis later revised by Pillai and once again the book by Sydney Breslik .

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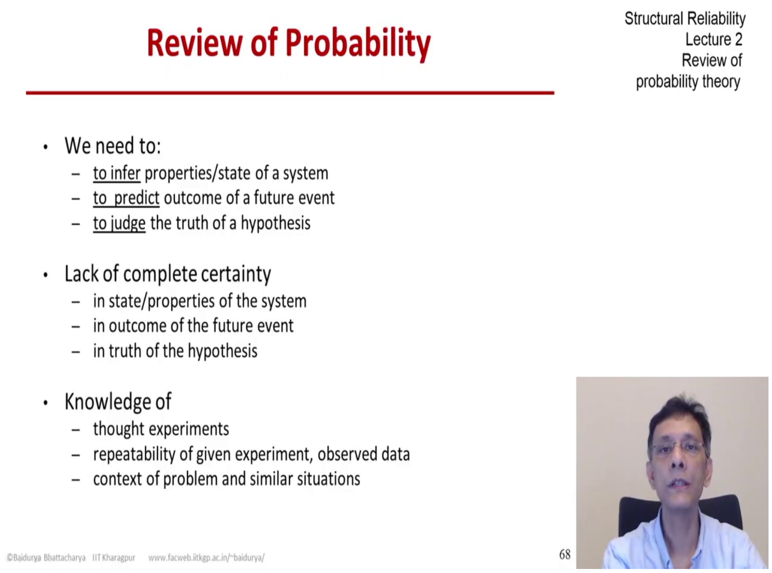

Now why do we need to define probability? We might find ourselves in a situation as we saw in the first lecture where we need to infer the properties or the state of a system or to predict the outcome of a future event or to judge the truth of a hypothesis or the accuracy of a model. The problem is we lack complete certainty we do not have all information about the quantities we are trying to define.

But what we do have is access to thought experiments or access to actual experiments under nominally identical conditions repeated many times or some understanding of the context of the problem and experience with similar situations.

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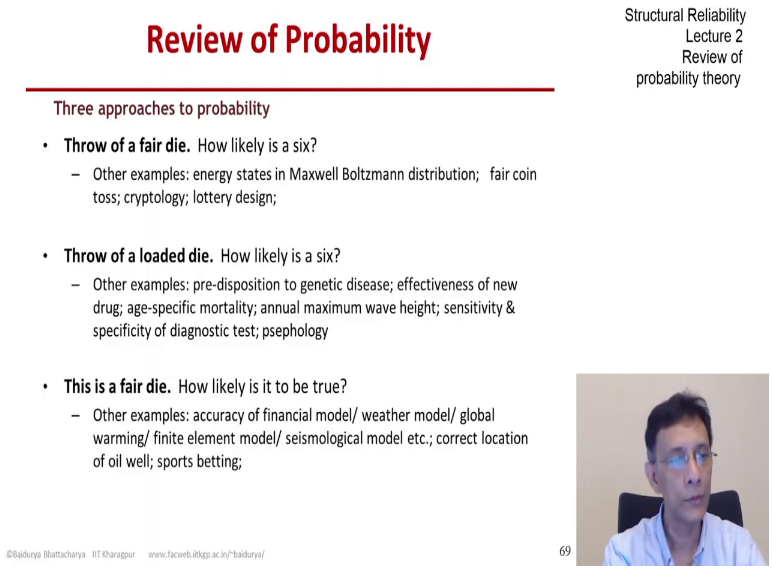

Now let me pose three questions and these would actually give rise to the 3 definitions of probability that we use. The first one is there is a fair die I want to throw it how likely is a 6. Now this represents a vast number of problems and I have listed just a few. The second one is the die is loaded how likely is a six and again this represents a large class of problems and I have listed a few examples. The third question sounds similar but each is subtly different from the others.

So, this one is there is an assertion that this die is fair. Now how likely that assertion to be true is this also represents a wide class of problems I have listed just a few examples.

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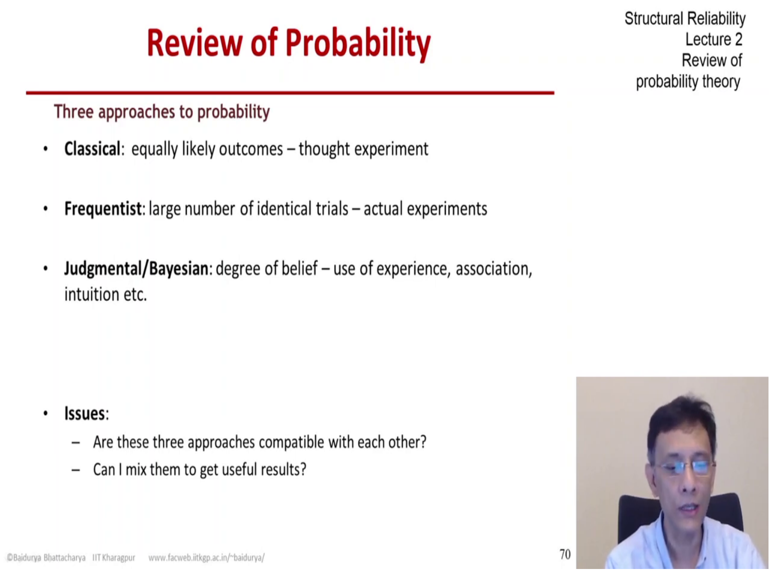

Now in the first example we can take advantage of the fact that all the outcomes are equally likely because the die is fair there are 6 faces. So the probability of getting a 6 is 1e over 6 and this constitutes the classical definition which involves thought experiments but requires as I said the the outcomes to be equally likely. In the second one I do not have the advantage of equally likely outcomes.

So, Ii have to resort to experiments I need a large number of nominally identical trials and then I can estimate the probability this is the frequency's definition of probability. Now in the third type of problem I may not even have access to experiments I may have access to some data but I have understanding of the problem its context and I might have experience also. So, in that particular case I can set up the hypothesis I can perform some tests and I can say that I am 50% or 90% or even 100% certain that the die is fair.

But I will have to bring in my judgment and my value system and how much I trust the data the experimenter or the model. So, the question is that whichever way I define probability are these approaches compatible with each other and if I have a problem that involves two or more such definitions can I mix them and get results.

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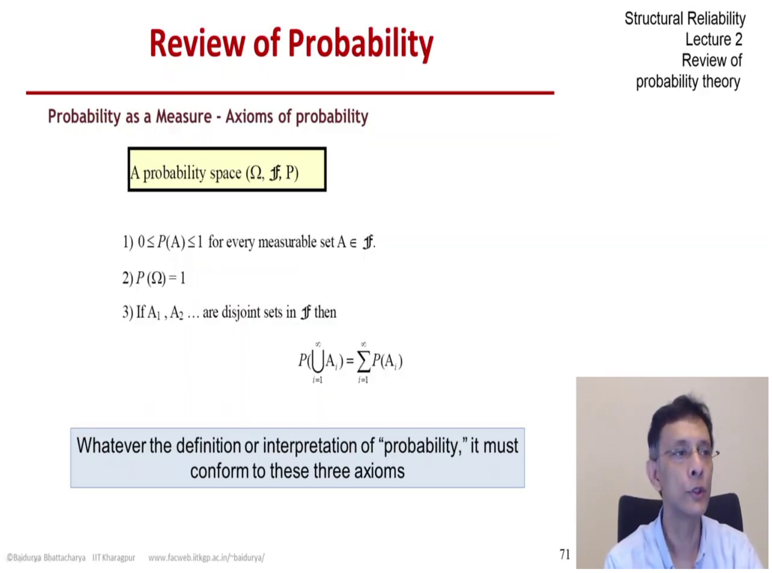

The answer is yes provided your definition satisfies the three actions of probability. So, we have a probability space consisting of the sample space an appropriately defined algebra defined on the sample space a collection of subsets of omega and an appropriate measure defined on that collections which we call probability. So, it is non-negative that is the first axiom. The second axiom uses normalization.

So, the probability of the sample space the shear event is one and the third axiom says that probability is additive in nature. So, if I have a finite or a countably infinite collection of sets in f the probability of the union is the sum of the individual probabilities.