Decision Modeling
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Lecture 01
Decision Analysis, Introduction

Today we are going to discuss a new topic that is decision analysis,

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This portion will be the introductory portion, first of all how do we define decision analysis, this is an analytic and systematic approach used to develop an optimal decision strategy, when a decision maker is faced with several decision alternatives,

Really speaking really is really happening in many different applications, some examples are here maybe in product design.

Service design, evaluating different financial alternatives, marketing decisions, capacity decisions, sales related decisions, you know in various situations what happens when a person has to make decision then few things occur, first of all there are different alternatives and these alternatives are to be formed as well because initially we really do not know what are the alternatives, so the design of the alternatives are to be done.

In order to design we have to collect data and also models and many different other things altogether they can be intelligence.

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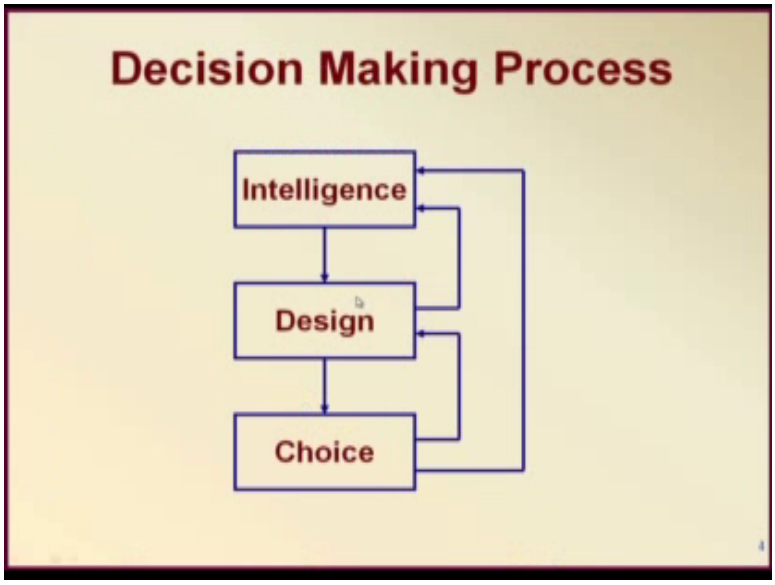

So you know this Harbord Symonds model which we can call decision making process essentially looks like this

That initially there is a thing which is called intelligence, what is intelligence? It consists of data, models, maybe database, model base and you know inferences which we draw out of those database and the model bases.

So after the intelligence what we need to do we have to design what is known as the alternatives, so alternative design essentially requires that trying to find out all possible data information models whatever we have got, what are the choices before us right, suppose we want to set up a new plant and we have zero dine on five locations, so these are the design portion that there is specific five alternatives which are available to us.

After this five alternatives are available we have to choose, how do we choose that choice phase basically means evaluating different alternatives right, now there are many feedbacks as you can see, now while we need to choose we may find that we do not have adequate data about the design of alternatives, so we go back to design, sometimes while we design we may find no we need more data, so you see we can go from choice phase to design phase.

Or we can again go from the design phase to intelligence phase or choice phase to intelligence phase as well but anyhow finally we have to make a choice and how do we make choice, what are the different things that are before asked, all of these forms the decision making process

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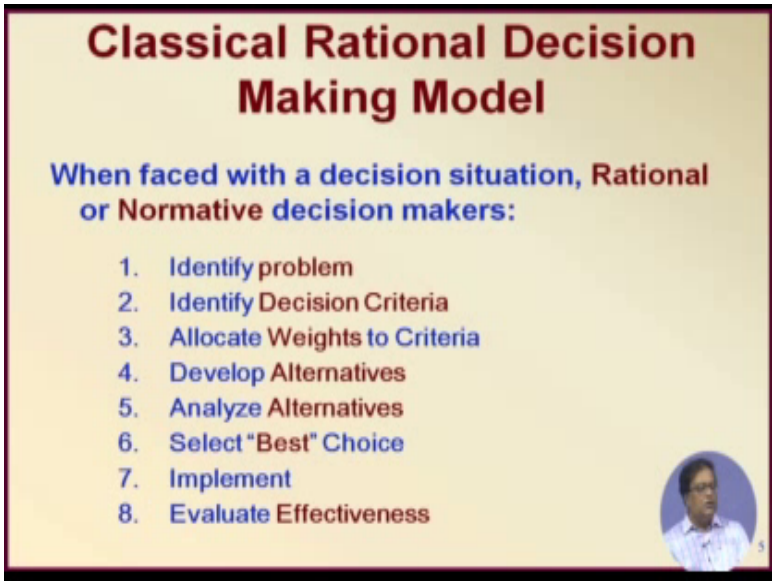

So here is for a typical rational or a normative decision maker would do such kind of things identify the problem, the decision criterion, the weights to criterion, the alternatives are developed.

They are analyzed, the best choice is selected, implemented and finally effectiveness is evaluated, so this is what is usually called the classical rational decision making model, now this classical model although looks very good and those of us who are very mathematically inclined, we may like to think that this is the best possible decision making model that we can have but it's not the case, there is another model which, although we are not going to discuss much.

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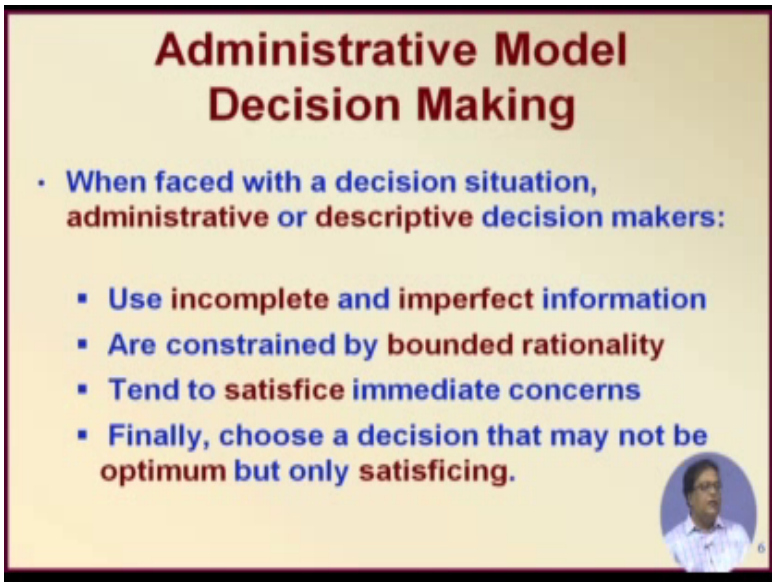

But let us know that this so called administrative model of decision maker, sometime also called the descriptive model of decision making is also not only popular but probably sometimes the only choice that we have in a complex real life decision making situation, what happens there, in a complex decision making let's take an example suppose we have to come up with a railway time table, just imagine a railway time table for a country like India how and what base this.

We have to take all the different kind of trains, the express trains, the local trains, the goods trains, then different other constraints like engine is available or not, like signaling system, so there are hundreds and thousands of constraints so under this situation if someone really thinks that we solve a mathematical model and then we come up with a solution, to come up with a very viable schedule it may not be possible right.

Because here is a situation where we have incomplete as well as perfect information, not only that the people who make decisions they are also constraints by bounded rationality, what is bounded rationality, they do not have enough information, they are in a given situation only they know only one part of the system, so in that happens it's not possible for a person to really look at the entire complexity and come up with a solution.

So what usually is done under such situations, the people really go for what is known as satisficing right, rather than optimizing, so instead of really trying to right, rather than

optimizing, so instead of really trying to find an optimum solution people would rather go for a satisfactory solution, it is like suppose we have a few choices, look at what are the different alternatives, the choices before us and look is there any alternative.

Which really supports most of our causes right, if we find yes here is one which does most of the job, go for it right, so that is a descriptive model of decision maker and most of the real life situations people really go for satisfying because there is bounded rationality right,

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But knowing that let us look at what exactly how can we really help people who have to make decisions particularly? who have to come up with. You see when there are several choices a very common word is what is known as pay off.

So I have these different alternatives which may likely to occur and these are the likely pay offs, so we have to come up with those pay offs, we'll discuss that more later, but let us understand the decision environment can essentially be of three types, what are they? It could be one with certainty, one with risk, and the other with uncertainty right.

So what happens when the decision making environment is certain then ambiguity and chance of making bad decision is low when it is under risk it is moderate and in uncertain situation it is high, what is the difference? the difference is look here we talked about in the first diagram the design of alternative

And then choosing between them, now you see what happens when we have to design the alternatives which alternative we should really choose. It depends on another thing which is known as states of nature, what is street of nature?

States of nature is something which is not in our control alright, so suppose we have to make really three decisions, let's say we talked about plant location problem and we identify three cities, so one of these three cities or four cities we have to choose from but different situations may occur, what are the different situations? Let's take something like.

One situation could be liberal government policies, the government policies are going to be very good liberal, second could be that government policies are going to be advanced instead of positive or liberal and third possibility could be that government policies will be as usual, so we have no control of this and that is why they are called states of nature, so when we have such kind of states of nature if we know that which state of nature is exactly going to come.

Then it's a decision making situation under certainty, if we know that the decision making situation is probable the states of nature are having certain probabilities, and the probabilities are known then we called it's a decision making situation under risk but when the decision making situation is uncertain then these probabilities are not known right, so when the probabilities are not known then what really happens is that.

Let's go back that is the decision making under uncertainty, when probabilities are not known then we have to have certain other kind of strategies for decision making, so we'll discuss them one by one,

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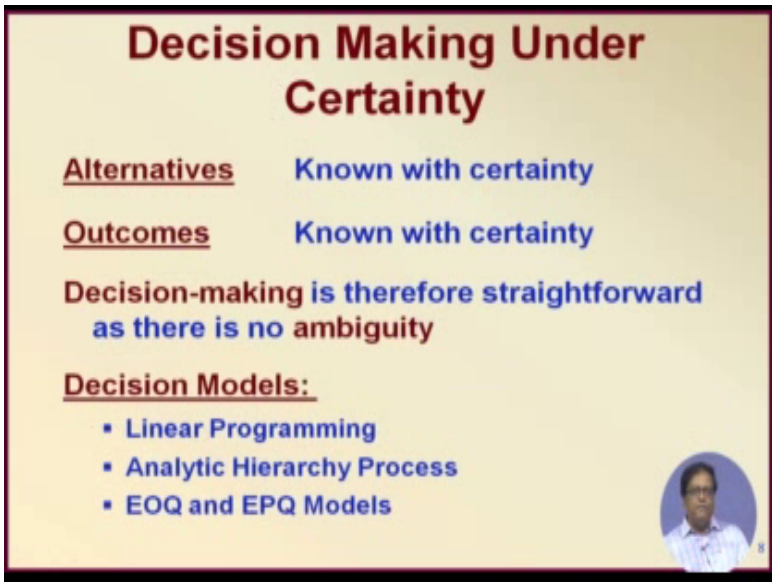

Let us look at first the decision making under certainty, here the alternatives are known with certainty, the outcomes are also known with certainty right, so we know the alternatives we also know the outcomes.

So since we already know the alternatives and already know the outcomes the decision making is therefore straight forward and there is no ambiguity, please do not get confused between the straight forward and low ambiguity with simplicity, it does not mean the problem is very simple, the problem can still be quite complex but the advantage here is it is solvable right? So like linear programming.

You have seen there are lot of linear programming problems which are quite complex right, there are large number of constraints, the objective function could be very difficult one, sometimes you have to linearise it and there are many different constraints that can come in a given situation, but whatever it is a decision making under certainty, not I am saying all linear programming problems are decision making uncertainty.

But whenever the alternatives are known the outcomes also known with certainty it is basically the challenge lies in the mathematics but not in the formulation right, so those are the situations which can be called decision making under certainty, other examples could be the HP process or so called the economic order quantity, economic production quantity EOQ EPQ models, there

could be hundred other examples. But these are some examples of decision making under certainty.

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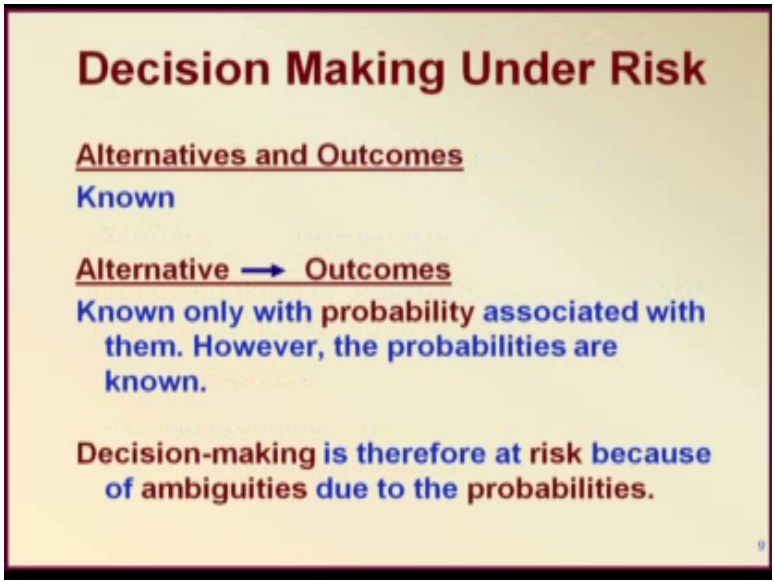

Now let us look at decision making under risk, as I told before in decision making under risk the states of nature are known but we do not know what are their exact probability, so if you look at from this angle then alternatives and outcomes are known but alternatives to outcomes known only with probability associated with them, so how the outcomes in vary.

Because as I said that different states of nature they occur and if one state of nature occur one sort of outcome will come, if another state of nature comes another type of outcome will result and they are associated with that means the states of nature are associated with certain probability going back to our previous example may be the liberal government policies will be forty percent probability.

Advance let's say twenty percent and business as usual the same policies maybe another forty percent right, now we really do not know what is going to come but we can assume this probabilities and come up with suitable pay off values in these kind of situation, so this therefore is called decision making at risk right, decision making under risk or decision making at risk because of the ambiguities due to the probabilities, so this is the decision making under risk.

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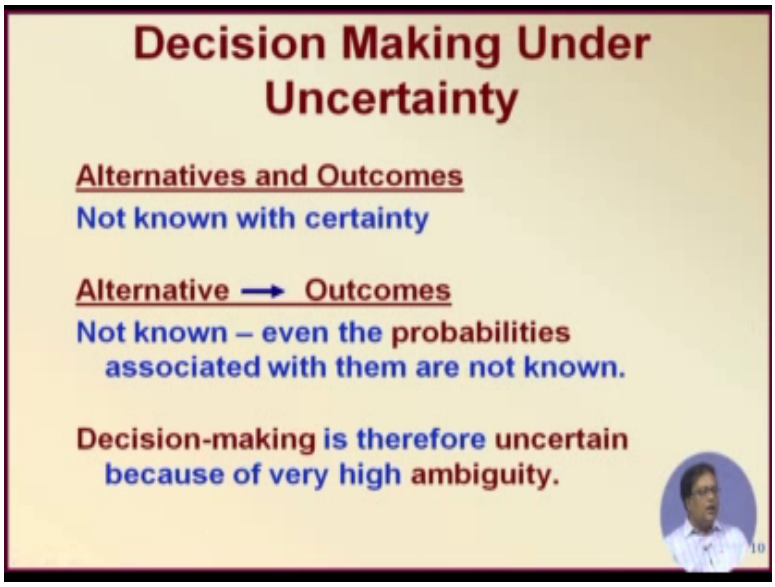

But what happens under decision making under uncertainty here the alternatives are outcomes at also sometimes not known with certainty, look here those kind of problems are called unstructured problem, see there are two types of problems one can be called a structured problem the other can be called as an unstructured problem, if we have a structured problem, in a structured problem what happens.

The alternatives and outcomes are known but suppose even alternatives and outcomes are also not known then what can we do right, we really cannot do much under that situation so we have to really come up with alternatives and outcomes but here there is a very important thing, there are lot of uncertainty problem where we try to put a structure by arbitrarily assuming alternatives and outcomes, so alternatives sometimes can really be fix but outcomes may not be known.

But do we fit a model just because we have to fit a model, this could be the biggest mistake, sometimes if we really do not have information, really do not have any means by which we can actually compute outcome, it is better to keep it like that and put the final decision as an if then else logic right, rather do what is known as scenario generation like some sort of perspective we have to really bring but not really try to force upon certain alternatives and outcomes.

Or in other words don't try really to put a structure into a problem that do not have any structure right, so having said that if suppose a structure can be put that means we can actually come up

with alternatives and outcomes then the problem become a little simpler but again the other problem comes that you really do not know the probabilities, so because you do not know the probabilities you do not know which state of nature is going to come.

Going back to the kind of problem I was referring suppose we have to make decision from three plants A B and C and which plant are we going to choose, we know there are three states of nature the liberal government policies, the adverse government policies, and usual government policies, so we do not know which is the probable state of nature, in that sense it is an uncertain situation, so therefore since we do not know the probabilities.

It really is a uncertain problem and because of high ambiguity.

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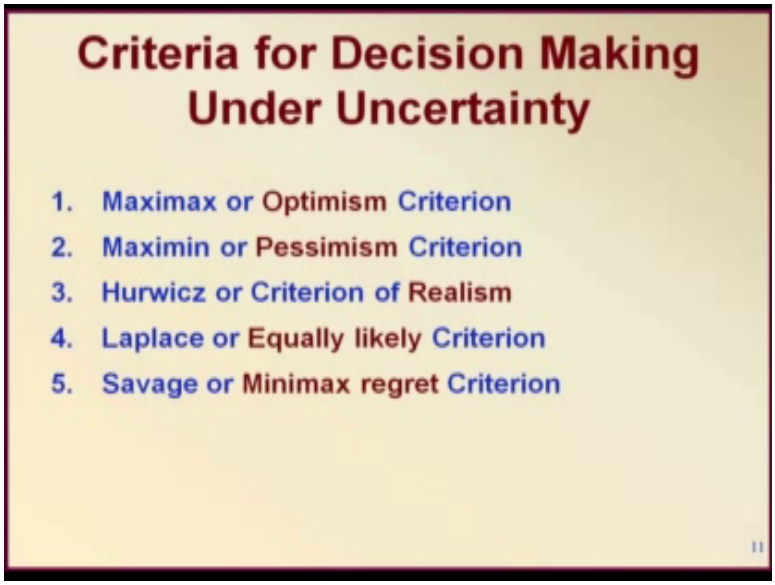

Now in subsequent classes we shall take up different criterion for decision making under those uncertain situations. So while we discuss we shall be taking up really five different criterion, what are those five different criterion, the first one is the maxim ax or optimism criterion, the second one is a maximin or pessimism criterion, third one which is called Hurwicz or criterion of realism.

This particular criterion is really a mix of the maximin or the maxi max, I'll discuss this a little more, the forth one is the Laplace or equally likely criterion and finally the savage or the minimax regret criterion right, so they are different criterion for decision making under

uncertainty, the first one is called the maximax or optimism criteria at an appropriate point we'll discuss this in detail but at this point it has only said that in their maximax or optimism criterion.

The decision maker tend to believe that the best state of nature is going to occur for each decision strategy, what exactly it means, it means that as I have said.

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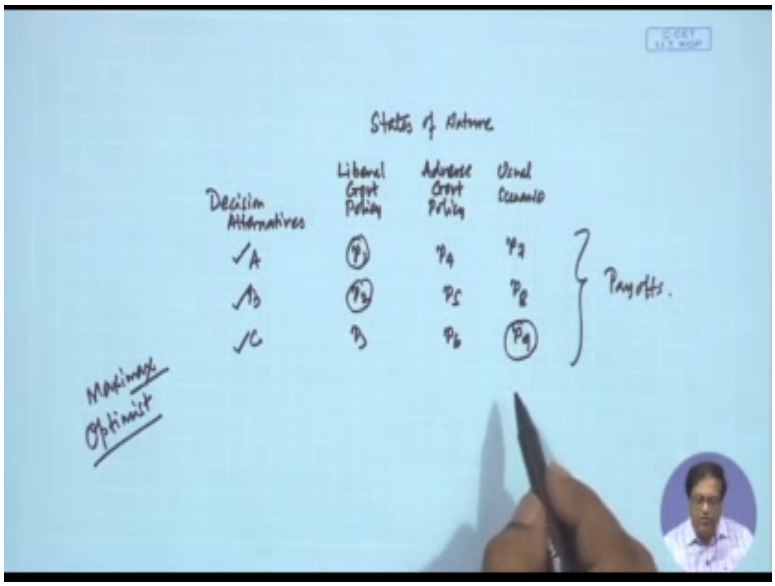

Let me draw a diagram that is the diagram is what these are my decision alternatives and these are my states of nature and all of these are payoffs, so please look at this carefully, what we have that let us say that the decision maker is an optimist, when the decision maker is an optimist.

Or basically he is a maximax operator what he does, the decision maker really believes that suppose he goes for A then the best possible state of nature will occur and he will get the best possible payoff under that situation, similarly if he suppose it is P one, if he goes for the decision alternative B again he will choose the best possible payoff under a state of nature means he believes that particular state of nature may occur, maybe P two.

Let us say when he goes for C he believes again the best possible state of nature will occur and he might get the best possible payoff, so he will believe that usual scenario will happen and he will get P nine right, so these are the kind of things that may happen when a person is a maximax operator or an optimist, the second one when a decision maker is a pessimist at that time the decision maker tend to believe that the worst thing may happen is it alright.

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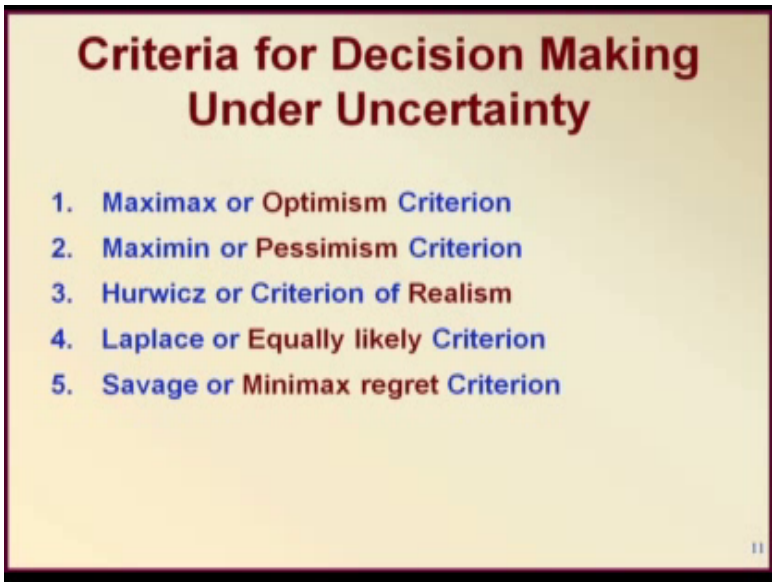

So there is a difference between a maximax operator and a maximin operator, the maximin thinks that the worst state of nature is going to happen and he or she likely to get the worst possible payoff for every decision alternative, Hurwicz is a mix of the two, what is the mix, mix is that the decision that comes out from a maximax criterion and the decision that comes out from a maximin criterion the Hurwicz decision maker really comes up with something.

Which is an in between thing right, based on a factor which is called a degree of optimism, the next one is what is known as the Laplace or equally likely criterion, a Laplace decision maker would put equal probability for each of the states of nature right,

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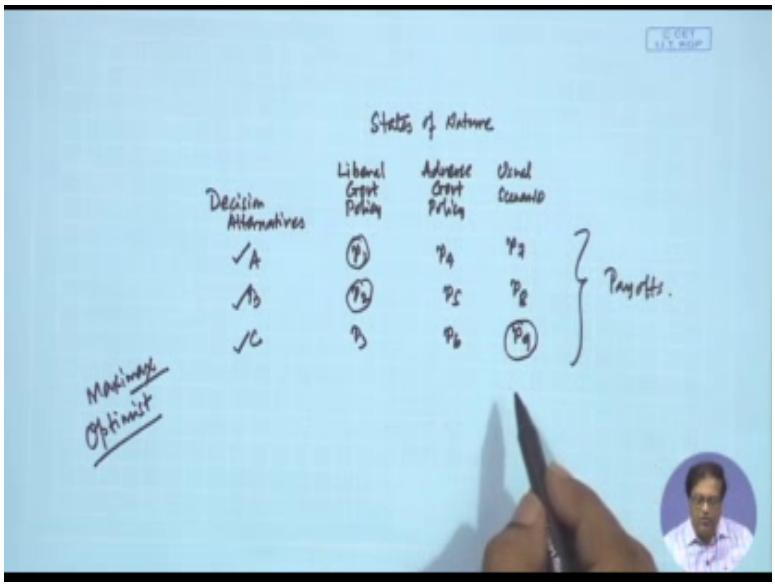

So if you again look here in this particular thing that the Laplace decision maker would assume that liberal government policy will have an one third probability.

Adverse government policy will also have one third probability and usual scenario will have a one third probability right, so that is about the Laplace decision maker,

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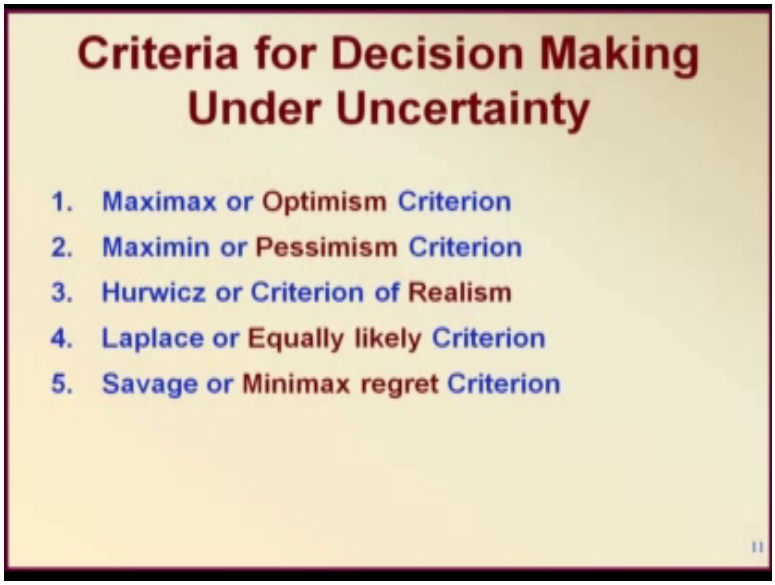

The final one the savage or the minimax regret criterion essentially trying to find out what is the regret of not able to make the best possible decision right, for each scenario and then from a regret matrix and really try to minimize regret right, so that is what happens under such situations.

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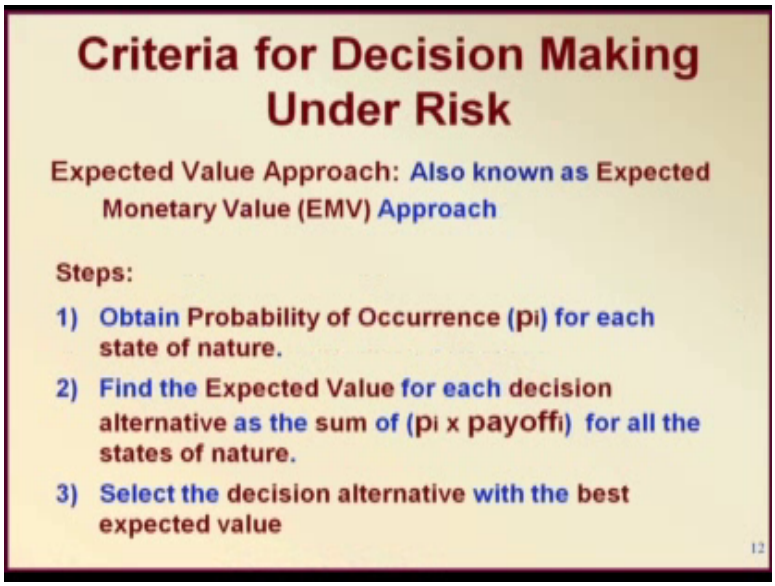

The second situation when we have a decision making under risk at that time the approach we usually follow is known as the expected value approach, the expected value approach sometimes it is also known as an expected monitory value approach, what really is done there the probability of occurrences for each state of nature is computed right, and then for using those probability of occurrences if we multiply this probabilities with the payoffs.

And then take the sum for every state of nature then we can come out something like an expected value right, so these expected values are to be calculated for all states of nature and for every decision alternative right, after obtaining all the different sum of these expected values, the sum of P I into payoff which comes out to be the expected value, select that decision alternative which has the best expected value. So this is how we take decisions for decision making situations under risk,

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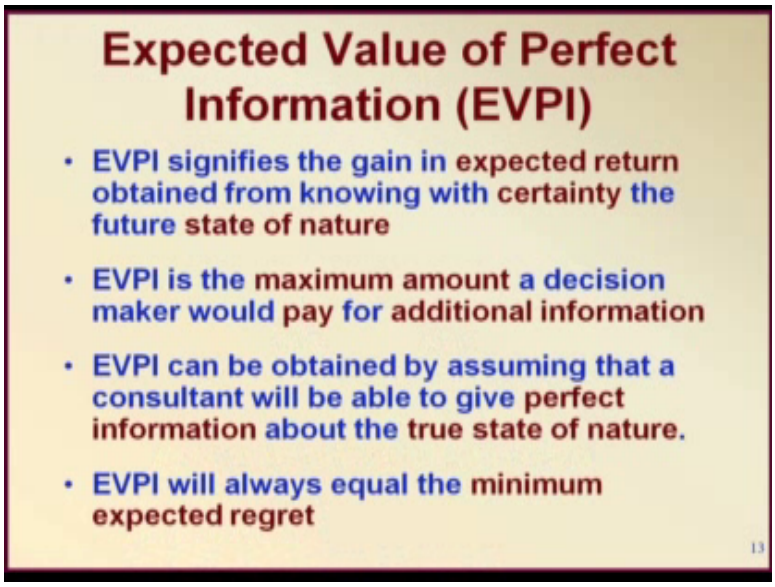

Now please understand one thing that falls out automatically that what is the payoff that we are getting in the form of an expected value if the person becomes an expected value operator and what is the maximum payoff that a person could have got, right?

So it is like supposing the best states of nature would have come and everything gone in the best possible manner. The people the decision maker could have got a certain amount of payoff that expected value of perfect information is a maximum amount of decision maker would be for additional information, so basically really what it is,

It is the kind of the maximum possible value which you can really get if you would have taken the best possible decision minus the kind of decision that you have already taken right. So the difference between what you could have got if the best possible decisions would were taken and what you have actually got, right?

The difference between that two, that we'll determine the expected value of perfect information, sometimes it is simply called value of information right, so it is like in a share market situation you have brought a particular share, you have got a certain amount of payoff but suppose you would have got the best possible shares.

What is the payoff that you could have got right, suppose you have got something like hundred and you could have got two hundred, the difference is the value of information right, what is the importance of the value of information, this is also can be sold id equal to the minimum expected regret and this is also the amount that you could have paid right to buy information, suppose someone tells you you're buying this share do not buy.

Buy something else you will make more profit but you have to pay me some money right, if you can believe that you can make hundred additional money, you can pay twenty rupees for buying that additional information that is why this difference is called the value of information right, so this is another very important topic which we shall discuss.

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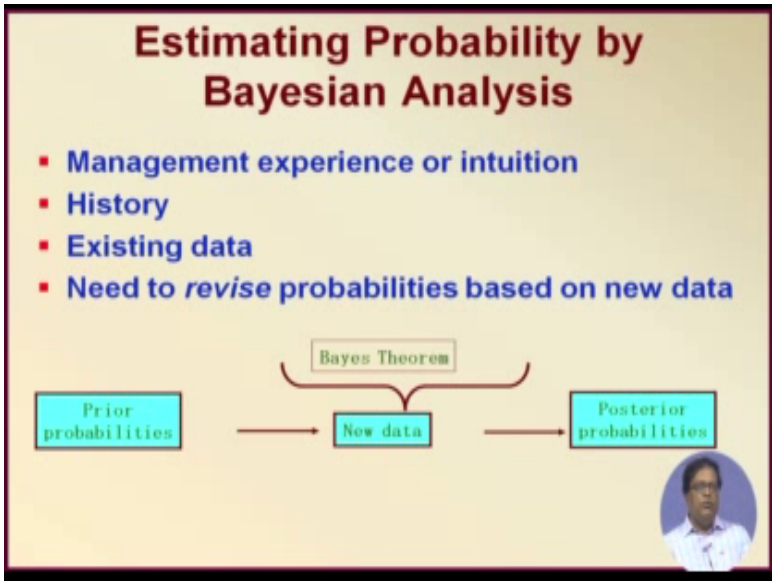

The third most important thing that we are going to discuss is the Bayesian analysis. Really when we have probabilities and after having the probabilities if you have new data on the basis of an experimentation then the prior probabilities gets modified to what is known as posterior probabilities, so really what happens you know certain probabilities about the states of nature, you do an experimentation, based on experimentation you get some new data and those new data helps you in getting the posterior probabilities.

Which can really help us in making better decisions, so a quite portion of our study we shall really focus on what is known as the Bayesian analysis.

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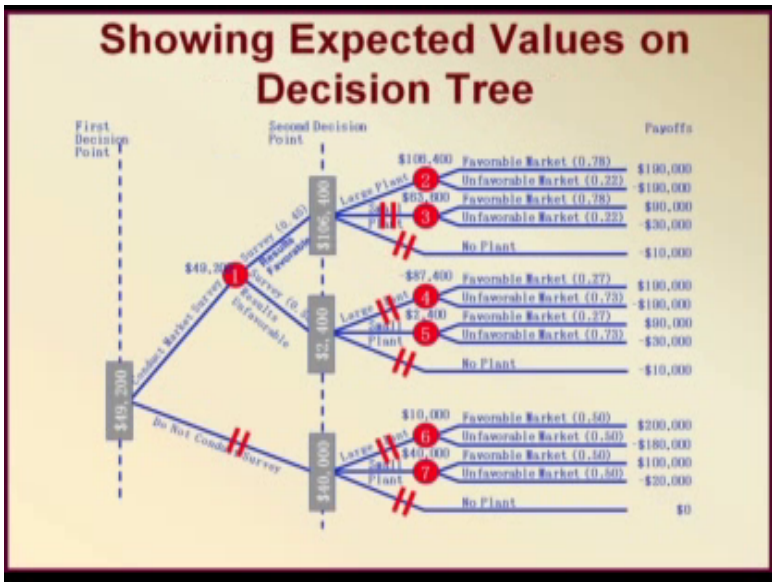

Finally you can see that kind of diagram which we can draw, which we can call a decision tree analysis with the Bayesian analysis.

So you can see at the very first there are two options either conduct survey or do not conduct survey, if you conduct survey then you can get favorable result or unfavorable result.

If you do favorable result you get one type of payoffs, if you get unfavorable survey results you get another kind of payoff, so what kind of payoff are you going to get under different situations and putting them together that could be what is known as a decision tree right, so really starting from decision situations we shall try to understand the different situations under certainty uncertainty and risk and then put them together into a payoff matrix.

Obtain calculations for different kinds of decision makers then we can have experimentation in the form of a Bayesian analysis, put them altogether in a decision tree and then finally evaluate what kind of decision a decision maker should be making right, so all these can really help a decision making situation in practical situations and therefore it's a very important subject right, so we complete here the introduction portion.

Thank you very much.