Decision Making Under Uncertainty
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Lecture – 01
Background and Relevance

Hi. The first topic in this course - Decision Making under Uncertainty, is Background and Introduction. It is important to do a little bit of background for this course because most of the material that we will see later, relies a lot on topics such as probability and statistics. We talk a little bit about decisions, about objectives and things like that. So, it's important we do a little bit of a preview right up front.

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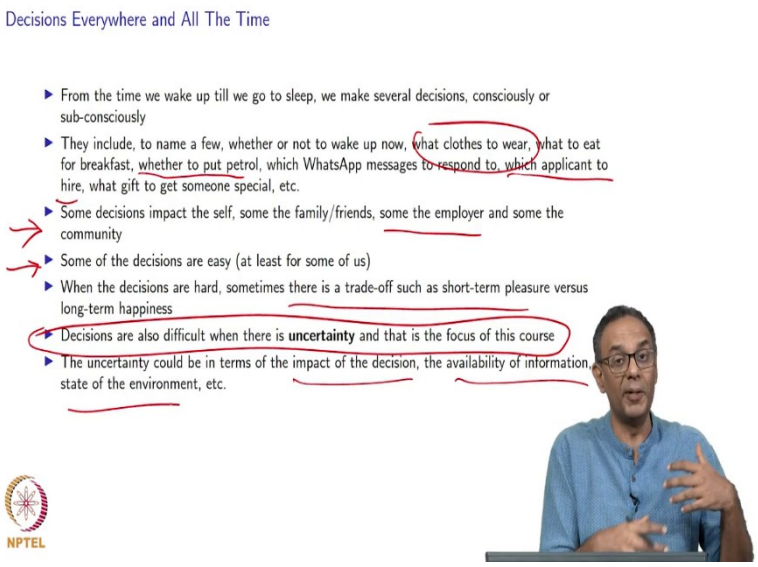

So, let's see where we make decisions. Turns out, we make decisions everywhere, all the time. Any time we are in a situation such as you wake up in the morning, you make some decisions all the way till when you go to bed, you are making a lot of decisions.

Now, some of these decisions - you make consciously, you think about it, you analyze, you over think it and make them. Other decisions, well! You just wing it. Sometimes, you make decisions in a very subconscious fashion. So, let us take a few examples. Let us say, the alarm rings and it is time to wake up, you have one of three choices. You could either turn off the alarm, wake up and go start brushing your teeth and getting ready. I don't know how many people are like that. I am not one of those. Or you could hit the snooze button and after

a few minutes, the alarm will come back again. Or you could say, turn off the alarm and go to sleep, not worry about it. So, you have three choices and the question is what should you be doing? So, that is a decision you need to make and you are making that decision when you are not in your best of states in life.

Now, let's take another example of what clothes to wear. So, a lot of times, for a lot of people, this is a major decision - what should I wear today? What would look nice on me? What is something that would impress someone? And, these are decisions to be made and we make that every single day.

For example, some of us, not everyone, would like to decide what we want to eat for breakfast. If you are making your own food, this is a choice. If you are not, then you have only one option - go eat what you get in your canteen, okay. Then, once step out of your house, you go, see your car or your bike, and you find that there is not enough petrol. Well! You might make it to your college or office; however, on your way back, I probably have to stop by. Should I put petrol now or should I come back and put patrol? Well! That's another decision that we make.

This one is a very popular one. There are this WhatsApp messages. You wake up and you are ready to go to work or school or to college and then you see, I have to respond to a bunch of messages. But, when you touch your message, the other person knows you have seen it. Now, you have to respond. You have to make a decision there. Which WhatsApp message to look at? Which not to look at? Okay.

Once you go to your office, for those of you that are working, you have to make a decision about which applicant to hire. Let's say, you have a bunch of applications that have come in; they all look very nice and they are all perfectly legitimate candidates for the job. And, you ask the question - who should we hire? That is a decision you need to make as a manager for example.

Now, at the end of the day; you are coming home. You are already late. You have someone special waiting for you at home. You would like to buy a gift. What gift should I get? Would this person like what I am buying? And, you have to make some decisions like that.

Now, the next point is very important. It turns out who cares, is the question. So, some decisions impact yourself. It is, for example, what clothes you would wear, perhaps impact

yourself more than anything else or anybody; some decisions impact your family and your friends like the very last one. A gift that you would get does impact you. But, for the most part, it probably impacts your family or your friend, okay. Some decisions like the example that we saw with respect to which applicant to hire, for the most part impacts the employer, and some decisions clearly impact the community. I have an aunt who while going on the road, sees someone threw a certain thing on the road instead of putting it in the dustbin, she would step out of her car, pick it up and then, puts it back in the dustbin when she finds it. So, that is clearly an impact of the community. Yes! Her car has stopped on the road. It impacts the community in a very different way as well, okay.

Now, the next thing to ask is - are all decisions easy? Some decisions are hard while some decisions are easy. People like me over think everything. For me, every decision is hard. Some people are just really good at making these decisions. So, let's look at this. When is the decision hard? - Well! When there is a tradeoff such as a tradeoff between what is called short term pleasure versus long term happiness. Let's take an example for short term pleasure. So, you are walking along and then, you find this store where they have wonderful ice cream. Ice cream gives tremendous short term pleasure. However, when it comes to long term happiness, it is not so good. So, when you think about it, you have a tradeoff - should I get the ice cream and get the short term pleasure or should I be smart and think about long term happiness, heart healthy and so on. So, this is a tradeoff that we have to make. So, the decisions become a little bit difficult because your objective is - should I be happy now or should I worry about being happy later.

Now, the decision also is difficult. This is probably the most important point of the slide. Decisions are also difficult when there is a lot of uncertainty. And that is the focus of this course. This course is called "Decision Making Under Uncertainty". So, when there is uncertainty, how do you make decisions? For example, think of the case where you have to hire someone, say you want to hire a manager. Now, the person you hire could turn out in very different ways. They could be extremely effective. That would be nice. Or they could be so-so. So, we do not know how the person would turn out. So, there is an impact of the decision. So, there is an uncertainty of how this decision would be impacted or would impact your company. The second question is the availability of the information. Now, this person could be a terrible person for all you know, could have committed crimes. You don't have the kind of information. So, there is that uncertainty as well.

And finally, there is also an uncertainty state of the environment. Do we need this job description anymore? Is this product going to become obsolete? Are we going to stop doing this? We don't know how the future is going to fold. Once you have hired somebody, they are here to stay for a long time. So, you have to make this decision being conscious of the fact that the environment could change tremendously into the future.

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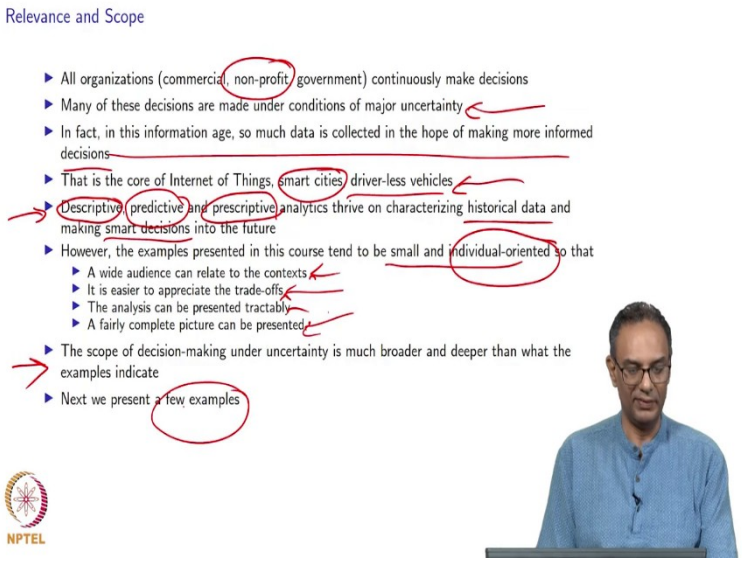

So, now that we have seen we make decisions all the time, wherever we go; now, let's see what is some of the relevance and scope of this course in particular. Every organization come what may, are commercial or business or not profit. By not profit, what I me really mean is not for profit. In the year 2008, every company was not profit. I am not talking about that. I am talking about the situation where you have something where the organization is not interested in profits such as an educational institution. You could also think of a government that is making decisions. And, for them as well, they make these decisions continuously. From time to time, they keep making this decision. Some of these decisions are made under major uncertainty like I said. That is the real focus of this course. Not too long ago, in India, there was a new state of Andhra. And then, the state of Andhra needed to pick a capital and they made a wonderful decision of picking a new place such as Amaravati and said that we will have a capital there to start the city from scratch. Now, this is a major uncertain type of situation because we don't know how this will pan out. You have to make a good decision under such circumstances.

In a little bit more of a situation, you want to make some informed decisions. Today, everybody is so excited about collecting data and making wonderful decisions. So, how do you go about doing that? Everybody is in the business of making what we call as informed decisions. So, this is something that we want to do. If you think about the hot topics today in terms of research are the topics of internet of things or smart cities, driverless cars. What are these things? Well! Essentially, what they are about is collecting information, analyzing them and making decisions. So, think about internet of things. Let's say you are sensing the status of a tool in a manufacturing shop floor and you are asking yourself the question - why should I go in and replace the tool? But, if you go and replace the tool, you are going to spend a whole bunch of time putting the machine idle. So, you have to make the decisions. However, you are collecting that type of information. That is going to be the core of things like internet of things.

Now, if you look at for example, even your refrigerator might be connected to the internet. So, that if you don't have milk, it will let you know – "Hey! You don't have milk" when you are near a shop. It will tell you to go ahead and buy some milk so that we can have breakfast tomorrow, that we are talking about in terms of making decisions in the previous slide.

Now, another initiative that is popular in several countries around the world or Singapore in particular, is this initiative of smart city. They want the cities to be smart. You are collecting all kinds of information - monitoring the air quality, monitoring the noise levels and things like that, in order to make smart decisions about how to run this city for the most part. Now, another extremely popular area this day and age is this notion of driverless vehicles. So, you want to sense you are in situations and make a decision - should I speed up, should I slow down, should I swerve to the right, should I change lanes. There are many such things that need to be done. For all that, information is collected and you are making decisions.

So, the field of operations research is rich in terms of making decisions. And, this day and age, we are talking about these going into three parts. The first part is what we call as descriptive operations research or descriptive characterization. So, I am going to tell you - what is it, what is the correlation between two things or what causes something to happen. So, this is what is called descriptive, just describing what is going on between, what happened and what is going to happen for example. Predictive is to make a prediction. So, is it going to rain tomorrow? What is the probability that it will rain tomorrow? This is what is called predictive analytics, okay. And, prescriptive analytics is taking the predictions and

making a decision. Now, you want to do all three. You want to use historical data to make descriptive decisions. And then, use the descriptions to make predictions to tell you what is going to happen in the future. And finally, using that information, you want to prescribe decisions. So, this is usually based on historical data and you want to make what is called smart decisions going into the future.

Now, in this course in particular, we are going to look at small decisions. We are going to look at individual oriented decisions. Now, you could ask – Well! I am not here to look at toy problems. Well, there is some benefit in doing toy problems. The first benefit is we could really cater to a wider audience. Now, if I talk about decisions in a very specific field like communications or manufacturing, we may cut off a lot of the audiences. So, we want to keep this somewhat generic for a wide variety of audience and for a lot of people. The other thing is we want to give examples so that the trade-offs are somewhat easy to appreciate. So, we want to pick examples where people can say – Yes! I see the trade-offs in the decisions, okay. We saw some examples so far. We saw those were not particularly million rupees type of decision. These are small decisions; they might be fairly individual oriented. Now, that's the other thing. We are not talking about a company for the most part. The reason is, I am expecting this course to be taken mostly by students who are at a university or school, who may not be exposed to a lot of what happens in a company. The other reason is that we want to do our analysis in a tractable fashion. If I had multiple variables and I had a humungous program, the whole course might just be explaining that. That will take me several hours to do. So, we want to pick an example that I could present in a tractable fashion, something that people can understand. Finally, we also wanted to give a complete picture. We don't want to talk about a problem and then say, there is smoke and then, the smoke clears - this is the final answer. We could do that; but, turns out that I am choosing to present this in a more of a complete way so that you see what goes from beginning to the end.

So, I do want to say this important caveat, which is that decision making under uncertainty is much broader than what I am going to be presenting in this course. It is way deeper than what I will be presenting. However, remember that the prerequisite of this course is also not something that is tremendously heavy; the prerequisite is mainly the topic of basic probability. So, I am taking things from right there. So, I cannot go extraordinarily deep. I am going to go in such a manner so that you know your appetite is wet and you could go take, perhaps a follow-on course that talks about much deeper and much broader topics.

So, I am going to end this module now. And, in the next module, we will see a few examples.

Thank you.