Advanced Business Decision Support Systems

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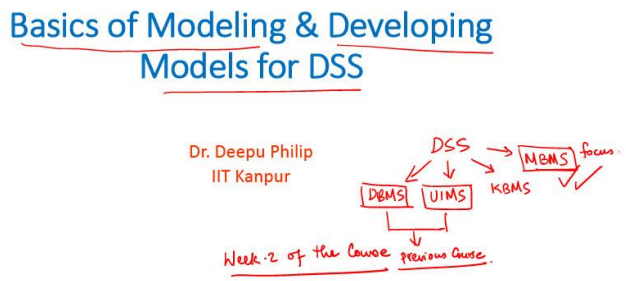
Lecture 06

Basics of Modeling and Developing for DSS (Part-1)

Good afternoon, everyone, welcome to yet another lecture of the Advanced Business Decision Support System Course, which is part of the MOOC's program and I am Dr. Deepu Philip from IIT Kanpur. And, along with me in this course is Dr. Amandeep Singh Oberoi and Dr. Prabal Pratap Singh. All three of us will be teaching this course together.

And, this is the successor of the previous course, basically, Web Based Decision Support System course that was already been successor of this course which was already plotted in NPTEL MOOC's. And, if you are not gone through that course, please go through that because lot of the things that we are discussing in this course is part of or is an augmentation of what we already discussed in that course.

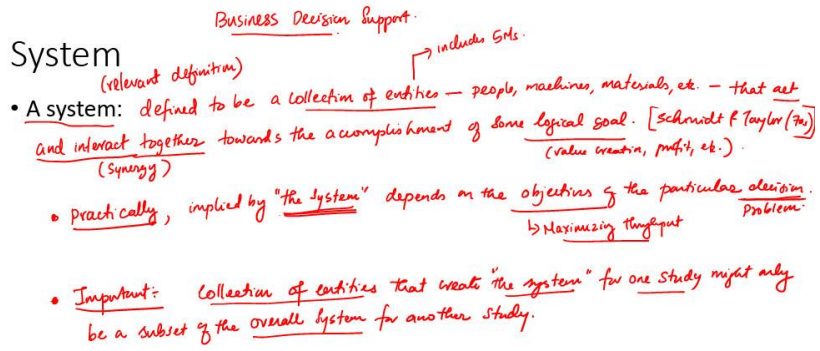
And, we have already seen the previous lectures and overview of the DSS what are the major components of it. And, in the previous course, we have focused more on User Interface and Database part and this we are actually focusing more towards modeling and how the DSS is applied to various Business Decision Problems. We are talking it more from the business standpoint, like a Corporate Organized Decision standpoint.



So, without much delay, let us get into today's topic and it we will be covering what we call as the "Basics of Modeling and How do we Develop Models for DSS". So, remember we had earlier talked about DSS as one major component as DBMS (Database Management System) then we had a User Interface Management System (UIMS) then we also had what we call as a KBMS (Knowledge Base Management System) and we had MBMS (Model Base Management System). So, we are now going to focus in MBMS in the current course okay.

This is our current focus which is going to be as part of the previous course the major aspects of this was covered as part of this in the previous course in the basics of web based DSS course.

So, we are now talking about the modeling and model aspects of it and we are now in the week 2 of the course. So, this is part of the week 2 what we are discussing today. So, our focus is Model Based Management System and for that, we need to understand the Basics of Modeling and stuff like that.



So, before we get into the basics of Modeling, remember we are talking about a Business Decision Support System. So, most of the time, when you talk about a Business Decision Support, the term system is very important to us and we have to understand what a system is and there are many definitions of system, but the one we are talking about a relevant definition which what we are going to apply in the business and standpoint.

So, we can define a system. It can be defined to be a collection of entities and what are some of those entities? Entities can be people, machines, materials etcetera, these are the collection of entities, we can give methods and etcetera. And, what do they do that, act all these entities interact?

They act among them within themselves and interact among themselves and they act and interact together. It is in a synergy towards the accomplishment or some logical goal.

So, this systemic definition is organizationally focused definition So, they act and interact together. This action and interaction together you can think about as Synergy, towards the accomplishment of some logical goal. That logical call can be something like you know value, creation, profit etcetera. So, if you think from a business standpoint, when we talk about a system, this is what we will be talking about. So, this is the theoretical definition of Schmidt and Taylor.

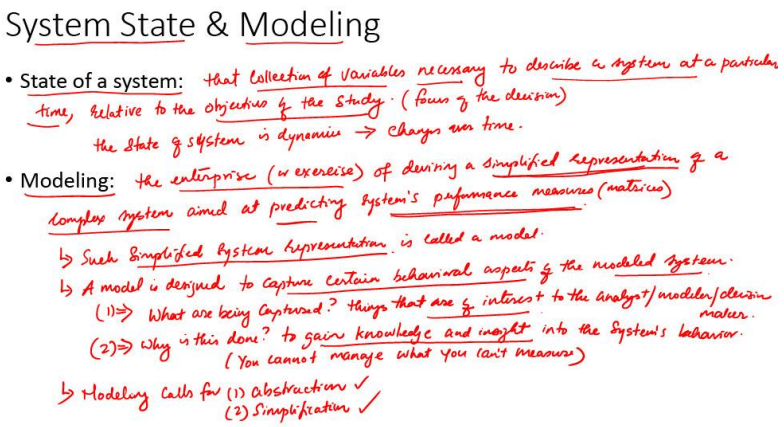
So, practically implied by system, the word system, what do you imply by the word systems depends on the objectives of the particular decision or we can think about it as a problem decision or we can think about as a problem. So, whatever you are talking about the objectives, for example, advertising throughput of a production line.

So, then you are talking about just that production line, you are not worried about making assumption that the raw materials and etcetera are already available you are not worried about the stores and etcetera like that. So, whatever you talk about as a system in practical sense, this definition of the system can change depending upon what decision or what problem you are trying to solve. So, that is the practical aspect of this.

So, we can say we have a factory system, but that does not mean you are going to make decision about the factory, you may make a decision about a small component of the factory, but that decision, since it is about some small aspect of the factory, the system is only limited to that.

So, in another way, we can think about it. So, it is important to note this, I am making it as important. Collection of entities that create system, I am using the word the system in double quotes "System" for one study might only be a subset of the overall system for another study. So, what we are saying is, that the collection of entities that create the system in one study, a particular study might only be a subset of the overall system for another study.

So, depending upon the focus of your study, what you are looking at as the focus of the study of the overall system you may or may not have the entire system in place or you may have only a portion of that you are focusing on the study.



So, coming to the next part, then we understand the System State and what is Modelling? These are two important aspects because we are going to talk about modelling and the importance in the Decision Support System.

So, let us talk about State of a System. This is a very common or very popularly used word and the simplest definition for it is, that collection of variables necessary to describe a system at a particular instant of time related to the objectives of the study. With respect

to the objectives of the study or the focus of the decision, what do you want to decide? Based on the objective of the study or the focus of the decision, you require a particular collection of the variables, which are necessary, which are require, which are important to describe the state of the system at a particular given time because you can say that the state of system is dynamics- change over time.

So, if you describe that I have made this decision today, ten years around ago ask the time progress is, your system will change, your machines will change, your throughput will change, your capacity will change. So, the decision that is taken today, is not going to be valid ten years around ago. For that matter, it would not probably we would not even be valid after 6 months.

So, since the business system is dynamic, your decisions will also need to change. So, whatever the variables that is required for you to completely describe the system from the standpoint of the decision or your objectives at a given point of time is that what is called as a System State.

So, then what is Modeling? So, there are many ways you can look into it. So, let us first think about the academic definition. The enterprise or the exercise is the enterprise or exercise of devising a simplified representation of a complex system aimed at predicting systems performance measures or you can call as matrices.

So, you want to measure or quantify the performance of the system or you want to quantify what the system is doing or you want to predict or understand and you want to figure out what is going to happen.

So, the exercise or your enterprise your endeavor, you are trying to devise a simplified representation. So, that is why people call it as a Model is the easiest way to do. It is so an abstraction of a system. So, you do not want to study the entire complex system yourself, all you are trying to do is to create a simplified representation of a complex system and what is a simplified representation name in which, you want to study the performance of that system for a particular performance measure.

So, in our way, such simplified representation is called a Model. So, when somebody says, I am building a Model, you are talking about a simplified system representation that is aimed at understanding the performance of a system at point of time. So, also other thing is, you should understand that usually, a model is designed to capture certain behavioral aspects of the system aspects of the modeled system. So, you are modeling a system and you are trying to capture certain behavioral aspects of the system that you are trying to Model. That is the Model. The prime aspect of the model is and couple of things are part of this.

So, the first one you can think about is, these capturing, what are you capturing? what is being captured? The answer to that question is things that are of interest to the analyst, modeler or decision maker. Whatever that is of interest, that is important to the person who is analyzing or modeling or decision making, that is what is being done. And, the second aspect of it is, why is this done?

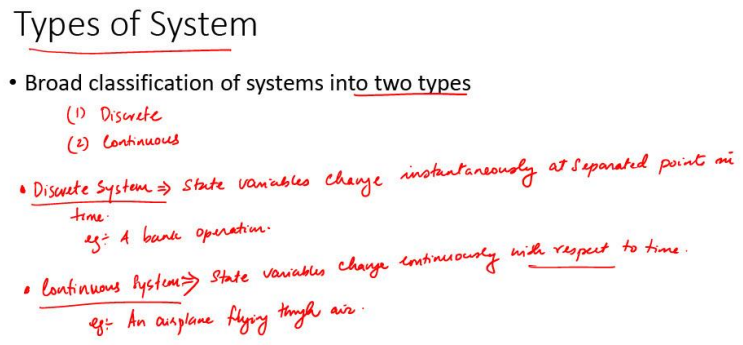
The answer to that is to gain knowledge and insight into the systems behavior. So, the one way to think about it is, the rule is, you cannot manage a decision making. Manage what you cannot measure.

So, by gaining knowledge and insight what you are actually doing is, you are measuring or quantifying the behavior of the system. So, that you understand the details of the system. So, the other part of it is also modeling calls for two things one, Abstraction and number two, Simplification.

Abstraction means, only take things that are relevant to the aim or the goal of the study or the decision problem at hand. So, only take those aspects, do not take anything. More simplification is, you may do not want to capture the exact behavior of the system you may want to.

So, like for example, you are trying to see parts coming into a factory, and if you stand there and notice let us say, if you take 1 hour, you see that in an hour, 6 parts arrived into the system. So, 6 parts arrived means, on an average, 10 minutes a part is coming into the system. But in real life, it may not be that way. You may see that in the first 15 minutes, 3 parts have come in and in the 45 minutes, the rest of the 3 parts have come in.

But when you simplify it, you will actually take that the arrival rate of parts into the system, you know one in every 10 minutes or 6 per hour or something like that. So, that is the simplification aspect of the system. So, Abstraction and simplification are the 2 key aspects that modeling actually calls for.



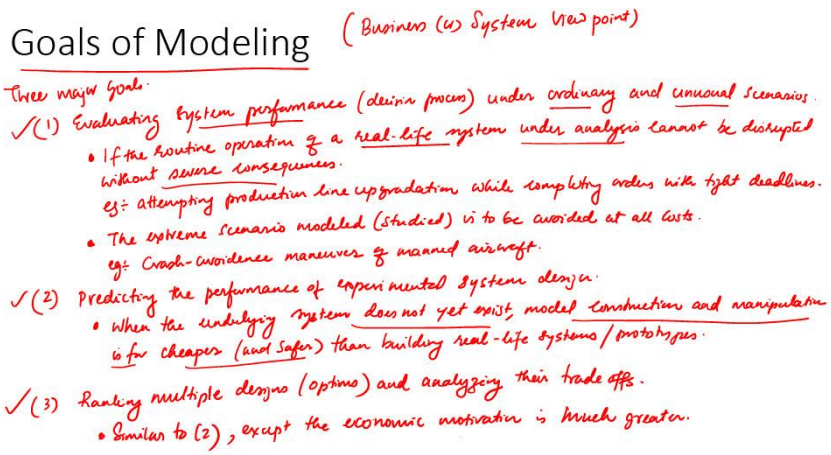
So now, before we get into the steps of Modeling, we also need to understand the types of the system first. So, we can broadly classify the systems into 2 types.

Number 1 Discrete, number 2 is Continuous. There are the 2 broadest classifications that are used. So, what is a Discrete system? So, the state variables mean the state of the system, the variables that describe the state of the system.

State variables change instantaneously at separated points in time. At specific interest in the points in the time is when the state of the system changes. Let us give it an example as a bank operation. So, the time instant at which the person comes into the bank, that is when the state of the system changes. If I know, customer comes into the bank, the state of the system remains as idle.

The second one is let us talk about what is the Continuous system? I am always worried about the spelling of continuous cannot spell it properly ever. A continuous system state variables change continuously. They change continuously with respect to time. They keep on changing with respect to time. Let us give an example.

The classic example of it is an airplane flying through the air. So, every second, the state of the aircraft, the position, the velocity, the thrust all these aspects keep on changing. So, these are the two broad aspects. The Discrete system and the Continuous system. While the Discrete system things change only at specific instances of the time whereas, continuous system change continuously with respect to time things.



Now, we talked about the type of system. So, why the major goals of modelling? We also need to know why do we do Model. There are many goals of modelling, but we are going to talk about from the business or system viewpoint.

So, we have three major goals if you look at it from this standpoint. Number one, there are many goals, but these are the three major ones, evaluating system performance or decision process under Ordinary and Unusual scenarios. So, the first one is, you want to evaluate the performance of the system both under ordinary circumstances and unusual circumstances or scenario.

So, why do we do this? So, one of the aspects is, if the routine operation of the system, real life system under study, analysis cannot be disrupted without severe consequences. So, you have a real-life system and you are studying it. You are analyzing it, but if you want to do the unusual scenario, you have to stop the disrupt system performance and that consequences are very severe. So, here is an example of that: attempting production line up gradation while completing orders with tight deadlines.

So, you have many customer orders that you need to complete and the deadlines are tight and then you want to upgrade the production line in between. If you do that, then you will have a bunch of pissed off customer at you and that will really cause problem for you.

So, this may be the production lineup gradation, which is a routine decision, but then still it is the consequences of that will be extremely large. Then other aspect is we said Unusual Scenarios. The extreme scenario modelled the one or you want to study is to be avoided at all costs. You want to do study the Unusual Scenario, but you do not really want that Unusual Scenario to happen. So, an example is, crash avoidance maneuver of manned aircraft.

You want to study what there is going to be crash and I want to get out of the crash. So, let us me first create a crash or scenario where a crash can happen and then try to get out of it. That let us say you are not able to get out of it, then obviously the crash will happen and the people in the aircraft will die.

So, that you want to avoid at any cost. So, hence you would rather like to create a computer model of it and study it using a simulator or something and then see what will happen if the crash happens.

So, these are the unusual scenario that is the number 1. So, in both Ordinary and Unusual scenarios, the system performance in Ordinary and Unusual scenarios. Second one, predicting the performance of the experimental system design.

So, the main point here is that when the underlying system does not yet exist model construction and manipulation. Constructing a model and manipulating is far cheaper obviously and safer also than building real life systems or prototypes.

So, for example, let us say a big vehicle manufacturer company wants to create a new factory that can produce 3 lakh vehicles per year and want to know whether such a factory, there will be enough demand and all those kinds of things. So, one way to do is, the company go ahead, invest a large amount of money, build the factory, make the cars and try to sell it or create a simulation model of a factory where similar throughput is created and demand is simulated and see how many cars are being sold and how many are being held up as inventory or different distribution centers etcetera.

And, then say oh, we actually do not need a capacity of factory of 3 lakhs, we only require 1.5 lakhs. So, if you really try to create a factory of 3 lakhs you cannot go back and cut it out and say I only want 1.5 lakhs.

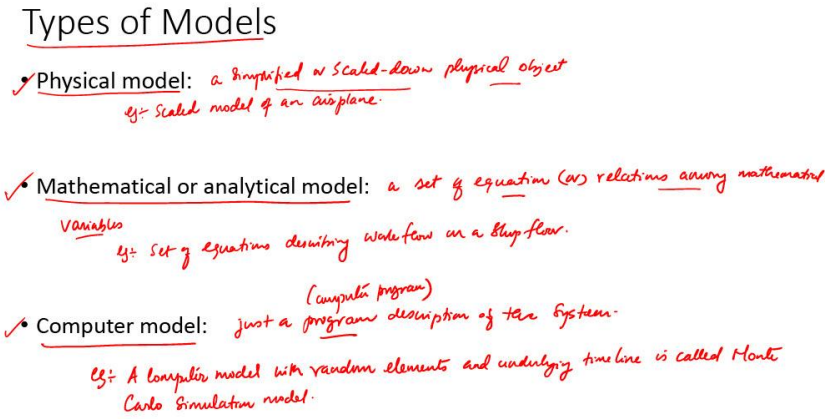
By the time, you have invested so much money into this. So, it will be a very expensive proposition. So, hence, when you have an experimental design or you have an idea or the actual system does not exist yet. So, if it is not in physical existence.

Then, constructing a model and manipulating the model is far cheaper and safer than building the actual system.

Then, third one is, ranking multiple designs or options and analyzing their tradeoffs. So, you can say it is similar to number 2 except the economic motivation, which is much greater. So, if somebody says, ok I want to see whether annual production of the factory should be 1.2 lakh cars per annum, 1.9 lakh cars per annum, 2.5 lakhs car per annum, 3 lakhs car per annum.

You cannot really build all these factories and decide oh, well the 1.5 is the one and we will demolish the rest of the factories, that is a stupid idea and it is very expensive. So, it

is better that when you have multiple options or opportunities in front of you to identify which is best suiting for you. You would need to build models and manipulate these models to come up with the appropriate decision. So, tradeoff analysis is the third major aspects of Modeling. So, these are the number 1, 2 and 3, which are the 3 major prime goals of modeling which are relevant to this course as such.



So, now we will study about the types of models. So, the first one is the Physical model. It is in the simplest sense the definition is a simplified or scaled down physical object.

For example, scaled model of an airplane. So, when an aircraft initially is being created or we talk about Boeing or Airbus or something, they make a much smaller model of it and they initially make kind of a toy, kind of a model take it to wind tunnel, do the study.

Then, they make another model, put an engine and other things and fly it and try to find out the actual performance of the stuff. Then they finally, go and build the big model. So, it is a simplified or a scaled down model of the physical object that is the physical model.

Second is the mathematical or analytical model. It is a set of equations or relations among mathematical variables mathematical variables ok. So, either it is a set of equations or relations among certain mathematical variables. So, for example, set of equations describing workflow on a factory floor on a shop floor ok.

Or like people say that I have a parcel of land I can either plant wheat or rice and if I plant wheat, I will get this much profit if I plant rice, I will get this much profit. For planting wheat, I require this much of fertilizer and water whereas, for wheat I require this much more fertilizer and this much less water.

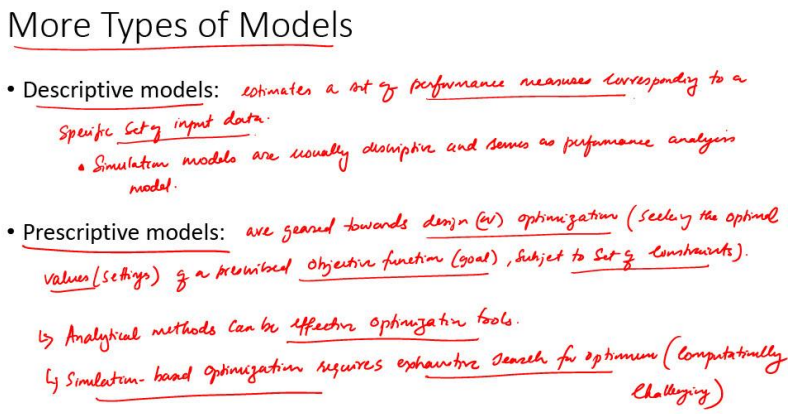
So, what is the ideal plantation in my total if my total land area is 2 hectares what should I do kind of a thing. So, that is like simply people will say it as a linear programming problem linear problem which you will study in linear programming problem. But the important aspect is that you can create that entire decision problem into the form of a set of linear equations right.

So, that will be a mathematical model. Instead of that, if you have set of numbers and from there, you derive that, if this much change in x will result in this much change in y you can think about that as an Analytical model as well.

And, then the third one we talk about is a computer model is just a program description of the system. When I say program, I mean computer program. It is more like a logical representation system. So, an example of this is a computer model with random elements and underlying timeline is called Monte Carlo simulation model.

So, Monte Carlo simulation model is an example of how you can create which can be an equation or mathematical equation, but you really do not know the value of the variables.

We know that this particular variable can take any value between these two in this particular fashion. So, then you use random numbers to recreate the scenario and try to find out how the behaviour of the system and how can you model the behaviour of the system. So, we can have a Physical model is one option a Mathematical or Analytical model or a computer model. These are the three major aspects of model which are important to us in this study or this course.



The two more other type of models which are sometimes you know is very popularly used and lot of this is to contributed with the help of due to management people.

And, the first one is we call as a Descriptive model. So, what does it estimates a set of performance measures? Performance measures estimates a set of performance measures corresponding to a specific set of input data.

So, you have a specific set of input data and for that input data you want to estimate a set of performance measures corresponding to that specific set of input data. So, that is called as a Descriptive model's example. So, simulation models are clearly descriptive and serve as performance Analysis models. So, even computation flow, CFD models etcetera, all are part of the descriptive models.

Second one is the Prescriptive models. So, they are geared towards design or optimization. So, when you say optimization, what do you mean by optimization? You are seeking the optimal values or settings of a prescribed objective function.

You can call it as a (goal) subject to Set of Constraints. So, when you start studying Linear Program and Decision Trees and etcetera, you will understand what we are talking about here. But the idea here is that you are focusing more on optimizing or you are trying to find out the optimal settings or optimal values.

So, that a prescribed objective function, a goal can be achieved within a set of limitations or a set of constraints. So, another point you need to note is Analytical methods can be effective optimization tools. So, you will see lot of analytical methods used in optimization. The simulation-based optimization, if you want to use simulation models for optimization, it requires exhaustive search optimum.

So, hence and computationally challenging. So, analytical methods are better. They are far more effective as optimization tools. If you want to do optimization with the help of simulation, then you need to do an exhaustive search and the search can be really you know computationally challenging and both time wise resource, etcetera.

So, thank you for your patient hearing and wish you good luck and I will see you soon with the second week lecture very soon.

Thank you very much.