Computational Systems Biology
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Lecture – 07
Some Example Models

In today's video, we will look at some example models which are interesting because you want to understand whether you know a model is mechanistic or dynamic or stochastic and so on and what are the assumptions that go into a model. So, to fixate all the ideas that we looked at in the last few videos, let us look at a few interesting example models.

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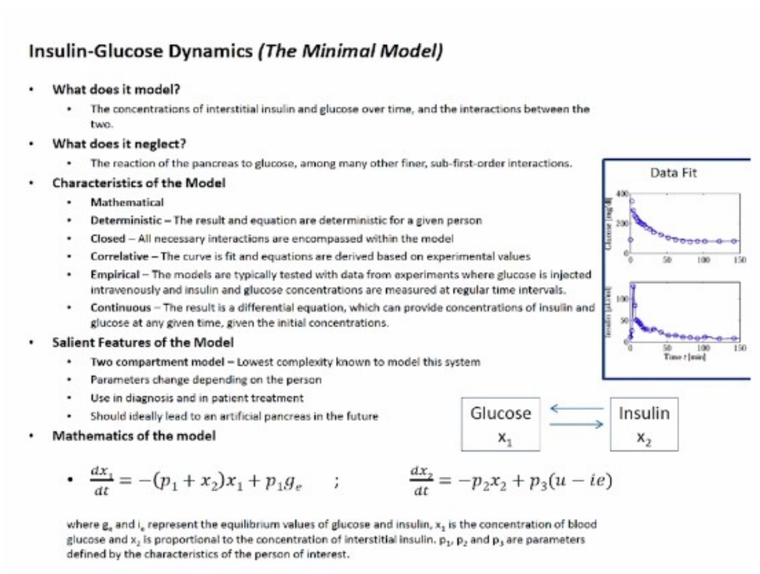

Welcome back, let’s just take a closer look at some nice example models and try to understand various aspects of it, you know the modelling process that we discussed earlier about what is the scope, whether it’s a continuous model, empirical model, correlatory model, dynamic model and so on. This is a classic very, very simple model of insulin-glucose dynamics.

It is a minimal model. What does it model? It just models interstitial insulin and glucose over time and the interactions between the two. It neglects so many other things, right? Now, there is pancreas, there is glucagon and there is a very complicated signalling network, there is some receptors involved. All that is ignored. It’s a very, very simple simplified model of what happens to glucose and insulin.

So, this is a deterministic model. No stochasticity is considered. It's a closed model, It's a correlative model. It's also somewhat empirical in the sense, it's not a mechanistic model, it's continuous of course because it varies with time and it's considered as a two compartment model. You have one box with glucose, one box with insulin. It is a two compartment model and very simple equations, right? Just two differential equations to explain.

So, this is a very simple example, this is a kind of what I want you to work on in your assignment, your first assignment where you want to make a single slide about a particular model.

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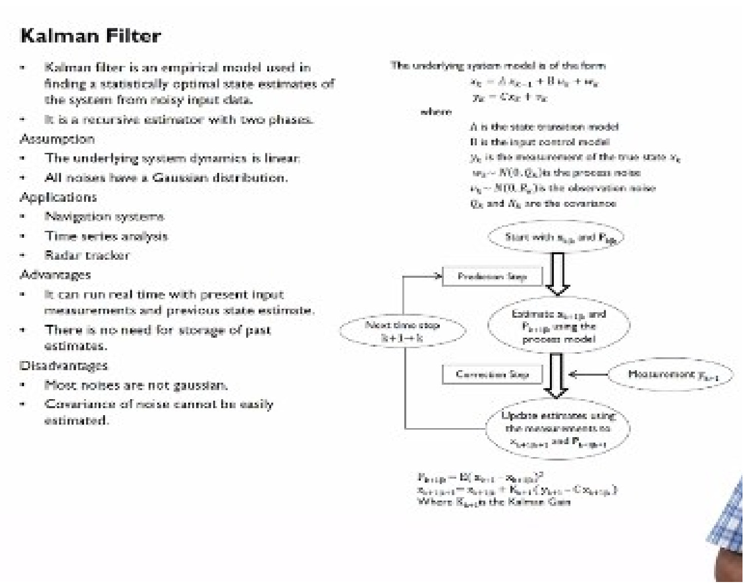

Another example is the Kalman filter which is till date remains a very, very popular model for handling noise and so on, so I will not go through the details.

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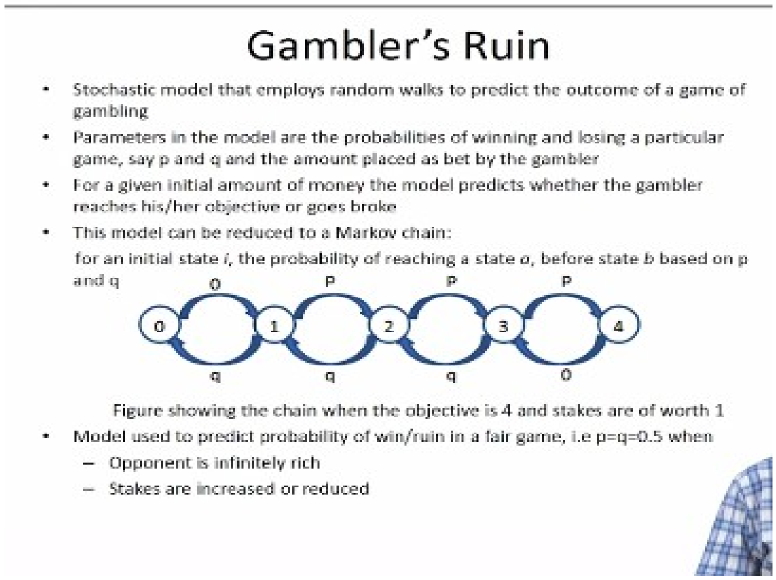

But this is another example model which talks about Gambler's ruin. It's a stochastic model that employs some random walks to predict what happens in a game. Similarly, a very good example is you can actually model a tennis game. So, you can have just setup a Markovian process wherein you have every state will be a particular score in the game and you can transit to different states and similarly, you can have a set of states for the match and so on and so forth.

So and this is potentially a model. You say that a player 1 wins with a probability P and player 2 wins with probability 1 - p and you can actually set up equations and say what is the probability of player 1 winning the match, right? That can be derived based on, so that would be a, it would be a stochastic model because each time you run it, you will get a different set of results.

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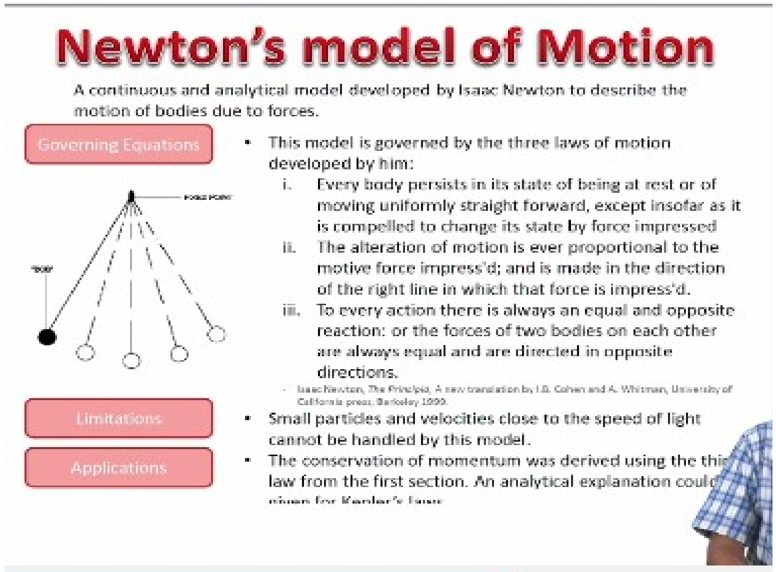

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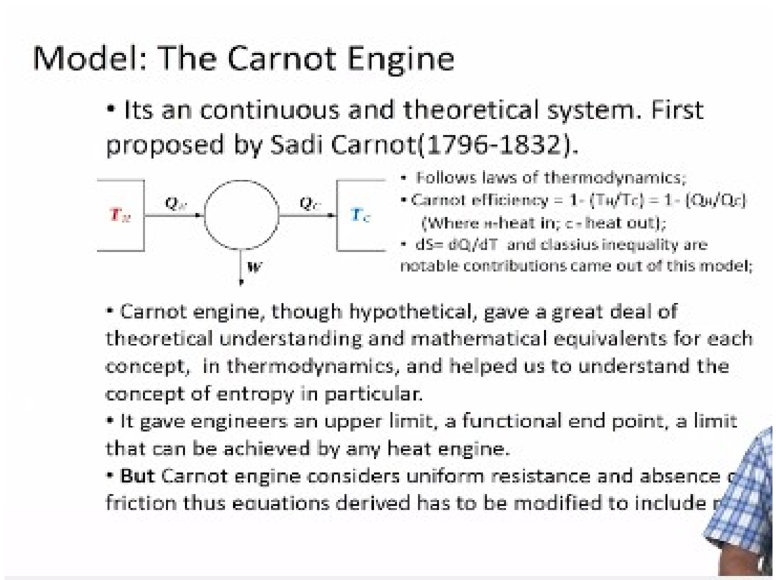

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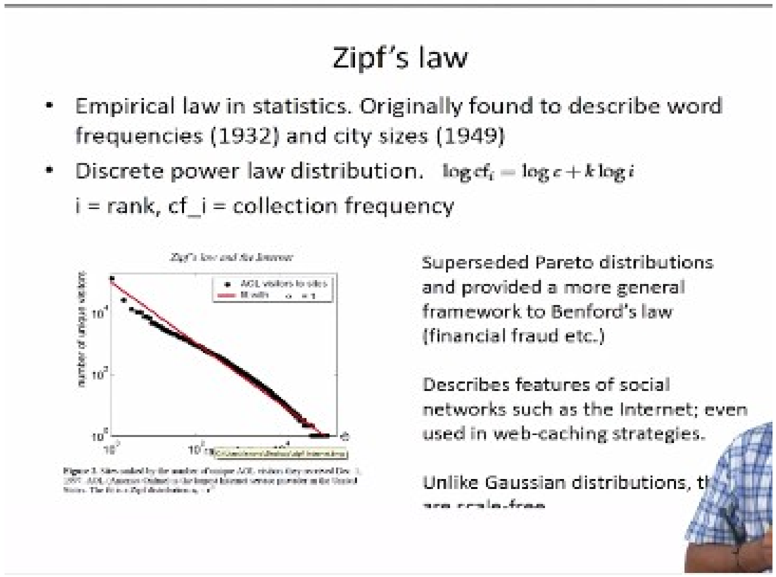

Good old Newton's model of motion or the Carnot engine. Zipf's law, this is actually a very interesting law particularly in the context of what we will study couple of classes down the line. So, this study is the word frequencies in English text, so what it finds, what do you see? What do you see here? It is a power law kind of thing, right? So, you have the log-log plot. It's linear, so for, okay this is the internet but this doesn't actually describe Zipf's law.

The Zipf's law was originally for word frequencies. So, what would you expect if you looked at word frequencies in the English language? You will have few words that are repeated an astronomical number of times and the rest of the words all have much lower frequencies and so on. So, majority of the words will have very low frequencies and a few words like, "A", "the", prepositions and so on and some other you know conjunctions all of those will have a very high usage. So, you end up finding a power law kind of distribution and this is something we will see in biological networks as well as we go on.

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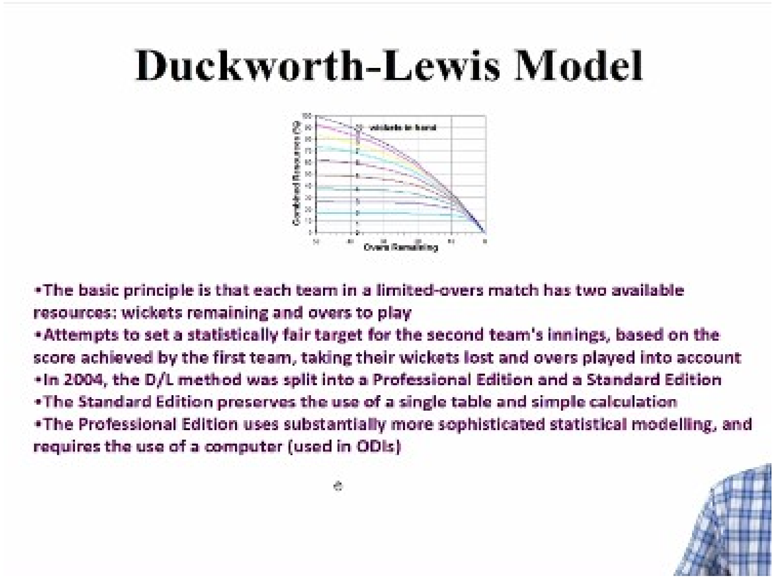

Of course, Duckworth Lewis, right? Our favourite model. So, essentially there are various ways to characterise these models, so you want to understand deterministic, stochastic, dynamic and empirical, correlative, mechanistic all of these things is what you need to think of when you analyse any model, when you want to understand the characteristics of a model. So, this is just a basic recap of what we did earlier.

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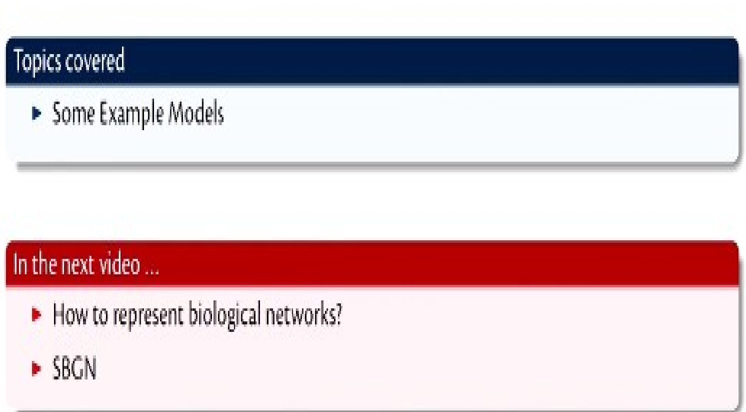

So, with this, we have sort of done with some of the fundamentals of mathematical modelling. So, in the next video, let's start looking at how we represent biological networks and something known as SBGN or systems biology graphical notation.