Computational Systems Biology
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Lecture - 17
Introduction to Network Biology

In today's lecture I will try to wrap up the basic introduction to network theory concepts with a brief discussion about connected components and network motifs.

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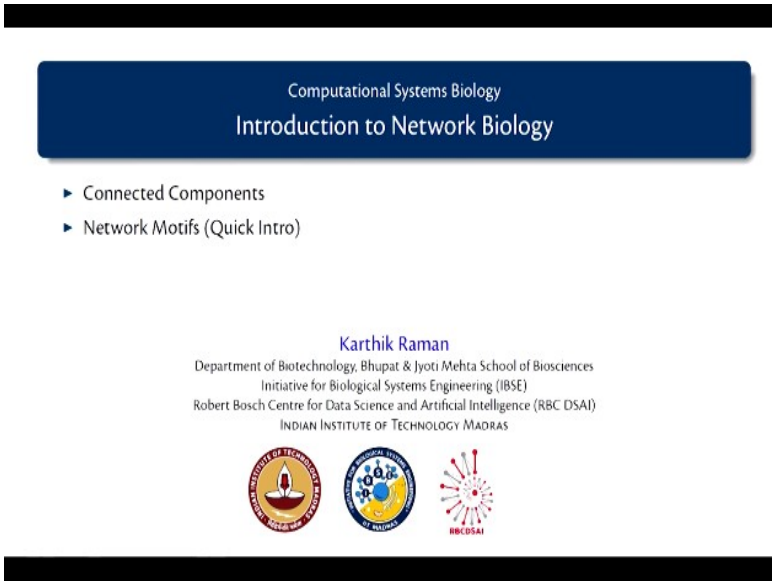

Let's continue with some of the concepts we had left behind in the morning.

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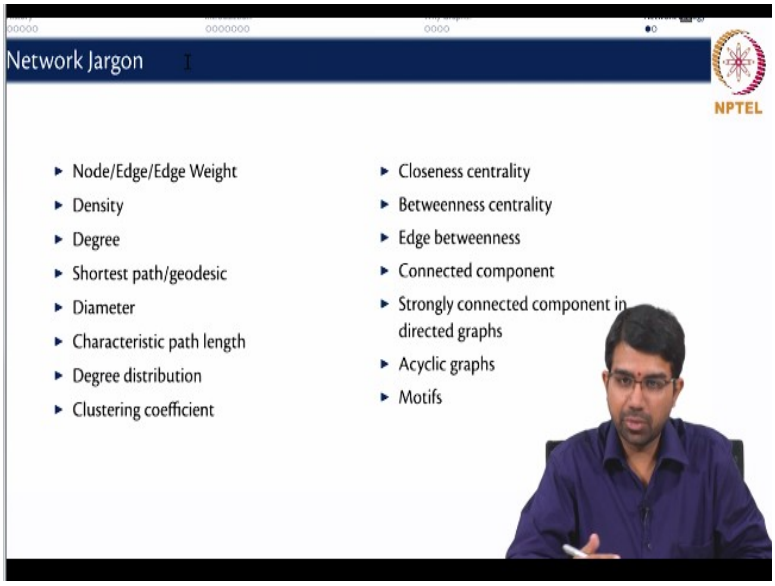

So, first is what is a connected component?

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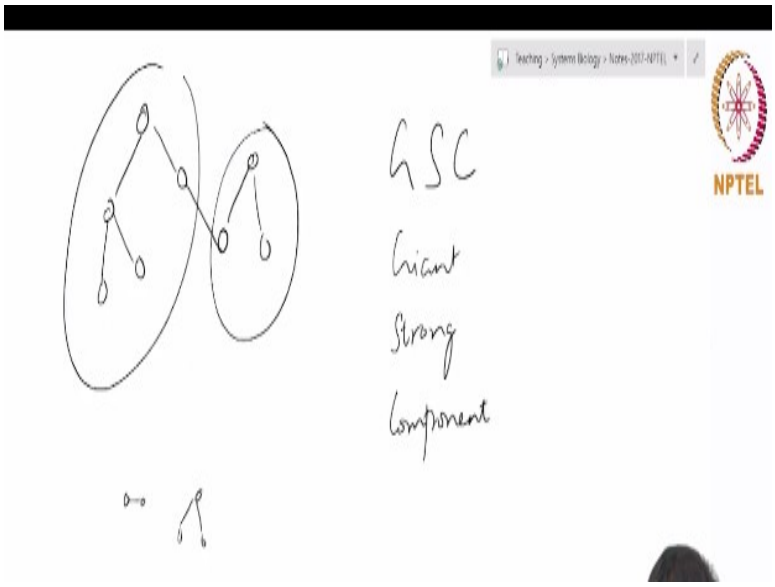

So, connected component is, this is a graph with 2 connected components. Basically 2 pieces, so within a connected component you have a path between every pair of nodes, right, so here there is no path between any node in this group, any node in this group, right. So, if you add this edge you now have a single connected component right. A very common characteristic of most biological networks is what is called a giant strong component.

Or in other words, a single massively connected component, right you will typically find something like 90%-95% of the nodes are in a single connected component. There might be a few stray nodes here something like this, we will commonly find it, but majority of the nodes are in like one proper single connected component. So, if we were to now extend this definition to a directed graph you get what is known as a strongly connected component.

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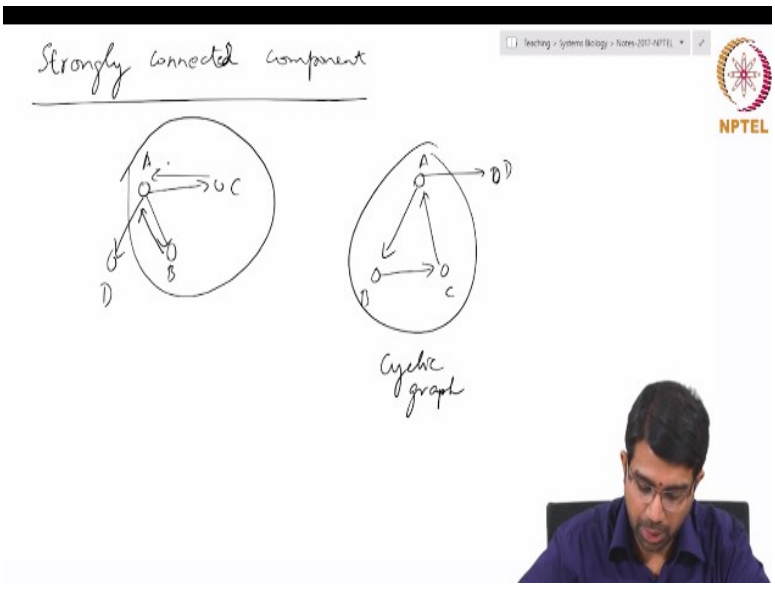

So, what is a strongly connected component? This holds for a directed graph. So, in a directed graph if you have a path between every pair of nodes in a component in both directions, that is what is a strongly connected component. So, in this graph what would be a strongly connected component? Is it ABC? so ABC would be a strongly connected component because you have a path from A to B, B to A, A to C, C to A and B to C, C to B, right.

So, this is what is a strongly connected component. There is C to A to B indirect, so it is not an edge, it is a path, so you are not worried about edges here, the existence of a path. Another simple way would be, you have a cycle, you automatically have a strongly connected component. We have a path from A to B, B to A, B to C, C to B and so on, okay. So that brings us to the definition of what is a cyclic versus an acyclic graph.

Right so this is a graph where there is a cycle, in this graph well you have again cycles, smaller cycles, you have an AB cycle and then AC cycle, right, there is a path from a node to itself, that is the definition of a cyclic graph. So, and sort of the last concept that we wanted to look at, I will just briefly go over it and we will spend a whole class almost a little way down the line.

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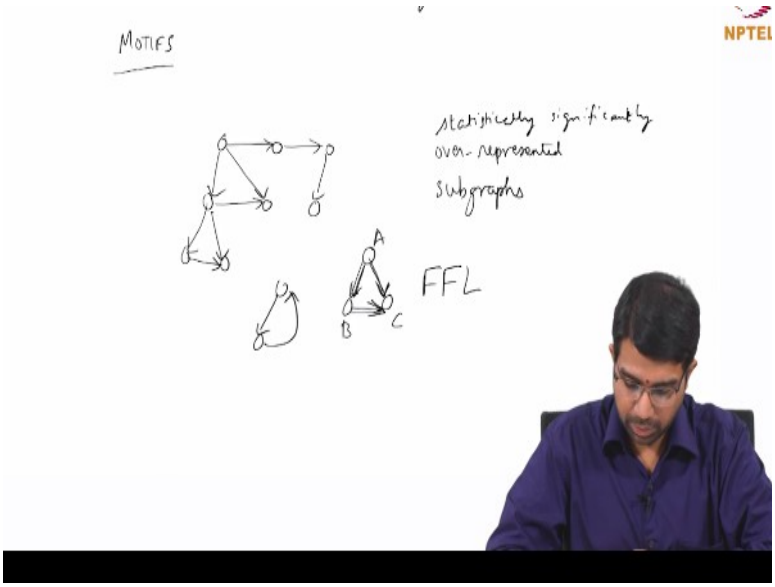

What is a motif? What is a motif in general? You heard the word in English right, it is some sort of a pattern or usually a logo or something like that so that fashion if you look at a graph like this, you will find that there seem to be a few repeating patterns, right, so motifs are basically you should probably say, subgraphs, they are over-represented subgraphs or in fact statistically significantly overrepresented subgraphs.

So, can you tell me what is a motif here? No here, in this picture, the triangle and it also seems to have a particular order right. So, you have this, it is actually called a feed forward loop, right. This basically is feeding forward and you can also call it a coherent feed forward loop, but essentially so there is a link like this and there is also link which feeds forward, direct and indirect.

So, this is one way but this is already feeding forward to that point. So, A is already feeding forward to C. You can have a feedback that is like more classic thing so have something like this or through another node. So, there are many different kinds of motifs. We will look at it at a little later stage.

"Professor - student conversation" What is meant by statistically significant? That is quite interesting we will have to I think wait, so anytime you use the word statistically significant it means that you need to have a null model in the first place. You need to expect something right. So, to quickly answer your question if you take a dice and throw it 10 times and you find 6 or like 8 times you find 6, the 6 is statistically over-represented there, because you expect 6 much fewer times.

You expect 6 about twice almost once or twice, but if you get it 6 times it is statistically over-represented right which means that's because you have a basal expectation, you have an expectation of what is the outcome initially based on a fair dice or a null model right. So, what is a null model for this we will look at it when we look at motifs. Should all strongly connected components be cyclic because there is a path from a node to itself? So, it doesn't need to have a path from a node to itself in a strongly connected component, it only needs to have a path from A to B, yeah but, probably I guess, but I have to there may be an exception, but it does seem so. No, it is technically cyclic right, so that's the example we already saw here so this is cyclic, so there are 2 cycles, yeah, so there is a path from A to itself. Well I need to just make sure that this is called a cycle and if there is a slight difference.

This is not a loop right I mean, okay, you could call it a loop this would be a self-loop whereas that is a.

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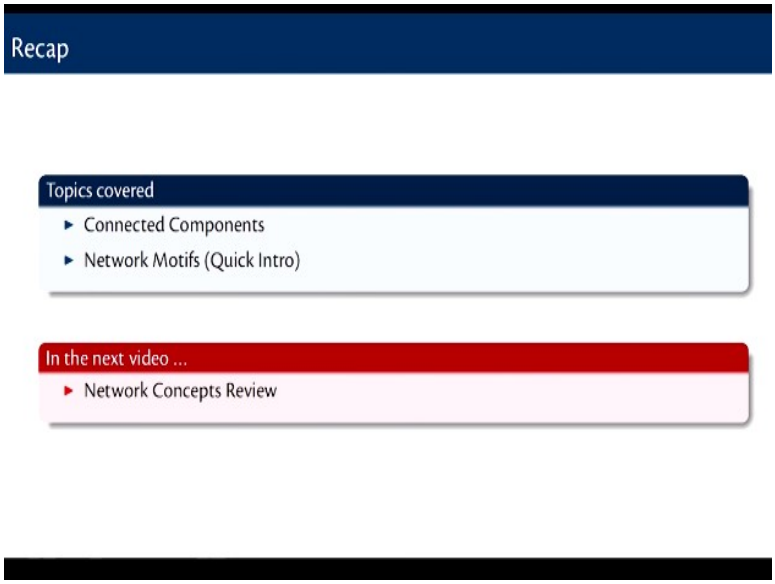

I hope you had a good introduction to connected components and network motifs today and in the next video we will try to review all of the network concepts that we have covered so far and set the tone for further topics.