Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Deep Learning – Part II

Module 16.7 – Independencies encoded by a Bayesian network
(Case 2: Node and its non-parents)

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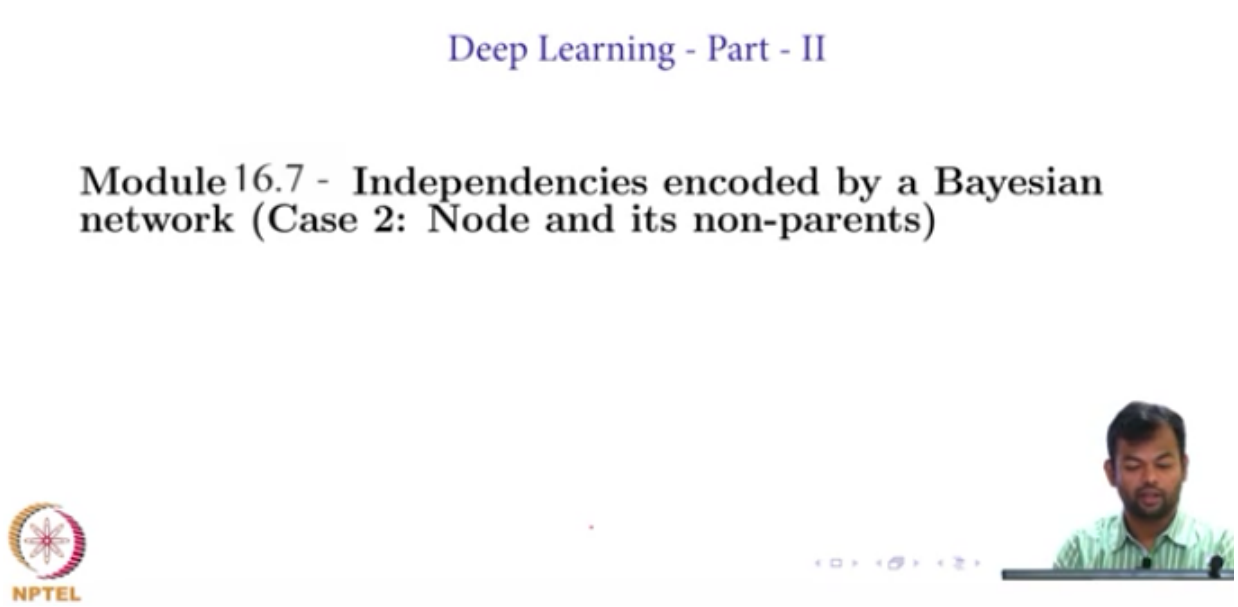

Okay, so that was the case when you have parents and the child. Now what about node and its non-parents? So let's look at those example it, so is L independent of S?
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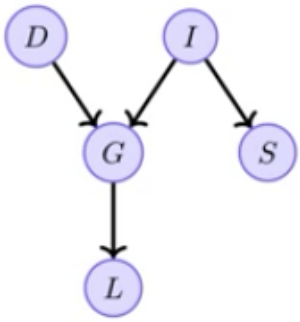

- Now let's look at the relation between a node and its non-parent nodes
- Is $L \perp S$?

Is L independent of S? Louder, louder but correct answer, so that's the illusion right, it looks like L is not, L is independent of S, right, it's not dependent on S.

Can you argue that it is actually dependent on S? S tells you something about the intelligence, which in turn tells you something about the grade, which in turn tells you something about L, right, so in general right you would expect this that if I told you that the SAT score was high, then the probability of getting a good recommendation letter would be higher when the case when I told you that the SAT score was low,

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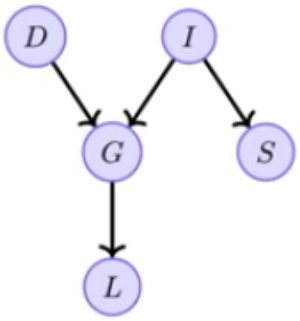

- Now let's look at the relation between a node and its non-parent nodes
- Is $L \perp S$?
- No, knowing the SAT score tells us about I which in turn tells us something about G and hence L
- Hence we expect $P(l^1|s^1) > P(l^1|s^0)$

and this is exactly because of the reasoning which I said that because SAT score tells you something about intelligence which in turn already propagates back to the recommendation.
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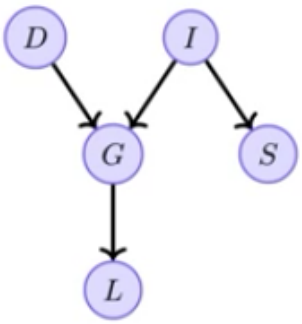

- Now let's look at the relation between a node and its non-parent nodes
- Is $L \perp S$?
- No, knowing the SAT score tells us about I which in turn tells us something about G and hence L
- Hence we expect $P(l^1|s^1) > P(l^1|s^0)$
- Similarly we can argue $L \not\perp D$ and $L \not\perp I$

And similarly we can argue that L is not independent of D, and L is also not independent of I, right, knowing the intelligence tells you something about the grade and hence about the letter and so on.

Now where am I headed with this? I really want L and S to be independent given G, what if I know the value of G? Why are they independent now? Because whatever S could have probably told me about the grade which actually matters for deciding the recommendation, so S would have okay gone and whispered something to this guy and then come and whisper something with this guy, but then this guy would say I already know this, right I mean so, there is no new information that you are actually adding, right,
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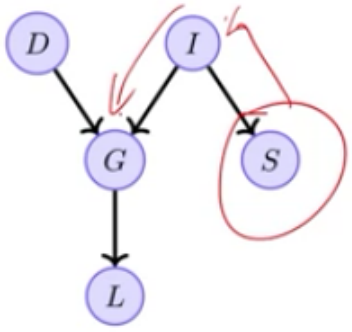

- But what if we know the value of G?
- Is $(L \perp S)|G$?

so that's why it doesn't matter, once you know the grade everything else can be blocked out, right, this is fine.

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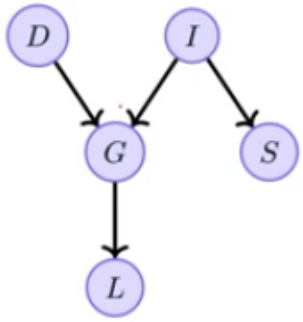

- But what if we know the value of G?
- Is $(L \perp S)|G$?
- Yes, the grade completely determines the recommendation letter
- Once we know the grade, other variables do not add any information
- Hence $(L \perp S)|G$
- Similarly we can argue $(L \perp I)|G$ and $(L \perp D)|G$

Can you argue that L is independent of I given the grade? Whether grade depends on I? Whatever the grade I can, whatever I can tell you about the grade, the grade has already told you that is what it doesn't matter whatever extra information I have, and the same thing about D, okay. So the instructor may also, so we're just saying that given the grade, so this is what you're telling me, and I'm going to challenge this,

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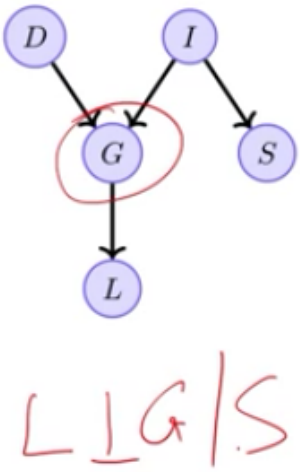

- But, wait a minute!
- The instructor may also want to look at the SAT score in addition to the grade

L I G S

the instructor may want to look at the SAT score right, sorry, sorry, or whatever, so we assume that the instructor relies only on the grade, right, that's the modeling assumption that you made, once you make this assumption this is what our belief of the student world is,

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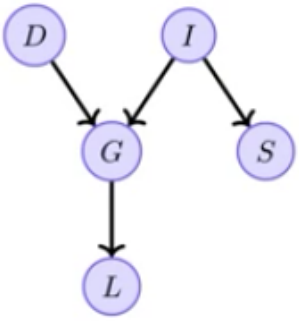

- But, wait a minute!
- The instructor may also want to look at the SAT score in addition to the grade
- Well, we "assumed" that the instructor only relies on the grade.
- That was our "belief" of how the world works
- And hence we drew the network accordingly

and once you have made this it's not fair to ask me these what if question, right, what if this had happened, and what if that had, if you believe that this is not how a instructor writes a recommendation letter, you are free to change our assumptions, right, we want to assume that the instructor also looks at the SAT score, then this add this H tell me that this is the model that you have,

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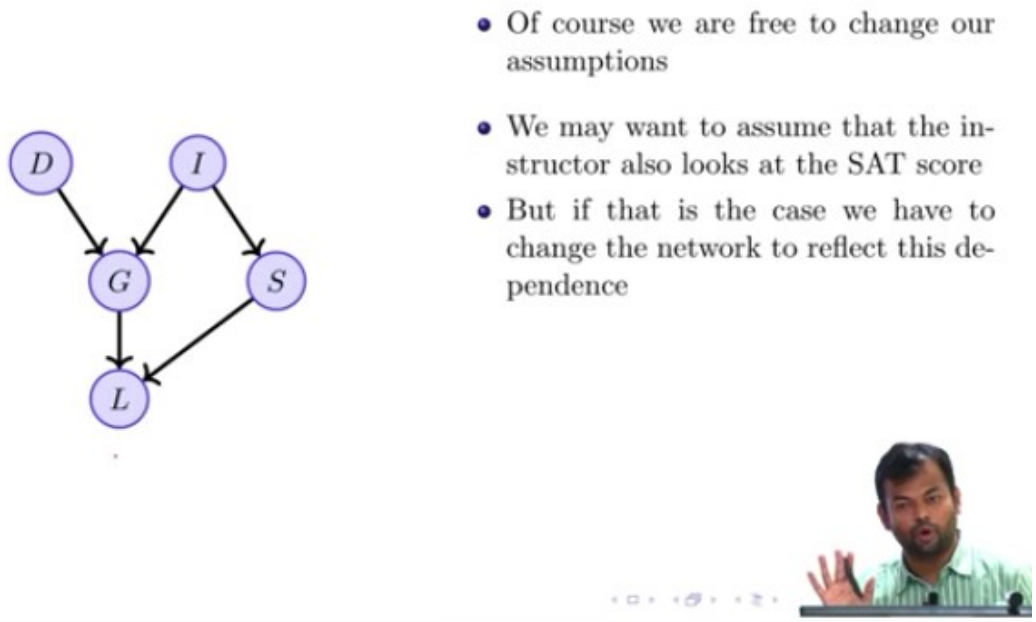

this will in turn tell me what are the kinds of conditional distributions that I want to learn it.

So now here this table would actually be L given, G,S which is fine, as long as you tell me this is what you want, we'll figure out a way of learning those parameters, but once you tell me that L does not depend on S directly and then you ask me these what if question, it doesn't work that correct, so to make a modeling assumption you're free to make whatever modeling assumptions you want to make, once you make that you freeze the network and then do the analysis on top of that, right.

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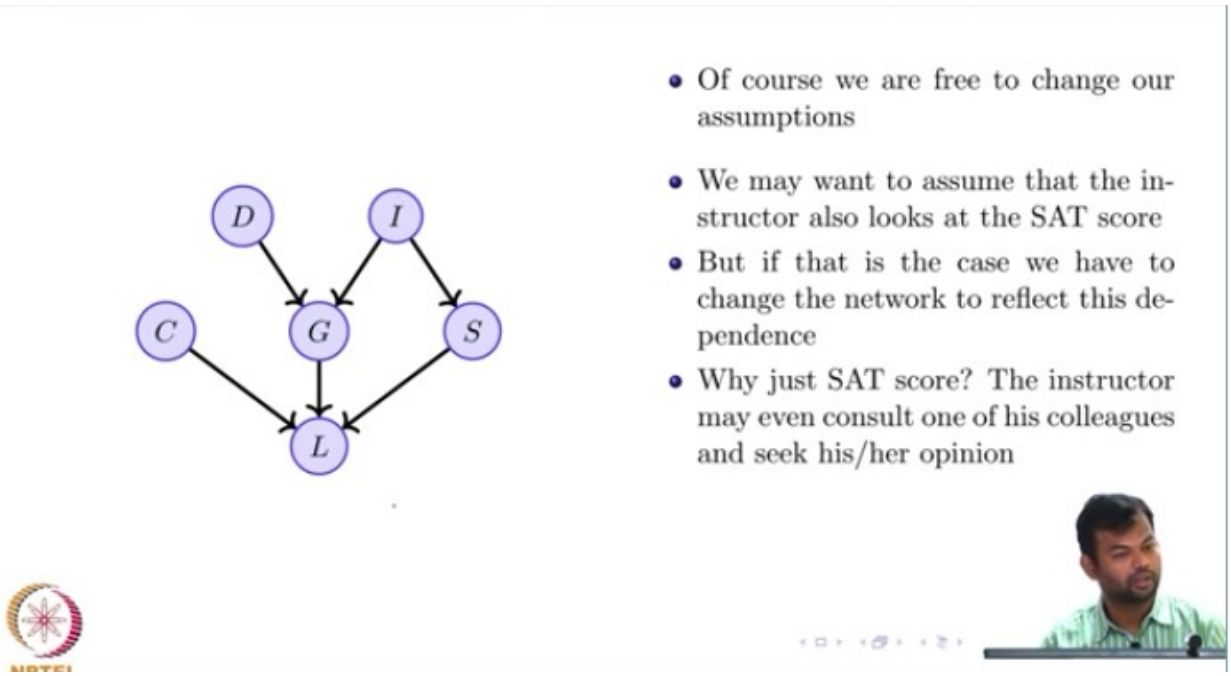

And why just SAT score, right I mean you could also tell me that it depends on, the instructor may also consult one of his colleagues, right, the instructor might feel that okay this person is done a project with that colleague and I trust this colleague, so let me ask that colleagues opinion, and it doesn't end anywhere, right you could just introduce as many random variables as you want, right.

What if the instructor was in a bad mood, so that also added random variable for mood, right, and so these kind of things will just go on, so you have to make some kind of assumptions, live with those assumptions and do all the analysis within that set of assumptions, right, so the graph is just a reflection of what you decided how the world works, and once you have done that you're going to freeze it and not make any changes,

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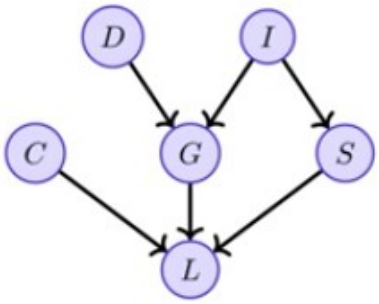

- Remember: The graph is a reflection of our assumptions about how the world works
- Our assumptions about dependencies are encoded in the graph
- Once we build the graph we freeze it and do all the reasoning and analysis (independence) on this graph
- It is not fair to ask "what if" questions involving other factors (For example, what if the professor was in a bad mood?)

and not ask these what if question, I'm just discouraging you from asking many questions, don't ask me these what if questions, but I mean jokes apart, this is what you mean by that, right,

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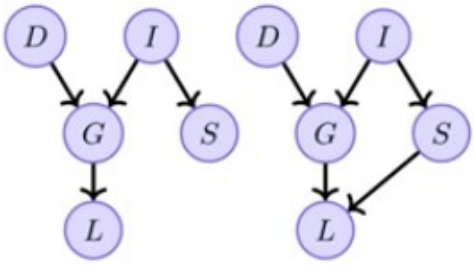

- If we believe Graph (a) is how the world works then $(L \perp S)|G$

so if we believe that A is how the model works or the world works, then N is independent of S given G, if you believe that B is how the world works, then L is not independent of S given G, I think that's straight forward, okay.

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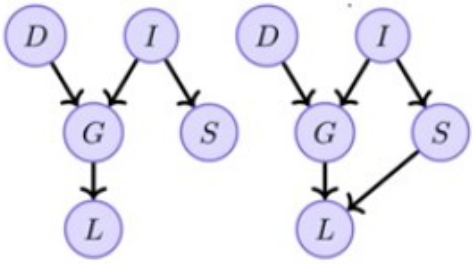

- If we believe Graph (a) is how the world works then $(L \perp S)|G$
- If we believe Graph(b) is how the world works then $(L \not\perp S)|G$
- We will stick to Graph(a) for the discussion

And if we now we'll just stick to graph A that's more convenient, so we'll just assume that the grade completed determines 3 recommendation letter, okay.

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- Let's return back to our discussion of finding independence relations in the graph

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