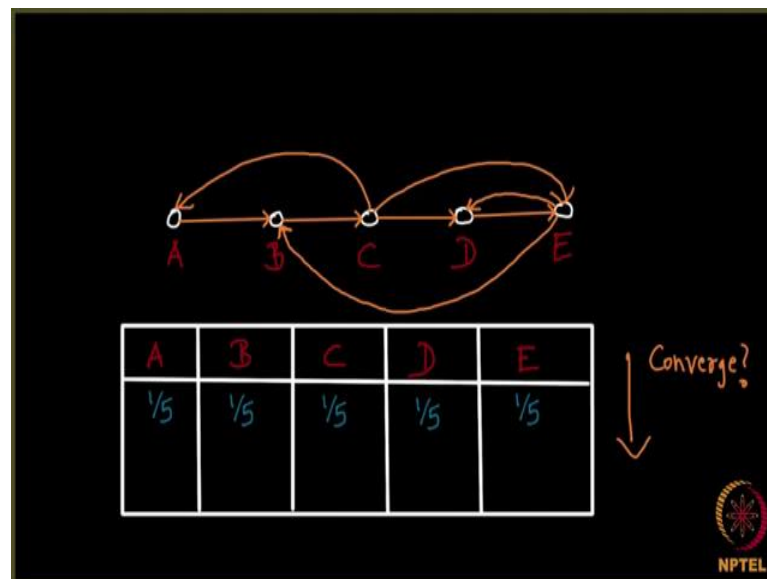


Social Networks
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Link Analysis (Continued)
Lecture - 108
PageRank, conservation, and convergence - Another example

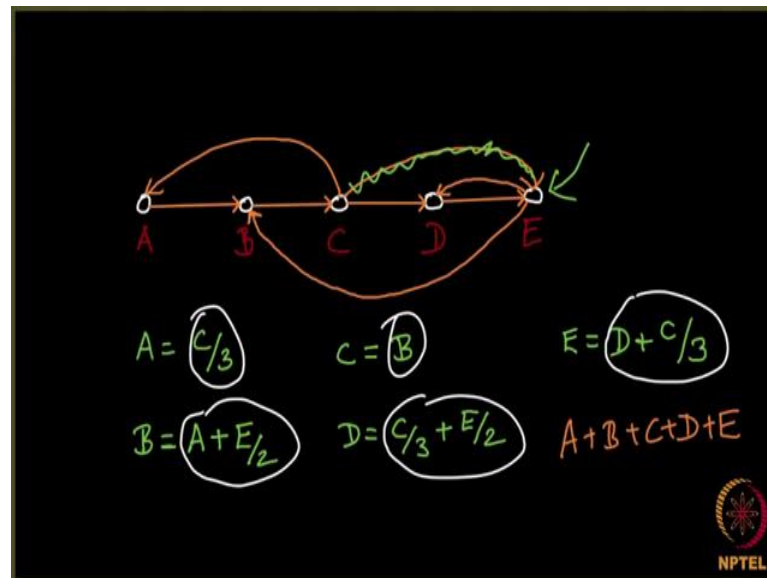
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Let me consider a new graph with 5 vertices, let me call them A B C D and E and then let me put some random edges here and there. So, that every edge has some incoming links and some outgoing links. So, this is my graph, fine. And now let me create a table for this A B C D values and then start off with some values for A B C D E; I divided my resources equally to A B C D E resources or gold coins as in the previous example that we have seen in our lectures. So, what will that do? It will be $\frac{1}{5}$ $\frac{1}{5}$ $\frac{1}{5}$ and $\frac{1}{5}$ correct.

So, if I continue like this, we observed that it converged for 3 nodes. Now, I have taken 5 nodes not so, easy looking graph will it converge here as well is my big question, will it converge here or not. Let us go to the excel sheet and then the Google spreadsheet and then try doing the same thing that we did before, and we will see whether it converges or not. So, let us be prepared to go and edit there, let us observe what is happening here so, that the punching in of the equation will be easier for it.

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Now, look at this A is actually equal to C by 3 correct, why is that? From C you see that there are 3 edges going out. So, the value of C will be divided between these 3 people. So, I will say $A = C/3$, good next: $B = A + E/2$. You can check why, maybe you should pause and then check for each value. I have written it down; I will just go through it is for you to check whether its right or not. B gets all the values from A; it also gets half the value from E because it have 2 edges going from E as you can observe ok.

So, C will be B because there is only one thing that is coming inside C and B sends only 1 edge to see; I mean from emanating from B there are only 1 there is only 1 edge. And, then D is $C/3 + E/2$ you can check why and finally, $E = D$. So, we will keep these things and then try to go to our spreadsheet and then try to code it. So, what I will do is I will directly go there to the spreadsheet, finish this assignments of A B C D E, start with 1/5 1/5 1/5 and bring you people there. And, then show you as I pull down the values on excel, on Google spreadsheet you will observe that I am populating everything, and we will see whether it converges or not.

So, that I forgot something here. So, let me just write that down E as you saw has incoming link from C as well not just from D. So, you have an incoming link from C. So, let me make a note of this E is not just equal to D, it is plus $C/3$; a good way to see if all of them add up to 1 is to see if these things add up to, if these 5 things add up to, if you add these things you must get; what should you get guess. You must get $A + B + C + D$

+ E, see if you are getting this and you just think of how and why exactly do I say they should add to $A + B + C + D + E$; it is a simple quiz question.

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	A	B	C	D	E
1					
2					
3	0.2	0.2	0.2	0.2	0.2
4	0.066666667	0.3	0.2	0.166666667	0.266666667
5	0.066666667	0.2	0.3	0.2	0.233333333
6	0.1	0.183333333	0.2	0.216666667	0.3
7	0.066666667	0.25	0.183333333	0.216666667	0.283333333
8	0.061111111	0.208333333	0.25	0.202777778	0.277777778
9	0.083333333	0.2	0.208333333	0.222222222	0.286111111
10	0.064444444	0.226388889	0.2	0.2125	0.291666667
11	0.066666667	0.215277778	0.226388889	0.2125	0.279166667
12	0.0754296296	0.20625	0.215277778	0.215046296	0.287962963
13	0.07175925926	0.219444444	0.20625	0.2157407407	0.2868055556
14	0.06875	0.215162037	0.219444444	0.215277778	0.2844907407
15	0.07314814815	0.2109653704	0.215162037	0.2153935185	0.2853009259
16	0.07172067901	0.2157986111	0.2109653704	0.214371142	0.2871141975
17	0.07033179012	0.215277778	0.2157986111	0.213888889	0.2847029321
18	0.07193287037	0.2126832562	0.215277778	0.2142843364	0.2858217593
19					
20					
21					
22					

I have now opened the Google spreadsheet and the values of A B C D and E as you would have guessed starts from $1/5$. So, I am going to populate it with $1/5$ throughout and as we computed in our previous lecture the value of A is going to be C divided by 3. I think you all know how Google spreadsheet works, as I told you earlier you just need to take the value of this which is C column and the third row. You should in fact, punch in is equal to $C \cdot 3/3$ ok. And then what was B? B was simply same as A plus what was in E divided by 2, is not it ok. What was my C?

My C was nothing else but, B you may want to look at my previous lecture if you are not following what I am doing. It is a pretty straightforward process my D is going to be D was slightly complicated. It was $C/3 + E/2$, $E/2$ that is it. And what was E? E was equal to my $D + C/3$, a good way to check whether it is right or not is just to see if it is equal to the entire row, is this equal to $A^4 + B^4$ plus; what is that $A^4 + B^4 + C^4 + D^4 + E^4$. It should be 1 perfect, which means the values are properly put; let me delete this now ok.

So, now what I do is I copy this and paste this and this creates a new iteration, as you see the value of this changes, but this value remains the same because it is simply again $0.2/3$

C/3 and so on and so forth. Let me just pull this and see whether it converges or not, it is no way converging maybe it does not converge I do not know.

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	A	B	C	D	E
247	0.07142857143	0.2142857143	0.2142857143	0.2142857143	0.2857142857
248	0.07142857143	0.2142857143	0.2142857143	0.2142857143	0.2857142857
249	0.07142857143	0.2142857143	0.2142857143	0.2142857143	0.2857142857
250	0.07142857143	0.2142857143	0.2142857143	0.2142857143	0.2857142857
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Let me go ahead and see well I see something promising; it looks like it is converging. You see 0.07 and 0.07 here 0.21 and 0.21 although the third decimal digit is not change, it is something else. I sort of see a ray of hope here maybe it will converge. Let me go on, let me go on the point is to keep going until you get the same values. It looks like it is converging, you see the last 3 the 3 decimal digits after the point looks like the same.

But I am not really happy I want to see the exact converged values. Let me go on, like go on and on I am still not happy, let me pull this too let us say as you can see, I am in 76th row. I have repeated this 76 times, if I go on to let us say 200 or let us say little over 100 I see that the values are exactly the same right. It looks like it is exactly the same. When it is exactly the same no matter where, until what point I go, I am going to 250 it will still be the same. You see these 2 cells it was so much and it still remains the same. Let us make a note of this, we are observing that the graphs here that the graph given graph here with 5 notes A B C D E; when you start with 1/5 1/5 1/5 it is converging right, it is converging to these values.

So, let us go to the next lecture and see what can one say about this, why exactly this is happening.