Consider a case of... **You've went to a local book-store....**


- Obviously, you'll see the most popular books along with the less popular books. And another P2N here is... *The proportion of non-popular books will be more than the popular books*. Correct right..??, you would have seen it probably. -- Yes.
- Now think of.. **If you were in the position of the owner of the book-store**..and try answering this question..
  - **For what reason, you kept the less-popular books, when the most-popular books gives you the more sales than the less-popular books?**, you can simply discard those right..?? But **Why** the popular or whatever books-store will have those..??

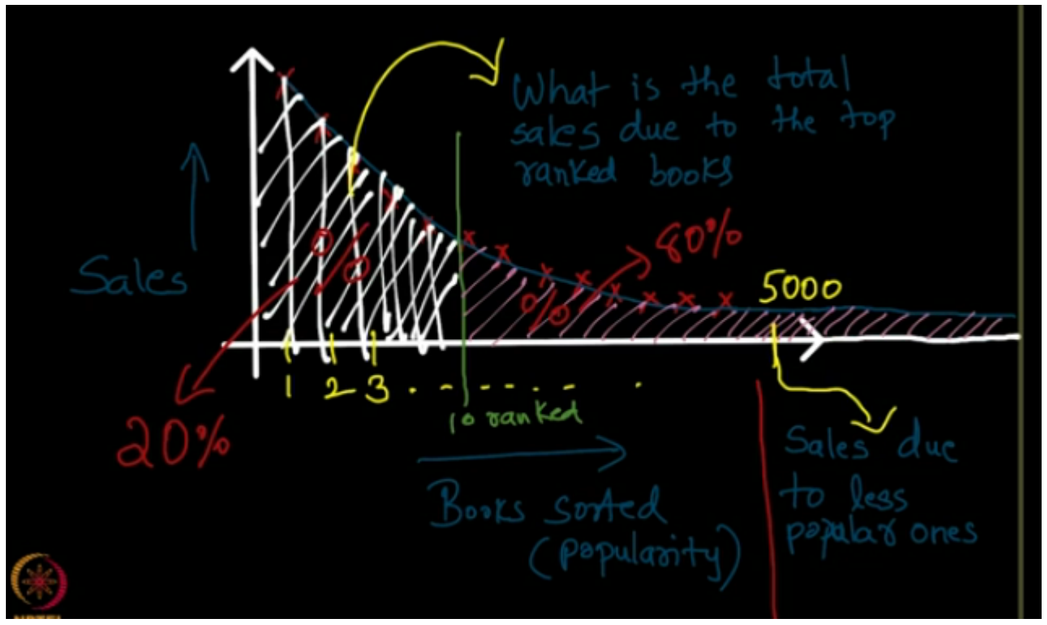
The question has to be posed in a different manner..

- **Plot a graph**: On ***X-axis*** take the -- from *Most-popular* way to the *Least popular* on all books and over Y-axis, the *Sales* it made to store-keeper.

  > It resembles the **Power Law** right..!!.*(Please look the below figure)*

- Take some (Say-10) popular books and find the total sales (White hatch).
- and rest of the less-popular books.

Now question .. **What % of sales do each make..??**



This answers the question:

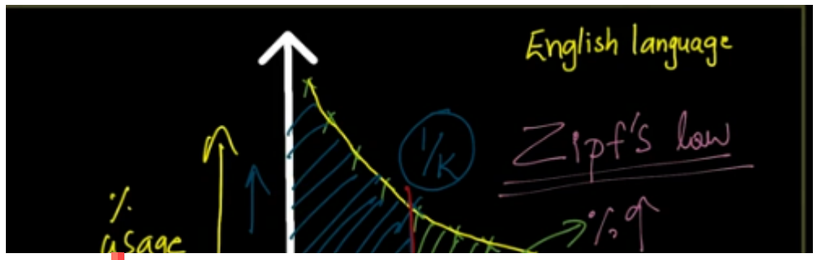
> See the proportion..***Which books % of sales is more?***, its clearly the *Less-popular ones*. Hence, to have the sales, they even need to have the less-popular ones too.

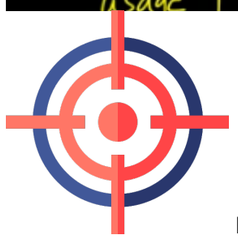
Another view...

Do you think...**A best-seller book now, will ever be the best one..???** -- slight thougt says..

> **No**. It means, book in 20%, will some day lands in 80% *(it can also be like 30-70, 50-50,..)*---- as nothing worldly stays ever constant right..

The same case with the **English Language**...





Focus the **.....LLLLLL OOOOO NNN GG TAIL**

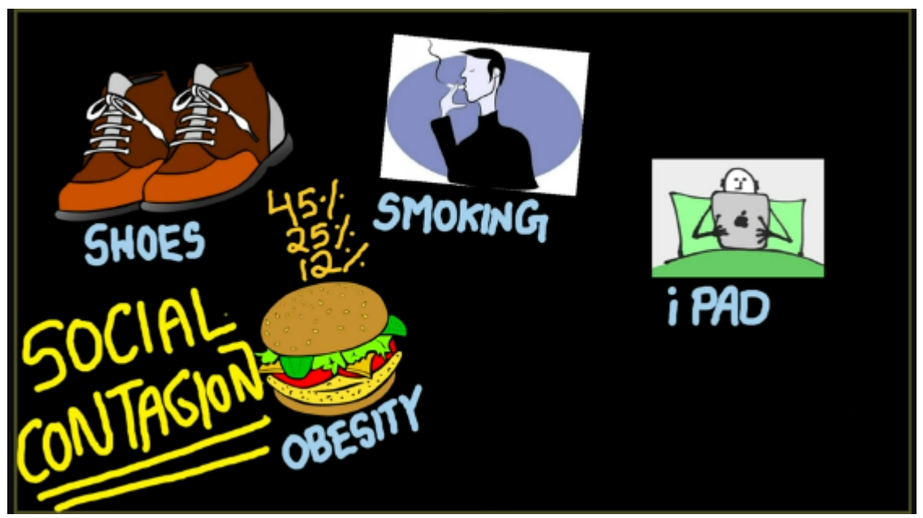
LONG-tail concept: Popular products are less in number, less products are more in number.

Module-3: **Epidemics - An Introduction**

Recollect....

Cascading behavior in networks -- where we seen, How **Ideas, actions, behaviors spread on a network**, with some examples like..

- Shoes advertisement
- Smoking friends
- Obesity contagiousnes.
- iPad...



*----------All these are **Social contagions****

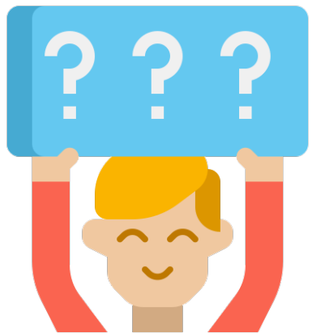
That's what we done in the Week-7

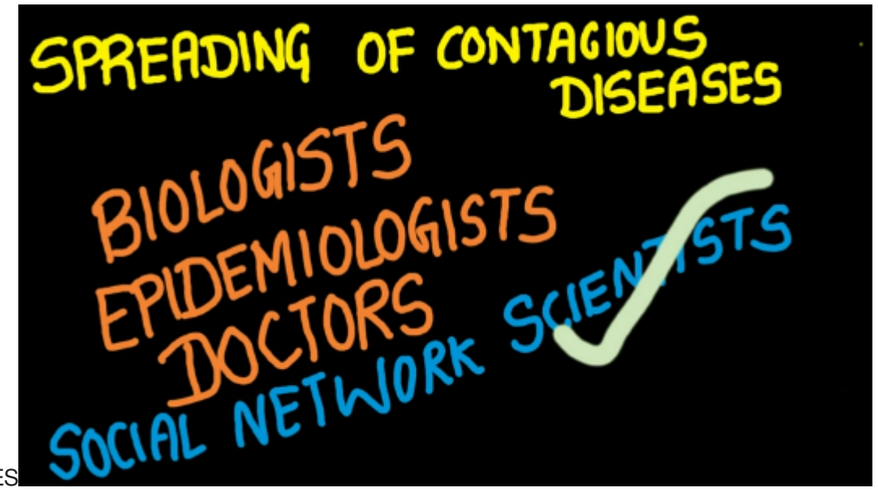
Now.... gonna look only at the **Contagion** in social contagion -- i.e., about the contagious diseases.

Why need to study about them..??????????????????????? 

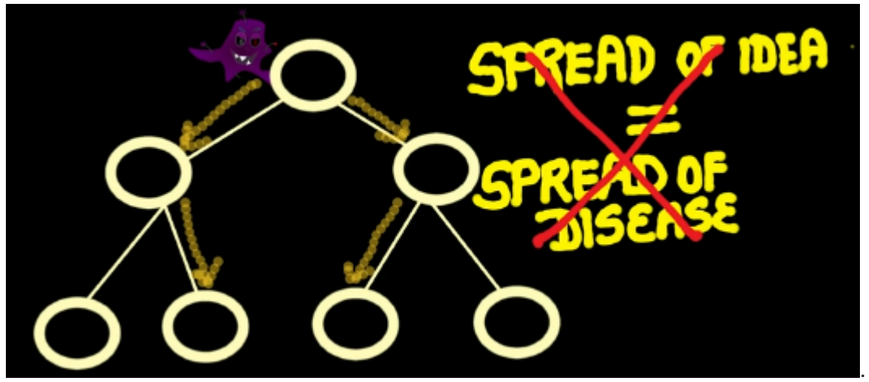
> Helps in fighting epidemics. (like the recent **CoViD-19 pandemic**)

So, we are going to study about the **Spreading of contagious diseases**....

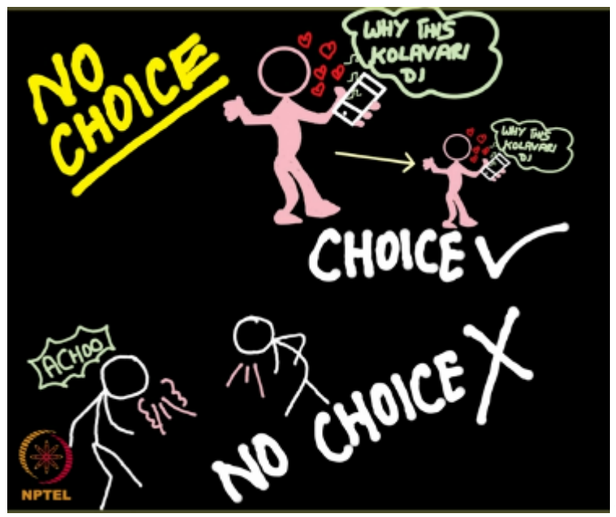


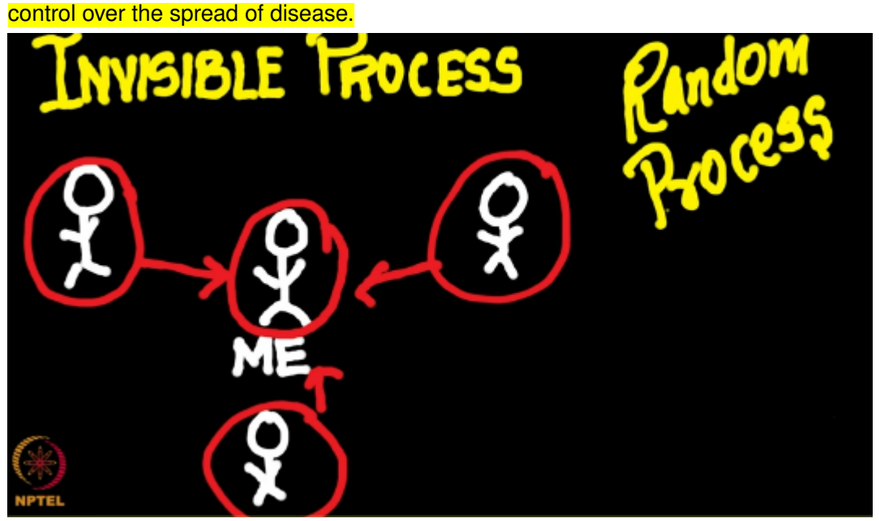
.. Are we...?? YES 

Why..?? because its happens in the (loosely-speaking..) tree-fashion....



. But is it as like the spread- of idea .. NO.. **WHY.....??**

1. 

-- If its a bad song recommendation, you can ignore. For virus, you can't if it harms(say, you could have identified it) ----------i.e., No proper control over the spread of disease.
2. 

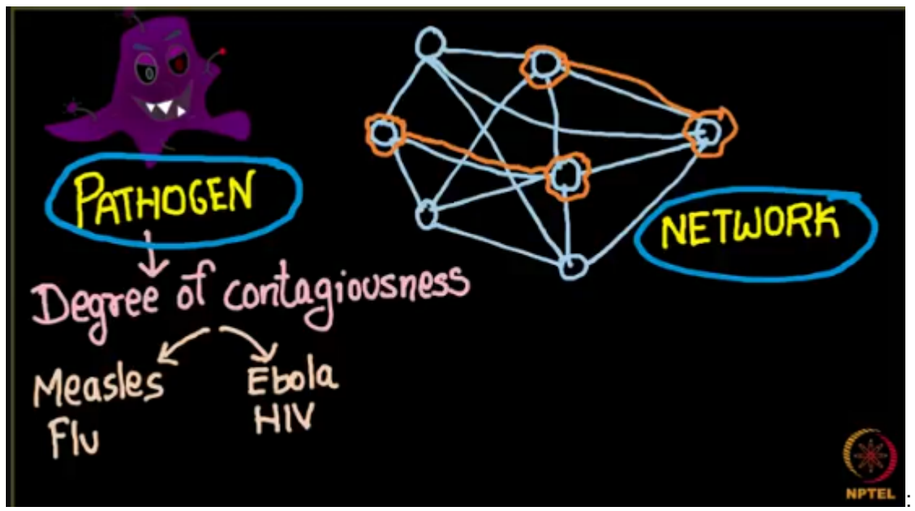
-- in case of idea. can know, from whom it came, but for this **How** can one tell.??

Module-4: **Introduction to epidemics (contd..)**

Assume the scenario.. You were in the class, some one had the flu. He sneezed or coughed, and it starts spreading.., **how will you model this..??**

Some ideas...

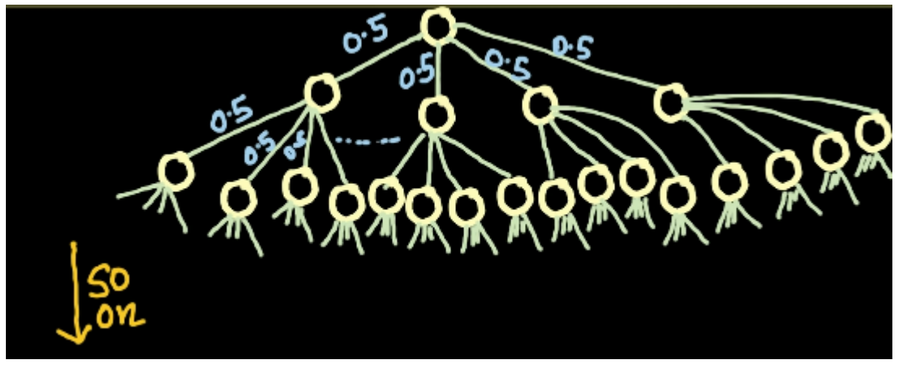
1. Know what is spreading..?? i.e., the type of Pathogens. -- to be specific--> **Degree of contagiousness**: How quickly or slowly it spreads..
2. Network structure
    - **If network is sparse**: Takes time to spread.
    - **If denser**: Quicker.



: Contact network:- Red for HIV (which spreads slowly) -- so sparse, Blue for flu (which spreads faster) -- denser

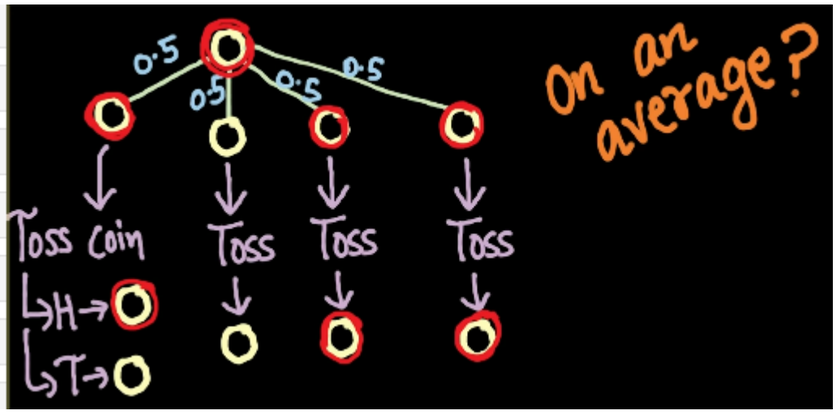
Module-5: **Simple Branching Process for Modeling Epidemics**

Now, we are ready to jump-in to the modelling -- *(for the starting steps -- a simple one)*



- Consider a person (root-node), and he as 4 friends -- and they in-turn have the 4 friends --- ofcourse, in a real-network there will be even triads (for simple model, let's go for this.).
- (Say), now the root-person is affected, and (say) the chances of spreading to his friends(descendant nodes) is of probability 0.5.

Taking the top-part..... **What does it mean by spreading from one person to another with 0.5 probablity...??**

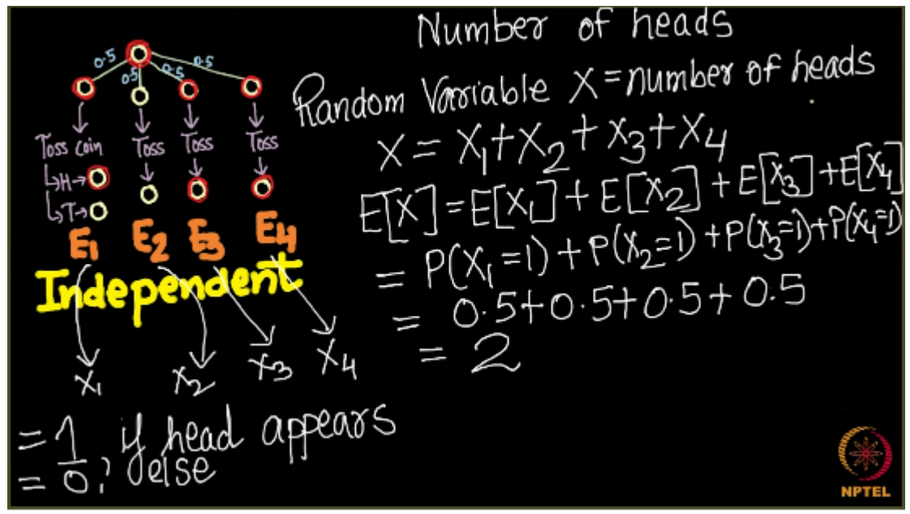


Consider a toss of fair coin. If H: Infected *(Red-circle)*, T: *(White-circle)*.

But what's on an average..?? i.e., the **""expected value""**.

Mathematically.....

- Consider all of them are independent events.
- They are mapped to a random variable *(to be precise, its **Indicator random-variable** - the variable which holds either 0 or 1)*. Here $\\H->1, \\ T->0$



-- !!!! Don't link the numbers on network and the written-solution.

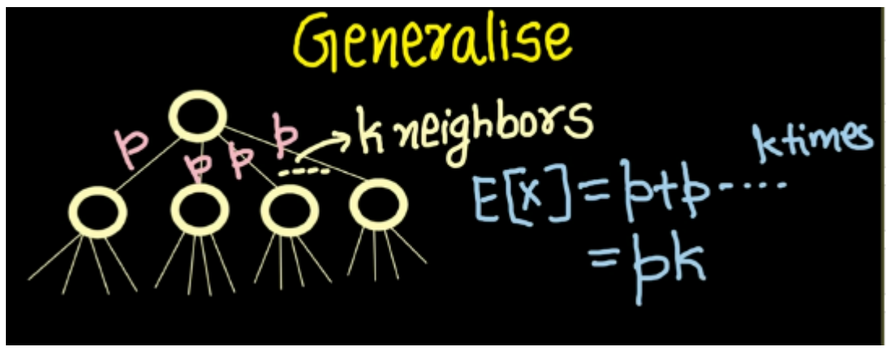
- **Intuitive-way**: If a coin is tossed 4 times, what is the probability of getting heads..?? 50% chance, so $50\% \text{of } 4 = 2$

Now,.... lets do some variation.. this time with the probability of 0.25. But, how do we do this..

> via a Biased coin -- which gives H, with 0.25 probability of getting Head, and 0.75 of getting Tail. *A fair coin is the one which has equal chance of getting both the sides.*

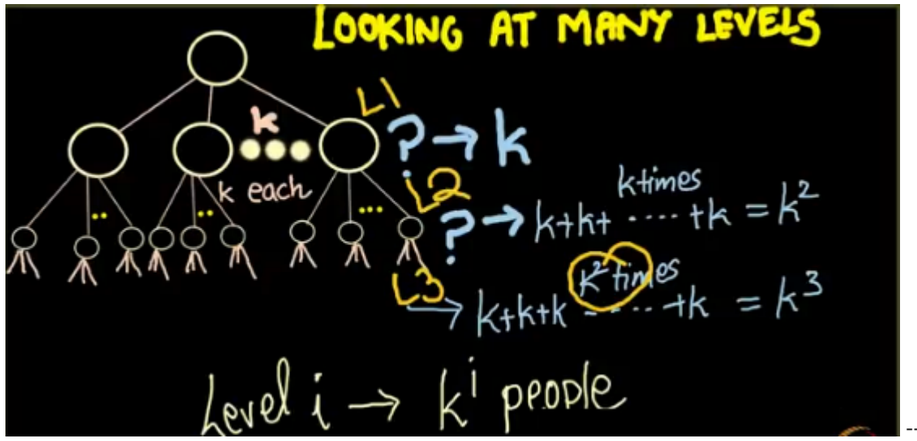
Doing so, in the above manner.. yields..

Generalized version



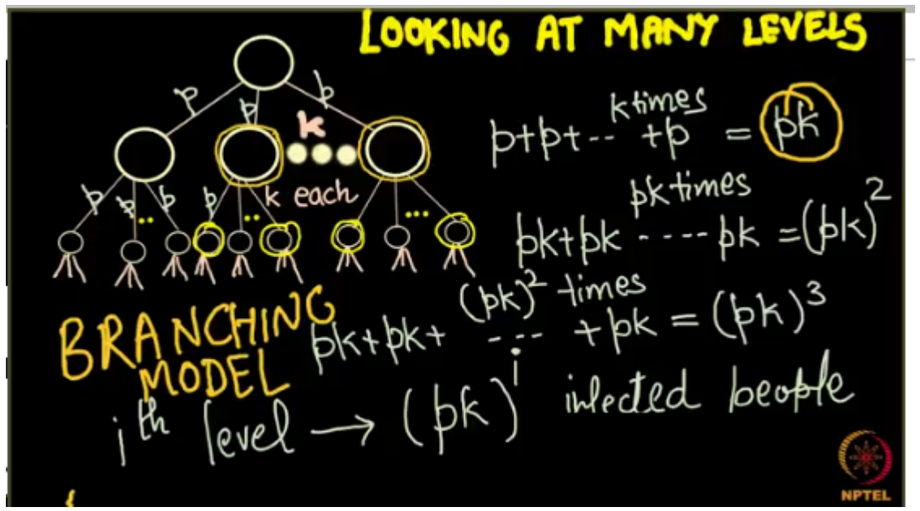
Module-6: **Simple Branching Process for Modeling Epidemics (contd..)**

Now look at hihger levels

i.e., Earlier looked that, via one person, how it spreads to its child nodes. Now, will be looking at further levels.. 

-- Tells, as how level increases, the no. of people increases.

Now, lets look at the spread via probability p.

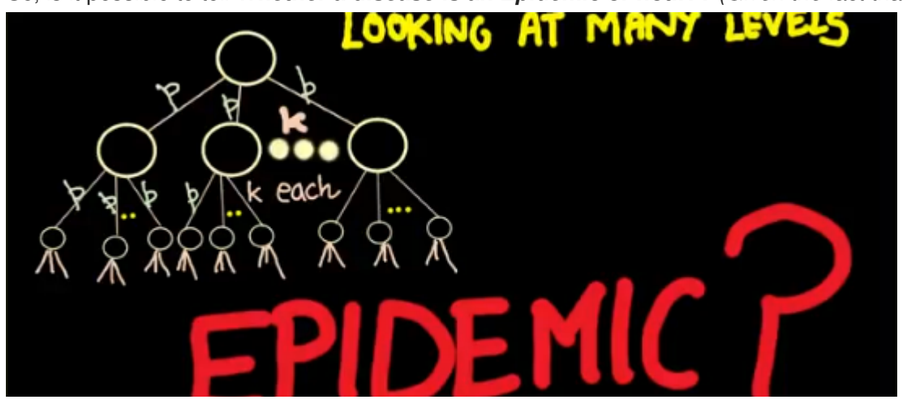


---------Its called as Branching Model

Now, recollect, why are we doing this..??

> To know the measure of spread of a disease .....right..??

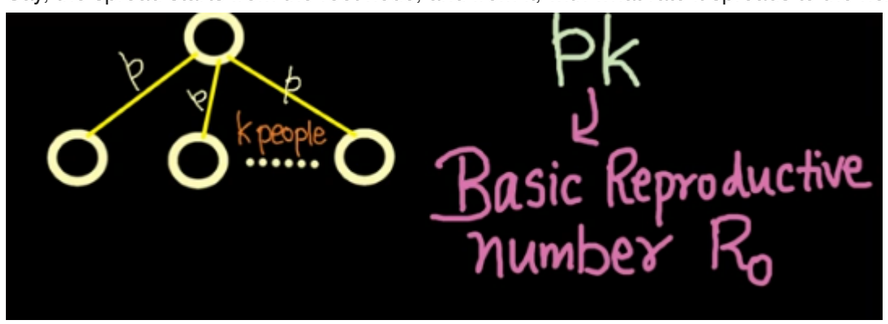
So, is it possible to tell **Whether a disease is an *Epidemic* or not..??** *(Given the fact that,, p and k are given.)*



Module-7: **Basic Reproductive Number**

Previously we've seen what $p \cdot k$ tells... It tells, the spread in k^th level.

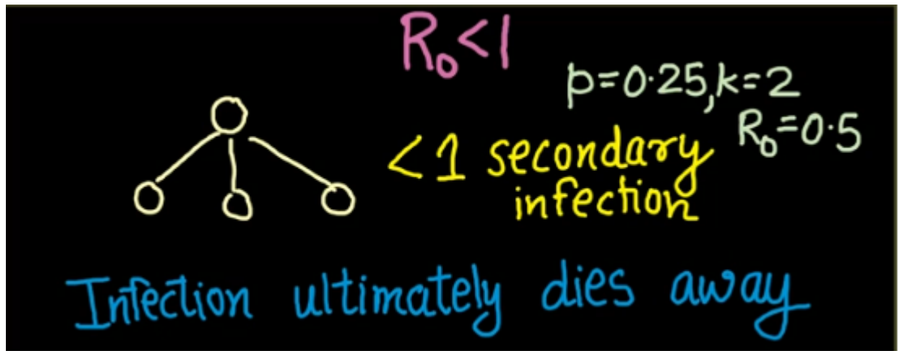
Say, the spread starts from the root node, and from it, with what rate it spreads to the next level... -- so on to the k^th level.



-- Its called the Reproductive Number R_0

Let's unravel the facts revealed by this number... ----- ***Tells about the chances of becoming Epidemic or not***

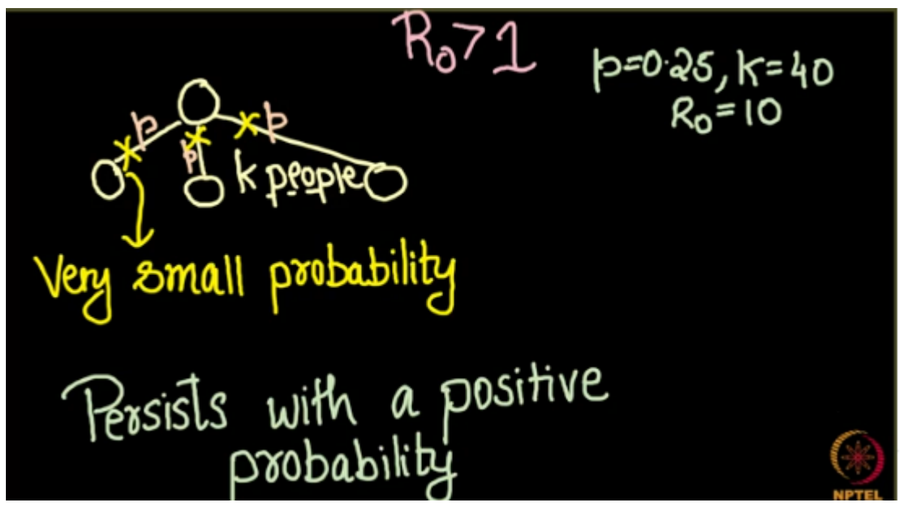
Case: **$R_0 < 1$**:



----------this contagion is not going to become an epidemic. Why? as it couldn't survive for the longer levels, its strength weakened in the initial levels itself.

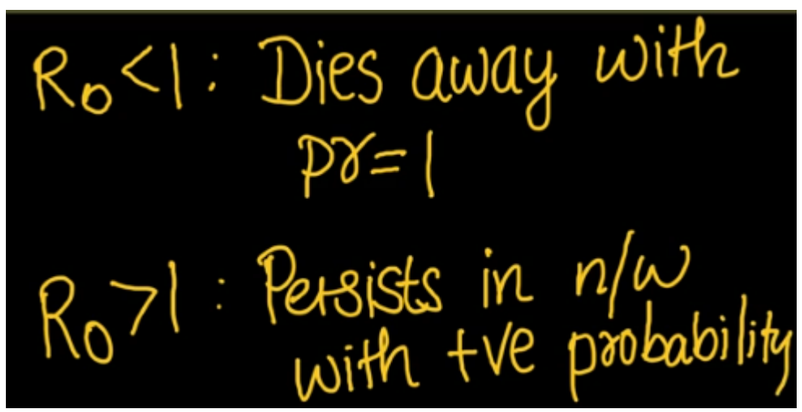
----------*Here it (won't even) survive, and for sure($P=1$) -- it dies.*

Case: **$R_0 > 1$**:



Here it survives with high probability---ie., **BECOMES the EPIDEMIC**, but still there are **(VERY.. VERY)chances** of becoming weak and ultimately to death.

--------*Notice.... that its not of sure($P=1$) becoming Epidemic (its a bit less -- which gives scope of death to the contagions) -- it dies.*



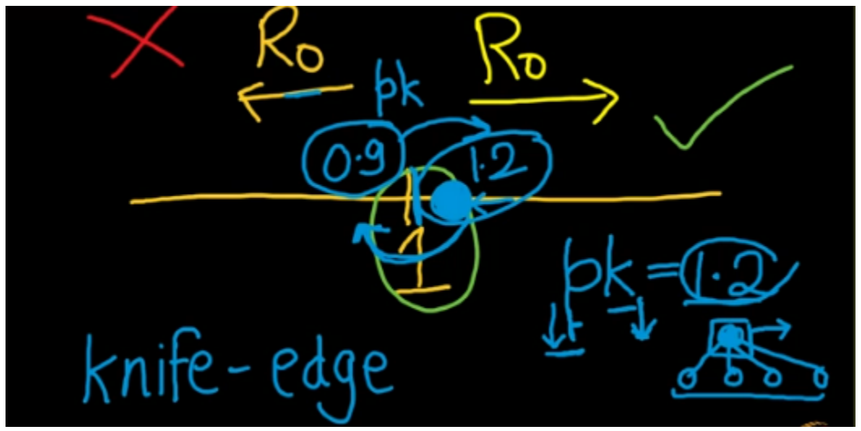
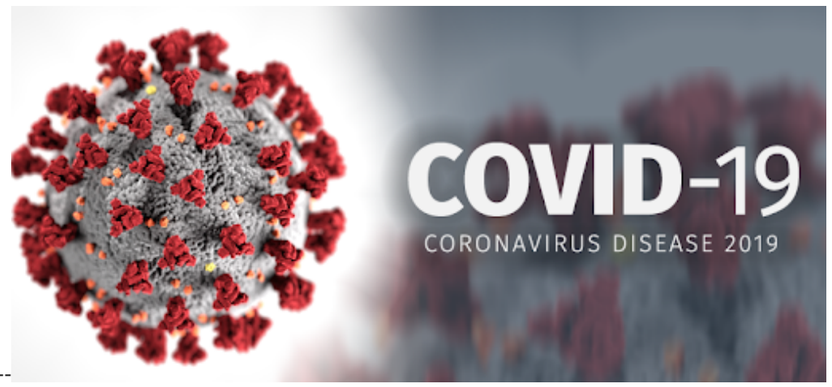
If <1 .. it dies

>1, it spreads virally.

What's the 1 doing by sitting there..?

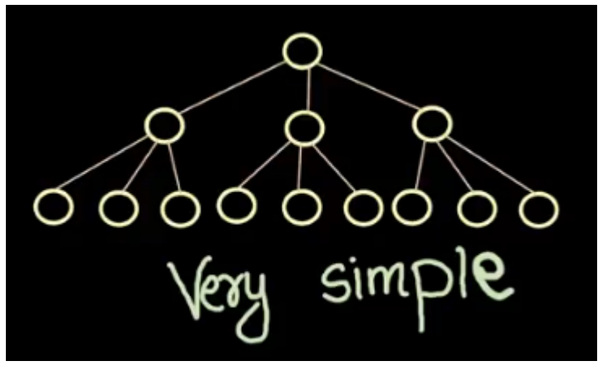
> Its very important.
>
> - Its like the edge of a sharp-knife. i.e. _value of R_0 slightly >1, chances of becoming viral... and slightly <1 -- what..?? chances of decreasing right..??. Yes that's it_. ----------
> - Even happen from other side too... i.e., when the value is slightly <1, and when it becomes >1, chances of it growing goes on.

How it helps us..??

> We can try getting the value <1, by either controlling p or k.... because, they both are in product. Hence, by reducing any one of it, the ultimate value reduces.
>
> - p (The degree of contagious) -- informing people to, have a good healthy diet, doing proper exercise.....
> - k (the no. of people in spreading) ---- Placing the Lockdowns to the localities, and quanrantining, isolating the people who were attacked with the contagious disease.
>
> 
>
> -- its called the Knife-edge property
>
> -------- 
>
> is the good and experienced example to link

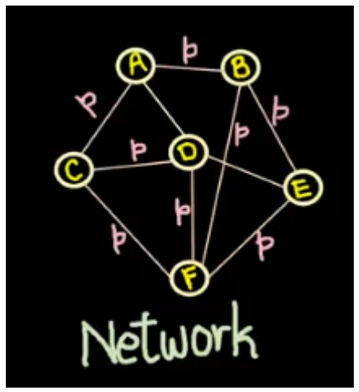
Module-8: **Modeling epidemics on complex networks**

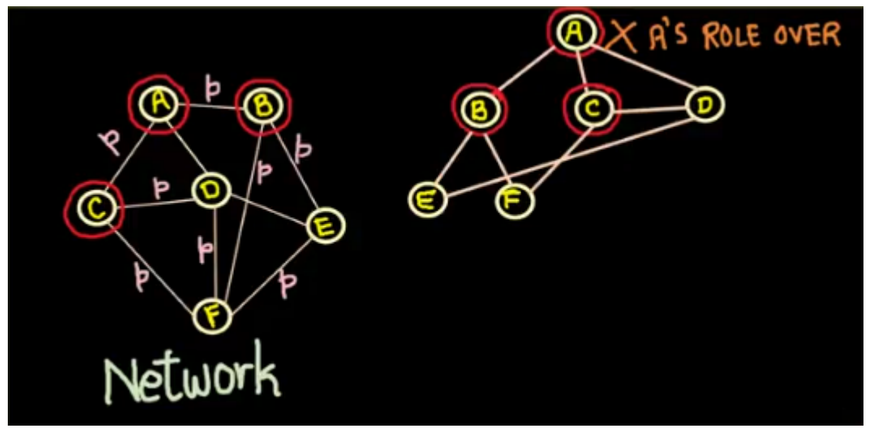
What's going to be in this chapter..?



-- Till now seen about the basic networks, which were not going to work actually in this world as the network is complex here..!!
So, that's what we are going to look in this chapter..!! Modelling epidemics on complex networks.

How are we going to convert to a complex network..?? making it graph from tree.



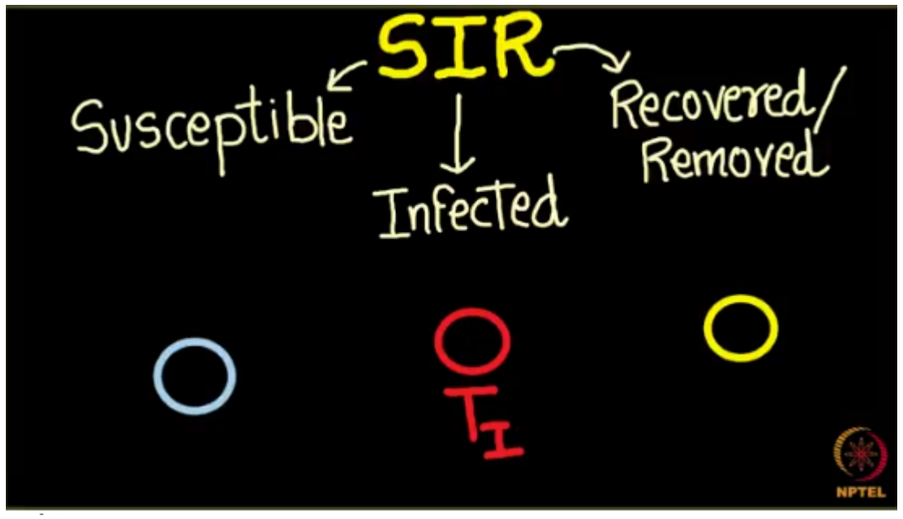
Let's simulate the spreading on this..


- (Say) it started with A, (can spread via its edges -- INDEPENDENTLY with SAME PROBABILITY).
- Once, A has done, its role completed.
    - **How its role completes..??**

Now going to discuss a brand new model, which not just works for the tree networks, but for any networks.

SIR MODEL --as it talks about 3 cycles.

- **Susceptible**: happily living, not infected from disease.
- **Infected**: Got contacted with some person having disease.
- **Recovered**: The one who built-up the immunity against the disease, will get recovered.
- **Removed**: -- The terminal illness. ie., infected person has faced death.



-- what the T_I tells..?? (its noted a bit below... please look down)

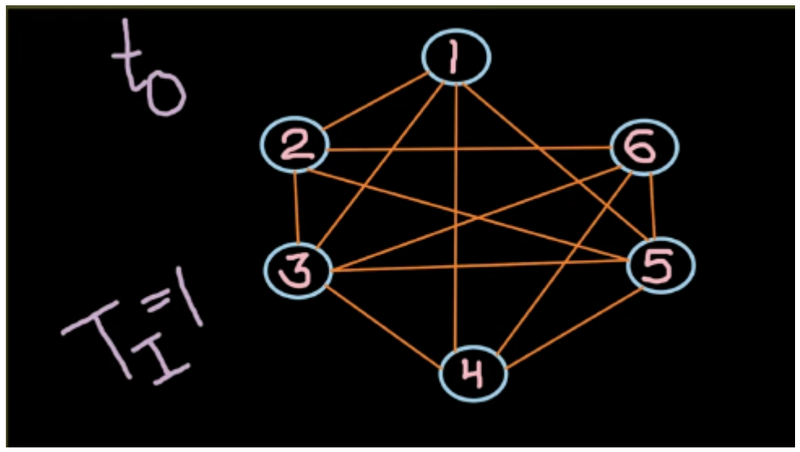
Its used for two types of diseases...

1. For **Terminal diseases**, the one who affected, ultimately lands in hands of death god. --------- removed from the network
2. For **Recoverable Diseases**, those, when a person gets affected, their body develops the life-time immunity. Ex: **Measles.**.

NOTE: One can't be in >= two states at any instant - only in one phase at a time.

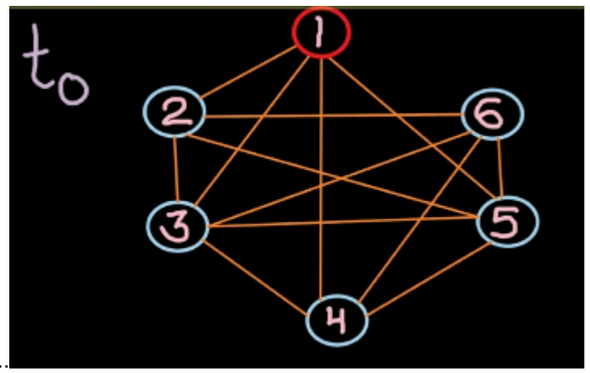
Module-8: **SIR and SIS spreading model**

Spreading of measles in no of iterations and no .of days on a network.
(for our example, probability is taken equally over all the edges)

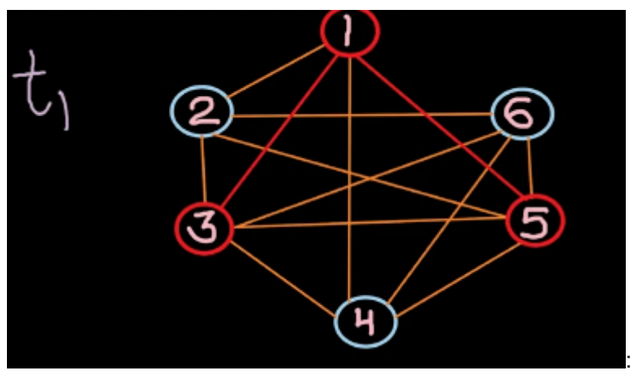


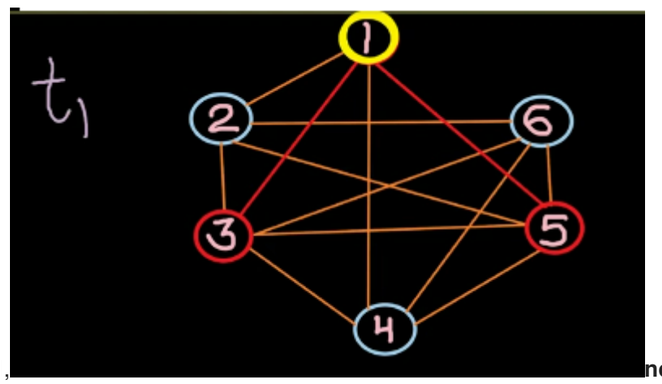
-- For sake of example, consider the duration of disease being int the person is 1day (but measles stays for even longer days than that) -- and note that after the T_I, the immunity will be developed(For measles, its life-time).
Let's see the spread of the disease day-by-day..

NOTE: BLUE-circles: Susceptible, RED-INFECTED, YELLOW-Recovered/Removed.

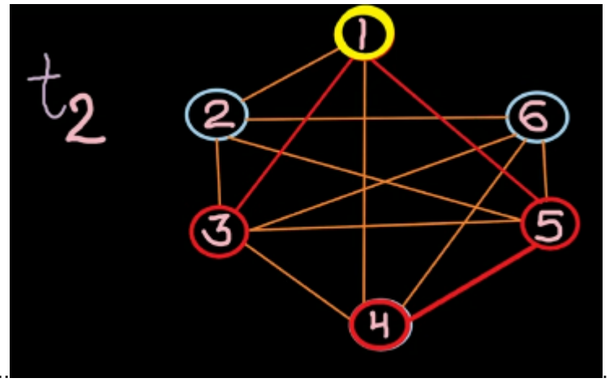
At day_0 (beginning).. 

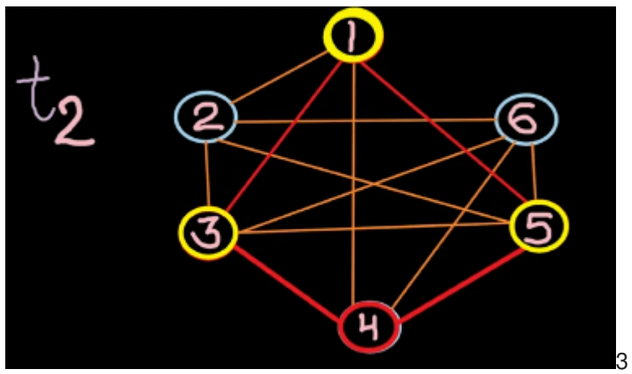
It spreads through some(like earlier, taken as 0.5) probability -- Nodes are selected **RANDOMLY**.

At day-1(beginning): 

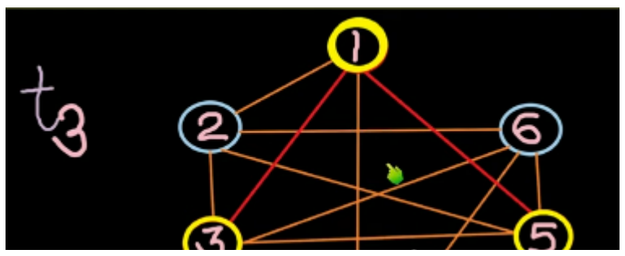
: Hold on..!! By end of day_1, 

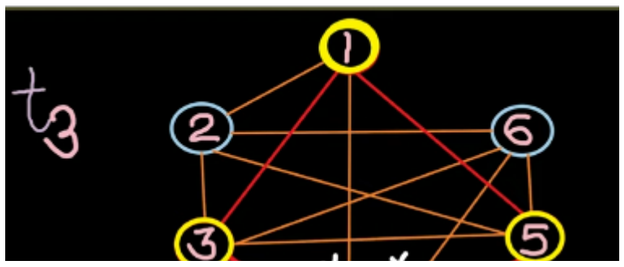
node-1 gets recovered...!!, so circled with yellow.

At day-2: beginning.. 

. By end of day-2, 

3 and 5 does its work (3 couldn't able to affect, but 5 could, to 4). As by end o f day-2, nodes 3 and 5 complete their T_I, so circled with Yellow.





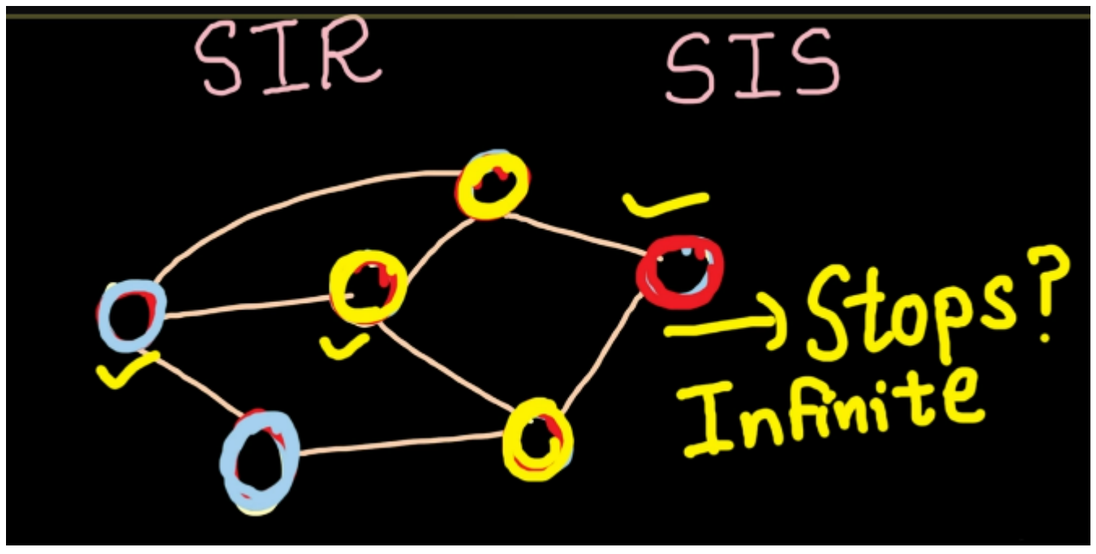
Module-9: **Comparison between SIR and SIS spreading models**

Till now, we've seen two models (SIR and SIS)... right..??
Have you noticed that...

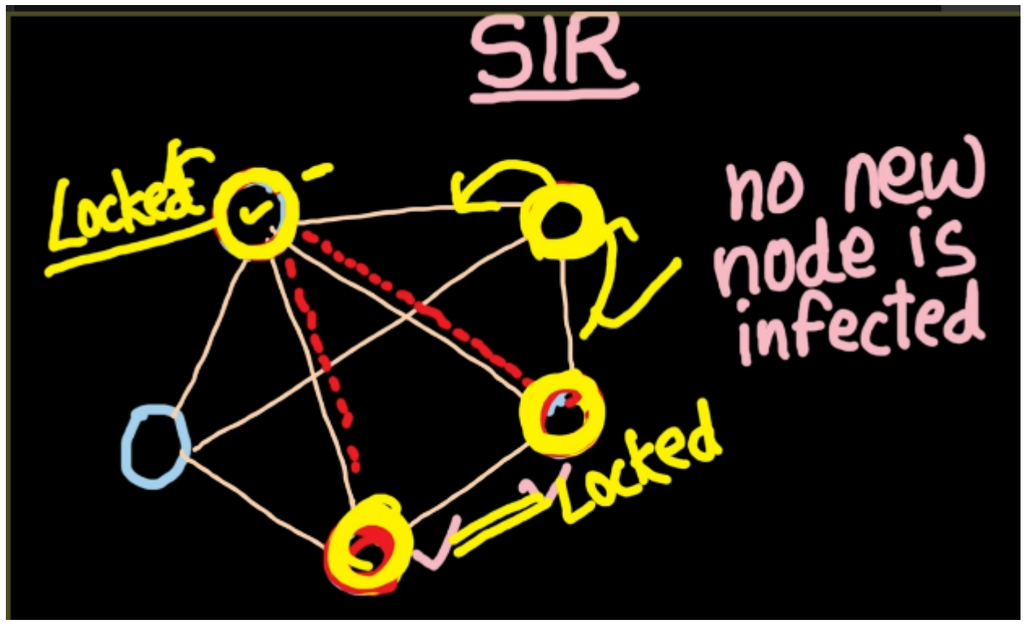
> Initially, the network was with one color (blue -- susceptible), then later one or more gets infected(then changed to red), then after their recovery/removal, turned to yellow.

A question....Will this color changing stops??

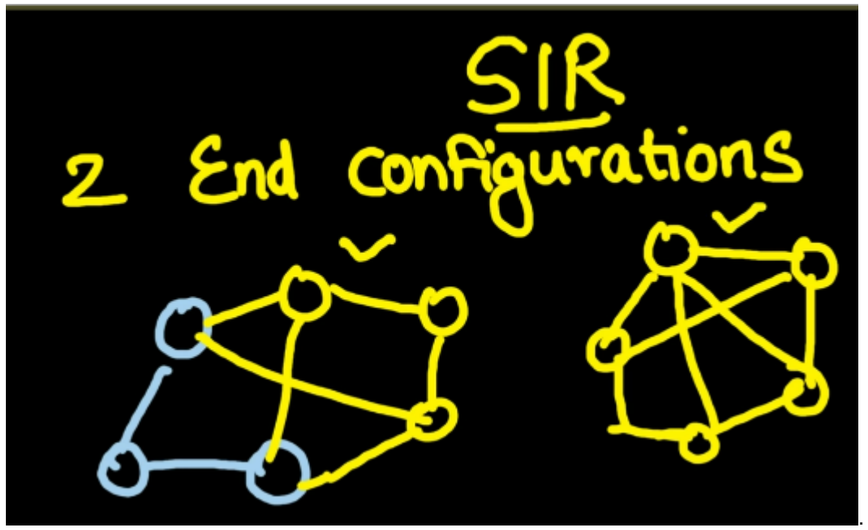
> - For deadly diseases, there is no chance of getting affected again. (like measles) -- changing stops. (may the network gets vanished, after sometime),
> - But , what about diseases that will occur again even after the recovery.. it goes on right..!!



Let's look at individually..!!



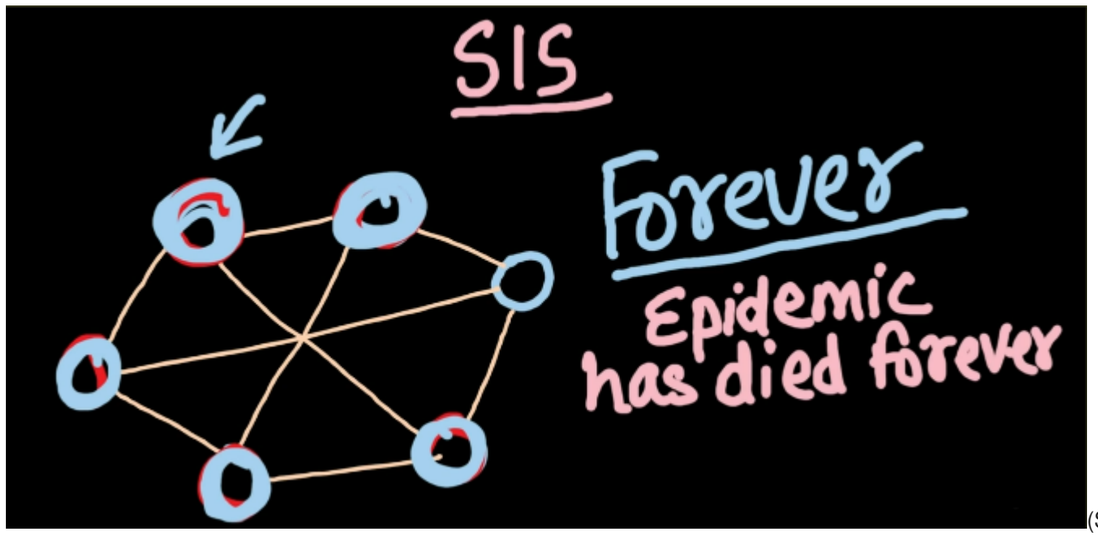
The locked refers to the ""**Recoverable**"" or ""**Removed**"". Meant as.. after they attain the life-time immunity or the node was removed, its not going to be affected. So, the state of it doesn't change -- the LOCKed connotates that.
The end configurations of the SIR model..



. (Starts all the nodes with susceptible and one got infected)

- Some may remain susceptible and some got recovered or removed.....or...
- All would have got recovered. So, this tells that, it won't run for infinite time, it stops some time.

A look at SIS..



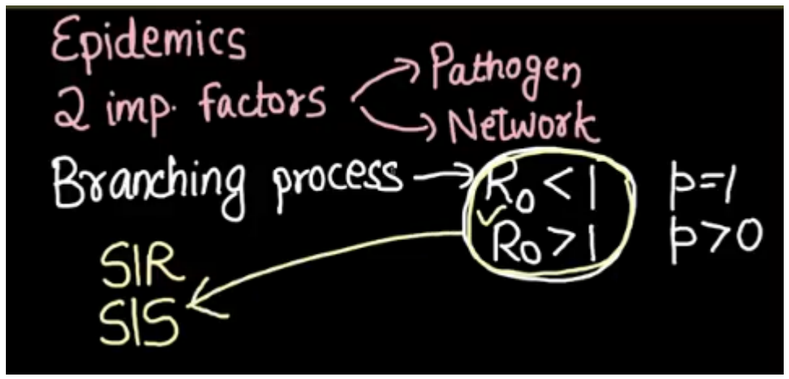
(Starts all the nodes with susceptible and one got infected)

- Chance that, the node which got turned from susceptible to infected, may again come to susceptible, again to infected. ---------- this cycle may go on indefinately.
- But, if all the nodes became susceptible, then it would surely stop.

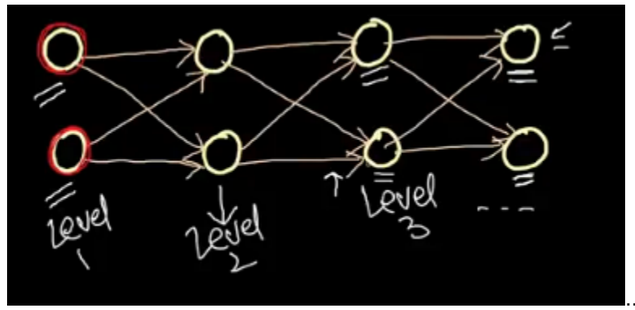
So, in conclusion..

Module-10: **Basic Reproductive Number Revisited for Complex Networks**

A short recap of the content till now, and a question..

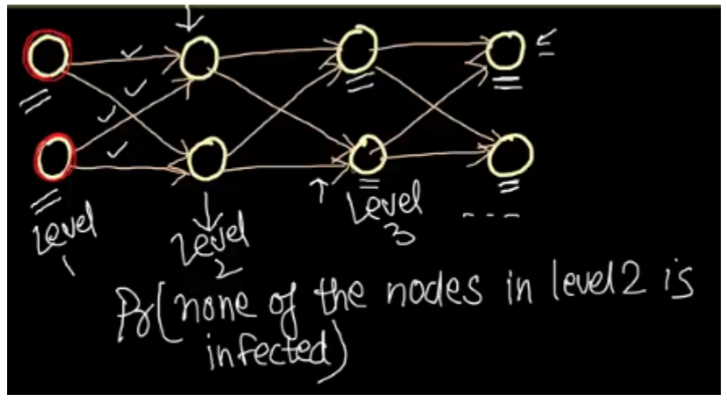


Question: The concept of reproductive number worked fro Branching model,... Now will it work even for the SIS and SIR model..??

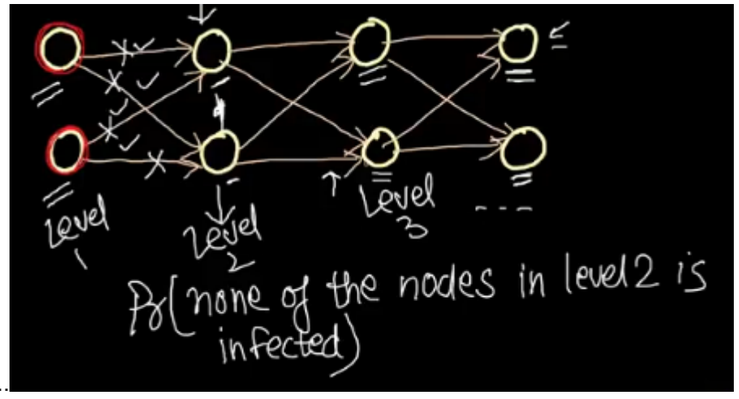
> No
> How..??
> Let's go with an example..
> 
>
> ..
>
> - The first two are infected..
> - Each subsequent nodes are connected by two parents.

Now, interested in looking at...

> None of the people at level-2 are infected.

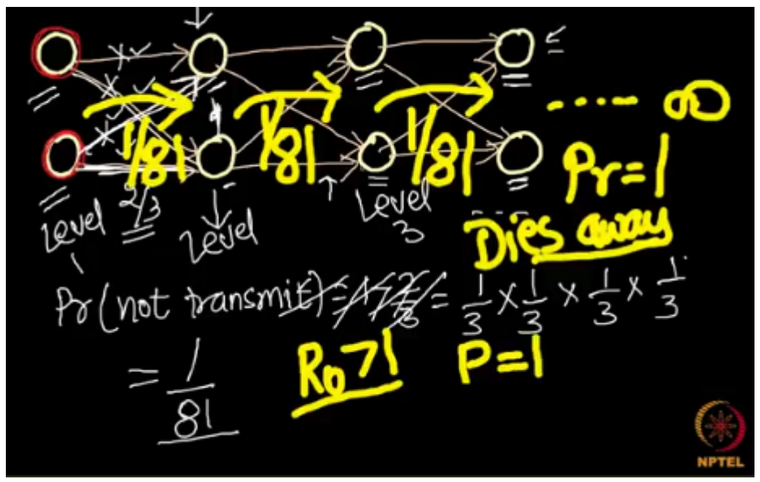


-- If any one of the 4 links work, either of the two get infected.



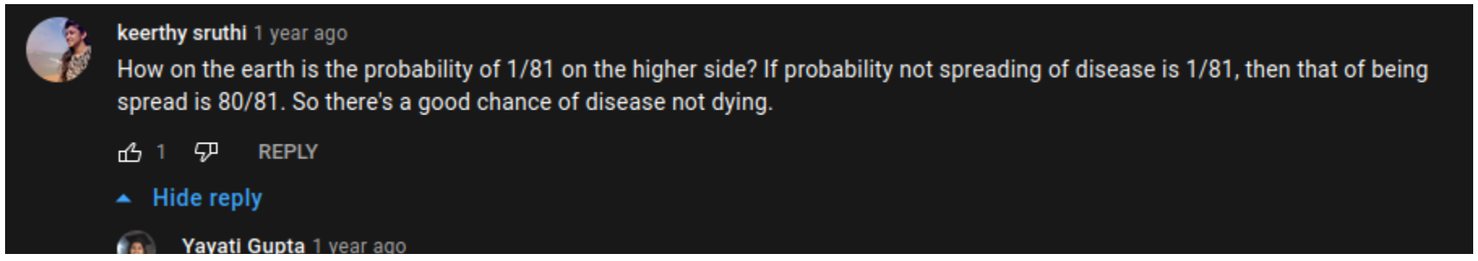
- So, when will none of them are infected...?? Obvious answer would be like... when none worked out..
- Probability of infection spread across an edge $2/3$.
- **Hence**, probability of not transmission is simply $1 - \text{Pr(not transmit,)} 1-2/3 = 1/3$

Now, looking it for further levels (Recollect the Multiplication rule... from Disc Math).... -- as needed, will this survive in the network. So seeing in all successive levels.



-- So the that's happening here counter-intuitively is..

> Even though $R_0 > 1$, the disease ends with with the surity of $P = 1$.
>
> ---
>
> A final comment by **Yayati Gupta** -- *(May be, she is the madam behind the screen)*

> Yayati Gupta
>
> ```
> Probability of the disease dying at layer n
> = 1 - Pr[Disease reaches layer n]
> = 1 - Pr[Disease reaches from layer 1 to layer 2] * Pr[Disease reaches from layer 2 to layer 3] .... * Pr[Disease reaches from layer n-1 to layer n]
> = 1- (80/81)^n
> As n tends to infinity, the second term of the above expression tends to be 0
> Hence, Pr[Disease dies away at level n when n tends to infinity] = 1
> ```
>
> ---
>
> If a question like..
>
> 
>

Module-11: **Percolation model**

---------*Its not a new model, instead its a **new angle to view the existing models***

(At end.... look that, explained vie pipes-flow... meaning that, Water is percolating in the network over pipes of edges)

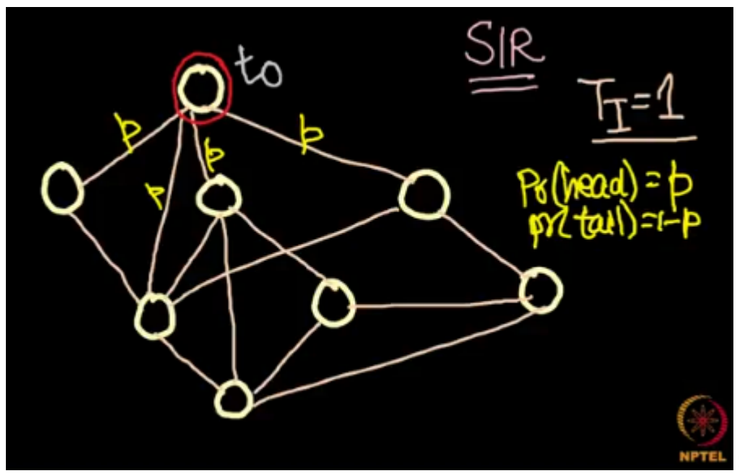
Meaning of percolation

In physics, chemistry and materials science, percolation refers to the movement and filtering of fluids through porous materials. It is described by Darcy's law.

---- as per Wikipedia

What's that different angle of looking...??

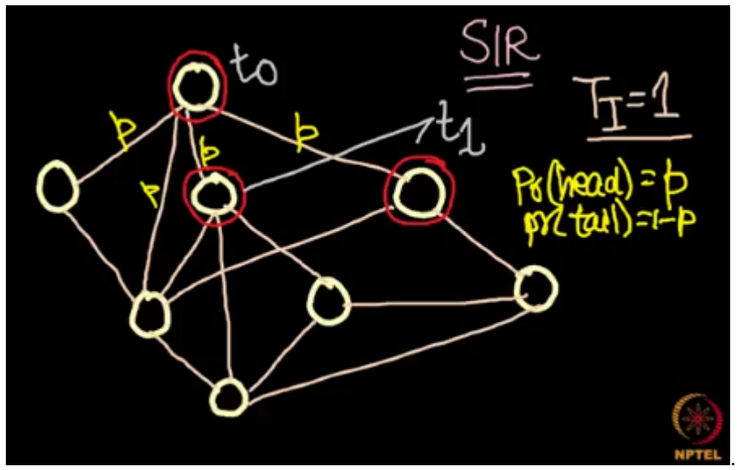
Consider a network on which we simluate the SIR model, with $T_I = 1$ *(i.e., Infection stays for 1 day, after it, they gain the life-time immunity)*



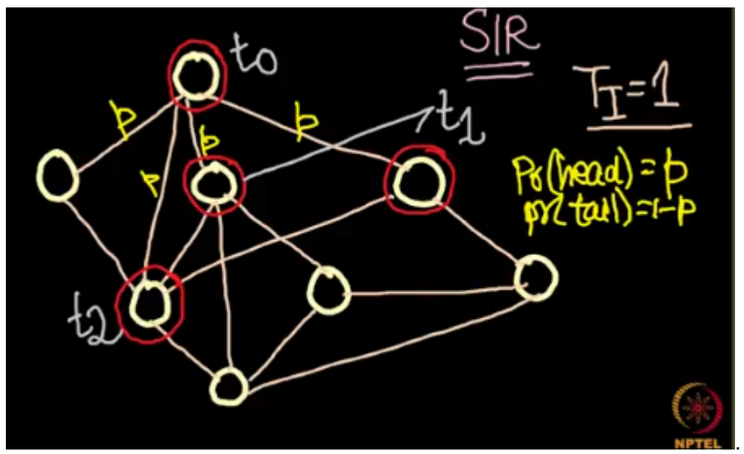
Say, intially (t_0), the top-node is the infected one.

- See that, it is connected with 4 other childs, the probability of infection spread is ... p.
- For choosing the node is either infected or not, using a toss --

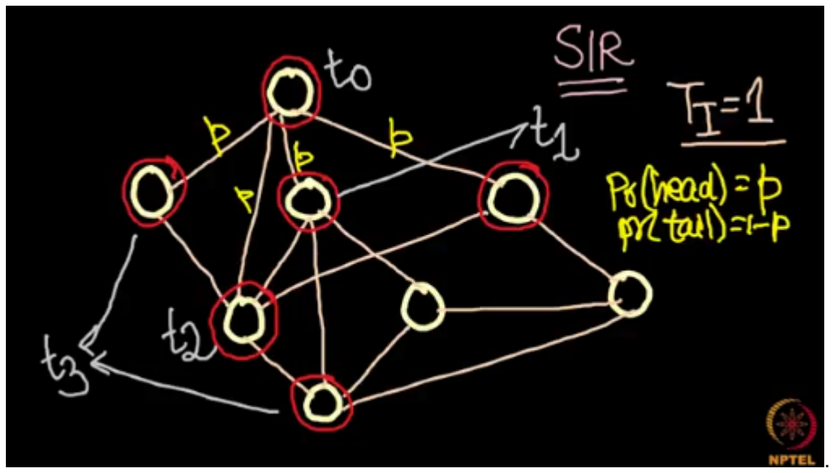
- if H, we consider as infection transmitted and the person becomes red-color *(meant as INFECTED)*
- if T, considred as not transmitted, and they stay susceptible *(as the previous color in which they are)*.

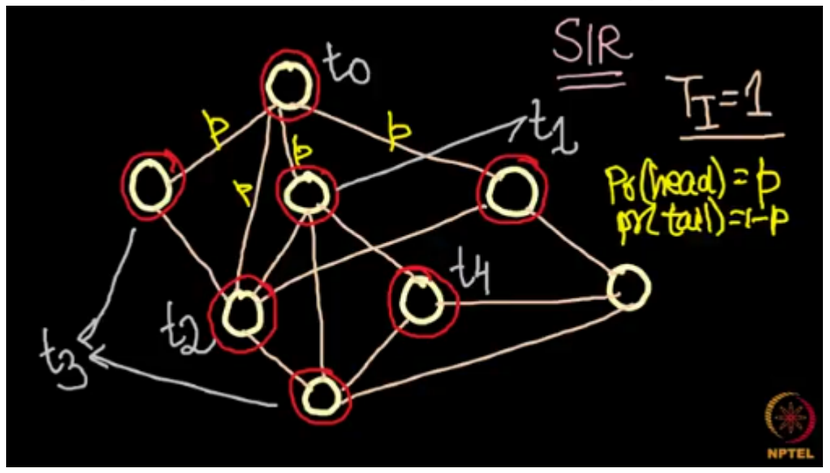


. After transmission, it gets recovered(so, it won't spread further), as its one-day time.



. Now at t_2. via the middle one or right one (but not from the top, as it recovered). Next they get recover.



. -- In next iteration.--> 

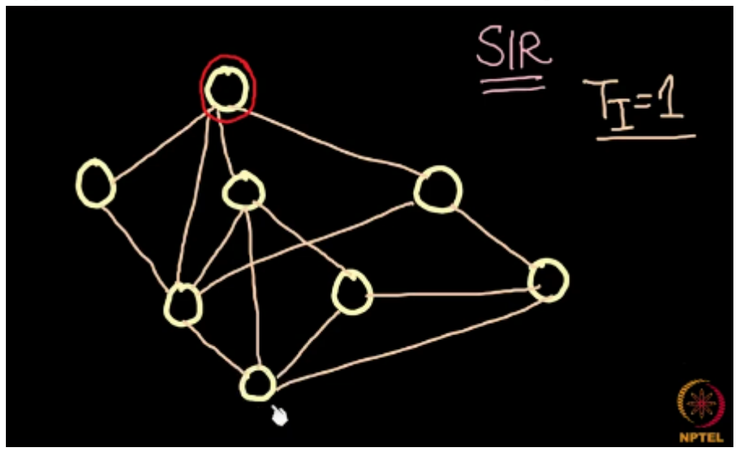
Now focus..!! on how we did this....

> Via time-stamps. i.e., At t_0, this node was infected, and at t_0, these nodes ... so on....

> - It's like the dynamic process (i.e.,, Which one will get infected next, is purely time-based ***[like in programming terms, decision at run-time]***)

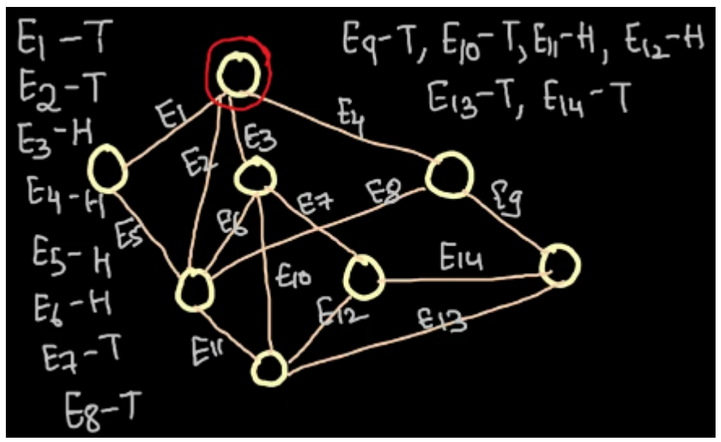
Now, percolation model asks this question.... **Could you remove the notion of time and make it static...???**

Say, in the initial network, we are interested in knowing, whether the person at bottom *(where arrow is shown in image)*, **Will get infected or not..??**.



> For that, we ran the simulation of the SIR model, and came to know that in t_2, it got infected in terms of time..

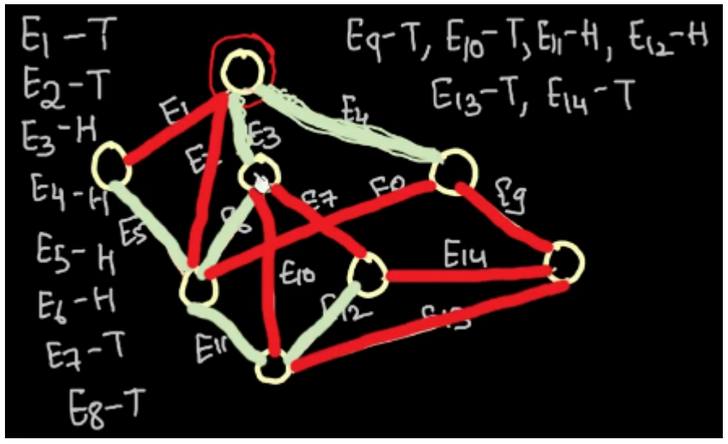
A noble way is... can we make it static..



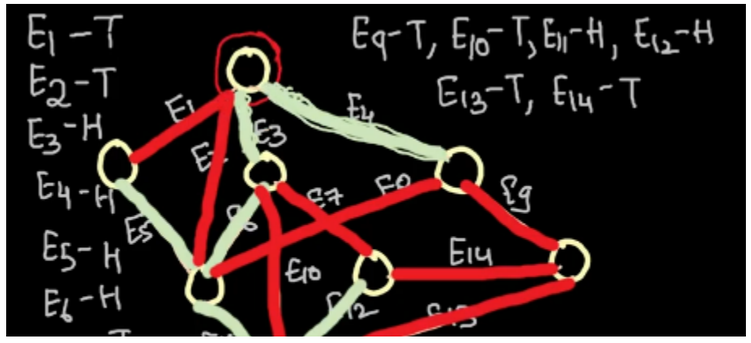
-- For each edge, coin is tossed, and written at its right ---- **!!!! At beginning itself**, whereas for SIR, **we've done it on the go *(i.e., time-based)* at each node**

Now...

Now.. Imagine the edges as the pipe flows..



H for connection-open (as green color). and T for connection-close (red-colored).



Hosting (free)

- Netlify (for frontend)
- Heroku (for backend APIs)-- completely free

Royalty Free images & Video

- Unsplash.com
- Pexels.com
- coverr.co
- undraw.co/illustrations --- Free and open ---- no attributions required..

Icons and Fonts

- google fonts
- font awesome
- flaticon
- icons8.com/animated-icons

Learning

- freecodecamp
- theodinproject.com -- full stack curriculum, supported by open-src commuity
- mem.dev --- for practising what we learnt

Mockup tools -- how the application is going to look and feel

- figma.com
- zeplin.io - better way to share, organize and collaborate on designs

Freelancing

- upwork.com -- for the projects, worked till months
- freelancer.com -- same
- fiverr.com -- short, small one-time projects

Design ideas

- awwwards.com/websites -- contains ratings of different websites
- dribble.com

Exercise, Algorithms, improving logical thinking..

- leetcode.com -- C, Java...
- exercism.io -- More webdesign friendly.
- codewars.com

General tools

- emailjs.com -- ability to send the emails, without any server code. Especially needed for the portfolio things, and not much interested on backend of mailing.
- caniuse.com -- Checks the syntax-- is it usable on all devices..
- imagecompressor.com
- css-tricks.com
- stackoverflow.com
- src: JavascriptMastery

- 100 Daily UI free
- icons8
- UI kits
  - In Vision
  - Uplabs
  - SketchAppSources
  - Free UI designs
- Images and illustrations
  - Opens-source Illustration website UnDraw
  - For background patterns Paaatterns
  - https://www.manypixels.co/
  - [Human illustrations] (https://www.humaaans.com/)
  - A Free Set of Open-Source Illustrations, OpenDoodles
- Backgrounds

- Free Illustrations

Vector-Image-credits: flaticon.com