Week-7: **Cascading behaviour in networks**

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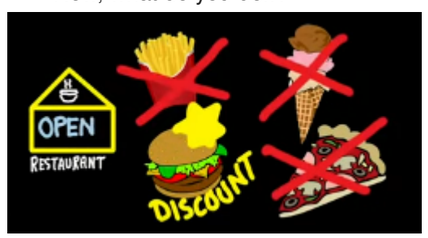
Module-1: **We Follow**

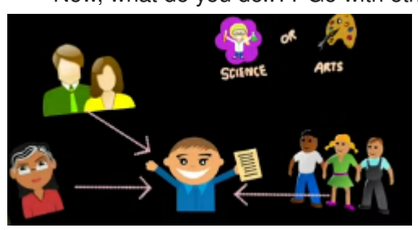
Keypoints:

- Shown some cases of **Follow**ing, with a short clip --- where a group of people in a lift, one or two tries to do an action and all others repeat.
  - Like, some people tilt to the walls of lift, and all the ones in the lift tilt.
  - Some people, remove their hats and place back, and all does the same.

Why did they follow?? --- seems like a silly reason.... Look at some cases...

1. 

Decision at a road-block..
   - Some people going in one side of the road, (**MAY BE** due to some construction work happening over there.. or any reasonn) and even they don't know the reason.
   - Now, what do you do..?
2. 

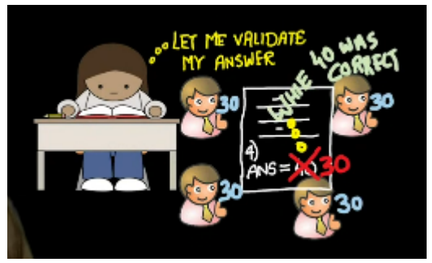
Ordering items in restaurant
   - All the items you've ordered are out of stock or spoiled. The they announced discount on one item.
   - Now, what do you do..?? Go with others like -- choosing it or negotiate with refund..??
3. 

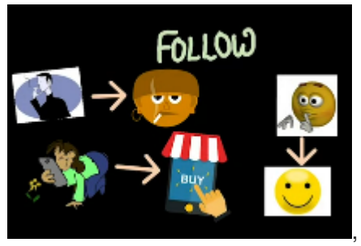
Taking a decision to choose the direction after 10th class.
   - You asked different options from various people you know and you saw your friends where they are going.
   - Now, what do you choose..?? Take your own decision or follow your friends..??

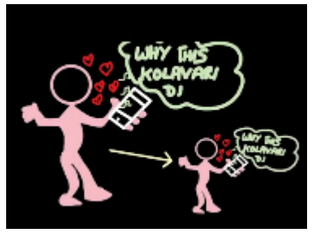
Module-2: **Why do we Follow?**

Ok, we follow someone. But..... .... But,

1. 

Some people falling in a well.
    - Now do you follow that..??
2. 

In an exam hall, invigilator went out. Some of your friends are discussing answer or some validating..
    - for 4th question you got 40, and you are quite sure about it.
    - But, your friends got as 30.
    - what do you do..?? Will you update it or keep it as is...
3. 



,
    - Some people smoking, do you?
    - Some people using iPad, and you liked it, do you buy?
    - some one was very fond of some song, and they told you. Do you listen..??

Why do we follow..?? -- *(let's see with an example..)*

> 
>
> One of your friend approached you and asked to advertise the shoes.
>
> - There are a lot of products in the market. So, should you care about it?
> - What if he approaches with some monetory benefit or a free pair of shoes..

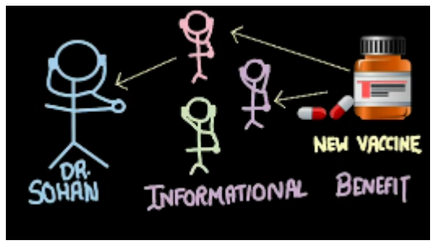
. Now what...??

- May likely..

Agriculture example..

- One of the Sohan's friend... his income from crop got double by using some hybrid seeds. and even other friends did after knowing.
- Now.... do you follow..??
  - May be, as profit getting doubled.

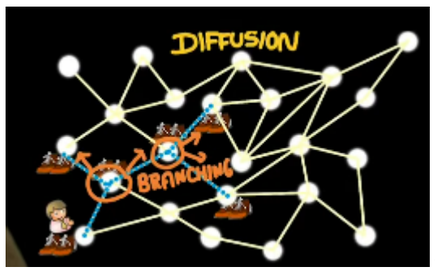
A doctor's situation..



- One of his patient need the vaccine which he didn't know/aware. His friends know it.
- Now will he..??
  - For purpose of saving his patient life, may be

Module-3: **Diffusion in Networks**

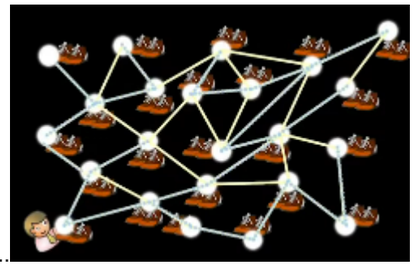
Consider the example of **Shoes advertisement of a friend** example..

You adopted it, and you recommended it and they recommended to others... 

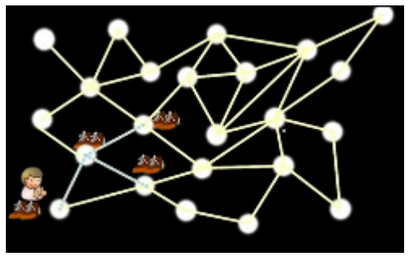
-- See how its getting branched..

----------That's called **Diffusion**. Started with 1, branched to 2, then to 4....

Now, a question **Will all adopt the recommendation/idea..??**



If so, then it diffused over entire network...
or<b/r> If some adopted it, it soon dies ..



It depends on product or information which needs to be diffused.

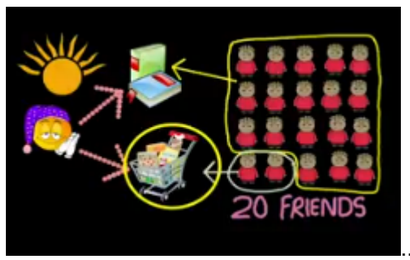
But, **How do we quantify this..??**
coming up..

Module-4: **Modeling Diffusion**

On a sunny day, (say)your options are...

.. What do you choose?? Library, to complete the Wednesday's assignment or shopping to have fun..??

Let it become a puzzle...



.. Now..??

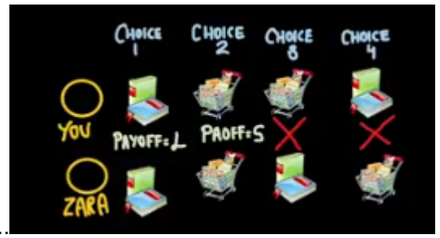
How do you weigh your options..??

> First factor, **How much it interests you*** as **PayOff**.

For you, its like 

> 2nd factor, the count of friends.

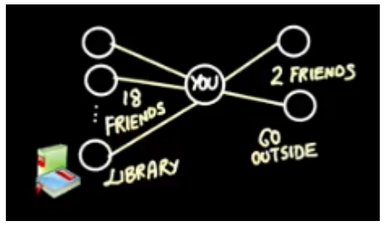
How do we compare this notion of friends..?

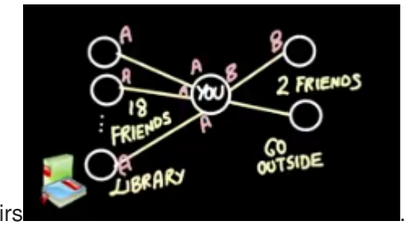
. To keep it simple, consider one friend and work on options.. 

There is no payoff for diff activities, as they don't do it together. They get a payoff, when they do the same thing (for them its some value).

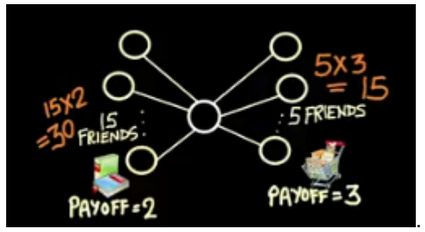
> Hence, for one friend case, you choose the option, which has much payoff.

But, how it applies to many friends (which is our actual case..)..??

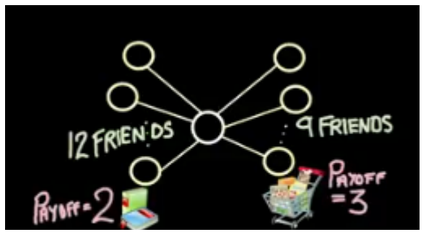


-- How... Consider as pairs 

.

Say payoff is 2 for library and 3 for outside. Now, 

. As **Going to library is more, may choose this**

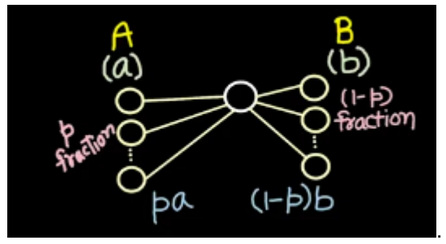


Module-5: **Modeling Diffusion (continued)**

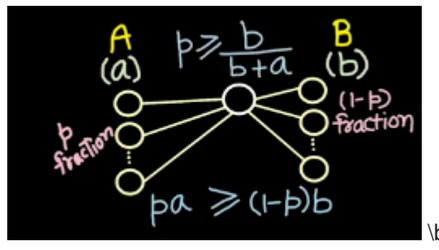
Let's define it a bit rigourously..<br/.

- Consider two events A and B, and the payoffs associated with them are a and b respectively.
- p fraction of friends are interested in event A, so for event B, its $1-p$.

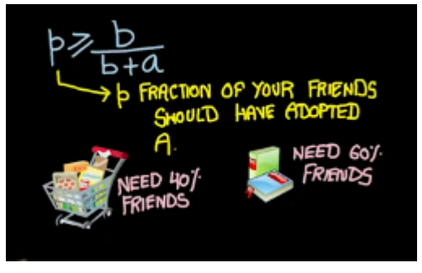
- So, what's the payoff would you get if adopted A... is $p \cdot a$, whereas for B, it would be $(1-p) \cdot b$



. To adopt A, its total-payoff should be more than B right..?? ie., $p \cdot a \ge (1-p) \cdot b$, then

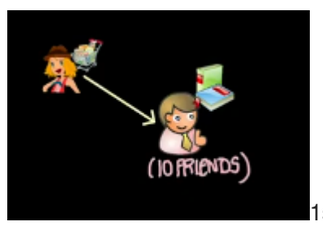


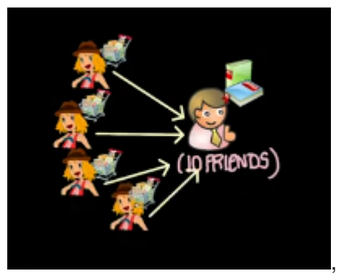
\begin{align*} & pa \ge (1-p)b \\ & pa + pb \ge b \\ & p(a+b) \ge b \\ & p \ge \frac{b}{(a+b)} \\ \end{align*}



So depending on value of p, you choose the option.

What's happening there..?? Consider an example. You had 10 friends, and 4 of them need to go outside to take you outside. And look it sequentially..
You've decided to go to library and do the assignment, and your friends come one by one...

- 

1st friend comes and tells, Iam going outside. You'll be steady.
- 

, and you r 2nd, 3rd,. 4th friends come and tells the same, and you... 

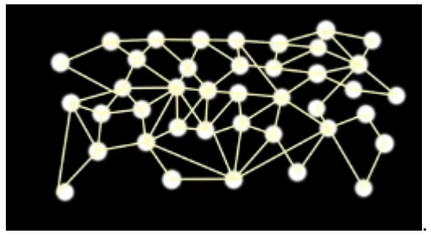
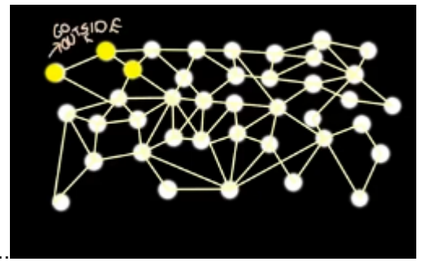
, you got disturbed.

This phenomenon is called **Social Reinforcement** -- when more and more people come and tell, we tend to beleive that information.

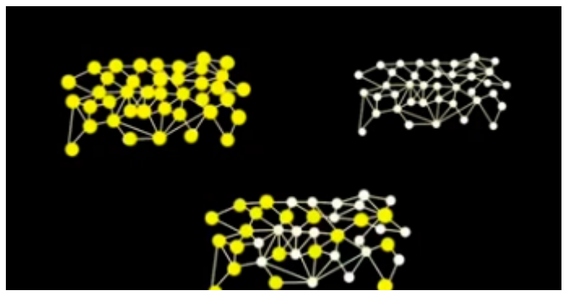
Let's extend to the big network..

- There, not just one who look sides and decide rather, all do the same, looks others and decides, weighing their options and getting impacted by them.

Let's put it clearly,... A class of students and all decided to work on assignment.


. But 2 outrageous people, decided to have fun..


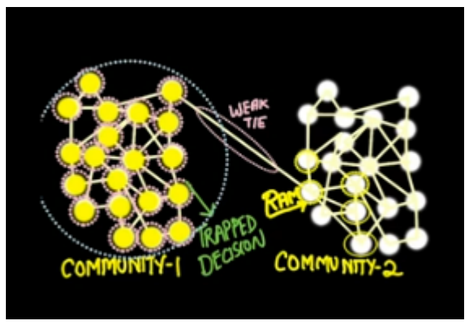
- Now, the decision becomes playful... everybody, looks them and flips around the decision -- either outside or fun.
- So, what happens at the end.. how it stabilizes??
  - Will everybody flips to go out..??
  - All decided to go to library.
  - Two clusters forming.. one of **fun** and other of **library**.



\begin{align*} & pa \ge (1-p)b \\ & pa + pb \ge b \\ & p(a+b) \ge b \\ & p \ge \frac{b}{(a+b)} \\ \end{align*}

Module-6: **Impact of Commmunities on Diffusion)**

Linking the above reslts to the Weak-ties..



Those two are communities.

- Infecting a person in Community-2, is difficult as around him are all of **Going to library**, so they can't easily convince him.

Another example... Release of new OS, and people adopting to it.

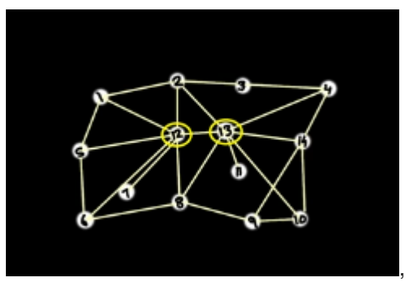
- **There is a problem here....**, its like risky if they don't know how to operate on it after switching.

Another examples...

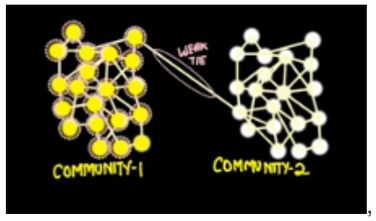
- You've seen a bike in your college, now should you convince your sibling or mother to buy that for you.. Or will you approach house-head. After house-head accepts, it might fulfill very soon. Sibling's and mother's can't make much impact(.... in their case..)

This is what happens to promote a product by some celebrity. Like...

etc.,... this tye of marketing is called **Viral Marketing**.

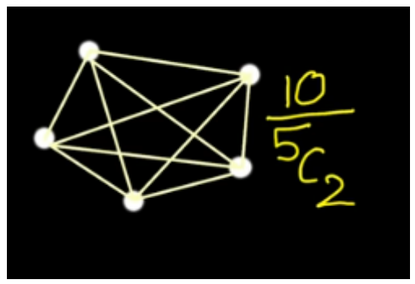


, if could convince them, then all other soon.



, but the communities at here, remain unaffected as there were not much links. If need to convince the other community too, then find some key people.

A question, do you think, the density of community has any effect on this.

> **Density of community** means, how well the community is connected.
>
> - Mathematically, its $\frac {\text{Actual edges}} {\text{Total no. of possible edges}}$
>
> Ex: If had a community with 10 links, then.. 
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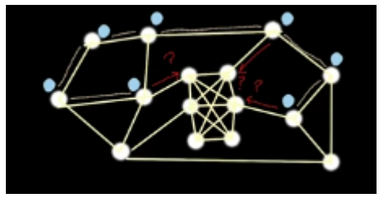
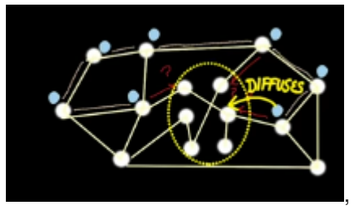
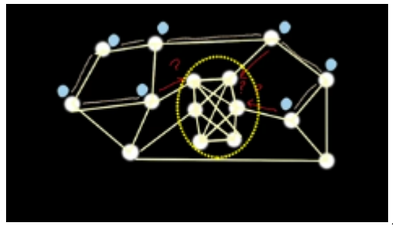
So, Density of the community has a role in spreading of a info..



> A story recap...
>
> - 3 sons of a father always fights themselves -- father, want to teach a lesson -- 3 sticks -- break them -- individual try, all breaks -- try together, they couldn't.



, if they are not strong enough (about trust in relatinship), then some chance of affecting.

If of having a good relationship, they won't  __-|

Apply the same to the two clusters of the class. If they are good trust, others couldn't break it.

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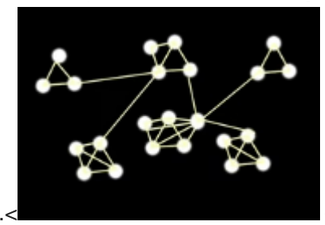
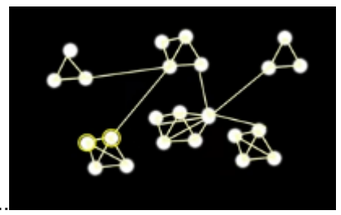
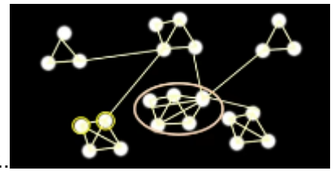
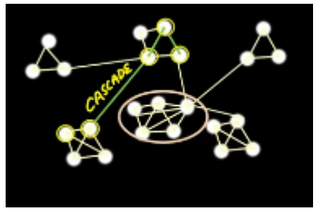
Module-7: **Cascade and Clusters**

The above claim, **Higher the density, difficult it is to infect**, is an intuitive way. Now let's prove it mathematically...

A scenario, to tackle it..Unlike earlier, not just 2 clusters, but more than it. Say like..  -- even this happens in actual classroom right...

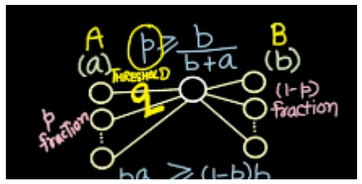
Now, these people would like to have fun...  (look at yellow circles at left-bottom)

Now, **will this idea spread over the class.....?** or a group, despite even all went to fun, they would go to library.. 

So, whenever an idea diffuses, the trajectory of diffusion is called **Cascade** 

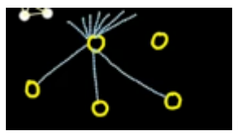
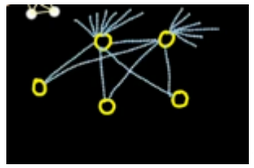
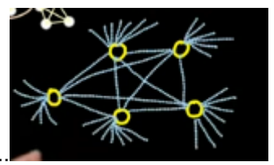
Our question, **Will this be complete spread..??**, for that let's revise some definitions..

Threshold(q): *If the fraction of a person's friend going out **exceeds** this threshold, then even he'll go.*



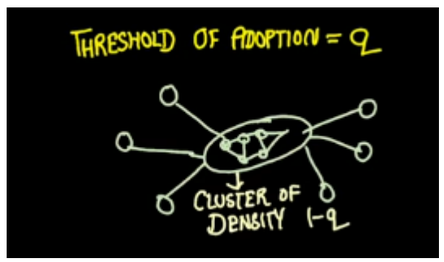
Density of a cluster : *Density of cluster is D, if you look at every node in the cluster and atleast D fraction of that node is in the same cluster.*

Ex: If said 30% for a cluster, then out of 100%, 30% of their connections should be within.. i.e., if said 10 friends, 3 should be within

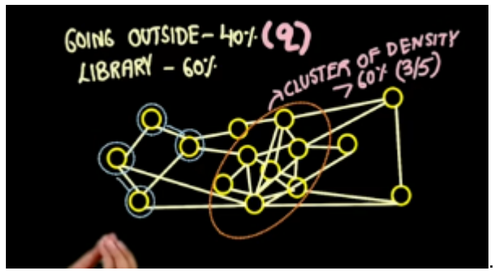
 for one node,  for next node.... for entire... 

Now a claim....in a network, the q (the threshold of adoption) is for every node in network, then cascade cannot complete itself.

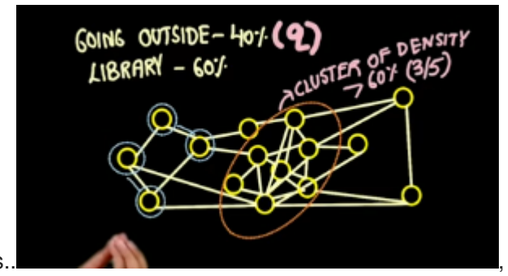
Means, cascading starts from a node, and it can't spread to whole.

Complete cascade fails, if there exists a cluster of density greater than $1-q$ 

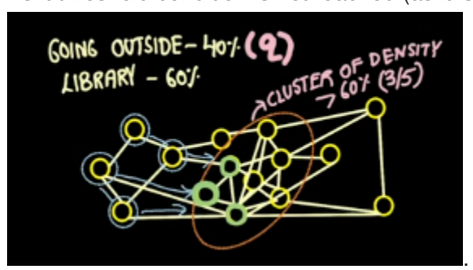
How do we prove it..? consider an example...



. **What does cluster-density >60% means**, >60% of their friends are within the cluster.

Now, the idea diffuses.. 

, what happens now...??

> As it threshold condition is not reached (as it is 60%, and the coming one is of 40%), so he won't convince (stays in library). ...
>
> 
>
>
> . This happens for every node in that cluster.

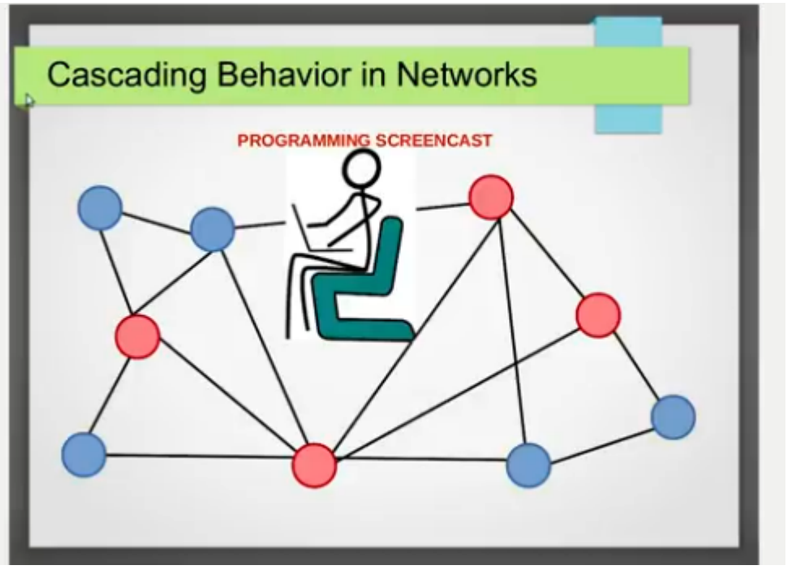
So, this way the whole cascading fails.

A test, **Given a network, and an info of *Cascading didn't complete***, then what does it mean...??

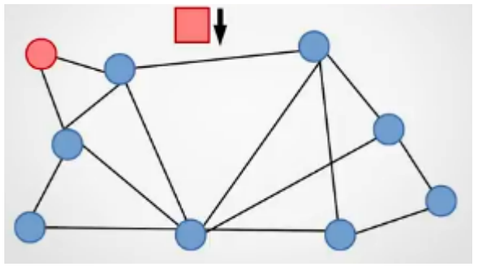
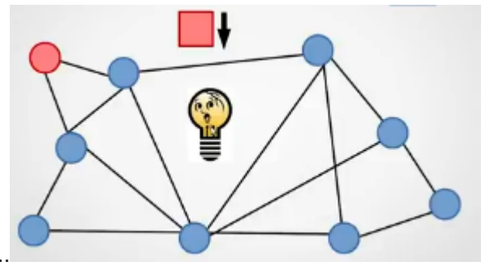
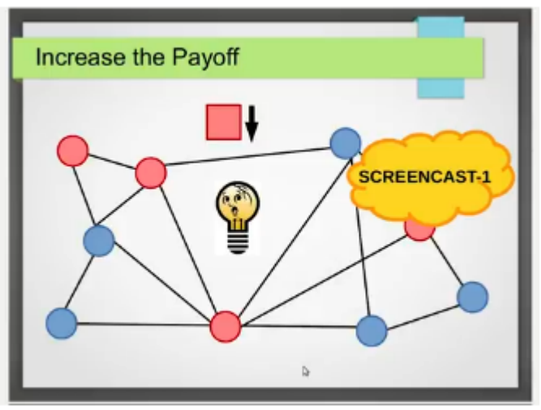
> Surely, there exits a cluster whose clustrering coefficient is higher -- i.e, there are some nodes which didn't adopt the idea.

So, the above one and now.. state the same thing.. they are bi-implication..

asdf

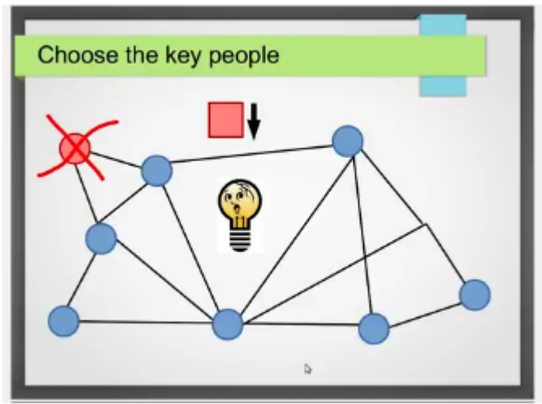


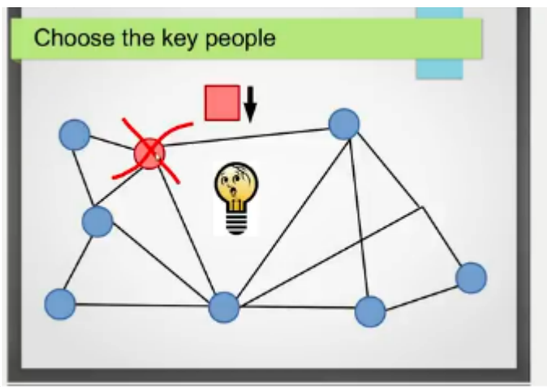
Recap of 4 main scenarios....

1.  Every one in network has adpoted some idea(the blues -- to library) and ther comes a new idea(red -- to fun).
   - As the cascading action, behaviour goes on..But some may find it risky.. 
   - then, 

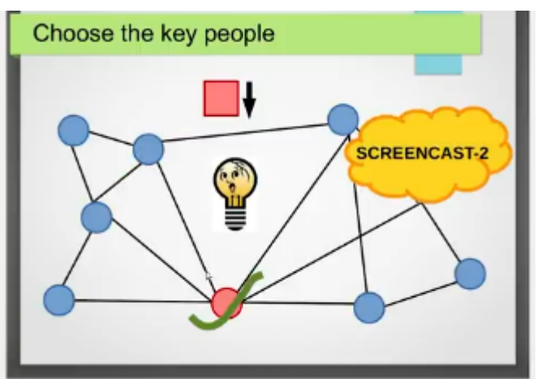
   -- as we increase benefits associated with it, it finally cascades. ---------- in screencast-1

2. Choosing the right people.

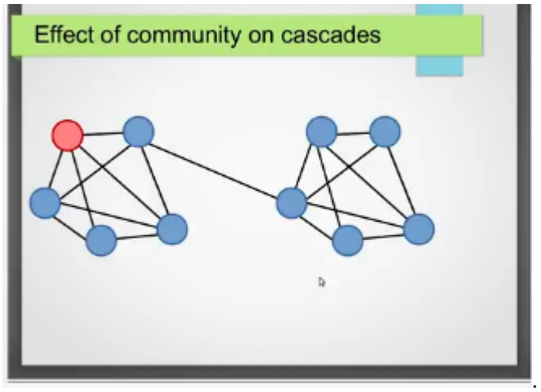


-- started with here, couldn't cascade..


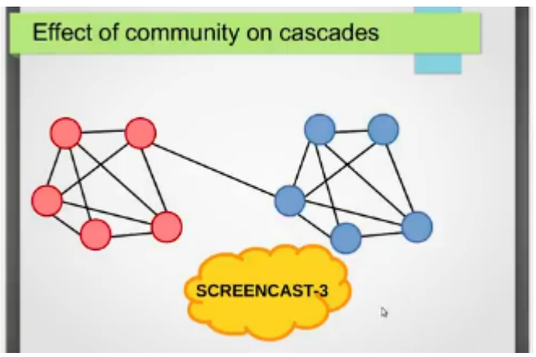
-- here too.



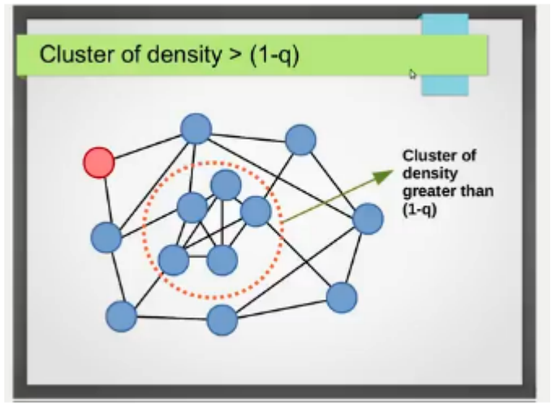
-- here you could -- as well connected with that node.

3. 

. An idea spreading in a network(in one of the community)

- It cascades that comunity 

- but difficult to spread to other community.

4. 

- **Cluster of density p:** *If each and every node in the cluster has **atleast** p fraction of friends are in the same cluster.*
- **Threshold associated with new idea q:** *If $\ge$ of a person's friends adopt a new idea, then he too adopts it* So the theorem says as..

> If a cluster of density $>(1-q)$ in the network, then idea can't diffuse in it.