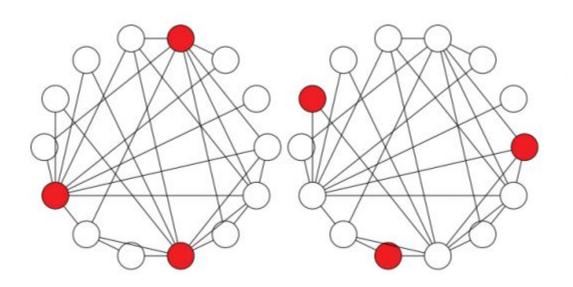
# Discrete Ideas

Information Diffusion, Epidemics and Emergence of Knowledge in Networks

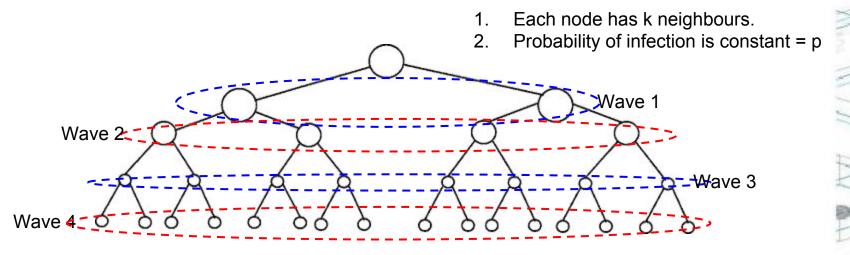
S. R. Sudarshan Iyengar CSE department IIT Ropar

# The Majority Illusion



The majority illusion in Social Networks, Kristina et al., PloS one, Vol 11, Issue 2, 17/Feb/2016

#### The Branching Model

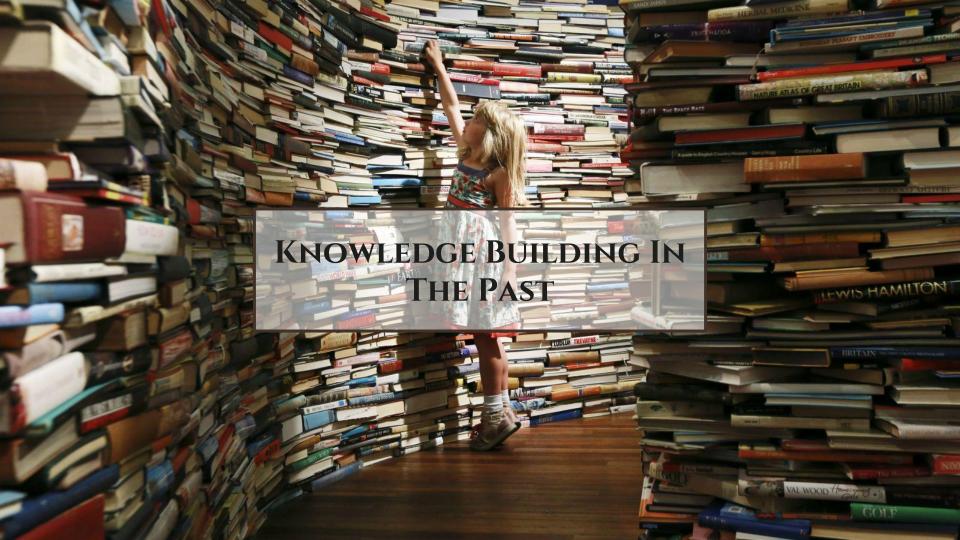


- 1. Expected number of neighbours each person infects = k . p
- 2. The process stops when none of the nodes in a wave is infected.
- 3. The value k.p has a cutting edge significance. What happens when k.p < 0, when k.p>0 and when k.p ~ 0?

#### Emergence of Knowledge:

9

**Epidemic or Information Diffusion?** 



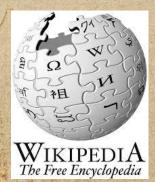
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#### Crowdsourcing= Crowd + Outsourcing













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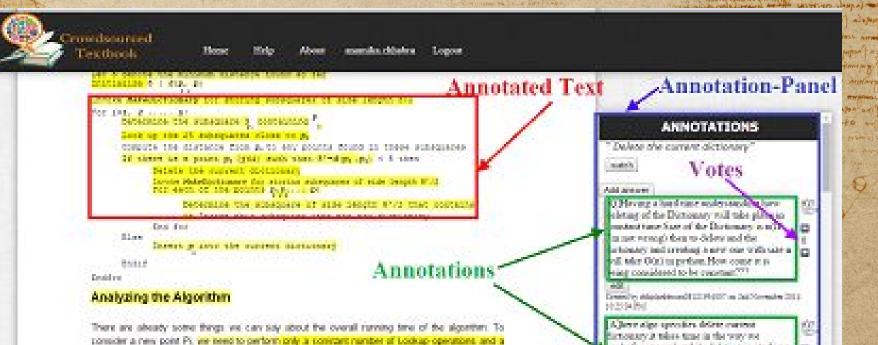


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## Crowdsourced Textbook

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- Questions
- Answers

Pointers







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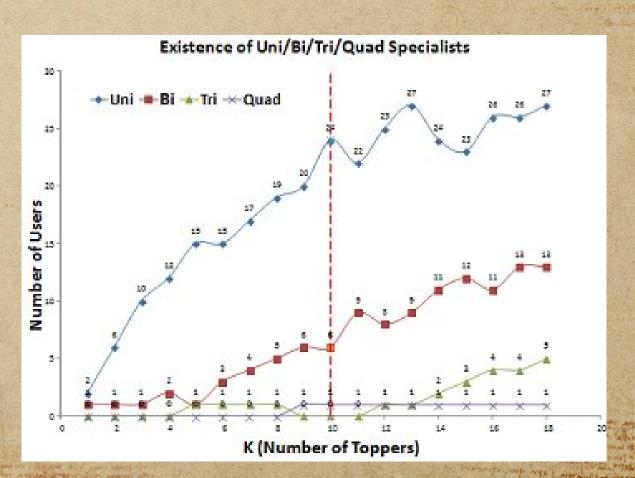
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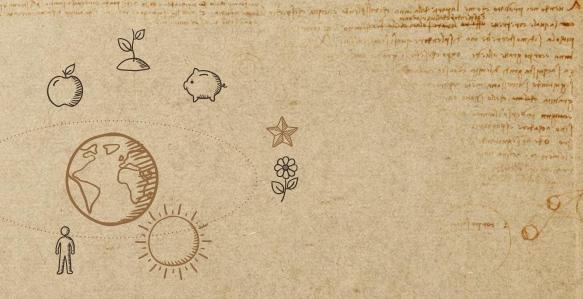


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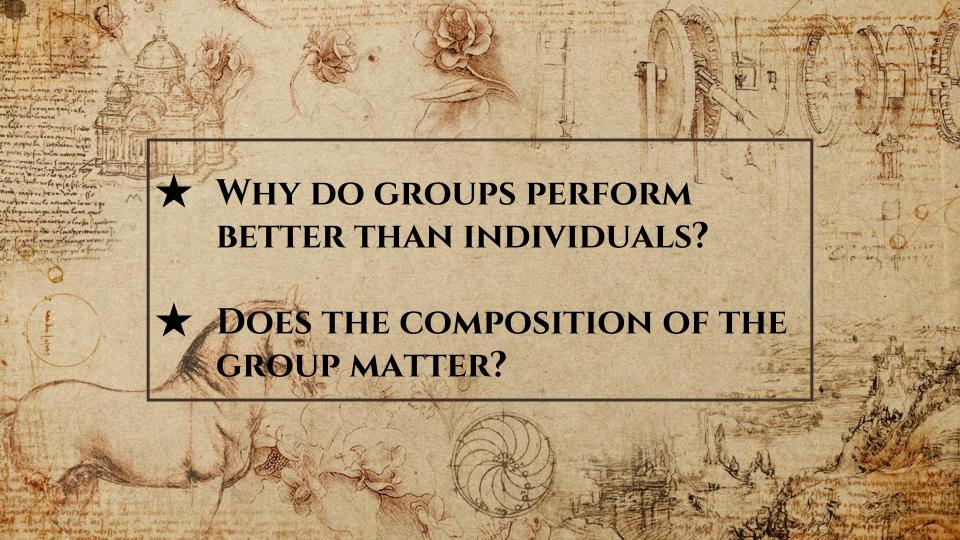


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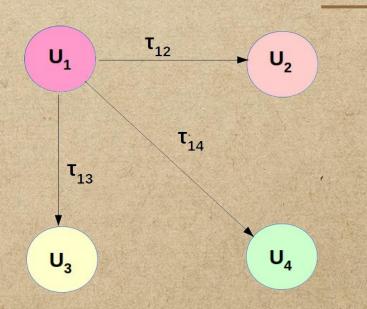
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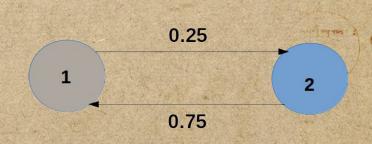
# ECOSYSTEM

There are categories of users in any Collaborative Knowledge Building System, which leads to an ECOSYSTEM.



#### THE APPLE HITTING PHENOMENON...





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The Triggering Phenomenon

#### ELEMENTARY THEORIES ON TRIGGERING

- Luhmann's Theory [1]
  - Social System and Cognitive System
  - Irritations
  - Structural Coupling
- \* Piaget's Model of Equilibration [2]
  - Incongruency leads to Cognitive Conflicts
  - Equilibration
- Information Processing Theory [3]
  - Knowledge Frames related by various conditions

[1] Seidl, David. "Luhmanns theory of autopoietic social systems." Ludwig-Maximilians-Universitt Mnchen-Munich School of Management (2004).

[2] Piaget, Jean. Piagets theory. Springer Berlin Heidelberg, 1976.

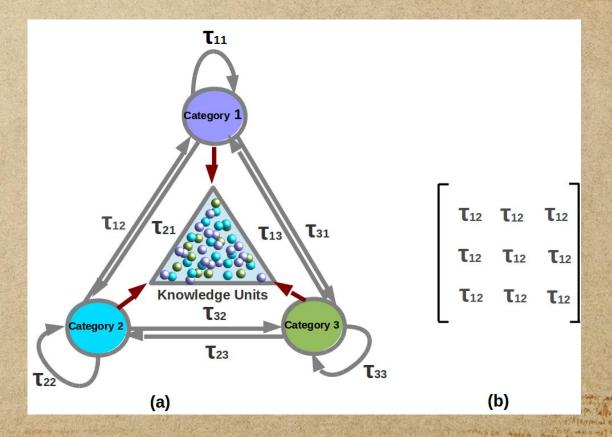
[3] Minsky, Marvin. "Frame-system theory." Thinking: Readings in cognitive science (1977): 355-376

#### THE TRIGGERING PHENOMENON IN CATEGORIES

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#### KU'S AT A GIVEN TIME

KUs of a category that get added at time t are dependent on:

- ★ The number of KUs of all the categories that get added to the system at time (t-1).
- The triggering factors from all other categories to the considered category.
- ★ The number of users in the considered category.
- ★ The internal knowledge of the users of the considered category.

#### THE PROBLEM STATEMENT

Comment of the state of the second of the se

simply with one

#### Given the:

- \* Number of users,
- + Categories and
- \* The triggering among the categories,

Find the ideal number of users for each category to build maximum amount of knowledge

# SOURCES OF KNOWLEDGE UNITS IN A KNOWLEDGE BUILDING SYSTEM

Internal Knowledge

\* Triggered Knowledge

#### **TERMINOLOGY**

n; = the number of users in category 'i', such that

$$\sum_{i=1}^m n_i = n$$

m = the number of categories,

r<sub>i</sub> = the internal knowledge contribution of a user of category

 $\mathbf{r}_{i}(\mathbf{t})$  = the internal knowledge contribution of a user of category 'i' at time 't', such that,  $\sum_{i=1}^{\infty} r_{i}(t) = r_{i}$ 

τ<sub>ij</sub> = the number of knowledge units (KUs) of type 'i' that get triggered due to one KU of type 'j'.

#### KU'S AT A GIVEN TIME CONTD..

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KUs of a category 'i' that get added at time 't' is given by:

$$k_i(t) = n_i(\tau_{i1}k_1(t-1) + \tau_{i2}k_2(t-1) + \cdots + \tau_{im}k_m(t-1)) + n_ir_i(t)$$

i.e.,

$$k_i(t) = n_i \left( \sum_{j=1}^m \tau_{ij} k_j(t-1) + r_i(t) \right)$$

#### THE MATRICES USED...

**K(t)** = The column vector consisting of the knowledge generated by various categories at time 't'.

T = The triggering matrix

N = Matrix storing the number of users in each category

**R(t)** = the column matrix storing the function by which each category users add their internal knowledge to the system.

$$K(t) = \begin{bmatrix} k_1(t) \\ k_2(t) \\ \vdots \\ k_m(t) \end{bmatrix}$$

$$T = egin{bmatrix} au_{11} & au_{12} & \cdots & au_{1m} \ au_{21} & au_{22} & \cdots & au_{2m} \ dots & & dots \ au_{m1} & \cdots & \cdots & au_{mm} \end{bmatrix}$$

$$R(t) = \begin{bmatrix} r_1(t) \\ r_2(t) \\ \vdots \\ r_m(t) \end{bmatrix}$$

## KU'S AT A GIVEN TIME CONTD.

The knowledge generated by various categories at time 't' can be represented as:

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$$K(t) = N(TK(t-1) + R(t))$$

## TOTAL KNOWLEDGE AT TIME 'T

**Lemma** The total knowledge generated in the system at time t is given by:

$$K(t) = \sum_{i=0}^{t} (NT)^{i} NR(t-i)$$

## NET KNOWLEDGE IN THE SYSTEM

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**Theorem** Given the matrices N, T and R, the net knowledge in the system at the end of the Knowledge building process is given by:

$$K = (I - NT)^{-1}NR$$

when

$$\rho(NT) < 1$$

where I is an Identity Matrix of the order  $m \times m$  and  $\rho$  is the spectral radius.

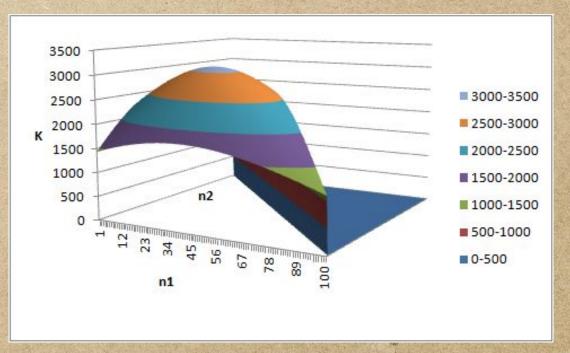
$$R = \begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ r_m \end{bmatrix}$$

$$K = \begin{bmatrix} k_1 \\ k_2 \\ \vdots \\ k_m \end{bmatrix}$$

#### **IDEAL DISTRIBUTION OF USERS**

#### THE SURFACE PLOT

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#### HILL CLIMBING ALGORITHM

#### Algorithm 1 Hill Climbing Algorithm For Perfect Skill set Distribution

- ① Pick a random distribution  $D = [n_1, n_2, ..., n_m]$  of users across different categories, such that  $\sum_{i=1}^{m} n_i = n$
- 2 Consider all the  $2*\binom{m}{2}=m(m-1)$  neighboring distributions(N) of D, defined as: N=[

for i = 1: m

for j = 1 : m

If  $i \neq j$ :

N.append((D[1], D[2], ..., D[i] - 1, ..., D[j] + 1, ..., D[m]))

**3** Calculate  $K_{N[j]} \forall \ 1 \leq j \leq m(m-1)$  based on the following formula:

$$K = (I - \delta)R$$

where  $K_{N[j]}$  represents the net knowledge in the system with the distribution N[j] Choose i such that  $K_{N[i]} = \max_j K_{N[j]}$ 

• If  $K_{N[i]} > K_D$  then D = N[i] and we repeat steps 2 to 4 else: return D //The perfect skill set distribution agus unhanos miga valuesto in opinistolisto, il villator y valuesto le odino, vum

#### CONCLUSION

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★ Right mix of users leads to acceleration in the knowledge building process.

It should not necessarily be a group of experts, even the presence of non-experts helps.

"The sum of some is greater than parts!"

