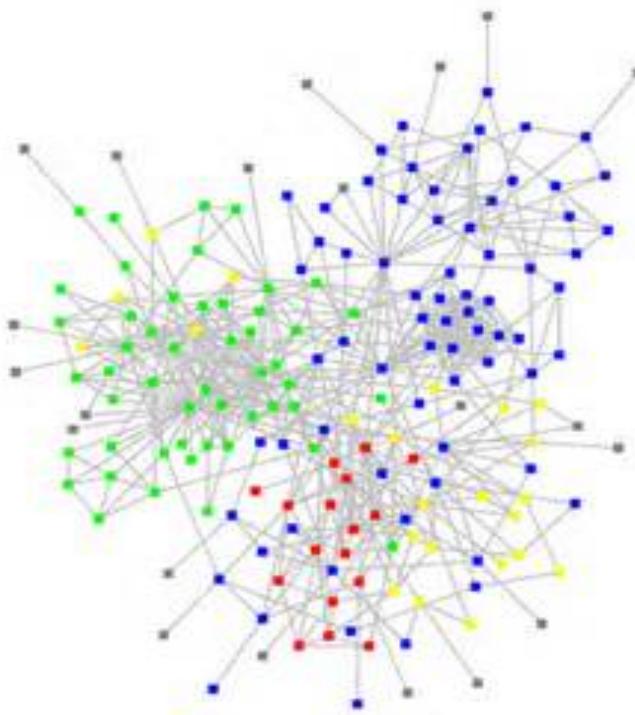


A General Attribute Diffusion Mechanism on Social Networks

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- Introduction
 - Social Network
 - Diffusion
- Donation Game
- Numerical Results
- Summary and Applications

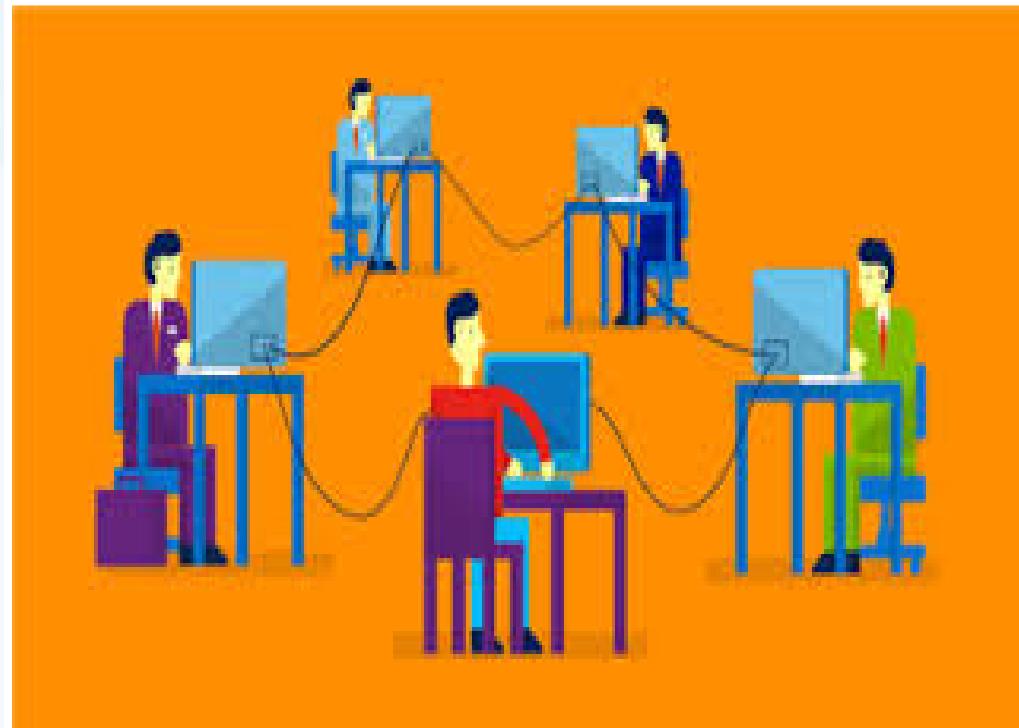
Social Network



A social network is a social structure (interaction) made up of a set of social actors (such as individuals, groups, organizations) and a set of the dyadic ties between these actors, which is to connect any given social unit to represent the convergence of the various social unit.

Social Network-School



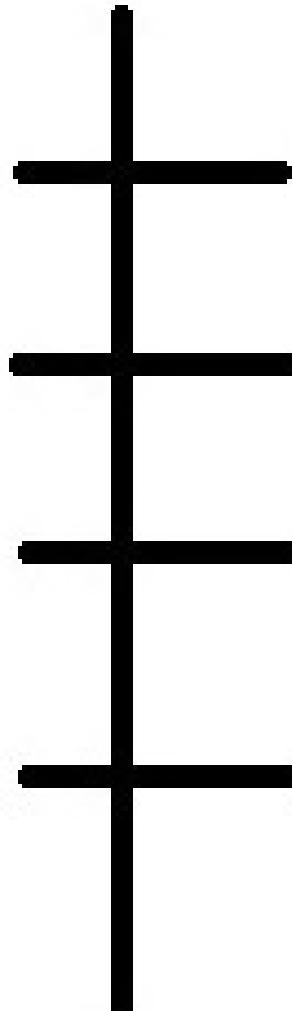


Office Social Network



World Social Network

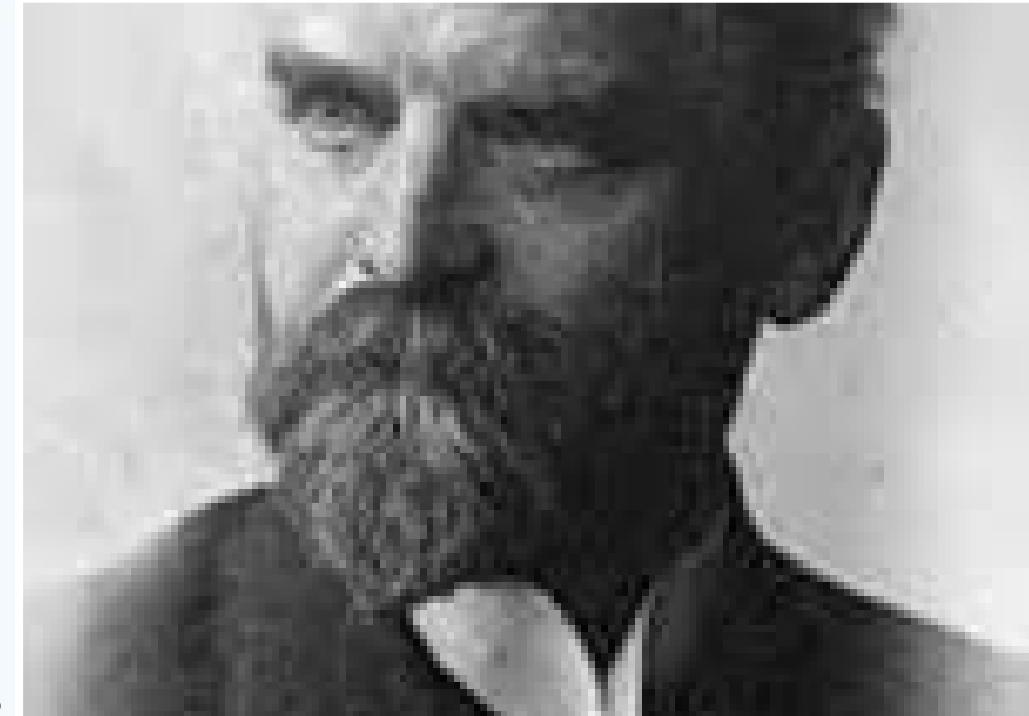
History



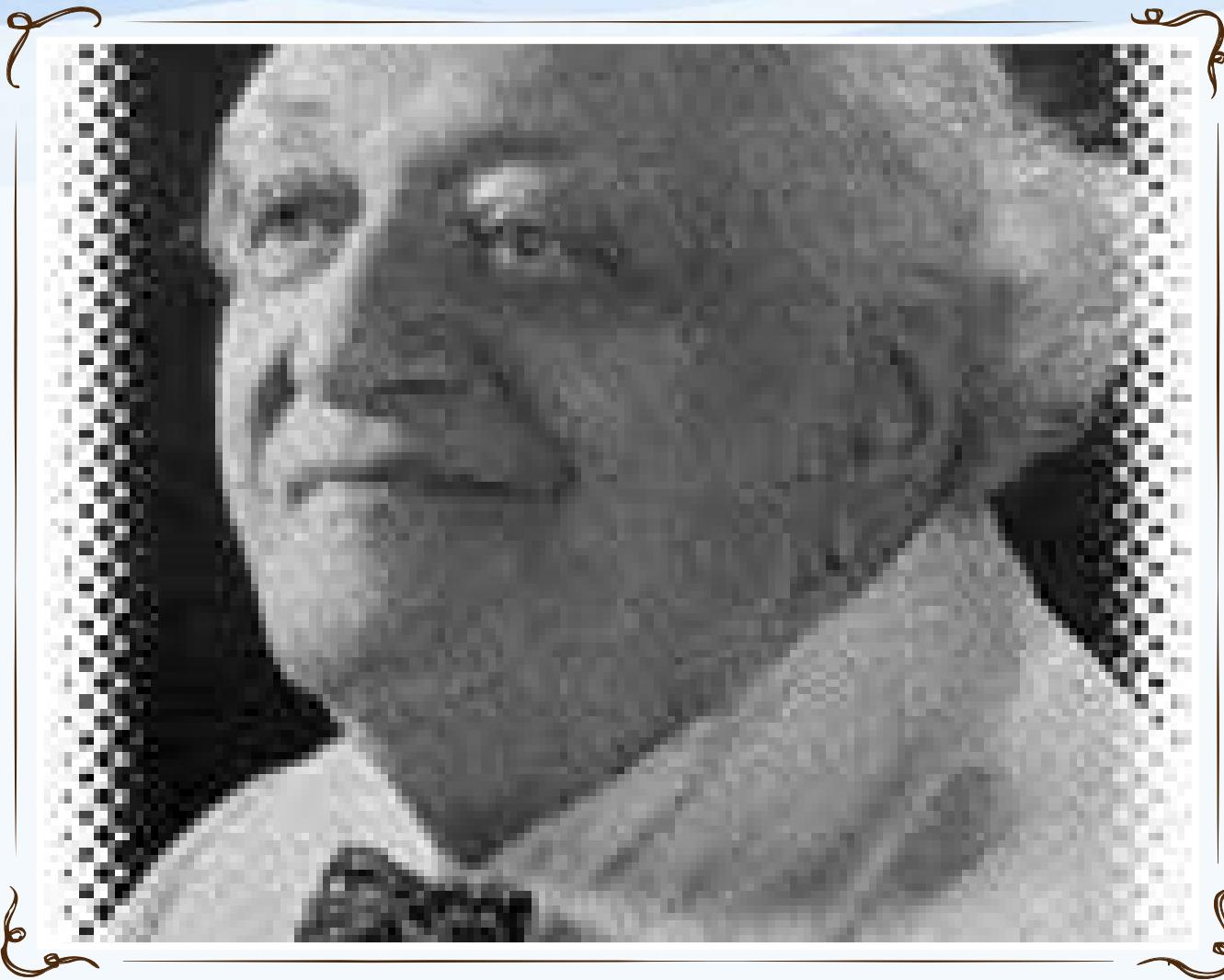
- 1890: Durkheim and Tonnies firstly applied social network on social groups.
- 1930s: There are major developments.
- 1933: Moreno analyzed the social interaction in small groups.
- 1935: Parsons discussed social structure.



Emile Durkheim



Ferdinand Tönnies



Jacob Levy Moreno

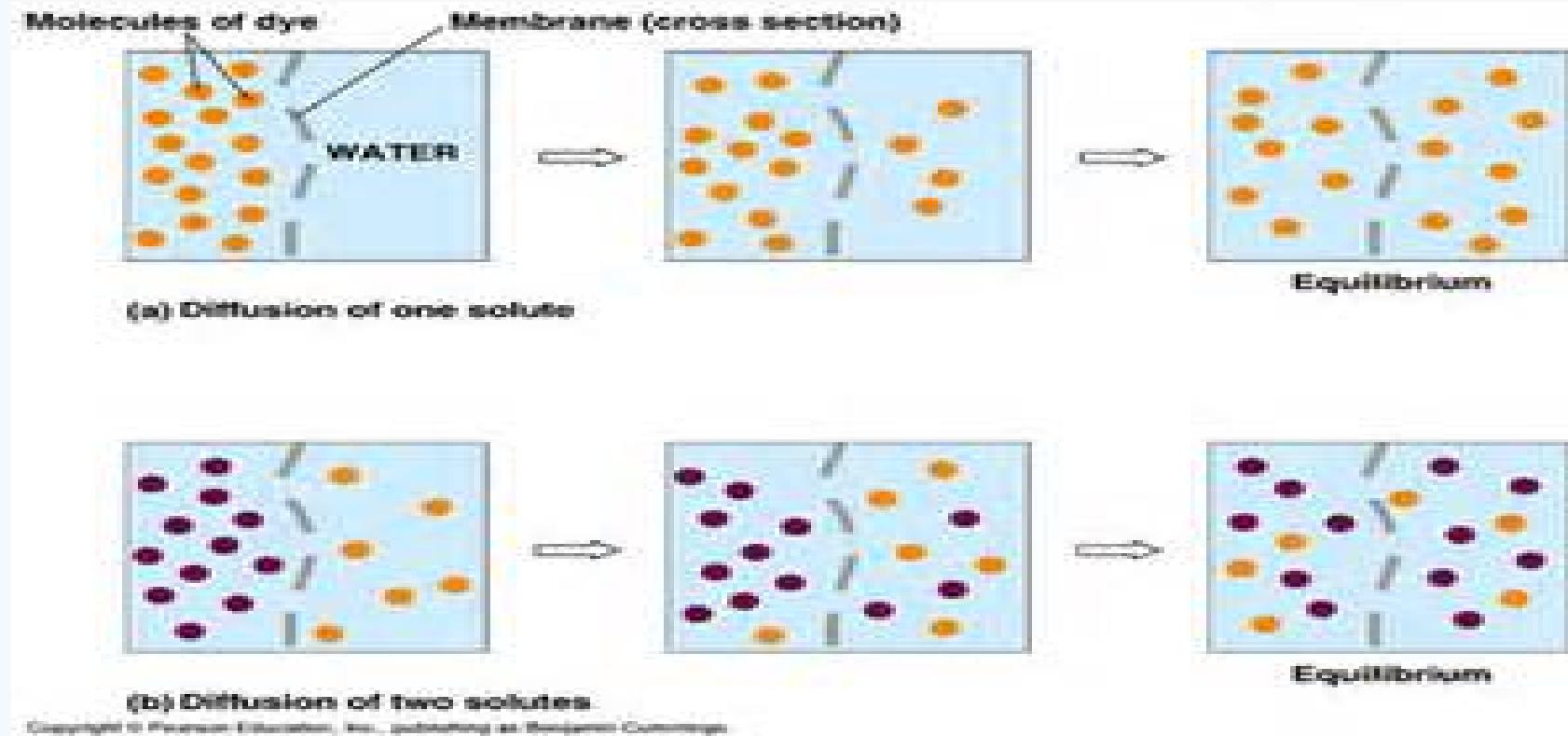
1. The founder of social network analysis.
2. Quantitative evaluation of an individual's role and analysis of connections in the community.
3. Who Shall Survive.



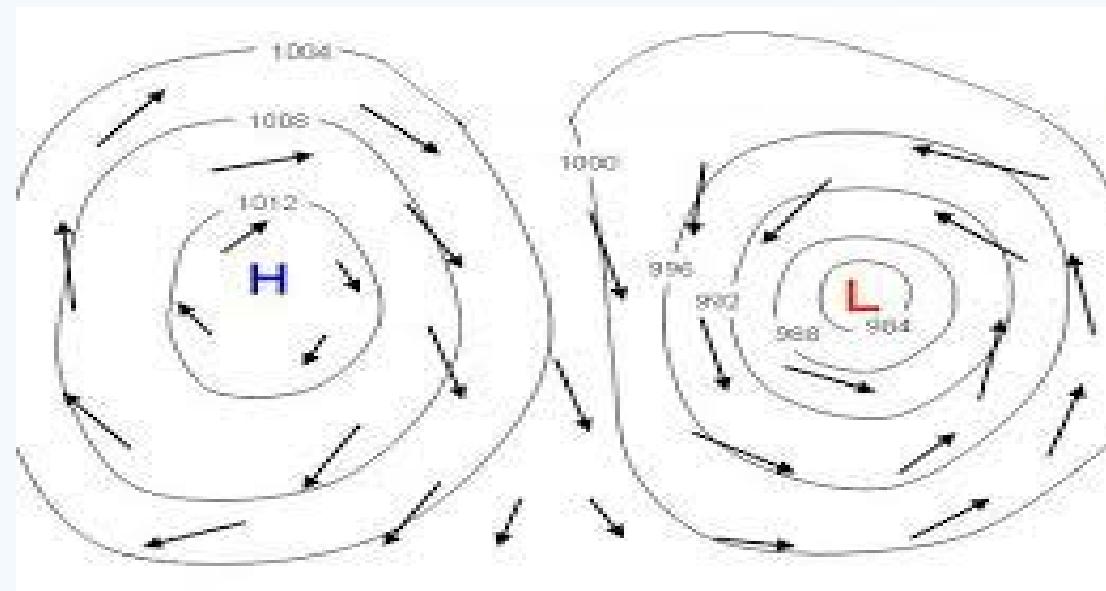
Talcott Parsons

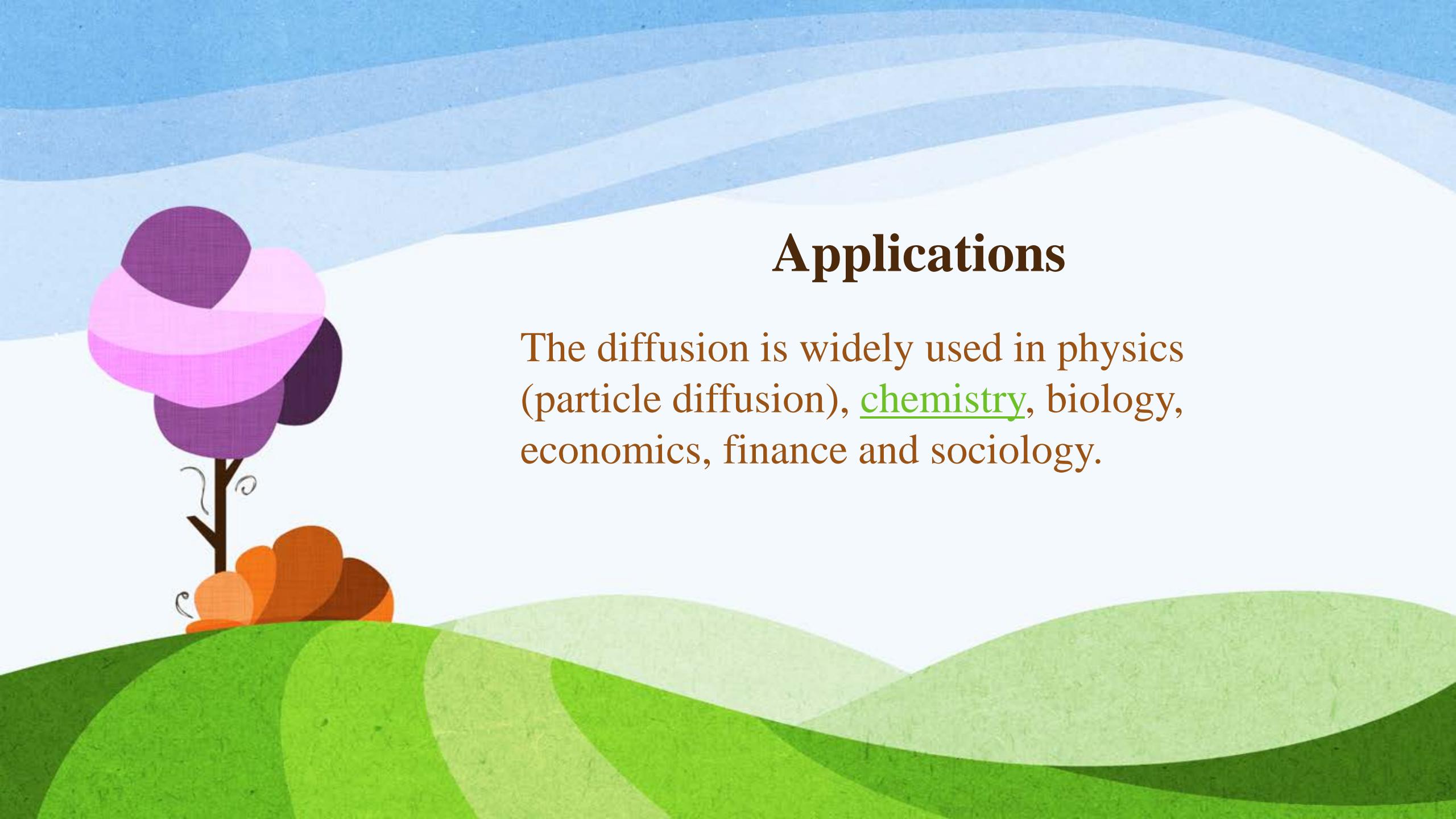
- 1) Action theory
- 2) Voluntarism and analytical realism
- 3) A theory of social evolution and directions of world history

Diffusion is the net movement of a substance (e.g. atom, ion, molecule) from a region of high concentration to a region of low concentration.



A gradient is the change in the value of a quantity (e.g. concentration, pressure, temperature) with the change in another variable (e.g. distance, time)

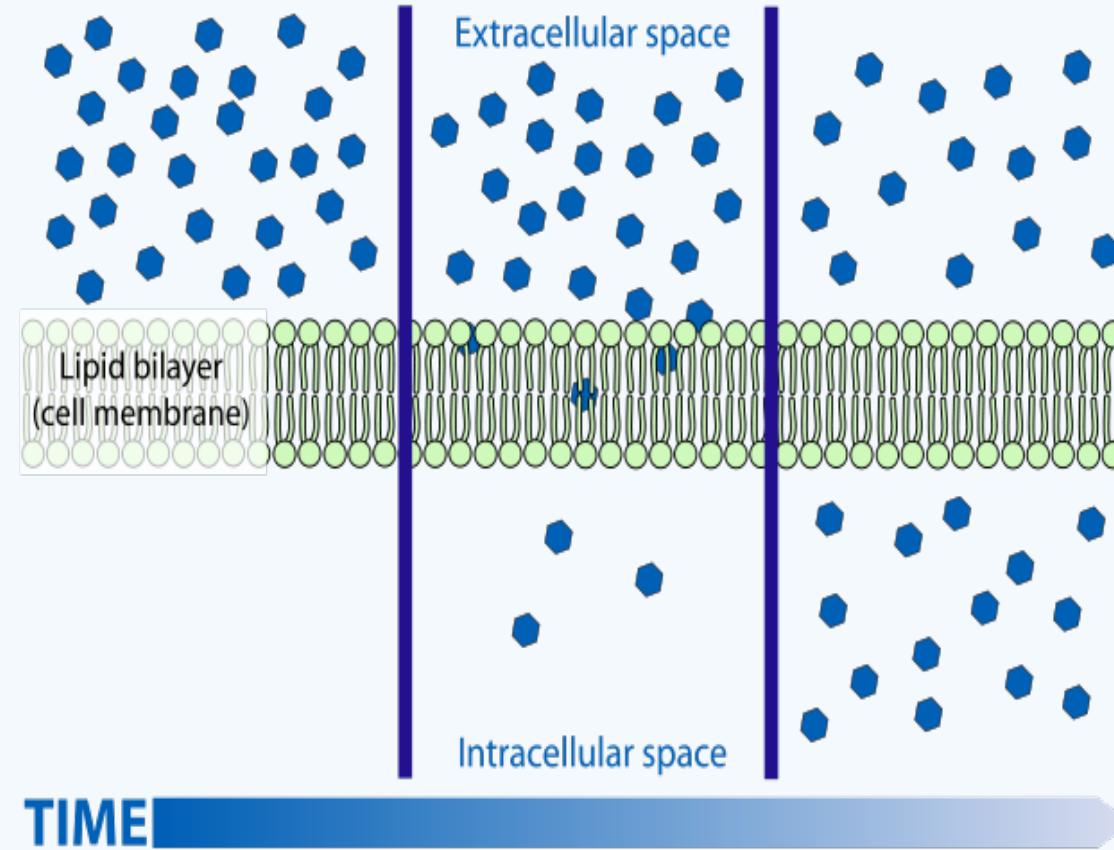




Applications

The diffusion is widely used in physics (particle diffusion), chemistry, biology, economics, finance and sociology.

Biology-Passive transport



Economics Diffusion- The process of a new idea or new product is accepted by the market. There are two factors: rate of diffusion and adoption.





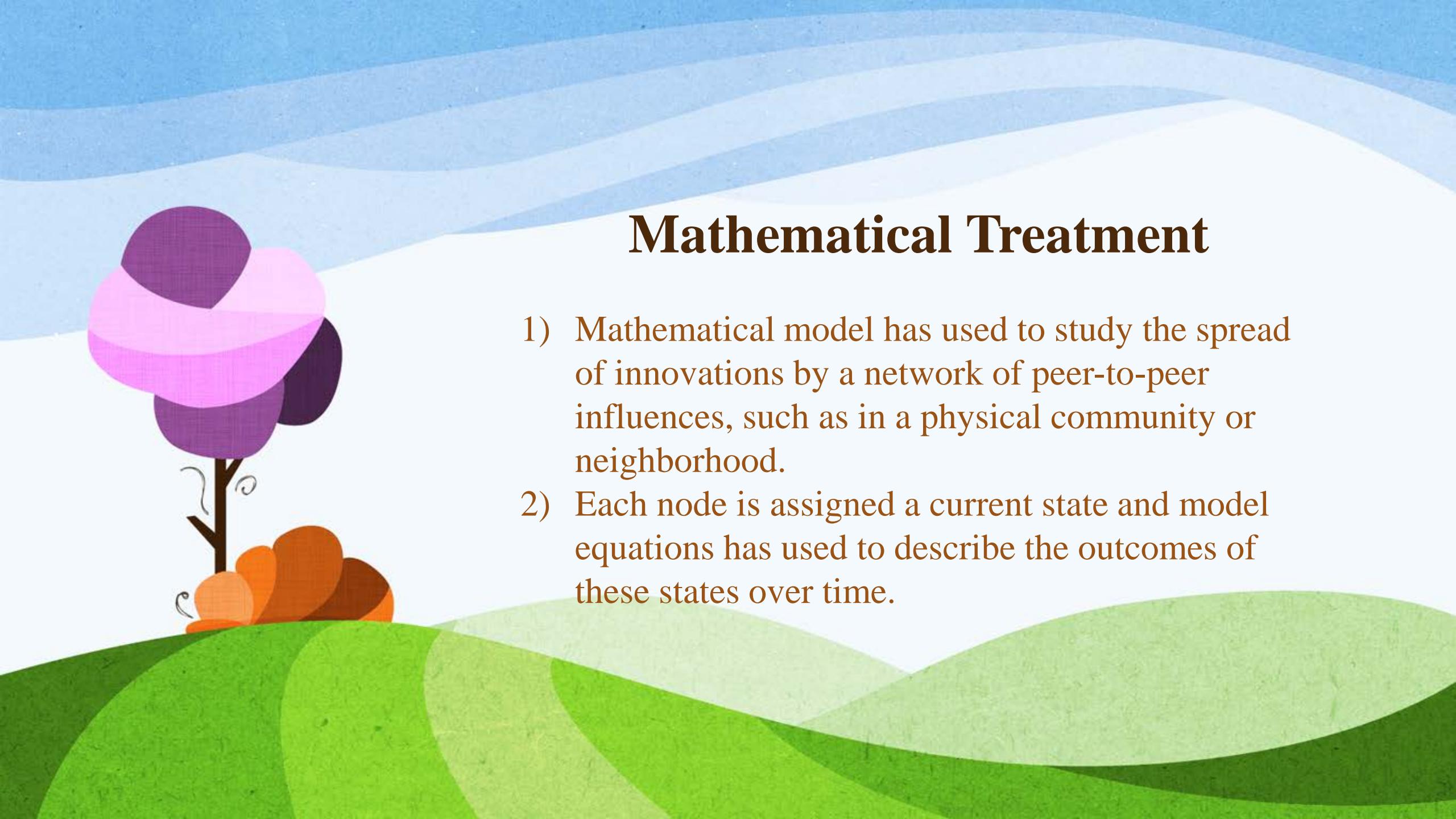
Sociology Diffusion

- Sociology theory of diffusion is to study the diffusion of innovations throughout social groups and organizations.
- The sociology diffusion is a process in a social system where an innovative idea or concept is spread by the social group through certain channels.



Rogers-a new idea is diffused through a decision-making

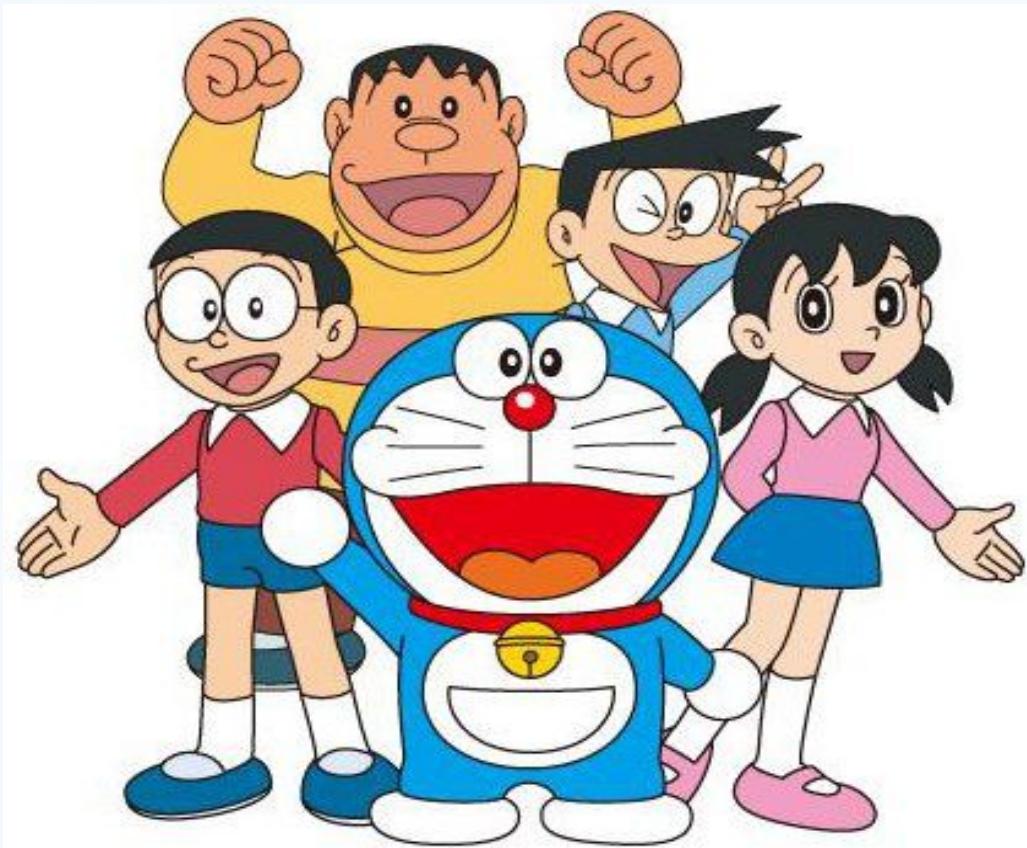
1. Knowledge: knows the new innovation but lacks information and inspiration.
2. Persuasion: starts to research.
3. Decision: positive and negative results (**Key part-adopt or reject**)
4. Implementation: determine the innovation's usefulness
5. Confirmation: decide to continue with the new innovation



Mathematical Treatment

- 1) Mathematical model has used to study the spread of innovations by a network of peer-to-peer influences, such as in a physical community or neighborhood.
- 2) Each node is assigned a current state and model equations has used to describe the outcomes of these states over time.

Donation Game





X100



X300



X 200



X400



大雄(100)->靜香(40)
->小夫(10)
->胖虎(0)

靜香(200)->大雄(70)
->小夫(40)
->胖虎(30)

胖虎(300)->大雄(0)
->靜香(40)
->小夫(50)

小夫(400)->大雄(50)
->靜香(110)
->胖虎(80)

1st round

大雄: 100->170, 靜香: 200->250, 胖虎: 300->320, 小夫: 400->260
Donation: 小夫(240)>靜香(140)>胖虎(90)>大雄(50)

Generosity Degree

大雄: 100 (50)-> 0.5

靜香: 200 (140)-> 0.7

胖虎: 300 (90)-> 0.3

小夫: 400 (240)-> 0.6

Generosity:

靜香>小夫>大雄>胖虎

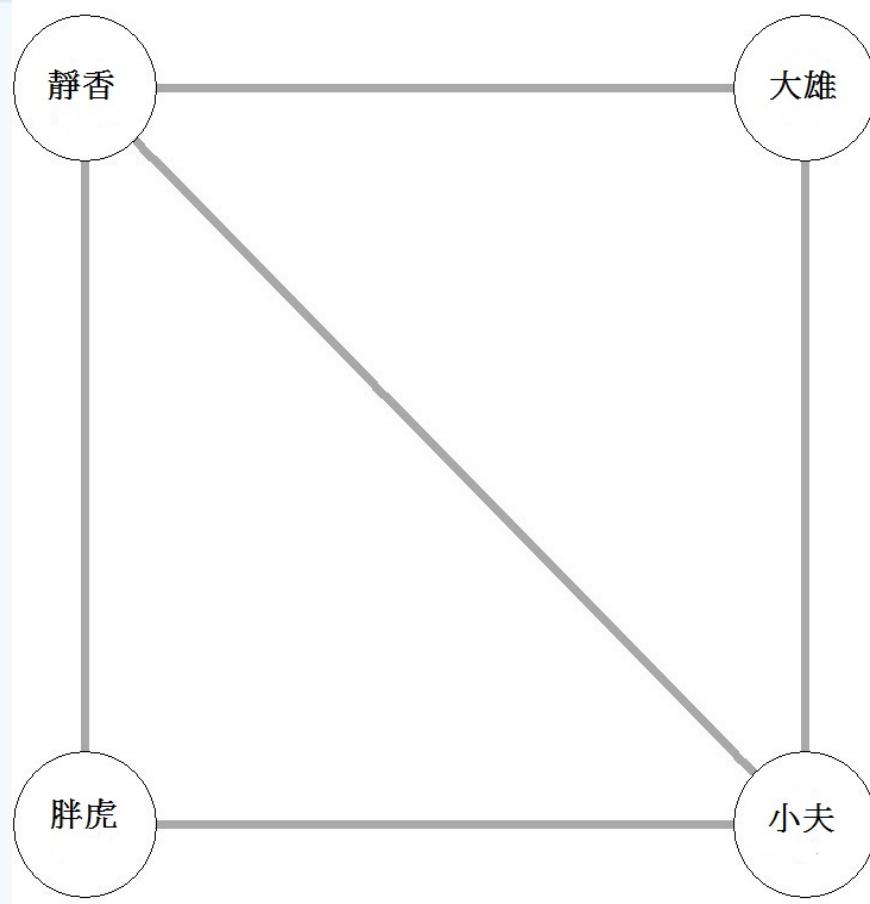
Diffusion Constant

0 <-----> 1

Selfish

Generous

Relationship- Tie Graph





大雄(170)->靜香(50)
->胖虎(0)
->小夫(35)

靜香(250)->大雄(90)
->胖虎(30)
->小夫(55)

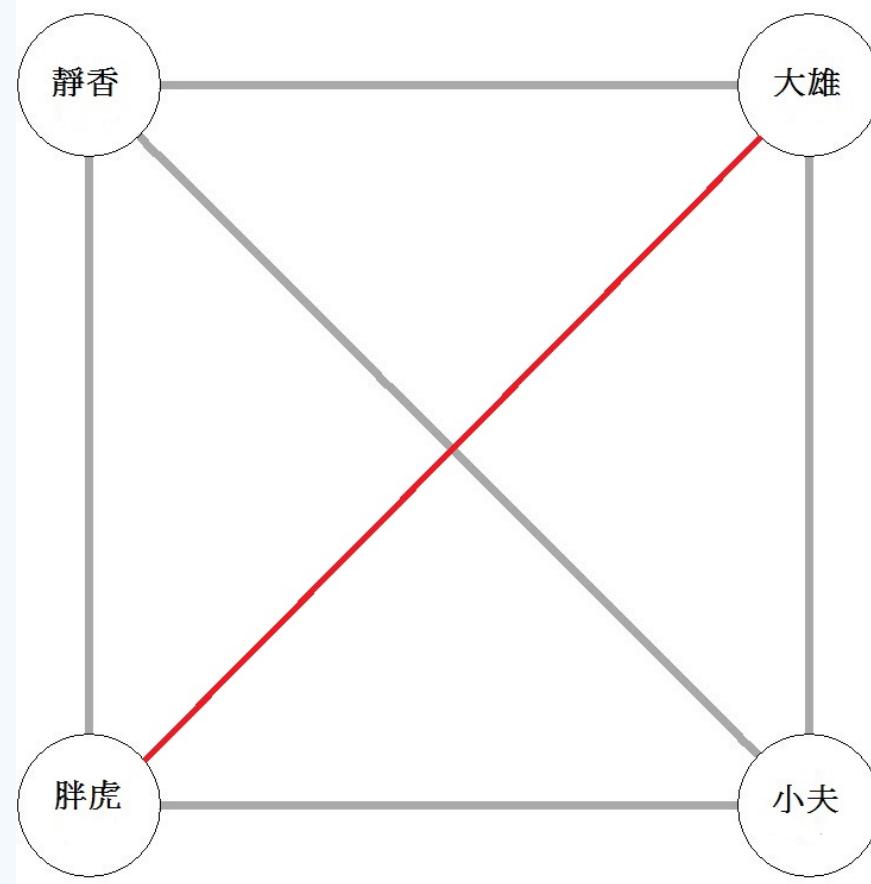
胖虎(320)->大雄(0)
->靜香(56)
->小夫(40)

小夫(260)->大雄(20)
->靜香(56)
->胖虎(80)

2nd round

大雄: 170->195, 靜香: 250->237, 胖虎: 320->334, 小夫: 260->234

Scenario (I): Tie Graph



Generosity Degree

大雄: 0.5

靜香: 0.7

胖虎: 0.3

小夫: 0.6



大雄(100)->靜香(30)
->胖虎(5)
->小夫(15)

胖虎(300)->大雄(10)
->靜香(30)
->小夫(50)

靜香(200)->大雄(90)
->胖虎(25)
->小夫(25)

小夫(400)-> 大雄(50)
-> 靜香(90)
-> 胖虎(100)

1st round

大雄: 100->200, 靜香: 200->210, 胖虎: 300->340, 小夫: 400->250



大雄(200)->靜香(60)
->胖虎(10)
->小夫(30)

胖虎(340)->大雄(10)
->靜香(60)
->小夫(32)

靜香(210)->大雄(80)
->胖虎(20)
->小夫(47)

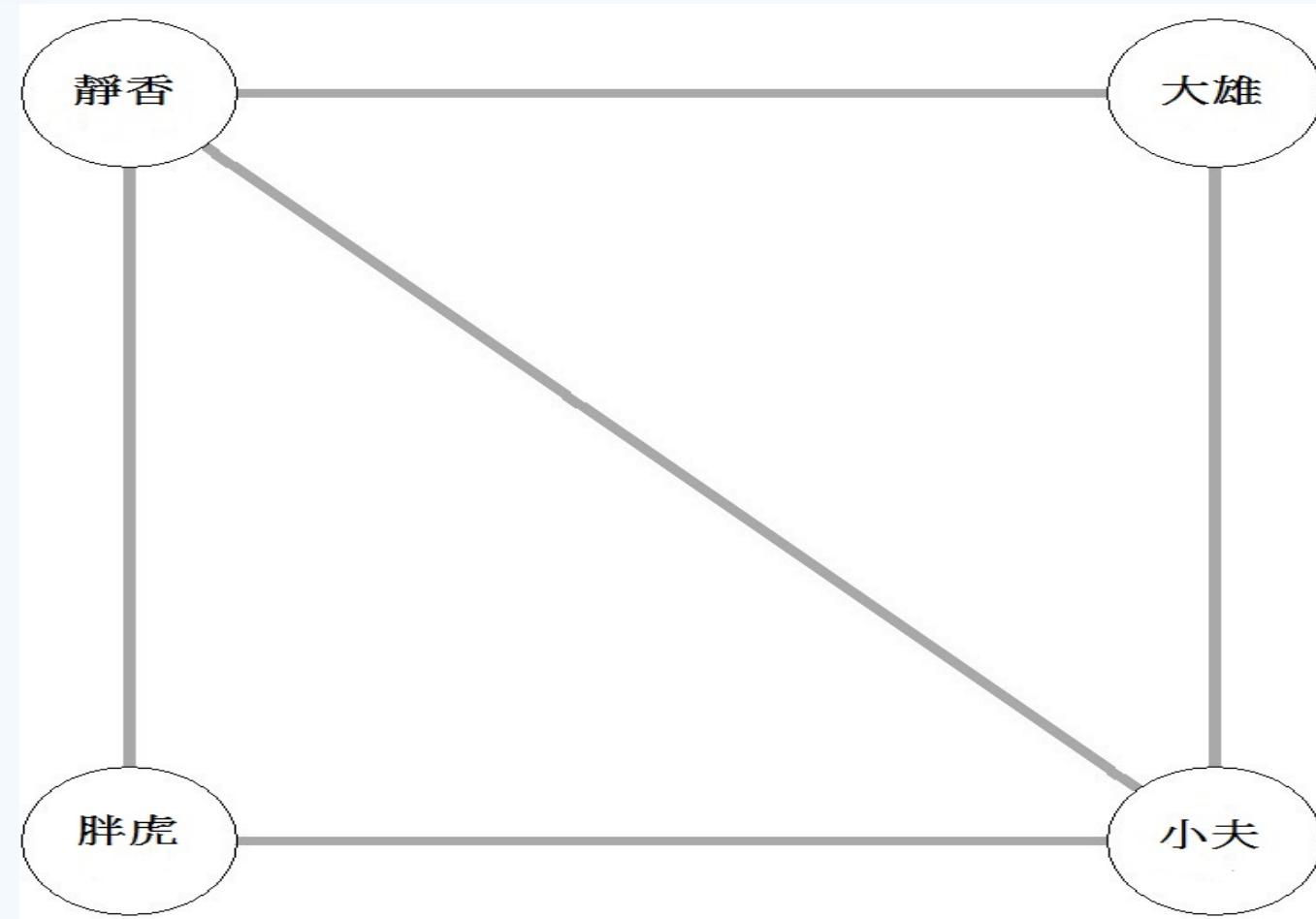
小夫(250)->大雄(20)
->靜香(80)
->胖虎(50)

2nd round

大雄: 200->210, 靜香: 210->263, 胖虎: 340->318, 小夫: 250->209

Scenario (II): Diffusion Constant

大雄: 0.5->0.1, 靜香: 0.7->0.1, 胖虎: 0.3->0.1, 小夫: 0.6->0.1





大雄(100)->靜香(8)
->胖虎(0)
->小夫(2)

胖虎(300)->大雄(0)
->靜香(10)
->小夫(20)

靜香(200)->大雄(10)
->胖虎(4)
->小夫(6)

小夫(400)->大雄(5)
->靜香(20)
->胖虎(15)

1st round

大雄: 100->105, 靜香: 200->218, 胖虎: 300->289, 小夫: 400->388



大雄(105)-> 靜香(7)
-> 胖虎(0)
-> 小夫(4)

胖虎(289)-> 大雄(0)
-> 靜香(9)
-> 小夫(20)

靜香(218)-> 大雄(12)
-> 胖虎(5)
-> 小夫(5)

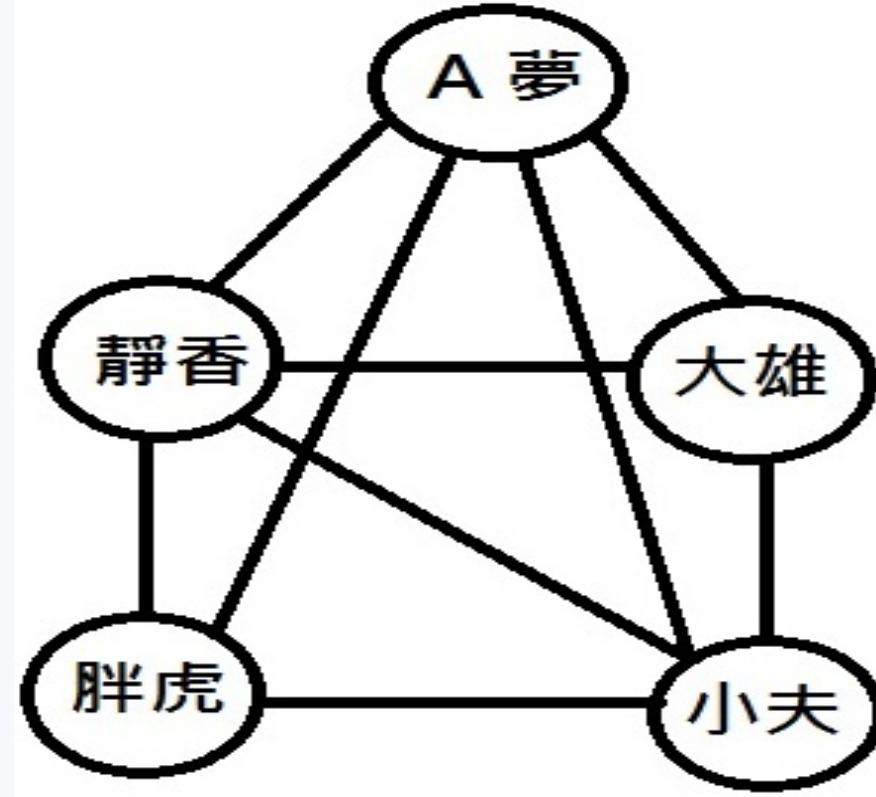
小夫(388)-> 大雄(6)
-> 靜香(21)
-> 胖虎(12)

2nd round

大雄: 105->112, 靜香: 218->233, 胖虎: 289->277, 小夫: 388->378

Scenario (III): Nodes n





大雄(100): 0.5
靜香(200): 0.7
胖虎(300): 0.3
小夫(400): 0.6
A 夢(500): 0.8



大雄(100)->A 夢(15)	靜香(200)->A 夢(40)	胖虎(300)->A 夢(15)
->靜香(25)	->大雄(60)	->大雄(0)
->胖虎 (0)	->胖虎(15)	->靜香(50)
->小夫(10)	->小夫(25)	->小夫(25)

小夫(400)->A 夢(40)	A 夢(500)->大雄(200)
->大雄(30)	->靜香(100)
->靜香(70)	->胖虎(30)
->胖虎(100)	->小夫(70)

1st round

大雄: 100->340, 靜香: 200->305, 胖虎: 300->355, 小夫: 400->290, A夢: 500->210



大雄(340)->A夢(50)
-> 靜香(90)
-> 胖虎(0)
-> 小夫(30)

靜香(305)-> A夢(53)
-> 大雄(121)
-> 胖虎(10)
-> 小夫(30)

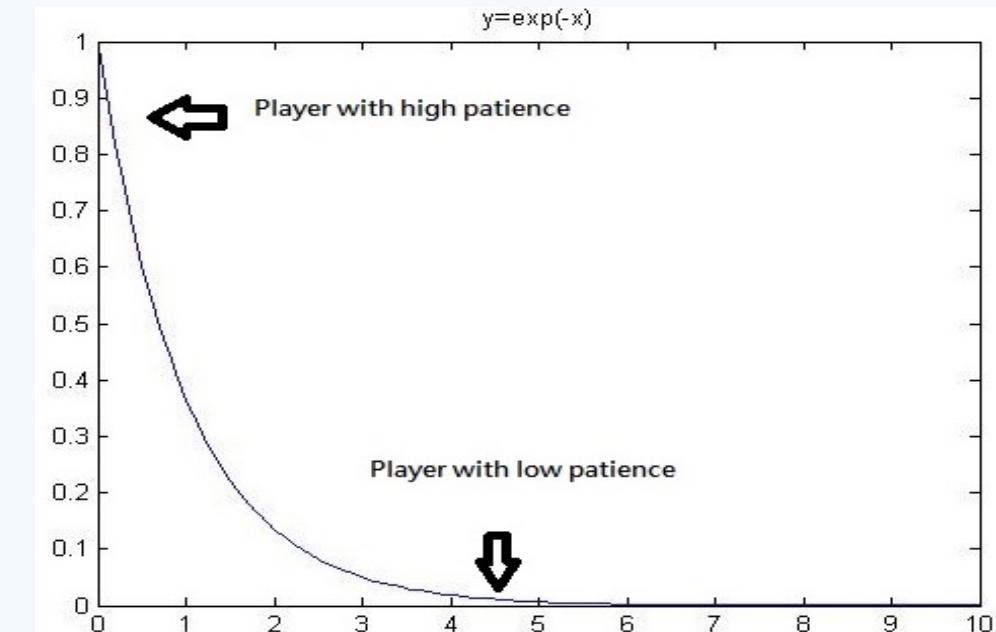
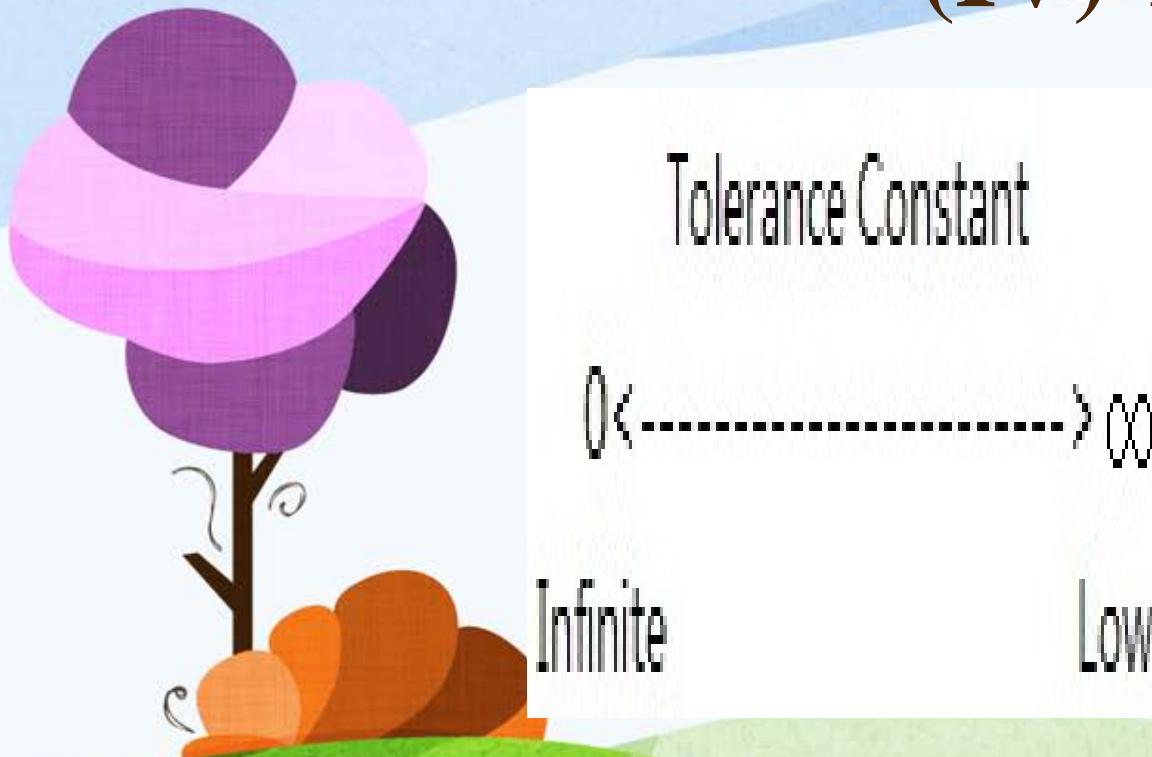
胖虎(355)-> A夢(21)
-> 大雄(0)
-> 靜香(51)
-> 小夫(35)

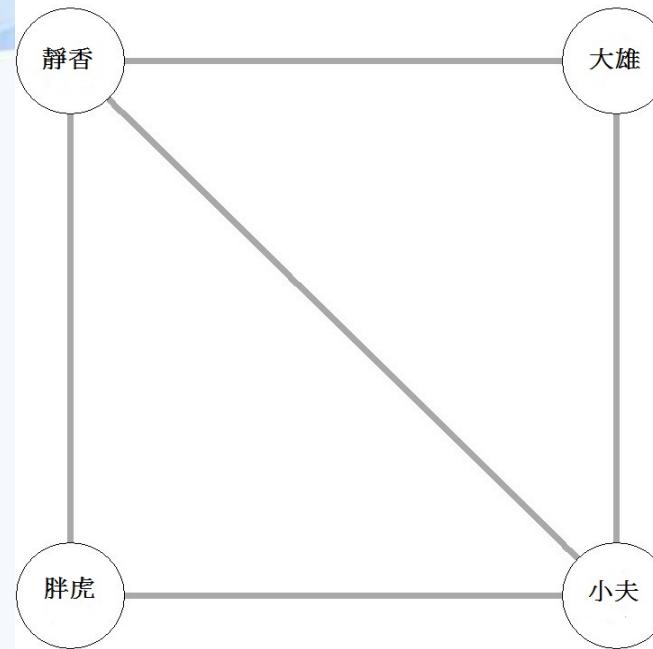
小夫(290)->A夢(34) A夢(210)->大雄(60)
-> 大雄(10) -> 靜香(58)
-> 靜香(70) -> 胖虎(20)
-> 胖虎(60) -> 小夫(30)

2nd round

大雄: 340->361, 靜香: 305->360, 胖虎: 355->338, 小夫: 290->241, A
夢: 210->200

(IV) Tolerance Constant





Generosity Degree

大雄: 0.5

靜香: 0.7

胖虎: 0.3

小夫: 0.6



大雄(100)->靜香(40)
->小夫(10)
->胖虎(0)

胖虎(300)->大雄(0)
->靜香(40)
->小夫(50)

靜香(200)->大雄(70)
->小夫(40)
->胖虎(30)

小夫(400)->大雄(50)
->靜香(110)
->胖虎(80)

1st round

大雄: 100->170, 靜香: 200->250, 胖虎: 300->320, 小夫: 400->260

$$d_{\{t+1\}} = d_{\{t\}} e^{\{-rt\}}$$

t is the number iteration, r is the tolerance vector

Tolerance Constant

大雄: 0.6

靜香: 0.8

胖虎: 0.5

小夫: 0.7

Diffusion Constant

大雄: 0.5-> 0.27

靜香: 0.7-> 0.31

胖虎: 0.3-> 0.18

小夫: 0.6-> 0.3





大雄(170)->靜香(30)
-> 胖虎(0)
-> 小夫(16)

靜香(250)-> 大雄(40)
-> 胖虎(18)
-> 小夫(20)

胖虎(320)-> 大雄(0)
-> 靜香(30)
-> 小夫(28)

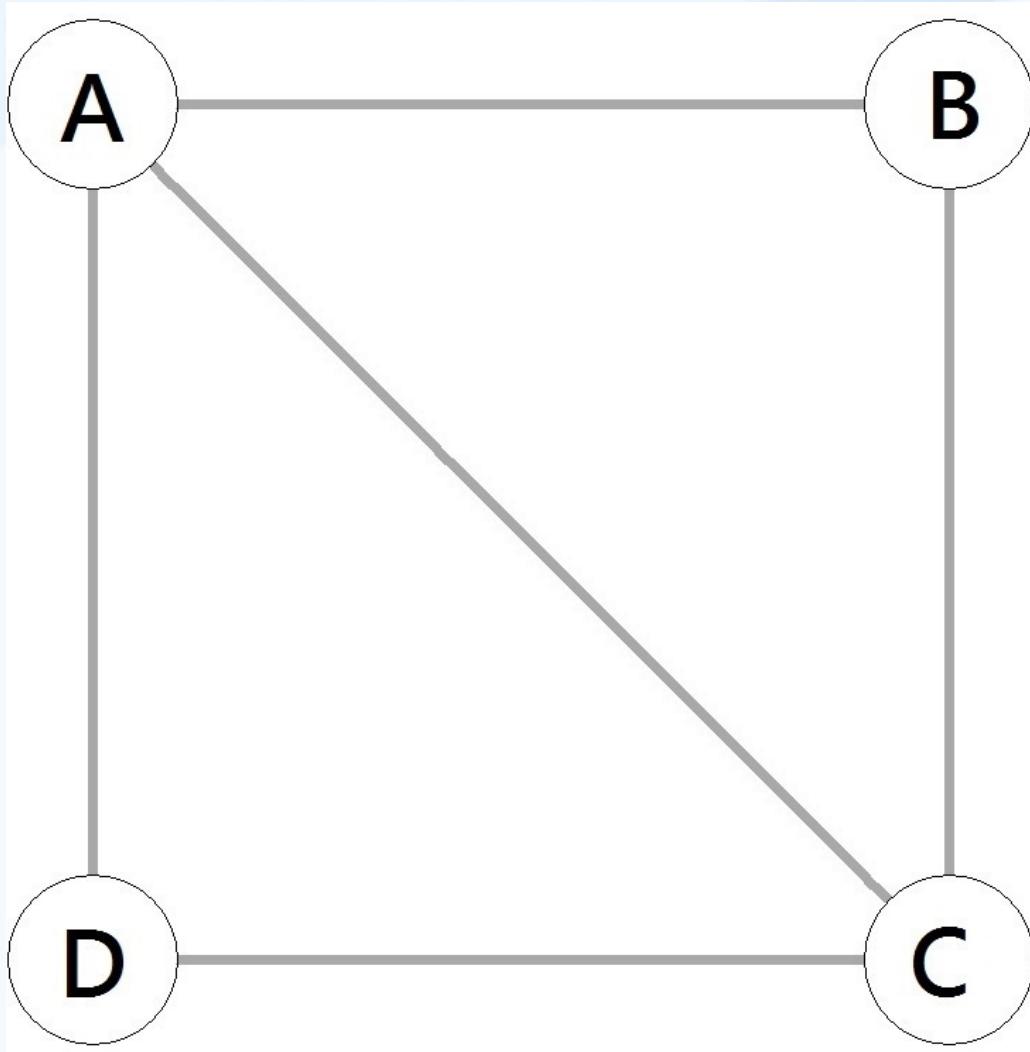
小夫(260)->大雄(18)
-> 靜香(35)
-> 胖虎(25)

2nd round

大雄: 170->182, 靜香: 250->267, 胖虎: 320->305, 小夫: 260->246

Numerical Results- Assumptions

- 
1. The tokens are distributed between two nodes, that is, A with less tokens will donate less tokens to B with many tokens and B will donate some tokens to A.
 2. During a limited time, the total tokens have not been changed, that is, there is no extra people to join the donation game and players cannot give up the game until it is finished.
 3. Each person has different generous degree according to diffusion constants, that is, the amount of A's tokens on B's mind is related to diffusion constants and the formula will be devised below.
 4. Each person should be connected with a person at least in the tie graph.

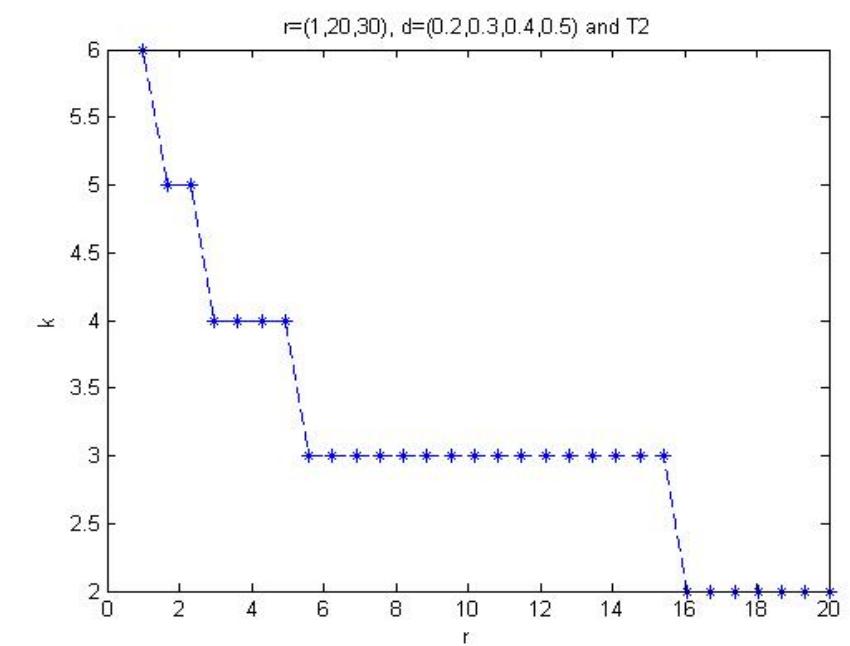
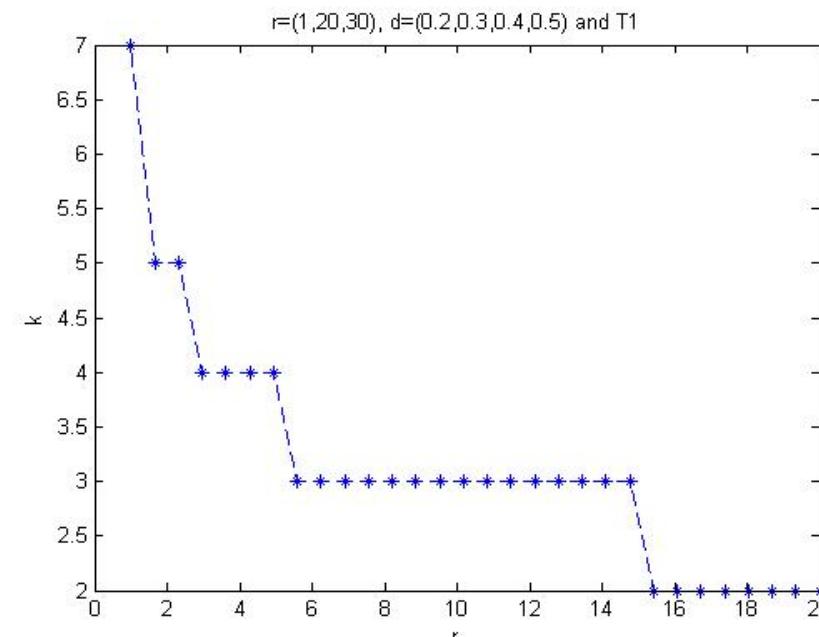


A:100, B:200, C:300, D:400

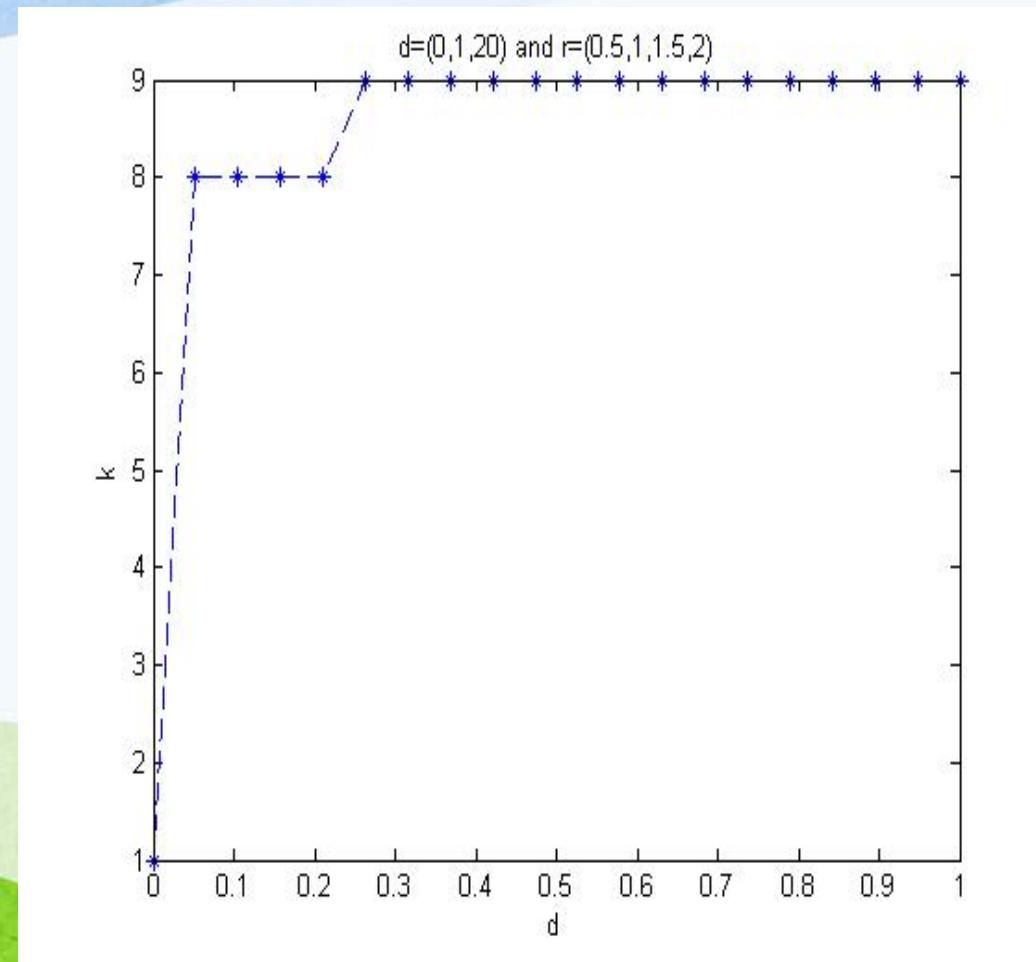
$d_A=0.2, d_B=0.3, d_C=0.4, d_D=0.5$

$r_A=0.5, r_B=1, r_C=1.5, r_D=2$

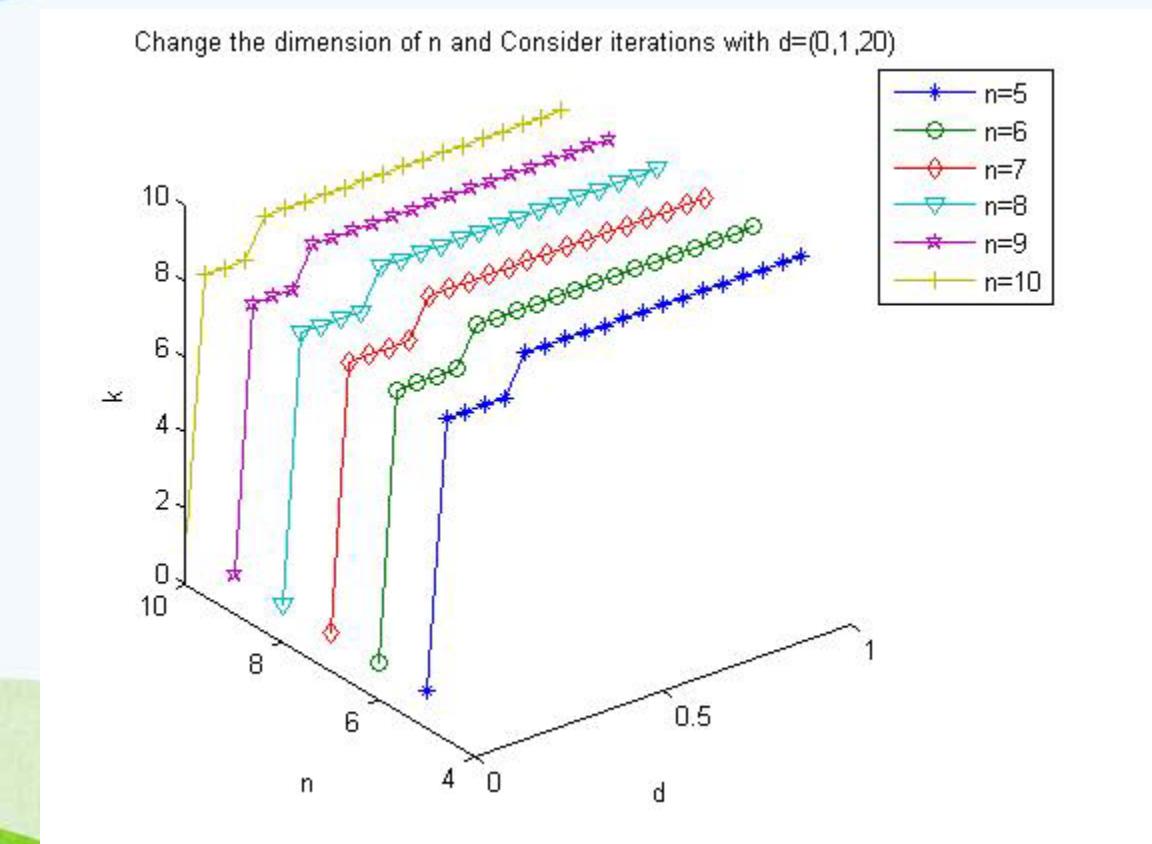
(I) Tie Graph



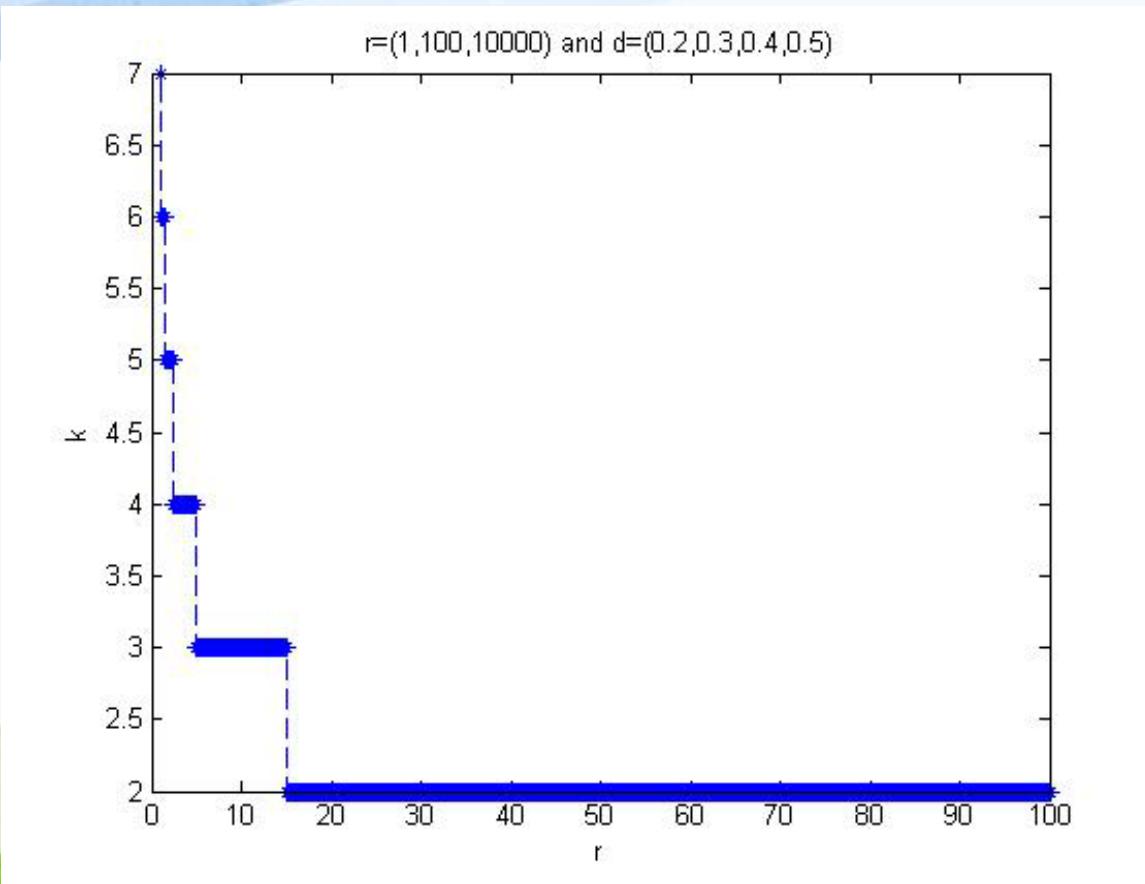
(II) Diffusion Constant

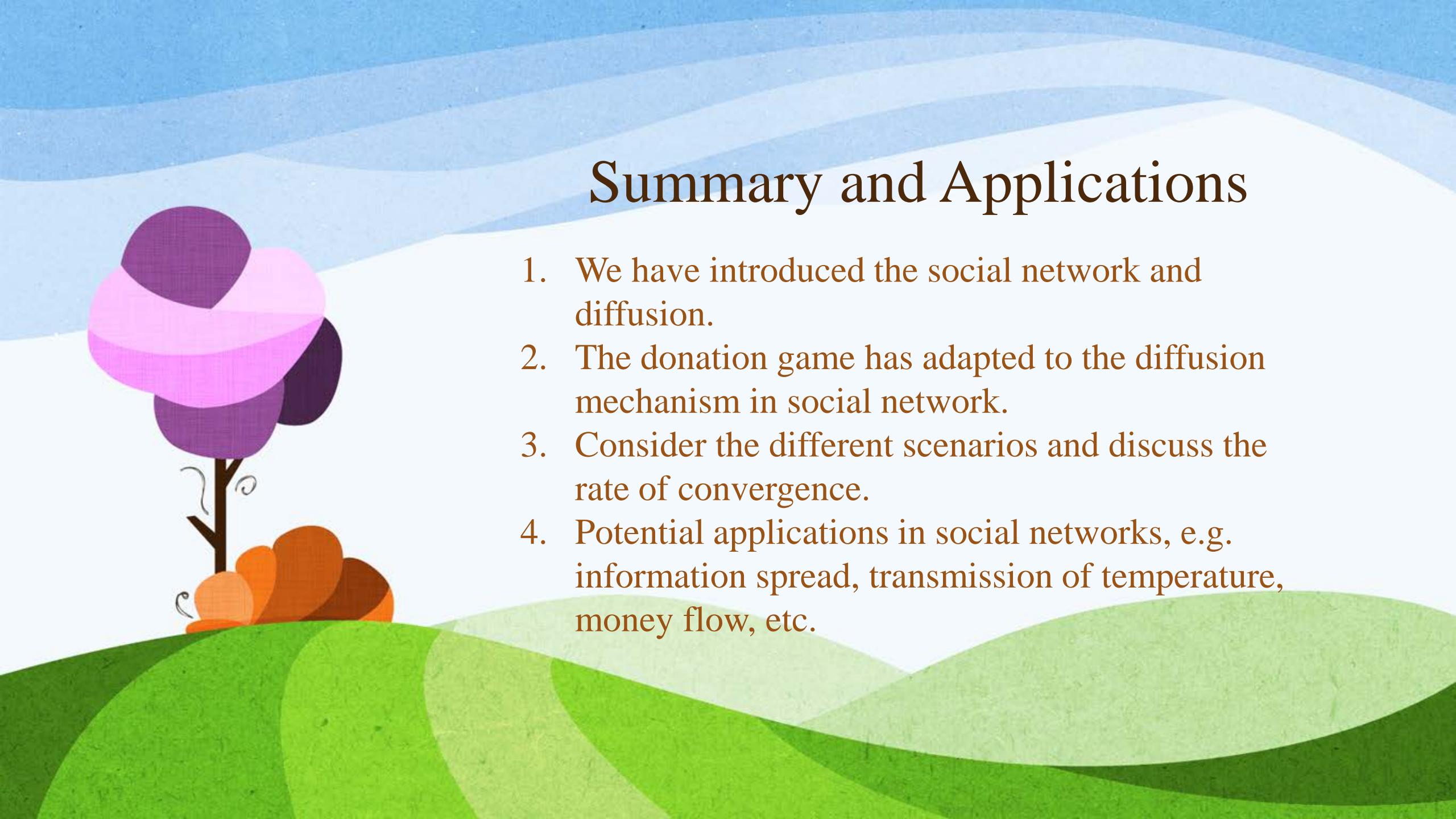


(III) Nodes



(IV) Tolerance Constant





Summary and Applications

1. We have introduced the social network and diffusion.
2. The donation game has adapted to the diffusion mechanism in social network.
3. Consider the different scenarios and discuss the rate of convergence.
4. Potential applications in social networks, e.g. information spread, transmission of temperature, money flow, etc.

Reference

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1. P.C.-Y. Weng, F.K.H. Phoa and Y.S. Chiang. A general attribute diffusion mechanism on social networks, accepted. (2015+)
 2. F. Xiong, Y. Liu, Z.-J. Zhang, J. Zhu and Y. Zhang. An information diffusion model based on retweeting mechanism for online social media, Physics Letters A, Vol. 376, pp. 2103--2108 (2012).
 3. S. Wasserman and K. Faust. Social Network Analysis: Methods and Applications, Cambridge, UK, 1994.