Networks of Information Exchange: Evidence on Information Hubs

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  - It proposes a novel way to measure the number of links of the match
  - And controls for the endogeneity of this independent variable.

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- Comola (2007) looks at the models bilateral link formation and the impact of links of links. The value of each link is measured by wealth.

Networks of Information Exchange: Theoretical Basis

Networks Formation Games: Star Networks

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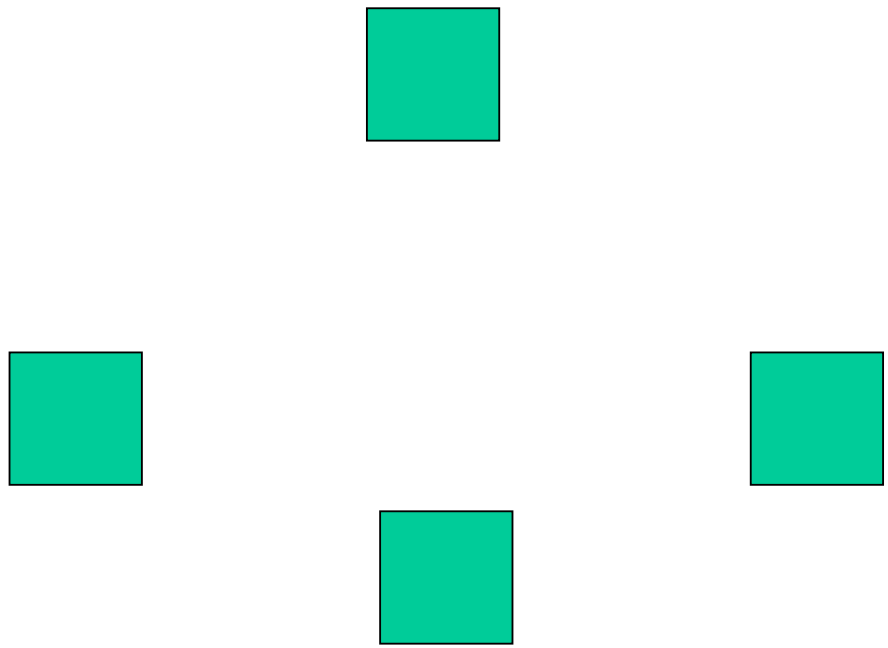
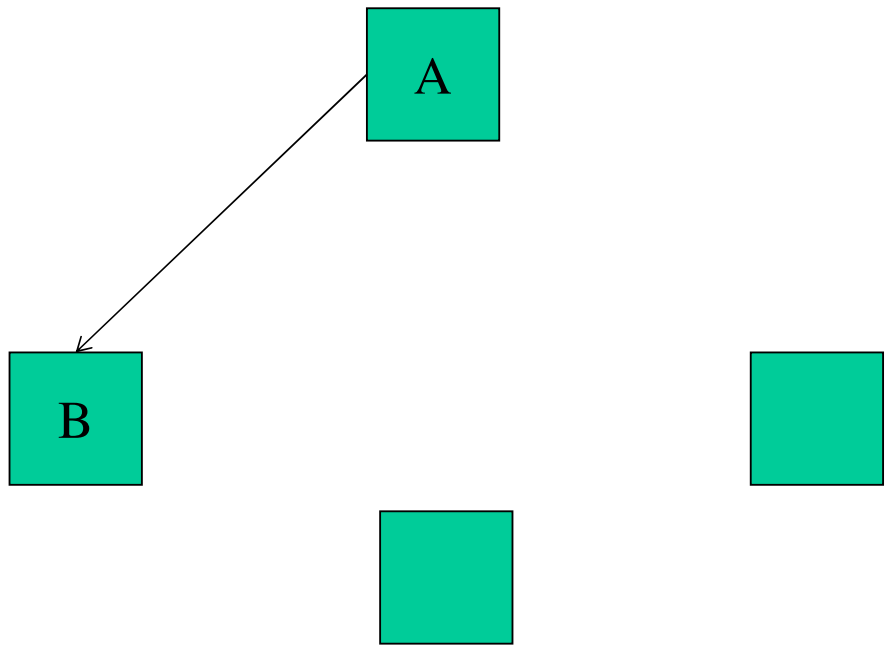
  - Information is not passed along perfectly but with some **decay**
  - The **cost** of link formation is high enough

Network Formation: Role of Decay



4 node network

Any Network Possible Without Decay



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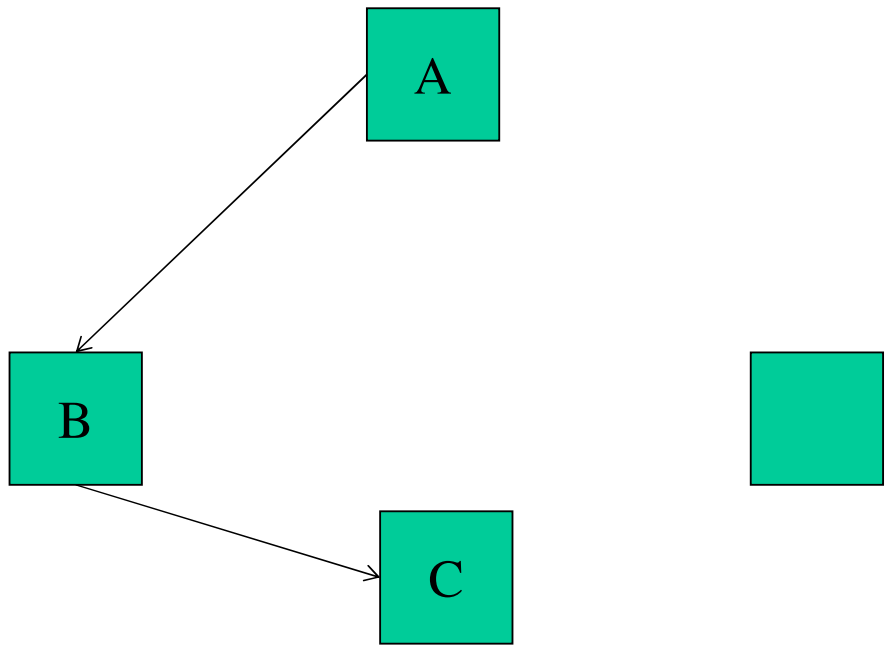

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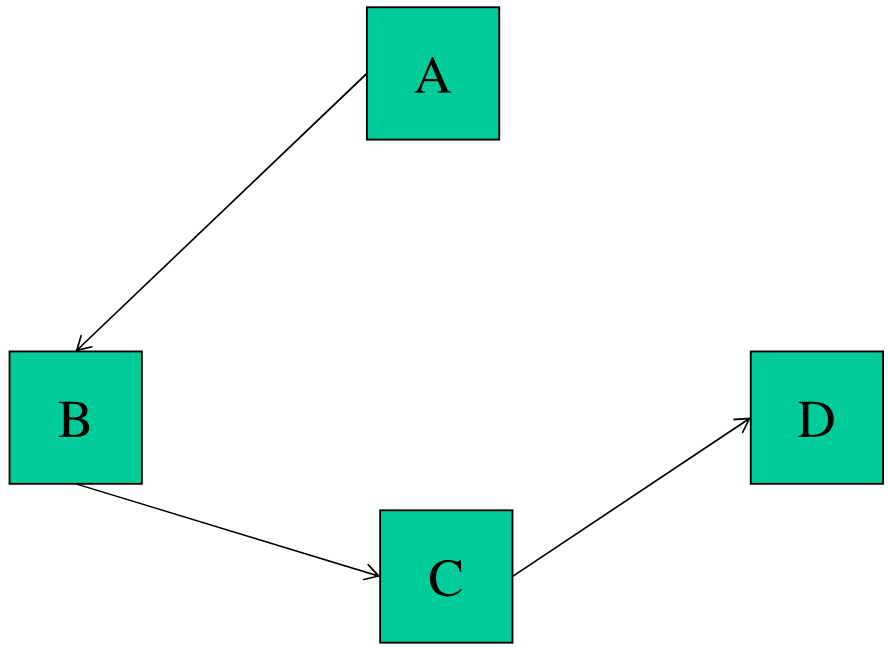
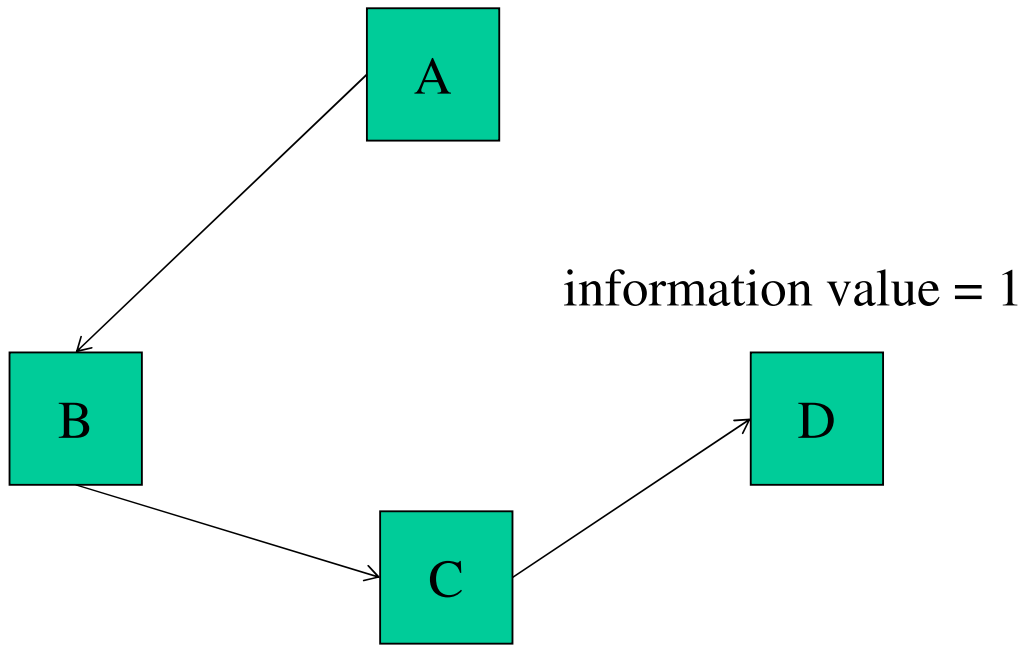


Information Flow is Perfect Without Decay



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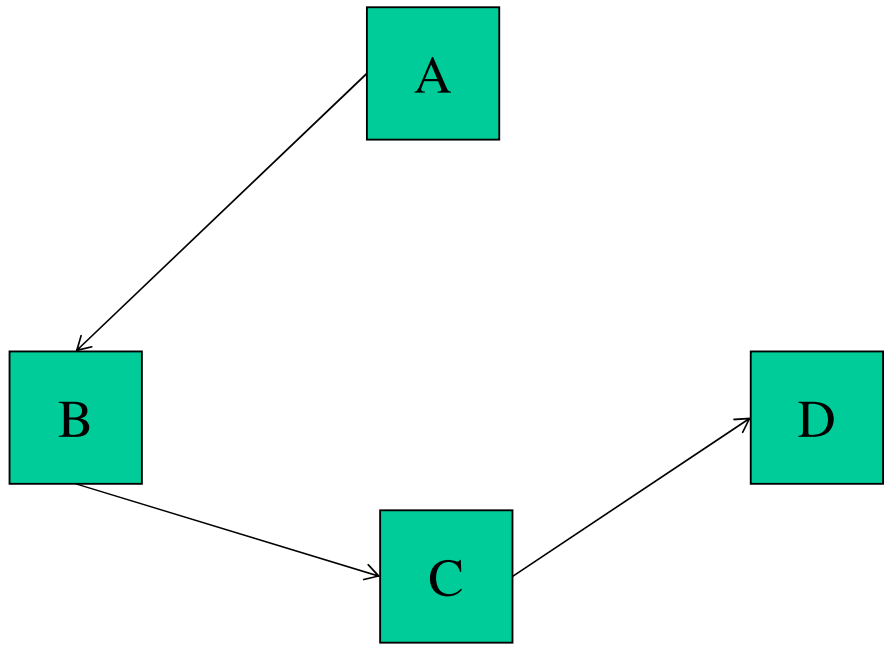

information value = 1

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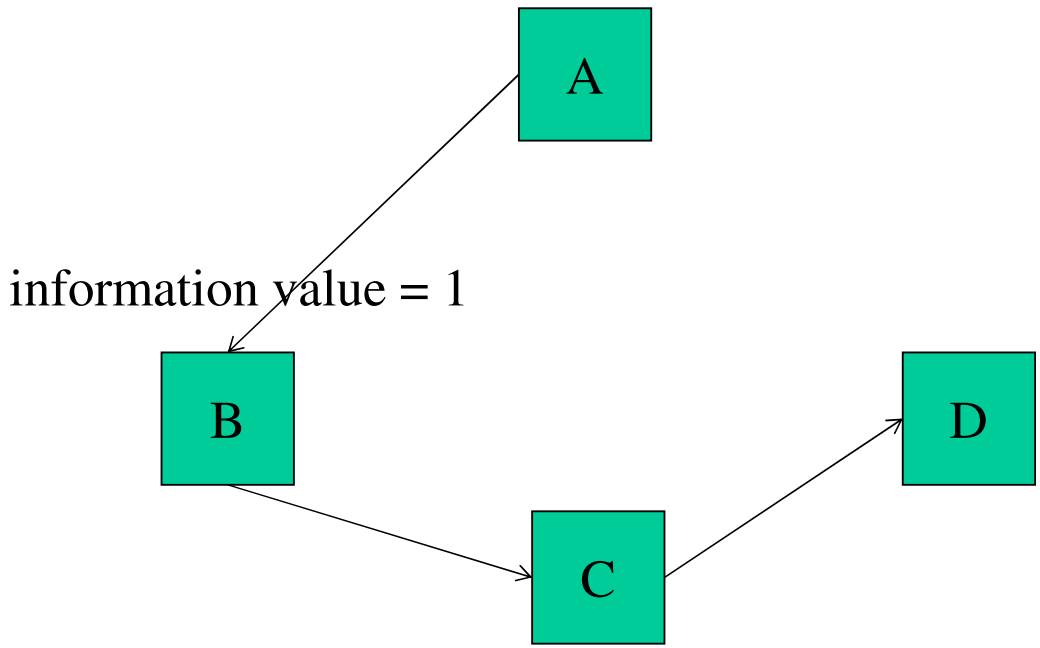

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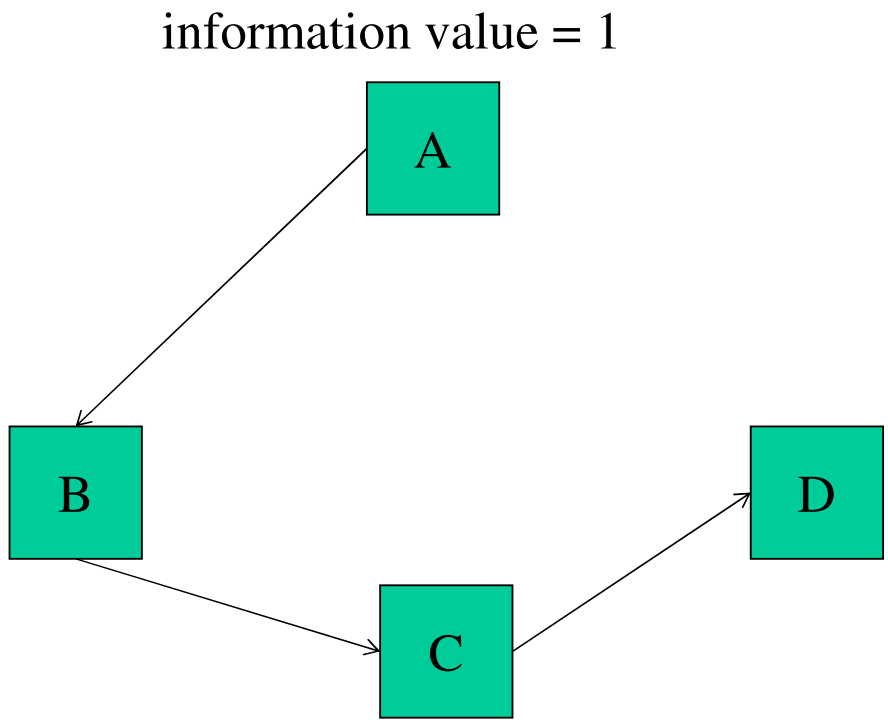
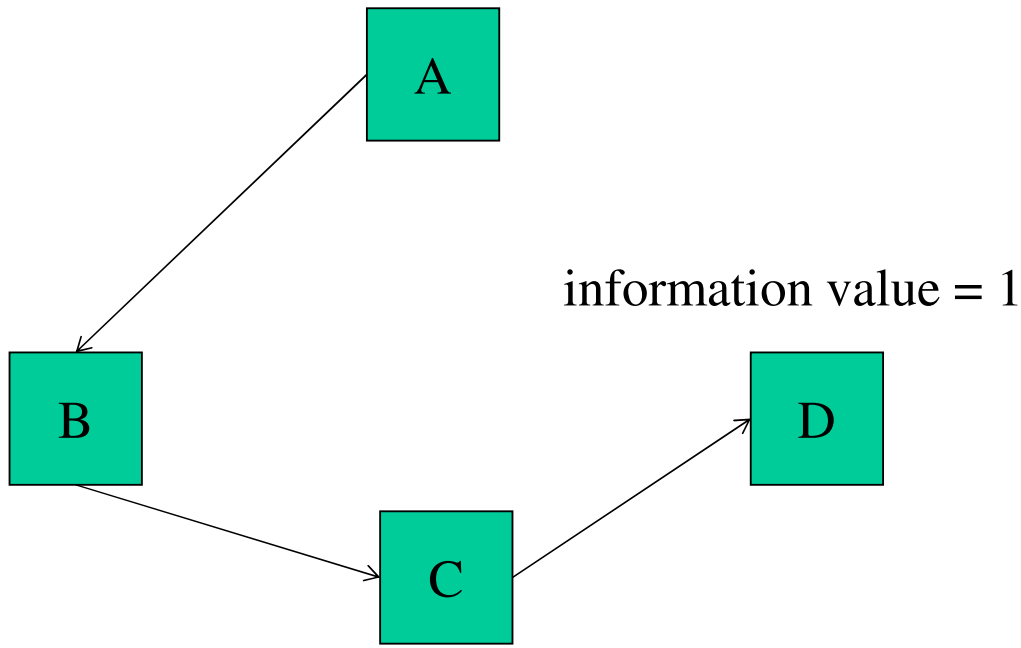


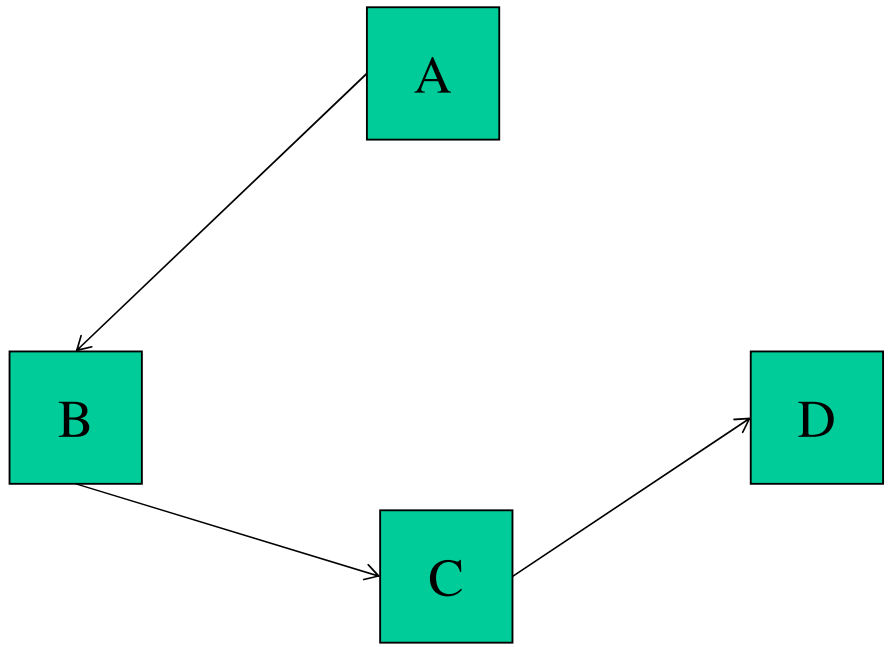
Information Flow With NO Decay

Information Flow is NOT Perfect With Decay



Information Flow With Decay of 10%

Information Flow is NOT Perfect With Decay



information value = .9

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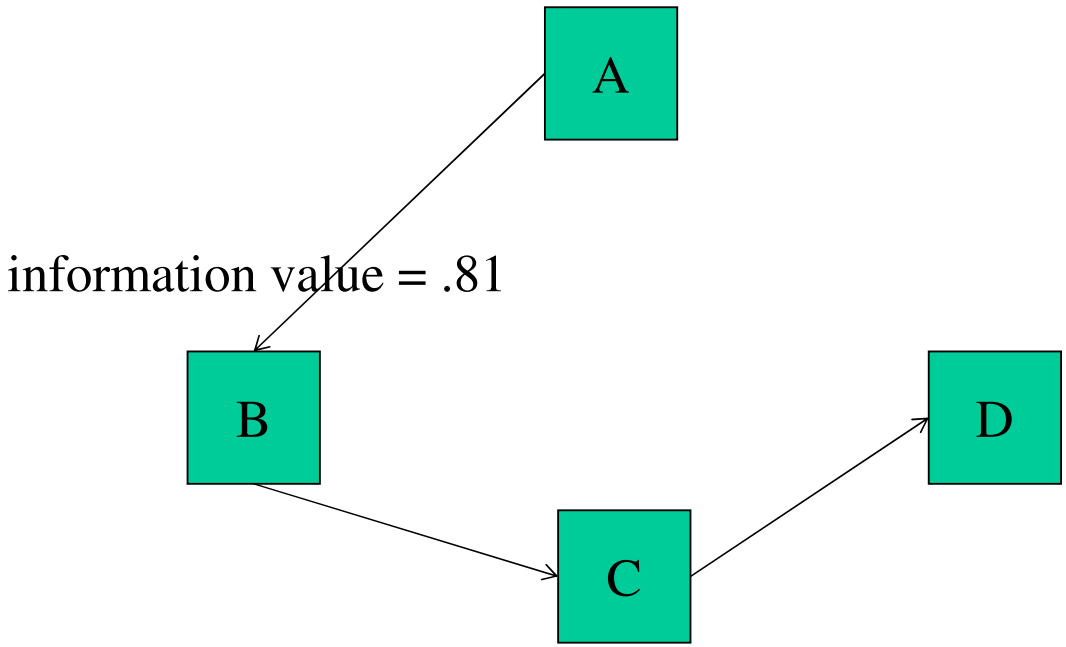

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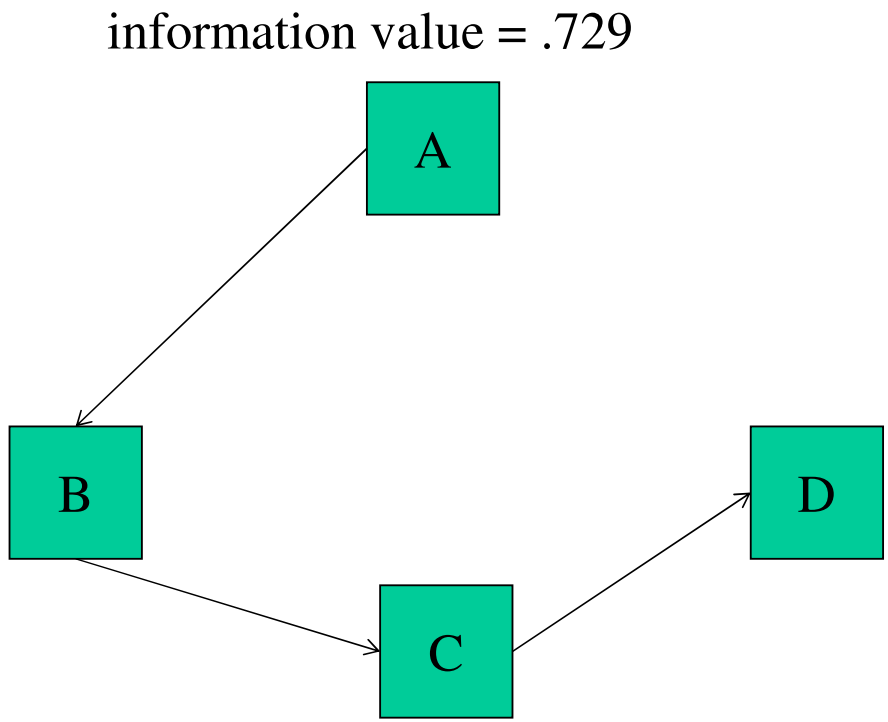
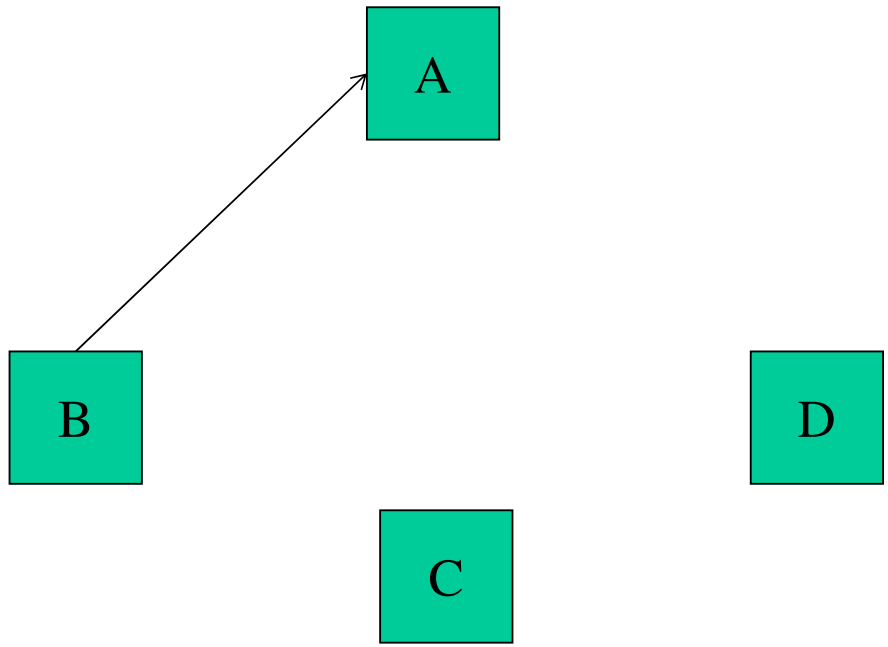


Information Flow With Decay of 10%

Star Network: Most Efficient With Decay



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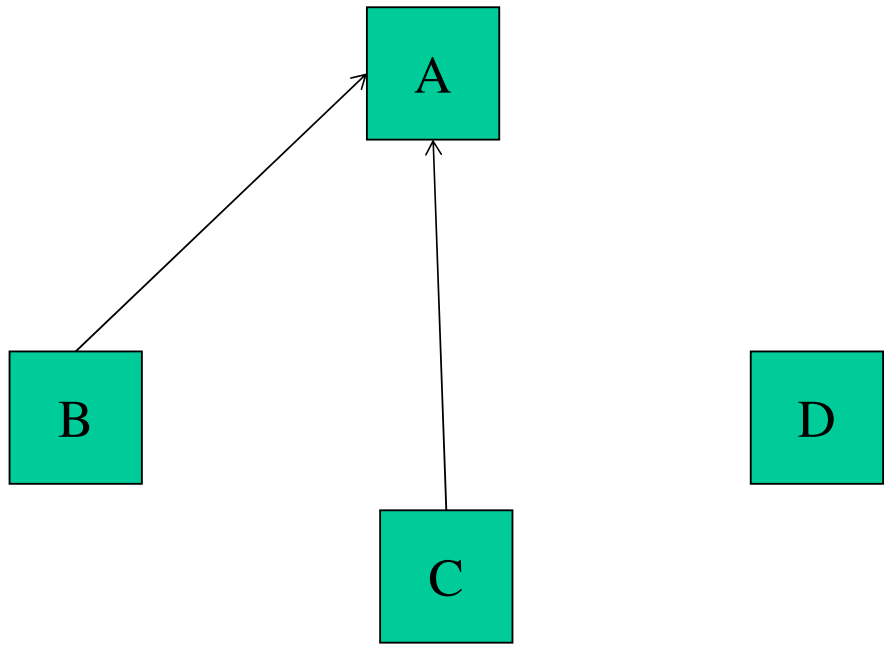

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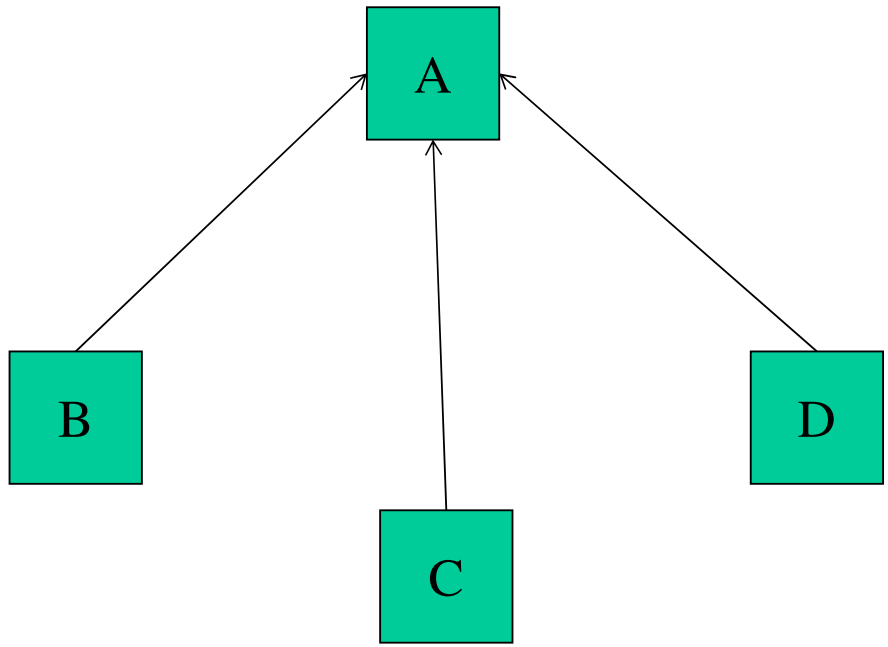

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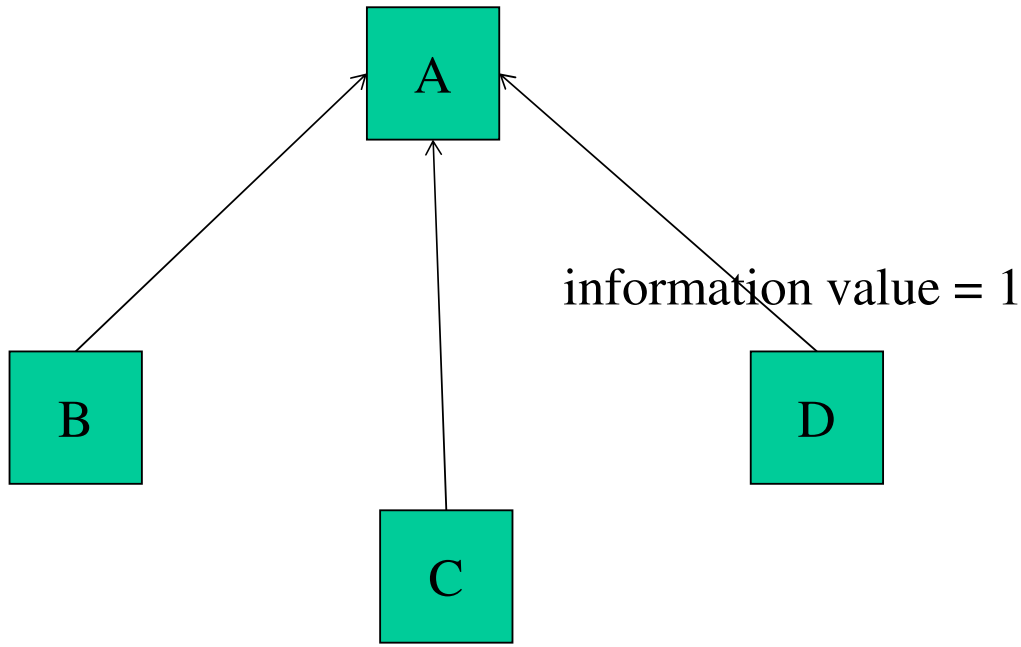

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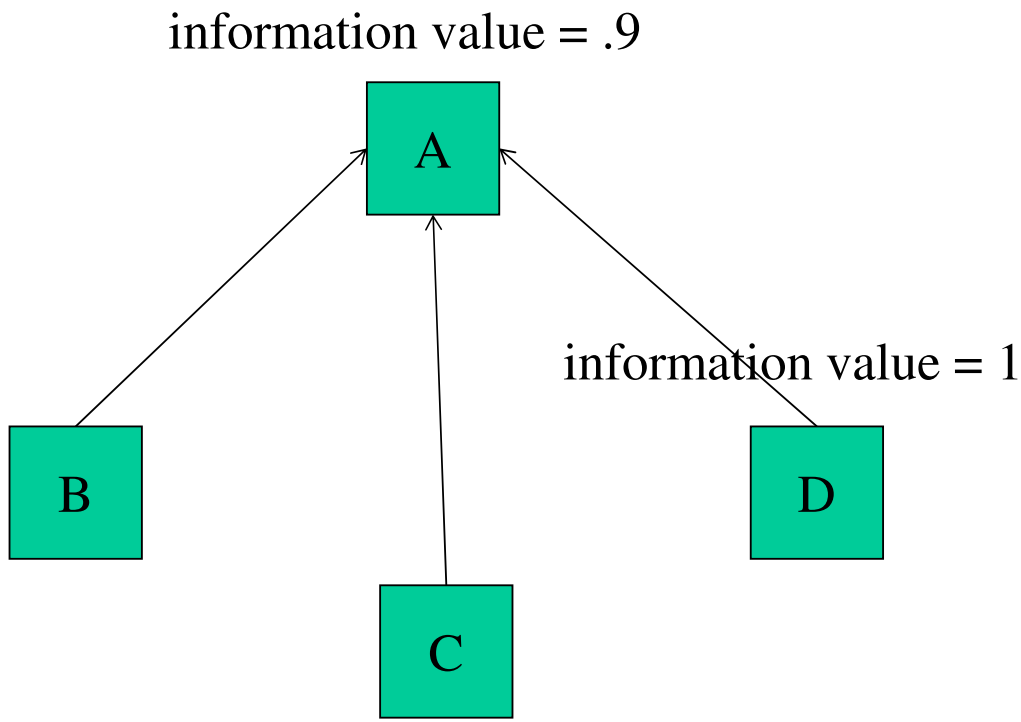

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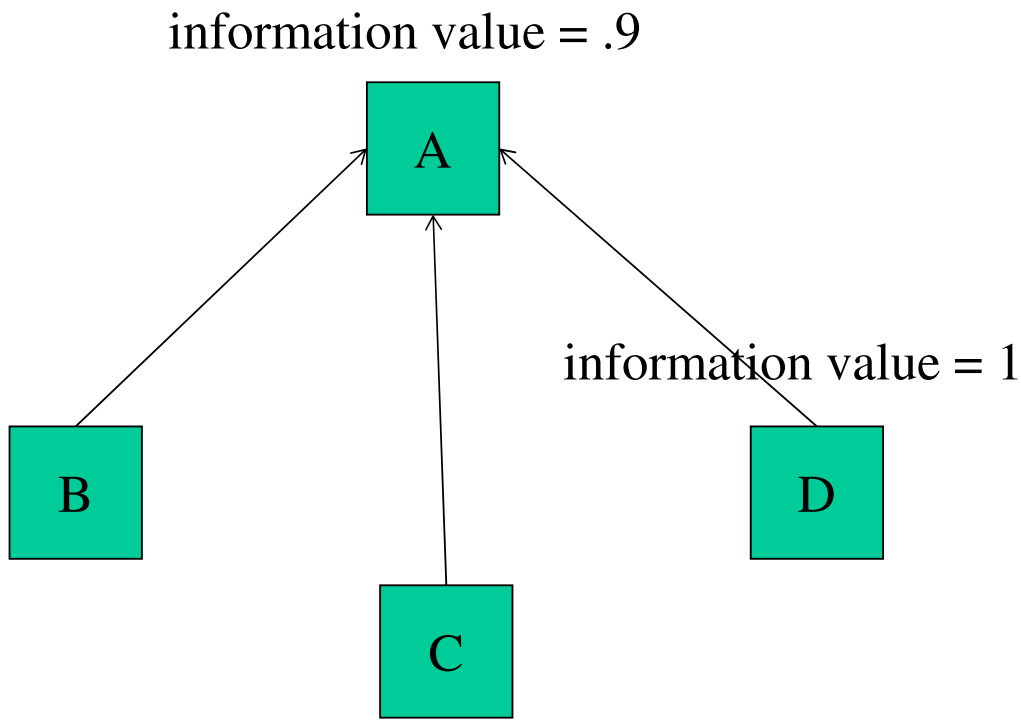

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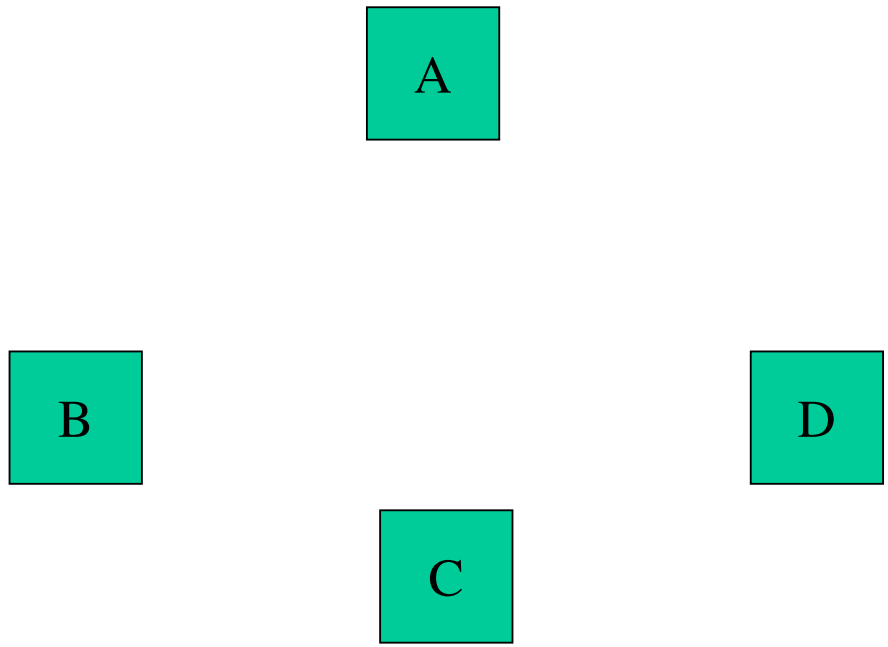
Network Formation: Role of Link Cost



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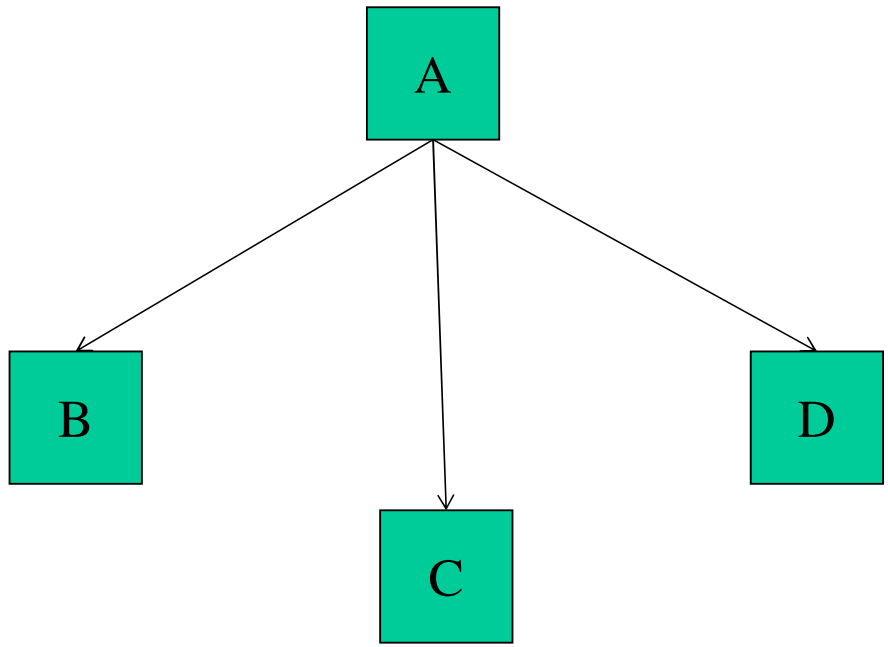

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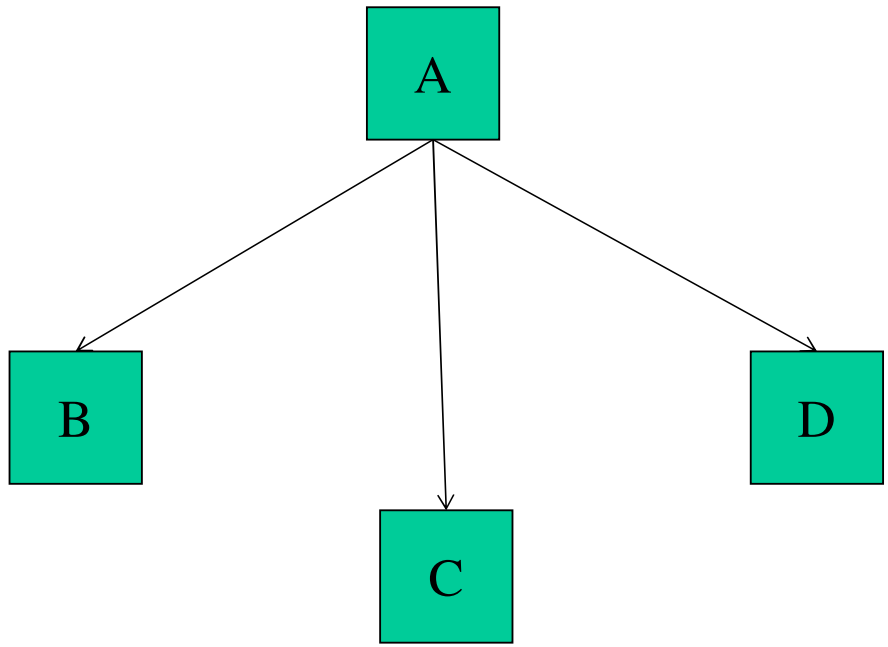
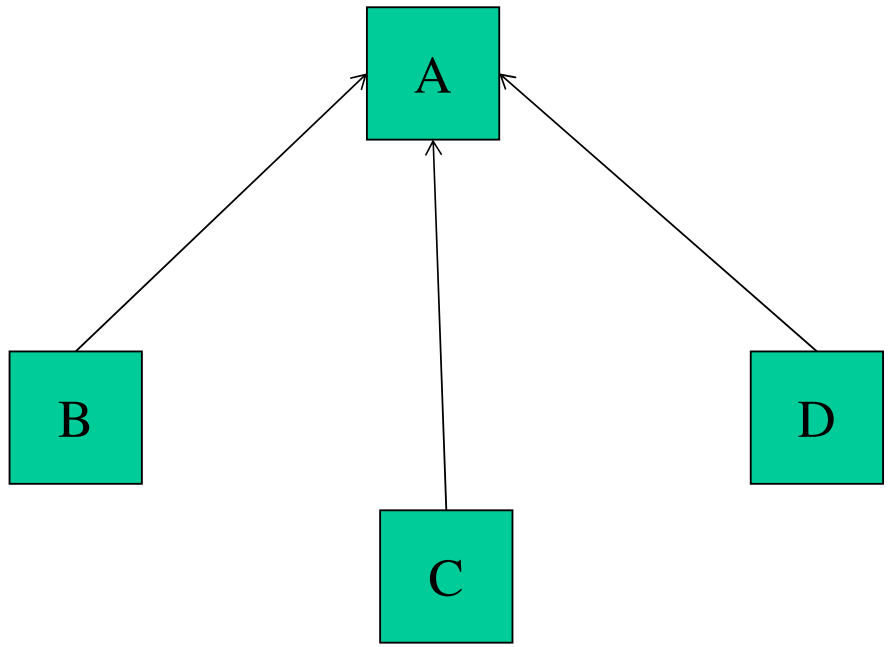


Network Formation with NO Cost

=>

Everyone Links to Everyone Else

Decay + High Cost = Star Network



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- An **Information Aggregator** is a player who can double (or more) the value of any information received by him and transmit it (back) to his direct links.
- If the above game is changed to have one player who is an Information Aggregator, then any non-empty Nash network has the structure of a periphery sponsored star with this player as the center.

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- Such networks arise when costs of link formation are variable and depend on group membership/social distance.

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- Or, the bias is always negative.

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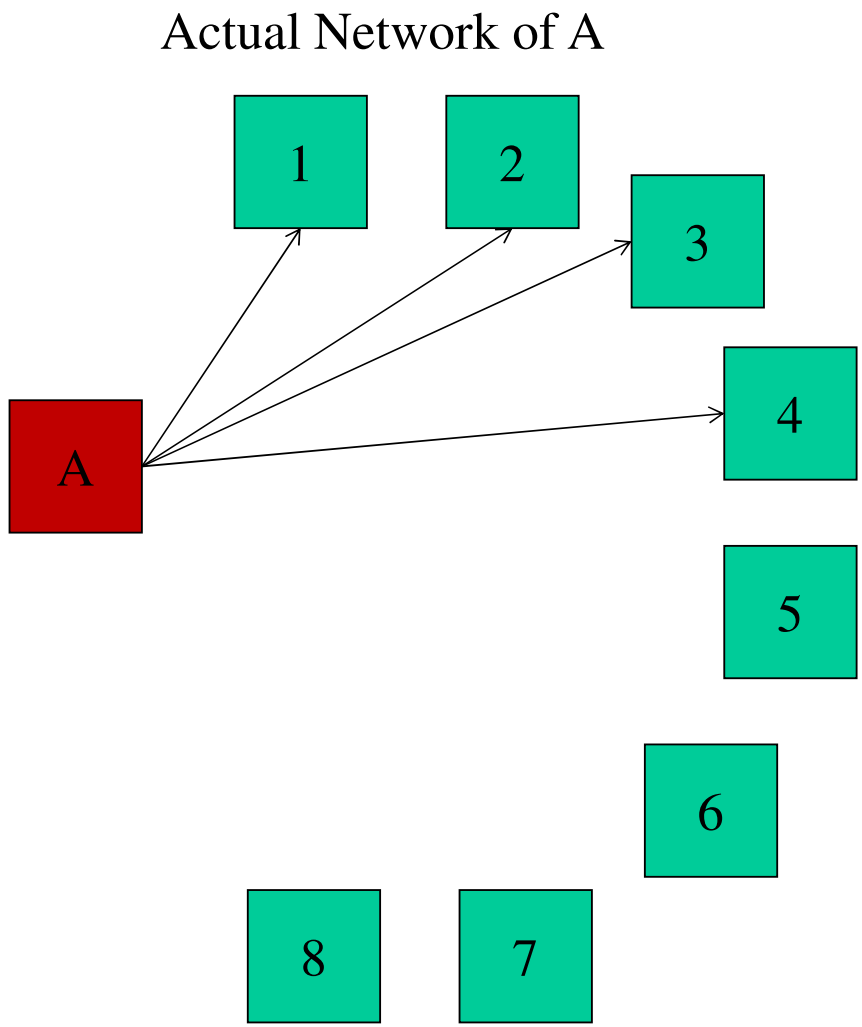

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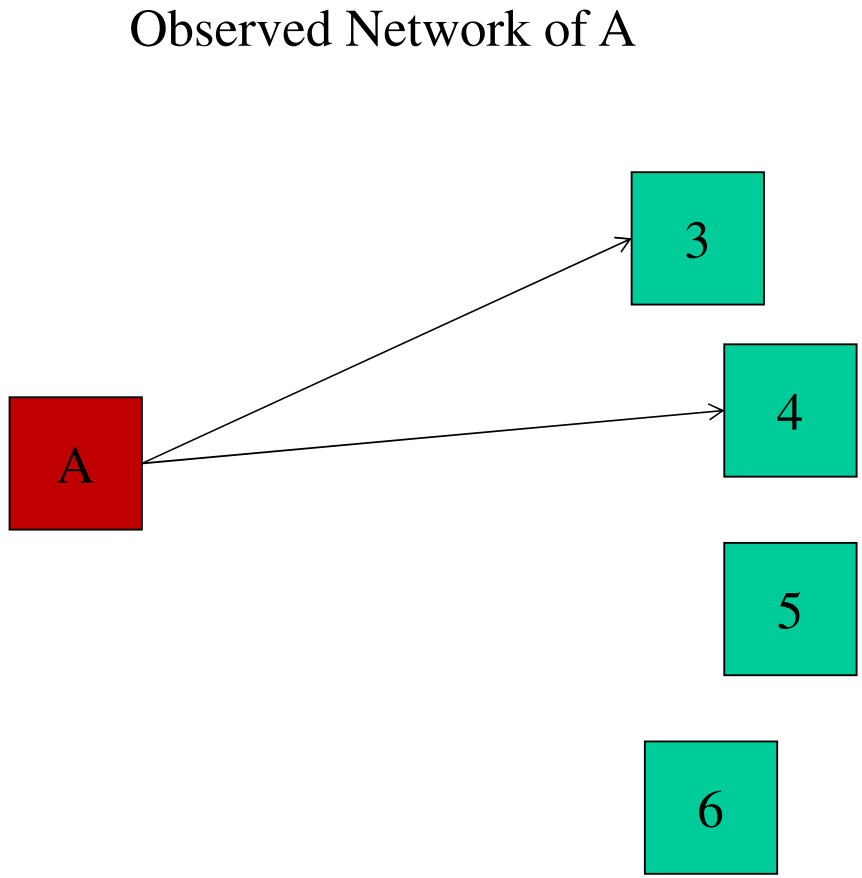

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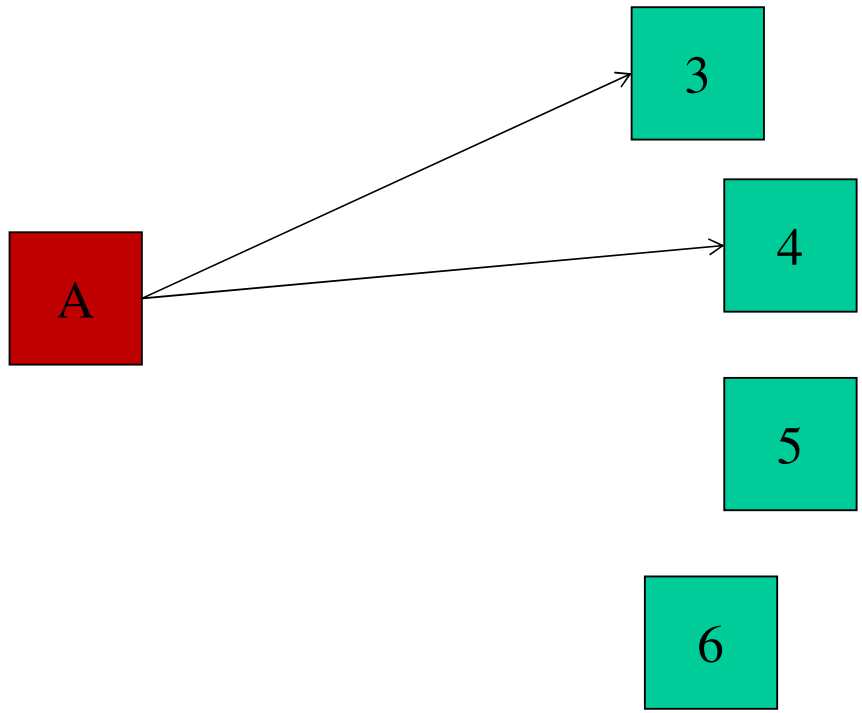

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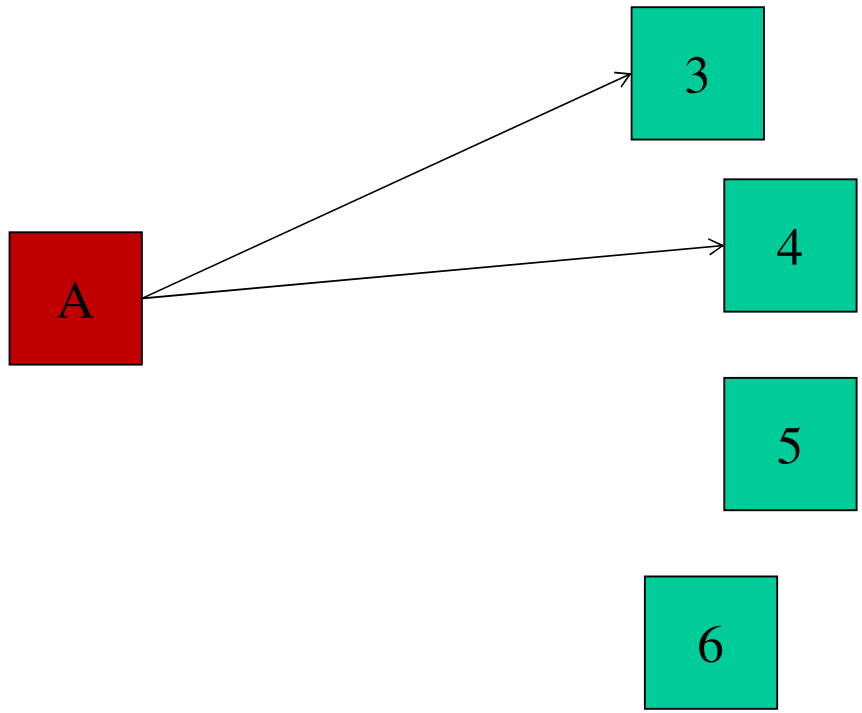

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- While the total links received or made by a node are measured with a negative bias, the proportion of links received/made is not
- Hence, the mismeasured variable is replaced by the variable measuring the proportion of links received/made by a node which is directly related to the mismeasured variable.

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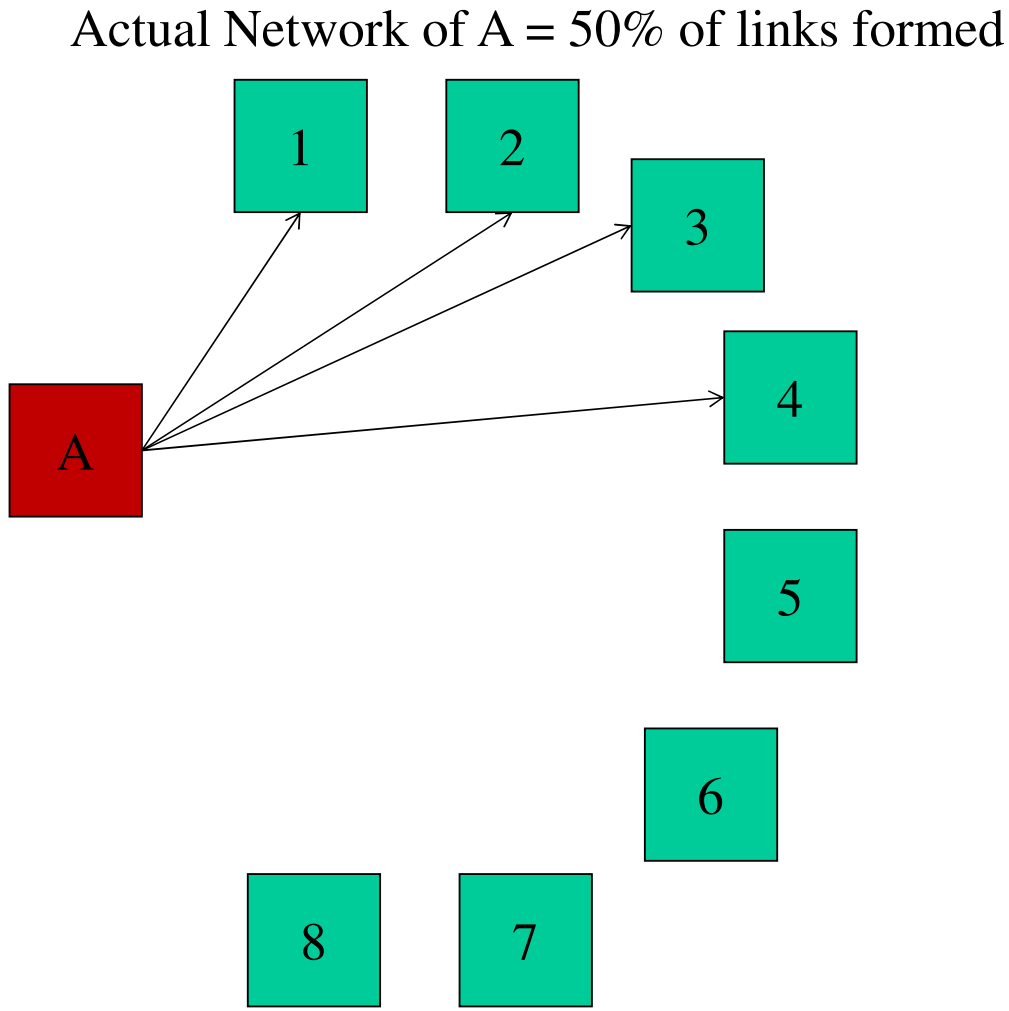
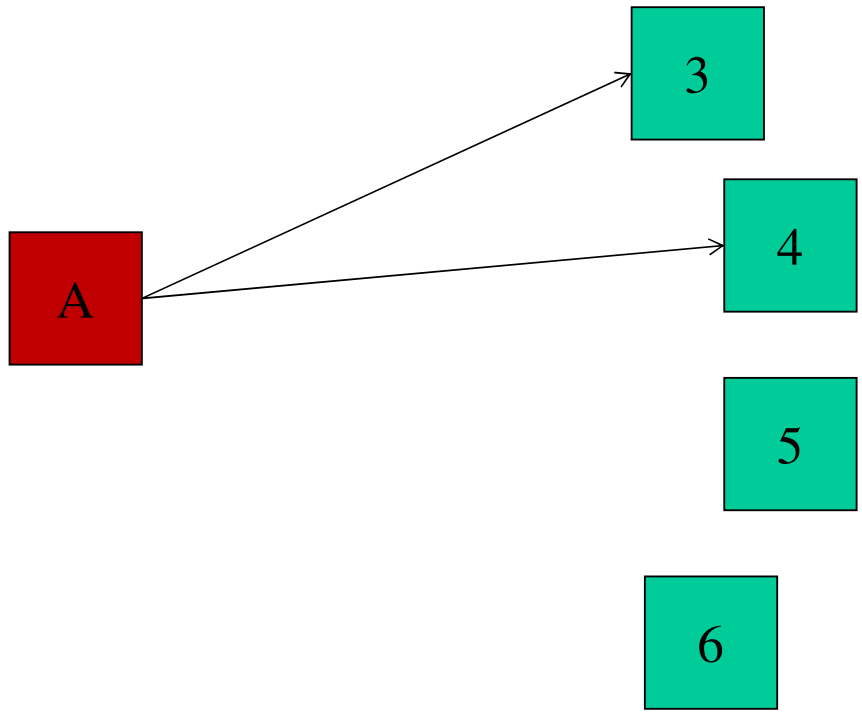


Measurement Bias: Problem

Observed Network of A = 50% of links formed



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- The independent variable is the total links of B, which depend on the decisions to link taken by B.
- Since all the decisions to link are assumed to be taken simultaneously, there is the concern of endogeneity.

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  - Or total links of the match can be modeled as the social distance between the match and the representative/average individual as well his level of information aggregation.
- The endogeneity is modeled as the correlation between the error terms - the first coming from the estimation of A's decision to link with B and the second coming from the estimations of total links of B

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- Note that the cost of link formation must be proportional to the social distance or say $\beta d(X_i, X_j)$

Empirical Model

The the following represents the decision of player i:

$$\begin{aligned} g_{ij} &= 1(\pi_{ij}(g) > 0) \\ \pi_{ij}(g) &= \delta m_j + \alpha v_j + \beta d(X_i, X_j) + \varepsilon_{ij} \\ m_j &= \gamma d(X_j, X_A) + \eta_j \\ \varepsilon_{ij} &= \rho \eta_j + \nu_{ij} \end{aligned}$$

where δ, α, β are parameters to be estimated, ε_{ij} is the error term, ν_{ij} and η_j are independent of all the regressors and all errors are assumed to be normally distributed.

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- Similarly, g_{ji} and g_{ki} reflect j's and k's decision, respectively, to form a link with i. Since both of these decisions depend on the characteristics of i they are not independent and neither are the errors ν_{ji} and ν_{ki}.

Spatial Correlation

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- Use the corrected standard errors as suggested by Cameron, Gelbach and Miller (2011).

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- Link question used is: Could you go to x if you had a problem with unhealthy crops?
- The data on identity: age, religion, clan, gender, if they are the first of their family to reside in that village, experience with pineapples, wealth and soil type.

Table: Variables Measuring Presence of Link

Variable	Definition	Mean
Askprob	1 if respondent would ask match if they had a problem with unhealthy crop, 0 o.w.	0.327
Askfert	1 if respondent would go to match for advice on new fertilizer, 0 o.w.	0.303
Askplant	1 if respondent would go to match to discuss planting method, 0 o.w.	0.309
Askbuyer	1 if respondent would go to match for find a buyer, 0 o.w.	0.253
Ask	sum of the previous four variables	1.191

Table: Summary Statistics of the Respondent

age	age in years	40.079
off	1 if respondent hold an office, 0 o.w.	0.206
school_level	values from 0 to 5 for school level	1.53
pineyrs	experience in years with pineapple farming	2.125
firsthere	1 if respondent is first of his family to reside in the village, 0 o.w.	0.231
resprel	values from 1 to 16 for religion	4.272
Clan	values from 1 to 30 for clan	7.233
Gender	1 if respondent is female, 2 if male	1.454
stype	values 1 to 3 for soil type	1.887
tot_wealth	value of the nonland assets (in million cedis)	0.851

Table: Corresponding Variables for the Match

Variable	Definition
Mage	age of the match in years
Moff	value 1 if match holds an office, 0 o.w.
Mschool_level	discrete variable taking values from 0 to 5
Mpineyrs	match's experience in years with pineapple farming
Mfirsthere	1 if match is first of his family to reside in the village, 0 o.w.
Mresprel	discrete variable taking values from 1 to 16
MClan	discrete variable taking values from 1 to 13
MGender	value 1 if match is female, 2 if male
Mstype	values 1 to 3 for soil type
Mtot_wealth	value of the nonland assets (in million cedis)

Table: Variables Measuring Distance between Respondent and Match

Variable	Definition	Mean
Shhn	1 if both from the same household, 0 o.w.	0.007
Sfirsthere	1 if either both first from their families in the village, or both not the first in the village, 0 o.w.	0.655
Sresprel	1 if both have the same religion, 0 o.w.	0.272
Sgender	1 if both have the same gender, 0 o.w.	0.499
Sclan	1 if both belong to the same clan, 0 o.w.	0.304
Sptot_wealth	absolute difference in wealth if respondent is wealthier	0.448
Sntot_wealth	absolute difference in wealth if match is wealthier	0.98
Sstype	1 if both have the same soil type, 0 o.w	0.41

Table: Variables Measuring Total Links of Match

Variable	Definition	Mean
Mpin_prob	Proportion of links received by match regarding information on unhealthy crop	0.277
Mpin_fert	Proportion of links received by match regarding information new fertilizer	0.233
Mpin_plant	Proportion of links received by match regarding information on planting method	0.258
Mpin_buyer	Proportion of links received by match regarding information on finding a buyer	0.252
Mpin	Proportion of links received by match regarding any information	0.255

Mpout_prob	Proportion of links made by match regarding information on unhealthy crop	0.324
Mpout_fert	Proportion of links made by match regarding information on new fertilizer	0.304
Mpout_plant	Proportion of links made by match regarding information on planting method	0.308
Mpout_buyer	Proportion of links made by match regarding information on finding a buyer	0.252
Mpout	Proportion of links made by match regarding any information	0.297

Table: Variables Measuring Distance of Match from Average Respondent

Variable	Definition	Mean
Mdmoderesprel	1 if match has the modal religion , 0 o.w.	0.438
Mdmodeclan	1 if match belongs to the modal clan, 0 o.w	0.464
Mdpmeanage	Absolute difference in age between match and average if match is older, 0 o.w.	5.576
Mdnmeanage	Absolute difference in age between match and average if match is younger, 0 o.w.	4.908

Mdpmeantot_wealth	Absolute difference in wealth between match and average if match is poorer, 0 o.w.	0.368
Mdnmeantot_wealth	Absolute difference in wealth between match and average if match is wealthier, 0 o.w.	0.364
Mdmodestype	1 if match has the the modal soil type, 0 o.w	0.72

Table: Simple OLS results for the Variable Ask

	Ask
MPin	3.541
	(15.08)**
MPout	0.048
	-0.28
off	-0.6
	(2.68)**
Mschool_level	-0.133
	(3.02)**
pineyrs	-0.057
	(2.26)*
Shhn	1.543
	(2.87)**
Observations	790
z statistics in parentheses	
* significant at 5%; ** significant at 1%	

Table: First stage OLS results for total links received by match

	MPin
Moff	-0.006
	-0.1
Mschool_level	0.001
	-0.06
Mpineyrs	0.016
	(2.70)**
Mfirsthere	-0.097
	-1.83
Mdmoderesprel	-0.005
	-0.11
Mdpmeantot_wealth	-0.052
	-0.66
Mdnmeantot_wealth	0.004
	-0.26
Observations	133
R-squared	0.13

Table: First stage OLS results for total links made by match

	MPout
Moff	-0.088
	-1.33
Mschool_level	-0.072
	(3.10)**
Mpineyrs	0.004
	-0.65
Mfirsthere	-0.172
	(3.03)**
Mdmoderesprel	0.014
	-0.31
Mdpmeantot_wealth	0.209
	(2.49)*
Mdnmeantot_wealth	0.031
	-1.65
Observations	133
R-squared	0.23

Table: Control Function results for the Variable Ask with correct S.E.

	Ask
MPin	4.659
	(3.51)**
MPout	-1.109
	(2.00)*
off	-0.664
	(2.71)**
Moff	-0.162
	-1
school_level	-0.123
	-1.38
Mschool_level	-0.232
	(3.72)**
pineyrs	-0.07
	(2.74)**
Mpineyrs	-0.01
	-0.44

Shhn	1.774
	(3.05)**
Sclan	0.343
	(2.06)*
Mpinresid	-1.393
	-1
Mpoutresid	1.313
	(2.06)*
Observations	630

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- The game theoretic models also suggest a way to overcome the inherent endogeneity of the previous prediction.
- The results from the data indicate that in the particular data set used, links are in fact formed taking into consideration both the number of links received and made by the match.
- The number of links made by the match is decreasing in their education and wealth level, indicating perhaps that more links are made by nodes of lower informational value. This is further reflected in the fact that the probability of forming a link is decreasing in the number of links made by the match.