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Characterizing the Relation between Hubs and Overlapping Nodes in Modular Networks

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Characterizing the Relation between Hubs and Overlapping Nodes in Modular Networks

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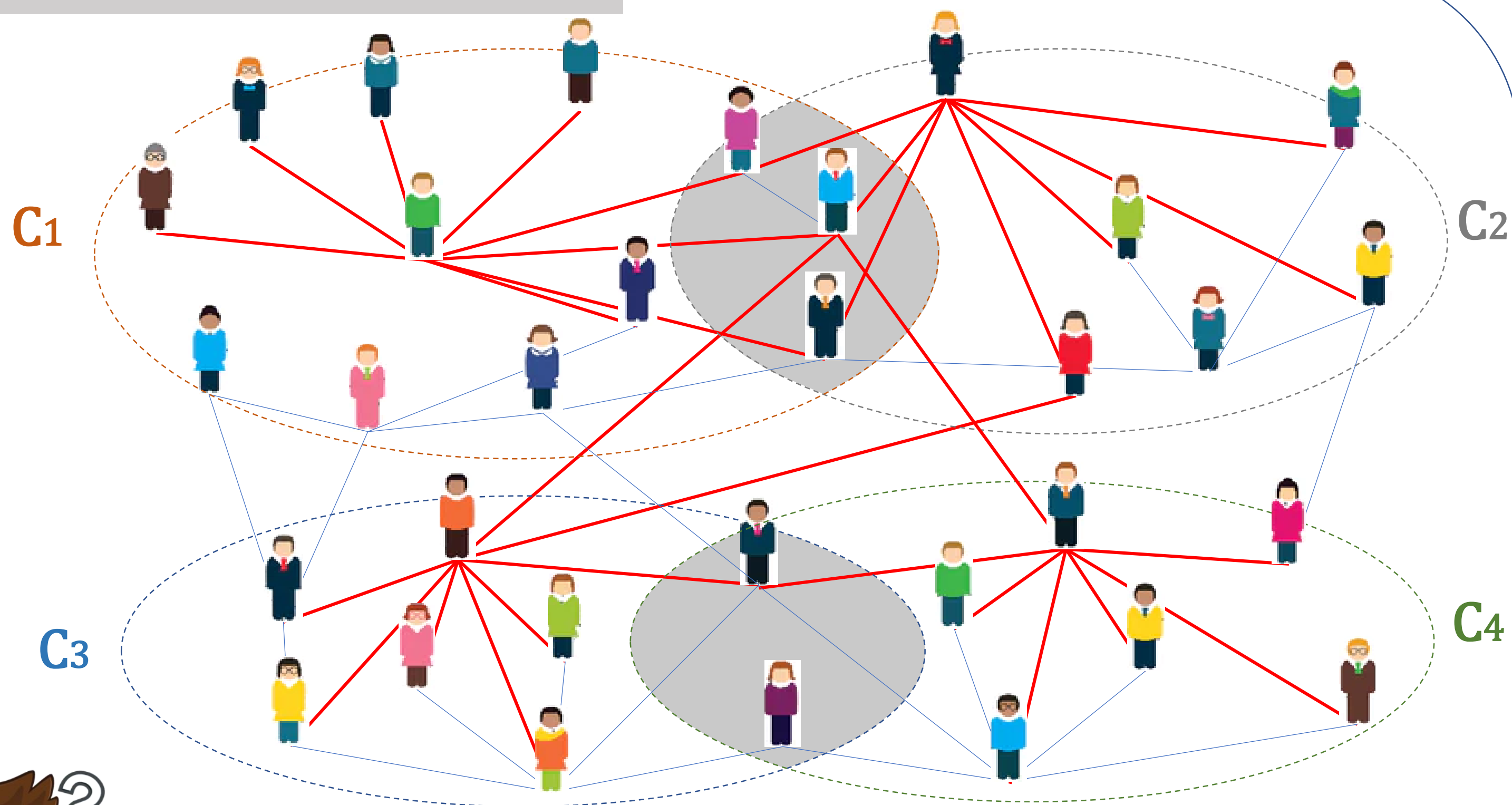
University of Burgundy FRANCE

University of Lyon 2 FRANCE

University of Burgundy FRANCE

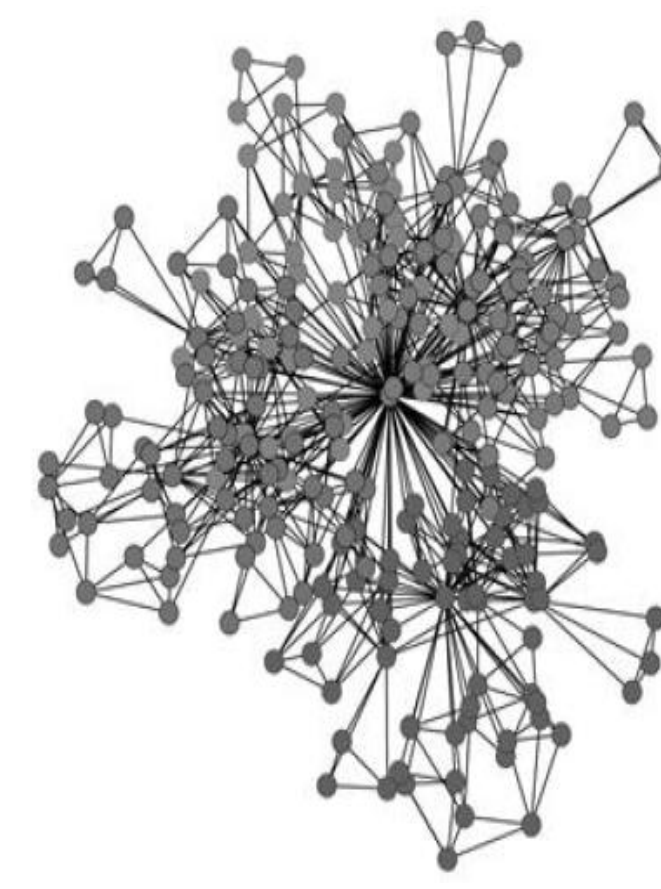
University Mohammed V MOROCCO

Problematic

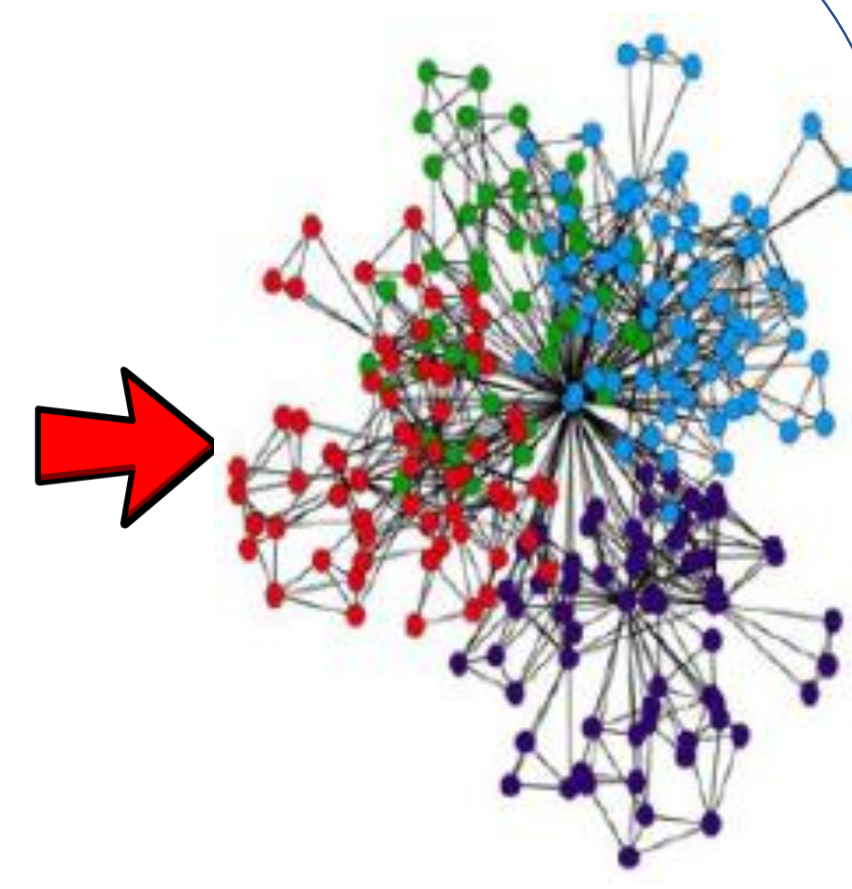


Overlapping nodes ↔ Hubs

Methodology



Community detection



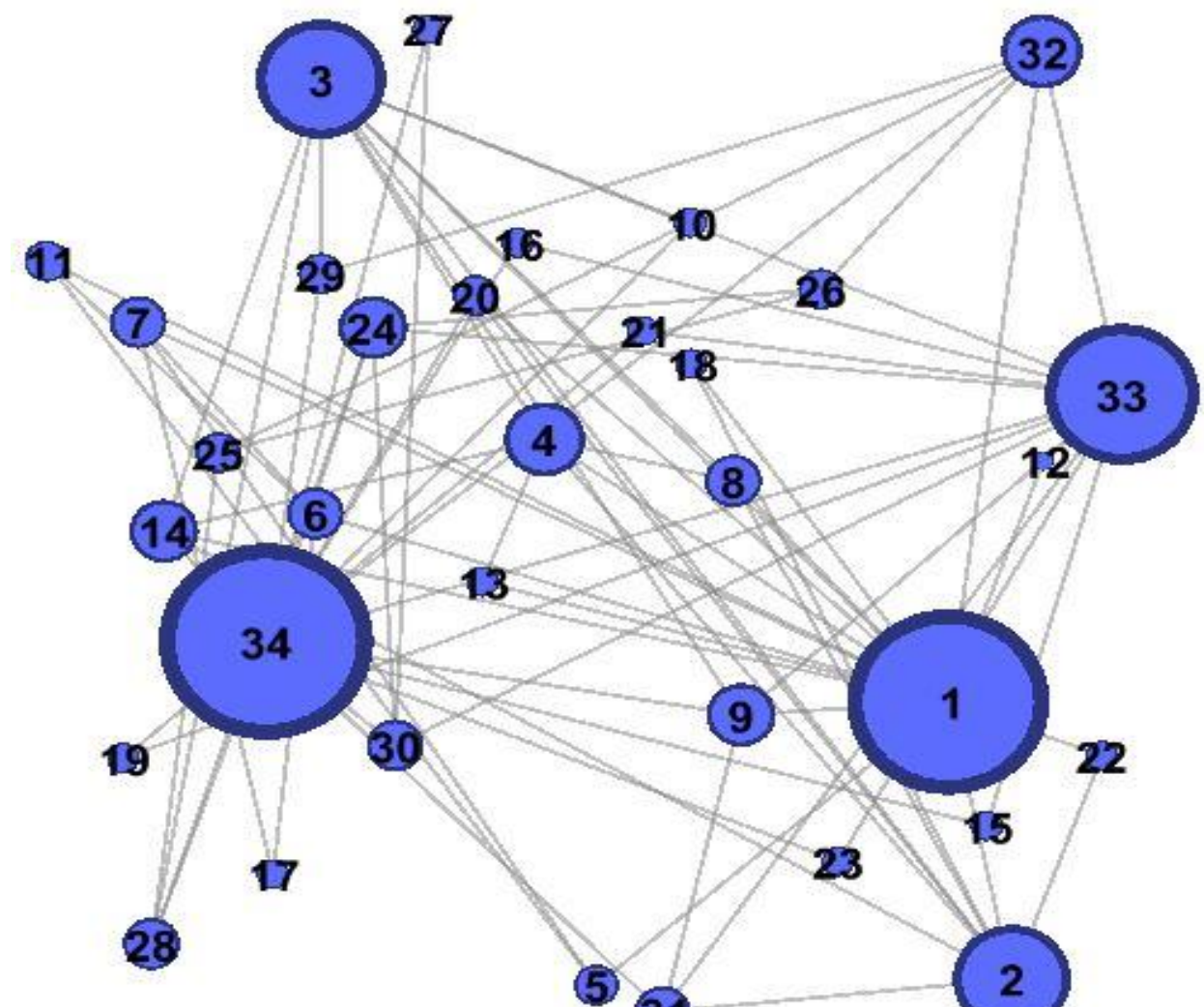
Evaluation measures

Proportion of hubs
Rank-biased overlap
Correlation
Degree distribution

Ego-network of overlapping nodes & List of Hubs

Empirical Networks

Small Size



Social network

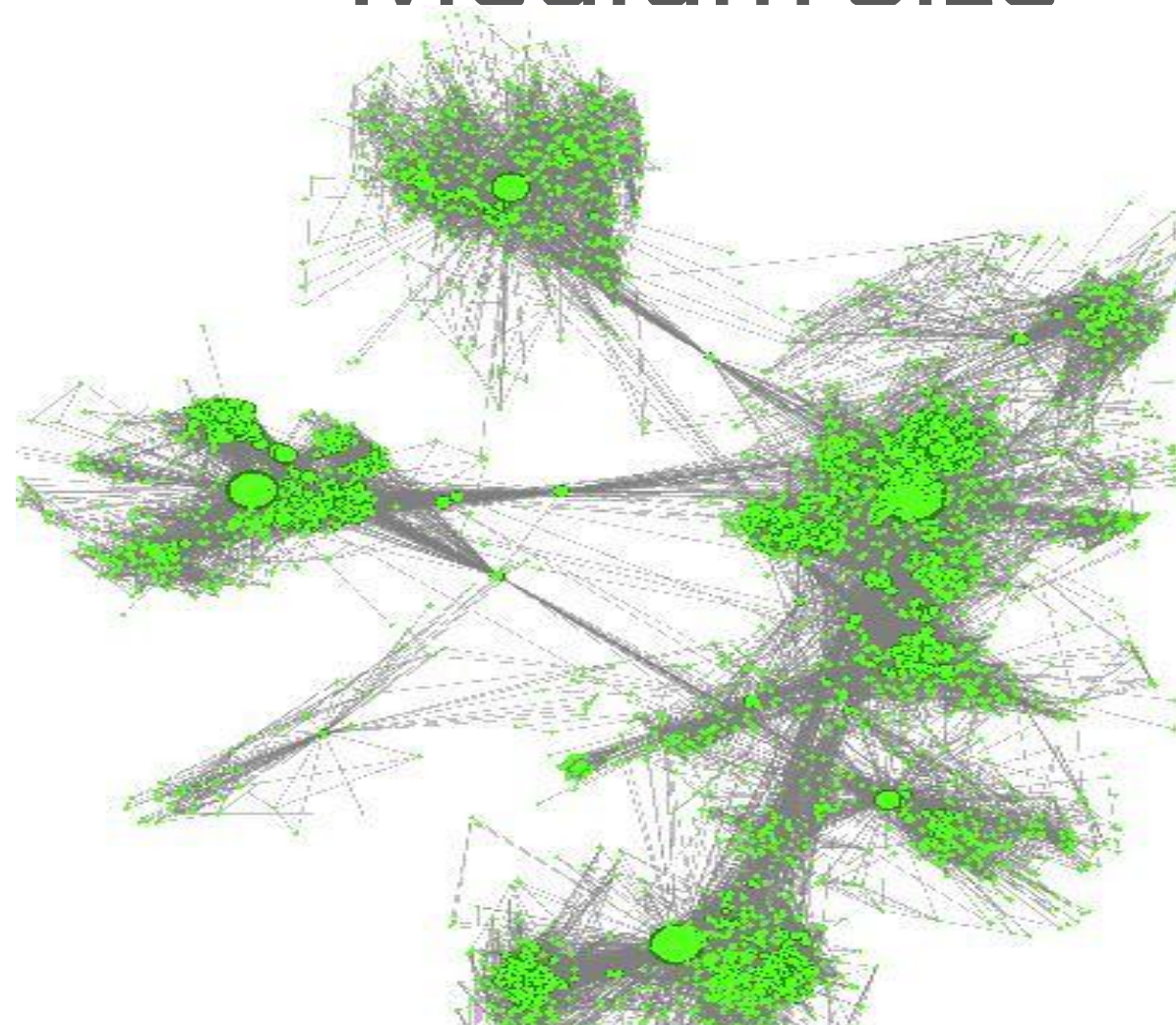
N 34
E 78

Relatively high density
Non Assortative

Karate club

Les Miserables
Dolphins
Game of thrones
American college football

Medium Size



Social network

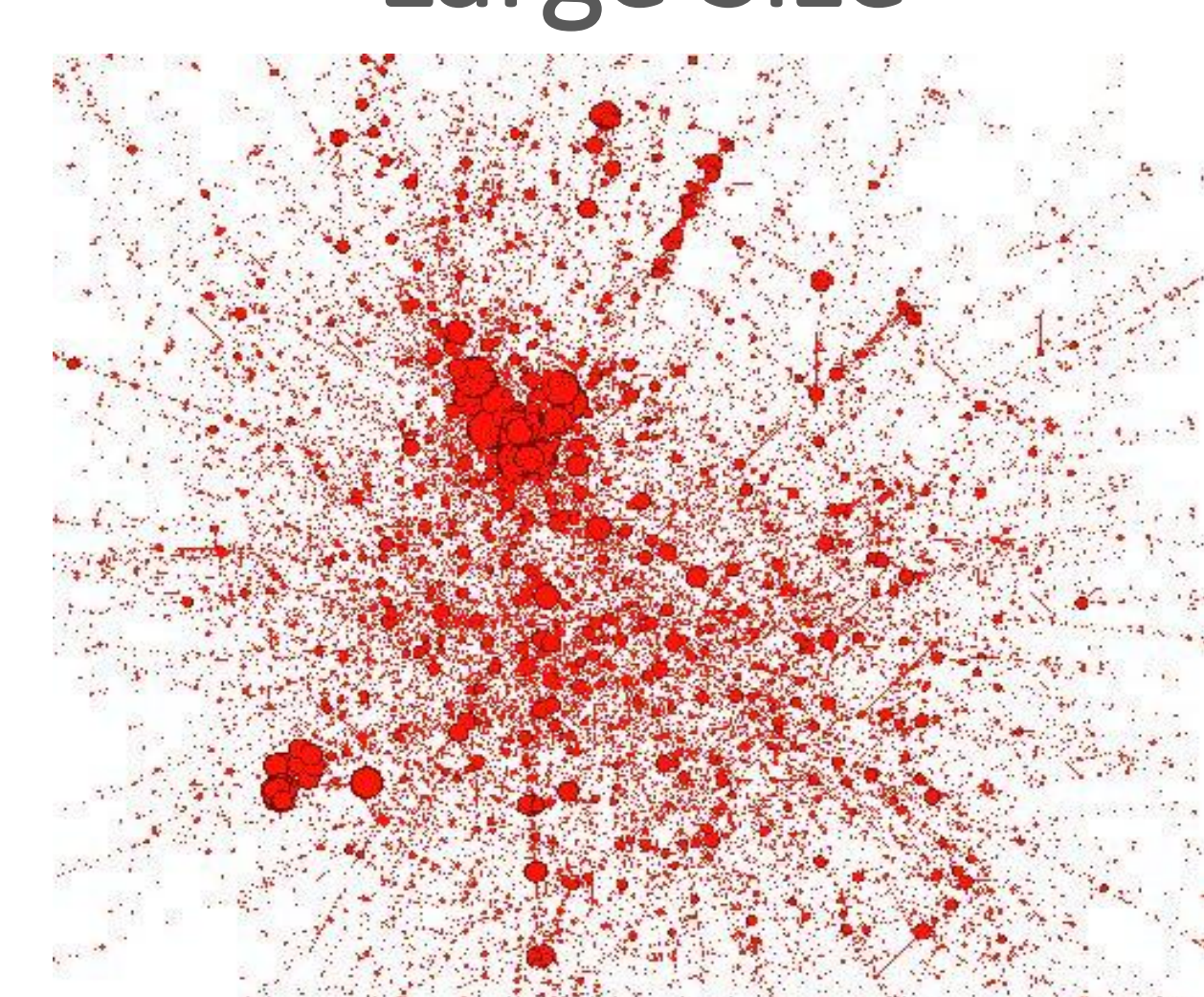
N 4039
E 88234

Small density
Assortative

Ego-Facebook

Ca-GrQc

Large Size



Collaboration network

N 23133
E 93497

Very small density
Assortative

Condense Matter

ca-HepTh
Enron Email
Amazon
dblp

Results

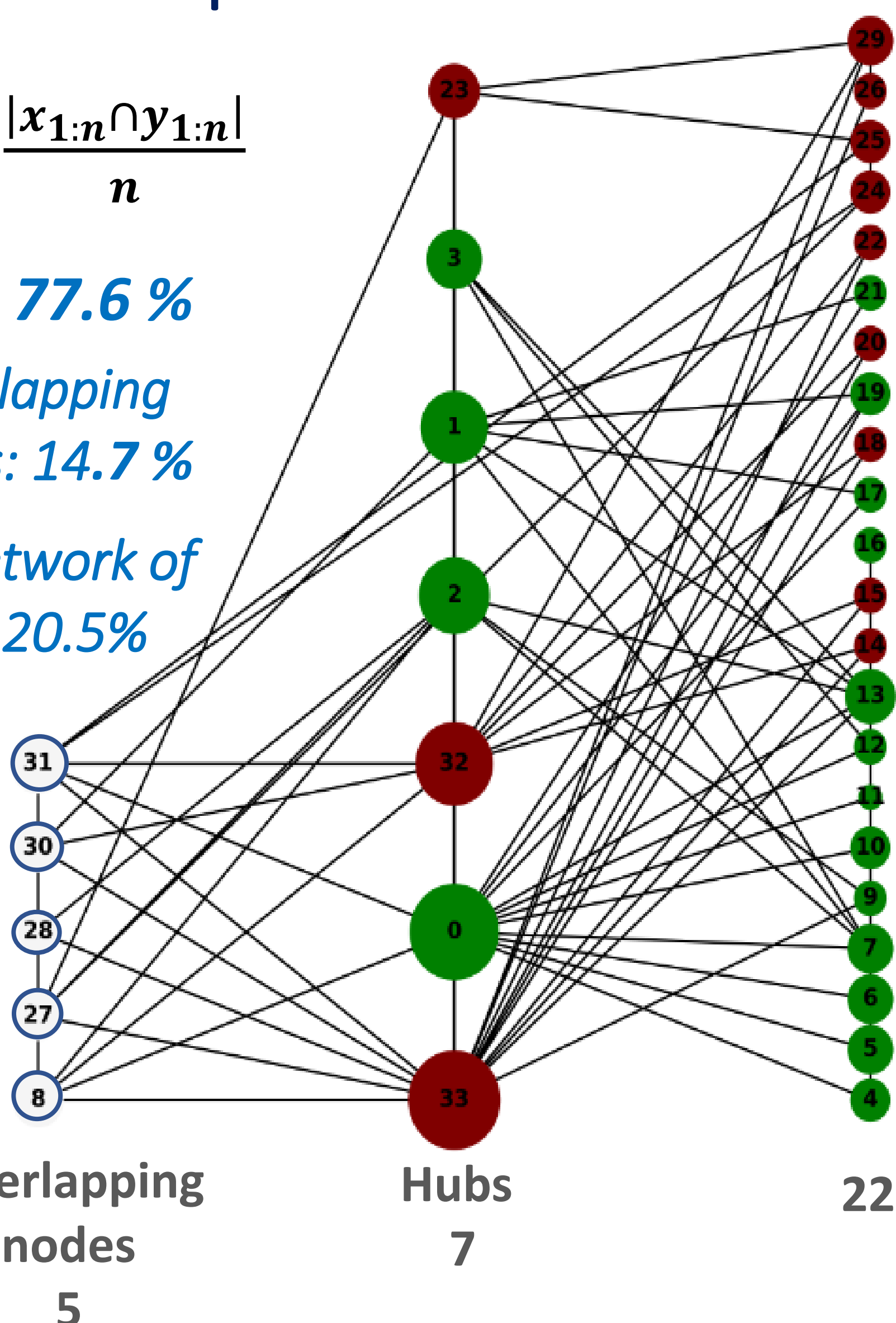
Proportion of hubs

$$A_n = \frac{|x_{1:n} \cap y_{1:n}|}{n}$$

$A_n = 77.6\%$

Overlapping nodes: 14.7%

Ego Network of O.N: 20.5%



Rank-biased overlap

$$g(X,Y) = \sum_{d=1}^n (1-P)P^{d-1} * A_d$$

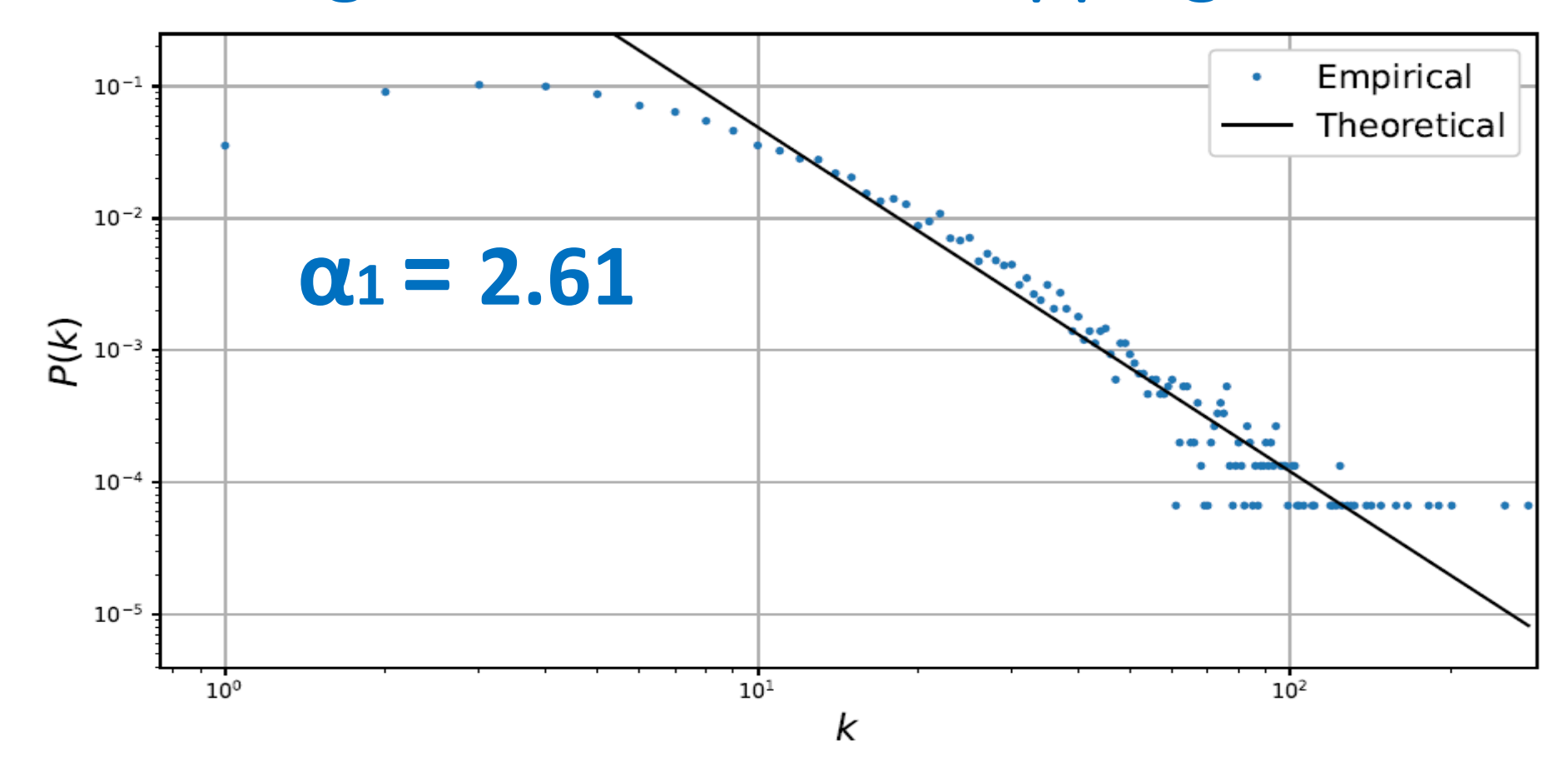
Network	$p=0.5$	$p=0.98$
Karate club	0.99	0.84
ego-Facebook	0.99	0.84
CondMat	1	0.99

Correlation

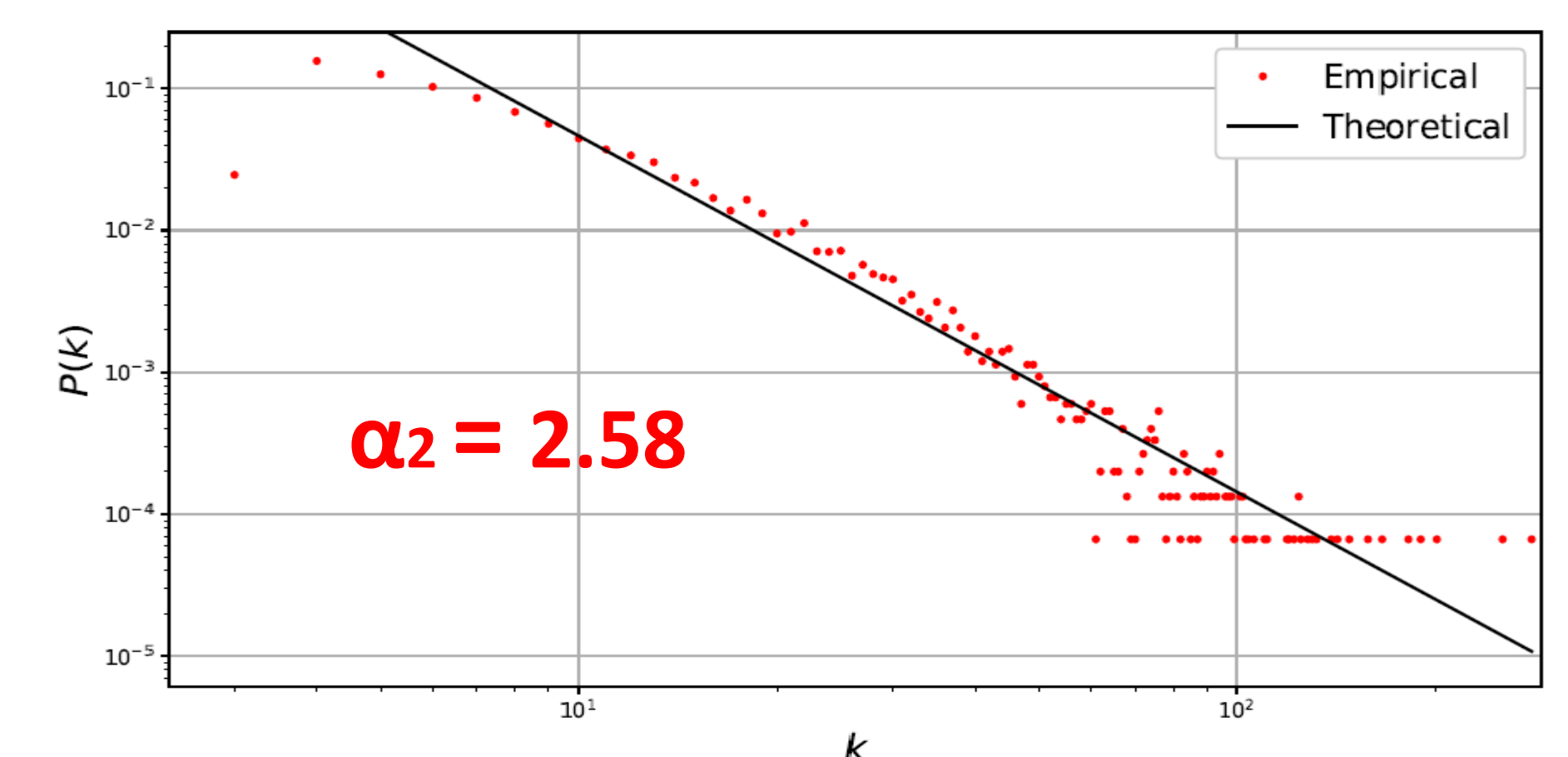
Network	Pearson Correlation	Spearman Correlation
Karate club	0.99	0.98
ego-Facebook	0.98	0.98
CondMat	0.98	0.99

Degree distribution

Neighbors of the overlapping nodes



$\alpha_1 = 2.61$



$\alpha_2 = 2.58$

Power law distribution

Distance

Global Network VS Overlap-Hub Network

Network	Overlapping nodes (%)	Ego network of O.N (%)	Proportion of hubs (%)
ego-Facebook	3.1	21.8	59.25
CondMat	9.34	50.9	79.57

Network	Distance Global		Distance Overlap-Hub	
	Average	Median	Average	Median
Karate club	2.408	2	1.616	2
Facebook	3.692	5	2.906	2
CondMat	5.352	6	2.232	3