40 Years of IETF: Hierarchy in an Evolving Graph

All analysis tools available here:
https://github.com/matthewrussellbarnes/mobility_taxonomy

Matthew Russell Barnes - 07/22

Funded by: moogsoft

IETF

- Internet Engineering Task Force
- Social graph of mailing list interactions
- Person IDs collating similar email addresses together

atoca	Discussion list for the IETF Authority-to-Citizen Alert (atoca) working group.
Autoconf	Ad-Hoc Network Autoconfiguration WG discussion list
avt	Audio/Video Transport Core Maintenance
babel	A list for discussion of the Babel Routing Protocol.
Banana	Bandwidth Aggregation for interNet Access: Discussion of bandwidth aggregation solutions based on IETF technologies.
bcause	BNG Control-plane And User-plane SEparation
BEC	BEC - Beyond Edge Computing
Behave	mailing list of BEHAVE IETF WG
BESS	BGP-Enabled ServiceS working group discussion list
Bgp-autoconf	BGP autoconfiguration design team discussion list
BIER	"Bit Indexed Explicit Replication discussion list"
bimi	Brand Indicators for Message Identification
BLISS	Basic Level of Interoperability for SIP Services (BLISS) BoF
Blockchain-interop	Blockchain Gateway Interoperability Protocol

The Web We Weave: Untangling the Social Graph of the IETF, Proc. ICWSM, P. Khare et al. (2022)

IETF

- Internet Engineering Task Force
- Social graph of mailing list interactions
- Person IDs collating similar email addresses together

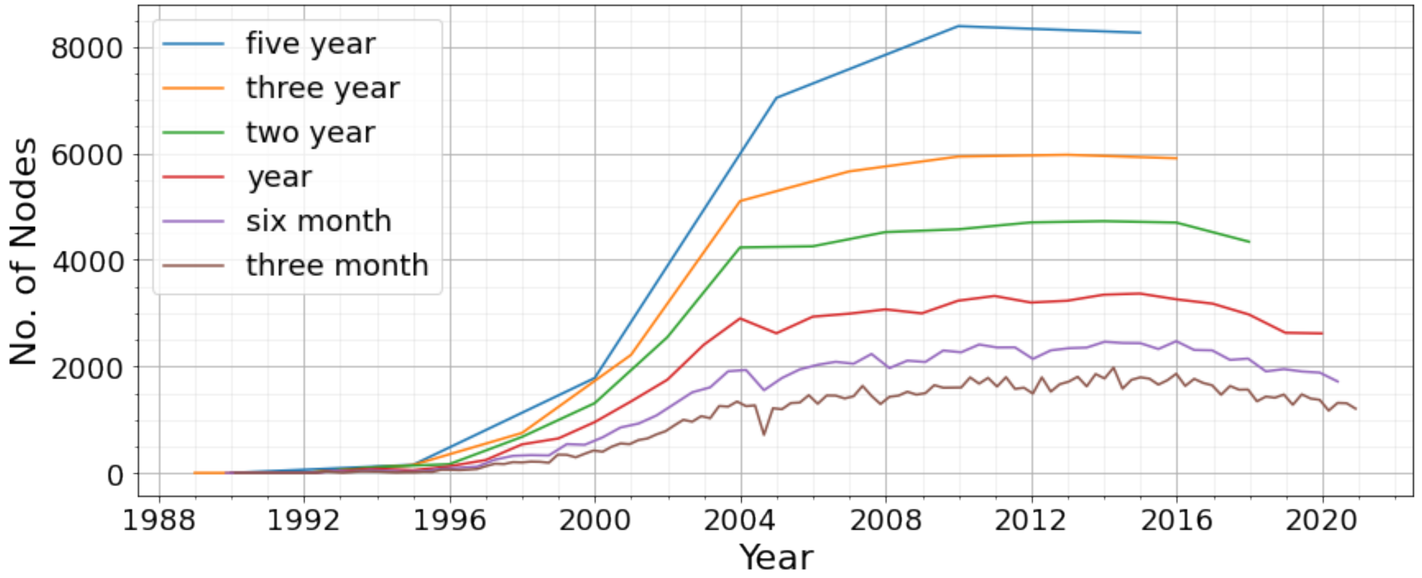
Basic Statistics

23,741 nodes

989,911 edges

04/01/1980 - 17/04/2021

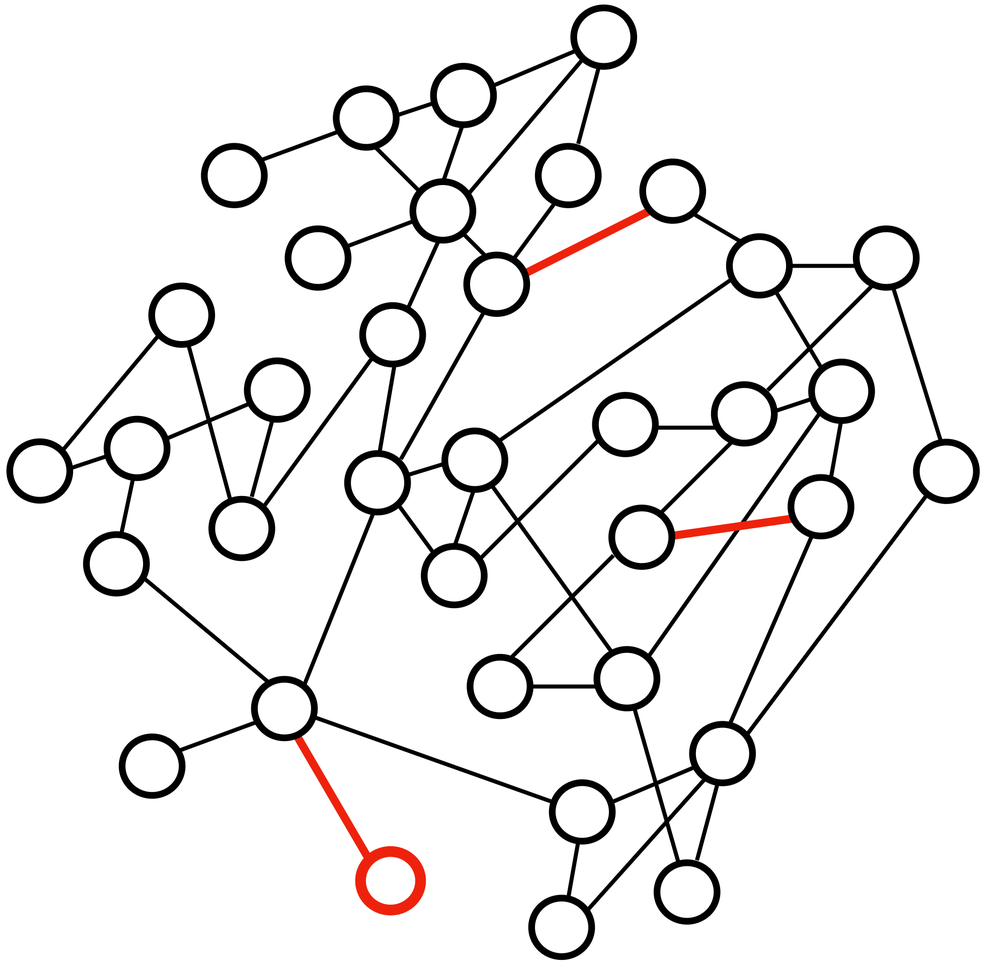
Active Nodes in Time Window



The Web We Weave: Untangling the Social Graph of the IETF, Proc. ICWSM, P. Khare et al. (2022)

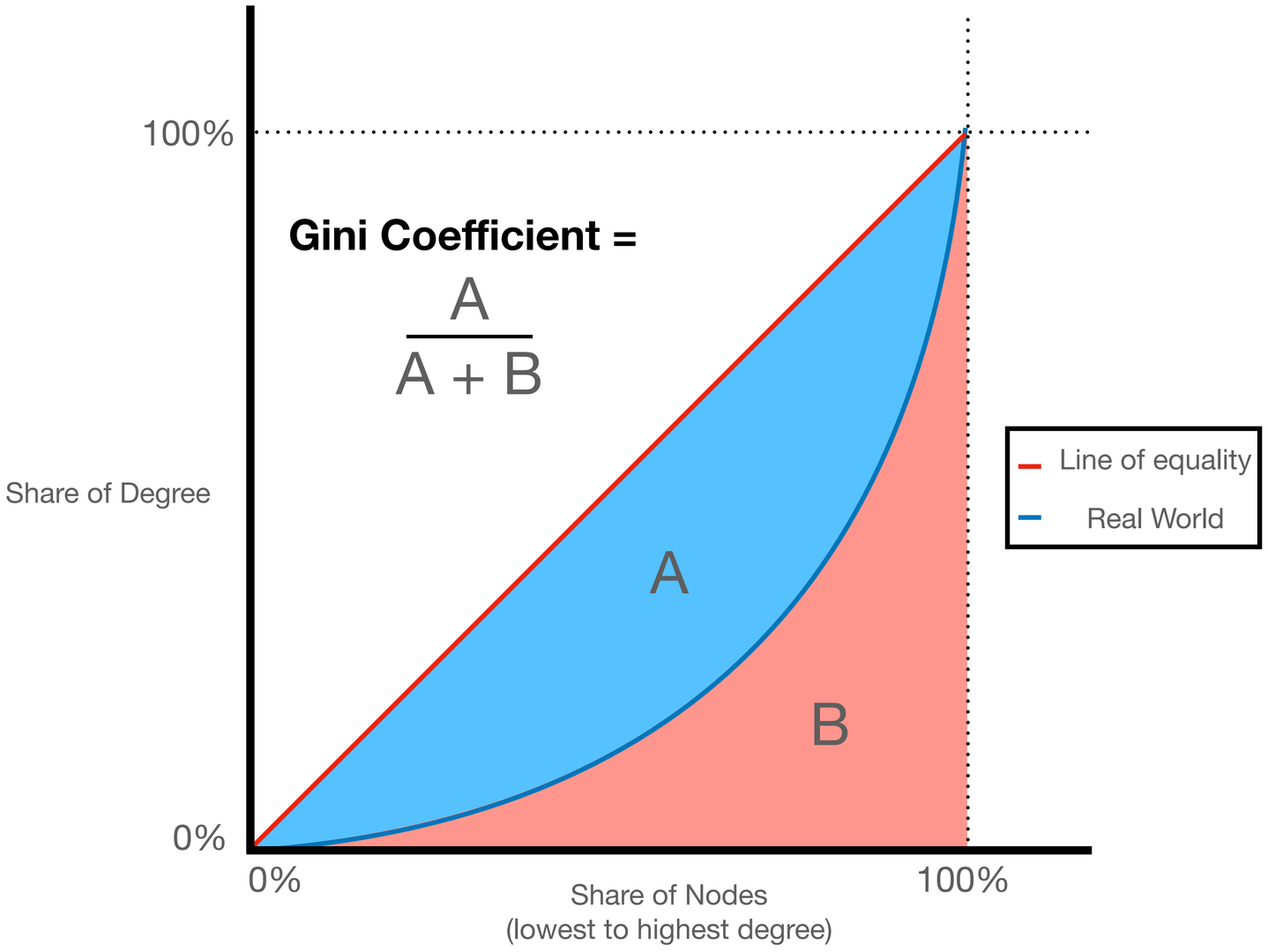
Motivation

- Determining the influence individual nodes have on the evolution of the importance hierarchy
- Interdependency between node importance?



Equality

- Lorenz Curve
- Gini Coefficient
- Equality of Degree

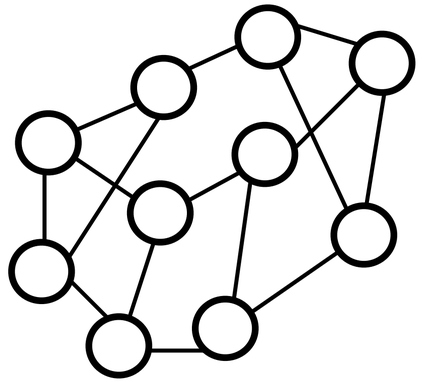


Equality

- Network examples

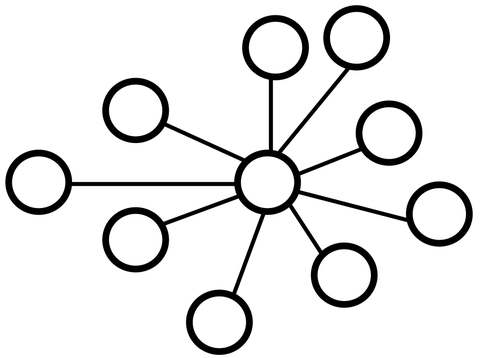
Gini Coefficient =

0



Perfect Equality

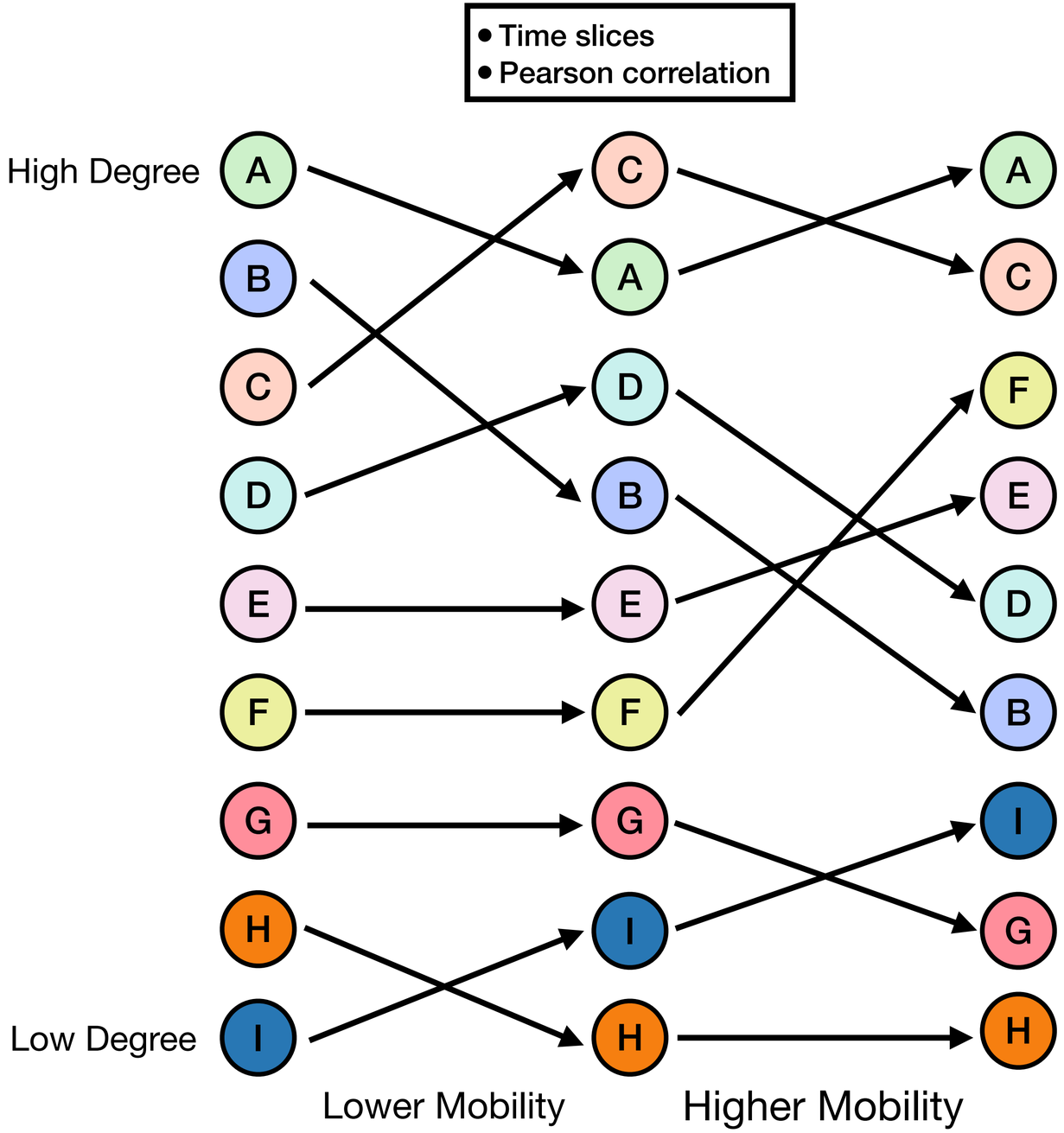
~1



Perfect Inequality

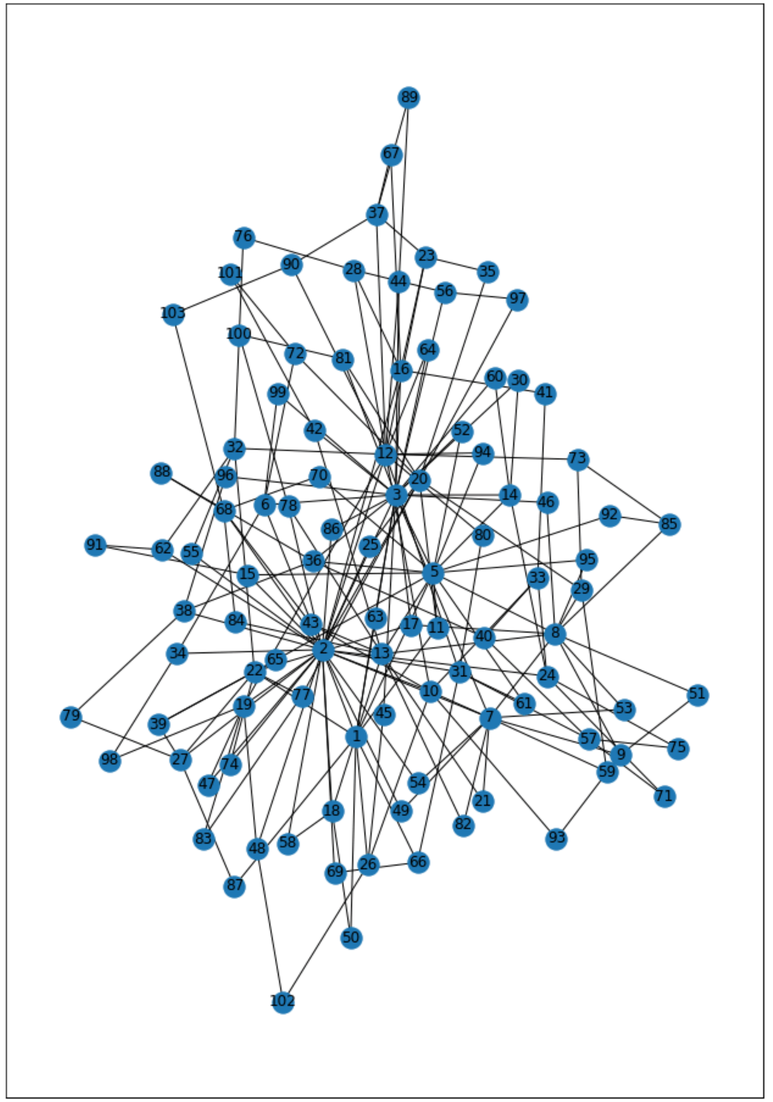
Hierarchical Mobility

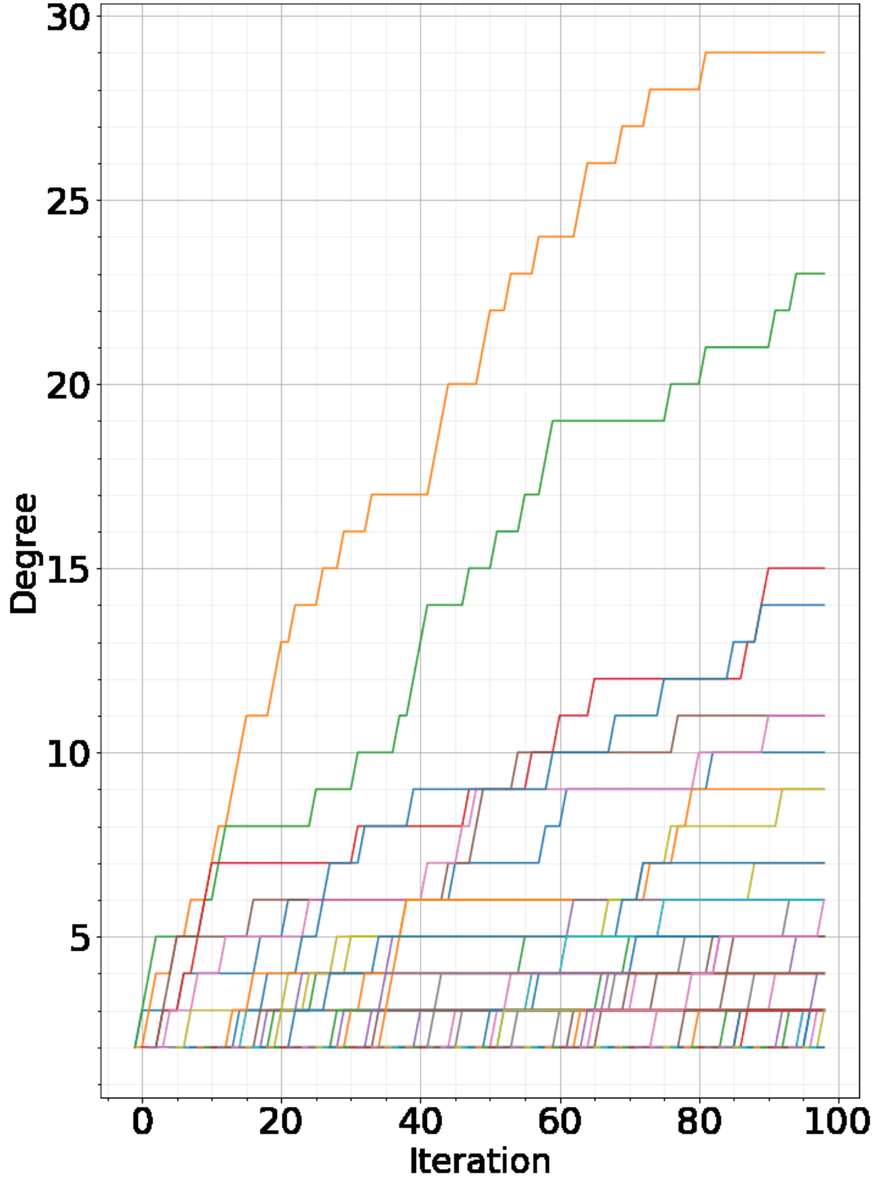
- Movement of nodes on the importance hierarchy over time
- Degree Mobility



Hierarchical Mobility

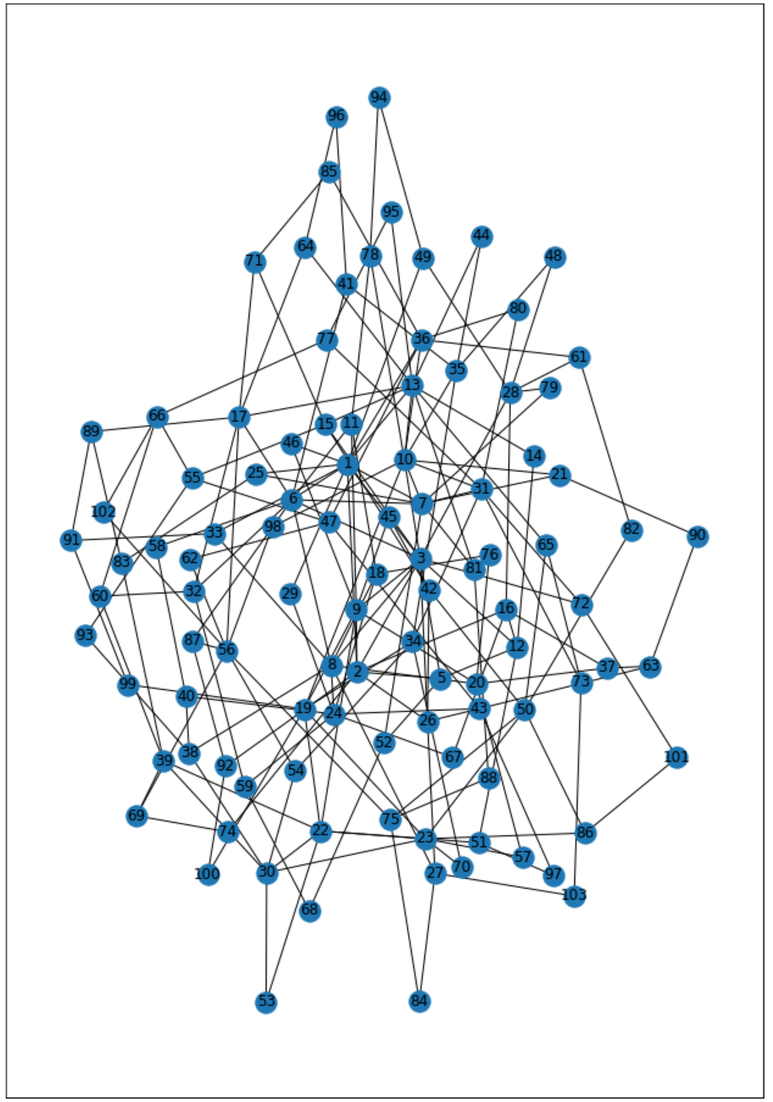
- Network Examples
- Preferential attachment

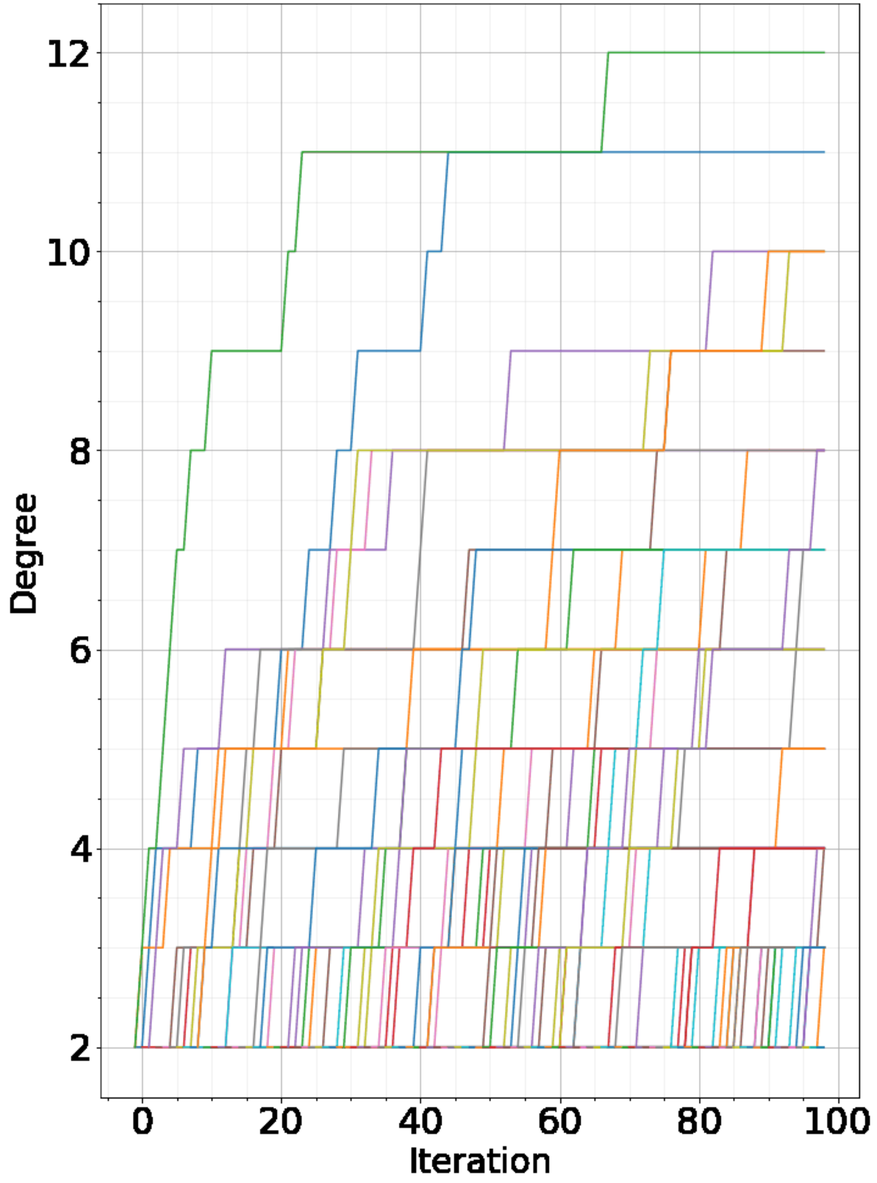




Hierarchical Mobility

- Network Examples
- Random attachment





Mobility Taxonomy

- Correlated between two timesteps

Correlation	Change in Degree	Mean Neighbourhood Degree	Change in Mean Neighbourhood Degree
Degree			
Change in Degree			
Mean Neighbourhood Degree			

Mobility Taxonomy

- Technically “Anti-Mobility”
- +ve: static hierarchy
- -ve: mobile hierarchy
- Correlated between two timesteps

Correlation	Change in Degree	Mean Neighbourhood Degree	Change in Mean Neighbourhood Degree
Degree	Mobility		
Change in Degree			
Mean Neighbourhood Degree			

Mobility Taxonomy

- Same but neighbours
- +ve: static hierarchy
- -ve: mobile hierarchy
- Correlated between two timesteps

Correlation	Change in Degree	Mean Neighbourhood Degree	Change in Mean Neighbourhood Degree
Degree	Mobility		
Change in Degree			
Mean Neighbourhood Degree			Neighbourhood Mobility

Mobility Taxonomy

- Shows interdependence
- +ve: nodes “give” degree to their neighbours
- -ve: Prima Donna
- Correlated between two timesteps

Correlation	**Change in Degree**	**Mean Neighbourhood Degree**	**Change in Mean Neighbourhood Degree**
Degree	Mobility		Philanthropy
Change in Degree			
Mean Neighbourhood Degree			Neighbourhood Mobility

Mobility Taxonomy

- Shows interdependence
- +ve: neighbours “give” degree to nodes
- -ve: leeching neighbours
- Correlated between two timesteps

Correlation	**Change in Degree**	**Mean Neighbourhood Degree**	**Change in Mean Neighbourhood Degree**
Degree	Mobility		Philanthropy
Change in Degree		Community	
Mean Neighbourhood Degree			Neighbourhood Mobility

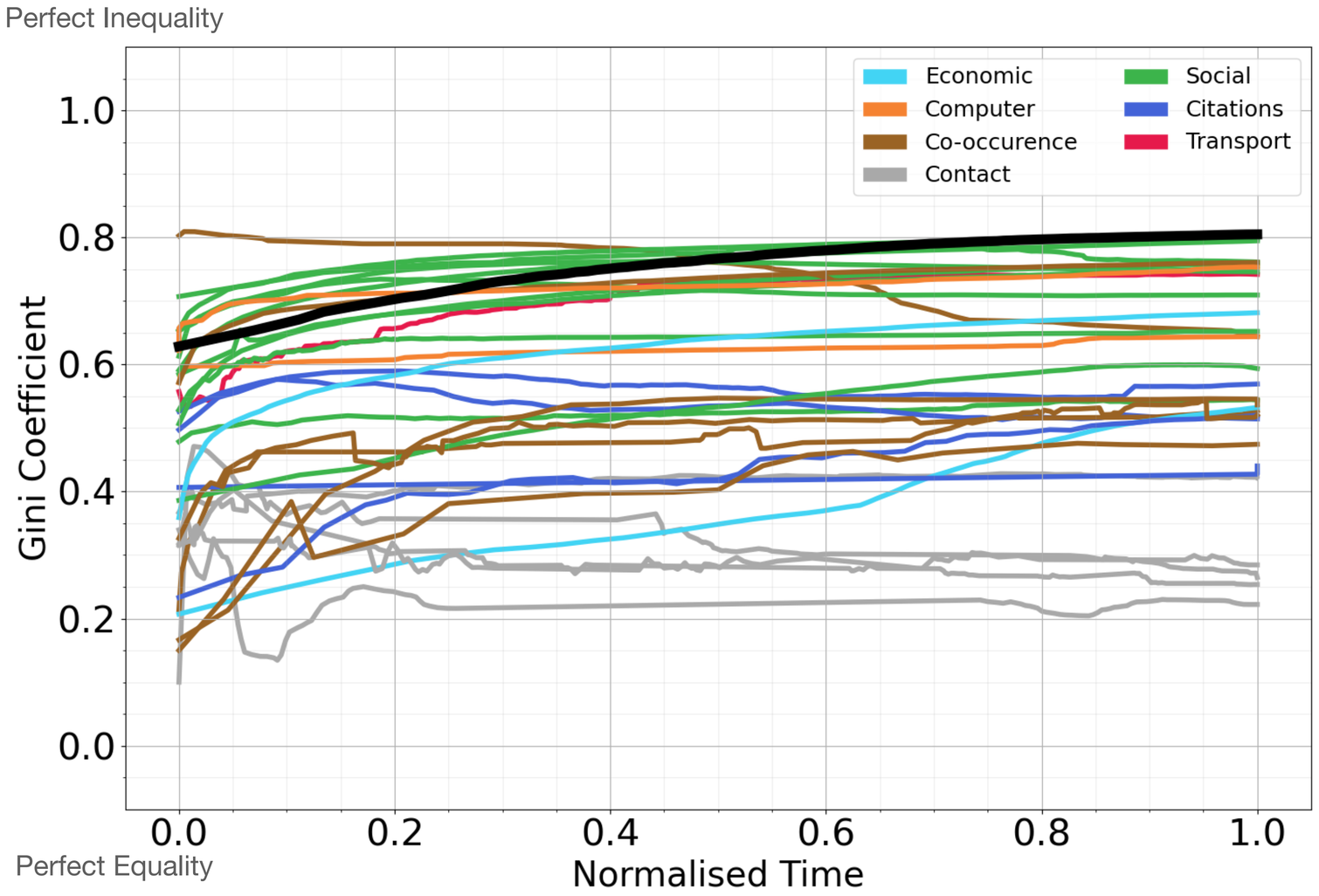
Hierarchical Mobility

- Well known measure
- +ve: rich club
- -ve: stars
- Only one timestep

Correlation	**Change in Degree**	**Mean Neighbourhood Degree**	**Change in Mean Neighbourhood Degree**
Degree	Mobility	Assortativity	Philanthropy
Change in Degree		Community	Change in Assortativity
Mean Neighbourhood Degree			Neighbourhood Mobility

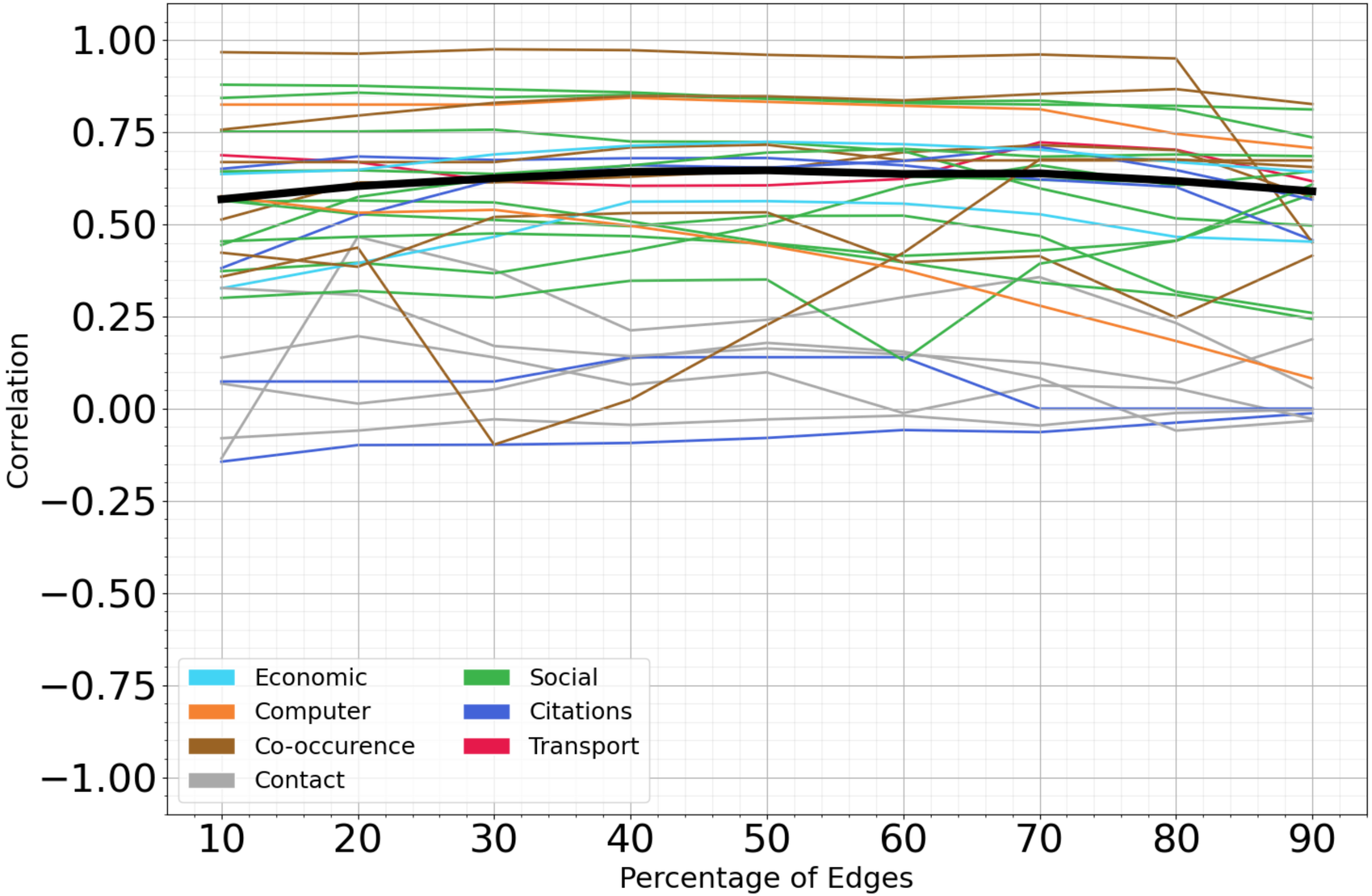
IETF

- Gini Coefficient
- One of most unequal networks in corpus
- Black network is IETF



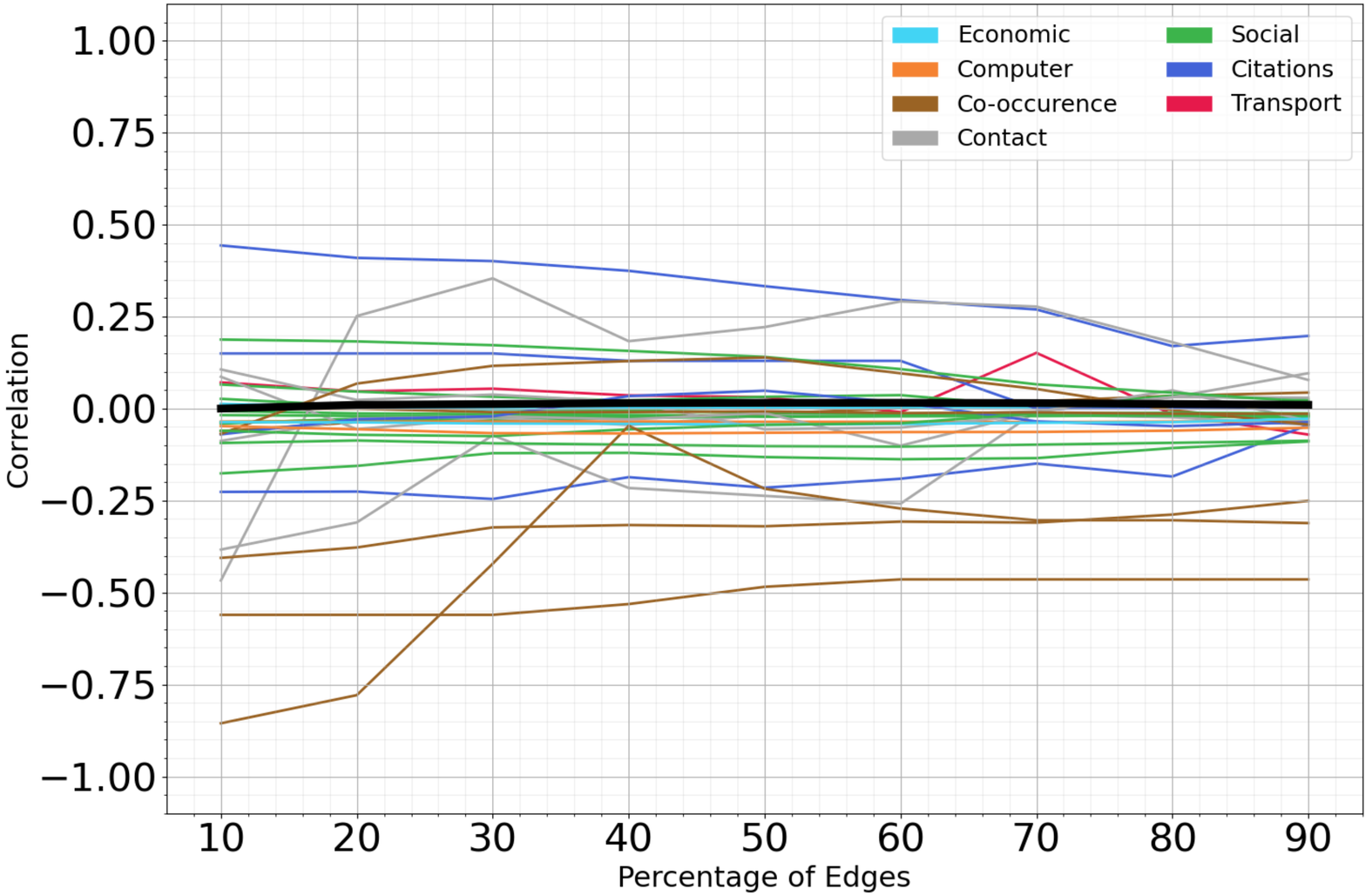
IETF

- Mobility
- Middling positive correlation with little change over time
- Black network is IETF



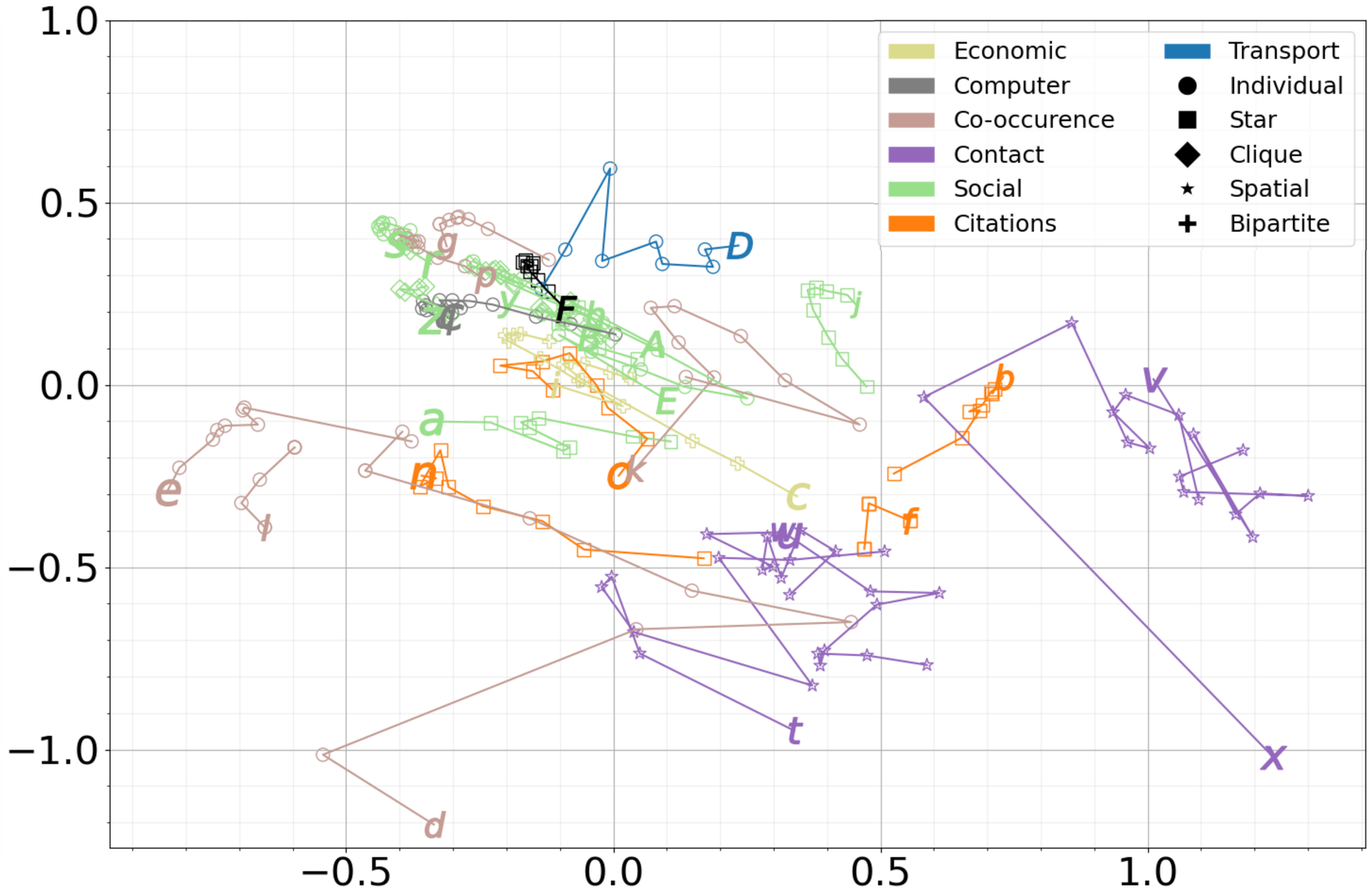
IETF

- Philanthropy
- Zero correlation with no over time
- Black network is IETF



IETF

- Principal Component Analysis
- Ossified
- Black network is IETF



Take homes

- **Equality** and **Mobility** are a new useful tool for analysing **time evolving networks**
- IETF is **low** in **equality** of degree
- Also, it is **low** in **mobility** of degree
- IETF’s degree hierarchy is **ossified**

All analysis tools available here:
https://github.com/matthewrussellbarnes/mobility_taxonomy