

# Mathematical approaches to modeling science from an algorithmic historiographic perspective

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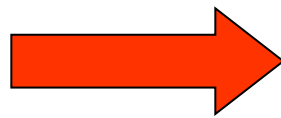
# I. Historical reconstruction of scientific developments

- Representation of science using scientific communication
  - Proposed by de Solla Price (1965) as a functional simplification of scientific discovery and communication.
  - Proxy for the study of scientific developments.
- Historical reconstruction through citations
  - Chronologically as a network of citations from scientific literature.
  - Citations: unidirectional links between a document and earlier ones (Garfield, 1973).
- Focus here is on links between texts (cognitive significance), rather than authors (social relationships).



“Citation analysis can be used to develop an accurate and useful network diagram of cumulative research that led to a scientific breakthrough”

Eugene Garfield, (1979). Citation Index it's theory and application in Science, technology and Humanities.



**ALGORITHMIC  
HISTORIOGRAPHY**



## II. Purpose of the study

- 1) Identify the bibliographic antecedents of today's mathematical models to understand science

**Following traces from the present to the past**

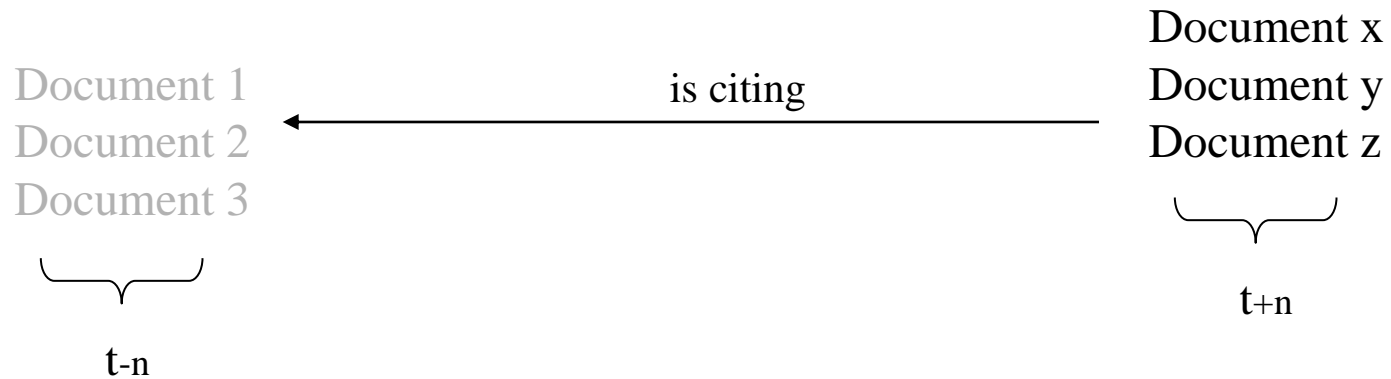
- 2) Follow the trajectories through which popular mathematical models have been diffused, why some models become more popular?

**Following traces from the past to the present**

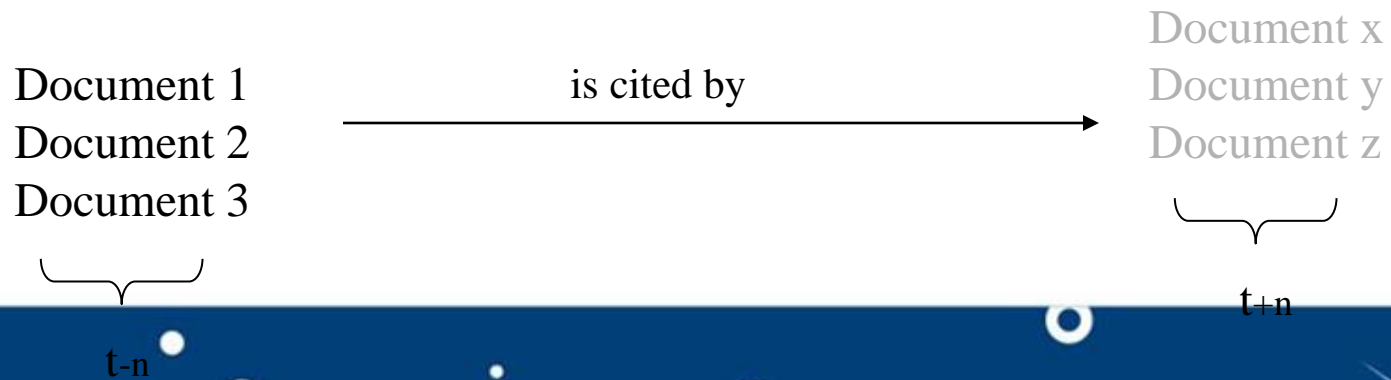
- a. Lotka- Volterra model
- b. Price network model
- c. Goffman's epidemic model



## 1) From the present to the past: Cognitive history



## 2) From the past to the present: diffusion trajectories



# III. Data

## 1) From the present to the past

<b>Journal</b>	<b>Docs</b>	<b>Inside Citations</b>	<b>Total citations</b>
JASIST	50	39	416
SCIENTOMETRICS	47	44	271
IP&M	20	5	63
J. INFORMETRICS	20	13	53



## 2) From the past to the present

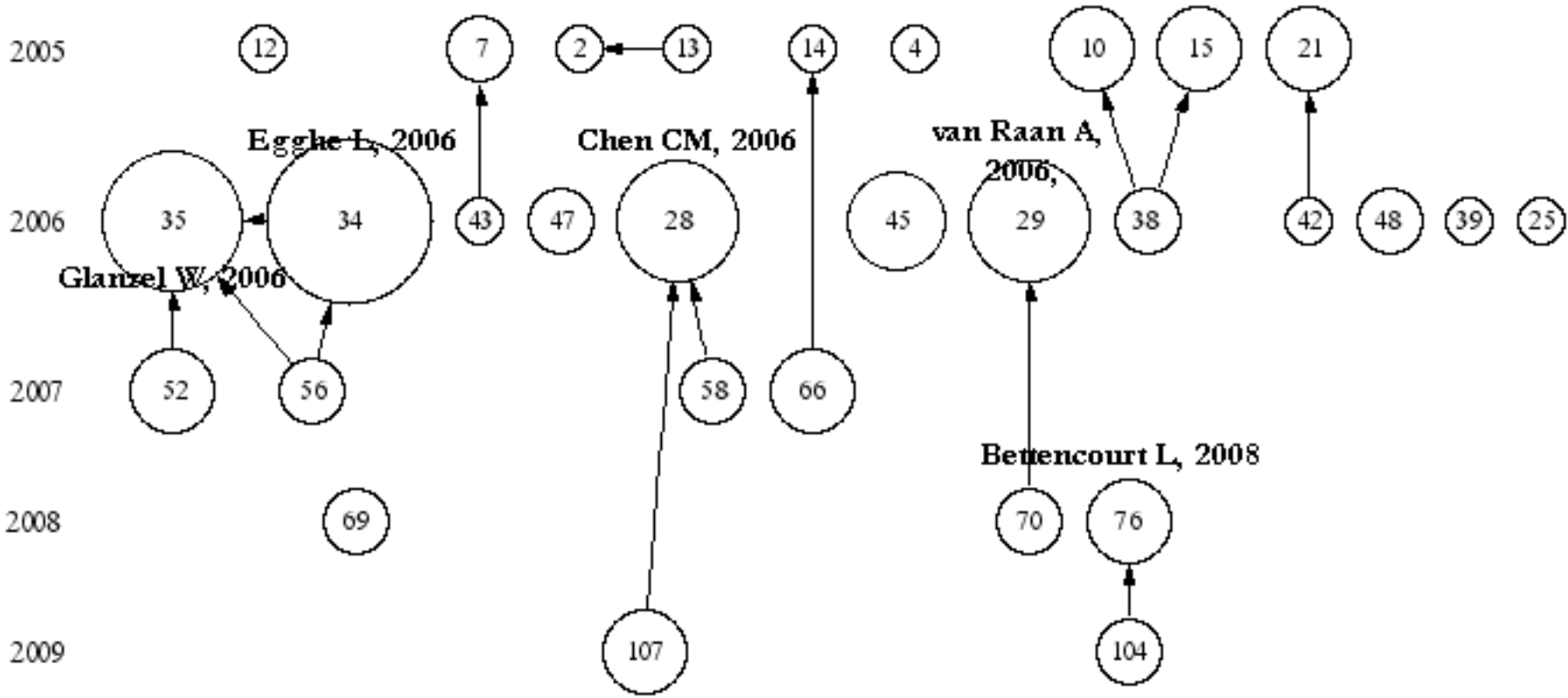
- a. Lotka, A.J. (1926). The frequency distribution of scientific productivity, *J. Wash. Acad. Sci.*, 16: 317.
- b. Price, D.J.D. (1965). Networks of scientific papers. The pattern of bibliographic references indicates the nature of the scientific front, *Science*, 149 (3683): 510-515
- c. GOFFMAN, W (1966). Mathematical Approach to Spread of Scientific Ideas-History of Mast Cell Research, *Nature*, 212 (5061): 449

Goffman, W., & Newill, V.A. (1964). Generalization of Epidemic Theory - Application to Transmission of Ideas, *Nature* 204: 225.



# IV. Results

## 1) Relationships inside the set of the mathematical approaches to study scientific activity, 2005-2009 (cognitive history)





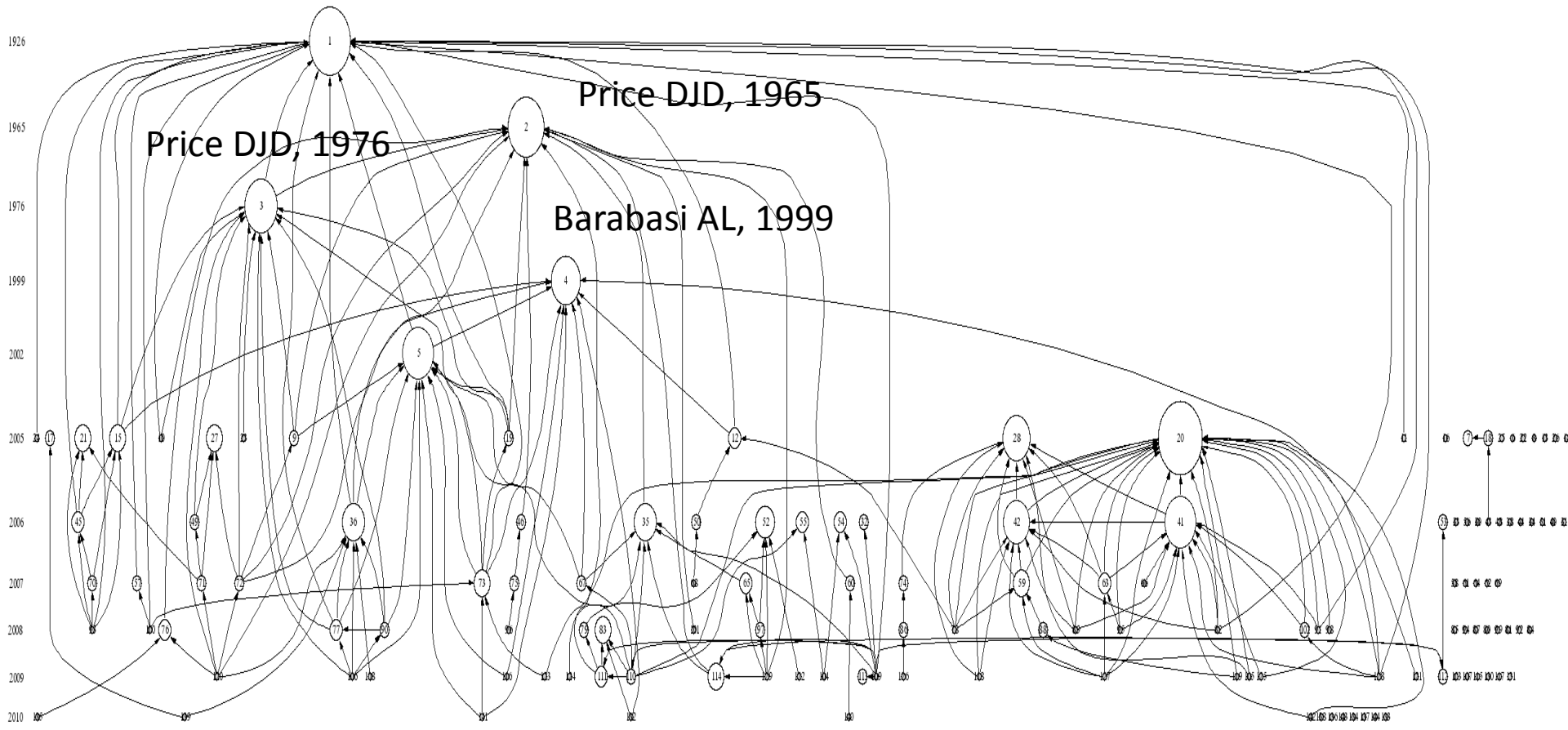
# Connected??

Lotka AJ, 1926

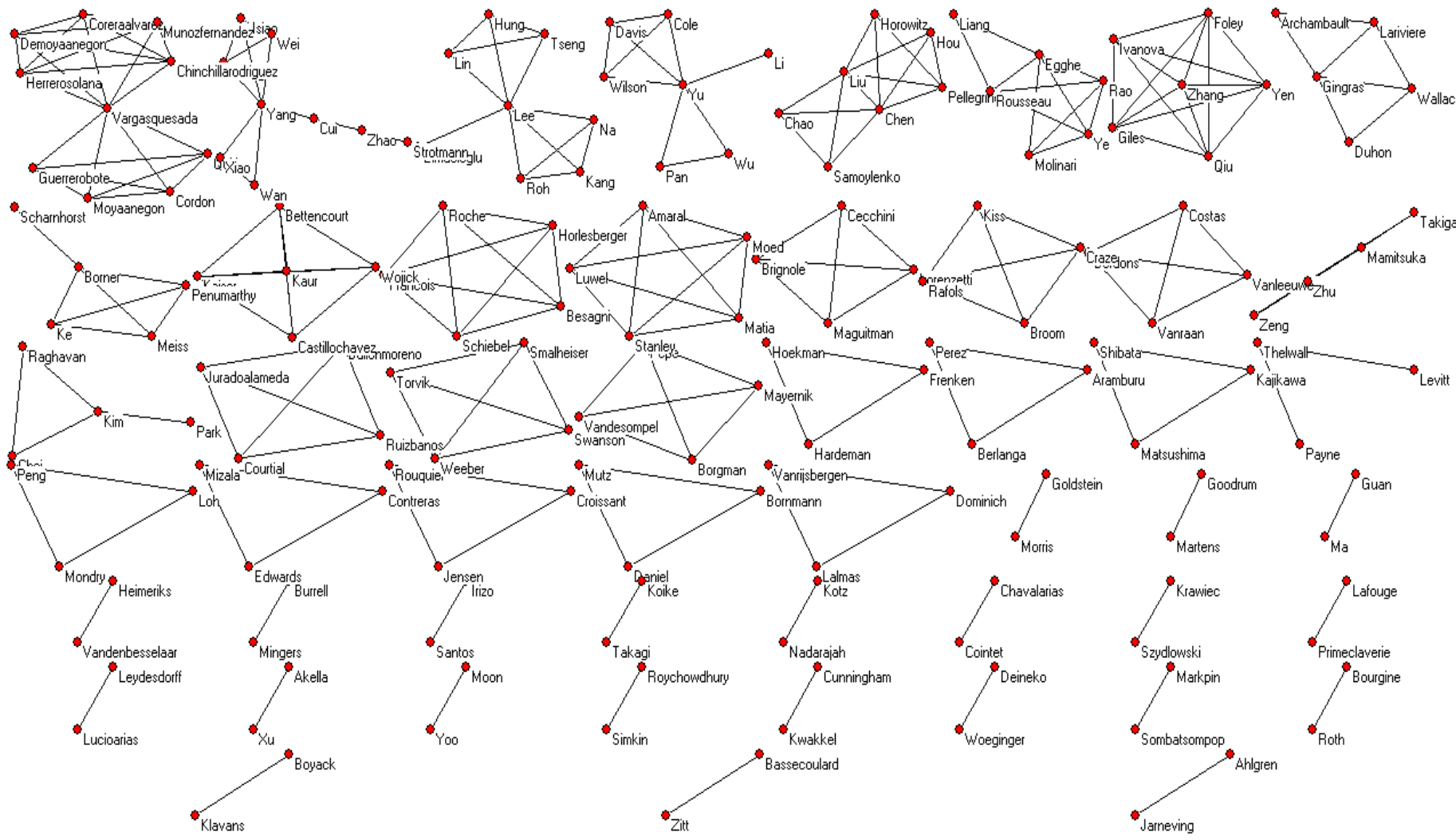
Price DJD, 1965

Price DJD, 1976

Barabasi AL, 1999

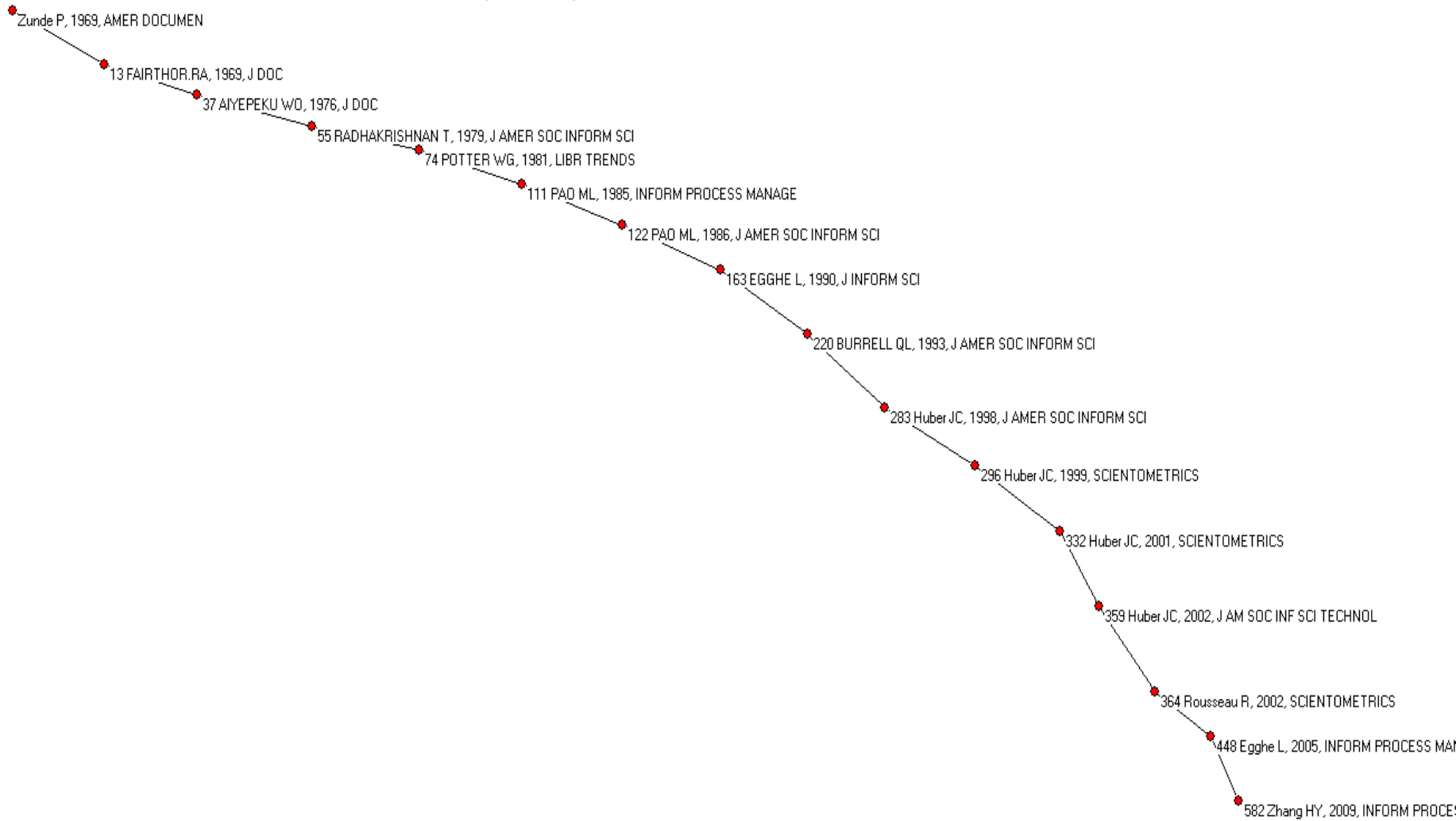


# Bibliographic coupling indicates cognitive dissimilarities

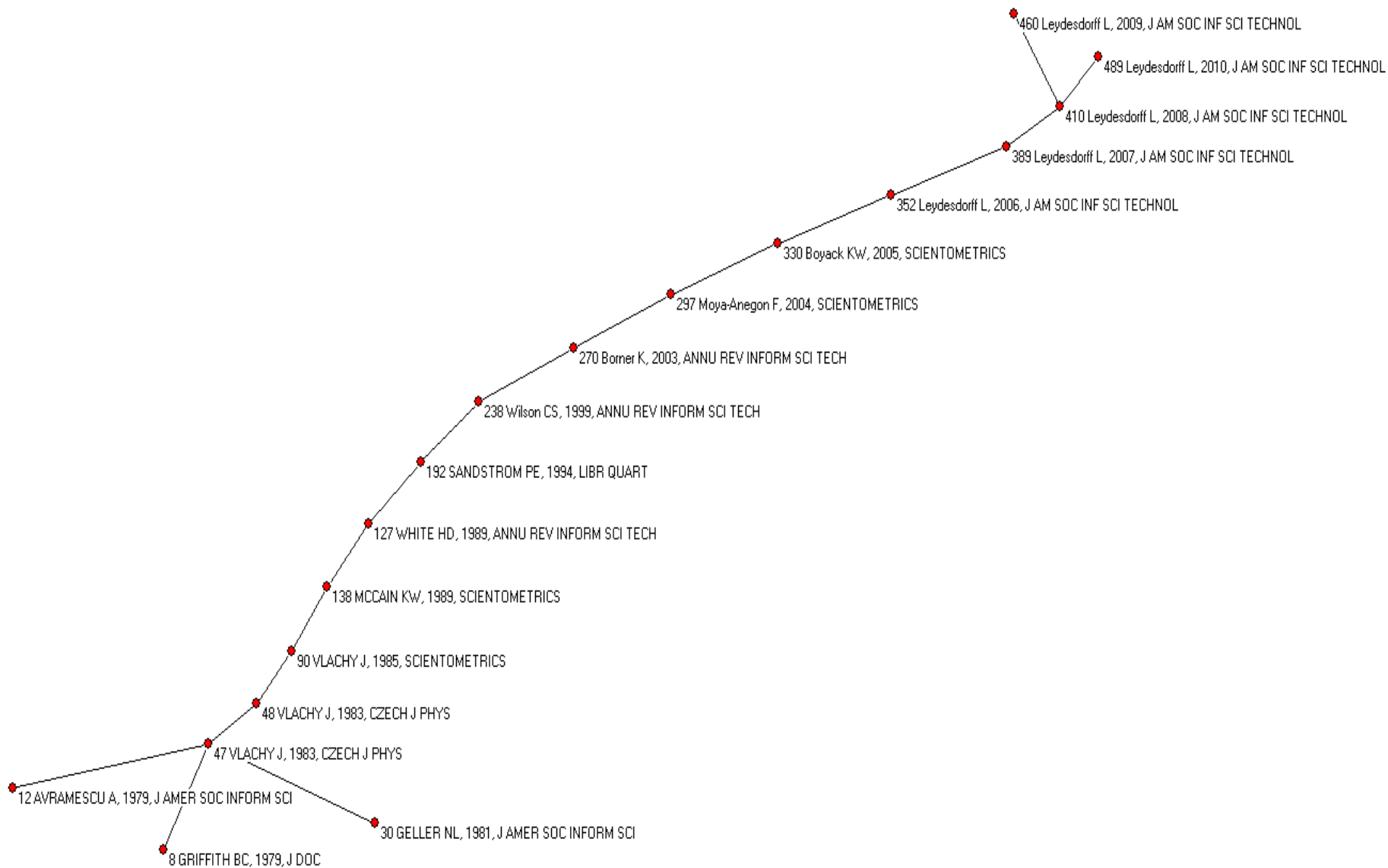


## 2) Diffusion trajectories

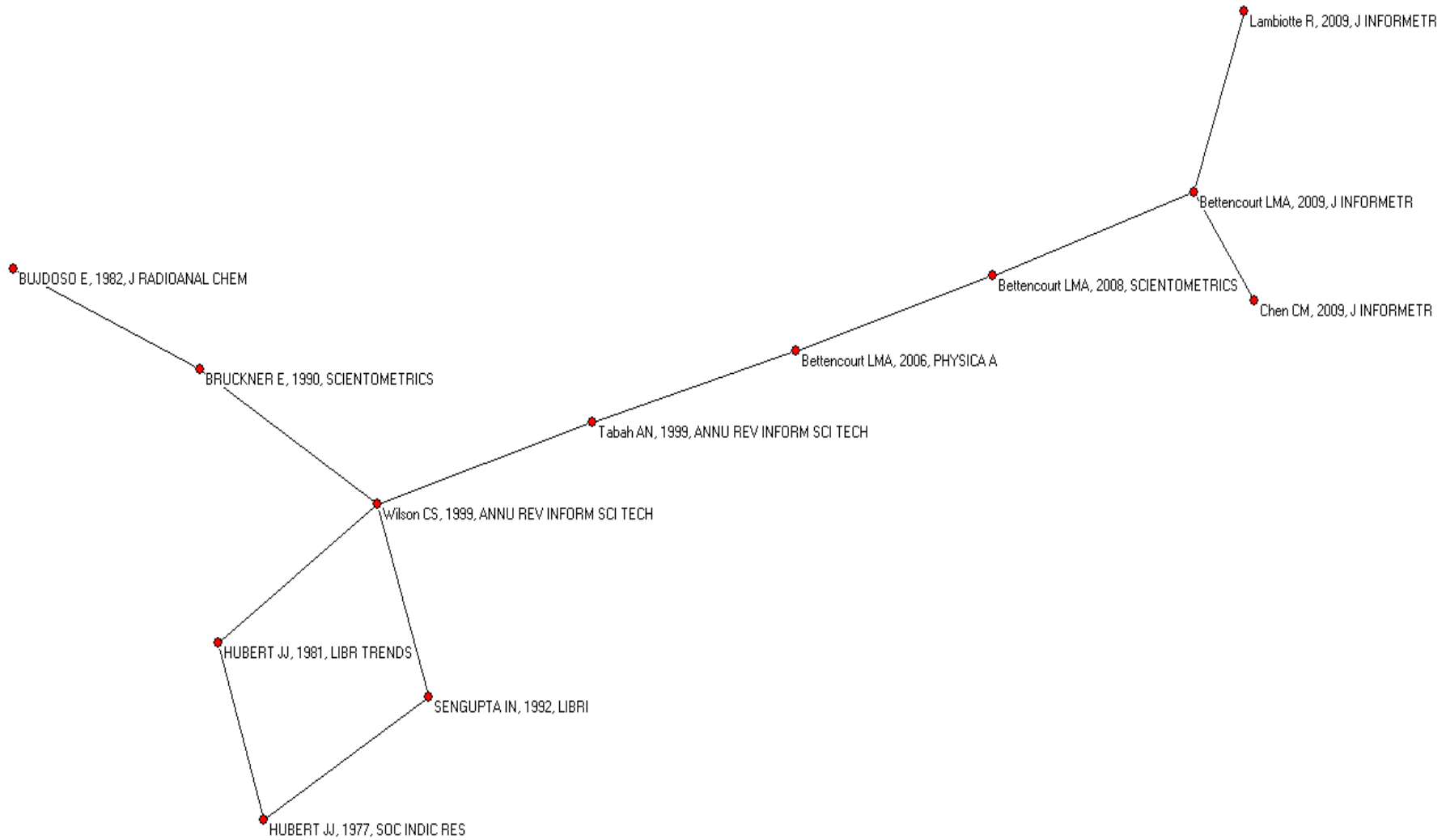
### a. Lotka- Volterra model (537)



## b. Price network model (497)



# c. Goffman epidemic model (73)



# V. Moving Forward

- Critical transitions to determine transitional shifts in the diffusion trajectories
- Content analysis of the documents citing Lotka, Price & Goffman. Are these documents presenting mathematical models as well? How do they expand the original papers?
- Critical transitions to determine characteristics of the cognitive history of current mathematical approaches
- Characterization of papers published between 2005 and 2009 that seem to be applying mathematical models to understand scientific activity



# VI. Conclusions of the chapter

- Are some models being obliterated while some others remain highly visible and used? Why?
- Are there evident weaknesses or strengths of the models that makes them highly cited or lost in time?
- Is there recombination of models into new methodologies to study the system of science?