



# I . Introduction

Three ways to use network theory in modeling religious movements:

(1) Understanding the structure of the physical and social world in which religious innovation occurs and spreads (Czachesz 2011; Duling 1999, 2000, 2013; White 1992)

**(2) Analyzing the thought-world of a certain religious movement**

(3) Modeling cultural and religious systems as networks (Czachesz 2013)



## 2. Network theory in analyzing textual data

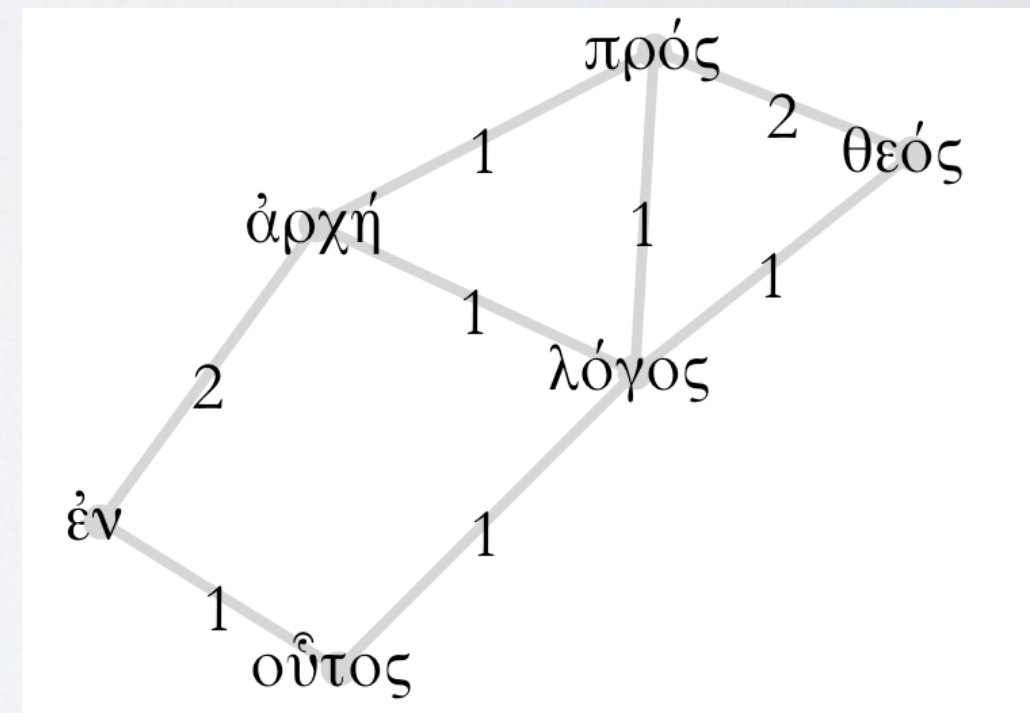
- Networks are mathematical objects that consist of vertices (nodes) connected by arcs (edges, links)
- Word co-occurrence networks: two words that occur near to each other in a text will be connected by an edge
- Reader-oriented framework: modeling the network of associations that the text generates in the readers' or listeners' minds
- Representing types rather than tokens: e.g., two occurrences of “disciple” in a text will be represented as one node
- Stop-words (e.g., *καί, δέ, γάρ*) ignored

### 3. Psychological realism

- Network representation of children's books (in French) found to be a good approximation of word-association networks collected from children (Lemaire et al. 2006)
- Orality: given the low rates of literacy & the practice of oral performance, the text of the Greek New Testament was accessed mainly in spoken form => information was inherently sequential
- (Scanning patterns complicate matters in reading comprehension; see relevant eye-movement tracking studies)
- New Testament Greek: little subordination, linear sentence structure (excessive use of "and" often identified as "semitic influence")

## 4. A simple network

- Ἐν ἀρχῇ ἦν ὁ λόγος, καὶ ὁ λόγος ἦν πρὸς τὸν θεόν, καὶ θεὸς ἦν ὁ λόγος. οὗτος ἦν ἐν ἀρχῇ πρὸς τὸν θεόν (Jn 1:1–2).
- weighted links (number of co-occurrences)
- node centrality measures:
  - degree (number of links a node has)
  - closeness
  - shortest path, betweenness
  - eigenvector (degrees of neighbors)





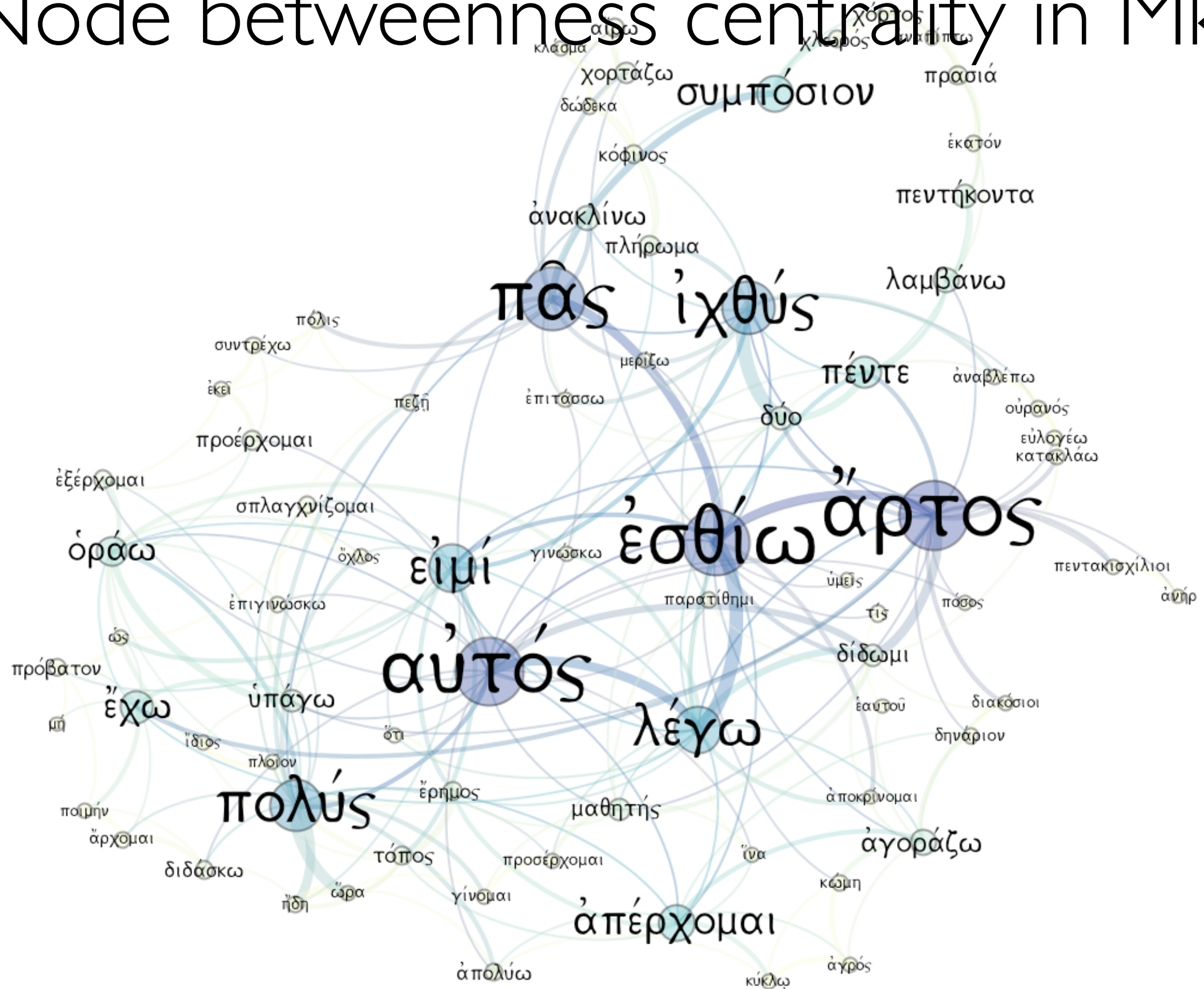
# 5. The miracle of feeding five thousand

- In: Biro & Tappenden, Eds, Language, Cognition and the Bible. Piscataway, NJ: Gorgias, in press
- Pilot study, didactic, kept as simple as possible
- Story: Jesus entertains five thousand people with five breads and two fish, plenty of leftovers remain
- Passages: Matthew 14:15–21; Mark 6:35–44; Luke 9:12–17; John 6:5–13
- Smaller textual unit => “Writing” => Corpus

# From text to network to interpretation

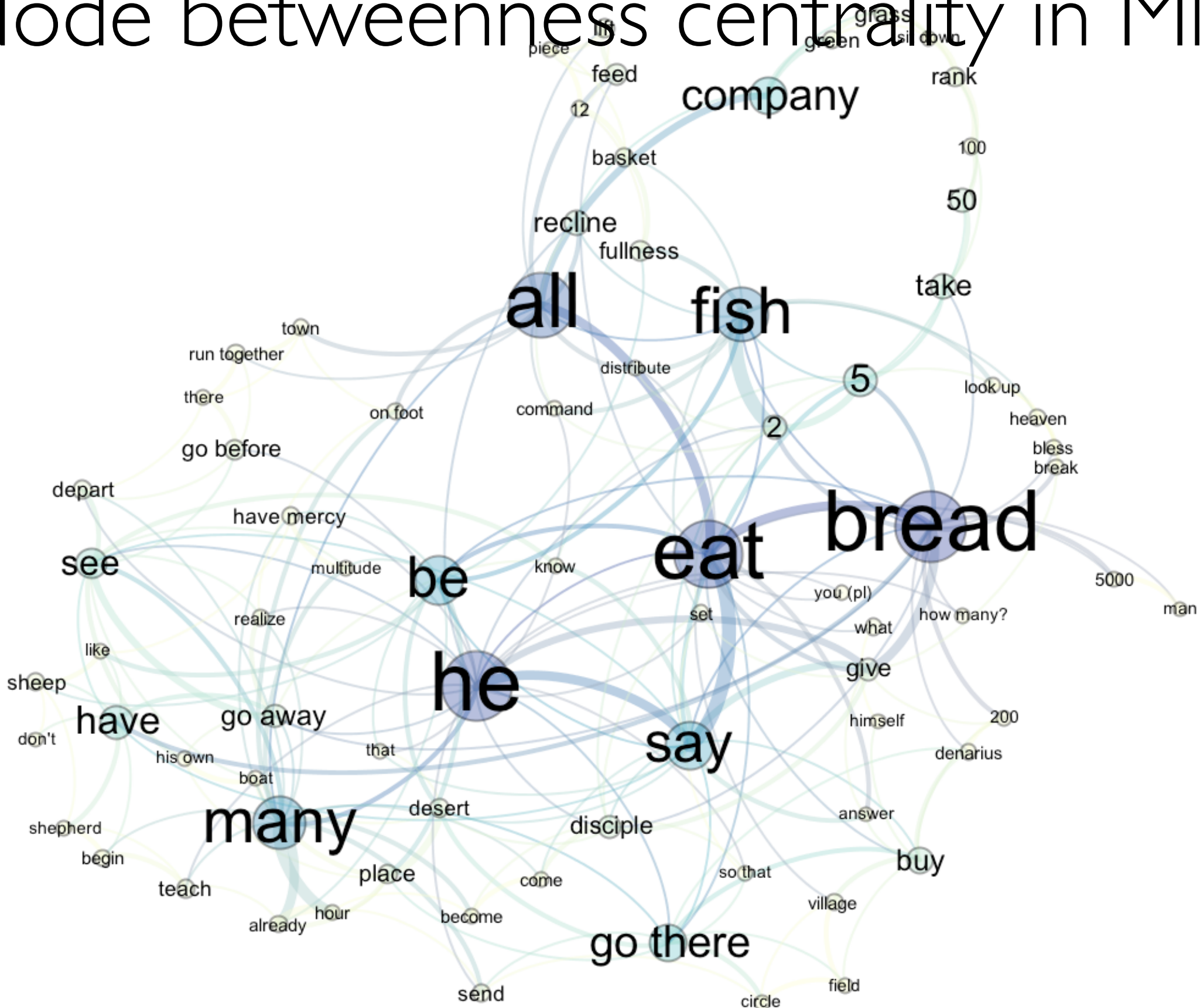
- Method: GNT from <http://wesley.nnu.edu/gnt/>; only verbs and nouns included; networks created in R; sliding window of 3; network analysis in igraph; visualization in Gephi
- Emphasis on node centrality measures
- Important question: What do centrality measures mean in a co-occurrence network?
- Higher-order associations (second, third neighbors) matter
- NB. The network of Mk 6 shown has more words (nouns, verbs, adverbs, adjectives) and a larger sliding window

# Node betweenness centrality in Mk

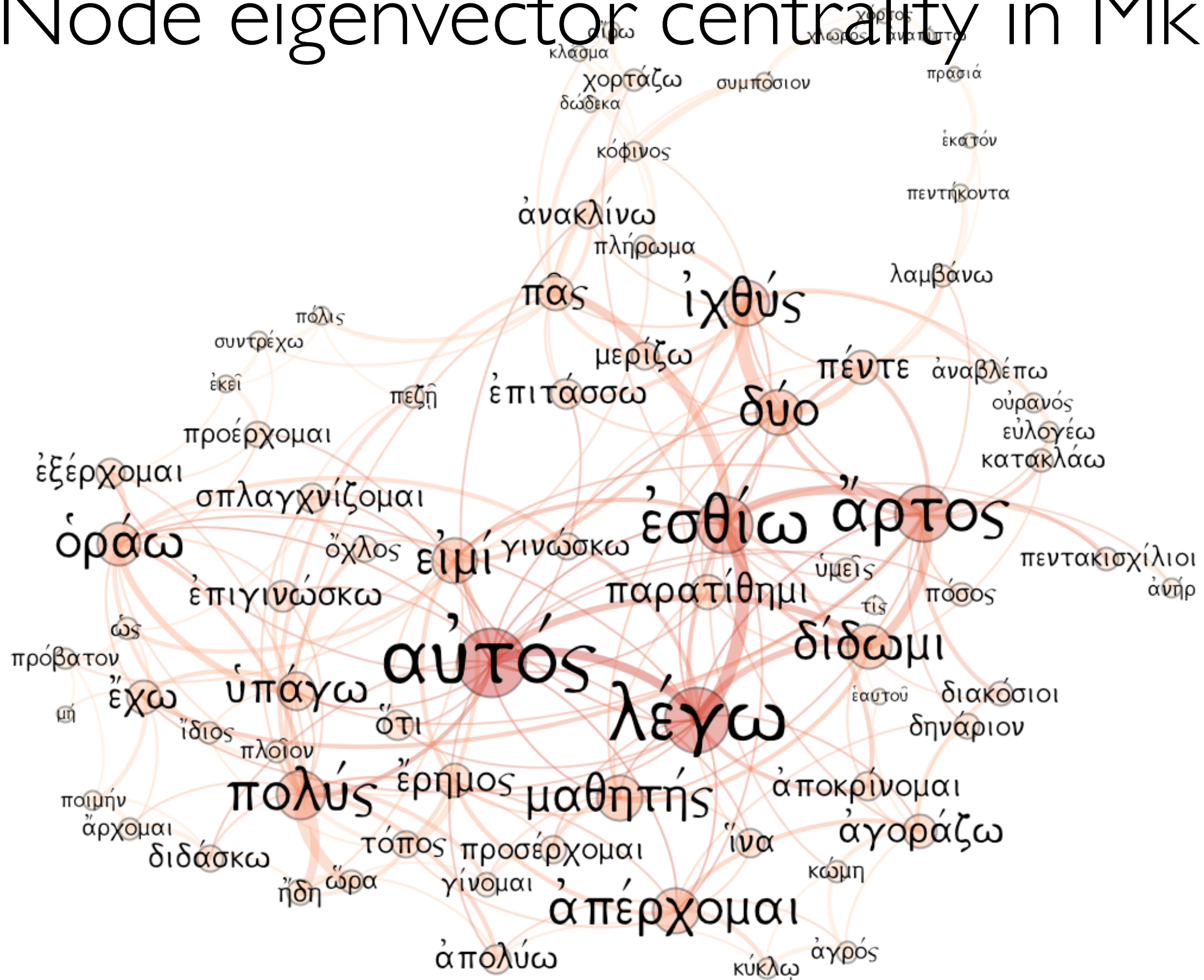




# Node betweenness centrality in Mk

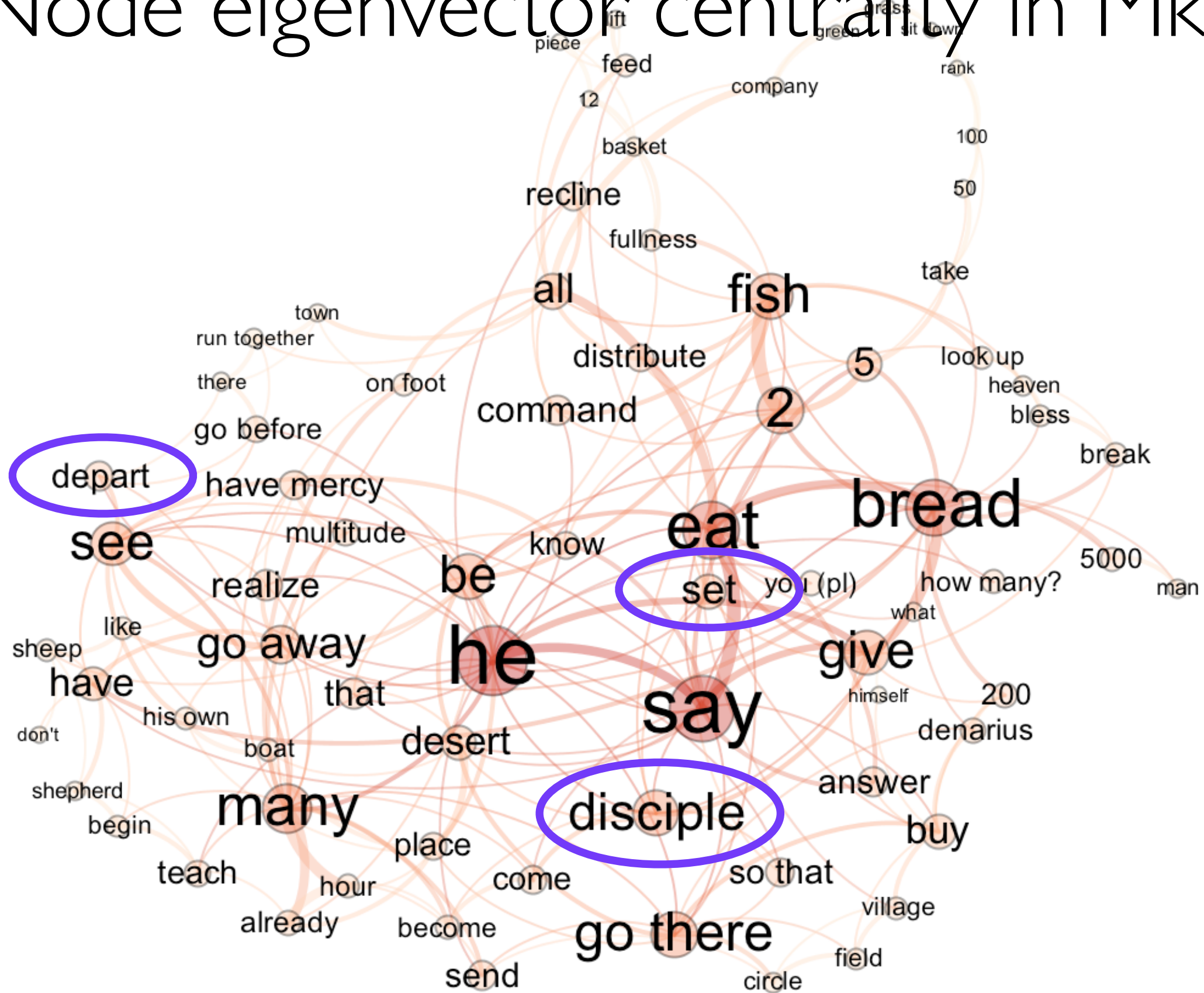


# Node eigenvector centrality in Mik

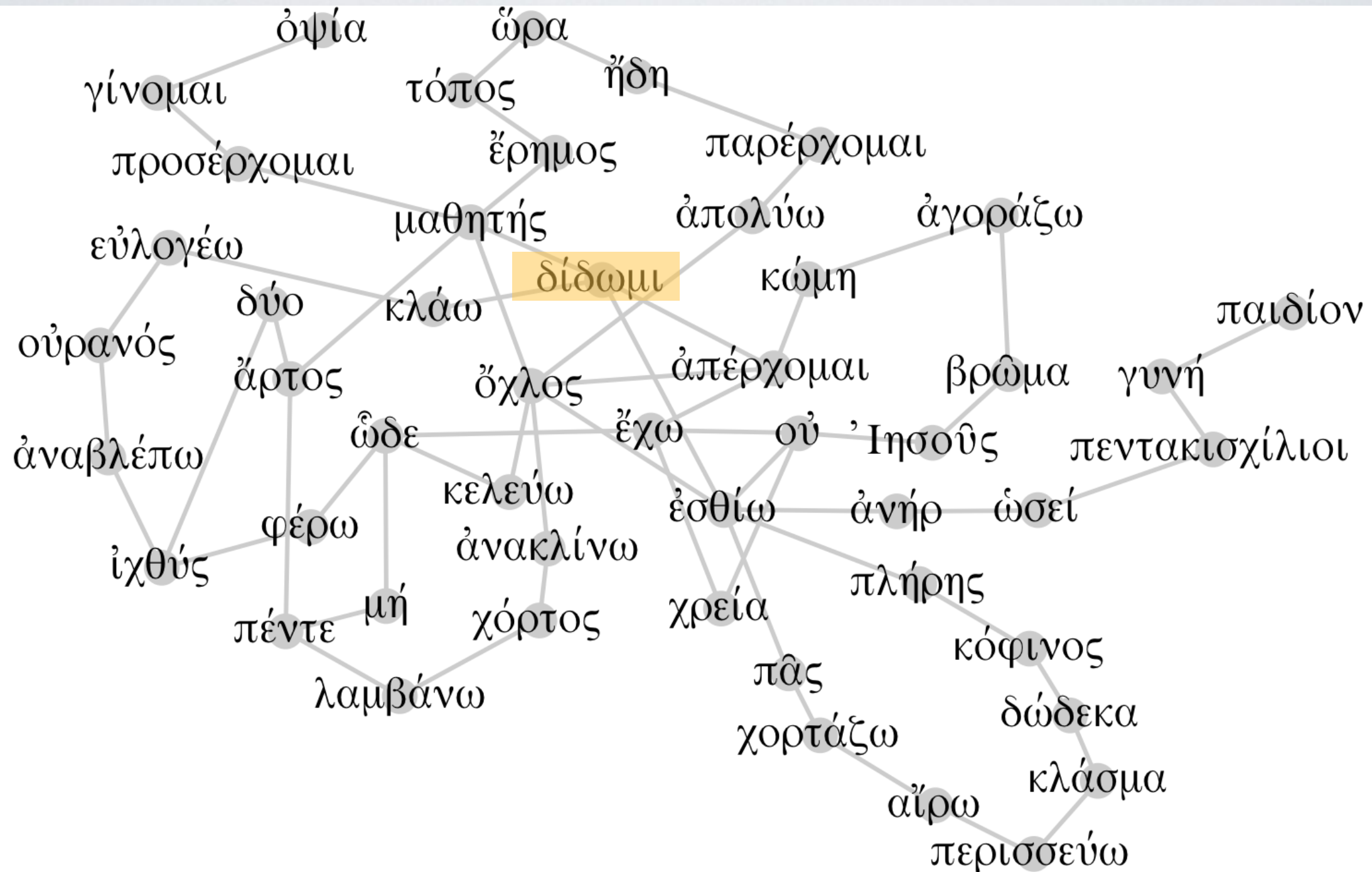




# Node eigenvector centrality in Mk



# Interpreting “give” in Mt 14:15-21





# Interpreting “give” in Mt 14:15-21

- How can we interpret centrality values?
- The most frequent words also have the highest degree: ἐσθίω (eat), ὄχλος (multitude), and μαθητής (disciple)
- δίδωμι (give) has higher betweenness and closeness than words with higher frequency and degree (μαθητής, ἄρτος)
- High betweenness suggests that the word creates associations between elements of the network that are otherwise unconnected or indirectly connected
- Theissen: “Gift miracle” (Geschenkwunder), Jesus giving without being asked & big gestures

# Interpreting “give” in Mt 14:15-21

Word	Degree	Betweenness	Eigenvector	Closeness	Freq.
ἐσθίω	6	568.73	0.95	0.0068	3
ὄχλος	6	408.20	1.00	0.0069	3
μαθητής	5	423.00	0.73	0.0061	3
ἀπέρχο- μαι	4	127.40	0.76	0.0061	2
δίδωμι	4	254.92	0.77	0.0064	2
ἔχω	4	70.61	0.60	0.0057	2
οὐ	4	135.74	0.60	0.0059	2
ὧδε	4	73.21	0.37	0.0053	2
ἄρτος	3	222.45	0.28	0.0042	3
ἰχθύς	3	85.33	0.08	0.0038	2
πέντε	3	77.66	0.15	0.0039	2

Table 4. Node centrality measures in the word co-occurrence network of Mt 14:15–21 (nodes with degree > 2)



# Interpreting “give” in Mt 14:15-21

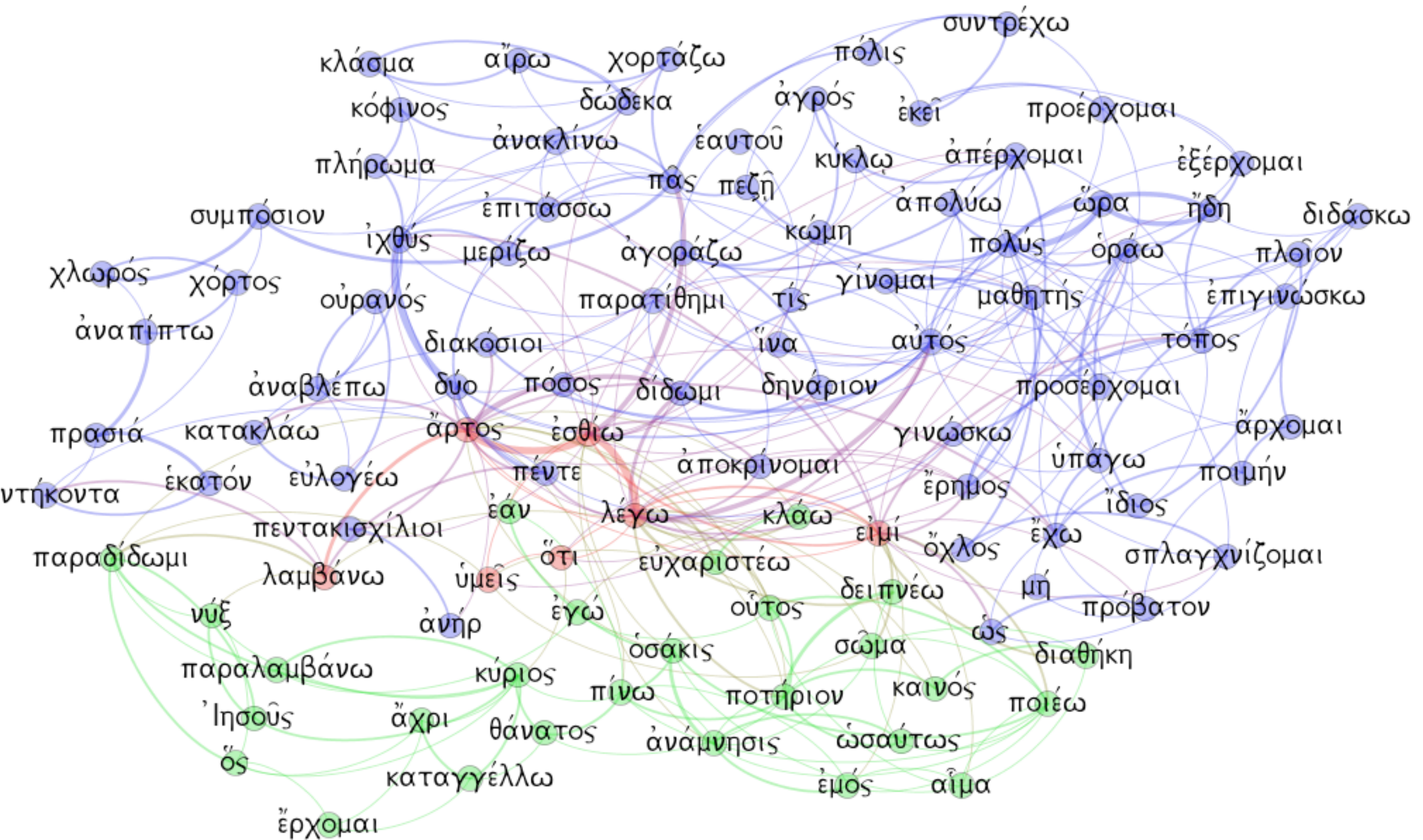
- δίδωμι is connected to two of the most central words of the story, ἐσθίω and μαθητής
- As these words are not directly connected, δίδωμι is on the shortest path between them
- Mt 14:16: “They need not go away; you give them [something] to eat.”
- Mt 14:19: “[Jesus] broke the loaves, and gave them to the disciples, and the disciples [gave them] to the crowds.”
- δίδωμι thus creates a link between the plan of the disciples to send the people to the villages and Jesus’ blessing and breaking the bread

# 7. What next?

- Discriminate automatically between the respective contributions of word frequency vs. word position to centrality
- Usual techniques: statistical manipulation, threshold
- Alternative techniques?
- Psychology of reading: knowledge matters
- Toy models: spreading activation generated by a passage after merging its graph with another graph representing “background knowledge”

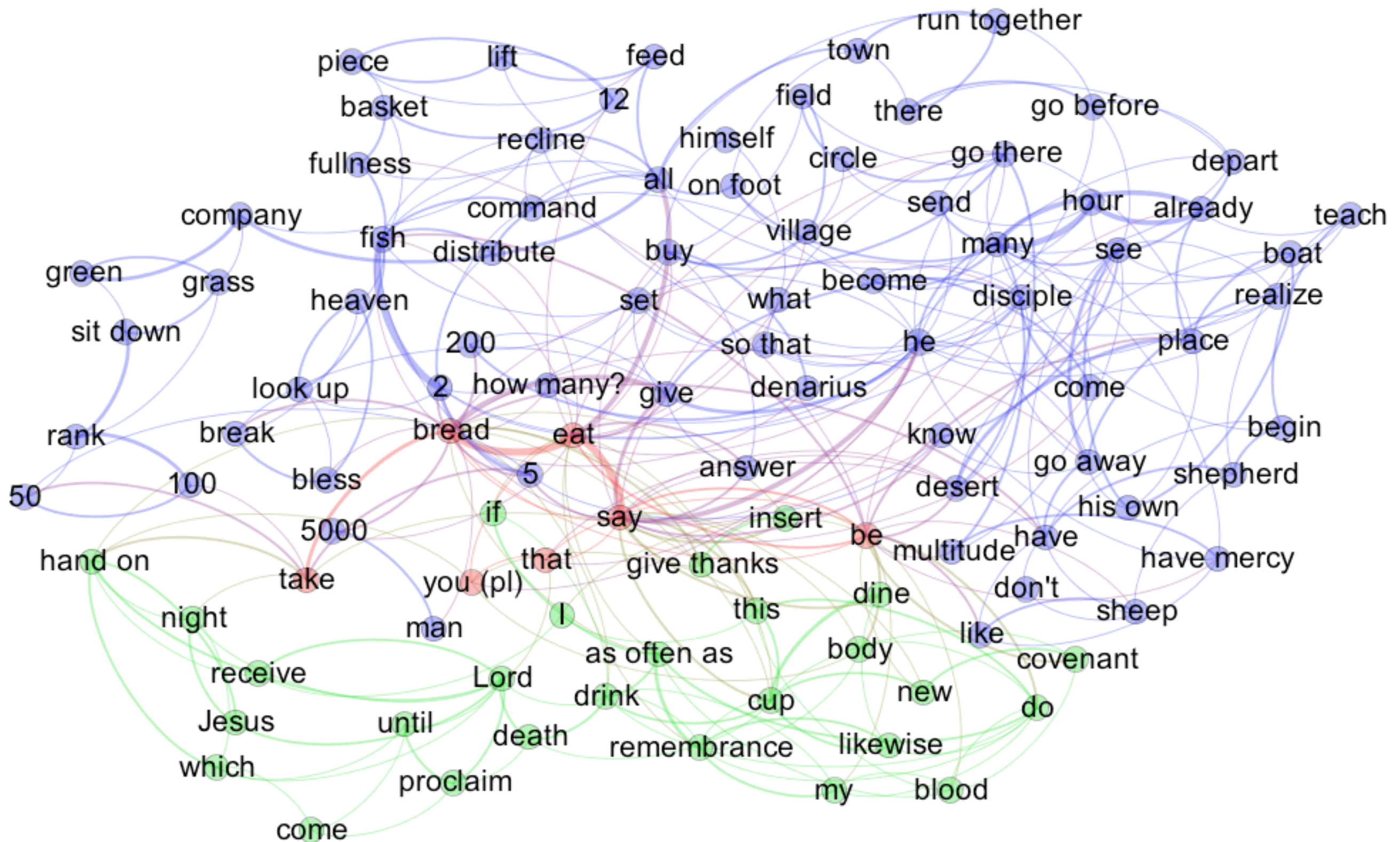


# Mark 6 and I Corinthians 11 (Eucharist)





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# Activated subnet from I Cor I I

