MODELLING THE NETWORK DYNAMICS OF MOOC OFFERINGS

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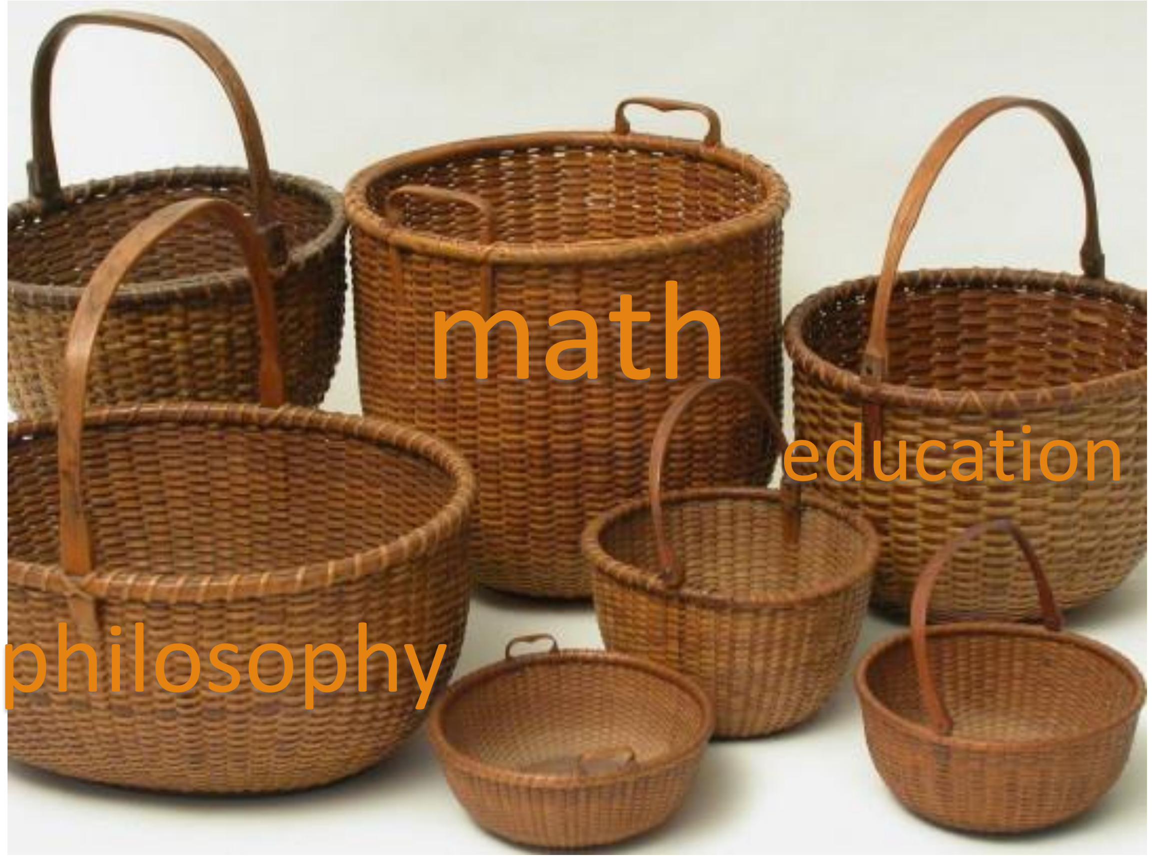
Introduction



- In an online, open and flexible learning environment, learning is not constrained by the existing university curricula, which follow conventional practices.
- 21st century skills demand ways of thinking that go beyond categories, to include interconnections between disciplinary boundaries.
- Yet, integrating courses across disciplines is a demanding and challenging pursuit.

MOOC Offerings

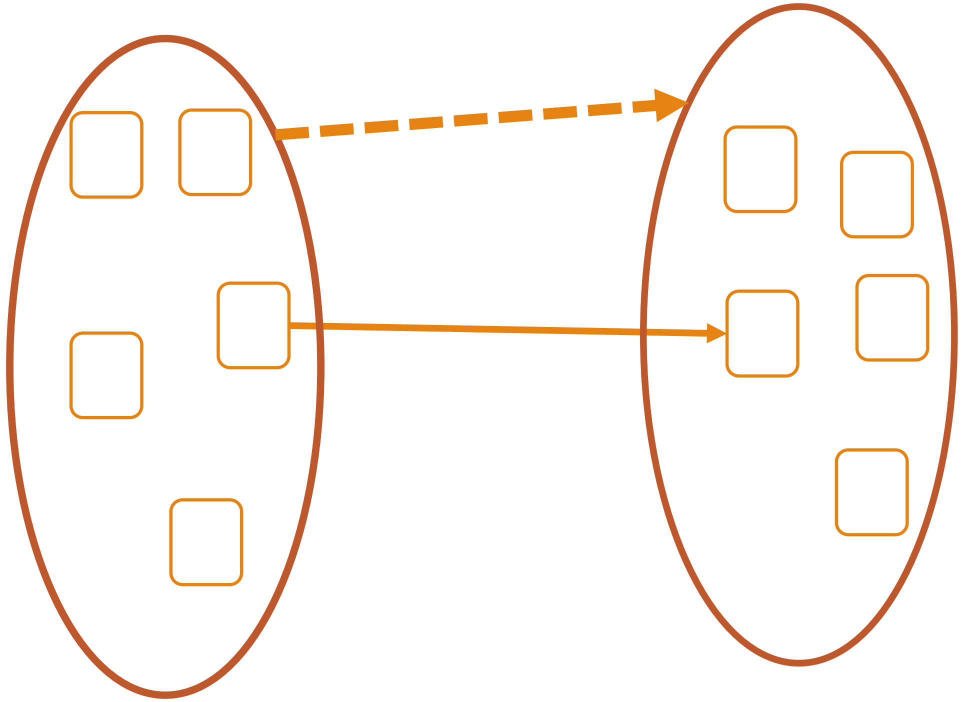
HELP!!!

Instead, MOOCs have been usually offered by experts in various areas from different universities or industry. As long as this is the case, MOOCs will continue to be offered in a rather haphazard manner without necessarily following any disciplinary guidelines.

This leaves the students to make the choices that they wish to make about what to study and when, it leaves them open to unfilled gaps in their knowledge about a body of subject matter.

One of the ways in which kind of help is made available to students is by making sure that there is some disciplinary cohesion in the MOOCs get offered.

Recommendation



An analysis of the topography of existing MOOCs is a good place to start. Network analysis is able to offer evidence-based decision making about cohesion in disciplinary knowledge in an open and flexible learning.

Recommendations engine offered by online learning portals can play a useful hidden dimension in the selection of courses.

These recommendations may not suggest that courses are related in any way, but that there might be an association of some kind that is worth exploring.

Identifying meaningful network structures of the MOOC offerings provides an overall picture of disciplinary knowledge.

Network Approach

network analysis is used as a means for exploring the hidden topological structure of MOOCs

Our goal is to provide insight into curriculum development in an online, open and flexible learning environment.

In this environment the increasing collection of MOOCs can be seen as a network of nodes with links between nodes.

This linkage between two courses are obtained from the recommendation mechanism of XuetangX, a widely recognized Chinese MOOC platform.

Research Questions

What are the network structures of recommended MOOCs, and to what extent might such structures allow for interdisciplinarity

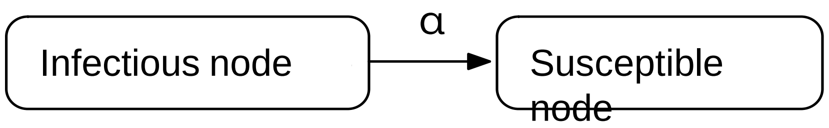
- What is the network structure of the disciplinary knowledge and how do they differ?
- To what extent the diversity of disciplinary knowledge changes by introducing courses from other disciplines?
  - The variety of interdisciplinarity
  - The balance of interdisciplinarity
  - The disparity of interdisciplinarity
- What are the new and evolving structures of disciplinary knowledge and to what extent do they differ from conventional topological structures of disciplines.

Methods

Network Metrics: *Node Degree, Shortest Path, Connected Components and Latent Communities, Modularity*

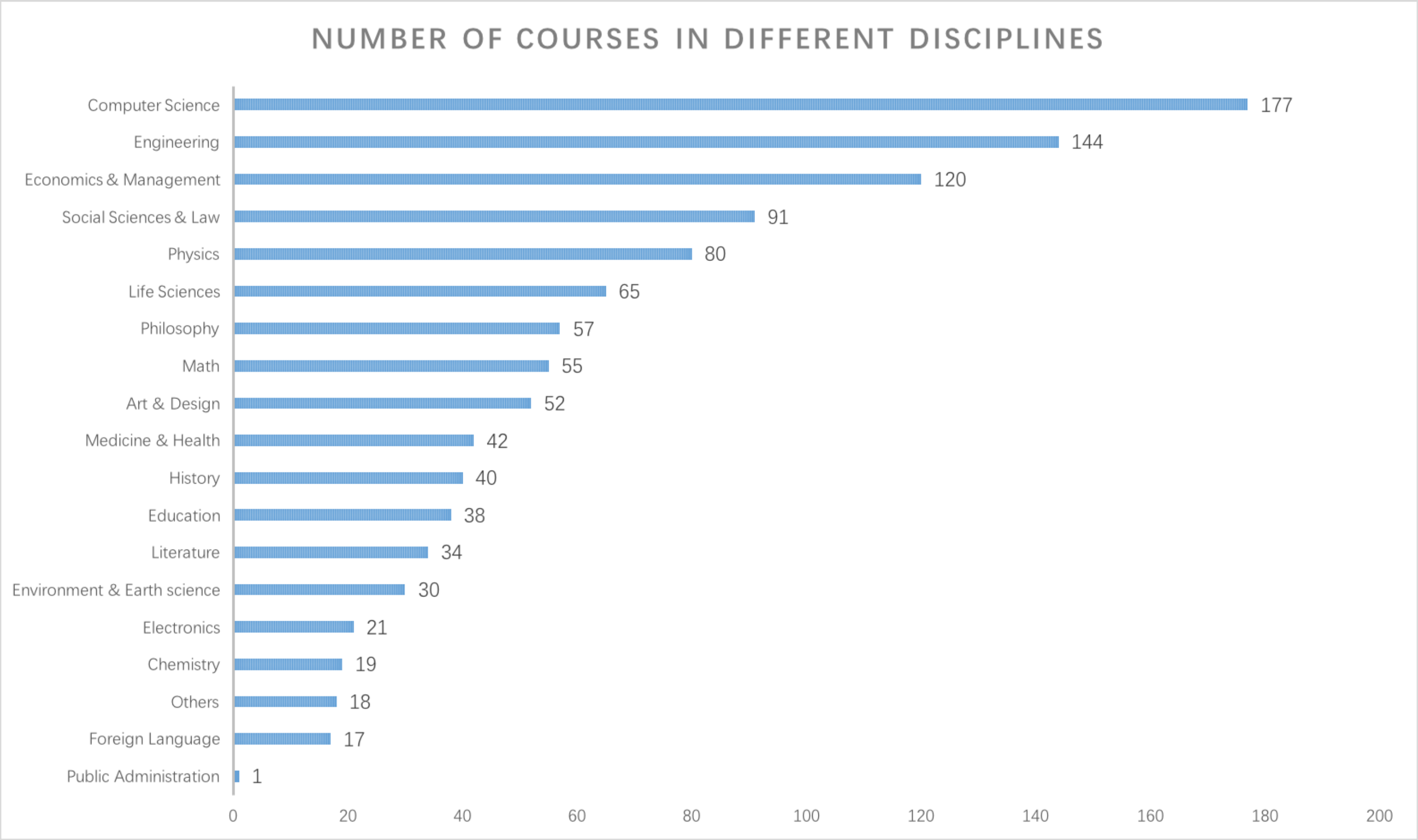
Cluster analysis is used to understand how many different parts is the recommendation network comprised, how do they fit together, and how might this influence the flow of information?

An **epidemic model** is also adopted in this study to understand the nature of information flow across disciplines.

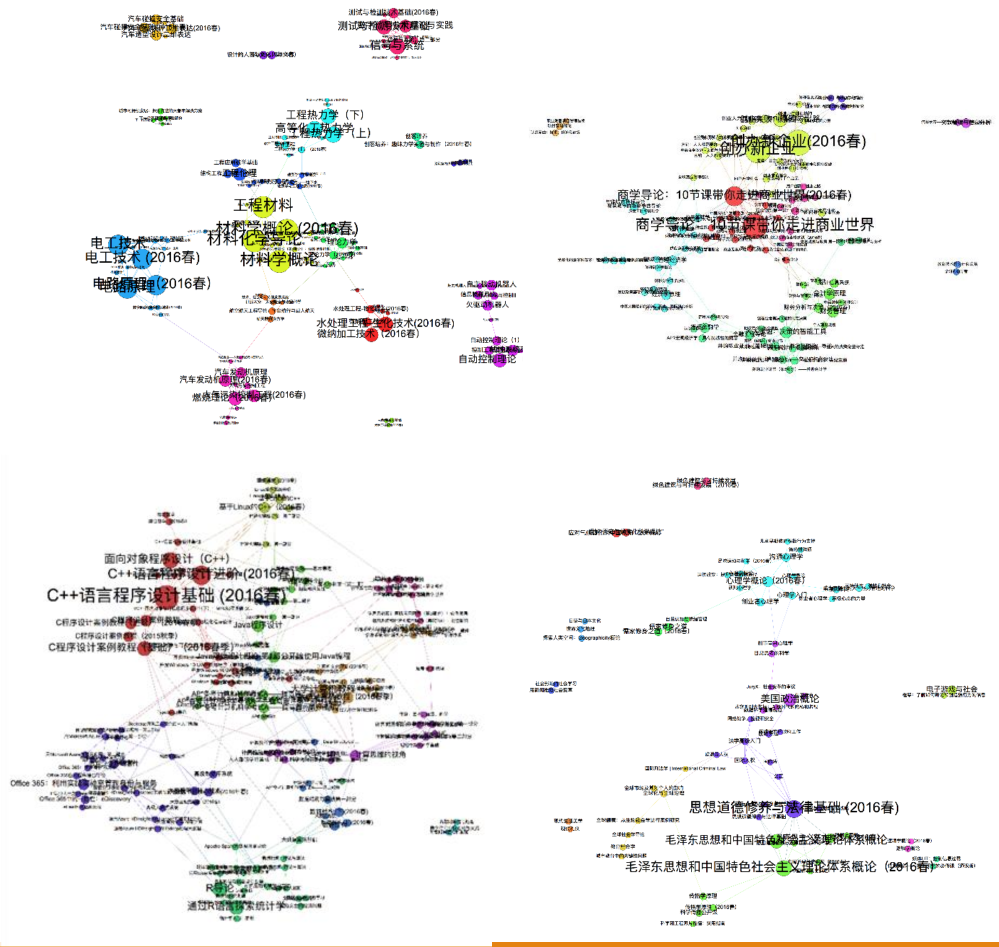


Context	Epidemiology	Resource acquisition
Process	Disease contagion	Information diffusion in the recommendation network
N	Number of individuals	Number of MOOCs
S	Susceptible individual	Unviewed MOOC
I	Infectious individual	Viewed MOOC
α	Infection rate	Probability of jumping via hyperlinks

Disciplinary Categories of MOOCs



Topological Structures of Disciplinary Network



All these four disciplinary networks have significant community structures (Newman 2004), as modularity values for all the four disciplinary network are greater than 0.3

Different communities (represented in different colours) contain courses in different topics. The courses in the same community are very densely connected which shows that the courses have similar themes

Four disciplinary networks are not complete networks, but consisted of multiple independent subgraphs. The network of computer science has the lowest degree of separation with only two sub-graphs

There are some differences between the larger sub-graph and smaller sub-graph. For example, in the network of “computer science”, the theme of the smaller sub-graph is engineering but the theme of the larger sub-graph is programming

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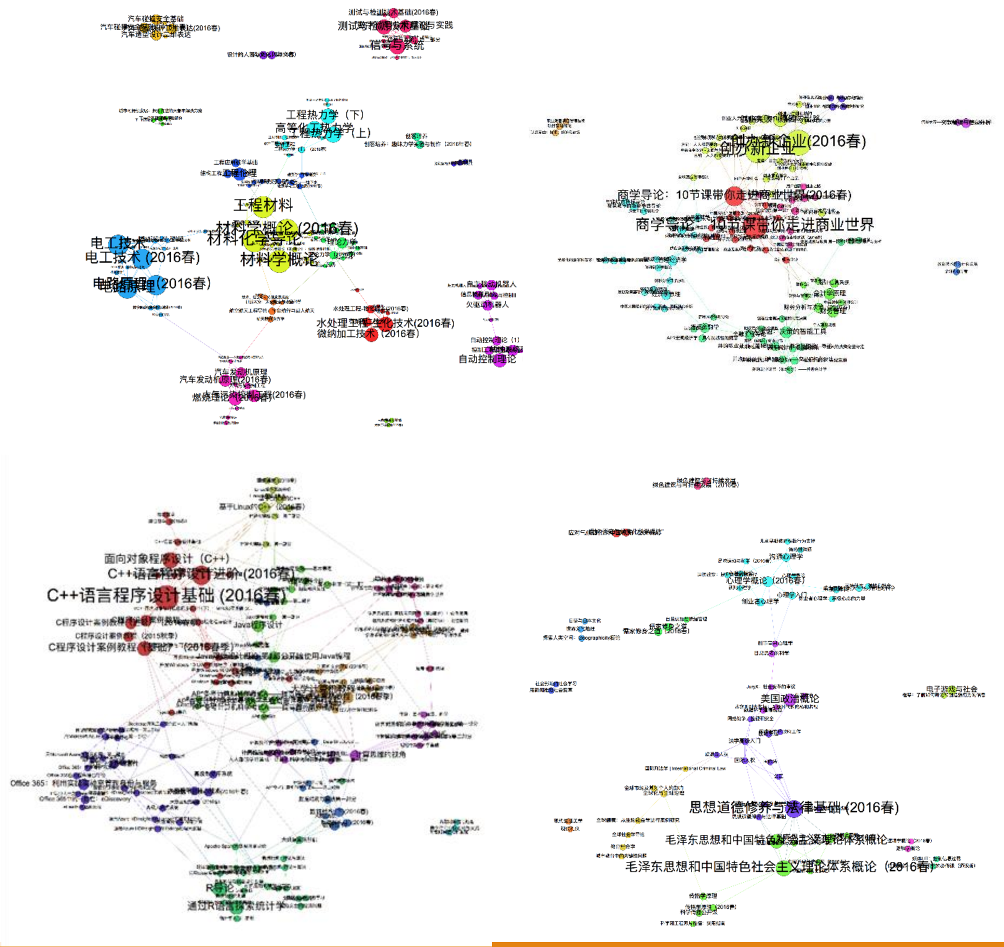
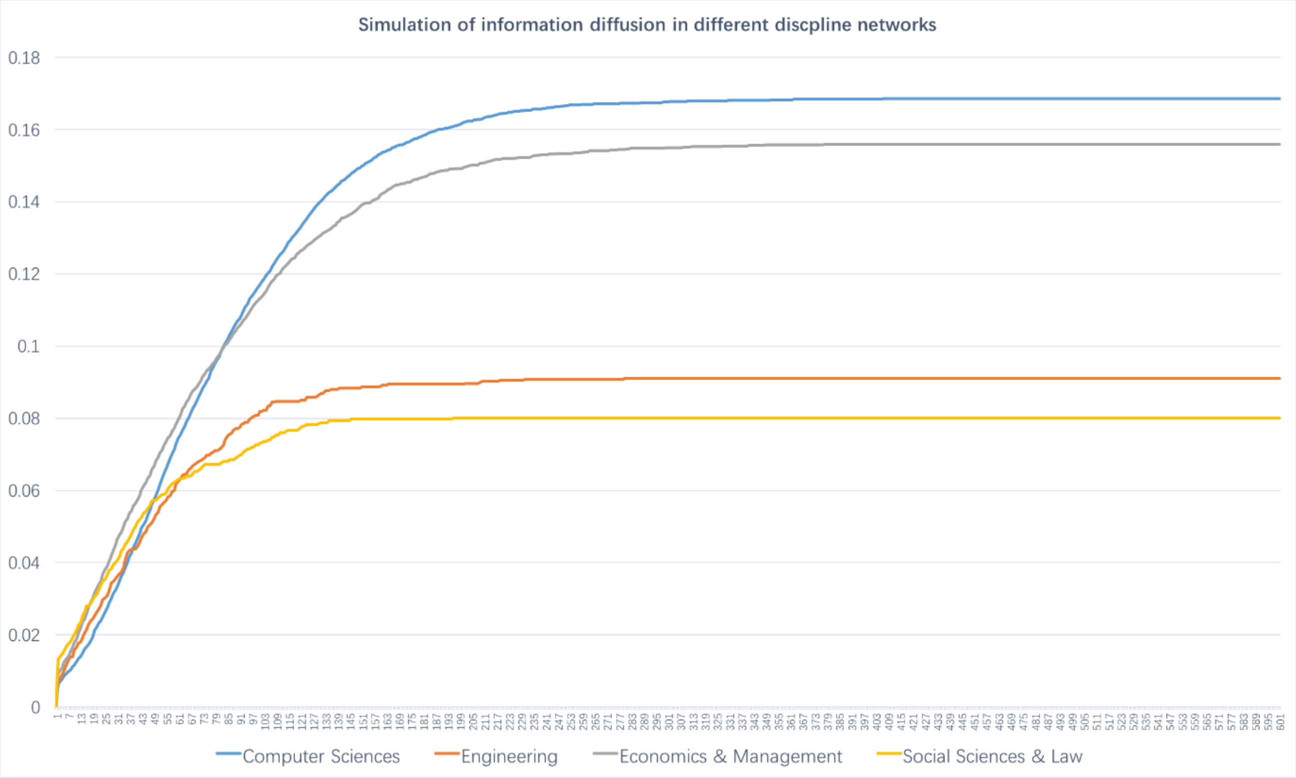


The courses in computer science are most closely interconnected. This structure can be measured by average degree, which is a global description for all the nodes in the network, to measure the number of neighbours, the nodes have on average. The average degree of computer science network is 2.422

The weakly connected component can be regarded as a subgraph of the network, and the subgraphs are not connected together. In the “computer science” disciplinary network the whole network contained 14 weakly connected component. Nine out of ten of the courses were bounded together in the largest connected component. This largest connected component contained almost all of the total recommendation link (n=400, 99.5%%). It consisted predominantly of courses in the topics of programming and data analysis, which are the popular and basic courses in computer sciences. In this network, programming courses, such as “C++ programming”, “java programming” occupy central position in the recommendation network of computer sciences, in which we use in-degree to measure the importance of course.

Information Diffusion



Disciplinary network	Minimum (%)	Maximum (%)	Average (%)
Computer science	0.56 (1 course)	35.59 (63 courses)	14.33 (25 courses)
Engineering	0.69 (1 course)	15.97 (23 courses)	3.94 (6 courses)
Economics & management	0.83 (1 courses)	26.67 (30 courses)	12.68 (14 courses)
Social sciences & law	0.11 (1 courses)	20 (18 courses)	4.65 (4 courses)

Simulating the process of forming interdisciplinary network

Interdisciplinary networks (i.e. extended disciplinary networks) were created by adding neighbour courses into the current four disciplinary networks.

We continued this process until no further any course in the previous steps was added.

Four interdisciplinary networks (extended disciplinary networks) of these four disciplines were created.

For each of these disciplinary networks, it takes 7-11 steps to converge.

As for the extended computer science network, the majority of newly added courses are from engineering, economics, physics and maths. For the extended economics network, computer science and engineers are the majority recommended courses. Social science and law discipline favours courses form the discipline of economics and computer science.

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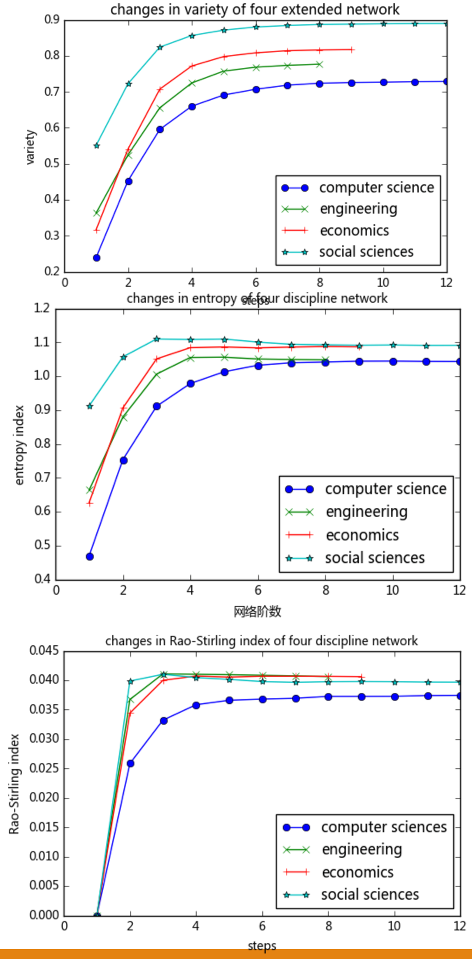
The diversity of these interdisciplinary networks



The diversity of interdisciplinarity is measured by three attributes of a network comprising courses from different disciplines (Stirling, 2007)

- Variety
- Balance
- disparity/similarity

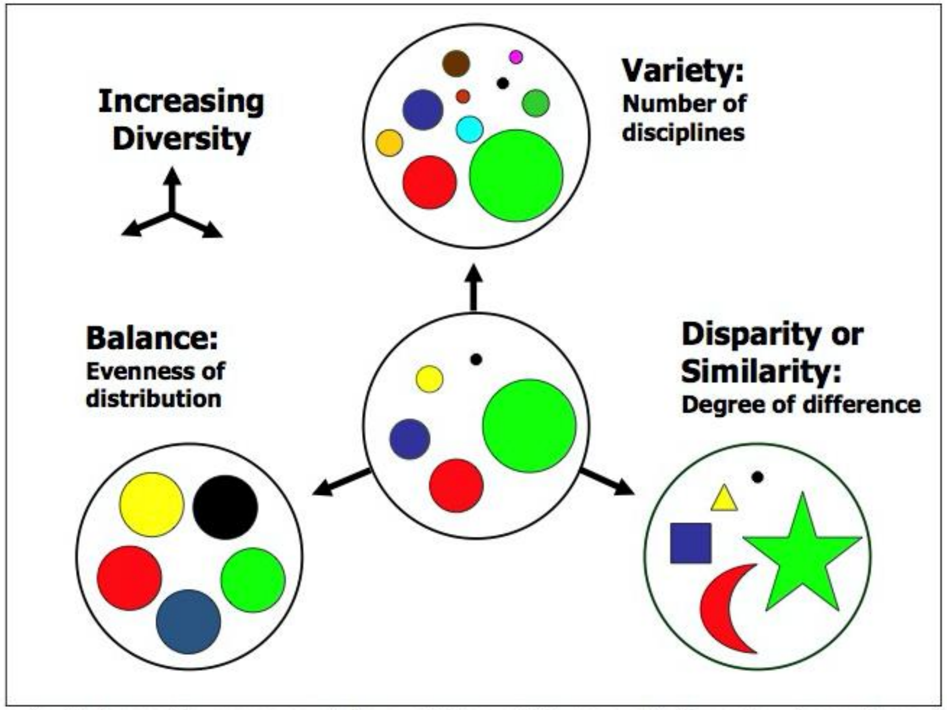


Figure 1. Schematic representation of the attributes of diversity, based on Stirling (1998, p. 41).

Information Diffusion within four interdisciplinary networks

Interestingly, the strongest connected component across the four extended disciplinary networks are the same network including the same 144 courses, among which 39 are Computer Science courses, 28 are Economics & Management, 14 are Education, 20 are Social Sciences, 17 are Engineering, 6 are Life Sciences, 6 are Medicine & Health, 8 are Math, 3 are Chemistry.

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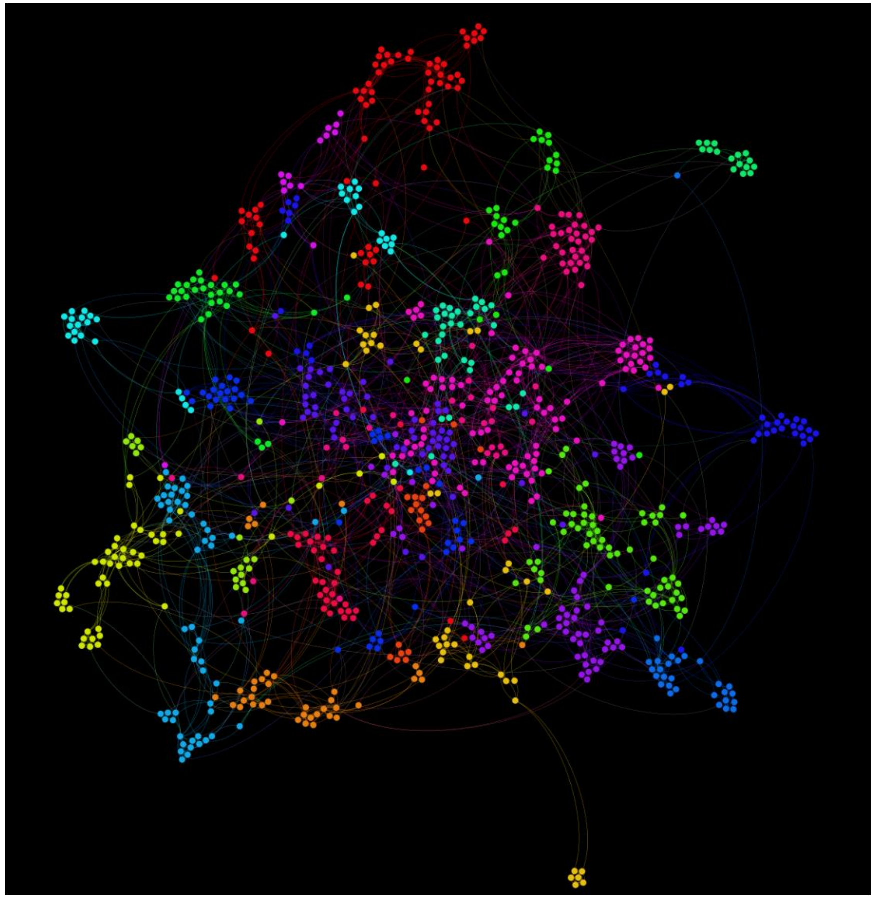
The Detected Communities of Recommendation network



Using Louvain method in Gephi, 19 different communities are detected in the whole course network. The value of modularity is 0.719, which shows that the community structure is significant.

The four largest communities are more interdisciplinary. For example, the majority of courses in community 1 belong to “economics & management”, but it also includes some courses from “computer sciences” and “social sciences & law”. In another example, the majority of courses in community 4 belong to “social sciences & law”, but it also includes some courses from “philosophy”.

The results showed that the detected courses in each community go beyond the disciplinary boundaries and the recommended courses are more likely from different disciplines.

Insights

To sum up, networks offer a powerful paradigm for the visualisation and analysis of complex systems.

Nevertheless, complex network analysis has not played a predominant role in providing evidence-based decision making about cohesion in disciplinary knowledge, which could provide insight into curriculum development in an online, open, and flexible learning environment

This study attempts to provide evidence showing that the new approach that has proved for studying complex systems like the brain cell can also be used to understand the MOOC offerings

The long-term goal of this ongoing project is to compare the network structure of MOOC offerings from multiple MOOC platforms.

Implication of how to produce integrated and coherent curricula for an online, open and flexible learning environment will be discussed.