

An attempt to discern patterns in polymathy in the exact sciences in early imperial China through bibliometrics

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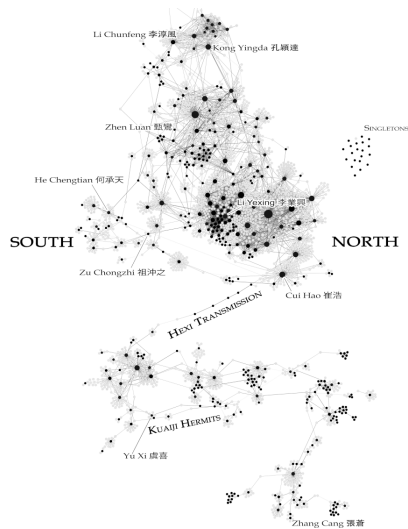
Outline

- 1 Common problems, potential future
- 2 Polymathy, bibliography and bibliometrics
- 3 Definitions, data cleaning and general statistics
- 4 The polymathic web

Common problems, potential future

Developments:

- 1950s discourse: secrecy, state monopoly, hereditary functionaries, science and the double-edged sword of bureaucracy (Eberhard 1957, Needham 1959).
- Text-focused, people-oriented studies: it is more complicated if not the opposite (Gaubil 1729–1732, Ruan Yuan 1795–1799, Yabuuti 1969, Deane 1989, **Cullen 2007**, **Sivin 2009**, **Cullen 2017**).
- 1980s–: deconstruction of ‘astronomy’, ‘mathematics’ along with ‘science’.
- 2000s–: realisation that most ‘astronomers’ were neither professionals nor specialists but *polymaths* (Goodman 2005, Cullen 2009, Goodman 2010, Lien 2011, Zuo Ya 2018).
- 2019–: social network analysis of ties between polymaths, blurring lines between the history and sociology of fields (Yang Qiao 2019, Morgan 2021).
- 1990s–: Actor’s categories! (esp. Sivin 1990)
- 2010s–: Astral and mathematical sciences intertwined with Confucian exegesis and classical ritual (Chen Kanli 2015, Zhu Yiwen 2017).

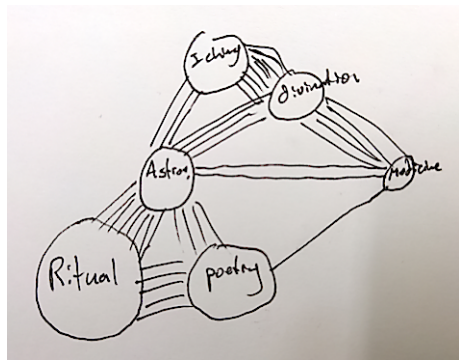


Astronomers and mathematicians, 206 B.C.–A.D. 670

Common problems, potential future

Potential future

- Reconstruction of operative emic knowledge-clusters via blind data gathering and analysis.
- Reorientation of traditional scholarship from 'science', 'astronomy', etc., to study of statistical clusters of actor's categories.
- Measurement of the place, activity, connectivity, etc., of one body of knowledge in the broader picture.



Daniel's napkin sketch

Polymathy, bibliography and bibliometrics

History of the Later Han, 'Biography of Zheng Xuan (127–200)':

遂造太學受業，師事京兆第五元，先始通『京氏易』、『公羊春秋』、『三統歷』、『九章算術』。

[Zheng Xuan] later went to the Imperial Academy to receive his patrimony, serving Diwu Yuan of the Capital as his disciple, [under whom] he first mastered Mr Jing's *Changes*, the *Gongyang Tradition of the Spring and Autumn Annals*, the *Triple Concordance Astronomy*, and the *Nine Chapters of Mathematical Procedures*.

Fundamental questions of ontologies and disambiguation:

- What is the thing behind a string of text like 'the *Triple Concordance Astronomy*'?
- How do we recognise the same thing as referenced somewhere else, possibly using an abbreviation or a different title?
- What do we do with non-written works, vis-à-vis books, or books in multiple editions?
- And how do we objectively tie the thing, whatever it may be, to an actor's category?

Polymathy, bibliography and bibliometrics

History of the Sui, 'Treatise on Classics and Books' 隋書·經籍志 (656)

- Part of the history of the Sui dynasty (581–618), compiled under the Tang (618–907) in 656.
- Massive four-volume bibliography, modelled on the catalogue of the Imperial Library, comprising: introduction, catalogue in 4 categories and 44 subcategories, and brief histories and descriptions of each genre.
- Not actually a catalogue of the Sui library, which was lost in 622, but a collation of what did survive with other extant catalogues from the period, between the Sui, in the north, and the Liang (502–557), in the south, meant to provide a comprehensive list of books in various sixth-century collections.
- Advantages
 - Massive list of written works, North and South, to A.D. 618
 - Division by seventh-century bibliographers into comprehensive taxonomy of knowledge
 - Formulaic, easy to parse
- Similar catalogues extant in the *History of the Han* 漢書 (111), the *Old History of the Tang* 舊唐書 (941), the *New History of the Tang* 新唐書 (1060), etc.

Polymathy, bibliography and bibliometrics

Organisation

- A) 經 Classics
- B) 史 History
- C) 子 Masters

- | | |
|---------------------------------------|------------------------------------|
| 1) 儒 Confucianism (philosophy) | 8) 農 Agriculturalists (philosophy) |
| 2) 道 Daoism (philosophy) | 9) 小說 Rhetoricians (philosophy) |
| 3) 法 Legalism (philosophy) | 10) 兵 Military |
| 4) 名 Nominalism (philosophy) | 11) 天文 Heavenly patterns |
| 5) 墨 Mohism (philosophy) | 12) 曆數 Astronomy and numbers |
| 6) 從橫 Military alliances (philosophy) | 13) 五行 Five Agents (divination) |
| 7) 雜 Misc. | 14) 醫方 Healing |

- D) 集 Collected writings (& Daoist and Buddhist religion)

'Masters: Astronomy and Numbers' 子·曆數

四分曆三卷梁四分曆三卷，漢修曆人李梵撰。梁又有三統曆法三卷，劉歆撰，亡。

Quarter Remainder Astronomy in 3 rolls. (The Liang [dynasty]: *Quarter Remainder Astronomy* in 3 rolls, written by Li Fan. The Liang also had a *Triple Concordance Astronomy* in 3 rolls, written by Liu Xin, which is lost).

趙隱居四分曆一卷

Hermit Zhao's *Quarter Remainder Astronomy* in 1 roll.

魏甲子元三統曆一卷

The Wei [Dynasty] Jiazi-origin Triple Concordance Astronomy in 1 roll.

姜氏三紀曆一卷

Mr Jiang's *Triple Epoch Astronomy* in 1 roll

曆序一卷姜氏撰。

Astronomy Preface in 1 roll, written by Mr Jiang.

乾象曆三卷吳太子太傅闕澤撰。梁有乾象曆五卷，漢會稽都尉劉洪等注；又有闕澤注五卷，又乾象五星幻術一卷。亡。

Supernal Icon Astronomy in 3 rolls. (Written by the Wu [dynasty] Grand Mentor to the Crown Prince, Kan Ze. The Liang had a *Supernal Icon Astronomy* in 5 rolls, annotated by the Han Commandant of Kuaiji, Liu Hong, et al.; they also had one annotated by Kan Ze in 5 rolls, and also a *Supernal Icon Procedures for the Illusions of the Five Planets* in 1 roll, which are lost)

'Masters: Astronomy and Numbers' 子·曆數

右一百部，二百六十三卷。

[The works to] the left (above) amount to 100 titles in 263 rolls.

曆數者，所以揆天道，察昏明，以定時日，以處百事，以辨三統，以知阨會，吉隆終始，窮理盡性，而至於命者也。易曰：「先王以治曆明時。」書叙：「朞，三百有六旬有六日，以閏月定四時，成歲。」春秋傳曰：「先王之正時也，履端於始，舉正於中，歸餘於終。」又曰：「閏以正時，時以序事，事以厚生，生民之道。」其在周官，則亦太史之職。小人為之，則壞大為小，削遠為近，是以道術破碎而難知。

Astronomy and numbers are the means by which one measures the dao of heaven and examines the dusk and bright; to fix the time and date, and to organise the hundred sacrifices; to distinguish [the cosmo-political cycle of] the Three Concordances, and to know of impending disaster. Auspicious and prosperous from beginning to end, comprehensive in principle and exhaustive of human nature, they are what get [us] to Fate. The *Changes* says 'The kings of old illuminated the seasons by tending to astronomy'. The *Documents* recounts that 'The period is three hundred, six decades and six days (366), the four seasons are fixed by means of the intercalary month, and the agricultural year is complete'. The [*Zuo*] *Tradition of the Spring and Autumn Annals* says... In the *Offices of the Zhou* (1045–771 B.C.), it is likewise the function of the Grand Clerk. When lesser men go about them, they pursue the petty in detriment to the great, and pare away the distant for the near at hand, and that is why [their] ways and methods are in pieces and difficult to understand.

Definitions, data cleaning and general statistics

Question: How many books are there?

total	extant (7c)		total	
	titles	vols	titles	vols
cat., global count	3127	36,708	4191	49,467
cat., subsection counts	3148	35,989	–	–
DPM, item by item	3239	37,225	5597	58,957

Question: What are we counting? 'Items'? 'Editions'? 'Works'?

子·天文 'Masters: Heavenly patterns':

太史注記六卷 *Astronomical Office Note Records*, 6 vols.

子·曆數 'Masters: Astronomy and Numbers':

太史注記六卷 *Astronomical Office Note Records*, 6 vols.

太史記注六卷 *Astronomical Office Record Notes*, 6 vols.

Definitions, data cleaning and general statistics

Problem 2: We can supplement missing authorship data from external sources, but I have only done so systematically for the astral and mathematical sciences.

History of the Sui, 'Treatise on Classics and Books', 'Masters: Heavenly Patterns':

靈臺祕苑一百一十五卷太史令庾季才撰。

Secret Garden of the Observatory, 115 vols (Written by Prefect Grand Clerk Yu Jicai).

太史注記六卷

Astronomical Office Note Records, 6 vols.

垂象志一百四十八卷

Monograph on Signs Sent Down [from Heaven], 148 vols.

History of the Sui, 'Biography of Yu Jicai 庾季才 (516–603)':

撰靈臺祕苑一百二十卷，垂象志一百四十二卷……

[Yu Jicai] wrote *Secret Garden of the Observatory* in 120 vols, *Monograph on Signs Sent Down* in 142 vols...

Definitions, data cleaning and general statistics

Problem 3: I have chosen to eliminate supplements—tables of contents (*mu* 目) and summaries (*lu* 錄)—which are not short, anonymous, particular to a handful of genres and, thus, they tend to skew distributions.

Adjusted totals:

5198 works in 5438 editions, in 58,814 volumes, divided into 4 categories and 44 subcategories

The place of astronomy and maths in cultural production

Bibliographic categories

A) 經 Classics

B) 史 History

C) 子 Masters

1) 儒 Confucianism (philosophy)

2) 道 Daoism (philosophy)

3) 法 Legalism (philosophy)

4) 名 Nominalism (philosophy)

5) 墨 Mohism (philosophy)

6) 從橫 Military alliances (philosophy)

7) 雜 Misc.

8) 農 Agriculturalists (philosophy)

9) 小說 Rhetoricians (philosophy)

10) 兵 Military

11) 天文 Heavenly patterns

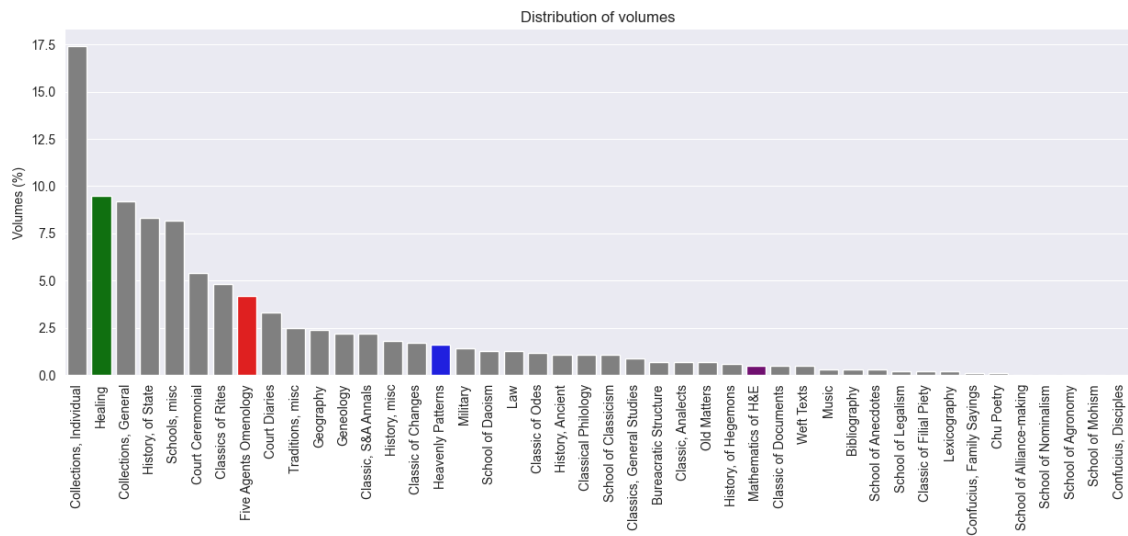
12) 曆數 Astronomy and numbers

13) 五行 Five Agents (divination)

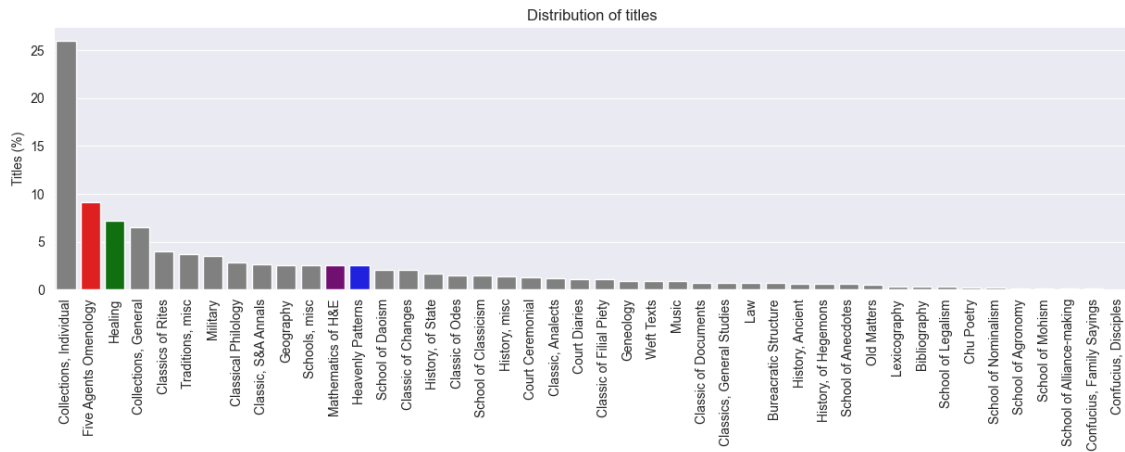
14) 醫方 Healing

D) 集 Collected writings (& Daoist and Buddhist religion)

The place of astronomy and maths in cultural production



The place of astronomy and maths in cultural production



Anonymity

Problems:

- The catalogue sometimes omits the author (e.g., Yu Jicai)
- It sometimes gives only the surname (e.g., 'Mr Jiang' = Jiang Ji 姜岌 (fl. 384))
- Pseudepigrapha:

黃帝鍼經九卷

The Yellow Emperor's Acupuncture Classic, 9 vols ('Masters: Healing')

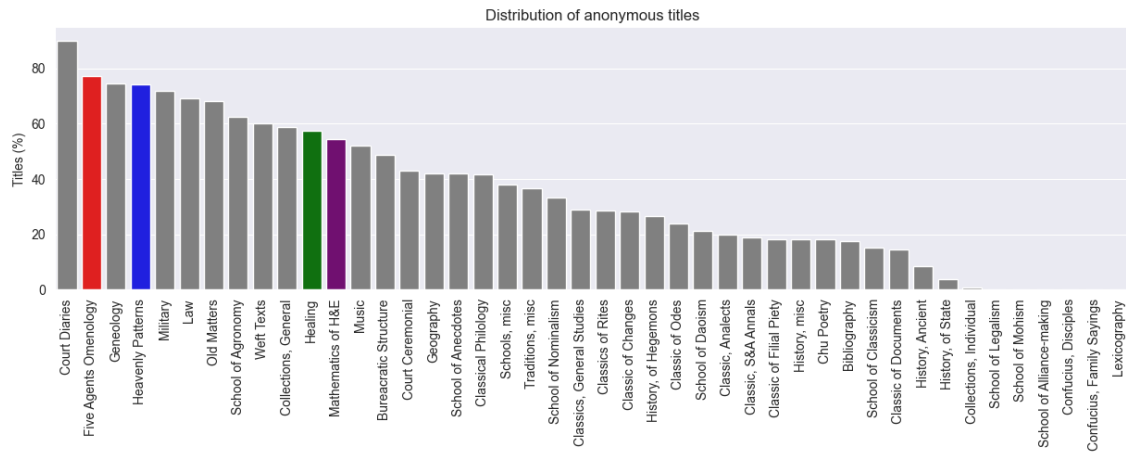
婆羅門天文經二十一卷婆羅門捨仙人所說

Brāhman Heavenly Patterns Classic, 21 vols, explanations of the Brāhmansha Immortal ('Masters: Heavenly Patterns')

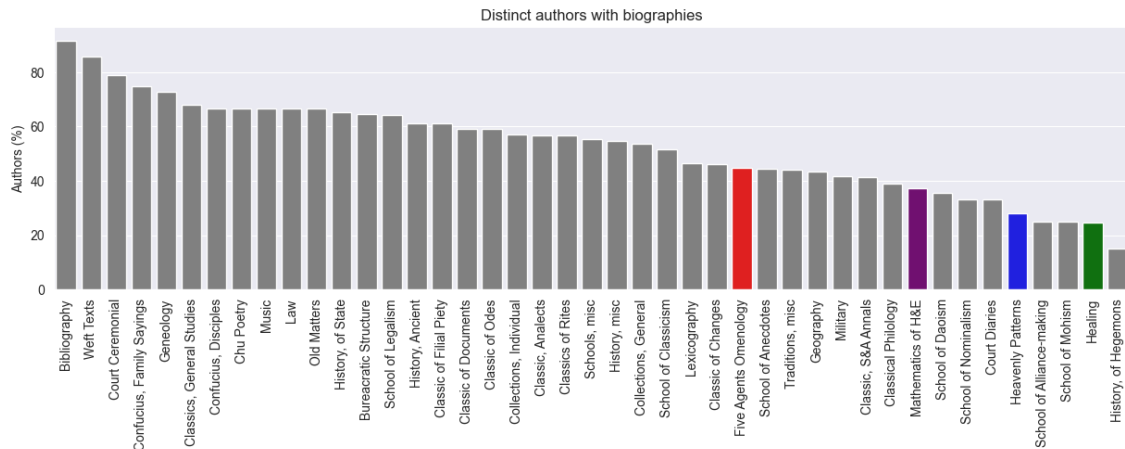
Good news:

- 3379/5198 (65%) of works are attributed!!! (*small percentage by me)
- Of 1797 distinct authors, 771 (43%) have biographies!!!

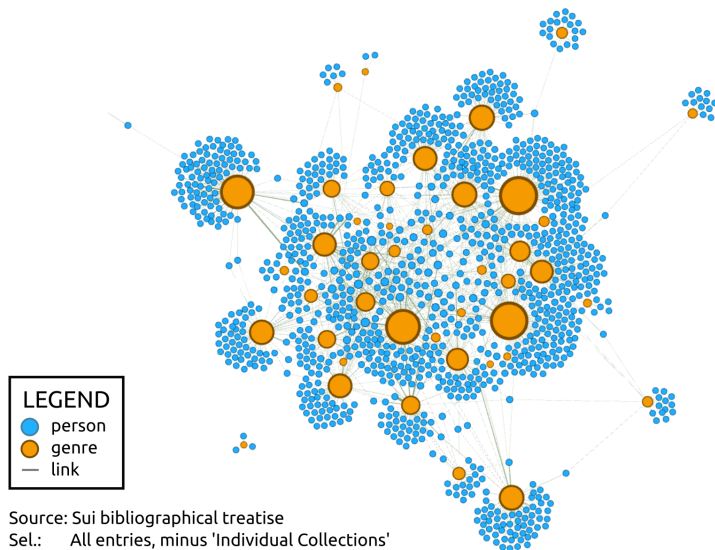
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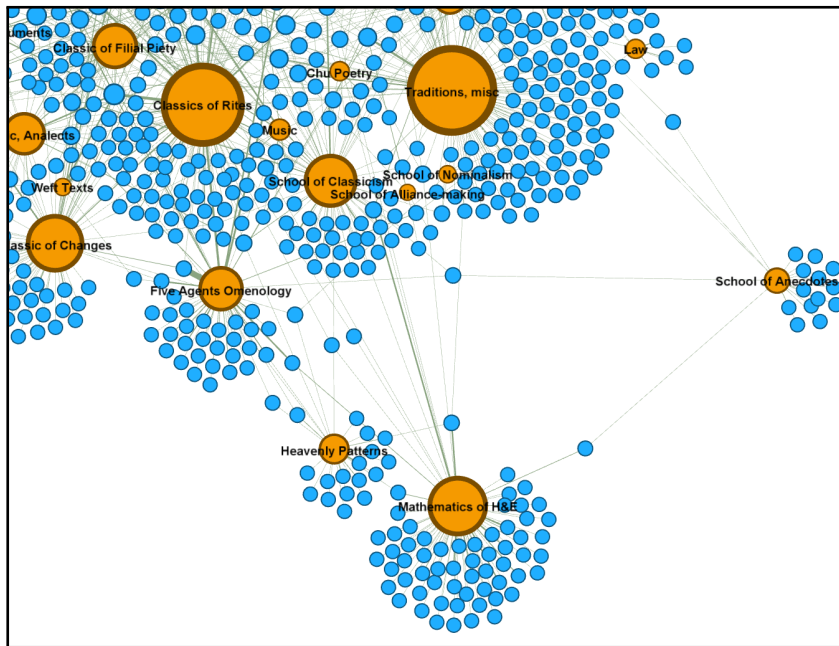


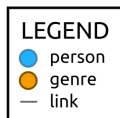
Anonymity



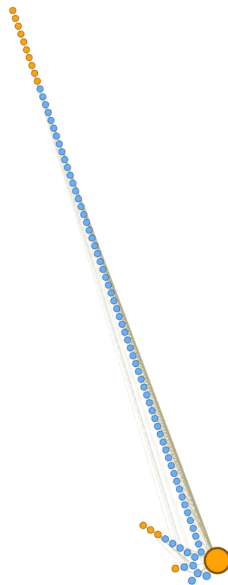
The polymathic web



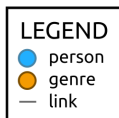




Source: Sui bibliographical treatise
Sel.: All entries, minus 'Individual Collections'
Vis.: Radial



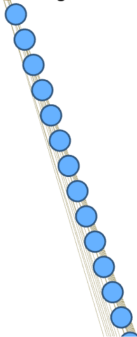
School of Alliance-making
 Collections, General
 Healing
 Military
 School of Anecdotes
 Bibliography
 Geography
 Classical Philology
 Classic of Filial Piety
 Classic of Changes



Source: Sui bibliographical treatise

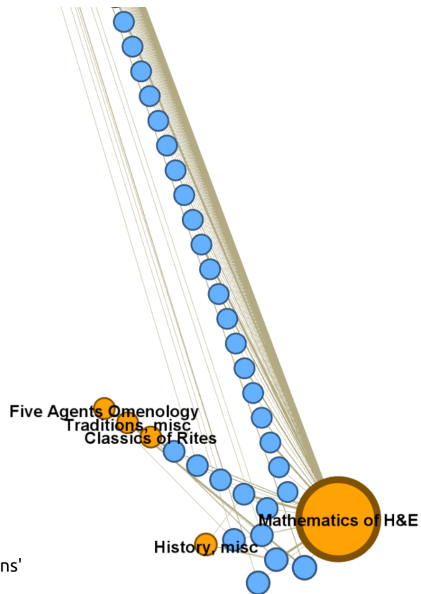
Sel.: All entries, minus 'Individual Collections'

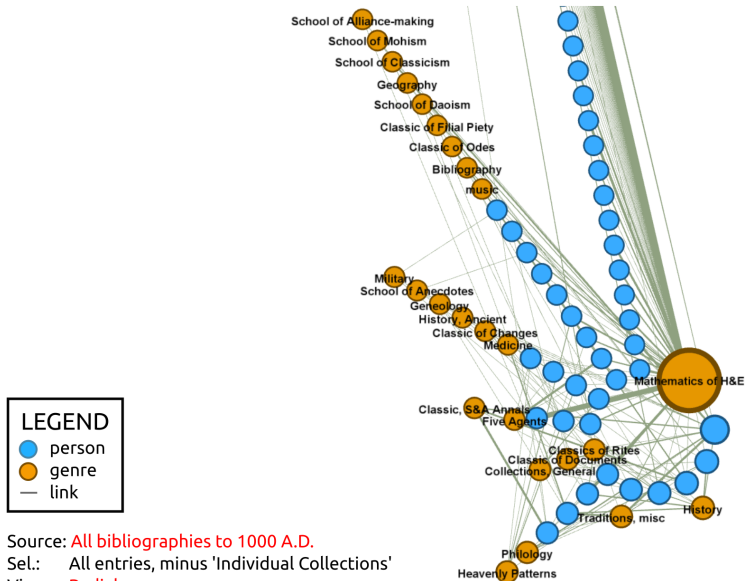
Vis.: Radial

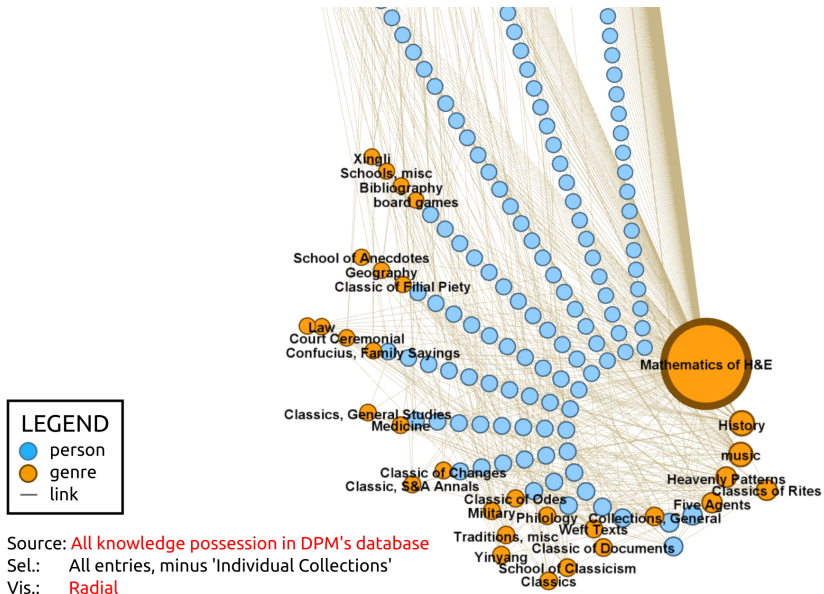


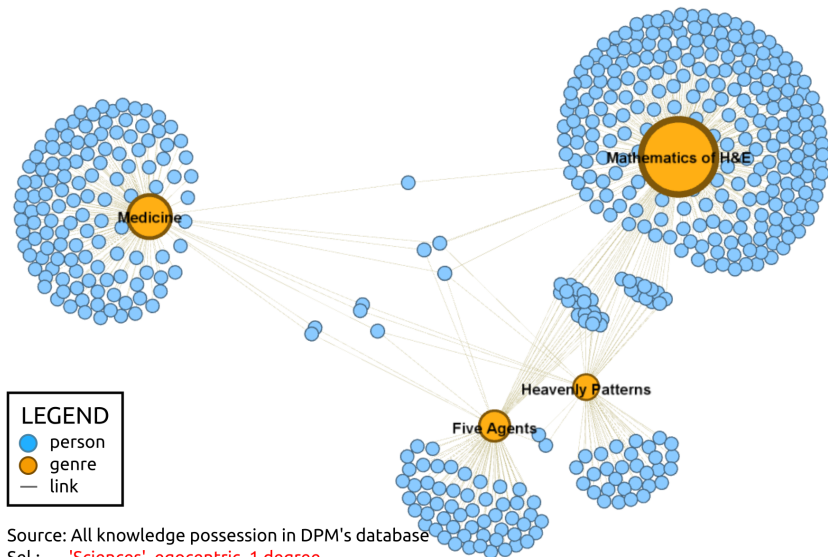


Source: Sui bibliographical treatise
 Sel.: All entries, minus 'Individual Collections'
 Vis.: Radial





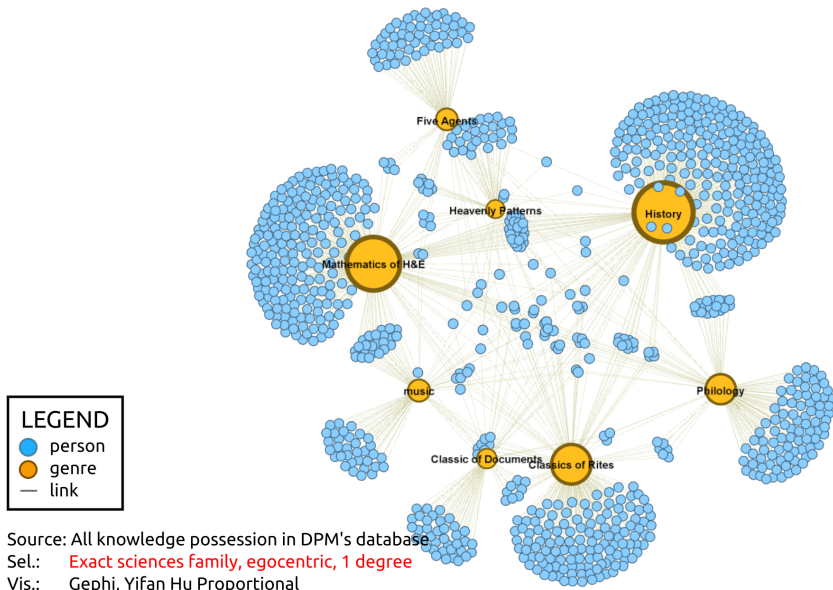




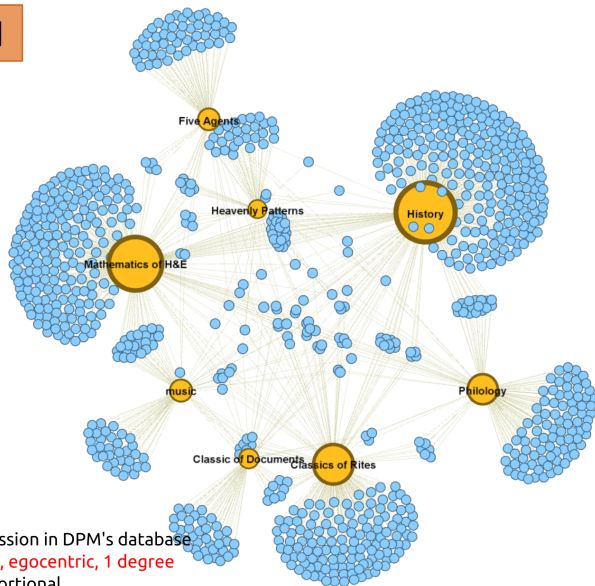
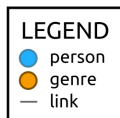
Source: All knowledge possession in DPM's database

Sel.: 'Sciences', egocentric, 1 degree

Vis.: Gephi, Yifan Hu Proportional



CONCLUSION

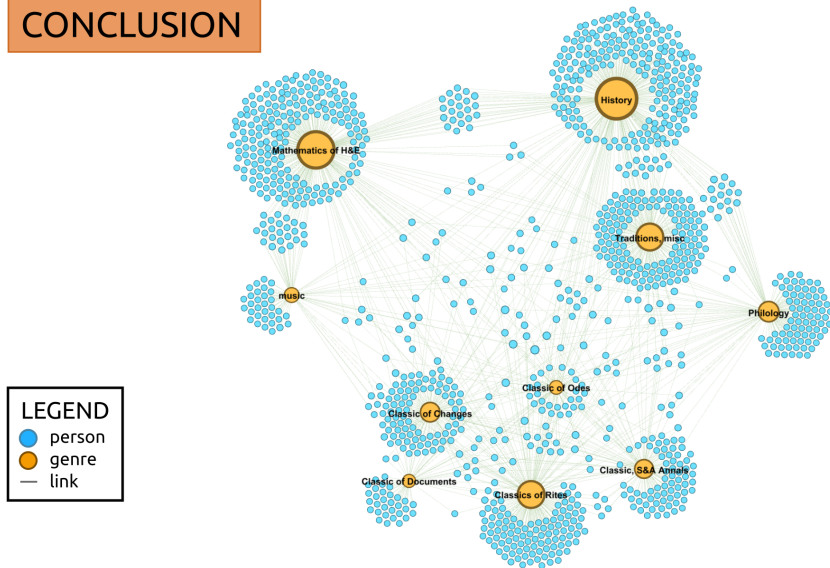


Source: All knowledge possession in DPM's database

Sel.: **Exact sciences family, egocentric, 1 degree**

Vis.: Gephi, Yifan Hu Proportional

CONCLUSION



CONCLUSION

