Part V

KNOWLEDGE ORGANIZATION

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M-*CLASSI*: A NEW DIGITAL TOOL FOR THE CLASSIFICATION OF THE SCIENCES, IN ISLAM AND BEYOND

Introduction

M-*Classi* is a new digital tool in the field of knowledge organization. It is conceived primarily as a means of cataloging and interrogating the classifications of the sciences in Islam and those cultures with which the Islamicate world came into contact from antiquity to the premodern era. Practically, M-*Classi* is focused, by priority, on Arabic, Persian, and Turkish classifications, but for comparative purposes it also integrates taxonomies in Syriac, Greek, Latin, Hebrew, and other languages. This said, the application is universally usable and can be adapted to any language and script. The aim of this article is to present this game changing tool whose vocation is to become an open-access engine for future research. After briefly recapitulating the current state of the art on Islamic classifications of the sciences and succinctly presenting the specificities of M-*Classi*'s technical configuration in its current beta version (available on request at https://www.m-classi.eu), we review some of the application's main functionalities. In particular, we provide examples of complex queries that M-*Classi* and its extensive database can address, and we illustrate, with screen captures, various aspects of its great potential in terms of visualization.

State of the Art

At present, the classifications of Islamic sciences remains largely understudied, especially when measured in relation to its vast historical record. From the third-/ninth-century epitomes of Aristotelian

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works, in which early attempts at structuring human knowledge in disciplines was noted[1], to the enormous catalogues of the rational sciences produced in Ottoman times by Ṭāshköprüzāda (d. 968/1561) and others, the classifications of the sciences, as devised by Muslim scholars in multiple fields – theologians, philosophers, logicians, naturalists, cosmographers, physicians, litterateurs – number in the hundreds, yet thus far, only a small fraction of this enormous production has received serious attention. Modern scholarship on encyclopedism and the organization of knowledge in Islam has traditionally focused on Arabic literature and the so-called "classical period", and considered only a very limited number of emblematic examples, among which we almost inevitably find al-Kindī's *Risāla fī kammiyya kutub Aristūṭālis* (d. ca. 259/873), the *Rasā'il Ikhwān al-Ṣafā'* (fourth/tenth century or earlier), al-Fārābī's *Iḥṣā' al-ʿulūm* (d. 339/950-51), and Ibn Sīnā's (d. 428/1037) *Risāla fī taqsīm al-ʿulūm al-ʿaqliyya*. Other writings regularly mentioned in this context are the *Mafātiḥ al-ʿulūm* by the civil servant Muḥammad b. Aḥmad al-Khuwārizmī (fourth/tenth century), the *Risāla fī l-ʿulūm* of the litterateur Abū Ḥayyān al-Tawḥīdī (d. 414/1023), Ibn Ḥazm's *Marātib al-ʿulūm* (d. 456/1064), and sometimes also Fakhr al-Dīn al-Rāzī's *Jāmiʿ al-ʿulūm* (d. 605/1209) and Ibn Khaldūn's *Muqaddima* (d. 808/1406). The list rarely goes much beyond this handful of books[2]. With the exception of valuable,

1. Ch. Hein, *Definition und Einteilung der Philosophie: von der spätantiken Einteilungsliteratur zur arabischen Enzyklopädie* (Frankfurt am Main 1985); D. Gutas, «The Greek and Persian Background of Early Arabic Encyclopedism». in *Organizing Knowledge: Encyclopaedic Activities in the Pre-Eighteenth Century Islamic World*, ed. G. Endress (Leiden 2006), 91-101.

2. The standard references in this field remain W. Heinrichs, «The Classification of the Sciences and the Consolidation of Philology in Classical Islam», in *Centres of Learning: Learning and Location in Pre-modern Europe and the Near East*, ed. J. W. Drijvers and A. MacDonald (Leiden 1995), 119-39; J. Jolivet, «Classifications of the Sciences», in *Encyclopedia of the History of Arabic Sciences*, ed. R. Rashed and R. Morelon, 3 vols. (London 1996), 1008-25; A. M. Al-Najjar, «Classification of Sciences in Islamic Thought: Between Imitation and Originality», *American Journal of Islamic Social Sciences* 13 no. 1 (1996), 59-87; O. Bakar, *Classification of Knowledge in Islam* (Cambridge 1998); H.-H. Biesterfeldt, «Medieval Arabic Encyclopedias of Science and Philosophy», in *The Medieval Hebrew Encyclopedias of Science of Philosophy: Proceedings of the Bar-Ilan University Conference*, ed. S. Harvey (Dordrecht 2000), 77-98; Biesterfeldt, «Arabisch-islamische Enzyklopädien: Formen und Funktionen», in *Die Enzyklopädie im Wandel vom Hochmittelalter bis zur Frühen Neuzeit: Akten des Kolloquiums des Projekts D im Sonderforschungsbereich 231 (29.11.-1.12. 1996)*, ed. Ch. Meier (Munich 2002),

but rather general contributions on Persian encyclopedias[3] and a few recent studies on specific Ottoman classifications[4], the exploration

43-83; P. Heck, «The Hierarchy of Knowledge in Islamic Civilization», *Arabica* 49 no. 1 (2002), 27-54; G. Endress, «The Cycle of Knowledge: Intellectual Traditions and Encyclopaedias of the Rational Sciences in Arabic Islamic Hellenism», in *Organizing Knowledge: Encyclopaedic Activities in the Pre-Eighteenth Century Islamic World*, ed. G. Endress (Leiden 2006), 103-33. More recently, Biesterfeldt also wrote articles on individual classifications such as, Biesterfeldt, «Ibn Farīghūn's *Jawāmiʿ al-ʿulūm*: Between Classification of Sciences and Mirror for Princes». in *Global Medieval: Mirrors for Princes Reconsidered* (Ilex Foundation Series 15), ed. R. Forster and N. Yavari (Boston 2015), 11-25; Biesterfeldt, «Eine arabische Klassifikation der Wissenschaften aus dem 4./5. Jahrhundert H.», *Studia graeco-arabica* 10 (2020), 261-70; Biesterfeldt and M. Cüneyt Kaya, «An Aristotelian Classification of the Sciences by Avicenna?», *Zeitschrift für Geschichte der Arabish-Islamischen Wissenschaften* 22 (2020), 1-21. See also, among G. de Callataÿ's recent contributions to the field: «The Classification of Knowledge in the *Rasāʾil*», in *The Ikhwān al-Ṣafāʾ and their Rasāʾil: An Introduction*, ed. N. El-Bizri (Oxford 2008), 58-82; G. de Callataÿ, «Trivium et quadrivium en Islam: des trajectoires contrastées», in *Une lumière venue d'ailleurs: Héritages et ouvertures dans les encyclopédies d'Orient et d'Occident au Moyen Age, Actes du colloque international tenu à Louvain-la-Neuve du 19 au 21 mai 2005* (Collection Réminisciences 9), ed. G. de Callataÿ and B. Van den Abeele (Turnhout 2008), 1-30; G. de Callataÿ, «Science in Islam: Classification», in *Encyclopedia of Sciences and Religions*, ed. A. L. C. Runehov and Ll. Oviedo (Dordrecht 2013), 2100-2; G. de Callataÿ, «Encyclopaedism on the Fringe of Islamic Orthodoxy: The *Rasāʾil Ikhwān al-Ṣafāʾ*, the *Rutbat al-ḥakīm* and the *Ghāyat al-ḥakīm* on the Division of Science», *Asiatische Studien* 71 no. 3 (2017), 857-77; G. de Callataÿ, «Dividing Science By Ten», *Studia Islamica* 111 (June 2020), 1-32.

3. For the Persian encyclopedic material, see in particular: Ž. Vesel, *Les encyclopédies persanes. Essai de typologie et de classification des sciences* (Paris 1986); Ž. Vesel, «Les encyclopédies persanes: culture scientifique en langue vernaculaire», in *Une lumière venue d'ailleurs: Héritages et ouvertures dans les encyclopédies d'Orient et d'Occident au Moyen Age, Actes du colloque international de Louvain-la-Neuve* (*19-21 mai 2005*), ed. G. de Callataÿ and B. Van den Abeele (Turnhout 2008), 49-89; M. Melvin-Koushki, «Powers of One: The Mathematicalization of the Occult Sciences in the High Persianate Tradition», *Intellectual History of the Islamicate World* 5 (2017), 127-99. See also Ž. Vesel and M. Melvin Koushki, «Encyclopedias, Persian», in *EI*[3] (forthcoming).

4. F. Bellino, «The Classification of Sciences in an Ottoman Arabic Encyclopaedia: Ṭāšköprüzāda's *Miftāḥ al-saʿāda*», *Quaderni di Studi Arabi* 9 (2014), 161-80; F. Bellino, «Arabic Encyclopaedias and Encyclopaedism between the Seventeenth and Nineteenth Centuries: Forms, Functions, Intersections of *adab* and Modernity», in *Adab and Modernity: A «Civilising Process»?* (*Sixteenth-Twenty-First Century*), ed. C. Mayeur-Jaouen (Leiden 2020), 123-27; F. S. Eryılmaz and G. de Callataÿ, «Following the Steps of the Ikhwān al-Ṣafāʾ in the Ottoman World I: Insights from Three Universal Histories», *JIS* 34 no. 3 (2023), 340-70; G. de Callataÿ, «Following the Steps of the Ikhwān al-Ṣafāʾ in the Ottoman World II: ʿAbd al-Raḥmān al-Biṣtāmī and His *tashjīr* Diagrams of Science», *Mediterranea: International Journal on the Transfer of Knowledge* 8 (2023), 55-88.

and exploitation of this "post-classical" heritage remains largely to be done. From this point of view, we can only observe that there still exists a major disproportion in the interest accorded, on the one hand, to the classifications of Greco-Latin antiquity and their heirs in the western medieval tradition and, on the other hand, to those of the Muslim world. The contrast is all the more striking as we compare the Islamic classifications of the sciences with those produced in the medieval Latin Christian West. It seems that these western classifications have been continuously and scrupulously inventoried and analyzed, despite the fact that they include only a small number of sciences and have changed very little over the centuries. In fact, these taxonomies appear to have been rooted once and for all on: (1) the Aristotelian tripartite division of science (*ἐπιστήμη*) into "speculative" (*θεωρητική*), "practical" (*πρακτική*), and "productive" (*ποιητική*); (2) Aristotle's further division of speculative science (or rational philosophy) into mathematics, physics, and theology, with logic as the "instrument" (*ὄργανον*) of science; (3) the notions of quadrivium and trivium, inherited from the Greco-Roman liberal arts education as handed down by Boethius (d. 524) and Cassiodorus (d. 585) at the crossroads of antiquity and the Middle Ages[5]. The situation could hardly be more diverse for the Islamic sciences. Not only do classifications in Islam generally include a greater number of sciences, reaching into the hundreds in some extreme cases such as Ṭāshköprüzāda's *Miftāḥ al-saʿāda*; but their authors also appear to have distanced themselves from the authorities of the past much more freely than their Latin counterparts, even while Aristotle's influence continue to play an important role in many of them[6].

Current scholarship on premodern classifications of the sciences, whether antique or medieval, western or eastern, has thus far suffered from another major flaw. In the absence of a digital tool allowing

5. We limit ourselves here to J. Weisheipl, «Classification of the Sciences in Medieval Thought», *Mediaeval Studies* 27 (1965), 54-90; I. Hadot, *Arts libéraux et philosophie dans la pensée antique. Contribution à l'histoire de l'éducation et de la culture de l'antiquité* (Paris 1984).

6. See now G. de Callataÿ, "Classifications of the sciences in Islamic cultures", in *Encyclopedia of Knowledge Organization* (International Society for Knowledge Organization), ed. B. Hjørland and C. Gnoli, available at https://www.isko.org/cyclo/islamic. This periodically revised contribution is intended to serve as a companion to M-*Classi*.

both the treatment and implementation of a massive collection of data and a visual comparison of numerous taxonomies with each other, approaches to these classifications have remained fragmented and static. It is also regrettable that the vast majority of researchers concerned with such classifications have not taken the trouble to reproduce faithfully and in full the hierarchical organizations of the sciences therein, much less to indicate the names of those sciences in the original languages[7].

Why Devise a New Tool?

Today even the best publications in the form of articles or books on the classification of knowledge cannot easily classify a number of things. How can we assert the position of a such and such a science in a particular hierarchical classification? How can we determine the original name that a science was given in such and such a classification? How can we gauge the relative importance of a particular group of sciences in a given taxonomy? Answering these kinds of questions would certainly be greatly facilitated by using a digital tool with an extensive database.

In what follows, we formulate examples of more elaborate queries that are incredibly hard to address without such a cumulative digital tool equipped with the appropriate filters to limit the selection of data (by authors, languages, periods, etc.) according to the user's choice:

• In which taxonomies is alchemy a science derived from physics, and are there any that consider it a mechanical art?

7. A partial exception is Raphaël Sandoz's *Interactive Historical Atlas of the Disciplines* (https://atlas-disciplines.unige.ch/), a rich online database in which the taxonomies of 255 authors (from Plato to Jean Piaget) are shown in the form of tree-shaped tables, sometimes accompanied by a reproduction of the same in a manuscript or an ancient edition. For the premodern section of the catalogue, sciences are normally mentioned by their English designation. The original appellation is also usually provided for the Latin classifications, but not for the Greek ones. Sandoz's database includes seven Arabic classifications, only one of which indicates the original Arabic designations (in transliteration).

• How many Arabic and Latin classifications incorporate the science of navigation, and do they all use ملاحة and *navigatio* (respectively) to name it?

• Were there more classifications between the eighth/fourteenth and the eleventh/seventeenth century than between third/ninth and sixth/twelfth centuries that include *adab* or *adab*-related disciplines?

• Are there other Persian classifications than Ibn Sīnā's *Dānēsh nāme* and Shīrāzī's *Durrat al-tāj* that include music as one of the four mathematical sciences?

• Which classifications prior to 656/1258 make time-keeping a sub-branch of astronomy?

• Is there any classification other than Ikhwān al-Ṣafā', *Epistle 7*, that divides the science of governance (سياسة) into five further branches?

• Which classifications consider blood compensation (ديات) a science derived from Islamic jurisprudence (فقه)?

Starting from scratch, M-*Classi* is designed to address these types of queries, and countless others, in a way that is as complete, systematic, objectifiable, and dynamic as possible.

M-Classi*'s IT Configuration*

M-*Classi* runs on a Linux server. Its backend was developed in Python with the Django web framework. Its frontend is coded in JavaScript and it uses the NextJS framework based on the React JavaScript library. The graphs are displayed using the vis.js JavaScript library. M-*Classi* has a responsive design (see figure 1), meaning that the interface may be adapted to different screen sizes and geometries. It incorporates a number of data visualization functionalities, which are described below. It also allows data to be edited, either from an Excel file or directly in the interface.

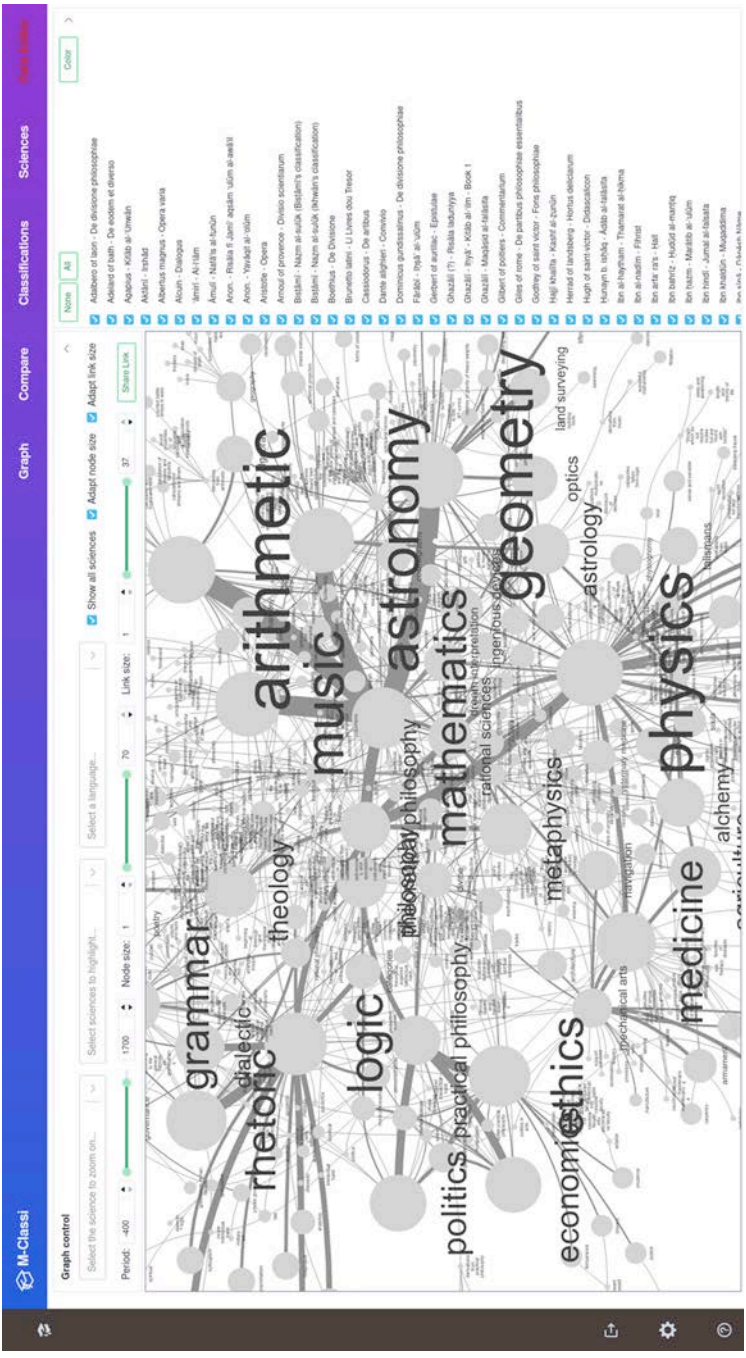

Fig. 1. M-*Classi* cumulative graph tool.

Main Functionalities

The tool's dashboard, in English, currently offers four main functionalities ("Classifications", "Compare", "Sciences", and "Graph"), which we briefly present here in succession.

1. Classifications

This function provides a full list of classifications, ordered alphabetically by author in English, and the titles of their works (when several classifications are provided for the same author). Clicking on a title gives access to the corresponding classification displayed in full, in both the source language and in English translation. Classifications are of three types: (1) "hierarchical" (in fact, the vast majority of them are), when they can be displayed either in the form of a spider chart (figure 2) or in the form of a tree, with branches and sub-branches (figure 3); (2) "ladder-shaped", when sciences are arranged to form a certain progression (figure 4); (3) "linear", when neither a tree-shaped hierarchy nor a ladder-shaped progression is indicated or suggested in the text (figure 5)[8].

8. A particular case is the *Kashf al-ẓunūn* by the Ottoman encyclopedist Kātip Çelebi (Ḥājjī Khalīfa, d. 1068/1657), a voluminous compilation the author wrote in Arabic and in which the sciences are listed in alphabetical order. Since this order cannot be properly considered a progression, we assimilated Ḥājjī Khalīfa's taxonomy to a linear classification.

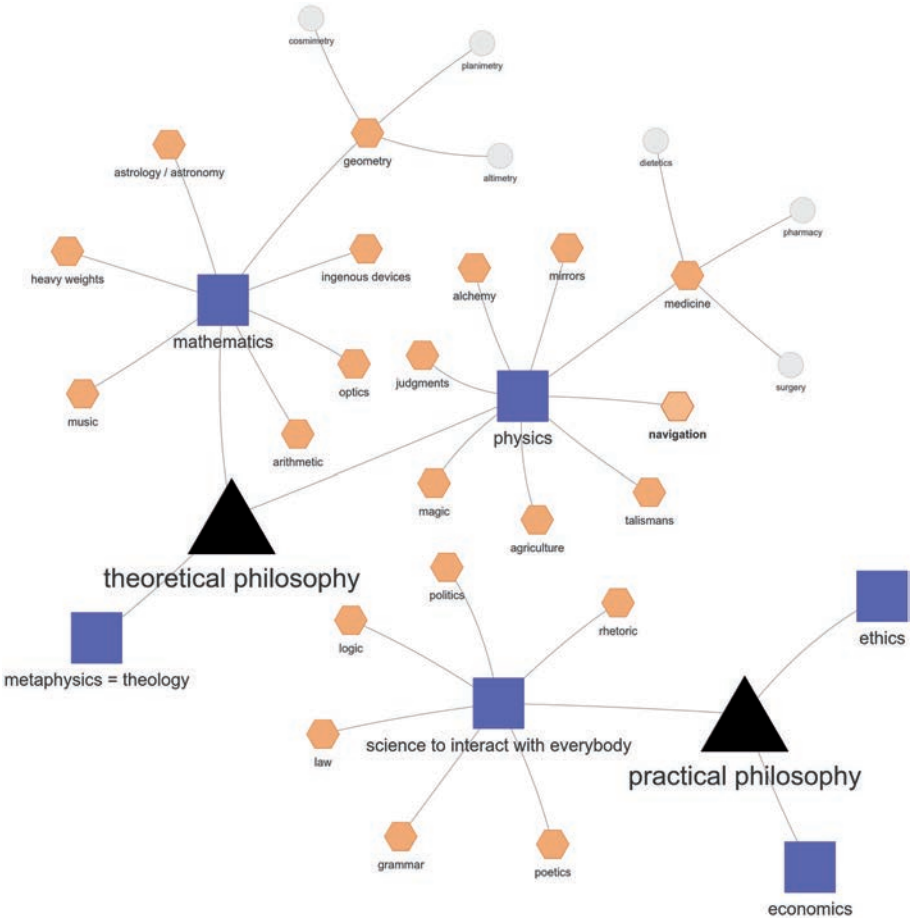

Fig. 2. Hierarchical classification, in the form of a spider chart (Dominicus Gundissalinus, *De divisione philosophiae*).

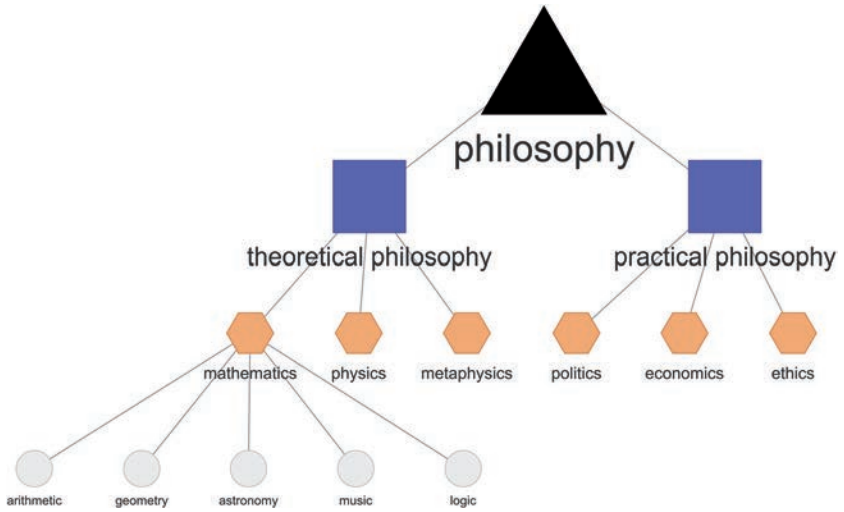

Fig. 3. Hierarchical classification, in the form of a tree (Ibn Hindī, *Jumal al-falsafa*).

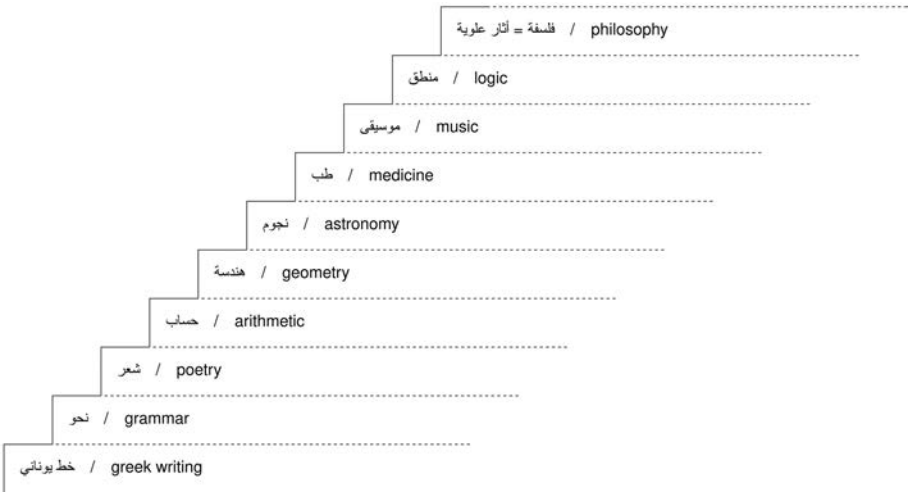

Fig. 4. Ladder-shaped classification (Ḥunayn b. Isḥāq, *Ādāb al-falāsifa*).

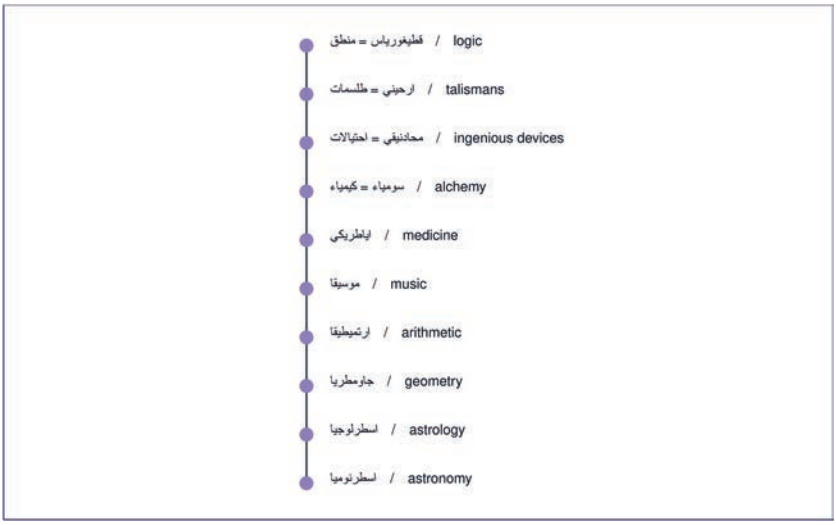

Fig. 5. Linear classification (Agapius, *Kitāb al-ʿunwān*).

2. Compare

This functionality allows users to visually compare any two classifications of the database with one another, highlighting the elements common to both and contrasting them with those found only in one (figure 6). The compare functionality is particularly useful in the case of a classification extant in different languages for example, between Maslama b. Qāsim al-Qurṭubī's *Ghāyat al-ḥakīm* (in the Arabic original), and the *Picatrix* (its Latin translation), or when we know of two different versions of the same taxonomy (as for instance the Ikhwān al-Ṣafā''s original classification in *Epistle 7* and its reuse by ʿAbd al-Raḥmān al-Bisṭāmī in his *Naẓm al-sulūk fī musāmarat al-mulūk*). In like manner, this functionality may greatly assist in evaluating whether one classification is the source of another. The compare functionality makes it clear at a glance, for instance, that Ṭāshköprüzāda's *Miftāḥ al-saʿāda* was a source for Ḥājjī Khalīfa when this latter compiled the *Kashf al-ẓunūn*.

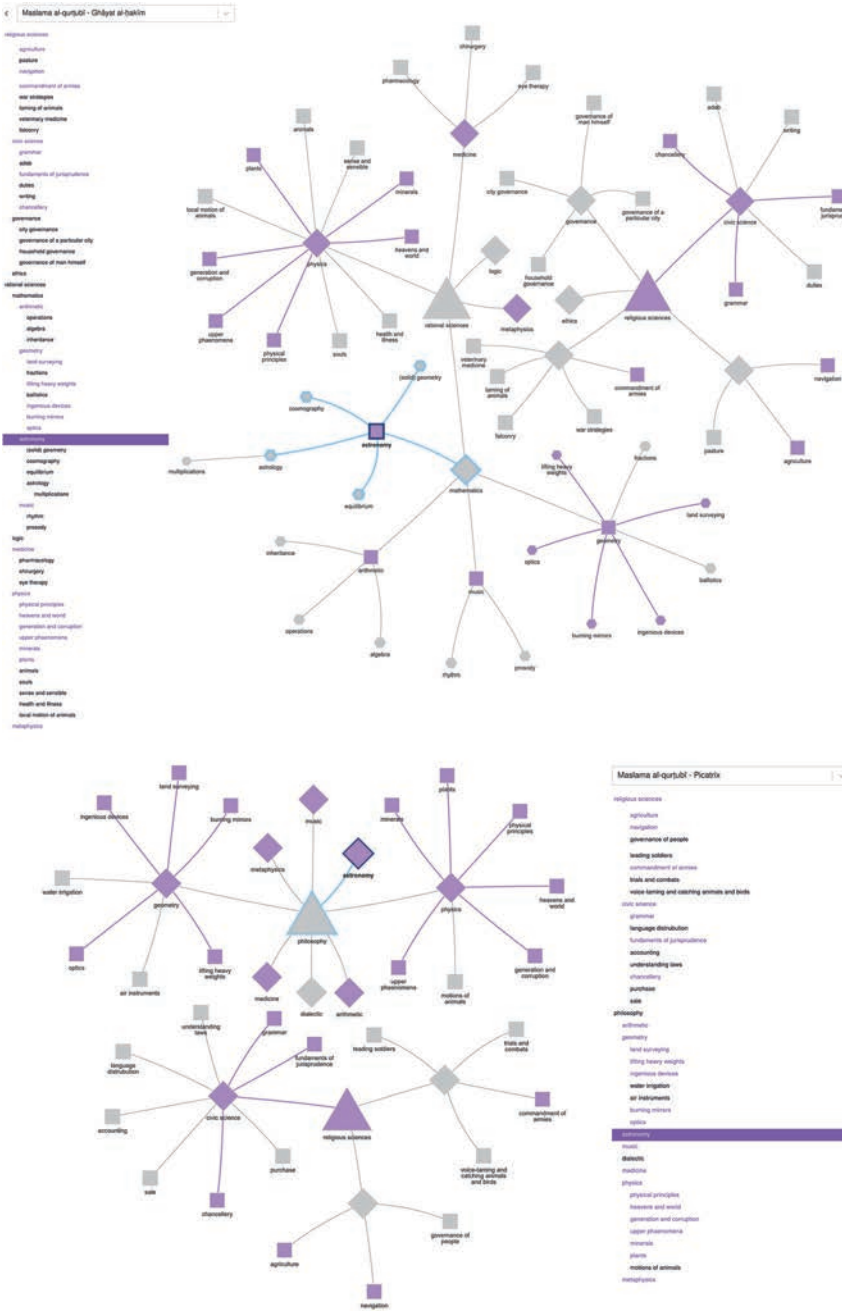

Fig. 6. Comparison of two classifications (*Ghāyat al-ḥakīm* vs. *Picatrix*).

1. Sciences

M-*Classi*'s general index of sciences is displayed in columns for different languages. In the first column, sciences are arranged in the alphabetical order of their designation in English, the interface language of the application. The other columns show the corresponding appellations in the other languages in which classifications have been incorporated into the system. This functionality allows users to make a variety of lexical comparisons between languages but also between the various appellations of any given science in one particular language (figure 7).

Here we provide a few examples to illustrate (1) the richness and diversity of the scientific vocabulary employed; (2) the kind of identification and translation problems that result from such richness and diversity; and (3) the value of the classifications of science to address such problems. Let us first take the case of the vocabulary concerned with the sciences of astronomy and astrology respectively. Astronomy is easily identified as such when it is designated by terms like اسطرنوميا or هيئة. Likewise, terms like أحكام النجوم, اسطرلوجيا, and قضاء unambiguously refer to astrology, as do more elaborate formulations such as نجوم وأحكام المواليد والطوالع (literally, "the planets and the judgments based on their risings and settings") as found in the pseudo-Ghazālī's *Risāla laduniyya*. But how then to understand and translate نجوم or تنجيم when they appear alone, given that these words can refer, in the absence of a context enabling one to decide, to both astronomy and astrology? One of the greatest advantages of scientific taxonomies is that they usually allow readers to make such epistemological discriminations since, by nature, they tend to provide a rational and objectifiable depiction of the sciences and their divisions, either explicitly or implicitly. For example, the title of the third epistle of the Ikhwān al-Ṣafā' علم النجوم refers to astronomy and not to astrology, as is made absolutely certain from the full title of the treatise in most manuscripts, which is الموسومة بالأسطرونوميا في علم النجوم وتركيب الأفلاك, that is, "[the science] referred to as astronomy on the science of the stars and the disposition of the spheres". Even in the absence of such explicit descriptions, the hierarchical presentations found in most taxonomies are sometimes sufficient to allow one to decide. Indeed, in the classification of Maslama's *Ghāyat al-Ḥakīm* we may perhaps infer that النجوم refers to astronomy from the fact that it is presented

English	Arabic	Persian	Turkish	Latin	French	Italian
astral magic	-	هیمیا	-	-	-	-
astrolabes	اسطرلاب	-	-	-	-	-
astrologia	-	-	-	astrologia	-	-
astrology	أحكام النجوم اسطرلوجيا نجوم قضاء وأحكام عليها وحركاتها، ودلائلها وأحكامها نجوم وأحكام المواليد والطوالع	نجوم أحكام أحكام النجوم	-	astrologia	-	astrologia = saturno
astrology / astronomy	-	-	-	astrologia / astronomia	-	-
astronomical calculation	حساب النجوم	-	-	-	-	-
astronomical instruments	آلات المنجمين	-	-	-	-	-
astronomy	تنجيم هيئة اسطرنوميا هيئة = كتاب المجسطى لبطلميوس نجوم علم الفلك وحركات النجوم الموسومة بالأسطرونوميا في علم النجوم وتركيب الأفلاك صورة الأفلاك وكيفية دورانها، وأبراج طلوعاتها، وكذلك الكواكب علم أوسط = تنجيم هيئة الأفلاك وحركاتها علم النجوم	نجوم هيئة اسطرنوما	nücûm	astronomia astrologia astronomica	astronomie	-
astronomy - astrology	-	-	-	astronomia - astrologia	-	-
astronomy / astrology	أحوال الكواكب \ أحكام في الأمور المستقبلة	-	-	astronomia / astrologia	-	-
atmospheric and terrestrial events	آثارعلوية وسفلية	-	-	-	-	-

Fig. 7. An example of lexical comparisons on a selection of classifications.

there as one of the four sciences of the mathematical quadrivium. In other words, the hierarchical structure of a classification provides a context of its own, which at times may compensate for the absence of a context in the text itself.

Certainly there are more problematic lexical issues, as with the following example. Thus, under the same quadrivium of mathematical sciences, the vast majority of the Arabic and Persian classifications include موسيقا (music), yet a few of them – as for instance al-ʿĀmirī's *al-Iʿlām* or ʿĀmulī's *Nafāyis al-funūn* – mention تأليف (harmony) instead. Does the venerability of the quadrivium tradition authorize us to regard موسيقا and تأليف as two different appellations for the same science? Evidently not, since music and harmony are two different

things in reality[9], but can we completely rule out the hypothesis that these two notions were confused in the minds of these authors? Conversely, it is evident that the name of a science did not always mean the same thing to everyone, in every age. In their tripartite classification of the sciences, the Ikhwān al-Ṣafā' use the same word *riyāḍiyyāt* (or *riyāḍiyya* in its adjectival form) to refer to two different groups: on the one hand, the propaedeutical sciences, including disciplines such as writing, reading, and poetry, but also magic, talismans, alchemy, and mechanical devices; and on the other hand, the properly named mathematical sciences, that is, the four sciences of the quadrivium of the Pythagorean tradition[10]. In like manner, the letters (حروف) that Ṭāshköprüzāda was concerned with in his discussion of the science of penmanship have little to do with lettrism, a sacred and occult science by the same name that ʿĀmulī classified as a Sufi discipline and whose secrets Ibn Khaldūn likened to theurgy or astral magic (سيمياء). It is not always clear how to respond to these issues. The exercise of defining and translating concepts to implement in a multi-language tool such as M-*Classi* is bound to include an element of subjectivity. It is our hope that by sharing these data among scholars we can, progressively, achieve greater precision in our definitions and conceptualizations of this scientific and technical vocabulary.

4. Graph

The graph is a synthesis of the M-*Classi* application. It is a cumulative visualization that shows the relative positions that sciences occupy in the general organization of knowledge, based on an algorithm that determines the location of these sciences according to the relationships they have with each other through the whole set of classifications. Sciences that are found in many classifications, and which have numerous hierarchical links with other sciences tend to occupy the center of the graph, whereas isolated sciences will remain at the periphery.

9. On this, see L. Tribuzio, «Restoring Harmony through the Propaedeutic Science of Music. A Reconsideration of the Brethren of Purity's Epistles on Music and Its Relation with the Epistle on Proportions», in this issue.

10. On this ambiguity, see G. de Callataÿ, «Introduction to Epistle 7», in *On Companionship and the Arts: An Arabic Critical Edition and English Translation of Epistles 6-8*, ed. N. El-Bizri and G. de Callataÿ (Oxford 2018), 80-82.

The overall principle of the graph is to represent each science by a circular "node" and show each hierarchical link between the two sciences by an arrow, either "ascending" or "descending," depending on their mutual positions in the hierarchy. Thus, for instance, since astronomy is often mentioned as a sub-branch of mathematics and almanacs as a sub-branch of astronomy, clicking on the node representing astronomy will show two arrows around this node: one "going-to" the other, representing a mother-to-daughter filiation from astronomy to almanacs, and one "coming-from"the other, representing the mother-to-daughter filiation from mathematics to astronomy (figure 8).

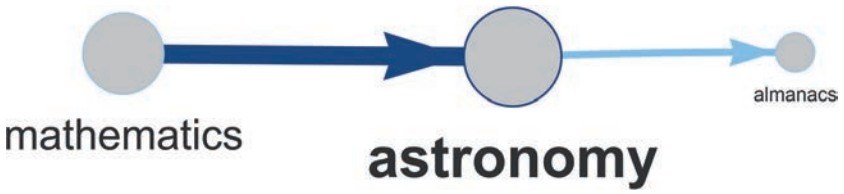

Fig. 8. "Going-to" and "coming-from" links around a node.

Two additional functions ("adapt node size" and "adapt link size") make it possible to visualize, respectively, (1) the relative importance that a science has in the overall organization of knowledge (according to the number of classifications in which the science is mentioned); and (2) the relative importance of a hierarchical link between two sciences (likewise, by taking into account the number of classifications in which this link appears). Adapting the node size for a science mentioned, for example, in 57 classifications will make its node appear larger. Likewise, adapting a hierarchical link size between two sciences will make the corresponding arrow appear larger by the same proportion. By clicking on the color picker button on the dashboard, the node will take the form of a colored 57-pie chart. Figures 10 to 13 illustrate these modalities.

Fig. 9. Simple nodes and links.

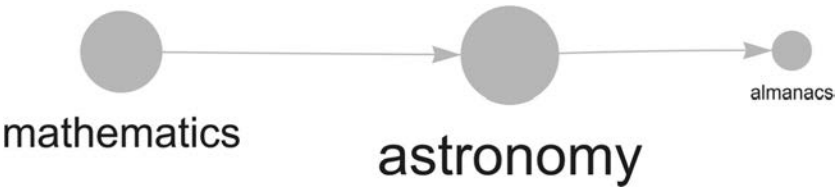

Fig. 10. "Adapt node size".

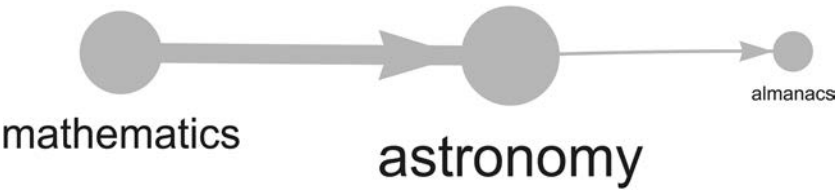

Fig. 11. "Adapt link size".

Fig. 12. "Show colors".

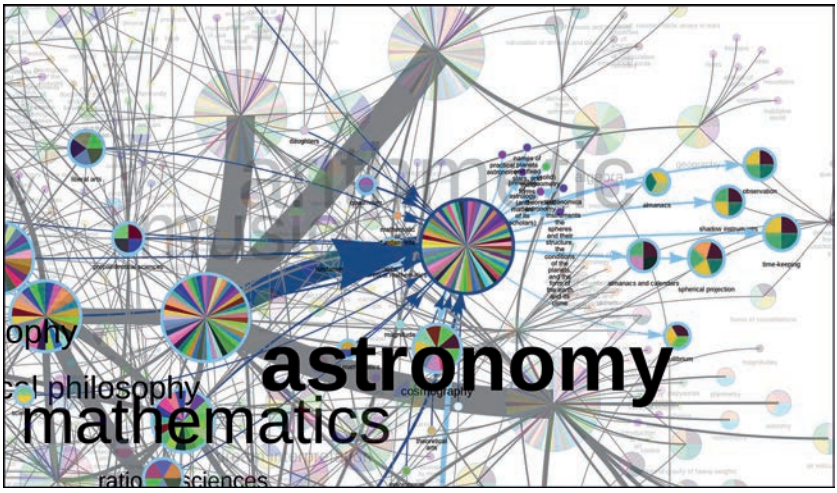

Fig. 13. "Show colors" in the cumulative graph.

If the cumulative graph enables one to visualize at a glance the distribution of the sciences in the general organization of knowledge, the three above-mentioned devices are also particularly helpful to see the extent to which certain features have survived over the *longue durée*, regardless of the cultural areas in which the classifications were produced (as is the case for the quadrivium of the mathematical sciences or Aristotle's tripartite division of practical philosophy into ethics, politics, and economics). Conversely, the same devices also reveal how infrequently certain human activities – like chess or shoemaking – have been considered worthy of inclusion in scientific classifications.

Filters and Other Devices

Various filters allow users of the M-*Classi* graph to refine their research, according to their specific needs. One filter enables a user to limit the research to a certain period of time (for example, "from 925 to 1650 CE"). Another filter permits the selection of one or more source languages (for example, "Persian" or "Arabic, Greek, and Persian"). It is also possible to refine the research by selecting an individual classification (like "Akfānī, *Irshād*") or any combination (for example, "Ibn Khaldūn, *Muqaddima*," "Nev'ī Efendi, *Netāyic ül-fünūn*", and "Dominicus Gundissalinus, *De divisione philosophiae*"). These different filters can also be all activated simultaneously.

The graph dashboard also contains a box ("Select the science to zoom on") which, as its name suggests, allows users to zoom in on the graph in search of any science, by typing its name in English or in any of the source languages for which a classification including this science has been incorporated (thus, for instance, "geomancy", رمل, or *geomantia*).

Finally, in combination with user-defined settings, another box ("Select sciences to highlight") of the graph dashboard allows users to select certain sciences (or a group of sciences) to make them appear more clearly on the graph. For pedagogical presentations this device is particularly convenient, as it allows one, for instance, to highlight certain contrasting groups of sciences (like "sciences of the trivium" vs "sciences of the quadrivium" or "rational sciences" vs "religious sciences"), or to pinpoint a case in which two sciences are close-

ly-related conceptually, even though usually, they are not assimilated to each other in classifications (such as theology and metaphysics or governance and politics).

As previously mentioned, M-Classi is currently in a beta mode accessible on request at https://www.m-classi.eu.

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Abstract

Godefroid de Callataÿ – Rémy Baranx – Hubert Naets, *M*-Classi: *A New Digital Tool for the Classification of the Sciences, in Islam and Beyond*

M-*Classi* is a new digital tool in the field of knowledge organization. It is conceived primarily as a means of cataloging and interrogating the classifications of the sciences in Islam and those of the cultures with which the Islamicate world came into contact from antiquity to the pre-modern era. The aim of this paper is to present this game changing tool, whose vocation is to become an open-access engine for future research. After briefly recapitulating the current state of the art on Islamic classifications of the sciences and succinctly presenting the specificities of M-*Classi*'s technical configuration in its current beta version, we review some of the application's main functionalities and illustrate various aspects of M-*Classi*'s potential in terms of visualization.

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