Syntax of facets and sources of foci: a review of alternatives

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Abstract: Although the notion of facet occurs in many knowledge organization systems (KOS), the term *facet* has been used with different meanings and roles over time. Generally, the term suggests the combination of several concepts in order to specify the subject of a document. However, the syntax of such combinations varies considerably, as do the sources from which the possible values of a facet (known as 'foci') can be taken. This paper provides an overview of syntactical alternatives in faceted systems. Concepts can be simply juxtaposed without expressing the relationship between them (free combination); or the relationship can be expressed and link two concepts taken from any part of the scheme (freely faceted systems, phase relationships); or it can be characteristic of only a given basic class and allow it to link to a choice of other concepts according to a facet formula (classical faceted classification, special facets); or it can link any basic class to a choice of auxiliary concepts such as space, time or form (common facets). Foci, in turn, can be taken from any other part of the system, or typically from a certain part, or be defined in the context of the facet itself. When describing a KOS as 'faceted', which now seems to be a fashionable attribute, the nature of such 'facets' should be made explicit. Finally, the supposed 'rationalistic' theoretical basis of facet analysis, as opposed to 'empirical' or 'pragmaticist', is briefly discussed.

Keywords: facet analysis; freely faceted classification; phase relationships; common auxiliaries; knowledge organization systems

1. Introduction

The notion of facet has been introduced explicitly into knowledge organization by Ranganathan (Beghtol, 2008), although analogous functionalities can also be identified in earlier works by Julius O. Kaiser (Dousa, 2011) and Paul Otlet (Rayward, 1997). Intuitively, it refers to an element that can be combined with other elements to produce a compound subject (Gnoli, 2008). This is usually meant within the context of document indexing: thus, a certain document can be said to deal with e.g. 'bottle manufacturing', a compound subject formed by two facets: 'bottles' and 'manufacturing'.

Since its introduction in 20th century, the term has been applied to a variety of different indexing systems, and not always with the same meaning. Therefore, it may be useful to review the various meanings that can be associated with it, according to their uses in different knowledge organization systems (KOS). While the semantics of these systems share the possibility to combine two or more concepts into a compound 'faceted' concept, their syntax can work in very different ways, which has consequences for what the resulting KOSs are able to express.

The tradition of different KOS types (e.g. thesauri vs. classifications), of different applications (e.g. library shelving vs. web information architecture) and of individual systems often introduce their own terminologies, which are not always consistent with the terminology in the existing literature. For this reason, in this paper I will try to propose a general approach not bound to any particular system. While keeping some terms that seem to be consolidated in the core literature on facet analysis, such as *facet*, *fundamental category*, and *focus* (pl. *foci*), I will describe the remaining structural elements with a more neutral, generalized language.

2. Free combination

Combination of concepts may occur already in very unstructured KOSs, in the form of pure juxtaposition. A document may be indexed as dealing with both history and literature, without specifying in any way which kind of relationship exists between them. Thus, the document could be about the history of literature, or about literature on history, or it could compare history and literature as two distinct disciplines, or it can even deal with literature in one part and with history in another part.

In this case, the term facet does not seem to be very appropriate, although it may occasionally be used. Gardin (1965) described this as a 'free classification' as opposed to 'faceted classification' proper.

Free combination is common in post-coordinated systems using descriptors or keywords, such as those assigned to academic papers by an indexing service or by the authors themselves. They are usually separated by commas or semicolons and listed in no particular order, or in alphabetical order, which provides no clue about the syntactical relationships between them.

A similar free combination occurs in folksonomies, where users can tag a document by a number of headings without specifying the relationships between them. Thus a video in YouTube may have been tagged as 'folk music', 'Italy' and 'dance', which suggests it offers a recording of some music performance connected to Italy and to dancing, although it remains ambiguous whether Italy is the place where the music is performed, or the country of origin of the music, or both, and whether dance is actually practiced in the same occasion or just the music is one conceived for being danced to on other occasions, nowadays (e.g. by the Internet users playing the video) or in the past.

More structured KOSs may also allow the expression of such a loose combination of concepts. For example, the Universal Decimal Classification (UDC) allows the loose combination of two simple subjects by a colon: *94:82* 'history (in some relation with) literature'. One way to suggest the kind of relationship is through the sequence of elements; so, the opposite order *82:94* 'literature (in some relation with) history' means that literature is the prior subject while history is only discussed in relevance to literature. A double colon,

as in *82::94*, a device available in UDC though not frequently used, expresses the fact that the order is important for the meaning and cannot be reversed. Szostak (2016) also suggests that freely-combined concepts can be cited in a meaningful order ('poly-coordination'), as a middle way between free combination and rigid facet formulas.

Such general relationships between two subjects have also been described by Ranganathan as 'phase relationships'. He has identified several kinds that would occur more frequently in document subjects such as bias, comparison, difference and influence (Ranganathan, 1967: 461). One should note that both his Colon Classification (CC) and UDC offer notational ways to express 'comparison between literature and history', 'literature influenced by history', etc.

3. Freely faceted systems

Phase relationships are already one step forward in the specification of the kind of relation between combined concepts. However, these are usually not described as 'facets' in classification literature.

A more canonical use of facet analysis, as introduced since Ranganathan's Colon Classification (CC), is grouping concepts that can be used in combinations into categories, that is, very general concepts that occupy the top of a hierarchical tree of more specific concepts. This has also started to be common in thesauri, such as Thesaurofacet or the still popular Art and Architecture Thesaurus (AAT). Such general categories as Things, Properties or Processes are identified in them.

Then a Thing (e.g. 'bottles') can be combined with a Process (e.g. 'manufacturing'). Hudon (2007) suggests that such combination in no particular order with a free syntax is suitable to online information retrieval. Otherwise, a standard citation order, which expresses the kind of relationship in a less ambiguous way, may be more suitable. Concepts then can be said to occupy syntactical 'roles', reminding one of the subject, predicate, direct and indirect object of grammar, such as is the case with the Preserved Context Indexing System (PRECIS).

Following this tradition, the recently-issued Nuovo Soggettario (NS) groups Italian terms into the following facet categories: Agents, Actions, Things and Time. These are subdivided into more specific categories that are called 'facets', in a sense syntactically very different from the one proposed by Ranganathan. For example, the category Agents includes the facets of Organisms, Organizations and Persons and groups; the category Things includes the facets of Matter, Objects, Space, Instruments, Structures and Forms (BNCF, 2006).

It should be noted that in freely faceted systems 'facets' are a semantical rather than a syntactical device. Hudon & Mustafa El Hadi (2017: 13-14) indicate that facets in this context represent the 'nature' as opposed to the 'function' of a concept. Indeed, a concept belonging to the category of Agents, such as 'herds',

can be both an agent of action (e.g. in 'herds' – 'grazing') or a patient of action (e.g. in 'herds' - 'breeding'). Syntax in NS, for instance, is controlled by a separate set of rules concerning the 'roles' within a subject statement, as mentioned some lines above. The function played by categories and facets in such a classical faceted classification as CC (see Section 4, below) corresponds to 'roles' rather than to 'facets' in such verbal systems as NS. This is a typical example of how different uses of the term *facet* in different contexts may introduce some terminological confusion.

A kind of classification that works similarly to a faceted thesauri was called a 'freely faceted classification' by Austin (1976), adopting an expression originally used by Ranganathan for the 6th edition of CC (Satija, 2017). Austin proposed this approach for the new general classification envisaged by the Classification Research Group (CRG) within its study granted by NATO. When the project was closed, Austin moved to the British National Bibliography where he developed and applied his ideas to PRECIS, which was an alphabetical subject indexing system rather than a classification. Similar to NS, PRECIS works with roles that correspond to Austin's 'free facets'. Another descendent of Austin's system is the Integrative Levels Classification (ILC), a freely faceted classification system where facets work similar to roles in PRECIS (Gnoli, 2017).

Freely faceted classifications also have fundamental facet categories, which are instantiated by specific facets within each class. These facets are 'free' because they allow the combination of classes with one another, irrespective of the main class to which they belong. In this sense, they work similar to phase relationships, albeit with more specific meanings thanks to the richer set of general categories from which they are taken. Thus 'soil' can be combined by the Agent facet with 'rain' to express a natural action of rain on the soil structure; but it can also be combined with 'car traffic' to express alterations due to vibrations produced by trucks passing over the soil. This is connected to the fact that both the CRG NATO draft system and ILC are phenomenon-based, as opposed to discipline-based, so that they encourage free combination across different disciplinary contexts.

4. Classical faceted systems

Classical faceted classification schemes such as CC, the Bliss Bibliographic Classification 2nd edition (BC2) and various special classifications also have sets of fundamental facet categories, such as Things, Kinds, Parts, Properties, Materials, Processes, Operations, Agents, Space and Time, but here they play a syntactical rather than a semantical function: indeed, in such a system the concept of 'herds' can be in either the Things or the Agents facet depending on its syntactical role in the subject of a particular indexed document. What matters is the syntax of the relationship rather than the semantics of the concept.

This is the original meaning of 'facet' in Ranganathan's works. Broughton (1999: 143) appropriately contrasts it with Farradane's and Gardin's systems of relationships, which are freely faceted. As compared to free facets, classical facets can be described as 'bound', in the sense that the meaning of a facet depends on the main class to which it belongs. For example, the general category of Agent can be instantiated in the main class of soil science by the facet of natural shaping factors, including rain, wind, freezing, etc. as its possible foci (the values it can take in particular subjects). In CC and BC2, the main class is by definition a discipline. Facets are thus facets of some discipline rather than general facets (although their meaning is related to the fundamental category they instantiate). Every discipline has its own facet formula, that is its set of facets that can typically occur in the subjects of that discipline.

The facet formula also provides a standard order in which facets should be cited: a faceted classmark should start with an entity studied in the discipline (Personality or Thing), followed by its attributes (Kind, Part, Property, Material, Processes), by Operations done on them, Agents of such operations and spatio-temporal coordinates (Space, Time). Thus, classical facets are a way of analysing and structuring a compound subject within a given disciplinary context, but do not allow the combination of any concept across main classes. The latter function is either not contemplated (e.g. in a domain-specific classification) or performed through devices other than facets (phase relators, 'subject device' in CC).

5. Common facets

Even in the classifications where fundamental categories are instantiated by different specific facets for every main class (e.g. the Agent category may be instantiated in chemistry by a 'catalyser' facet, while in religion by a 'celebrant' facet), there are some specific facets that are repeated in most main classes. Their classical example are facets of Space and Time. Indeed, for most phenomena a spatial and a temporal context can be specified. As a result, the notation for the possible foci of Space and Time facets is usually taken from one and the same table which is common to the whole scheme. Admittedly, different main classes can use different foci (e.g. history most often needs centuries and decades while geology needs million year periods), still many spatial and temporal concepts can be reused widely throughout the scheme.

This has led to the development (for most KOSs) of some kind of general tables for places and periods, as well as languages, ethnic groups, document forms and other concepts than can be appended as a facet to any class. These are called 'common auxiliaries' or 'common facets' in UDC (where they are expressed by punctuation marks such as brackets, quotation marks, equal sign etc.), as opposed to the 'special auxiliaries' or 'special facets' that are typical of particular main classes in the way described in the previous section.

Common facets are also used by enumerative schemes under such names as 'common subdivisions' or 'common auxiliaries'. It was probably their recurrence that suggested to such classificationists as Otlet and Kaiser the early idea of facet analysis, later extended by Ranganathan into classical facets, then by Austin into free facets. As Space, Time and document Form are ubiquitous and easy to assess, they have gradually been incorporated into enumerative systems such as Library of Congress Subject Headings (LCSH) and Dewey Decimal Classification (DDC). In this respect, they are also described now as 'faceted', as happens to be the case with the LCSH version called Faceted Application of Subject Terminology (FAST). DDC editors claim that their system currently has '12,194 facets (building blocks from Tables 1-6 and internal add tables, added to show languages, geographic areas, ethnic/national groups, genres, etc.)' (Green, 2017).

Such a very broad interpretation of the term *facet* may result in confusion and a general loss of awareness of what are instead the core principles and applications of facet analysis in a stricter sense. This extended meaning of the term is spreading because facet analysis is now acknowledged to be a basic requirement for any modern KOS; indeed, a trend towards adopting facet analysis is of interest to all existing KOSs. But full restructuring of an existing system according to facet analysis would require enormous effort and would take a long time.

A different case is the restructuring of individual classes from enumerative to faceted, as has happened with music in DDC or religion in UDC, which really apply classical facet analysis within the limits of a revised main class, while other parts of the KOS remain enumerative.

Common facets are also used in many online navigation systems that allow the searching of large datasets, e.g. newspaper archives, by Place, by Time, by Form or by Person (La Barre, 2010). As these are usually generated by indexing procedures automatically, they can only be effective with named concepts such as places or periods, that can be easily found in a gazetteer and associated to a general category. Much more difficult is identifying such syntactical roles as parts or agents in automatic ways (was it the dog who bit the postman or did the postman bite the dog?...), which explains why these categories are hardly used in website information architecture.

6. 'Ersatz' vs. 'real' facets

Frické (2010; 2011; 2013) makes an interesting distinction between 'Ersatz facets', such as in *red cars* and 'real facets', such as in *car manufacturing*. According to him, Ersatz facets are simply attributes of things that specify them better (a red car is still a kind of car) but do not connect them with other things in the same way real facets do (car manufacturing is not a kind of car).

This may have to do with the fact that facets have been applied to both disciplinary classes, such as in classical faceted classifications and phenomenon classes, as in ILC or in web catalogues of products (cars as a phenomenon entity can be searched by colour, by engine type, by firm, etc.) (Gnoli, 2006; cf. Hudon & Mustafa El Hadi, 2017: 15). In this sense, Ersatz facets appear to be facets of phenomena. However, in freely faceted systems phenomena from different main classes can also be combined by what Frické would call 'real facets', as in 'soils, affected by car traffic'.

The essence of Frické's distinction seems to be more connected with the general category to which a facet belongs. Indeed, what he calls Ersatz facets are the facets of the categories usually listed first in citation order, such as Part, Property and Material, while his 'real' facets are those of Process, Operation, Agent, Space and Time, which connect the phenomenon with other, external phenomena. In the perspective of general systems theory, the first cited categories correspond to the structure and composition of the system, while the latter correspond to external systems interacting with it (Broughton, 2013; Gnoli, 2017).

Still, both internal and external relationships can be seen as parts of the description of a system, that is of the 'thing' or 'personality' which is analysed into facets. If this system is taken as the leading noun in the verbal formulation of the subject, all its facets can be expressed as adjectival phrases, including the external ones: thus, although car manufacturing is not a car, manufactured cars are cars. So Frické's distinction can be reduced to the differences in-syntax rather than those in semantics.

7. Context-defined vs. extra-defined foci

Out of the numerous technical terms introduced by Ranganathan's theory of facet analysis (e.g. *array*, *chain*, *isolate*, *focus*, ...), some tend to be forgotten while others have been reused later with more consistency. Among the latter is *focus*, that is the particular value taken by a facet in a specific subject statement, which has been adopted even by the authors discussing the web information architecture (cf. Rosati, 2007). In the faceted subject 'bottle manufacturing', 'manufacturing' can be a focus of the facet of industrial process, which in turn is an instantiation of the general category of Process. Quality control, distribution and sale can be other foci which can replace manufacturing in different faceted combinations.

As we have seen, a facet can be a common facet reused through the whole KOS, or a special facet particular for a single main class. The facet 'industrial process' can be a special facet of the main class 'industry'. Now, as it would be normally the case with every other facet, it needs a source from which its possible foci are taken. This in turn is open to various possibilities. I have identified two basic kinds of foci: *context-defined foci (CDF)* that are defined

within the facet itself and *extra-defined foci (EDF)* that are defined elsewhere in the KOS; the latter in turn can be either *general* or *special* (Gnoli, 2006).

In the case of the industrial process facet, the instructions in a KOS schedule may state that foci are context-defined, that is that they are to be taken from a list of industrial processes which is defined in the same context of that class. In other words, 'manufacturing' or 'quality control' do not occur in parts of the KOS other than the facet of industrial process in the main class 'industry'. Another example are organs as a facet of 'animals': its foci, such as 'liver' or 'lung', are context-defined foci, because there are no livers or lungs outside the organ facet of animals. Therefore, a special notation will be needed in a classification to identify livers and lungs and this notation will reflect the fact that they are parts of animals (it will start with the same characters as the class of animals, plus further characters specifying the facet and focus).

On the other hand, in 'special libraries', a facet for the subject in which a library specializes can easily use foci taken from notations already existing in other parts of the KOS. The notation for e.g. 'agricultural libraries' can be formed by adding to the notation for 'special libraries' a facet indicator followed by the notation for 'agriculture'; and this can be replaced by the notation for 'high energy physics', 'literary criticism' or any other subject matter. This is a typical case of general extra-defined foci. For purposes of information retrieval, it is convenient that the notation for a general EDF reuses the existing notation for the same concept elsewhere in the scheme, so that it can be found by a query for that notation irrespective of the particular combinations where it occurs.

Freely faceted classifications rely widely on general EDFs, while 'bound' faceted classifications tend to redefine the same concept many times according to the context of its main class: this can be clearly seen in BC2, especially as its notation is not expressive so that the recurrence of the same concept cannot be exploited for retrieval. Still, some BC2 classes have provision for reusing notation from other classes. While some phase relationships can be introduced by auxiliaries *6T - 6Y*, this classification 'prefers where possible to use explicit, scheduled locations within a class in order to draw concepts from other main classes. In class *H* Medicine, e.g., a radiation type first appearing at the level of Physics will be drawn in as an agent of investigation, as an instrument of therapy, or as a cause of disease' (Mills, 1982: 75).

Finally, we have to consider special EDFs. These are foci that are taken from a different part of the scheme, but always from a specifically defined place. Veterinary medicine can have a facet of treated animals. The foci of this facet can easily be taken from a schedule of animals in systematic zoology: indeed, what is treated in veterinary medicine can be a cat, a canary or a horse, but never a planet or a car. Thus, instructions for the facet of treated animal will indicate that foci have to be taken from the existing schedule of animals in systematic zoology. Such instructions are sometimes described as 'parallel divisions', as they can occur not only within a facet, but also in an enumerative

system where two classes in different parts of the scheme can be subdivided by the same list of concepts (Slavic, 2011: 28).

8. The limits of combination

In a classification with expressive notation, the presence of EDFs suggests the opportunity to shorten the notation of foci in order to reduce the length of notation, which is always a desired quality. For example, instructions could prescribe that the initial notation for 'animals' is cut and only the following part is used as the focus to be attached to the facet of treated animal. This, however, will make the use of classification in information retrieval more complex, as the base notation that has been cut should also be recorded in the classification management database and non-trivial scripts i.e. algorithms must be associated to the search interface to check whether the focus is an EDF and to reconstruct its meaning from the tables.

Also, EDFs may not always be the best solution when a concept occurs more times in different parts of a scheme. As noticed by the supporters of domain analysis, within the context of different domains, it may be convenient to order the same concepts in different ways: while in chemistry silver and gold are just two among many listed elements, in jewellery they should have a prominent position, while oxygen or nitrogen are not relevant at all as foci of the material facet of jewels. Agriculture always has some plant species as foci of its facet of cultivated species, but most plants listed in botany are not relevant in agriculture, while others such as cotton and flax may be associated in agriculture despite being listed in different subclasses of botany. Similar questions arose while revising the classes of biology and palaeontology in UDC (Civallero, 2010): should fossil animals be listed by parallel divisions taken from zoology, or not? What to do with the many taxa of extinct animals that are much more relevant in palaeontology than they are in zoology?

In these cases, even a faceted system is not forced to express foci by reusing existing notation. Despite the advantages of combined notation, this should be limited to the cases where a concept can effectively be expressed as a combination of existing concepts without losing its identity. In UDC such concepts as 'religions of ancient Egypt' are represented with simple notations because the result of combination is itself an integrated entity (Slavic, pers. comm.). Although water is made of a combination of oxygen and hydrogen, it is usually not useful that it is expressed in this way, or this would eventually lead to such absurd combinations as 'making oxygen-hydrogen fall over plants' to express the concept of irrigation. In agriculture, the opportunity to retrieve the concept of oxygen is irrelevant, while that of retrieving the concept of water may be useful. Such situations should be considered also in systems promising to make combination their primary solution for notation, as is the case with Szostak's Basic Concept Classification. Foskett noticed that a

similar mechanism happens in Creole languages as they lack words for integrated concepts that are available in more mature languages.

In the cases where combined notation would be clumsy, it may still be useful to keep a track of the relationships between concepts (e.g. to keep a track that water is made of oxygen and hydrogen). The latter information can be recorded in a separate field of the schedules, while the concept ('water') can have its own simple notation or term. This will allow both to get reasonably combined notations (say, 'providing water') and to display see-also suggestions when the intermediate concept is listed (say, 'water', see also 'oxygen') (Gnoli, de Santis & Pusterla, 2015).

9. Is facet analysis rationalistic or pragmaticist?

As it was mentioned at the beginning of this paper, the idea of combining concepts using synthesized notations already appeared in the early 20th century. It emerged as a practical opportunity that proved to produce more effective systems. It was only later that Ranganathan (1967) and the Classification Research Group (Vickery, 1960) generalized it into fully faceted classification structures and treated it in more theoretical ways. I will conclude this paper with some considerations concerning the philosophical backgrounds of facet analysis.

Recently, the theory of facet analysis has been described by Hjørland (2013; 2014) as a champion of rationalism, in the context of his schema of four basic theoretical approaches to information science: empiricism, rationalism, historicism and pragmatism. Facet analysis would be 'rationalist' as it would start from abstract general facet categories, such as Part, Property, Process or Agent, to impose them from the top down on the subjects of actual documents.

The use of fundamental concept categories, however, is not exclusive of rationalism as a 17th century philosophical movement. It goes back to Aristotle, which is cited by Dahlberg (1978) explicitly as a reference for her method of classification based on ten categories (Systematifier). Veltman (2004) reviews categories adopted at several epochs in knowledge organization. Even the father of pragmatism, Charles Sanders Peirce, founds his research on a general logic and on the identification of fundamental categories (Firstness, Secondness and Thirdness) (Peirce, 1868).

By reading reference treatises of the theory of facet analysis, one can find statements that can be described as rationalist together with many others that express different approaches. Their authors indeed have a variety of theoretical backgrounds: Ranganathan combined Indian traditional culture with Western training, while Vickery was a follower of materialism, a philosophical view that is connected to historicism more than to rationalism.

Ranganathan's Prolegomena to library classification clearly is a very particular book. Its author could be said to be 'rationalistic' in the same way as Euclid or Spinoza were, because of his way of formulating 'postulates', 'principles', 'canons' etc. at the beginning of his works. However, this is more a formal method than a method of performing facet analysis itself. When he comes to the principles by which classificationists should choose the categories, facets, foci etc. of their classes, he says that they all depend on the 'purposes' of every classification, without specifying which they should be. His examples, such as the one of classing the boys in a school, show that classification can serve very different purposes and should be structured in different ways according to these (cfr. Ranganathan, 1967: 146 on 'relevance'; 154 on 'relevant succession'; 163 on 'helpful sequence').

In even less rationalistic terms is facet analysis presented in Vickery's manual on building faceted classifications, as noticed by Dousa and Ibekwe San-Juan (2014). Vickery claims that the 'subject field' of a special scheme has to be identified and defined on the basis of the needs of their actual users, rather than on abstract principles (Vickery, 1960: 6; 8; 14-17), someway anticipating the approach of domain analysis.

In identifying facets, 'logic' should be applied (Vickery, 1960: 12), which is not necessarily rationality as empiricism and pragmatism should be logical as well. Also, while logic can be a starting guide, it should only be 'a provisional guide' (Vickery, 1960: 24) and 'at a later stage it may be possible and advisable to present a less refined analysis' (Vickery, 1960: 12), which seems more empiricist.

The main explicit methodological reference is to literary warrant: categories, facets, classes etc. should be created and organized only on the basis of existing textbooks, essays, bibliographies etc. (Vickery, 1960: 20; 38). This is repeated in Vickery (1975: 18), also stating that 'the most relevant literature is that which arises directly from the establishment's activities - in particular, its research and development reports'. 'The empirical study of helpfulness to users should decide the whole sequence of facets...' (Vickery 1960: 28); 'it is their interest which is paramount' (Vickery, 1960: 31).

Green (2017a, section 3.1) provides a reference to Vickery (1960) suggesting that the bottom-up empirical approach and the top-down rationalistic ones can both be useful in the identification of facets. This echoes Szostak's thesis (e.g. Szostak, 2004: 25) that a combination of both induction and deduction should be adopted to develop knowledge organization systems. In conclusion, facet analysis appears to be more an expression of eclecticism in KO (Dousa & Ibekwe San-Juan, 2014) than one of rationalism alone.

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