VISUAL SEMANTIC CONCEPTUALIZATION "Conceptipedia" a collaboration platform for "WikiNizers"

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Abstract

We illustrate, with use cases supplied by a new personal knowledge organization tool called WikiNizer (wikinizer.com), how visualizing information and its conceptual organization, can help learners and knowledge workers accomplish knowledge organization tasks. The graphic features of WikiNizer, a wiki-like organizer implemented as a graph knowledge base, make visualizations of personal "associative complexes" within shared interests and topics possible, in the form of a Knowledge Graph of 'Things'. We describe a *"Conceptipedia"* collaboration concept, applicable not only within the educational field but also in knowledge work in general, which helps us to solve problems visually. Conceptipedia is a collaboration platform which enables WikiNizer users to compare, share, and merge their conceptualization of a domain in the form of meta-knowledge graphs. Conceptipedia helps the user define relations between concepts, and provides interactions which can be coupled with different collaboration techniques. Developing mappings between the meta-structures of the emergent graphs makes conceptualization *intellectually manageable*, and turns semantic structures into visual Knowledge Architectures that consolidate ontological relations. The collaborative epistemology of Conceptipedia co-evolves commensurate meta-structures to the mutual benefit of its users. Sense-making, by researching, exploring, capturing, articulating, mapping, visualizing and merging conceptual (meta)-structures and relationships can become a social process of consensus building.

Keywords: Intelligence Augmentation, conceptualization, collaborative knowledge management, knowledge architecture, visualization, Wiki, WikiNizer, Conceptipedia, experimental epistemology, personal digital archive, bootstrapping.

1 VISUAL KNOWLEDGE ORGANIZATION WITH WIKINIZER

In an earlier paper we spelt out our vision of what a "Next generation concept organization tool" should accomplish. (Benedek and Lajos 2012)

We sought to empower knowledge workers by taking a system oriented approach to the development of a *personal* knowledge organization tool called *WikiNizer*, (wikinizer.com). WikiNizer is a visual-wiki like, computer enhanced knowledge management environment, built in a new holistic way (Lajos and Benedek, 2013) designed to help us develop and visualize our conceptualizations as we pursue sense making. WikiNizer empowers individual knowledge workers in their efforts to integrate web research, bookmarking, digital archiving, note taking, brainstorming, (free/reflective) writing, linear breakdown and non-linear wiki like linking and elaboration, slide generation et al, into a common platform. It gives knowledge workers what they need as they attempt to seek, record, make sense of, structure, interpret, and represent, knowledge within an integrated goal focused end-to-end workflow. As a graph based knowledge management tool WikiNizer adds new visual and semantic capabilities to wiki like knowledge organization. Its graph based knowledge organization uses atomic nodes and edges which form a class hierarchy.

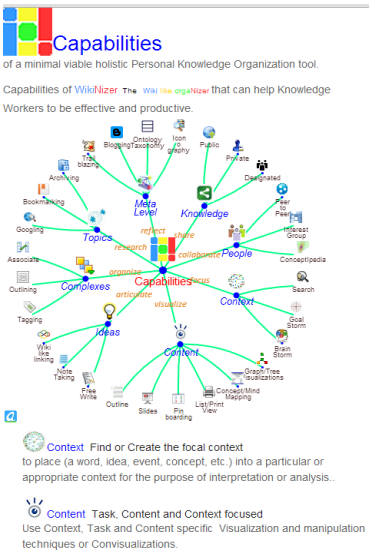

Fig. 1. Concept Map of WikiNizer's Capabilities in Radial Tree View

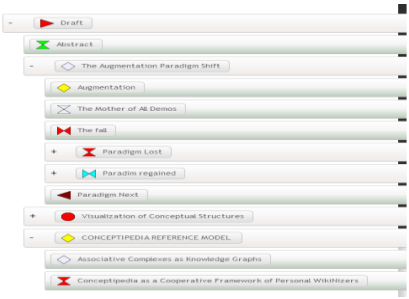

Fig. 2. Rearrange the pages in Outline View *via* Drag and Drop

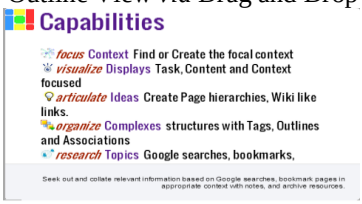

Fig. 3. Dynamic, auto-revealing, auto-cuing Slide Show

The root class is Page with a Title, Stub, Label and Body. Everything in WikiNizer is built on this foundation. This universality enables task focused visualizations of the same content in the variety of ways which meet your needs. Instead of WYSIWYG—**W**hat **Y**ou **S**ee **I**s **W**hat **Y**ou **G**et (and "yeah, but that's *all* you get") (Engelbart 2004) you have **W**hat **Y**ou **S**ee **I**s **W**hat **Y**ou *NEED* (WYSIWYN). For example when working

on a topic, a brainstorm can span a hierarchy of sections and paragraphs, with each paragraph having its own title, and its stub giving you a short summary of the intention of the paragraph. You can visualize it as a Tree or Concept/Intent Map. (intentmap.org/) (Fig. 1.) You can rearrange the pages in an Outline View with Drag and Drop, and do likewise with all the connected nodes. (Fig. 2.) At any time you can see just the text that can be extracted into a Read View. Content can be presented as a Flyer, showing sub pages as list items, where the icon for the subpage is shown together with the title of the page and its stub. The same content can be animated as a dynamic, auto-cuing, auto-revealing, Slide Show presentation, generated from the content of the Concept Map. (Fig. 3.) In Navigation View (Fig. 4.), along with the text, the titles and stubs for every page is shown allowing switching back to Tree View, Editing, etc. Since every page/paragraph is an entity with an ID, it is possible to construct more complex "virtual pages", "trails" and other special purpose Knowledge Architectural Components.

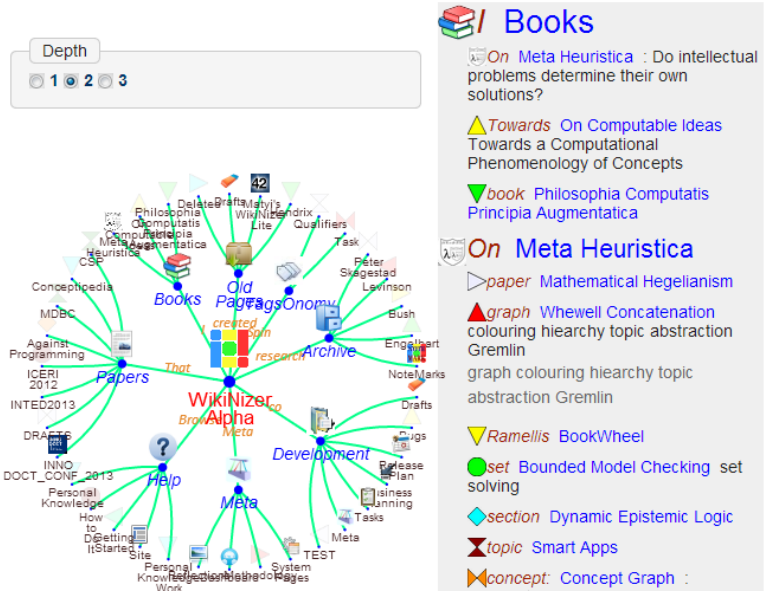

Fig. 4. Zooming on the 'Books' node (Depth 2) in Navigation View

At the meta level WikiNizer enables the user to construct the structures which conceptualize the particular domains of interest. Sharing the conceptual structures that emerge in the problem solving contexts which web linked personal knowledge supplies requires a common representation of concepts and related data. The collaborative use cases that WikiNizer generates create a *reference model* of graph based visual concept

organization which we have called a *"Conceptipedia"*. (Benedek, Goodman and Lajos 2013) In Section 3 after discussing the impact of visualization on conceptualization, we indicate our use proposals.

2 SIGNIFICANCE OF VISUALIZATION FOR KNOWLEDGE ORGANIZATION

The externalization of concepts and their relations

There is growing evidence that visual conceptualization takes place in non-human, even non-mammalian animals. There is quite a distance however from mental representation, or internal enactment of conceptualization, to objective presentation or inter-subjective expression of concepts and their relations. The Parry-Lord thesis (Goody and Watt 1962) that the structure and texture of our thinking relies upon our recording and information organising technology, can be applied to visualisation techniques as well as language recording tools such as the alphabet. Visual objectification not only renders fleeting thoughts more enduring, with re-perception facilitating additional inspection and re-consideration, shared technologies also help to create shared interpretations. Visual organization structure the conceptual content of our linguistic articulation into spatial, graphic, and iconic symbolic expressions of our knowledge organisation.

Advantages of visual knowledge architectures for conceptualization

Visualizing conceptual relations has the potential to generate a "Cartesian" knowledge organization system. A conceptual system binds together three constituents of conceptualization: (1) *clustering* (collecting, associating, grouping, classifying) *content* on the basis of intra-class and external relationships; (2) *identification, individualization or delineation of clusters* (naming, iconizing, and standardizing for the sake of symbolic identification by the discovery of characteristic features, patterns and parameters) (3) the *presentation of external relations* (links, aspects, colligations, connexions, correlations, and relationships). Visualization of conceptual relations requires a technology which can present them in a conceivable way. Visual tools help us explore complex conceptual relations, meanings, and program structures. Domain knowledge can be represented and visualized as systems of conceptual categories constrained by the nature and purpose of categorization.

With the advent of digital media, Visual Programming Languages, UML diagrams, linked hypertexts, visualizations of non-linear narratives, concept maps, graph and topological representations of conceptual spaces have left models which take problem solving to be a linear, stepwise

process, behind. In what could be described as an “Engelbart Galaxy”, in which collaborative bootstrapping promotes augmented problem solving (Engelbart 1962), we can edit video on-line, create info graphics, make use of various forms of visual cartography, and advance towards the development of ever more elaborated non-linear visual knowledge architectures. Topic maps can incorporate a variety of different forms of textual and visual e-content, and also serve as a means of structuring and navigating knowledge. Visual logics are e-didactic tools which increasingly are used to design a learning experience. In an educational environment these tools can remove the constraints of predefined paths in the learning material, and encourage students, teachers, and researchers to discover novel relations which better fit their epistemic needs.

Dynamism and cognitive flexibility of visualizations

Digital media provides new ways of representing and transferring meaningful information. Spiro and Jehng (1990) note that a hypertext and non-linear and multidimensional traversal of complex subject matters supports cognitive flexibility as they adapt to semantically rich, dynamically changing knowledge representations. “By cognitive flexibility, we mean the ability to spontaneously restructure one's knowledge, *in many ways*, in adaptive response to radically changing situational demands [...] This is a function of both the way knowledge is represented (e.g., along multiple rather single (sic) conceptual dimensions) and the processes that operate on those mental representations”. (165. emphasis ours.) Reorganization, *intellectual manageability*, and *cognitive flexibility* require more dynamic forms of knowledge representation. The *knowledge augmentation engine* we are proposing (Lajos and Benedek 2013) is a visual knowledge organization tool which helps us, through meta-design processes, to build conceptual meta-structures that co-evolve with knowledge organization. Visualizing interactive problem spaces in the form of conceptual graphs enables problem framers to play a more active role in defining the problems to be solved, and further visualization techniques render cross-interdependence between conceptual domains comprehensible. These learning ecosystems can be bootstrapped to *integrate* visual and verbal representations.

Amalgamation of textual and visual knowledge organization

Multimodal Web Scale Graph databases, and the multimedia capabilities of HTML5, give us the possibility of creating new “amalgamated” forms of visual and textual presentation:

1. Visual tools can organize and structure semantic information (textual as well as visual or auditive).

2. Textual/hypertextual structures can incorporate visual or multimedia presentations of audio-visual information.

An example of the first option is a concept map which visually organizes textual information, and its relations, but an UML activity diagram also belongs in this category. With regard to the second, articulation, exposition and framing of textual information is complemented with visual information and is composed of multimedia. Hypertexts, and HTML5 based learning, and knowledge transfer environments, fuse visual, audible, and complex perceptual experiences into integrated digital environments; supplying inter-subjective, and objectively reproducible records of sensory experience, not just text with illustrations. They have meta-structures which can be reproduced as templates or microformats (microformats.org). These formats can be seen as abstractions of the hypertextual structures (or "textures") of the information organization. These meta-structures can be described as augmented Cyber-textual knowledge architectures. (Benedek and Sándor 1999)

3 CONCEPTIPEDIA AS A TOOL OF COLLABORATIVE CONCEPTUALIZATION

How knowledge domains are visualized impacts upon the efficiency of conceptualization and collaborative problem solving. Real life problem situations rarely have a linear character, and their conceptual relations are often difficult to describe using words. When collecting and organizing information, *labeling* and *abstraction* help us comprehend and structure the relationships between the various components of a problem. These relationships are often expressed using labelled graph structures. They disrupt the linearity of lists and strict concatenation and admit non-linear dimensions of visual organization. Visual graph representations, such as node-link representation in Hypergraphs or TouchGraph can be viewed as externalizations of the cognitive associations which precede our conceptualizations. Cyber-textual knowledge architecture uses computers to enhance knowledge capture, elaboration, linking, and organization, amalgamating the visual and the textual components in graph structures, Web Apps, live HTML5 and video editing, in order to facilitate the articulation of concepts. Within such a wide range of Digital Content Creation new meanings are generated, and they not only express and externalize concepts, but also visualize their relations.

The graphic features of WikiNizer make visualization of personal "associative complexes" possible in the form of a Knowledge Graph of 'Things' which are amenable to interpretations defined at a meta-level. Conceptipedia supplies us with an intellectually manageable visual organization of conceptual relations, and abstracts their meta-structures in the form of externalized meta-class hierarchies. On the grounds that novel

meanings and conceptual relationships emerge as a consequence of social interaction, we offer Conceptipedia as a public "Forum" in which, with computer support, the conceptual meta-structures which emerge from specific problem domains can be exchanged, mediated, integrated, and collaboratively developed.

Using Conceptipedia as a Cloud based Co-operative Framework for Personal WikiNizers opens up the possibility of turning WikiNizer from a personal knowledge organizer into an augmentation engine of collaborative conceptualization. (Lajos and Benedek 2013) Because it is conceived as a graph of "Things" which enable relations between concepts to be defined within a meta-knowledge graph, it can be used by WikiNizer users as a collaboration platform that enables us to compare, share, and merge emerging Knowledge Architectures in a wiki-like collective graph knowledge base. WikiNizer supports collaboration in small teams, and can be coupled with Conceptipedia to build Knowledge Graphs that can be used interactively to define aspects and novel relationships between concepts and things via Collective Semantic Conceptualization. By developing mappings between meta-structures this concept adjusting service renders conceptualization intellectually manageable, and transforms underlying semantic structures into Knowledge Structures which consolidate ontological relations. It enables teams which collaborate on emergent Knowledge Architectures to share and compare conceptual structures. Sub graphs can be categorized by labels, 'aspects' and types of relations, and user groups can apply colored relations, where colors can represent agreed upon types of relations. In this way sense-making can be turned into a process of consensus building that facilitates the researching, ingesting, exploring, capturing, articulation, mapping, visualization, and merging, of conceptual meta-structures and their various relationships. Interactive operations open the way for comparing, selecting and merging conceptual structures, *both* at the object and the meta-level, supplying us with visual tools for semantic collaboration.

As users work on a topic, they can at any point search with keywords or submit graph queries within the entire Conceptipedia to find relevant contributions. These contributions will typically contain different domain concepts and relationships. Their graph structure can be compared at a "meta level" by looking at their structural characteristics. These meta-structures assist in identifying correspondences between what the user has, and what other users have found. For multiple users these relationships will have associated user definable processes, so that the proposed changes to existing structures arrive at an integrated conceptual structure which has agreed upon terms and commensurate relationships. If these changes are accepted by the affected parties this builds a consensus, and consensual conceptual graph structures can be saved as the rewards of collaborative sense making. A kind of meritocratic game –supported by a Reputation

System mechanism– can be played at the meta-level, until workable ideas win out. This Reputation System, together with the semantic graph operations of the meta-level, safeguard the efficacy of Collaborative Sense-making and conceptualization within the framework of an emerging collaborative concept oriented ‘Exploratory Epistemology’.

4 PROVIDING A TECHNOLOGY OF INTERACTIVE SEMANTIC OPERATIONS FOR BUILDING META LEVEL CONCEPT STRUCTURES

Since meta-structures and meta-level concepts are constructed in the same way as domain structures and domain concepts, they are amenable to being rendered, processed, and visualized, in the same way as domain structures based on graph representations. At both levels a consensus can be built by mutual re-factorings, defining commensurate concepts and structural mappings. Once meta level structures as graph patterns are saved these patterns can be called Meta Reflective Architectures, and become reusable. When re-using these patterns, new conceptualizations can be developed that synthesize and integrate what was there before. In this way Graph Representation based Meta Design empowers users to extend existing shared meta reflective system capabilities.

Concepts that define system capabilities as well as providing capabilities for a specific domain are elaborated as Effective (executable) Concepts. Knowledge items that have no executable counterparts are non effective concepts. The development of Knowledge Management software thus reduces to conceptual structuring, elaboration and injection of semantic primitives which end up becoming weaved into code as in *literate programming*. (Knuth 1992) This Effective Conceptualization is carried out in a single uniform content management framework which is applicable on all levels, and provides for a seamless elaboration and co-evolution of object level structures in tandem with the requisite meta level structures that define both the form and all the intended "meanings" as interpretations of those structures. One added benefit of having everything that is needed represented in the *same way* as first class things about the object/subject, and in a *common framework* with all the required meta-levels, is that it gives you full extensibility for free. The system can integrate new functionality with the same facility so that it can update its content. Hence, the system’s entire repertoire of capabilities is fully explicated in a form that is visible, modifiable, and *tinkerable* by the user.

Semantic Operations and Interactions Servicing Transparency

WikiNizer's built-in domain independent default visualization operations and interaction mechanism implements a whole range of

“Overview”, “Navigation”, and “Interaction techniques” (Kboubi et al. 2011). *Interactive graph operations* open the way for comparing, selecting and merging conceptual structures, both at the object and at the meta-level, providing visual tools for semantic collaboration. Within the context of collaborative conceptualization, discovery, and problem solving, the crucial sets of operations are (1) the *extension*, (2) the *merging*, and (3) *the contraction* of visual and hypertextual *meta-knowledge structures* — in addition to such operations as *expansion, update, cut, bifurcation, product or zooming on and exporting subgraphs*. These issues are analogous to the problems of *ontology merging*; we however, go well beyond common lexical vocabularies. Some of the content we represent may remind you of the Web Ontology Language (OWL), but for us a crucial point is that the *contents* which give semantic meaning, and the *ontological structures*, are not separate. All current Knowledge management frameworks that we are aware of, including W3C's Semantic Web initiative, share one deeply ingrained paradigmatic assumption viz. they all tend to separate the description/specification of representation (syntax) from the description/specification of interpretative processes (semantics).

Our practical experiences confirm that to promote effective conceptualization there is a better way: end this separation, since it is possible to engineer technology enhanced/augmented computational frameworks that handle content bearing syntactic structures as domain specific inferences and conceptual meta structures in a uniform way. For this reason we need to develop commensurable structures at the meta level which we call ‘meta-semantic trails’ of conceptualization. These meta-structures not only can be “abstracted” but can be effectively extracted, identified, labelled, saved and reused. As a result, they can be formally described and compared, whereas conceptual relations in the mind, or in plain text, are not visible. The mappings, and the necessary semantic operations which satisfy various requirements of *extensibility* and *mergeability*, can be defined and analyzed in terms of Dynamic Epistemic Logic and Category Theory, as theoretical backgrounds for formal description. (Ditmarsch at al. 2009, Hitzler et al. 2005) These operations facilitate the development of common interpretations, the dynamic re-factoring and collaborative re-purposing of context driven conceptual meta-structures.

Since crucially in WikiNizer (and consequently in the reference model of Conceptipedia) everything has a global unique ID and is a node in a Global Giant Graph, the structure may be seen as an RDF with an isomorphic correspondence to the graph. The crucial difference is that parts of this graph are explicitly dedicated from the outset to containing meta structures. Relevance can be assured by implementing trails that ensure that higher level concepts get activated in a specific context. This design methodology makes comparison and mapping of conceptual structures possible, exploring

common patterns, core structures and possible extensions, not just at the level of objects and domain ontologies, but in the form of common/commensurate communicable meta ontologies of relations at as many levels of reflection as is required.

Augmentation Engines for Semantic Conceptualization

In the tradition of Vannevar Bush's MEMEX (Bush 1945) and Doug Engelbart's Intellect Augmentation (1962) we consider that Building Knowledge is comprised of the following steps:

1) ‘extending the record’ with knowledge items in a given domain
2) creating associations between items
3) articulating at the meta-level the intended ‘meaning’ of the consolidated associations by portraying them as microformatted graph-structures
4) applying epistemic operations to arrive at domain specific visual semantics of the conceptualization
5) adding further Visualizations to get What We Need in the form of affordances

We consider 1-5 as the main steps of Visual Semantic Conceptualization, and the “trails” that can be “blazed” across these items are the Semantic Trails. In order to obtain a range of possible task focused interpretations of our conceptualizations, we can define epistemic operations for visual semantics which service the *dynamics* of explorative epistemology. When we apply them we build up knowledge about the conceptualization of a domain in the form of items of meta knowledge which are themselves semantically conceptualizable having their own meta-levels. Realising the above vision requires the construction of Knowledge Augmentation Engines, which can be bootstrapped into ever more capable systems; just as Engelbart had done with his oN Line System (NLS).

At a philosophical level we address the same problem that Engelbart addressed in his Intellect Augmentation Research viz.: how can we use computers to radically improve the ways in which “*we deploy symbols to portray concepts*” (Engelbart 2004). Our vision of “extending the record” as Bush proposed in his MEMEX, shares Shraefel’s emphasis on the active personal processes of ingesting, articulating, and conceptualizing, rather than simply just publishing for the World Readable Web. We see our work as anticipating Shraefel’s (2007) call “to take as a fundamental goal designing systems not just to support a particular task, but to support creativity” (9.) to “explore, associate, and connect information to build new knowledge.” (4.) We see the key to this in the move to “Go Meta” (Rosenberg 2007), extending the meaning of the paraphrase “meta-data is the message” (Shraefel 2009) to expressive conceptual meta-structures. The interpretation of the term “metadata” and the ways metadata is

structured are dependent on the fields in which they are used. (Cf. IEEE LOM, with ONIX; PICS with Mpeg21, or Dublin Core.) We would like to shift attention from "data" to its (re)*organization* as a creative *activity* of conceptualisation which produces a variety of meta-knowledge forms, that leave behind the idea of fixed templates or 'ontologies' of lexicographic terms.

WikiNizer and Conceptipedia have grown out of our attempt to re-constitute the conceptual clarity and intellectual manageability that characterize the language-oriented paradigm (Lajos 1992) within the world of (Personal) Knowledge Management. The improvements in the portrayal of concepts which WikiNizer gives us is also applicable to concepts that are "effective" – as the concepts portrayed by Engelbart's Grammar-driven Command Language description of system capabilities are effective. In WikiNizer the systems capabilities are described as conceptual structures which implicitly define command languages.

It is only two years ago that we realized that most of our "original" ideas are over 40 years old! This includes language orientation as a programming paradigm. The task of portraying domain specific effective concepts in a grammar is "isomorphic" to the ways in which conceptual elaboration proceeds within WikiNizer, except that it gives us a smooth transition from formulations which are only meaningful to humans to formulations that can be run on a virtual machine. In the "Humble Programmer" Dijkstra (Dijkstra 1972, 865) thinks about a future system that would "invite us to reflect, in the structure of what we write down, all the abstractions needed to cope conceptually with the complexity of what we are designing". WikiNizer invites "humble knowledge workers" to do likewise, in order to help them cope with the complexity of what they are thinking about. In our efforts to help the humble programmer our guiding principle is: If you get your concepts right implementation can take care of itself.

Because some conceptual problems tend to define their own solutions, arriving at congruent proposals should not perhaps have come as a surprise. Armed with 20-20 hindsight, and in the light of our experience in tackling comparable problems, we believe that the time has come to re-appraise Englebart's achievements, and see them, for the first time, as a Paradigm Lost. The greatest technical achievements of Engelbart and his team were lost because people's thinking was "understandably swayed" (Engelbart 2004) by the capabilities afforded by the mouse and the graphical display. People were eager to create the 'personal computing revolution' and ignored the "paradigm shift" embodied in NLS. In a future paper, "The Humble Knowledge Worker" we will set out how it can become a Paradigm Regained. Here we have only had the space to reflect upon the role which Visualization plays in WikiNizer and Conceptipedia, in our New World of **W**hat **Y**ou **S**ee **I**s **W**hat **Y**ou **N**eed.

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