Expressing Argumentative Discussions in Social Media Sites

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Abstract. Among the activities that people participate in on the Social Web are argumentative discussions and decision making. This paper analyzes a series of use-cases (from the perspective of social media sites) that share the presence of such argumentative discussions and where the structure of online discussions can be represented in SIOC. Our goal is to externalize implicit argumentation structures hidden in the user-generated content. For capturing it and making it explicit, we propose a SIOC Argumentation ontology module as a formal representation.

1 Introduction

Argumentation can be found and captured in a variety of fields ranging from scientific publications to ontology engineering or agent interaction. Social media sites, which represent the hype of the moment, also host argumentative discussions between their members. Such an interactive argumentative discussion usually starts with an initial proposition stated by a single creator. This is then followed by supporting propositions or counter-propositions from other contributors. The actual semantics, both of the interactivity and the argumentation side of the discussion, is hidden in the structure and content created by the participants, and therefore it is difficult to leverage for use by machines.

A possible solution for the first part of the problem is represented by the SIOC initiative (Semantically Interlinked Online Communities) [3]. SIOC aims at integrating online community information, by representing rich data from the social web in RDF. Lately, SIOC became a standard way for expressing user-generated content from social media sites, thus being able to capture their dynamic aspect (interactivity), by modeling the underlying structure of the content. In addition, when complemented with other commonly used vocabularies (like FOAF[3]), SIOC enables innovative ways of expressing personal profiles and social networking information.

[3] http://www.foaf-project.org/

Unfortunately, the second part of the problem, i. e. capturing the semantics of the argumentative discussions, is still open. SIOC provides the means for modeling the structure of the discussions, but it needs a complementary and more precise way to acquire the actual argumentation present in them. There is a relevant number of argumentation models, most of them following the direction given by the IBIS methodology [11]. One of the main issues with many of these models is the focus on a particular knowledge domain, limiting the view of the argumentation to the scope of that domain only, and enabling only partial re-use.

In this paper, we make the first steps towards building an argumentation module for SIOC. We performed a thorough analysis of the existing work done in the argumentation area, and step by step we created our own model that has the specific target of social media sites. By taking into account models like IBIS [11], or DILIGENT [17], our tendency was more towards building upon concepts from these models and adapting them for our own needs.

In sect. 2, we describe background research performed in the SIOC initiative. In sect. 3 we present use-cases from which we extracted the need for an argumentation model for social media sites. Sect. 4 details our proposal, and sect. 5 outlines our plans for deploying our model. In sect. 6 we provide a comprehensive overview of the related work. Sect. 7 presents our future work and conclusions.

2 SIOC Ontology

The SIOC initiative (Semantically Interlinked Online Communities) [3][4] aims to enable the integration of online community information by providing an ontology for representing rich data from social web sites in RDF. It has recently achieved significant adoption through its usage in a variety of commercial and open-source software applications, and is commonly used in conjunction with the FOAF vocabulary for expressing personal profile and social networking information. The SIOC ontology has been published as a W3C Member Submission[5].

The ontology consists of the SIOC Core ontology[6] (consisting of 11 classes and 53 properties) and three complementary ontology modules: SIOC Access, SIOC Services and SIOC Types.

The SIOC Core ontology defines the main concepts and properties required to describe information from online communities on the semantic web. The main terms in the SIOC Core ontology are shown in fig. 1. The SIOC Core ontology was created with the terms used to describe web-based discussion areas such as blogs and message boards: namely *Site*, *Forum* and *Post*. Users create *Post*s organized in *Forum*s which are hosted on *Site*s. *Post*s can reply to other *Post*s. Higher level concepts (data spaces, containers and content items) were added to SIOC as it evolved. By using these classes and related properties, SIOC allows us to structure the information in online community sites and distinguish between different kinds of social web objects.

[4] `http://sioc-project.org`
[5] `http://www.w3.org/Submission/2007/02/`
[6] `http://rdfs.org/sioc/spec`

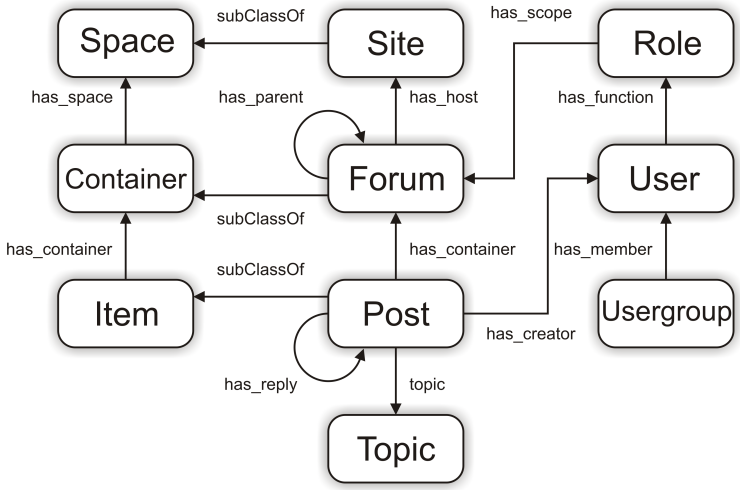

Fig. 1. Main classes and properties in the SIOC Core ontology.

Modules of the SIOC ontology were created as the core ontology was growing. They contain classes and properties that are too specific for the core ontology or cover a particular use case. E. g., the SIOC Types module defines subclasses of SIOC concepts needed for more precise representation of various elements of online community sites (e. g. *sioc_t:MessageBoard* is a subclass of *sioc:Forum*), and introduces new subclasses for describing different kinds of social web objects in SIOC. For example, as a subclass of *sioc:Forum*, one can use *sioc_t:ArgumentativeDiscussion*. With the SIOC Types module we have envisioned certain use cases and provided specific subclasses for them, but we have not further elaborated on supporting these use cases with SIOC. In this paper we are going to elaborate on specific support for argumentation.

3 Use Cases

This section describes use cases for argumentation as used on the social web.

3.1 Forum and Blog Discussions

Forums and blog posts are among the most popular ways of online discussions. Such discussions are a natural place where argumentation and decision making may take place. For example, a group of software developers may use a forum for deciding on the place for their next face-to-face meeting (or decide on details how a particular software function should work). We want to be able to formalize the argumentative structure of these online conversations.

A simple example is a blog post A with a number of replies (A-R_1, ..., A-R_n). The blog post may express an opinion (a position) about something, and

comments are agreeing or disagreeing with it. However, the two-level structure of blogs (post + comments) only allows for simple argumentation and may not be sufficient for "full scale" decision making. If we consider the whole blogosphere and conversations across blogs, argumentation is more interesting. E. g., when a blogger Bob makes a statement on his blog, another blogger Carl can refer to this from his own blog, e. g. with an argument why he thinks Bob is wrong.

Forums and bulletin boards usually have larger communities than blogs do and have a richer conversation structure which can be used for argumentative discussions. Forum sites usually have a number of discussion rooms or forums where each forum is used for conversation on a particular topic or subject area. Each forum consists of conversation threads. A conversation thread is the place where a particular discussion about the topic of this conversation takes place.

The first message starts a thread and is the root of all other conversations and decision making that is taking place in this thread. As such it defines what a thread is about. Imagine a thread which starts with a message "It is time for our monthly off-site meeting. Where shall we go?". This message defines an issue and a goal for this conversation (decision about the meeting venue).

Colleagues respond to this message by posting replies in the same thread. Some of these replies may offer suggestions about the venue (proposed solutions for the issue) and propose the following locations, each with a justification:

1. Aran Islands ("a relaxing place where we can be away from all the noise")
2. London ("a prime business location")
3. the local pub ("it's just across the road!")

Other messages express their support or disagreement with one of the proposals and, finally, the group will come up with a decision, e. g., "local pub it is!"

As can be seen from this example, forums can have a rich conversation structure and posts inside a thread may have different roles in the decision making process.

3.2 Wiki Discussions and Bug Tracking

Wiki discussion pages and comments in bug tracking systems have in common that they usually contain discussions about artifacts of domain knowledge: In wikis that are used as knowledge collections, one article page usually holds knowledge about a distinct subject of interest, and on the corresponding discussion page, people can discuss *about* that subject, or about the way that subject is presented on the article page. On Wikipedia, for example, the former type of discussion is discouraged, whereas the latter prevails [21]. It is common to report issues with the corresponding article (e. g. that the article is found to violate a community policy such as taking a neutral point of view), coming up with ideas on how to solve this problem, and finally voting on these ideas. It is then up to an experienced member of the community to identify the best solution and put it into practice by revising the article [12].

In bug tracking systems, users or developers of a software system report issues with that system (see, e. g., baetle [2]). While unexperienced users often report

issues with the system in general, developers can usually narrow them down to issues with a particular component of the system. Follow-up comments giving elaborations on the issue description or proposing solutions can be given. Some systems support voting on the importance of bugs. In the end a developer takes a decision and changes the affected source code, i. e. fixes the bug. Links from bug reports to the affected software artifacts are shown in some bug trackers which are closely integrated with (source code) revision management systems, such as Trac with Subversion[7]. Similar patterns (discussion of changes and voting or decisions on their acceptance) are present in source code review systems[8].

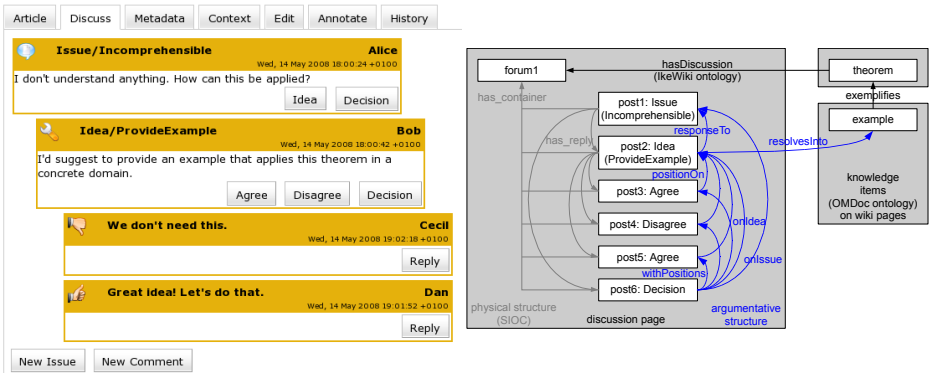

Fig. 2. A structured discussion about mathematical knowledge (left: user interface while discussing; right: full RDF graph)

In previous work [12], we have extended SWiM, a semantic wiki for mathematics, by discussion pages using SIOC for the infrastructure of threaded discussion pages and the DILIGENT argumentation ontology [17] for argumentative structures. The Wiki pages contain artifacts of domain knowledge such as definitions of symbols or theorems, and problems with their conceptualization or formalization can be discussed. In any step of the discussion, the system not just offers to post a "reply", but it displays a button for every type of argumentative primitive that can follow up on the type of the current post, as specified by the DILIGENT ontology. We extended the argumentation ontology by domain-specific subclasses of DILIGENT's *Issue* and *Idea* classes, which allows for arguing about common problems in a more directed way, and for offering semi-automatic software assistance in solving problems[9]. For example, a particular type of issue with a mathematical theorem could be that it is hard to understand, and an idea to

[7] `http://trac.edgewall.org/wiki/TracSubversion`

[8] `http://google-code-updates.blogspot.com/2008/07/looks-good-to-me-source-code-review.html`

[9] A public prototype of the system is currently used at `http://wiki.openmath.org` by domain experts who are revising the OpenMath Content Dictionaries, a lightweight ontology of mathematical symbols.

solve this could be to add an example to the Wiki, which applies the theorem in a practical setting.

This previous work on extending a semantic wiki with argumentation proves the usefulness of combining SIOC and argumentation models. Nevertheless, as we detail in sect. 4, it is not abstract enough to fit *all* the use-cases that generate and manage social media content. At the same time, the focus of DILIGENT on ontology engineering raises, from the social media sites perspective, differences in the interpretation of the semantics of the argumentation concepts. These differences in semantics constitute our main motivation in building a specific argumentation module for SIOC.

4 Approach

4.1 SIOC Argumentation Module

We have identified common cases of argumentative discussions on social media sites (cf. sect. 3) and developed a module for expressing argumentation in SIOC[10].

The SIOC Types module already contains a *sioc_t:ArgumentativeDiscussion*, a subclass of *sioc:Forum* and represents a "placeholder" for expressing that argumentative discussions are taking place in this discussion area (i. e. *sioc:Forum*). Nevertheless, in order to be able to provide a rich and comprehensive argumentation structure, we opted for creating an individual module, that captures the main argumentation concepts we identified as being relevant for our use cases.

The minimum needed for argumentation in SIOC is having a class that can be assigned to any resource in addition to *sioc:Item* or *sioc:Post*, stating that this post has the role of an argumentative *statement*. A post of type *sioc_arg:Statement* represents the root of the argumentative discussion, as it can be followed by a replying post of the same type, modeled by *sioc:has_reply* in core SIOC (thus one statement *refers to* another statement).

The way in which we modeled this relation, was by introducing *sioc_arg :refers_to* as a sub-property of *sioc:has_reply*. Starting from this, we specify additional classes and properties for arguments, all subclasses of *Statement*, or sub-properties of *refers_to*. The reason behind our design was to provide both developers and users with the flexibility of choosing their own way for identifying the argumentation (statement) types for their posts.

From the use cases described in sect. 3 we observe that discussions usually start with an issue or an idea. An *Issue* is a problem to be discussed, a decision on a solution being expected as the result of the discussion. An *Idea* can refer to an *Issue*, then taking the role of a solution proposed for that issue, or it can stand on its own. In this last case, the *Idea* can either be a general idea, not proposing to solve any *particular* issue, or it is a proposed solution for an implicit issue that is not addressed in a discussion post of its own.

On the other hand, *Issue*s can also follow up on *Idea*s – particularly when a discussion was initialized by an *Idea* and then the idea turns out to be problematic.

[10] `http://rdfs.org/sioc/argument`

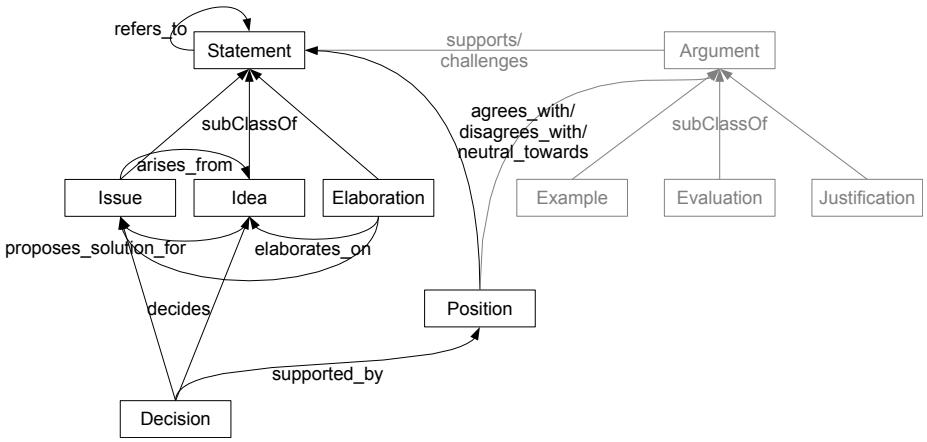

Fig. 3. The argumentation module for SIOC

Most of our concepts (as depicted in fig. 3) have their roots in the DILIGENT argumentation ontology [17], but have a slightly different semantics. A DILIGENT *Issue* states a requirement for the ontology to be designed, and an *Idea* would propose a concrete conceptualization or formalization; ideas cannot represent roots of argumentation threads. Both *Issue*s and *Idea*s can be followed up by *Elaboration*s, which continue the line given by the parent statement, and thus enrich the argumentation model of the discussion.

Users can reply to *Issue*s, *Idea*s, and *Elaboration*s on the former, with *Argument*s, which can be justifications or challenges. An *Argument* tries to argue objectively; it is distinct from a *Position* (see below), which rather conveys the personal opinion of a user. On the other hand, depending on the particular use-case, the presence of the *Argument* concept might not be needed (this being the reason for the different way of representing it in fig. 3). In the Blogosphere, every opinion can be seen as a personal interpretation of the reality, while in a bug tracking system, such opinions are supported by real issues, thus having the circumstance of being considered objective. In addition, the role of an *Argument* can be resumed to: (i) an expression that states if an *Issue* is considered legitimate and worth discussing, and (ii) an expression that shows if an *Idea* can be considered a good solution. Subclasses of *Argument* comprise: *Example*, *Evaluation*, and *Justification*, which can be attached to their parent post by one of the properties *supports* or *challenges*.

In this case, our design was motivated by the Cicero system [7] and allows the retrieval of supporting or challenging arguments with one query step less than a model with positive and negative argument classes and just one property. Also, we opted for only this small set of subclasses for the *Argument* concept, as earlier studies in argumentation have shown that a restricted space of argument types helps to keep a discussion more focused [16].

In a more subjective manner, users can express their *Position*s on a statement – either agreeing or disagreeing. The relation to the statement is represented by one of the properties *agrees_with*, *disagrees_with*, *neutral_towards*. While most argumentation ontologies do not allow the representation of neutral positions in order to force the argumentation towards solutions, they are nevertheless quite common in online discussions. In fact, they are different from the absence of the position in that they express "I do care about this statement, I'm just not decided whether to support it or not." For a minimum working model, it is sufficient to give *Position*s on *Idea*s, but in a more elaborate model *Position*s on *Issues*, *Elaborations*, and even *Arguments* could make sense.

At the end of an argumentative discussion a decision can be taken. It can be documented by replying to the post that started the discussion (either an *Issue* or an *Idea*) with a *Decision*. In the case of making a decision on an issue, one can also link the *Decision* to the winning *Idea*. A *Decision* should be backed by linking to the positions that were in favor of the action decided.

4.2 Overall Recommendations

We would like to leave to the developers of social applications the decision of how much of the SIOC Argumentation Module to support. As shown in sect. 3, the list of use cases is diverse, and thus the need for argumentation support is present. Nevertheless, we do recommend that applications restrict the statement types with which the user can reply to a post to exactly those that are allowed by the schema.

One aspect that our model currently does not capture is a voting scheme. The developer should make the choice of implementing positions as proper posts, or by introducing a vote mechanism on statements. There exist several possibilities to model voting: (i) Collaborative Protégé, for example, allows for either "5-star" or "yes/no" voting [19], whereas (ii) Cicero allows for "yes/no" voting either on individual ideas or in a multiple choice way [7].

When using voting in problem solving, the process can be made more efficient by separating it into two stages: setting a deadline until which all argumentation (such as coming up with ideas and arguing on them) has to be finished, and then allowing the community to vote, as to prepare a final decision. This has been investigated in the Cicero system (cf. sect. 6.3).

A final recommendation would be to close an argumentative thread with a decision, with no more possibility to submit posts. In some applications, such as bug tracking systems, however, the possibility to reopen a discussion should be offered. In a small web of trust it may be feasible to let every user make decisions, whereas in larger social networks we recommend this to be restricted to moderators.

5 Deploying Argumentation on Social Media Sites

The actual process of deploying the argumentation module for SIOC to social media sites is twofold: The software needs to support it, and the users should make

use of it. Concerning software support, the key difference from the deployment of the SIOC Core ontology is that the main SIOC concepts, such as forums, posts, and users, have always been present in software systems running social media sites. Each system had its own internal, idiosyncratic data model with notions of these concepts, so they just had to be externalized using SIOC as a common data model. The argumentation functionality is different in that only very few social media systems already have a model for it. In order to support the SIOC argumentation module, the data model of a system would have to be extended by new components.

Once the software supports the SIOC argumentation in principle, the next challenge is acquiring information about argumentative structures in discussions. This could be done automatically, or by letting the users annotate their posts manually. Automatic annotation would most likely be done using natural language processing techniques, whereas manual annotation needs to be encouraged by a simple and intuitive user interface. We believe that a good approach would offer both automated suggestions, which the user can approve manually, and a user interface that reflects the primitives of our model of argumentation. An example user interface is shown in fig. 2, where an appropriate set of reply buttons is displayed for each post.

6 Related Work

The background and previous research performed in argumentation covers, in general, an important number of related directions. In this section we will focus on three main aspects: (i) background theories and models, which were used as an inspiration by the majority of the currently existing argumentation models, (ii) existing argumentation models, having similar goals with our approach, and (iii) specific implementations of such models in social applications.

6.1 Background Theories

In terms of background theories and models, we found three of them as being relevant for covering the directions from which most of the argumentation models were inspired. The first of them is IBIS (Issue Based Information Systems) [11]. IBIS introduced a methodology for argumentation-based decision making in information systems, adopted by most of the current ontology-based argumentation frameworks, like DILIGENT [17], the Compendium methodology [14] or SALT [10]. A second important background theory is the Speech Acts Theory [5] that models the language aspects of speech acts and their planning in human communication. Although not directly (re)used in argumentation models (one of the main application areas being e-mail workflow modeling), this theory represented groundbreaking research that later led, for example, to the third important theory, i. e. the Dialogue Games Theory. The Dialogue Games theory [4] proposed a novel direction for the general Game Theory by considering discourse analysis and the logics and rhetorics of the human communication. This approach can be found as inspiration in most of the agent-based argumentation models.

6.2 Argumentation Models

One of the early argumentation models was the one of Conklin et al., i. e. gIBIS [6]. This was following closely the original IBIS model and applied its methodology in team-based deliberation. gIBIS served as inspiration for later models like: (i) DILIGENT [17], which applies argumentation in ontology engineering, (ii) Compendium [13], that follows a semiotic [15] approach for dealing with knowledge visualization and design rationale, while complementing argumentation with Cognitive Coherence Relations [14], or (iii) The Zeno argumentation framework [9] applied in mediation systems. Other relevant argumentation models include the one proposed by Torroni et al. in [18] for dealing with agent-based argumentation in the semantic web, in the case of communities of web services the one introduced by Bentahar et al. in [1], or a more lightweight text-based argumentation syntax, as the one proposed by Völkel[11].

6.3 Social Applications

Cicero is a Semantic MediaWiki extension for DILIGENT-like argumentation [7]. In contrast to the SWiM system introduced in sect. 3.2, Cicero is not made for arguing *about* knowledge items, but for solving problems in projects in general. One Wiki page corresponds to one project, issue, or solution proposal (= idea). Arguments are represented as subsections of a solution proposal page. Cicero offers versatile options for voting and deciding. The ontology is DILIGENT-like but slightly different. It is only available in the Wiki; no external implementation is known. For the non-argumentative infrastructure, no ontology (such as, e. g., SIOC) is used.

Fraser et al. have developed an argumentation ontology for e-mails [8]. They shallowly annotate on the top level of every e-mail to keep the annotation easy for users. That means, however, that if an e-mail agrees with some statements of another e-mail but disagrees with others, the value of the argumentative annotation is limited. This issue can also be present in our use cases, and that is why we intend to solve it in the near future, by allowing the representation of fine-grained structures within posts.

7 Conclusion

In this paper we presented the first steps that we have made towards creating an Argumentation Module for SIOC. We started with a series of use-cases that have two facts in common: (i) their structure can be represented semantically with SIOC, and (ii) part of the content created by the users has an implicit argumentative structure. Our goals were to externalize these argumentative discussions and make them explicit via models that are machine-understandable. The model that we have proposed is in its initial stage, and thus we are looking forward to improving it based on the community's feedback.

[11] `http://xam.de/2006/02-ibaw.html`

Most of the use cases presented here deal with problem solving, but we believe that another important benefit of making argumentative structures on social media sites explicit will be a precise *documentation* of discourses that led to earlier decisions. This strengthens the collective memory of a community and will allow new members to retrace and understand the steps of their "ancestors".

For future work, we consider unleashing the potential of SIOC in representing distributed conversation and interlinking argumentations across multiple social media sites. An analysis of the RDF graphs of the argumentations on a single site enables the identification of the merited members of one community, e. g. by counting how many of their ideas have received positive feedback (by *Argument*s or *Position*s) and finally got accepted (by *Decision*s). Then, by making the data of several SIOC-enabled social media sites available to a linked data crawler such as Sindice [20], we can identify traces of the same users in other communities. Such merited users could then automatically be promoted to moderators that are allowed to take decisions. Argumentation in distributed blog conversations can also be an interesting topic to explore in this way.

A second direction we want to follow is to model and enable the representation of fine-grained structured for argumentation in social media sites. Some of the main challenges here are: the creation of the appropriate underlying structures and their links to the SIOC concepts, proper identification of such structures for building the argumentation model, and how to make users willing to split their discourse and to describe its rhetorical structure, all without disrupting their normal flow of work.

In terms of deployment, an interesting direction would be enhancing the existing wiki talk pages (e. g. as used on Wikipedia for discussions and issue solving [12]) with a structured argumentation module as described here. Benefits of doing so can be a more efficient workflow for improving wiki content.

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