Cohere: A prototype for contested collective intelligence

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Cohere: A Prototype for Contested Collective Intelligence

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ABSTRACT
This paper presents the rationale for treating *Contested Collective Intelligence (CCI)* as a significant and distinctive dimension of the broader Collective Intelligence design space for organizations. CCI is contrasted with other forms of CI, and building on research in sensemaking, and the modeling of dialogue and debate, we motivate a set of requirements for an ideal CCI platform. We then describe a social, semantic annotation tool called *Cohere*, which serves as our working prototype of the CCI concept, now being deployed in several communities.

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Collective Intelligence, Annotation, Argumentation

Categories and Subject Descriptors
H.5.3 [**Group and Organization Interfaces**]: Collaborative Computing. H.5.1 [**Multimedia Information Systems**]: Hypertext navigation and maps.

General Terms
Design, Human Factors, Languages, Theory

INTRODUCTION
At its most ambitious, research into Collective Intelligence (CI) seeks to develop the conceptual foundations and sociotechnical infrastructures to increase our ability to resolve complex problems by combining individual contributions. An important challenge for the research agenda is to devise appropriate *theoretical dimensions* so that we can position different notions of CI in relation to each other meaningfully, and different *design dimensions* so that we can articulate design spaces of possibilities for rendering these different forms of CI. The identification and testing of these dimensions is a long term challenge for the CI community, as we seek to 'join the dots' representing our different conceptions.

This paper introduces the rationale for *Contested Collective Intelligence (CCI)*, which we propose as significant in organizational CI (but equally, in learning across many contexts):

1. there may not be one worldview subscribed to by all;
2. evidence can be ambiguous or of dubious reliability requiring the construction of plausible, possibly competing narratives;
3. growth in intelligence results from learning, which is socially constructed through different forms of discourse, such as dialogue and debate.

This motivates a tool-design approach focused on the construction and management of *connections* — between data, knowledge resources (such as documents), ideas (including issues, options and arguments), and people. A social, semantic web application called *Cohere* is then described as a working prototype for testing these ideas.

FROM UNCONSCIOUS TO CONSCIOUS TRACES
Central to most conceptions of CI as an online phenomenon is the activity trace left by individual users, since this is created as a by-product of their activity (possibly involving no explicit interpersonal interaction). What makes the data in that trace significant depends on the kind of CI that we want to construct. For instance, social networking and media websites track users' *views, purchases, ratings, comments* (of images, movies, music, product etc), and *relationships*, in order to make recommendations to others. This form of CI is an emergent, analysable picture generated as a by-product of the traces left by millions of clicks as users navigate, sometimes consciously disclosing information for others (ratings, comments, friending), while at other times this is an unconscious trace (navigation paths). Aggregation across sites increases the potential for new connections even further.

The dimension of *unconscious—conscious* may prove useful, since it corresponds with *low level—higher order cognition*: it is easy to leave traces of low level activity without thinking (e.g. what you view, bookmark or search for), but if a contribution requires a degree of reflection (e.g. an annotation, blog post or document) then this could only be unconsciously part of a collective intelligence if it was made public without the author's permission.

WHY "CONTESTED" CI?

Sensemaking

What kind of CI tools are needed to support stakeholders engaged in controversial issues such as urban planning, climate adaptation/mitigation, or international peace-keeping?

Our interest is in scaffolding the higher order cognition associated with *sensemaking* around complex dilemmas such as these. Sensemaking is an applied research field already in dialogue with Human-Computer Interaction research (e.g. [19]), and which, we suggest, contributes to the emerging CI/CSCW research agenda. As we explain below, CI is in our view another lens on both the process and products of sensemaking, just as personal intelligence is both the "store" of accumulated memories, *plus* the capacity to respond appropriately to a situation by transforming memories and new data into plausible narratives about what how the world was, is, or might be.

In sensemaking, lower level data traces, such as those characterized above, have a contribution to make in helping analysts to navigate the information ocean associated with such dilemmas (e.g. recommendations of reports to read, or people to contact), as do tools that help share information with relatively little effort on the part of users (microblogging status and links; or sharing action lists or favorites lists [10].

However, our proposal is that more powerful scaffolding for thinking and discourse is required, in order to support the emergence of CI around complex organizational dilemmas.

The importance of making plausible, *narrative connections* weaves like a thread through understandings of sensemaking. In a review of sensemaking, Klein, et al. [11] conclude:

> "By sensemaking, modern researchers seem to mean something different from creativity, comprehension, curiosity, mental modeling, explanation, or situational awareness, although all these factors or phenomena can be involved in or related to sensemaking. Sensemaking is a motivated, continuous effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively. […] A frame functions as a hypothesis about the connections among data."

Karl Weick [23] argues that sensemaking is literally "the making of sense", that is, giving *form* to *interpretations* (cf. the specific focus on sensemaking representations by Russell, et al. [16]). Weick proposes that:

> "Sensemaking is about such things as placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning." (Weick, [23], p.6)

His argument, echoed by extensive research into the interplay of cognition and external representations (e.g. see the review by Scaife and Rogers [17]), is that the very process of externalizing thought shapes that unfolding understanding: from attempting to verbalize inchoate thoughts, to sketching diagrams, to codifying data in a structured symbol system. Weick emphasizes that sensemaking is always in a social context, and cannot be treated as a purely cognitive, information processing challenge:

> "The point we want to make here is that sensemaking is about plausibility, coherence, and reasonableness. Sensemaking is about accounts that are socially acceptable and credible. […] It would be nice if these accounts were also accurate. But in an equivocal, postmodern world, infused with the politics of interpretation and conflicting interests and inhabited by people with multiple shifting identities, an obsession with accuracy seems fruitless, and not of much practical help, either." ([23] p.61)

In other words, in the design space of CI systems where there is insufficient data to confidently compute an answer, when there is ambiguity about the trustworthiness of environmental signals, and uncertainty about the impact of actions, *what else is there to do* but construct narratives — both retrospective and anticipatory — to fill in the gaps? In some situations (e.g. crisis response in a nuclear plant), there may be an objectively optimal or correct response (e.g. a robust strategy for fault diagnosis), even if this is only apparent in hindsight, free of tunnel vision. But in other contexts such as public policy or business strategy, there will almost always be contention over the right answer.

Sensemaking wrestles with conflicting interpretations, tracks technical facts with emerging issues and ideas as the problem is reframed, and tries to reconcile social and political arguments. This is a formidable context in which to seek to develop CI, but all the more important. Elsewhere [3] we trace the work of design and policy planning theorist Horst Rittel, whose characterisation in the 1970's of "wicked problems" has continued to resonate since: Wicked and incorrigible [problems]...defy efforts to delineate their boundaries and to identify their causes, and thus to expose their problematic nature [15].

Rittel concluded that many problems confronting policy planners and designers were qualitatively different to those that could be solved by formal models or methodologies, classed as the 'first-generation' design methodologies. Instead, an *argumentative* approach to such problems was required:

> First generation methods seem to start once all the truly difficult questions have been dealt with. …[Argumentative design] means that the statements are systematically challenged in order to expose them to the viewpoints of the different sides, and the structure of the process becomes one of alternating steps on the micro-level; that means the generation of solution specifications towards end statements, and subjecting them to discussion of their pros and cons.

This intersects with Engelbart's [9] 1963 definition of CI, to develop organizational capacity to augment human intellect, our "collective capability for coping with complex, urgent problems", and in particular Dynamic Knowledge Repositories, a component of which captures key elements of the collective dialogue. Our approach defines a class of "augmentation system" to assist "argumentative design", and other forms of workplace discourse such as modelling.

Turning very pragmatically to the pressing problems faced in public and private organizations, it is reasonable to assert that the most effective way to get anything accomplished is through people talking, building trust and sufficient common ground that they can frame problems in meaningful ways, and commit to mutually acceptable action.

REQUIREMENTS FOR CCI TOOLS

We have argued that it is important for stakeholders in an organization not only to see who their peers *know*, and what they are *doing* online (through the variety of social web traces that are now commonplace), but critically, staff need a sense of what peers are *thinking,* and on what issues they *agree/disagree*, if we are to support the emergence of what we are calling CCI around Rittel's wicked problems.

We propose an initial set of high-level functional requirements for the ideal CCI platform:

- A CCI platform builds collective *awareness* of contested knowledge;
- A CCI platform builds collective understanding of the *nature* of agreements and disagreements;
- A CCI platform builds collective understanding of ways to *resolve* disagreements.

This paper is not a specification document, but we highlight three more precise requirements that drive our approach:

- *Worldview:* The system should be as "ontologically open" as possible, such that users do not feel in appropriately constrained by the system's information model;
- *Interpretation:* Users must be able to ground dis/agreement in source documents if required, so that future readers not only become aware of peers' interpretations, but can read the target of the support/challenge;
- *Situated:* CCI functionality should be always ready to hand for an online user regardless of their activity.

Clearly, the processes and products of CCI (e.g. problems, questions, ideas, arguments, interpretations) are inherently more complex phenomena to track and reason about than lower level data, such as logging that users have viewed/rated media or interacted with each other. What technologies are available to deliver CCI tools for tracking people's interpretations of documents or situations, and beyond that, whether they are converging or diverging, and more interesting further, why they agree/disagree?

One approach is to deploy text analysis technologies to detect claims, agreement and disagreement in corpora. These are still in the research labs, but demonstrating potential. An introduction to some of the most promising work from computational linguistics and semantic web approaches in the realm of scholarly/scientific literature is in [8].

Our approach is complementary, adopting a human-annotation paradigm rather than machine-annotation. Eventually, we may well entrust the detection of certain classes of knowledge claim and citation (particularly where they involve robust named entities from the domain of inquiry) to automated annotation. From a sensemaking/CCI perspective, however, there will always remain a significant, and in our view critical, dimension of human interpretation. People will read new meanings into documents that are not expressed in the text, and make new connections that derive from their unique identities, both personal and collective. When we consider the social and political dimensions that can spark potential inconsistency or tension between complex viewpoints, we are on the edges of machine intelligence. We conclude that the "hand curation" of interpretive layers will remain central.

COHERE: A PROTOTYPE CCI TOOL

Cohere's conceptual model

From a research perspective, the *Cohere* application (http://cohere.open.ac.uk) derives from work in issue mapping and design rationale [4, 7], computational modeling of argumentation [2] and computational modeling of scholarly discourse in literatures [8, 21]. One strand of our work has been to evolve the original gIBIS *software* for hypertextually modeling Rittel's Issue-Based Information System (IBIS) model for argumentative design [5]. The second strand has been studying the *work practices* that make such tools effective CI tools in real world meetings, both physical and virtual [6, 18]. The tool's use in meetings requires the presence of a skilled facilitator. The challenge now is to evolve a tool with new work practices that will help asynchronous annotation and reflective discourse grow in scale without collapsing.

Viewed through the lens of contemporary web tools, Cohere sits at the intersection of web annotation (e.g. Diigo; Sidewiki), social bookmarking (e.g. Delicious), and mindmapping (e.g. MindMeister; Bubbl), using data feeds and an API to expose content to other services.

One of the most compelling aspects of social media platforms' user experience is the opportunistic discovery of interesting resources and people, through the connections that the platform makes around the focal artifacts, be they photos, movies, people, slides, documents, etc. In the context of organizational CCI, we would expect these to continue to be focal artifacts, but we need in addition to introduce some symbolic, conceptual artifacts tuned to the needs of a community of enquiry. Our prior work motivates the following set of constructs, whose relationships are summarized in the conceptual model of Figure 1:

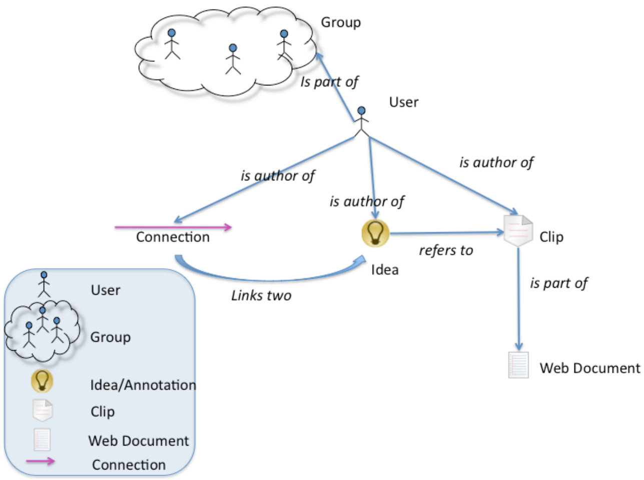

Figure 1: The Cohere conceptual model

The conceptual model supports the following key relationships. *Users* add to the Cohere system, in *private, group or public* spaces. They may annotate *textual web resources* with *clips* (highlighted text fragments of interest), which are optionally connected to one or more *ideas* (displayed as margin notes explaining the significance of clips). *Ideas may be optionally classified* by inventing or reusing a type (e.g. as a *Problem, Opinion, Data, Theory, Prediction*). Users may also *connect* ideas by inventing or reusing free-text expressions that capture the nature of the relationship, but these are also *classified* as broadly *positive/neutral/negative*, making them machine processable without language technology. The connections can be visualized as *semantic maps* (trees or networks), which can be *filtered* by connection-type, keywords, users and groups.

What this model can scaffold, therefore, is the collaborative construction of Clip/Idea annotations, and inter-connections, by users within and between different groups, as shown in Figure 2.

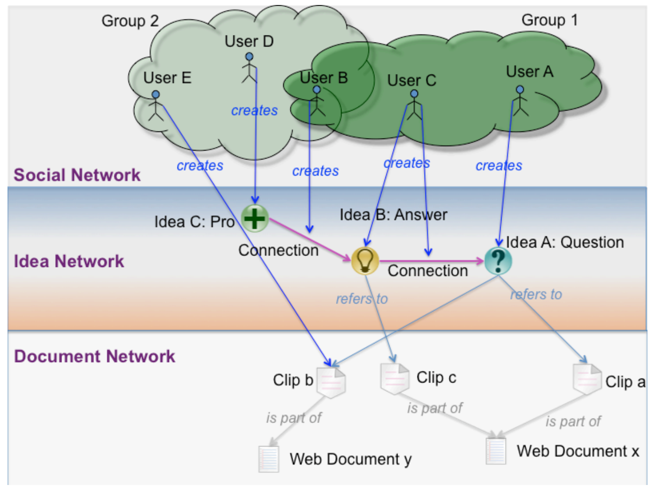

Figure 2: Example scenario of collaborative construction of a network of ideas/annotations anchored to clips within web documents

Connecting people and ideas

As standard social sites Cohere has the concept of people, people page, and groups. In particular, users can create their own ideas and gather them in a personal web page (Figure 3). These ideas can come from both thoughts that people has in their mind and would like to organize, communicate or share online, or they can be personal interpretation (annotations) of peace of online information (any web page, online resource), in the following we will refer to both these users contributions as "ideas". The Cohere user's personal page works as a personal online notebook of ideas and annotated contents, similar to the SparTag.us's reading notebook [13], or Diigo.com's personal page.

The reader notebook in SparTag.us shows the list of annotations done by a user. In addition to that Cohere also shows: i. the list of annotated websites together with the annotated clips; ii. the list of semantic connections created by the users between his ideas or other people ideas; iii. and the list of groups and people with which the user shared his contents. Moreover, from their personal page users can organize, search, edit, connect, and bookmark their ideas and web annotations, share them with other people and groups, or make them public for everybody to access and connect to them (see blue tabs in Figure 3 labeled 'Website', 'Connections', 'People & Groups'). Moreover, as showed in Figure 3, a drop down menu enables bookmarking, connecting, editing, deleting and sharing (embed code and URL) functions for every idea/annotation directly from the user notebook. Every idea/annotation is also associated to the specific website and clip to which it refers.

Figure 3: Example of user personal page listing annotations and ideas created by the user

Connecting ideas and web pages

Cohere provides standard functions of collaborative web annotation. It allows users to highlight (mark-up) and comment (annotate) a finer grained piece of information within a web page, that can be a chunk o text, a paragraph or a section, enriching it with personal ideas. In addition to standard web annotation Cohere provides two main functionalities: i. classification of annotations; ii. and semantic connections between annotations. In the following subsections we analyze these functionalities, motivating how they improve on standard annotation technologies.

Classification of annotations

In Cohere annotations of websites can be further defined associating an icon to them that explains the role that that annotation would play in a online discussion: is it a question, is it an answer, is it a piece of evidence? Is it a method? Figure 4 shows an example annotation of a Web Page done with the Cohere Mozilla extension (for the Firefox and Flock browsers). In the sidebar, annotations are characterized by different types: question, answer and reference. Those types can be enriched and customized by the users.

Figure 4: Annotation of a Web Page with the Cohere Firefox extension.

By providing this functionality Cohere allow users to express comments and ideas in a more meaningful way, by showing user understanding and interpretation of that piece of information, together with the rhetorical move that the user want to make, or the conceptual role that that idea would play in an online discussion: i.e. this *idea*, this *resource*, this *argument* helps to answer a certain *question*; or it contradicts a certain *opinion*, or supports a certain *claim*. Other users can pick on those moves and start structured online discussion.

Semantic connections between annotations

Common web annotation tools such as Diigo, Google Sidewiki, SharedCopy, ShiftSpace etc shows users annotations usually in a sidebar and simply listed in reverse chronological order. This makes particularly difficult to understand if different users have referred to each other annotations; even more complex is discovering threads of comments, and the only way to do so is by reading the entire list of annotations. This is a prominent issue also in most common forum and online discussion systems. To go beyond this issue we designed and developed Cohere so that, when making a comment or annotation, users can point directly to the specific comments or annotations they aim to reply to or connect to.

Connecting ideas

One of the main Cohere functionalities is making connections. Cohere allows to connect with and between other people ideas (and/or annotations) by creating meaningful connections between their ideas and your ideas, between their understandings and yours understanding. Each semantic connection is represented as a triple node-link-node. Each element of the triple can have a different author. This means that a user can also be the owner of a semantic connection between ideas/annotations created by two other users.

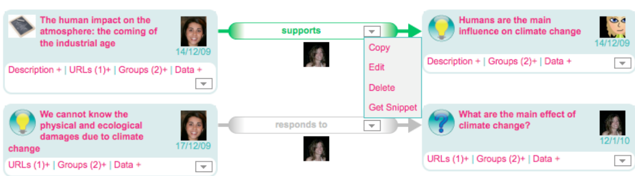

Figure 5: User-defined, or reused, connections between ideas.

The Firefox extension connections tab (Figure 6) provides a compact view of the connections between annotations on a given website, thus spotting: i. if there are threaded comments on the same website; ii. and what is the semantic of the thread (i.e. this comment is *in reply*, *in favor*, *against*, or *is equivalent to* this other comment).

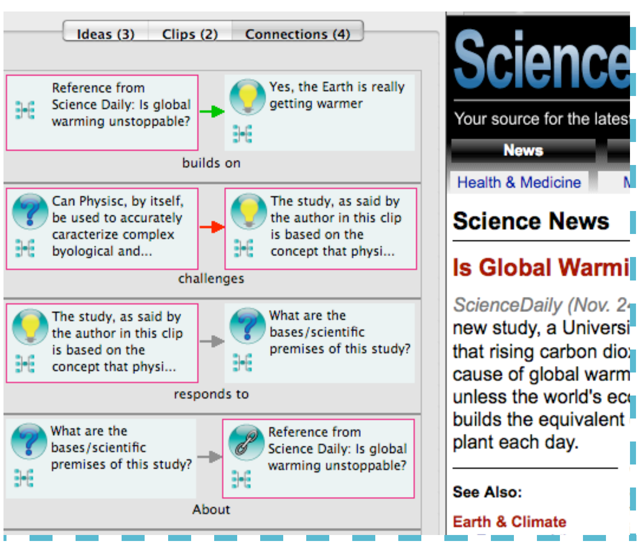

Figure 6: Connections tab in the browser sidebar shows semantic connections between Ideas annotated on that URL, including to/from Ideas on other websites.

Moreover, users can link their annotations across-context, that is to say, they can connect annotations of different web sites. This functionality further sophisticates the collaborative annotation function that Cohere offers, by enabling not only in-context discussion but also cross-context discussion, informed by several web sources. As shown in Figure 6, Cohere has been designed so that if annotations are in the same webpage they have a pink border otherwise they point to other websites and the user can visit them by clicking on the network icon (in Figure 6).

A different visualization provides a user-controllable network view using a spring graph layout algorithm (Figure 7).

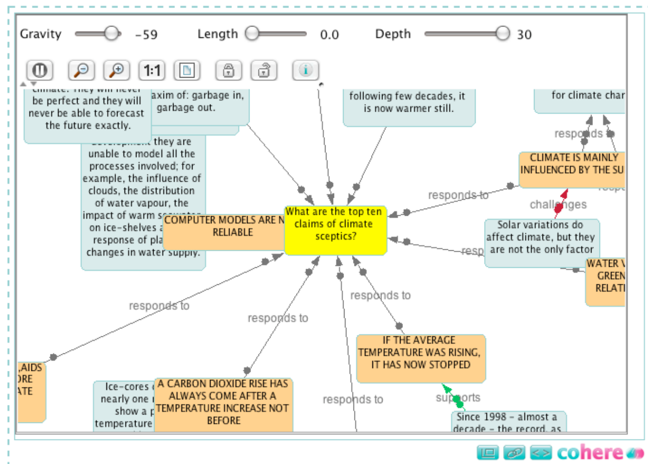

Figure 7: Cohere argument map using the ConnectionNet visualization.

Related work on Question-Answering and IBIS

Nowadays question-answer is an increasingly common format used to exchange knowledge online. Many web sites and tools use question-answer format to gather users feedback, or to understand users needs, e.g. Get Satisfaction, WikiAnswer, ThinkLink, etc. The popularity of those tools resides in the fact that questions are much easier to understand than general descriptions of needs and they leave less ambiguous interpretations of what is the issue the author of the question meant to tackle. A Question-answer format seems to be quite intuitive for users, more natural, and less disruptive of common ways of communicating and dialoguing online. Question-answer is also becoming an increasingly popular formats in users' interaction with web search engines such us i.e. Ask Jeeves, Answers.com, Yahoo answers etc. In fact, by asking users to make a question it is easier to make an estimate of what the users is really looking for, therefore increasing the probability of successful information retrieving. Moreover if we look at online dialogue technology, a question-answer communication format can be interpreted as a less sophisticated version of IBIS in which the pros and cons of every alternative answer to a question are not necessarily explored. This simplification aims at reducing the cognitive overload for non-expert hopefully lowering barrier to users' adoption of hypermedia discourse and sensemaking technologies. At the same time Cohere still supports IBIS modeled discussion to be used for structured argument mapping with a more restricted expert community.

It is fair to say that IBIS is emerging as a 'lingua franca' for introducing relatively simple semantic structure to online deliberation. In addition to Cohere, *Collaboratorium* [12] and *Debategraph* (http://debategraph.org) are other prominent examples of the maturation of IBIS-based tools, 20 years on from gIBIS.

CONCLUSION AND FUTURE WORK

We have made the case that *Contested Collective Intelligence (CCI)* should be considered as a significant and distinctive dimension of the broader Collective Intelligence design space for organizations. Research in sensemaking, and the modeling of dialogue and debate, motivates a conceptual model which begins to address the requirements for an ideal CCI platform. We have described a social, semantic annotation tool called *Cohere*, which serves as our working prototype of the CCI concept, now being deployed in several communities of inquiry, including Climate Change analysis and the Open Educational Resource (OER) movement. In contrast to most semantic web applications, the ontology of node and link classes is user-extensible, addressing the *worldview* requirement. The option to access Cohere through a Mozilla web browser extension addresses the *interpretation* requirement that readers should be able to access the target of an annotation, by placing them in a sidebar 'margin' of the page. Embedding Cohere as a web browser toolbar+sidebar also makes it *ready to hand* during any online activity.

Cohere does not currently satisfy the third proposed requirement of an ideal CCI platform, namely, to help *resolve* dilemmas. One approach would be integration with, for instance, group decision-support systems and simulations, depending on the problem domain and willingness of users to engage with such tools. Research on Collaboratorium [12] has been exploring climate change simulations.

Several strands of ongoing work seek to advance the research programme. We are analysing the processes and products of a recent CI experiment in which multiple analysts used Cohere in parallel to annotate climate change OERs. We are working with the developers of the leading IBIS-based online deliberation tools to facilitate interoperability, assisting the sharing of datasets across platforms. A structural search engine will enable more complex queries, and the recognition of patterns that might enable the platform to be more proactive in alerting users to similar situations, and hence, to potential resolutions. As networks grow in size, a recommendation engine will be needed, combined with better visualization interfaces.

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