Hyperchat and Hypervideo: Enabling Real-time Groupwise Conversations at Unlimited Scale

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***Abstract*— This paper explores a novel Generative AI based communication technology called Conversational Swarm Intelligence (CSI) or simply Hyperchat AI. It was developed to enable thoughtful real-time conversations among networked human groups of potentially unlimited size. It empowers large, distributed teams with hundreds of members to quickly discuss complex issues, brainstorm ideas, share information, debate alternatives and converge on optimized solutions that leverage their combined knowledge, expertise, and insight. Not only does hyperchat enable thoughtful discussions at unprecedented scale, it also amplifies the Collective Intelligence (CI) of large teams, quickly surfacing solutions that significantly outperform traditional CI methods in depth, accuracy, and insight. In addition, hyperchat supports large-scale deliberations among hybrid groups of human participants and AI Agents in real-time, fostering collaborative problem solving by leveraging the informational power of AI while ensuring that human values, morals, sensibilities, and interests remain inherently in the loop.**

Keywords*— *Generative AI, LLMs, Deliberation, Collaboration, AI, Hyperchat, Hypervideo, Swarm AI, Conversational Swarm Intelligence, Collective Intelligence, Collective Superintelligence

I. Background

A typical product team in a Fortune 1000 company has hundreds of members working together towards a common goal. Equally large teams exist in defense organizations, government agencies, big science, and civic groups. And yet, no technology exists to enable large teams to hold thoughtful real-time conversations in which members can efficiently share their knowledge, debate risks, discuss opportunities, brainstorm ideas, forecast outcomes, and converge on solutions that optimize their collective intelligence. Empowering large teams to hold productive real-time conversations could enable organizations to solve complex problems with intelligence, creativity, and efficiency that has never been possible before. In addition, AI agents are becoming part of the workforce. Enabling large *hybrid groups* of humans and AI agents to engage in collaborative discussions has the potential to amplify intelligence to levels that exceed every individual member, both human and AI (i.e., *Collective Superintelligence*).

Unfortunately, real-time conversational deliberations do not scale. Research suggests the maximum size for a productive real-time conversation is only about 8 members [1, 2]. At this size, each member has a good amount of *airtime* to share their knowledge, opinions, insights, and ideas, and each member has a low amount of *wait-time* to respond to others. But as group size grows, airtime falls, wait-time rises, and the dynamics of the conversation rapidly degrade into a series of monologues. In groups with over a dozen people, it quickly ceases to be an interactive discussion at all at becomes a presentation [3, 4].

A. Can Mother Nature Help us Solve This?

It is well known that the Collective Intelligence of large groups can significantly exceed individual participants or small teams [5-9]. And yet, no method existed for enabling large human teams to hold real-time conversational deliberations at scale. This changed in 2023 when researchers published the first studies showing that thoughtful real-time conversations among large, networked groups could be achieved through the novel use of Generative AI and conversational agents [10-14]. The method is called Conversational Swarm Intelligence (CSI) [10] or simply *Hyperchat AI*™ [36] and it leverages techniques inspired by efficient deliberative systems in nature including swarms of bees, flocks of birds, and schools of fish [15-21, 32]

For example, schooling fish with thousands of members can quickly harness information across the population and converge on rapid decisions to life-or-death problems. They achieve this using a novel ability to "deliberate" in small groups of nearby neighbors. Because each local group of neighbors overlaps with other local groups of neighbors, information quickly propagates through the school and rapid decisions are reached [32]. This natural process is called Swarm Intelligence, and it has evolved independently in a wide range of organisms including fish schools, bee swarms, and bird flocks. Similar "swarming" techniques have been used among networked human groups for optimized decision-making since 2014 but these previous "Artificial Swarm Intelligence" methods were limited to simple problems such as numerical estimations and multiple-choice questions [18, 21-29]. It has been a longstanding unsolved goal of researchers to combine the efficiency of swarm intelligence with the flexibility of natural conversational deliberation among human groups at large scale [10].

II. Enabling Conversation at Unlimited Scale

Inspired by the highly efficient decision-making dynamics of biological swarms, Conversational Swarm Intelligence, also known as *hyperchat*, works by partitioning large, networked groups into overlapping subgroups, each of about 4 to 7 members—an optimal size for real-time deliberation in human groups [1-4]. To enable these subgroups to engage in a unified real-time conversational deliberation, the dynamics of fish schools suggest that subgroups should overlap so information can propagate across the population. Unlike fish, however,

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humans are unable to simultaneously participate in multiple real-time conversations. This barrier is commonly called the "cocktail party problem" because small conversational groups often emerge in close proximity at cocktail parties. If you find yourself participating in a group conversation at a party and get distracted by a neighboring group's conversation, you will likely struggle to follow either discussion [33].

To overcome this human limitation, hyperchat uses Large Language Models (LLMs) in a unique manner by integrating a novel AI agent called a "Conversational Surrogate" [10–14]. Once the large group is segmented into small subgroups, a Surrogate Agent is embedded within each unique subgroup. These agents, and their supporting infrastructure, are designed to: (a) monitor the local discourse within their assigned subgroup, (b) extract and summarize important insights in real time, (c) relay those insights to other subgroups, and (d) articulate the incoming insights from other subgroups within their local discussion in as natural coherent dialog. This connects all of the subgroups together in real-time, enabling the larger population to engage in collaborative discussions in which they broadly share ideas and insights, assess alternatives and rationales, and efficiently reach collective decisions.

Figure 1 below shows a hyperchat architecture in which a networked 100-person team is partitioned into 14 small subgroups, each with about seven human members and one AI-powered Surrogate Agent. This enables the 100-person group to engage in a single real-time conversational deliberation in which information, ideas, insights, assessments, alternatives, and reasoning quickly propagate throughout, enabling the distributed group to efficiently consider perspectives and converge on solutions that leverage their collective knowledge, expertise, insight, and situational awareness.

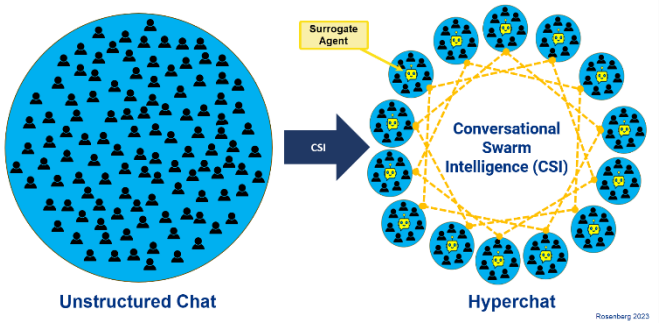

Fig. 1. Hyperchat enables productive real-time conversations at scale.

As shown above, an independent Surrogate Agent is added to each of the subgroups in the hyperchat structure. Each agent is designed to participate conversationally in its subgroup as an equal member of that group. Care is taken to ensure that the Surrogate Agent does not assume any implied role of authority so that human members will assess the agent's contributions the same way they would assess the contributions of human members [43].

Importantly, these Surrogate Agents do not bring new information into the global conversation and do not introduce any AI-generated opinions or perspectives. Instead, these agents only pass information among the set of local groups by conversationally representing the knowledge, views, perspectives, and/or insights of one or more humans. In addition, the Surrogate Agents are designed to modulate the wording and emphasis of their language to convey the strength of sentiments within those other subgroups. Thus, the surrogate agents are a proxy for one or more other humans, reflecting their insights – not adding new insights [10, 41].

Also, unlike biological swarms, for which content only passes between neighboring groups based on their spatial proximity, hyperchat is a *hyper-connected* structure in which information can freely pass from any subgroup to any other subgroup. This takes nature's basic concept of a "swarm" and turns it into a "hyperswarm" that is significantly more efficient at propagating information [35, 36].

Figure 2 below shows an example of a hyper-connected conversation as it is displayed to participants in a commercial hyperchat platform called Thinkscape®. The example shown is a snapshot taken during a real-time deliberation among 101 participants divided into 18 subgroups (called ThinkTanks) connected by AI agents.

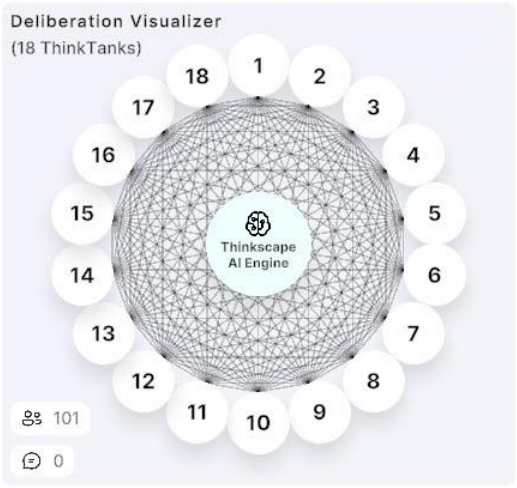

Fig. 2. Snapshot of "Deliberation Visualizer" in Thinkscape®

A. Hyperchat Reduces Conversational Biasing

In a traditional conversation among human groups, a single member with a strong personality can significantly sway the outcome. Sometimes referred to as "loudmouth bias," this can result in distorted outcomes. Similarly, a single individual with a role of authority (i.e. a manager) can significantly sway the outcome as others defer to his or her view. In addition, the individuals who speak first in a conversation can have an outsized influence on the direction of the deliberation. These problems are amplified with group size, as a small number of voices can impact large groups of participants.

Hyperchat greatly reduces the problems of loudmouth bias and authority bias because it divides the full population into a parallel set of overlapping subgroups. This means that a single strong personality or authority figure can only impact their own local subgroup (i.e., a small percent of the full population). In

order for an idea or perspective expressed by a "loudmouth" or authority figure to propagate across the full deliberation, it must gain support based its own deliberative merits when expressed within other subgroups by a Surrogate Agent [34].

Hyperchat also mitigates the problem of first-talker bias because it fosters a large number of "first ideas" to emerge in parallel. Figure 2 above shows a hyperchat structure with 18 parallel subgroups. As a consequence, this deliberation will have 18 different "first ideas" that get expressed in real-time, each of which must not only earn support within its local subgroup but must also compete with the early ideas that have emerged from other subgroups in order to propagate widely.

B. Optimizing Deliberations

A critical piece of the hyperchat technology stack is the Conversational Matching Engine (CME) that oversees passing ideas, opinions, rationales, arguments, and counter-arguments across subgroups. The matching system has been architected to optimize the sharing of conversational content by "challenging" each subgroup with points and perspectives that have not yet been raised or discussed adequately by the members of that subgroup. Enabling this real-time process requires the rapid analysis and tracking of all local conversations as they unfold, continually identifying each unique idea raised along with every argument made in favor (or counter-argument made in opposition) of that idea. In addition, it requires real-time databasing of deliberation content in a richly structured conversational taxonomy that can be rapidly interrogated to assess the current deliberative state in each subgroup.

Using this rich data structure, the CME identifies the specific ideas, perspectives, or arguments that are most likely to uniquely challenge each individual subgroup and thereby evoke thoughtful responses from its participants, revealing their confidence, conviction, or sentiment with respect to various points that are propagating around the conversational network. These customized messages are crafted and expressed into each subgroup by its Surrogate Agent at an opportune moment. Care is taken to emulate groupwise etiquette so as to not disrupt the deliberative flow when introducing new ideas, perspectives, or reasoning into a subgroup.

Most often, the ideas and rationales chosen and shared by Surrogate Agents aim to maximally challenge the subgroup's prevailing beliefs and thereby evoke responses that elicit rich information about each participant's confidence or conviction with respect to points currently being discussed. The hyperchat methodology prioritizes passing content that *challenges* participants because – if everyone simply agrees or tacitly accepts the "conventional wisdom" without being sufficiently challenged, the deliberating participants reveal very little about their true levels of confidence or conviction in the ideas, arguments, or perspectives being discussed.

C. Hybrid Hyperchat among Humans and AI Agents

Many experts predict that specialized AI agents will play an increasingly important role in the global workforce [38-40]. To prepare for this, the core hyperchat architecture has been adapted to enable AI agents to do more than just pass content between subgroups – but to also contribute unique information. While it is technically possible to have a single AI agent perform the Surrogate Agent functions and participate as a unique contributor, these two functions have been separated into two different conversational agents. That way, the human participants have a clear sense of which information shared by AI agents was sourced from people in other subgroups and which was uniquely added to the dialog by AI.

To achieve this, a second type of conversational AI agent has been integrated into the hyperchat architecture called a "*Contributor Agent."* It is tasked with monitoring each local discussion to determine if additional factual content should be expressed that is likely to support the ongoing discussion (i.e., it has not yet been surfaced within that subgroup or in a parallel subgroup). This content can be *supportive* by providing relevant factual information that strengthens a particular perspective, or *opposing*, by raising information that challenges a perspective.

As depicted in Figure 3, a *Hybrid Hyperchat* architecture is shown among 100 human members divided into 14 connected subgroups. Each subgroup contains approximately seven human members and is supported by one Surrogate Agent and one Contributor Agent. It is important to highlight the benefit of having a unique and independent Contributor Agent in each subgroup, as it means that unique content is contributed into each of many parallel conversations. This promotes informational diversity, ensuring the full population considers many competing facts in parallel.

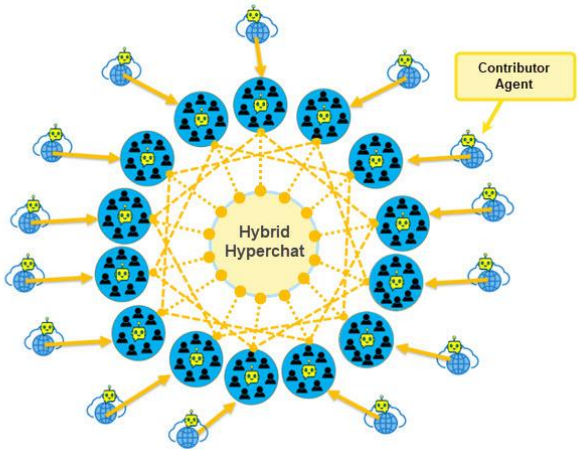

Fig. 3. A Hybrid Hyperchat structure with Contributor Agents

While the figure above shows a single Contributor Agent associated with each subgroup, the hyperchat architecture can employ multiple Contributor Agents within each subgroup to represent different perspectives, expertise, or insight [34, 41].

D. Enabling Unlimited Scaling

The fully-connected hyperchat architecture above, which is governed by a Conversational Matching Engine that helps to optimize the passing of content among subgroups, has been validated among hundreds of simultaneous users in real-time. To scale larger, for example to thousands or tens of thousands

of participants, a hierarchical hyperchat structure has been developed. As shown in Figure 4 below, it organizes the real-time population into subgroups of subgroups (and so on) and maintains an intelligent CME process at each level.

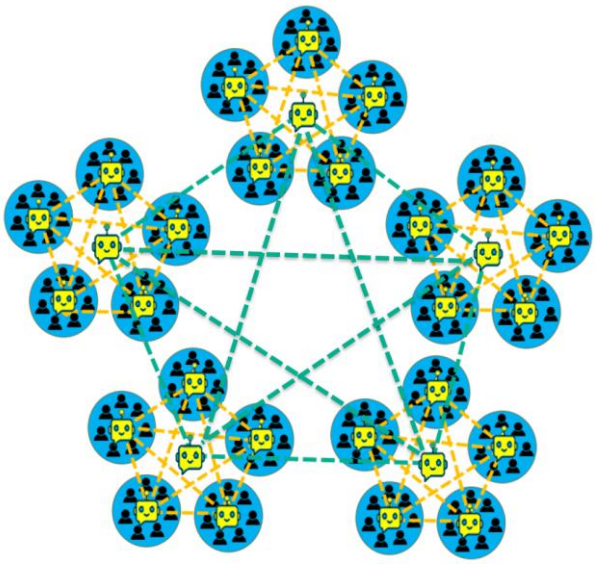

Fig 4. Hierarchical Hyperchat with Subgroups of Subgroups [37].

E. Enabling Asynchronous Hyperchat

One logistical challenge for large-scale conversational deliberations is the need to schedule a time when hundreds of members of a team are available. This can be difficult, especially for organizations that span many time zones. To address this, the hyperchat architectures supports semi-synchronous and asynchronous deliberations at large scale. This is achieved by allowing *later participants* to engage with real-time Surrogate Agents that represent the ideas, insights, or perspectives of *prior participants* [34, 41]. For example, very large groups can be divided into sequential subgroups in which surrogate agents share information across batches of deliberations as shown in Figure 5. These sequential groupings can vary in size, from large sets of groups to single subgroups to individual participants.

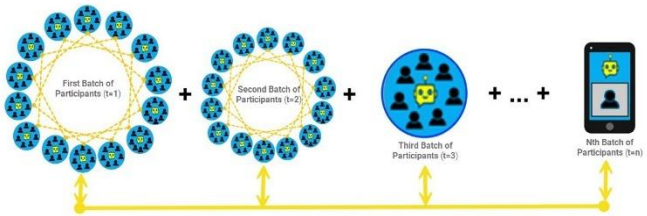

Fig. 5. Hyperchat structure for asynchronous deliberations [50].

F. Enabling Hypervideo at Large Scale

The hyperchat architecture is designed to support all major modes of real-time conversation from text chat and voice chat to video conferencing. Because there are unique requirements to enable video deliberations via real-time Surrogate Agents, this variant is sometimes referred to as *Hypervideo* [31]. It works by dividing large, networked groups into a set of parallel video-conferencing subgroups, each of which is provided with a Surrogate Agent that appears as a conversational participant (i.e., an animated avatar) as shown in Figure 6 and 7 below.

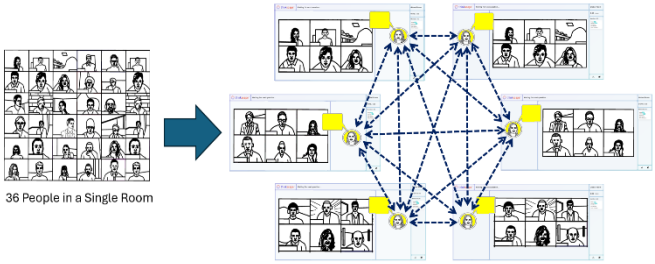

Fig. 6. Hypervideo conversation split into connected subgroups

As depicted above, an independent animated avatar is provided within each video-conferencing room and performs the functions of a Surrogate Agent by receiving insights from other subgroups and expressing those insights as natural dialog within its own subgroup. This connects the local deliberations into a single conversation in which very large groups can discuss complex problems, debate options, brainstorm ideas, prioritize alternatives, assess risks, and converge efficiently on a set of groupwise solutions.

Fig. 7. Each Hypervideo subgroup can be configured to display a photorealistic surrogate agent that participates (shown tinted green).

Although not shown above, one or more Contributor Agents can also be added to each subgroup as a unique animated avatar. In this way, very large groups of human participants and AI agents can deliberate at scale through real-time videoconferences comprised of a series of interconnected conversational subgroups, each with human and AI participants.

III. Validation Studies of Hyperchat

Several studies have been performed to assess the ability of hyperchat to enable large-scale conversations and amplify group intelligence. These studies used an online hyperchat platform

from Unanimous AI called Thinkscape®. It currently supports real-time text and voice-to-text conversations among groups of up to 400 participants in real-time.

A. Hyperchat Brainstorming Study:

In a study from researchers at Carnegie Mellon University and Unanimous AI, groups of 75 participants were tested using a common brainstorming intervention known as an Alternative Use Task (AUT). Participants were asked to brainstorm unconventional uses of common objects. Groups were tested in two ways: (i) by real-time conversation in a single large chat room similar to a Microsoft Teams or Google Chat environment and (ii) by real-time conversation using Thinkscape. As shown in Figure 7 below, a significant majority of participants reported that brainstorming using the hyperchat structure was more productive, more collaborative, and surfaced better solutions. In addition, a significant majority reported feeling more heard and feeling more ownership using CSI ($p<0.001$) [42].

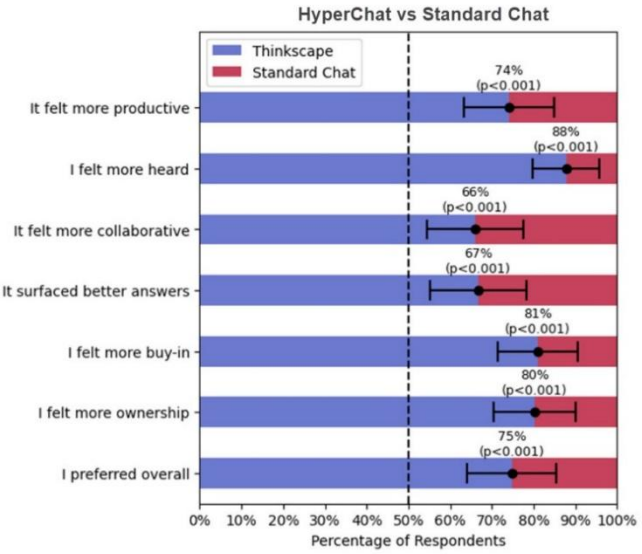

Fig. 7 Participant Feedback in large-scale brainstorming study

B. Hyperchat Estimation Study:

To replicate a common "Collective Intelligence" experiment in which large groups are asked to estimate the number of gumballs in a jar, researchers assembled groups of 240 randomly selected participants and asked them to estimate the gumballs in glass jar (provided as a digital photo). Three scenarios were compared: (i) as individuals filling out a survey, (ii) aggregating estimates across a pool of surveys, and (iii) as a conversational group using Thinkscape. In the hyperchat trials, the group of 240 participants was partitioned into 47 subgroups of 5 or 6 members and a single Surrogate Agent. The results showed the hyperchat groups had an average estimation error of 12% which was significantly more accurate than the average individual (55% error) and significantly more accurate than large-scale aggregation across survey responses (25% error) [10].

C. Hyperchat IQ Study:

Researchers at Carnegie Mellon and Unanimous AI tested networked groups of 35 members on a standardized IQ test (Raven's Matrix). Results showed that groups using the Thinkscape hyperchat platform could hold thoughtful real-time deliberations about IQ questions and could quickly converge answers. As shown in Figure 8, groups collaborating using the hyperchat platform scored an average IQ in the 97th percentile (IQ=128), significantly outperforming the median individual in each group (IQ=100) and significantly outperforming the most popular choice on each IQ question collected via a traditional survey from the groups of 35 (IQ=115) [11].

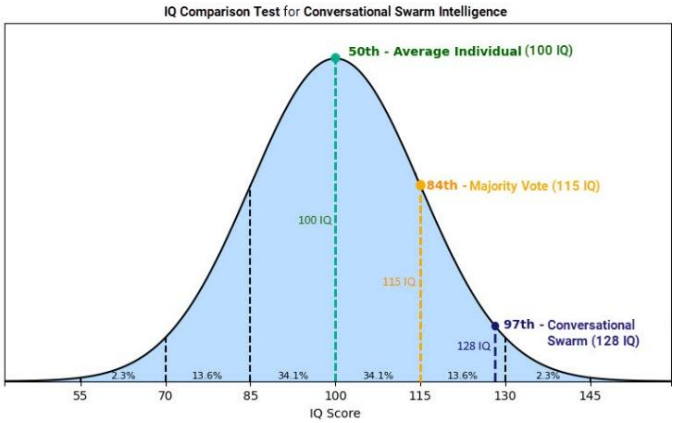

Fig 8. Research compares IQ Test scores of individuals and aggregated groups vs groups connected in hyperchat deliberations

D. Hybrid Hyperchat Study:

In another study conducted by researchers at Unanimous AI and Carnegie Mellon University, groups of 25 sports enthusiasts were asked to collaboratively field a Fantasy Baseball team for competition in a public daily fantasy contest [14]. While fantasy baseball may seem trivial, it serves as an effective model for organizational decision-making because it requires subject matter expertise, tactical forecasting skills, and the ability to make strategic tradeoffs when allocating a limited budget across multiple players. The test was run weekly for 10 consecutive weeks and scored using standard Fantasy Baseball rules.

Using the Thinkscape platform, the 25 person groups were split into five parallel subgroups, each containing five human members, one Surrogate Agent, and one Contributor Agent (called an *infobot* in the study). The infobot agents were designed to provide factual information about Major League Baseball, including statistics about various players and teams. [14]. Scoring showed the hyperchat groups amplified their performance to the 73rd percentile (among members who averaged in the 50th percentile). In addition, 87% of participants supported the statement*: "Our decisions were stronger because of information provided by the Infobot."*

IV. Conclusions and Recommendations

By leveraging the agentic power of Generative AI in a novel manner, the technology of Conversational Swarm Intelligence (i.e., *Hyperchat AI*) offers an innovative approach for large-scale communication and collaboration. This has been shown in early research studies facilitate thoughtful deliberation at scale and to significantly amplify collective intelligence. This could provide significant value to large organizations that currently lack an effective scalable method for real-time communication.

Future research should test hyperchat systems across a wide range of real-world applications, from strategic planning and sales forecasting to engineering management, risk assessment, business prioritization, employee feedback, team alignment, market research, change management, civic engagement and deliberative democracy.

In addition, future research should explore *hybrid hyperchat* systems in which large human groups deliberate in real-time collaboration with AI-powered "Contributor Agents." These hybrid systems could provide a pathway for enabling Collective Superintelligence to emerge among large human-AI teams while ensuring that human values, morals, sensibilities and interests remain inherently integrated into every decision [44].

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