FLORIDA ATLANTIC

COT 6930 - Generative Intelligence
and Software Development Lifecycle

Topic 8 - Collective Intelligence

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Agenda

Social Interactions

Collective Intelligence

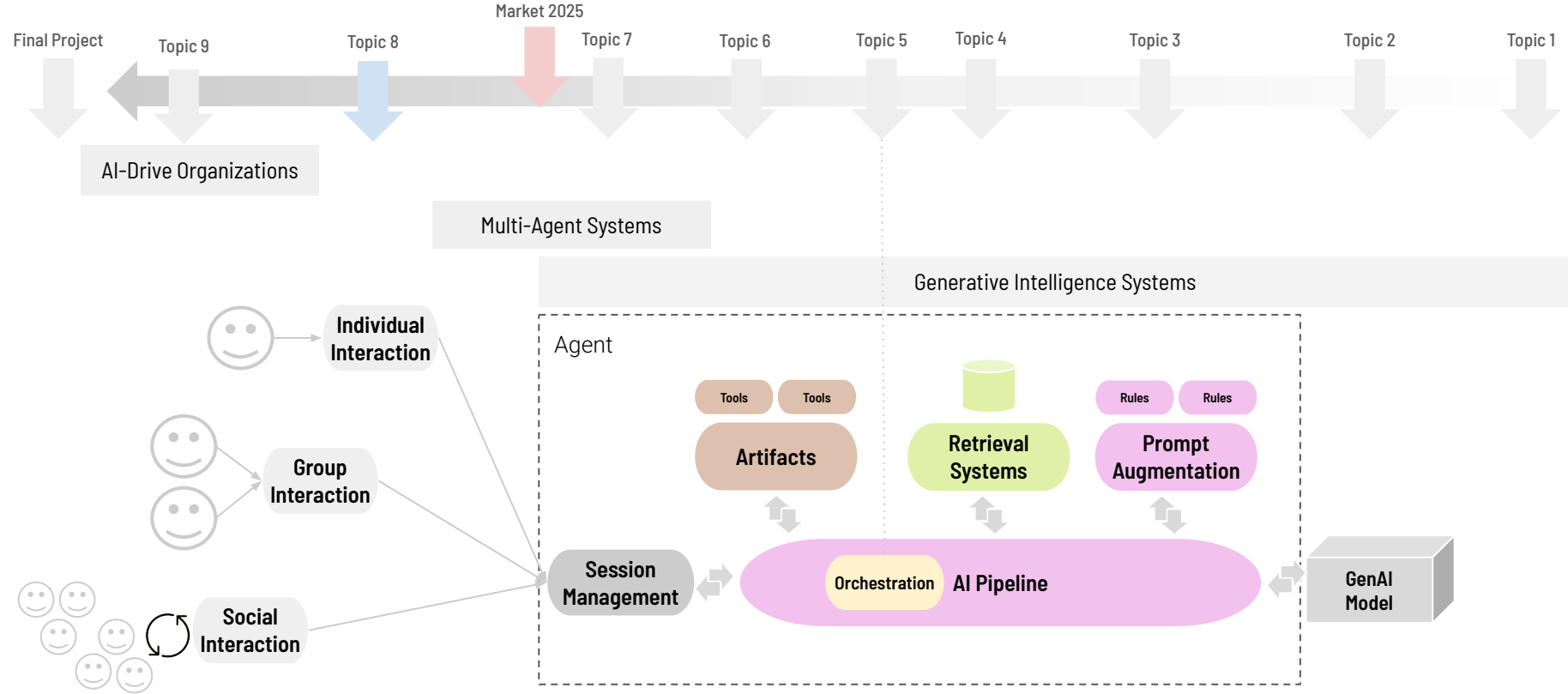
Adjusting Generative Intelligence Systems for Collective Intelligence

Use Cases

Our Key Question

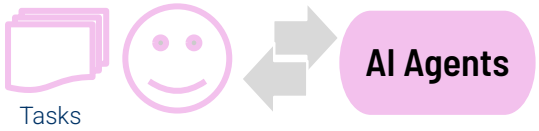
How can multi-human and multi-agent systems collaborate through diverse modes of interaction towards co-creative intelligence?

Course Timeline



Social Interactions

Humans and AI Agents



Human + AI
AI Agent augments human capacity to operate a task

AI + Human
AI Agent implement tasks with Human-In-The-Loop task support

Multi-Agents w/ Human Oversight
Group of AI Agents implement tasks with Human-In-The-Loop task observation

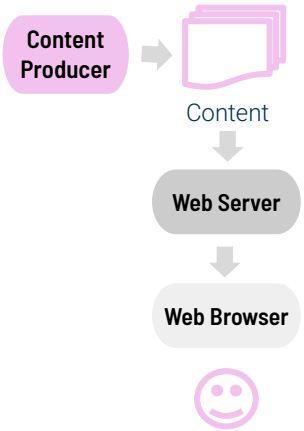
Multi-Humans and Multi-Agents
Group of Humans interact between themselves and with agents, working in (eventually invisible) cooperation.

Information Technology Always Evolves into Social Interactions

e.g. Evolution of Web Content Technology

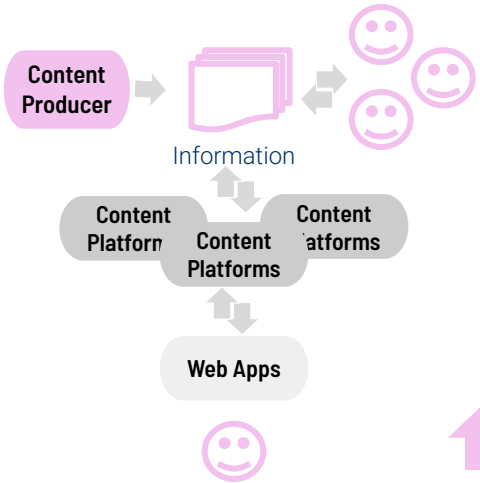
Web 1.0

Technology-centered; read-only content
(1990-2000s)



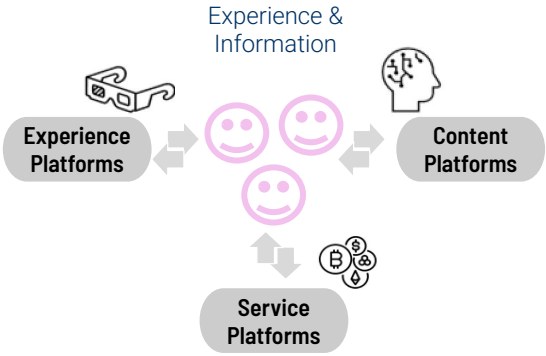
Web 2.0

Information-centered; interactive
(2000-2020s)



Web 3.0

User-centered; decentralized experiences
(2020s-)

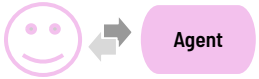


Web 2.5 (?)

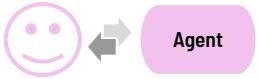
Synthetic Information-centered; interaction between humans-agents

Human-Agent Interactions

1-N Multi-Agents



Initiated by human



initiated by agent

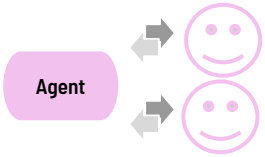
initiated by one agent

1-N Social Intelligence

motivated by another human

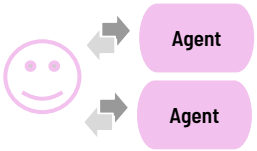
intermediated by agent

motivated by agent



agent motivates N-humans

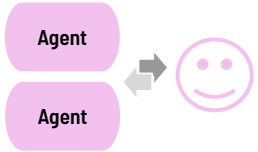
1-N Human / Multi-Agent



initiated by human

motivated by one agent

motivated by another agent



initiated by N-agents

User-User-Agent

The motivation to engage with the AI agent does not originate from the user making the request.

- User 1 “motivates“ User 2 to Request something from an Agent
- User 2 makes the request to the Agent
- Agent deliberation works the same.

Use cases:

- **Customer Support Escalation:** A manager asks a support representative to consult a ChatBot for a resolution.
- **Educational Assistance:** A teacher asks a student to interact with an AI tutor for further clarification on a topic

User-Agent-User

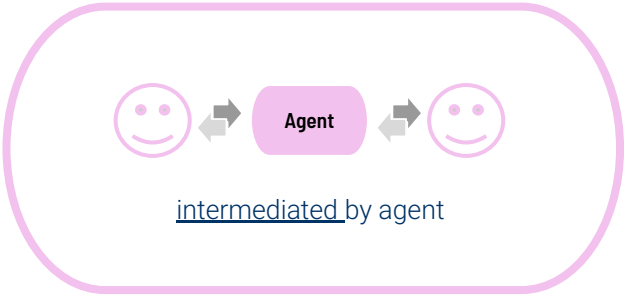
Information-chain Agents

- User 1 initiates a request to the Agent.
- Agent processes the request and generates a response.
- Agent communicates the response to User 2, who receives the information or instruction.

Use cases:

- **Task Delegation in Workflows:** A manager asks an AI system to assign a task to an employee.
- **Educational Feedback Systems**: A teacher submits student assessments to an AI tool, which then provides feedback directly to the student.
- **AI-Powered Translation Services:** One user submits a text, and the AI translates it for another user.

motivated by another human



intermediated by agent

motivated by agent

Agent-User-User

Influencer Agent

- Agent initiates communication with User 1 based on context, analysis, or prediction.
- User 1 is influenced by the agent's suggestion or request and motivates User 2 to take action.
- User 2 acts based on User 1's influence, completing the interaction chain.

Use cases:

- **AI-Driven Recommendations in Social Networks:** An AI suggests content to a user, who then shares or recommends it to others.
- **Educational AI Systems:** An AI suggests additional learning material to a tutor, who then shares it with students.

motivated by another human

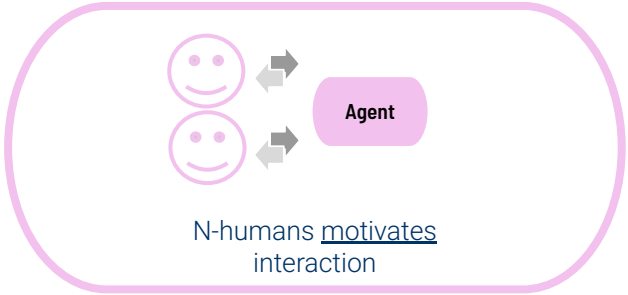
intermediated by agent

motivated by agent

Two-Users, One-Agent

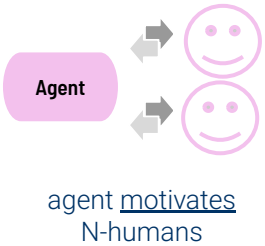
The agent manages, mediates, or synchronizes interactions, ensuring that both users receive relevant information or coordination.

- An agent interacts with multiple users simultaneously or in a closely linked sequence.
- Users engage with the agent independently or collaboratively, influenced by the agent's recommendations, alerts, or tasks



Use cases:

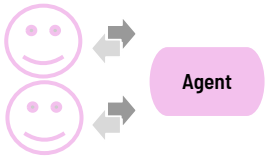
- **Real-Time Collaboration in Workplaces**: An AI assistant provides simultaneous updates to multiple team members working on a project.
- **Educational Tutoring Systems**: AI offers feedback to both students and teachers, helping facilitate learning.



One-Agent, Two-Users

The agent serves as a central orchestrator, ensuring that both users are engaged effectively.

- An agent initiates engagement with multiple users simultaneously.
- Each user may receive different instructions, insights, or tasks, depending on their role or relevance to the situation.



N-humans motivates interaction

Use cases:

- **Workplace Task Distribution:** An AI assistant assigns different but related tasks to two employees to work in parallel.
- **Educational AI Guidance:** An AI tutor suggests different study materials to multiple students based on their learning progress.

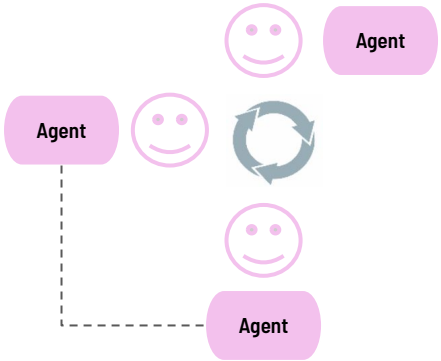
agent motivates N-humans

Collective Intelligence

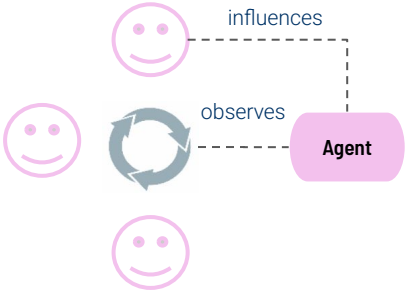
> ***Collective Intelligence*** *is the emergent capability of multi-human and multi-agent systems to collaborate, learn, and co-create knowledge or solutions through shared interactions, feedback, and adaptation.*

- **N–M Collaboration:** Dynamic interactions between multiple humans and multiple AI agents.
- **Mutual Influence:** Agents observe, analyze, and strategically influence human groups — while adapting from human feedback.
- **Shared Understanding:** Emerges through shared beliefs, intentions, and context across participants.
- **Emergent Behavior:** Intelligence arises not from a single entity but from the synergy of distributed actors.

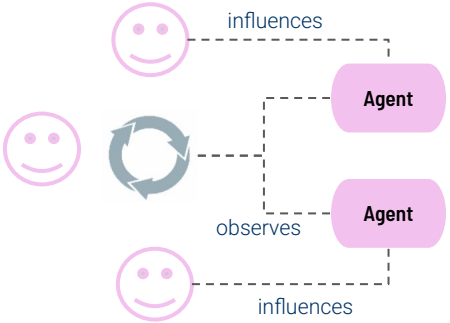
Collective Intelligence



N-M interactions between groups of humans influenced by agents



N-M interactions between groups of humans observed (and eventually influenced) by agents



N-M interactions between groups of humans observed (and eventually influenced) by groups of agents

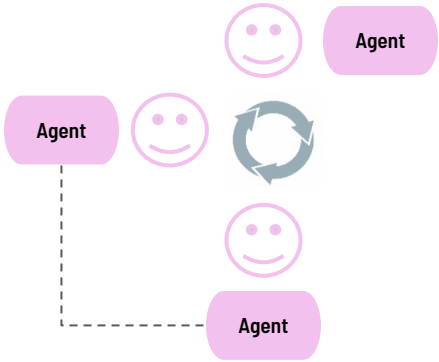
Collective Human-Agent Collaboration

Multiple human groups interact dynamically with multiple AI agents, forming an adaptive system.

- **Agents provide insights,** recommendations, or coordination, influencing human decision-making.
- **Humans engage in discussions,** knowledge exchange, or decision-making cycles, while AI agents refine, optimize, or facilitate processes.
- **A feedback loop exists** where agents influence humans, and human responses adjust agents.

Use cases:

- **Healthcare Collaboration and Diagnosis:** Doctors, nurses, and specialists interact with AI-driven diagnostic and treatment recommendation systems to optimize patient care.



N-M interactions between groups of humans influenced by agents

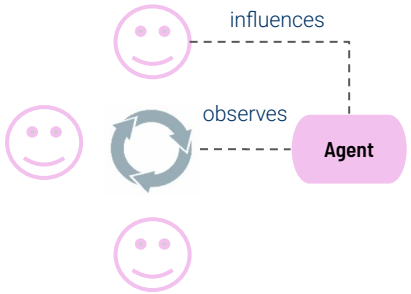
AI-Driven Human Behavior Analysis and Influence

The influence can be direct (suggestions, alerts) or indirect (adaptive changes in the environment based on AI insights).

- **AI agents observe human interactions**, discussions, or activities within a group.
- **The agents analyze patterns**, detect trends, or assess behaviors based on the observed data.
- Once patterns are understood, **agents may introduce strategic influences,** such as recommendations, nudges, or interventions.

Use cases:

- **AI-Assisted Organizational Decision-Making:** AI observes team dynamics, collaboration efficiency, and sentiment to optimize internal communication strategies.



N-M interactions between groups of humans observed (and eventually influenced) by agents

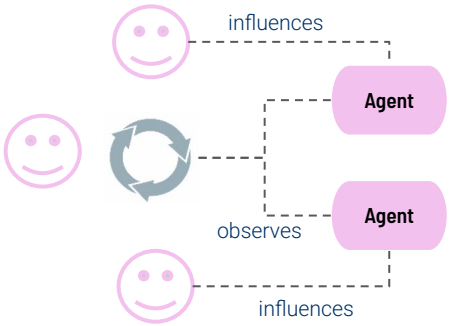
Multi-Agent Human Behavior Analysis and Influence

Multi-Agent Human Behavior Analysis and Adaptive Influence

- **Multiple AI agents observe and analyze human group interactions**, extracting patterns, behaviors, and decision-making trends.
- The **agents communicate, refining and cross-validating** observations to ensure accuracy and minimize biases.
- Once an understanding is formed, **AI agents influence human groups through recommendations,** nudges, or direct interventions.
- **Human behavior adapts** in response to AI suggestions.

Use cases:

- **AI-Governed Smart Cities:** AI agents track human mobility, energy usage, and social behaviors, then coordinate city infrastructure and services to improve urban life.



N-M interactions between groups of humans observed (and eventually influenced) by groups of agents

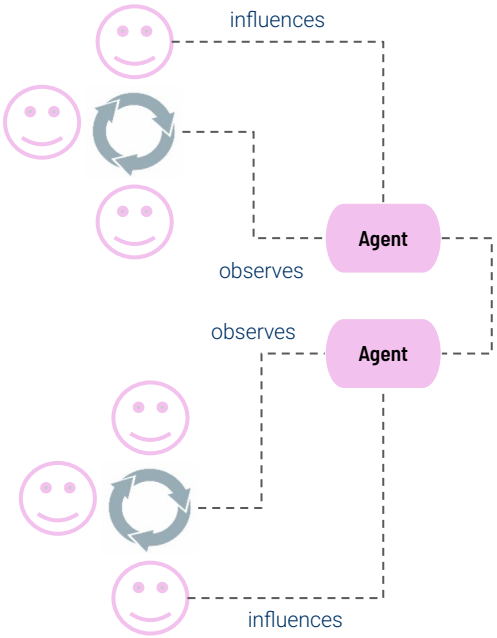
Multi-Agent Influence on Diverse Human Networks

Influences can vary per group based on cultural, demographic, or contextual differences, ensuring tailored AI interventions.

- **Multiple human groups interact**, forming distinct yet interconnected communities.
- AI agents observe behaviors, communication patterns, and decision-making processes within each group.
- The agents communicate with each other to compare insights, validate findings, and refine their strategies.
- Based on observations, **agents strategically influence different human groups**

Use cases:

- **Personalized AI-Driven Education:** AI systems monitor diverse student groups, tailoring adaptive learning content to different learning styles and cultural backgrounds.



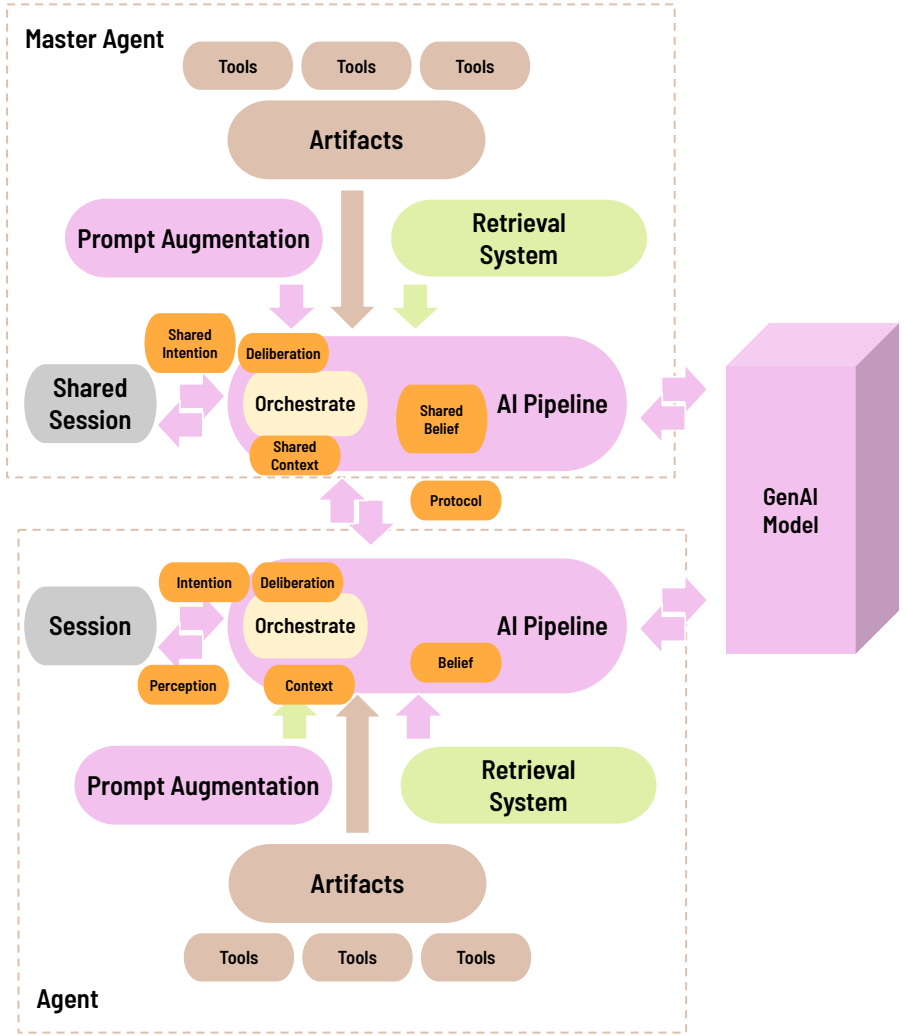
N-M interactions between groups of humans observed (and eventually influenced) by groups of agents

Adjusting Generative Intelligence Systems for Collective Intelligence

How to adjust the architecture to support Collective Intelligence?

Key Components of Generative Intelligence Systems to Evolve for Collective Intelligence:

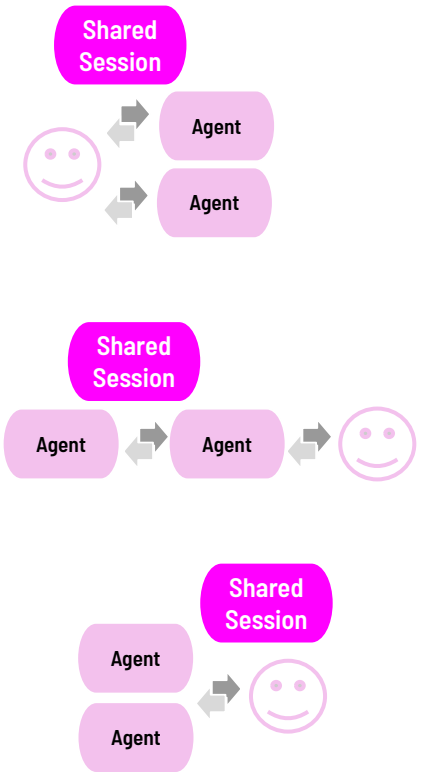
- Shared Sessions
- Shared Beliefs.
- Shared Intentions.
- Feedback Loop for Co-Learning.
- Distributed Intent Negotiation.
- Cross-Agent Orchestration Network



Shared Sessions

How can multiple agents and humans operate within a unified session while maintaining context and coherence?

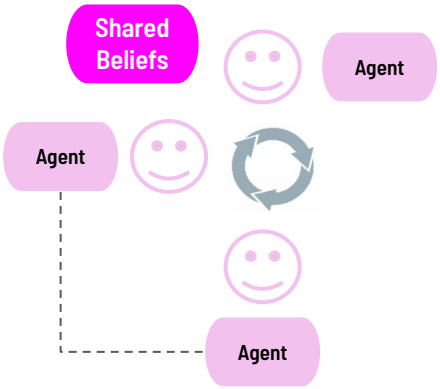
- Maintain a **common workspace across agents** and users for persistent collaboration.
- Allow context sharing across parallel sessions.
- Support temporal memory for ongoing collective tasks.
- Enable real-time orchestration between distributed participants.



Shared Beliefs

How can agents ensure consistent understanding and interpretation of information across the collective?

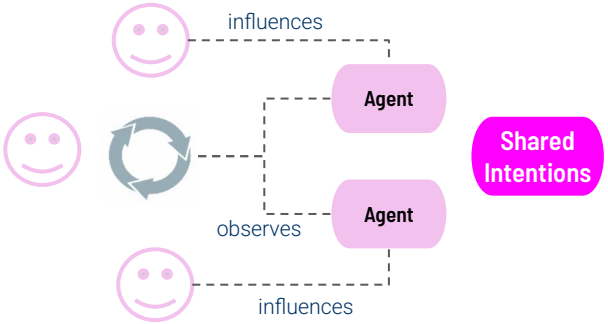
- Use shared knowledge graphs to unify representations.
- Synchronize belief states across agents to reduce conflicts.
- Integrate semantic reasoning layers for consistent context interpretation.
- Promote transparency in how AI agents form conclusions.



Shared Intentions

How can diverse agents and humans align intentions to achieve shared goals dynamically?

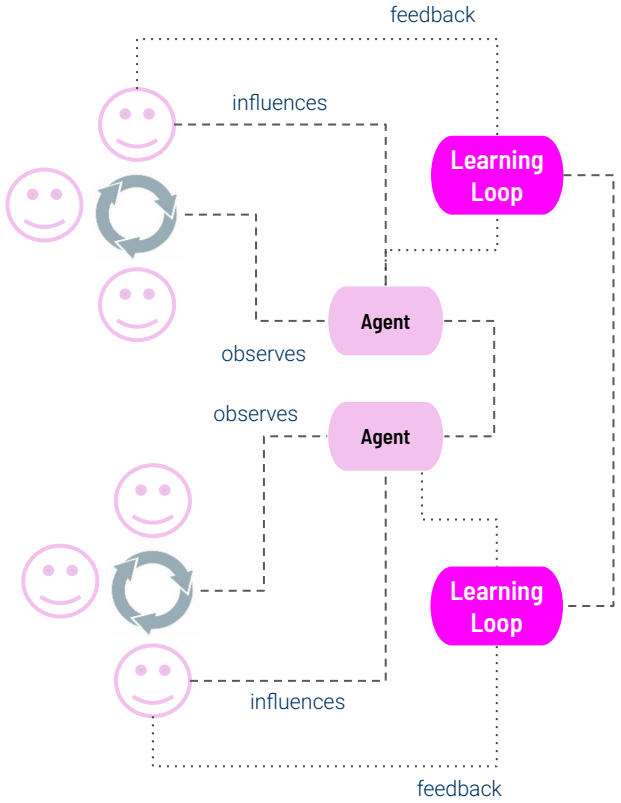
- Implement **intent negotiation protocols for goal alignment.**
- Manage role and responsibility assignment adaptively.
- Maintain a goal-state tracker for group progress.
- Support adaptive planning to harmonize conflicting objectives.



Feedback Loop for Co-Learning

How can AI systems learn from human feedback and peer agents to evolve their collective intelligence?

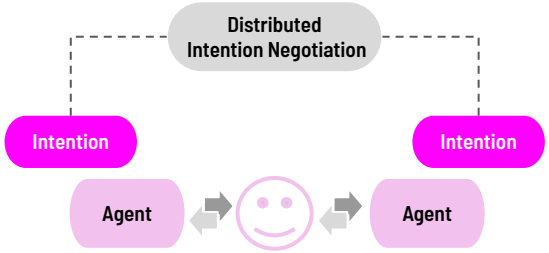
- Capture user and agent feedback signals for model refinement.
- Enable cross-validation among agents to mitigate bias.
- Apply reinforcement learning mechanisms for adaptation.
- Incorporate human judgment into retraining processes.



Distributed Intent Negotiation

How can distributed agents negotiate and coordinate actions autonomously while maintaining shared objectives?

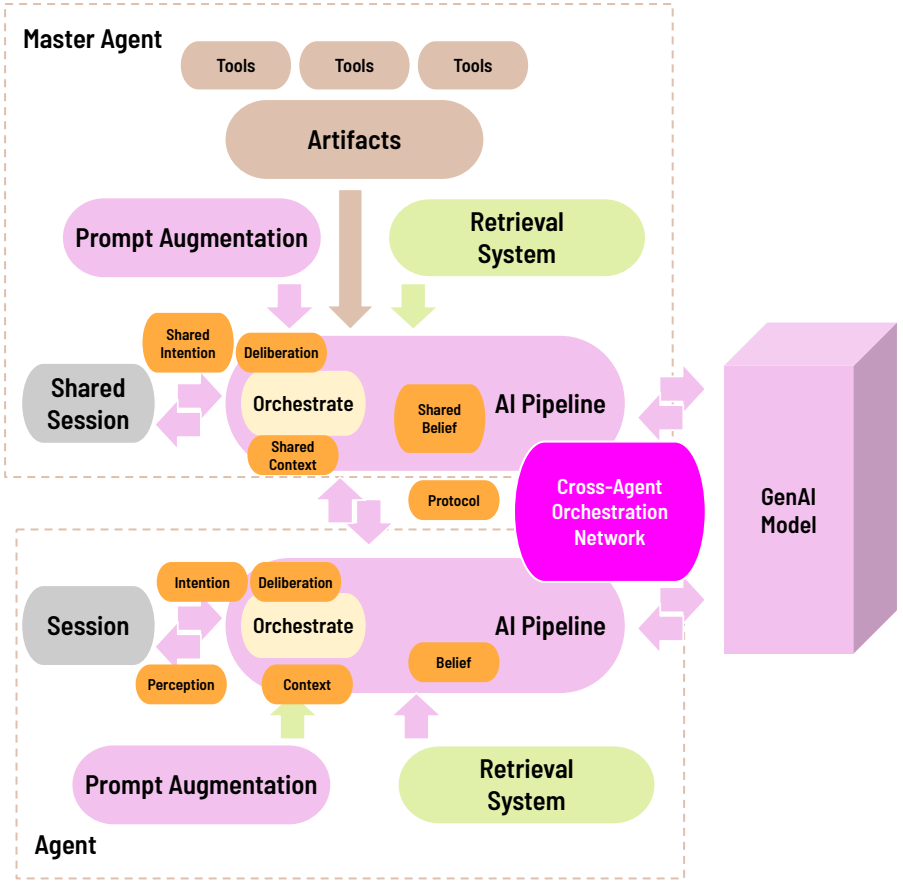
- Implement multi-agent communication protocols for deliberation.
- Use trust-weighted consensus models for decision-making.
- Support conflict resolution frameworks among agents.
- Foster autonomy with accountability within collective systems.



Cross-Agent Orchestration Network

How can a GenAI ecosystem orchestrate multiple specialized agents to act coherently as one collective?

- Introduce a Master Orchestrator for coordination and load balancing.
- Enable dynamic task routing between agent subsystems.
- Facilitate artifact and context sharing across pipelines.
- Ensure system-wide coherence and emergent intelligence monitoring.



Use Cases

Smart Grid Energy Management

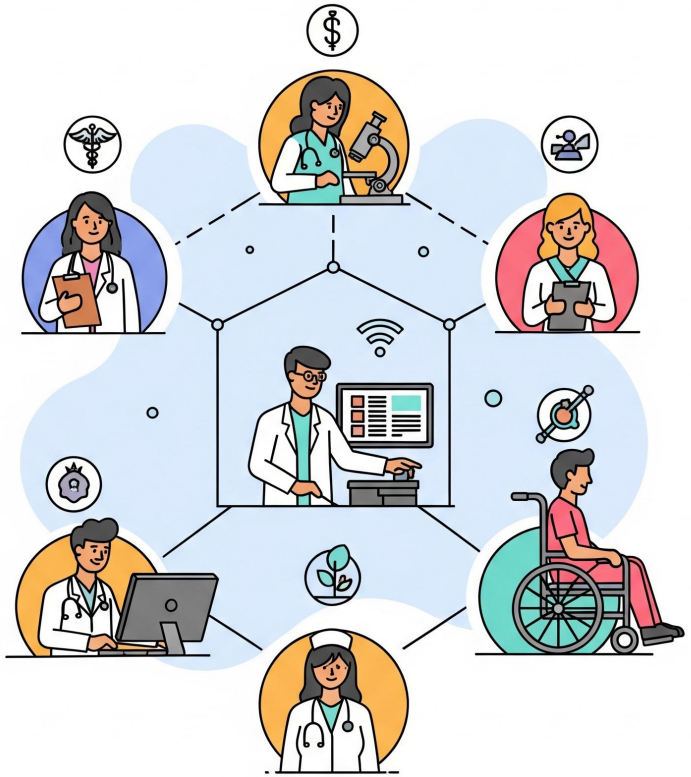
Regional energy controllers (AI agents) manage distributed renewable sources to balance supply and demand dynamically.

- **Shared Beliefs:** Agents share data on local production, weather, and consumption.
- **Distributed Intent Negotiation:** Agents negotiate load balancing and energy routing without central control.
- **Cross-Agent Orchestration:** A master orchestrator monitors efficiency and stability across regions.
- **Feedback Loop for Co-Learning:** Agents adapt to consumer behavior and evolving grid conditions.

Multi-Agent Healthcare Collaboration

Hospitals deploy AI agents to support doctors, nurses, and administrators in diagnosis, scheduling, and treatment optimization.

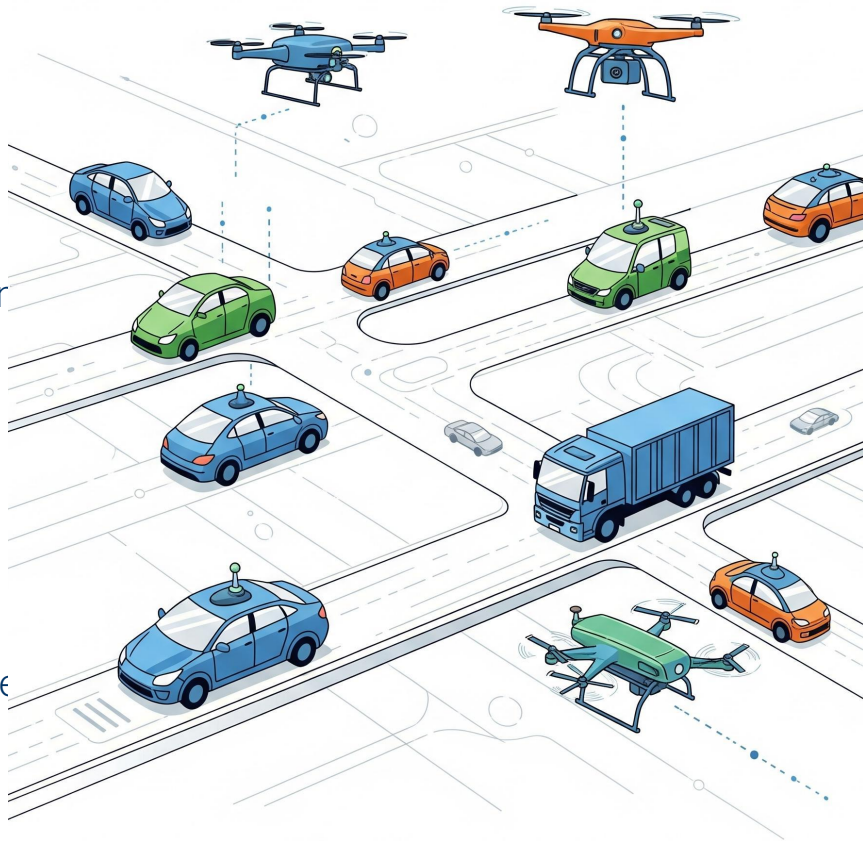
- **Shared Sessions:** All agents and human experts access the same patient context in real time.
- **Shared Beliefs:** Agents synchronize medical knowledge bases to ensure consistent diagnostics.
- **Distributed Intent Negotiation:** AI agents negotiate treatment priorities (e.g., risk vs. resource availability) across departments.
- **Feedback Loop for Co-Learning:** System adapts from doctor feedback to refine decision rules.



Autonomous Vehicle Coordination

Self-driving cars communicate via a shared AI framework to prevent collisions and optimize traffic flow.

- **Shared Sessions:** Vehicles share live situational data ar road context.
- **Shared Intentions:** Agents align on movement goals (speed, path, safety constraints).
- **Distributed Intent Negotiation:** Cars negotiate right-of-way and rerouting decisions collectively.
- **Feedback Loop:** Continuous adaptation improves future route predictions and behaviors.



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