

Synthesizing Disparate Experiences in Episodic Planning



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Objective

- The purpose of this project is to allow groups of peer planners to achieve **self-synchronization** by using:
 - **Coherence**: Contributing and understanding unique experiences in a group context.
 - **Critical Rationalism**: Providing expertise that corresponds with the truth of a situation.



Problem

From Planning: Complex Endeavors (Alberts & Hayes)

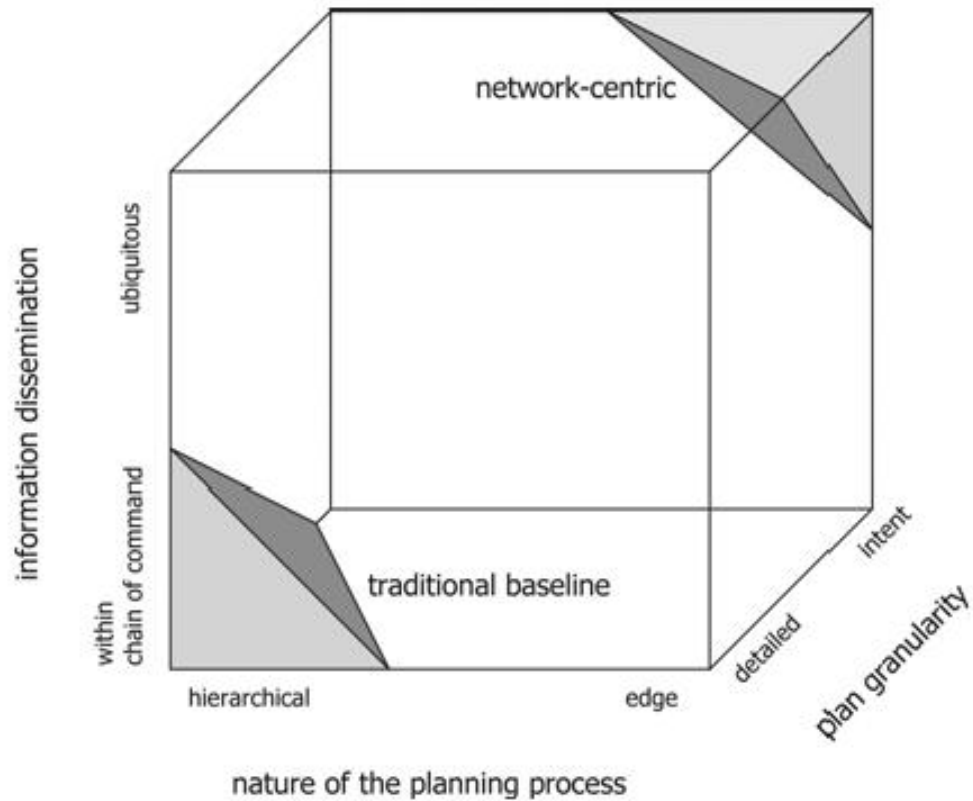


Figure 5: Planning Space



Problem

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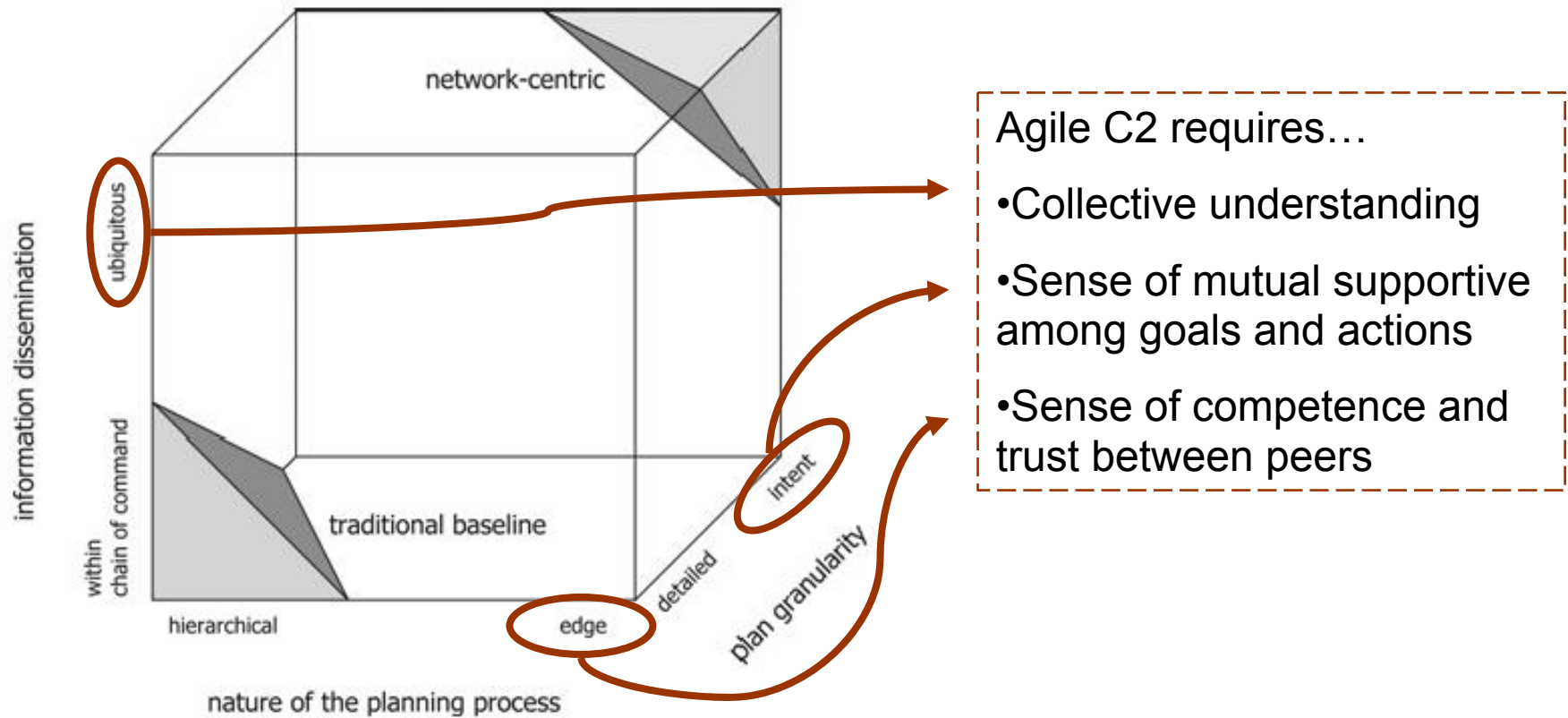


Figure 5: Planning Space



Addressing the Problem

Agile C2 requires...

- Collective understanding
- Sense of mutual supportive among goals and actions
- Sense of competence and trust between peers



Questions...

- How does a group **believe** the contributions of its members?
- How does a group collectively **decide** what actions and goals are prudent?
- How can individual **experience** contribute to a group in a trusted way?



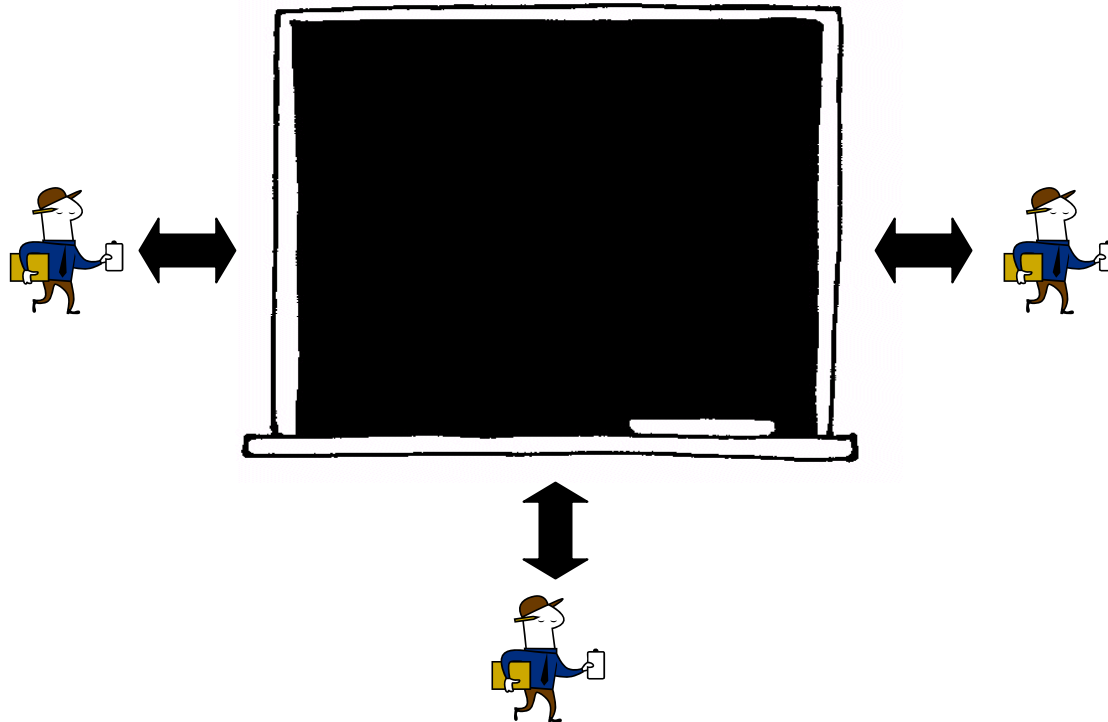
Distributed Episodic Exploratory Planning (DEEP)

- Research project with US Air Force Research Lab
- Key Objectives:
 - Provide a **mixed-initiative planning** environment where **human expertise** is captured and developed, then adapted and provided by a machine to augment **human intuition** and **creativity**.
 - Support **distributed planners** in multiple cooperating command centers to conduct distributed and **collaborative decision making**.



(Very) Simplified DEEP Architecture

Blackboard for sharing information



Experience-Based **Planning agents** to provide diverse perspectives



Coherence

- Samples from Webster's Dictionary...
 - to **hold together firmly** as parts of the same mass
 - to **become united** in principles, relationships, or interests
 - to be logically or aesthetically **consistent**
- In the Philosophy of Knowledge (Epistemology)...
 - Beliefs are justified by **mutual support relationships** which hold all of the beliefs in a 'package' or 'web'



Coherence

- Two relationships:
 - **Coherent** relations such as: explains, associates, facilitates, etc.
 - **Incoherent** relations such as: incompatible, contradictory, inconsistent, etc.



Coherence as Constraint Satisfaction

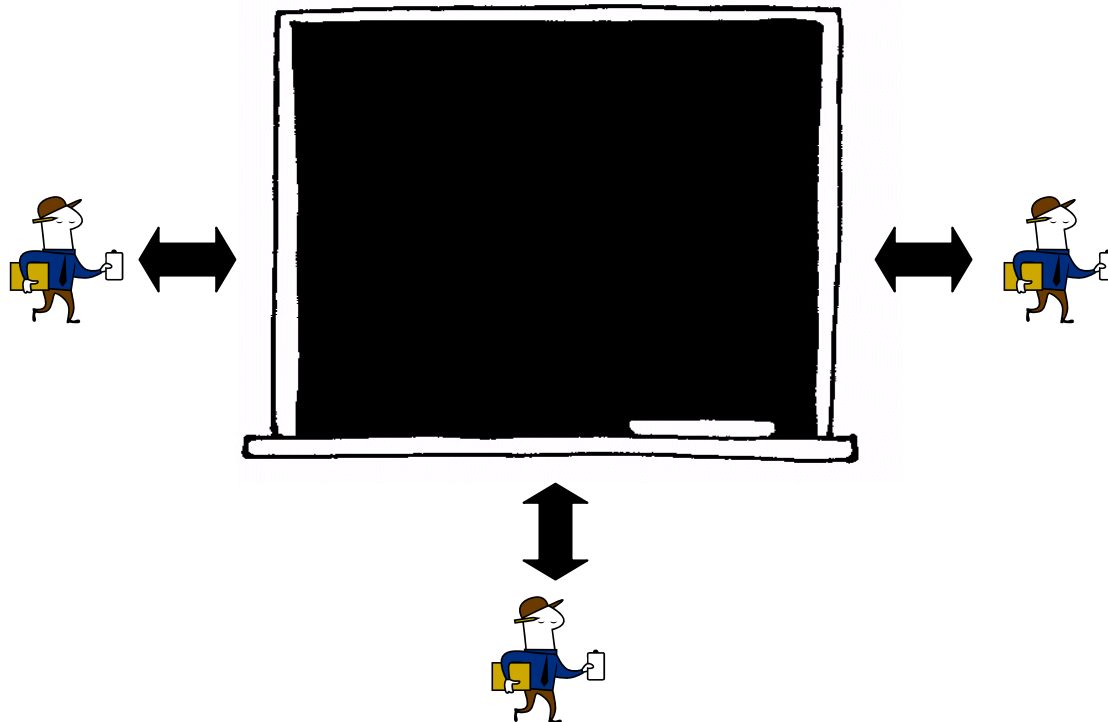
Relation	Constraint	Explanation	Operation
Coherent	Positive	These elements support one another, either both are accepted or both are rejected.	AND
Incoherent	Negative	These elements cannot coexist, if one is accepted then the other is rejected	XOR

Overall Coherence = Σ Strength of Satisfied Constraints



Applied to Planning

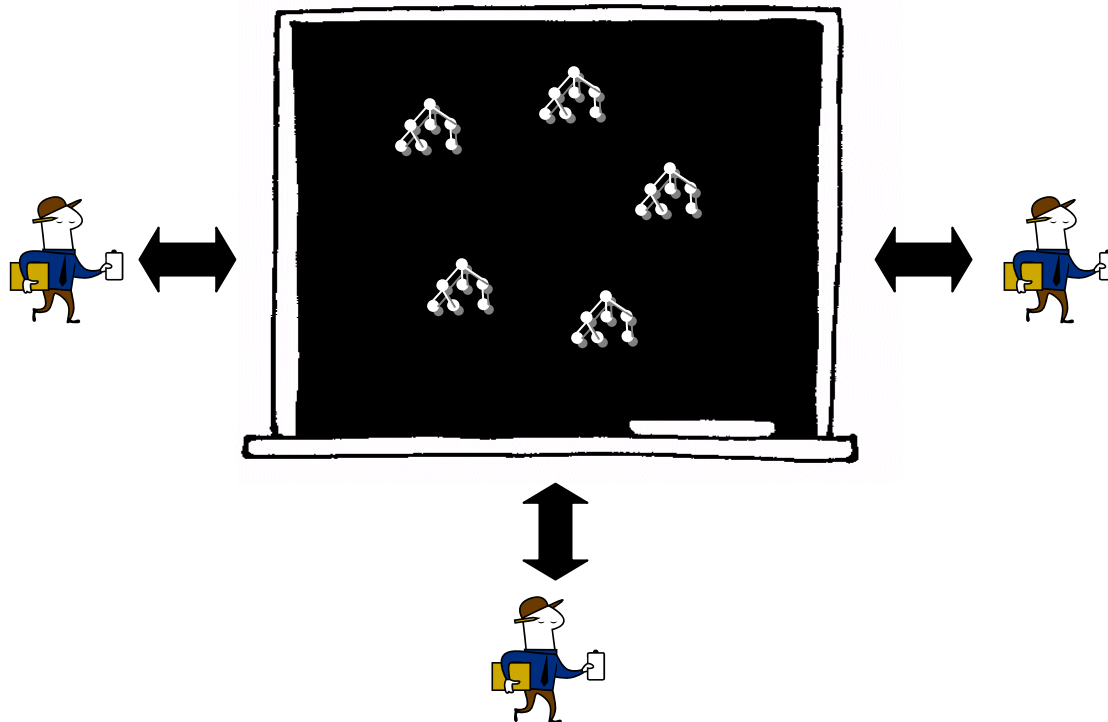
- Agents contribute **actions** and **goals** from experience.





Applied to Planning

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Forming Relationships

- There are two problems here:
 - Experiences don't **explicitly state** the required facilitation and contradiction information
 - Experiences from the past **need to be adapted** to the present to see if they have non-obvious relationships
- The **Coherence Adaptation Agents** adapt and examine these experiences on the blackboard.



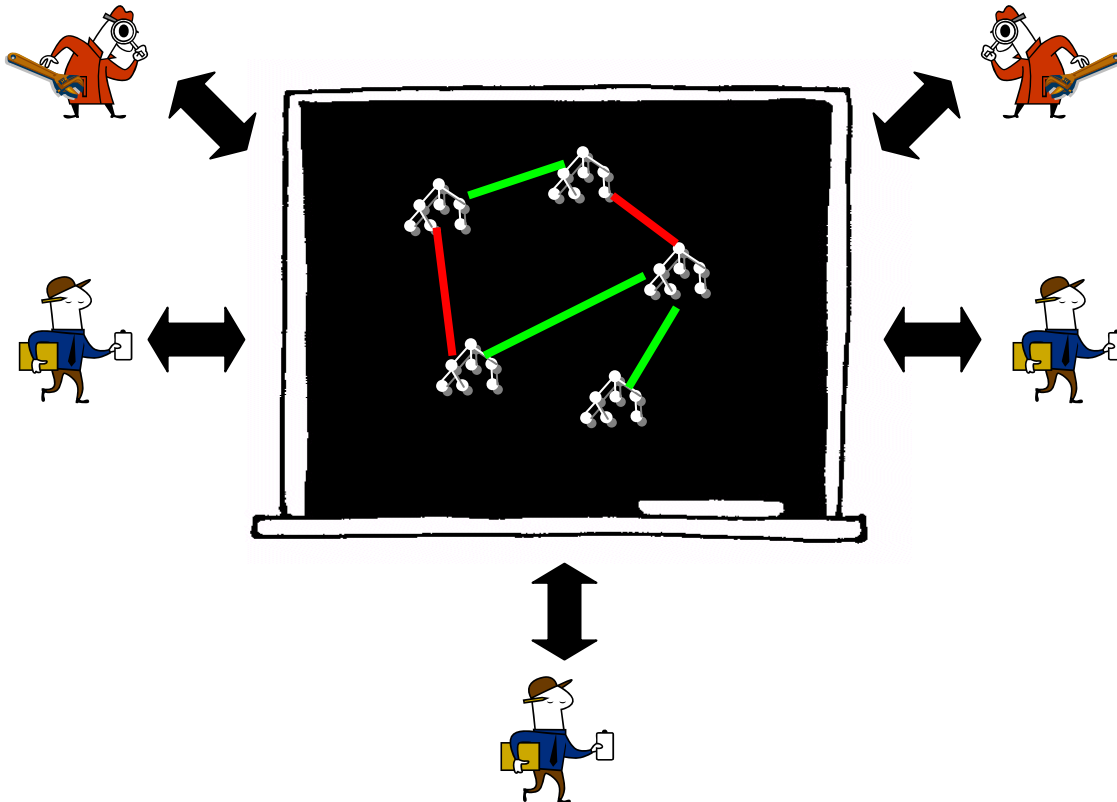
Inferring Relationships

- This requires certain **assumptions** about the structure and content of experiences from the past.
 - *Structure*. Within an experience, Actions facilitate achieved Goals, but are incompatible with failed Goals.
 - *Competition*. Between experiences, Actions which facilitate similar Goals do not necessarily have to be performed together, so they are incompatible.
- This also requires that these cases be **adapted** to the present situation to discover other relations.
 - *Overlap*. Actions which must compete for the same resources are incompatible with each other.
 - *Effect Transitivity*. If an Action achieves an effect which is required by another factor, then that Action facilitates that factor.



Applied to Planning

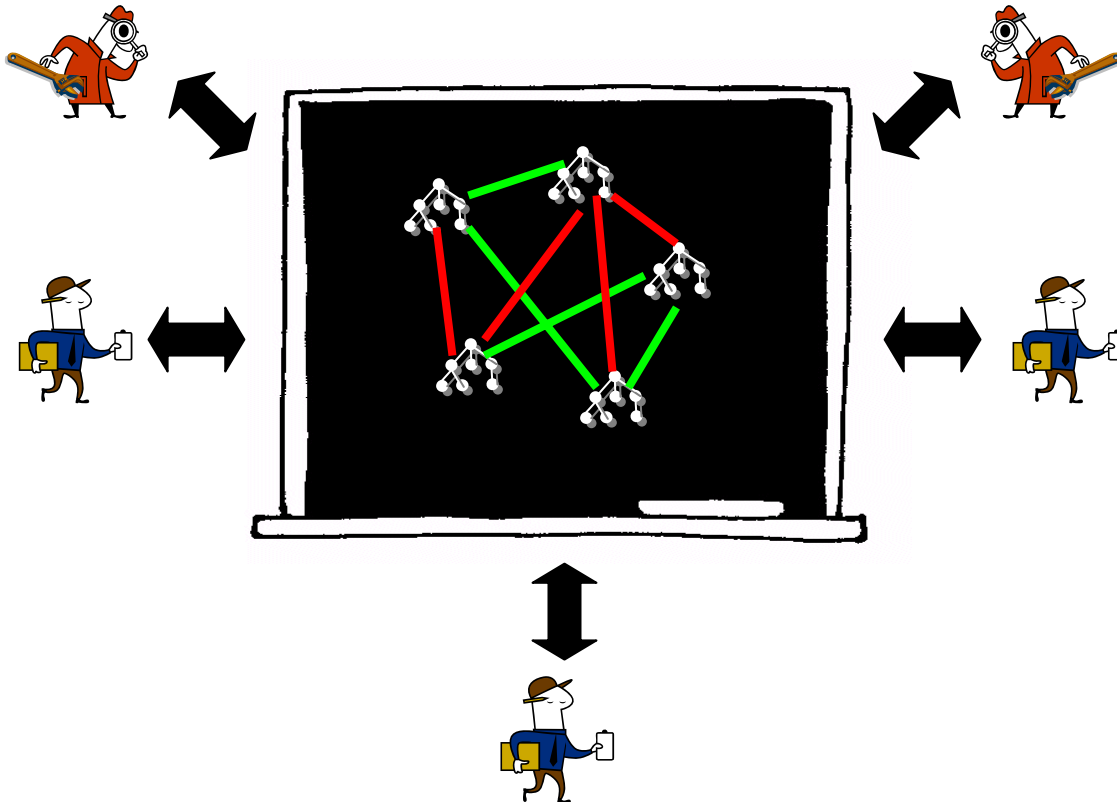
- Agents contribute **actions** and **goals** from experience.
- By understanding the **coherence** of these elements, agents can make decisions





Applied to Planning

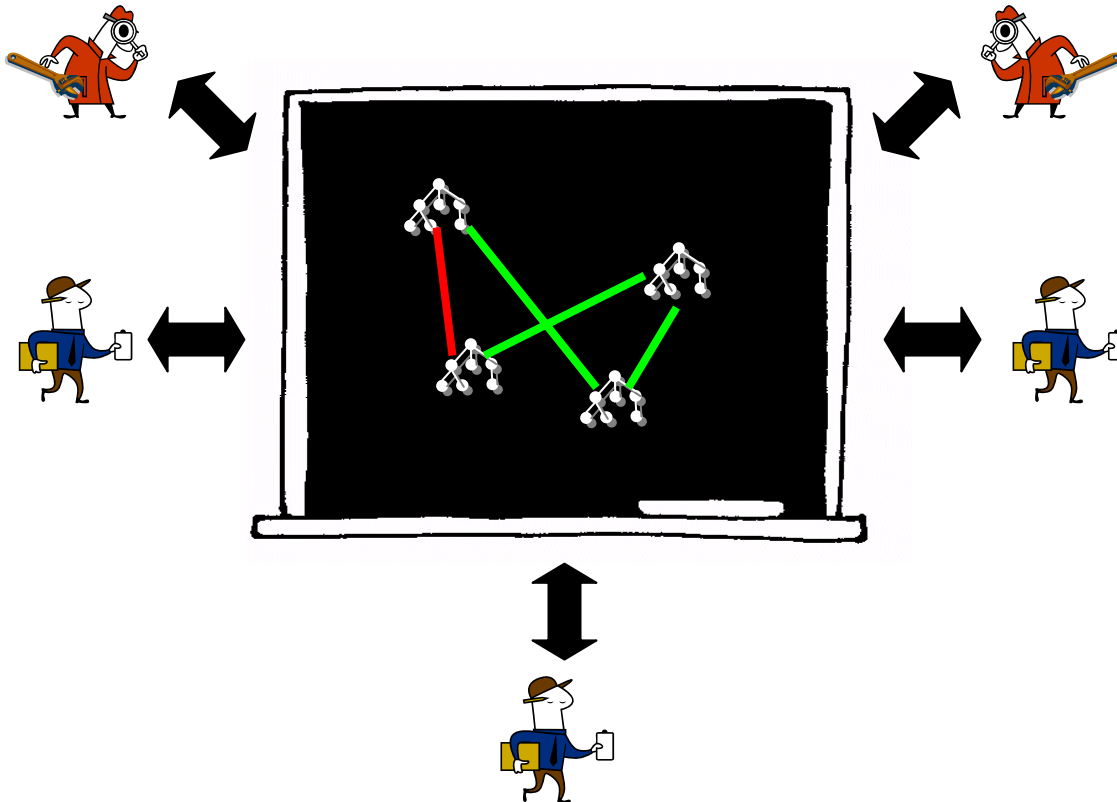
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Objections to Coherence

- Something can be **coherent** and **untrue** at the same time.
- This is one of the biggest objections to coherence as a method of justification.
- Correspondence Theory of Truth
 - Truth is correspondence to a fact in reality.
- There must be a role for truth itself.



Critical Rationalism

- A theory of knowledge that values deductive falsification over inductive confirmation for beliefs.
- Opposes a theory of justification, because information is used to *refute* beliefs, rather than *support* them.
- A belief has a level of falseness: **Verisimilitude**.
 - This contrasts with justification, support, verification, etc.



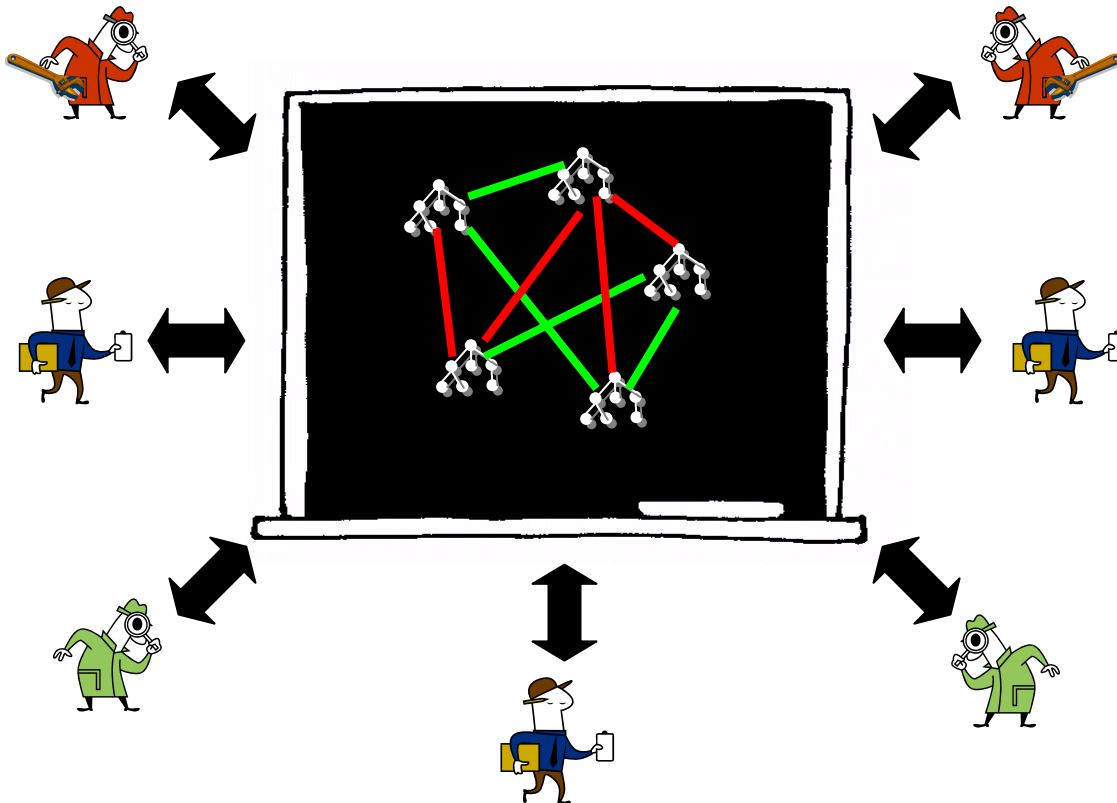
Incorporating Verisimilitude

- Verisimilitude can change the strength of relationships involving falsified elements.
- This steers the coherence problem towards truth, making coherence more *robust*.
- The **Counterexamples Critic Agents** change the constraint satisfaction problem to reflect counterexamples from outside information.



Applied to Planning

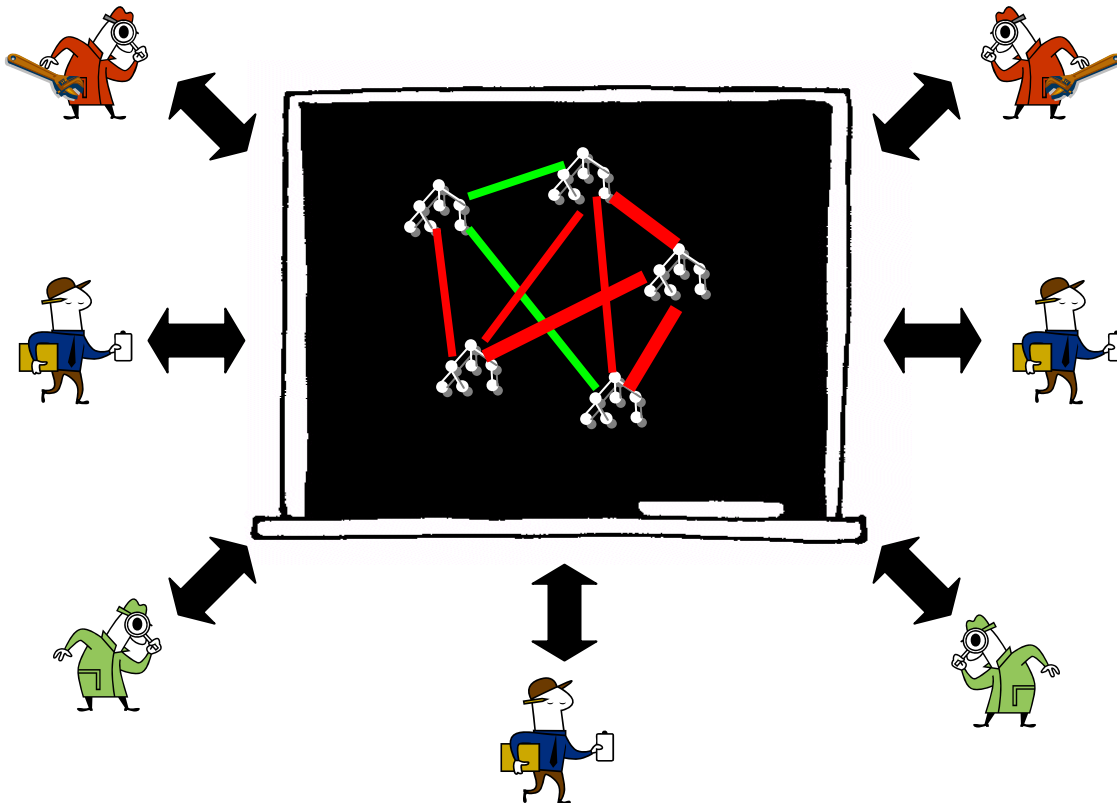
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Applied to Planning

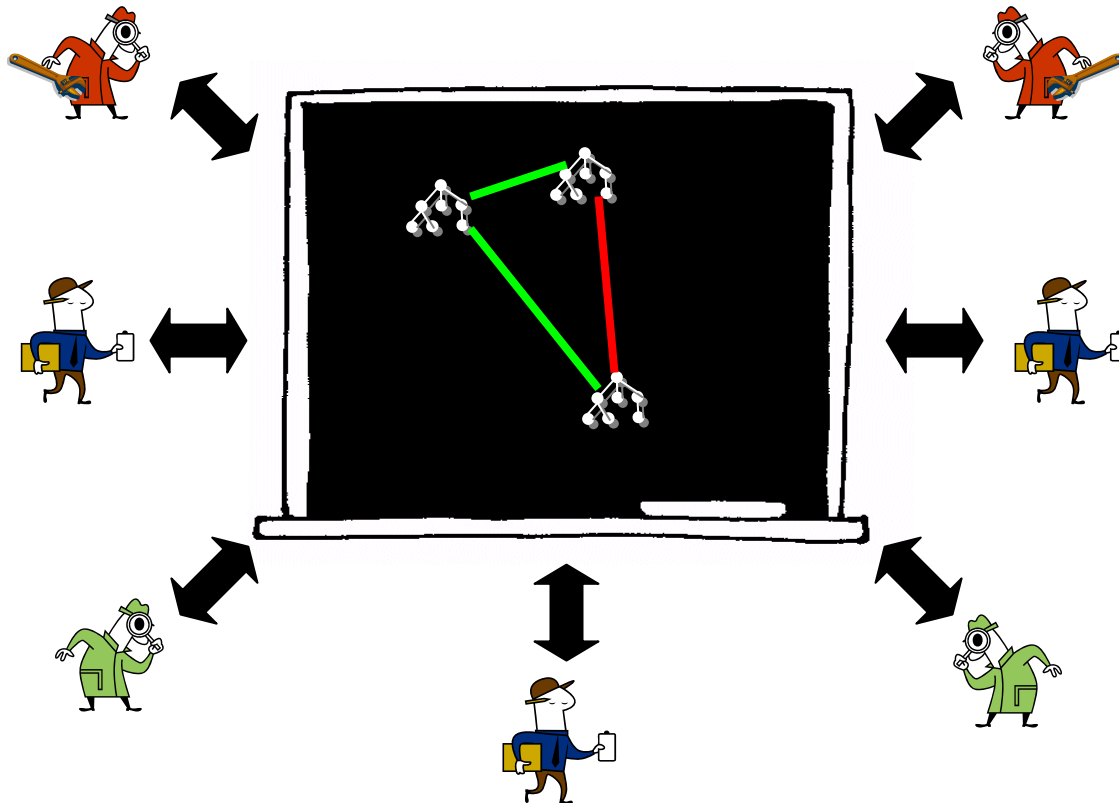
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Summary

- Agile C2 requires high levels of **self-synchronization** and **shared understanding**.
- The Distributed Episodic Exploratory Planning project seeks to use **mixed-initiative planning** to address these requirements by using:
 - Experience-based reasoning agents to supplement intuition
 - Distributed blackboard storage to facilitate decision making
- Artificial agents can help humans communicate, analyze, and make decisions about disparate experiences using **coherence**.
- Coherence can be made more responsive and robust to a changing world through **verisimilitude**.



Questions?

- Thank you for your attention.