Distributed Hypotheses Finding using SOLAR

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Workshop on Hypotheses Finding and its Application - Orsay

Presentation Layout

Context

- Making hypotheses
  - Background theory
  - Observations
  - "Adequate" Hypothesis
- Distribution
  - How are data distributed ?
  - What knowledge about system ?
  - Communication constraints
  - Local reasoning

Learner-Critic Approach

- Based on general framework abstracting away from local reasoning
  - Consistency relation (at different level)
  - Local Hypothesis Formation and Critic processes
- Principles
  - Propose
  - Counter-exemple
  - Accept
- With *n* agents
  - Static (complete graph)
  - Static with propagation(connected graph)
  - Rumor-like propagation

Conditions

- But...
  - only works for a compositional consistency relation :

$$Cons(h, K_1) \wedge Cons(h, K_2) \text{ iff } Cons(h, K_1 \cup K_2)$$

  - Not realistic in some applications (especially with abduction)
- Simple problem where no compositionality
  - Cover set abduction with distributed background theory
  - First step : Horn Clause with observations as heads

Distributed Diagnosis

- Distributed sources of informations
  - Different part of a global theory
  - Observes locally
  - Make hypotheses (diagnoses locally)
- Aim : solve such a system without centralizing everything
  - No recognized authorities
  - Better practicability (get only useful informations)
  - Privacy concern ?
- Context of this work
  - Global consistency of theories and observations
  - Each entity is autonomous

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Agents knowledge

Here we consider only Individual knowledge (no explicit common information).

- Non-revisable knowledge : individual informations
  - Individual Theory $\mathcal{T}_i^I$: *individual knowledge*
  - Observation set O_i : *acquired factual knowledge*

    Manifestation set $M_i \subseteq O_i$: *non self-explanatory*
- Revisable knowledge : hypotheses.
  - set of Hypotheses H_i
  - favorite hypothesis h_i

Presentation Layout

Coherence and Completeness

Need to capture consistency, or adequation, of an hypothesis H with non-revisable knowledge $\mathcal{T}$.

- Coherence
  - Cannot derive contradictions from $(H, \mathcal{T})$: $(H, \mathcal{T}) \not\models \bot$
  - Needed to ensure soundness of subsequent reasoning
  - No coherent hypothesis if $\mathcal{T} \models \bot$
- Completeness
  - Can non-trivially derive all manifestations M from hypothesis and theory : $(H \cup \mathcal{T}) \setminus M \models M$
  - if only a subset of M is derived : partial hypothesis (complete with `unexplainedManif`)

Coherence and Completeness (2)

Need to capture consistency, or adequation, of an hypothesis H with non-revisable knowledge $\mathcal{T}$.

- Individual aspect
  - Internal coherence/completeness
  - $\mathcal{T}$ is the full individual theory $\mathcal{T}_\rangle \cup O_i$
- Within groups
  - Group coherence/completeness
  - H should be coherent/complete with the union of the individual theories $\mathcal{T}_i$.

Example

Horn Clause, with observations as heads and abducibles as body.

- Theory

```
[hasSymptom(fever), -hasDisease(flu)]
[hasSymptom(throatache), -hasDisease(angina)]
[hasSymptom(fever), -hasDisease(angina)]
[hasSymptom(mucus), -hasDisease(flu)]
[hasSymptom(mucus), -hasDisease(rhino)]
```

- Observations

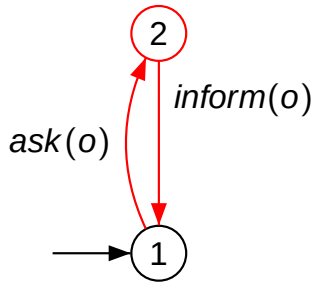
```
[hasSymptom(fever)]
[-hasSymptom(mucus)]
[hasSymptom(throatache)]
```

Presentation Layout

Protocol

1 (Learner) Compute hypothesis (h_i consistent for ($\mathcal{T}_i, O_i$)).

Protocol



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2. (Learner) Check external coherence (h_i coherent for ($\mathcal{T}_i, O_j$))

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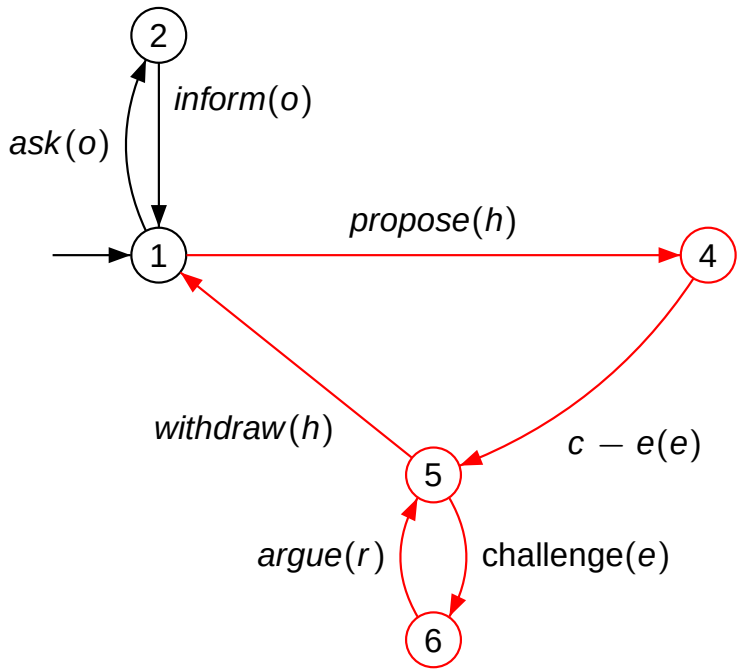

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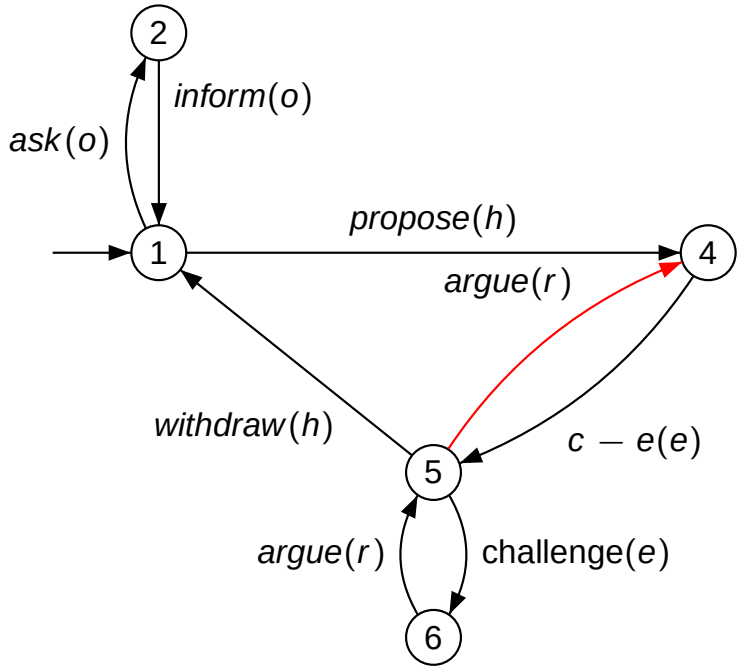

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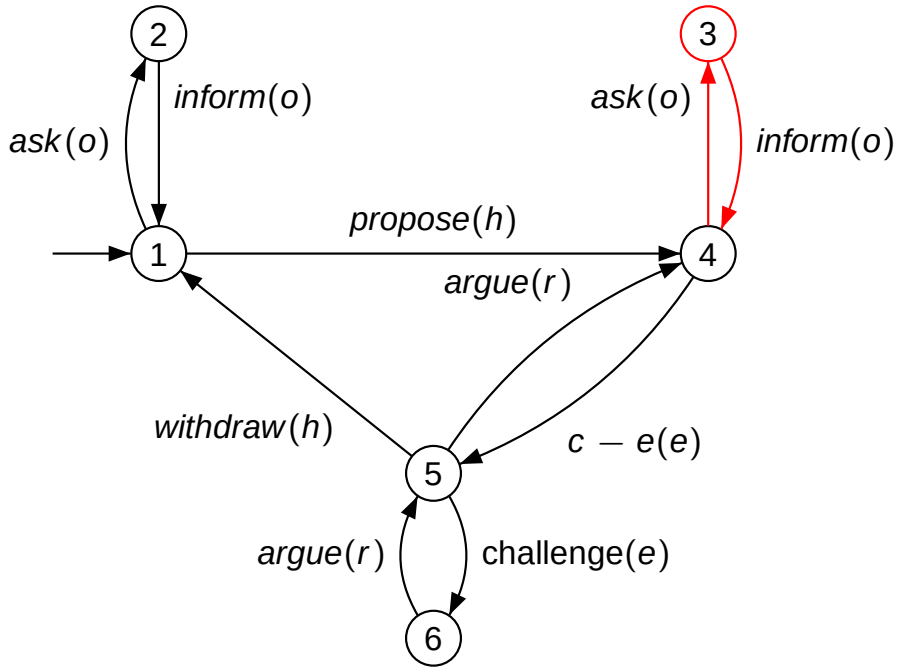

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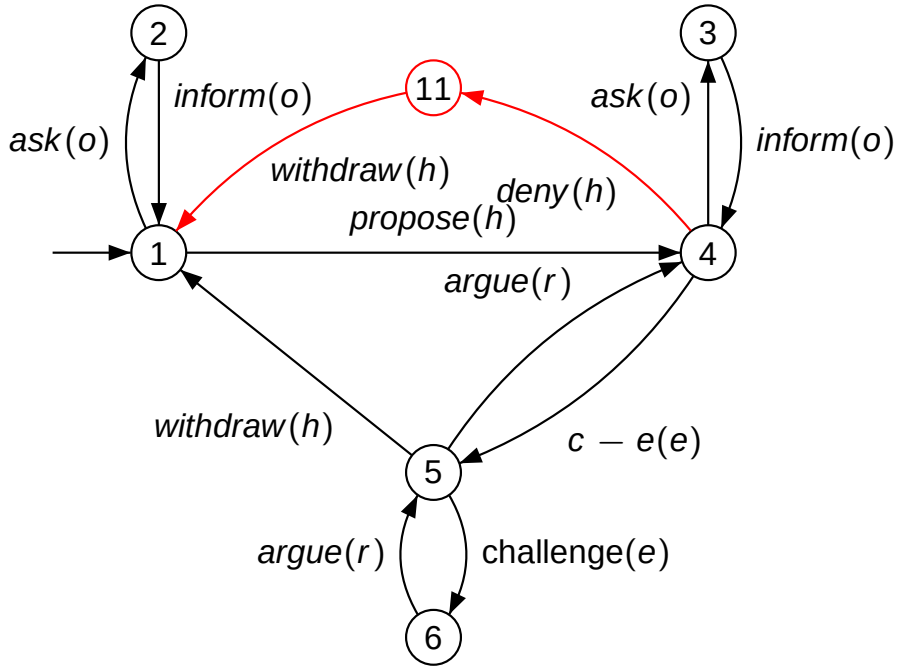

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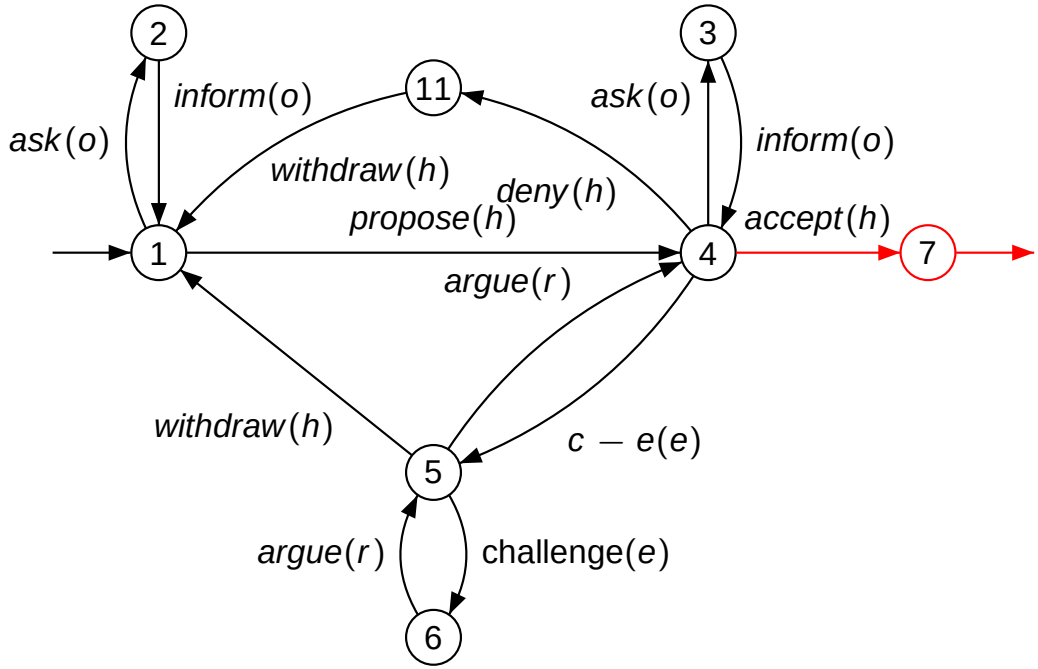

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CF tasks (1)

- Computing hypothesis
  - $R \cup (O \setminus M) \cup \neg M \models \neg H$
  - Production field : hypothesis field (`hasDisease(X)`)
- Extended Hypothesis
  - $R_{ext} \cup (O \setminus M) \cup \neg M \models \neg H$
  - Production field : extended hypothesis field (`hasDisease(X), unexplainedManif(X)`)
- Computing context (external coherence and completeness) :
  - $R_{ext} \cup O \cup H \models Ctx$
  - Production field : observation field (`hasSymptom(X)`)

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CF tasks (2)

- Checking internal coherence
  - $R_{ext} \cup O \cup H \models ...$
  - Production field : none (refutation seeking)
  - get proof
- Arguing completeness
  - $R_{ext} \cup O \cup H \models ...$
  - Production field : target manifestation (`hasSymptom(ce)`)
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Demo

Demonstration

Properties

- Terminates and ensures peer-consistency
- Also ensures global consistency with n fully connected agents
- If agents are not fully connected, do not ensure global consistency
- Need to incorporate admissible context to hypotheses

Presentation Layout

Extensions and future work

- Base mechanism for studying fully distributed diagnosis
  - Experiments
  - Refinements (avoid redundant messages with memory)
- Heterogeneity
  - Specialized theories
  - Different role (diagnoser, critic only)
  - Observation source (with a cost ?)
- Devise global protocol
- Minimal support

Thanks for your attention.

Any questions ?