

Strategically knowing: a new framework of modal logics

Andrés R. Saravia

CONICET and Universidad Nacional de Córdoba, Argentina

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Who am I?

- PhD student in Computer Science (since March 2020)
- Director: Raul Fervari
- Member of the Logics, Interaction and Intelligent Systems (LIIS) group, at FaMAF-UNC.
- Working on Modal Logics featuring knowledge and abilities: epistemic notions, deontic notions, etc.

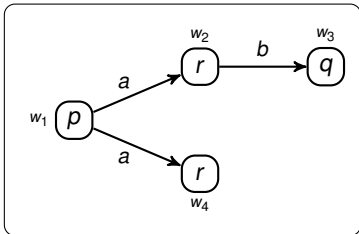
Where it all started: “an epistemic approach”

- **Epistemic Logic:** reasoning about knowledge of agents.
 - 'Knowing that' assertions.
E.g. *John knows that it is sunny in Paris.*
 - Knowing how: abilities of the agent to achieve a certain goal.
- Wang [2015,2018] proposed a framework for knowing how logics.

Knowing how on LTSs

$\mathcal{M} \models \text{Kh}(\psi, \varphi)$ iff exists a plan σ such that

- (1) is *fail-proof* at all ψ -states and
- (2) from ψ -states, σ *always ends* in φ -states.



$\models \text{Kh}(p, r)$

plan a takes the agent from every p -state and reach only r -states.

$\not\models \text{Kh}(p, q)$

- ϵ and a are not suitable actions as they do not reach a q -state (w_3);
- ab aborts at w_4 .

Is this logic epistemic?

- **Knowing that:**

- **ontic** information: facts and propositional truths in a state;
- **epistemic** information: uncertainty or indistinguishability relation, agent's perception.

- **Knowing how:**

- the agent has at her disposal **all plans** to choose a witness.
- there is **no distinction** between ontic and epistemic information.

Modeling uncertainty

- The agent has at her disposal **all plans** to choose a witness.
What if she has not the **knowledge** that certain plans exist?
Example: the empty plan (“skip”).
- For the agent, every plan is different from each other.
What if she is not able to **distinguish** certain plans from others?
Example: between basic actions or the the order of these.

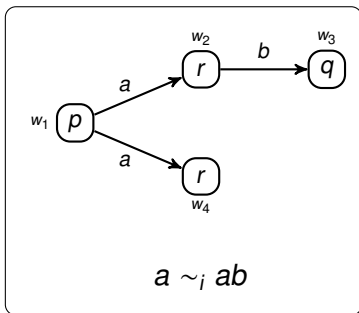
Many different reasons for **not knowing how**.

C. Areces, R. Fervari, A. R. Saravia, F. R. Velázquez-Quesada. *Uncertainty-Based Semantics for Multi-Agent Knowing How Logics*. (TARK 2021).

Uncertainty-based semantics

$\mathcal{M} \models \text{Kh}_i(\psi, \varphi)$ iff exists **a set of plans π** such that

- (1) every plan in π is **indistinguishable** from each other,
- (2) every plan in π is **fail-proof** at all ψ -states and
- (3) from ψ -states, every plan in π **always ends** in φ -states.



$\mathcal{M} \not\models \text{Kh}_i(p, r)$

plan **a** takes the agent from every **p**-state and reach only **r**-states;
 however, plan **ab** aborts at w_4 and
 the set **{a, ab}** is not fail-proof at w_1 .

More about our contributions

- **Uncertainty-Based Multi-Agent Knowing How** Logics:
 - Indistinguishability relation between plans, for **multiple agents**.
 - Describe other reasons for **not “knowing how”**.

Moreover:

- Model checking is in P.
- SAT is NP-complete.
- Strongly complete axiom system.
- Weaker than the original proposal (but a more general logic).

Ongoing and future works

Ongoing:

- Reinterpretation in Deontic Logic: **Knowingly complying** with C. Areces, V. Cassano, P. Castro, R. Fervari.
- Dynamic operators: **Learning/forgetting how.** with C. Areces, R. Fervari, F. Velázquez-Quesada.

Future work:

- Resource Bounded Strategies.
- Combine **knowing how** + **knowing that**.
- **Collective knowledge**, groups of agents.