Task Planning for a Collaborative Robot

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Context of the Joint Action

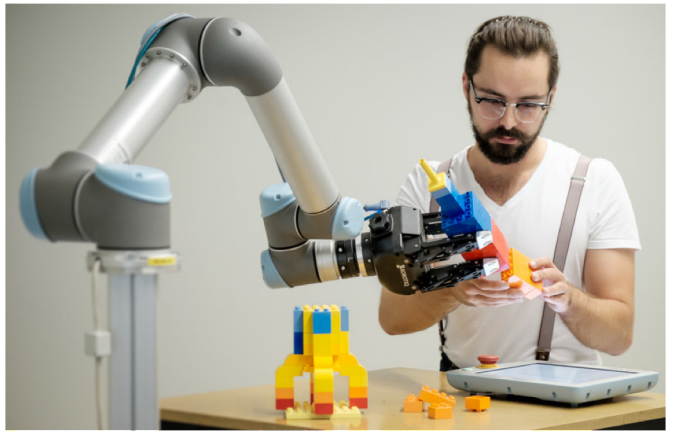
Definition

“ Joint Action can be regarded as any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment ” *(Sebanz et al. 2006)*

Goal

Produce a robot behavior that is:

- **Acceptable**
- **Efficient**
- **Legible**
- **Compliant**



David Vogt *et al.* [2017]

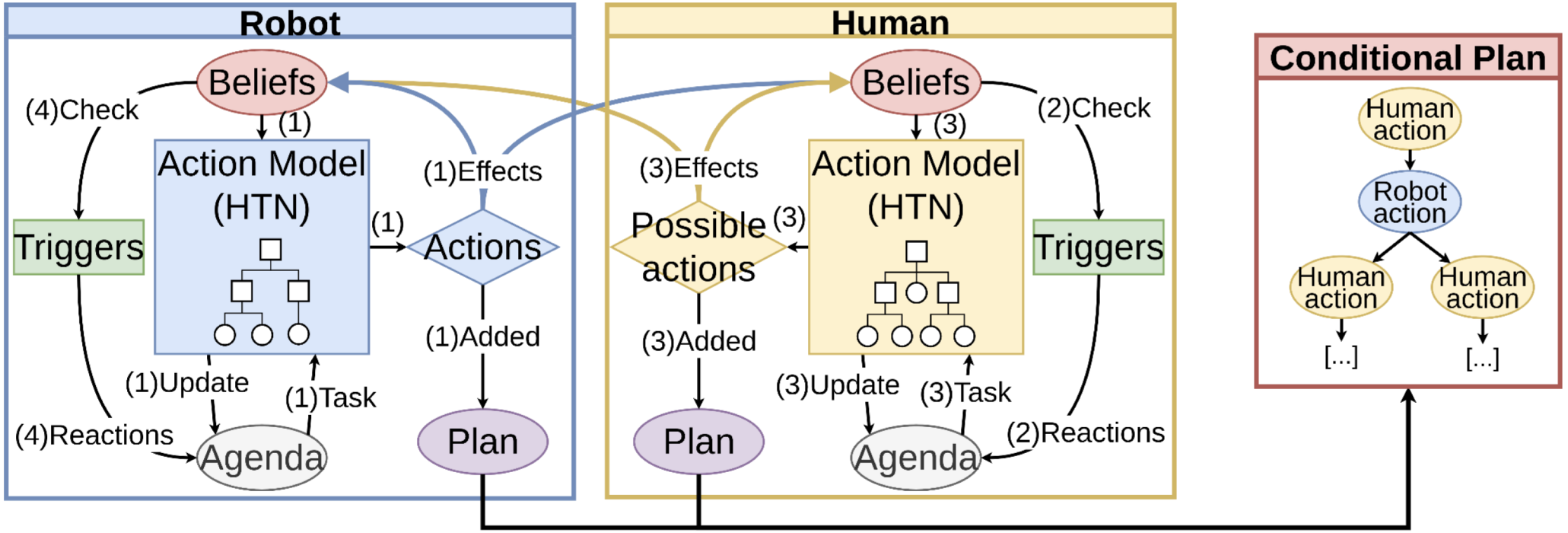
Assumptions

- Humans and robots are not equal: Robot should assist humans.
- Humans are uncontrollable agents: Humans should not be dictated what to do.
- Humans are cooperative, rational and congruent: Adversarial approaches aren’t suited (e.g. Min-Max).
- Humans use social signals to share their decisions and intents.

HATP/EHDA: A Task Planner Anticipating Human Decisions

Overview of HATP/EHDA

(Buisan et al. 2022)



Main properties

- **Distinct Human Goals**
- **Turn Taking**
- **Distinct Human Beliefs**
- **Implicitly coordinated plans**

Estimating and Reasoning on the Human Beliefs

Description

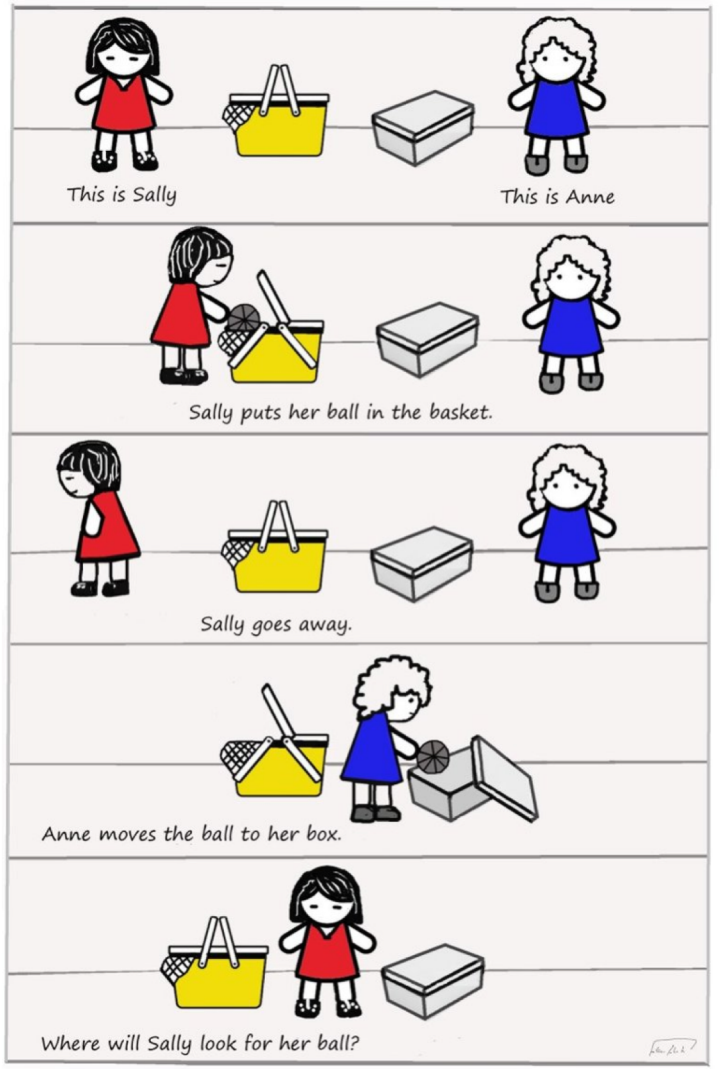
Extension of HATP/EHDA with some concept of Theory of Mind.
It allows the robot to more accurately estimate the human beliefs and solve false beliefs task, such as Sally and Anne.

Methods

Enriched problem description with symbolic locations and observability types for state variables.

Reason on new problem description with two processes:
- Learn from observing an **action execution**
- Learn from observing the **state**

Detect and solve relevant false beliefs with:
- **Minimal verbal communication**
- **Delaying a non-observed robot action**



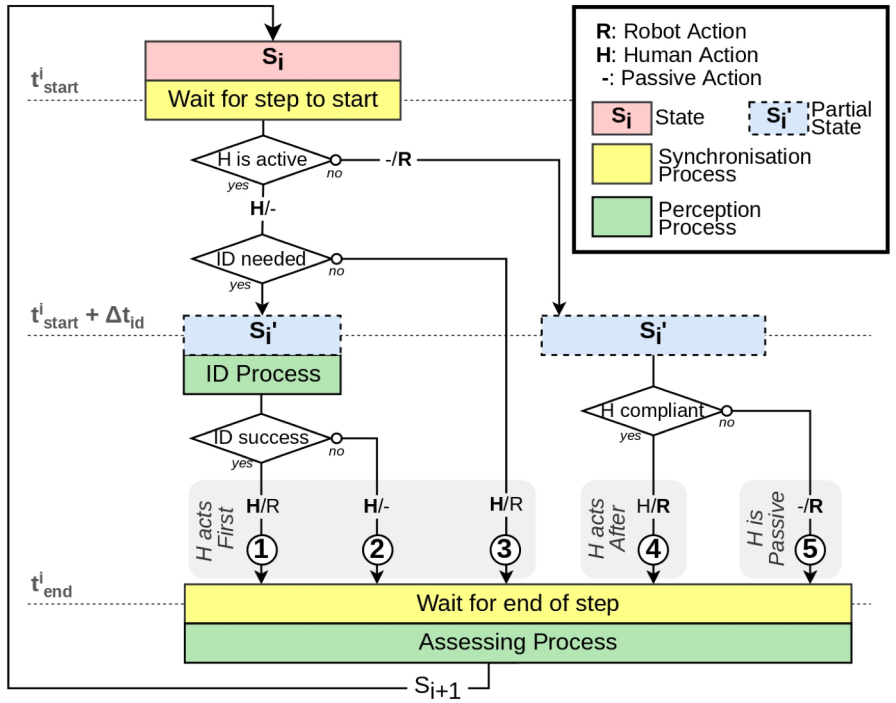
Sally and Anne Test

Planning for Compliant Concurrent Joint Action

Description

Extension of HATP/EHDA grasping some subtleties of the concurrent joint action execution.

At each step, the human can decide to either:
- Start acting and the robot will act in parallel compliantly
- Be passive, letting the robot act alone
- Let the robot start and be compliant with it



Model of Execution - Automaton

Methods

Inspired by the joint action literature, we designed a Model of Execution in the form of an automaton grasping the (non-)verbal signals sent between the human and the robot, and explicit perception phases used by the agents to synchronize together.

Then, reasoning on an estimation of the human's preferences regarding the task, the robot policy is generated and is compliant to both online human decisions and preferences.

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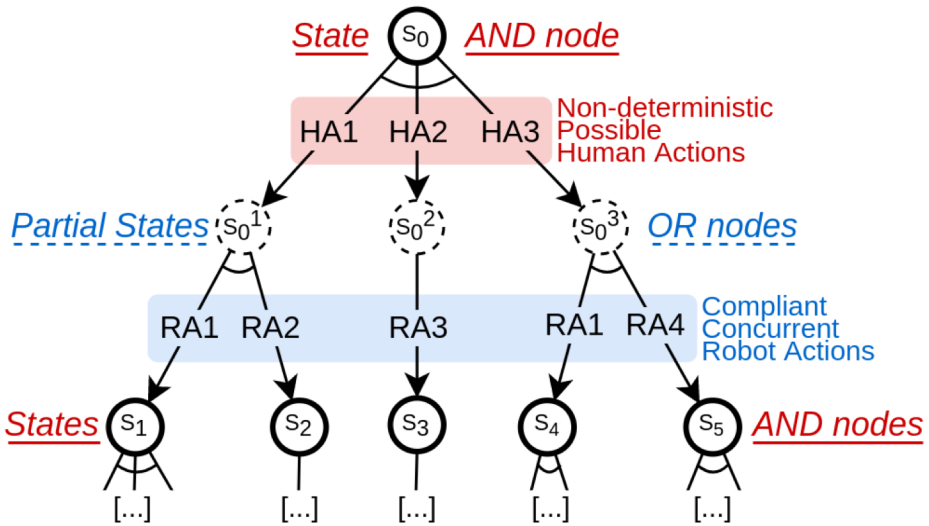

Conditional plans

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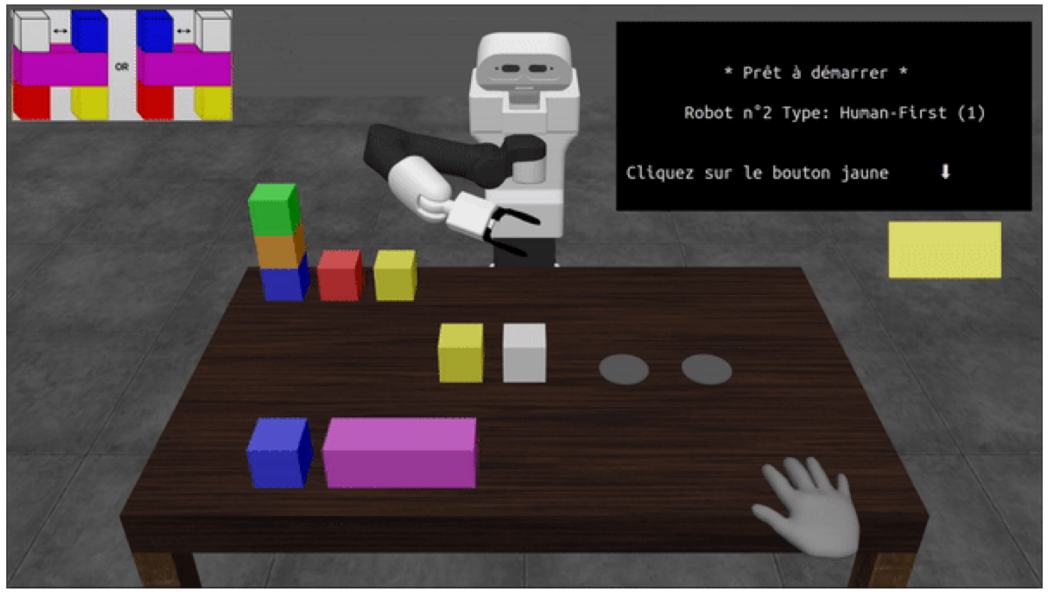

Execution

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Thank you for your attention !