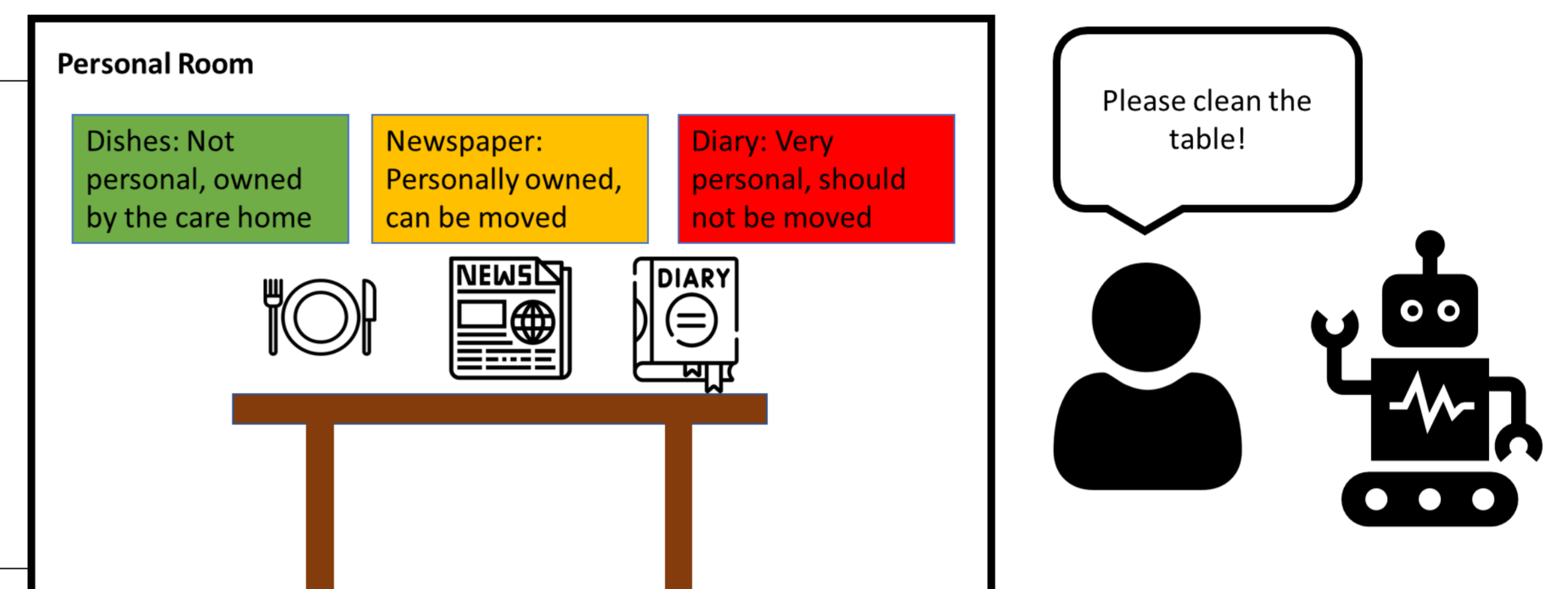


How To Raise a Robot – Beyond Access Control

Constraints in Assistive Humanoid Robots

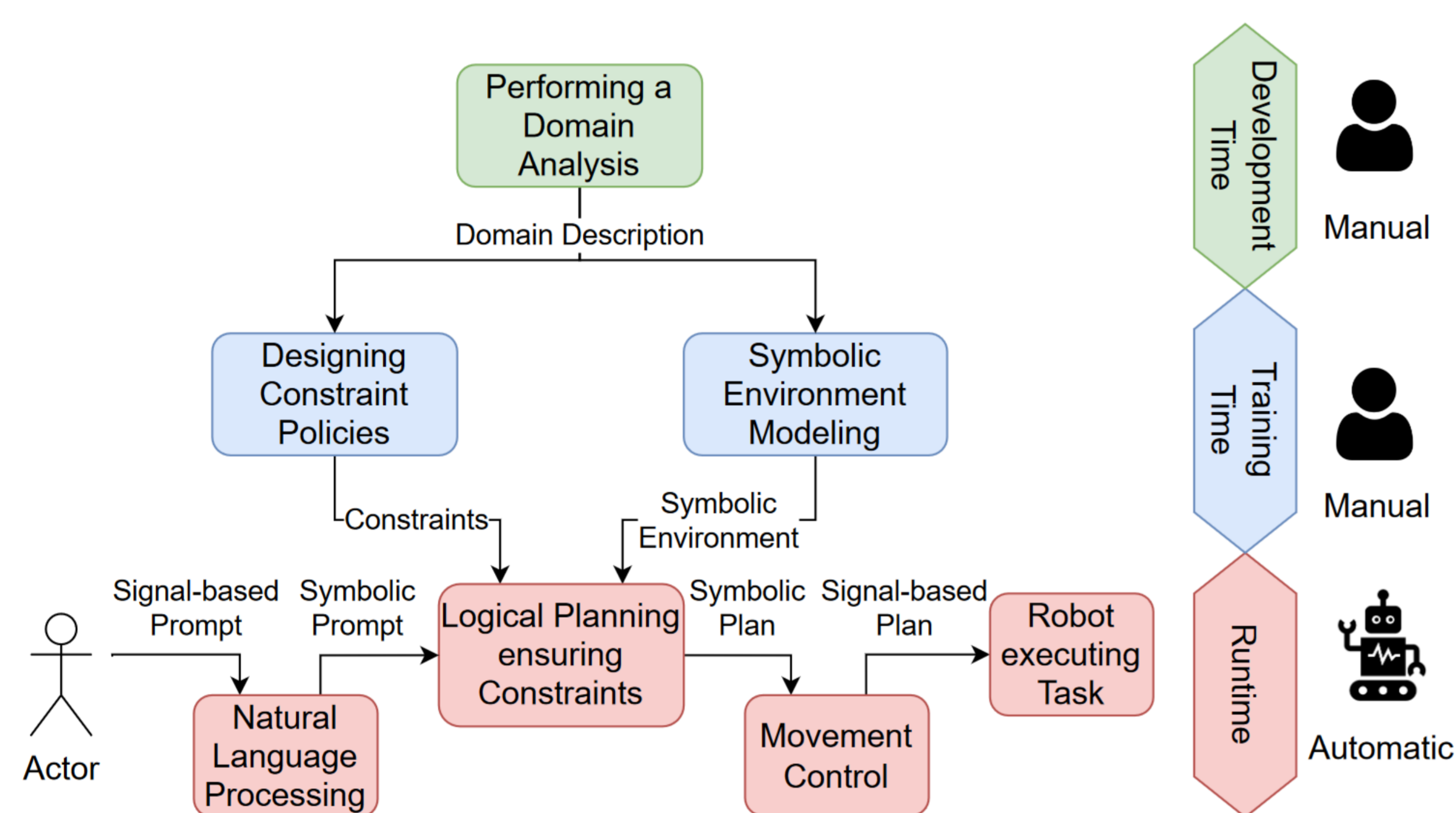
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- Task-universal robots need to fulfill constraints beyond access control
 - Usage control, safety, security, privacy, personalization, ...
- Given a prompt for a task, the robot derives a plan to fulfill the task
- Generated plans and executed actions should obey given constraints



Logical Planning *enforcing* Logical Constraints

- Constraints represented as logical formulas
- Cumbersome manual work, does not scale
- Easy administration
- High accuracy



- Excerpts from a logical domain description:

```
(:action clean_from_table
:parameters
  (?robot - robot
   ?table - location
   ?obj - on_table
   ?remove - location)
:precondition
  (and
    (non_personal ?obj)
    (at ?robot ?table)
    (at ?obj ?table)
    (remove_loc ?remove)
  )
:effect
  (and
    (not (at ?obj ?table))
    (at ?obj ?remove)
  )
))
```

```
(:init
  (at robot start)
  (at newspaper table)
  (at diary table)
  (at dishes table)
  (non_personal dishes)
  (non_personal newspaper)
  (personal diary)
  (remove_loc remove))
(:goal
  (forall (?obj - on_table)
    (or
      (and (non_personal ?obj) (at ?obj remove))
      (and (personal ?obj) (at ?obj table))
    )
  )))
```

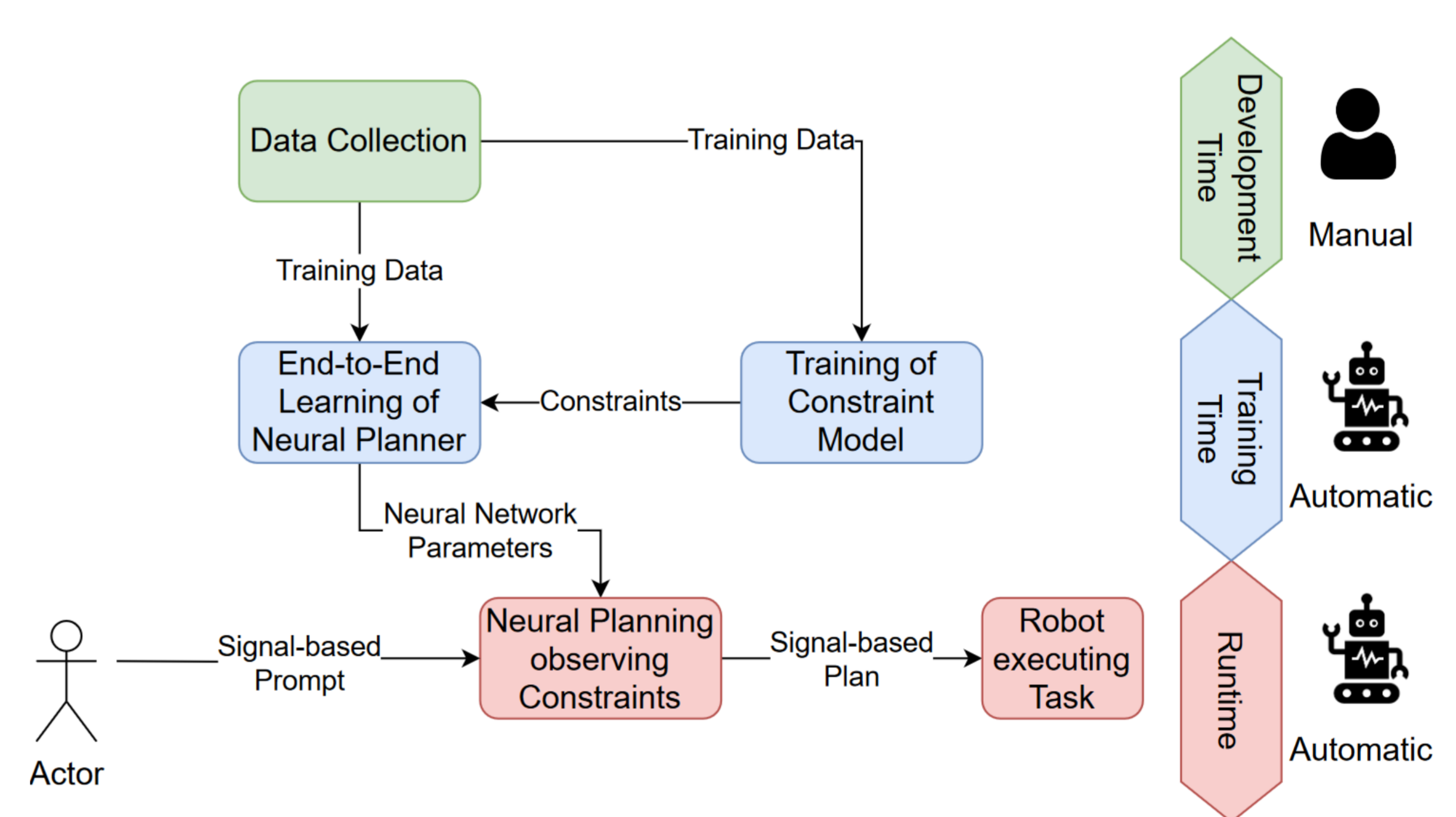
Proposal: Hybrid Approaches

- Combining advantages of neural and logical systems
 - Use logical planner for high security requirements
 - Use neural systems for low security requirements and as a recommendation engine for policies

- Neural planning observing neural constraints scales to real-world problems, but is inaccurate
- Logical planning enforcing logical constraints is accurate, but does not scale
- Future:** Test hybrid approaches on real robots, integrate neural constraints into neural planning

Neural Planning *observing* Neural Constraints

- Constraints represented as neural network
- Mostly automatic, scales to real-world problems
- Administration might require retraining
- No accuracy guarantees



- Exemplary prompt for ChatGPT as Neural Planner:

Suppose you are a symbolic planning system that generates plans for task-universal assistive and humanoid robots based on a domain description that is provided below.

Domain:

- Care home that uses robots to care for their residents. The care home has lots of personal rooms for the residents, common spaces like a dining area, and administrative spaces like a kitchen or offices
- Personal Room of a resident, that has a table inside
- On the table are the following things:
 - newspaper that was paid for by the resident
 - dirty dishes that are owned by the care home and are cleaned by the care home
 - a diary that most certainly contains very private information

Goal: Remove as many objects from the table as possible Constraints: Do not interact with objects that you would consider personal.

Possible actions: Move, analyze an object, take an object, place an object Put out the plan in terms of a sequence of actions the robot performs. Put out the action you used and the object you interacted with or where the object was placed. You can only use the actions from the list above. Only put out the sequence of actions as formatted list. The plan must be conform with all given constraints.

Answer

- Analyze the objects on the table.
- Identify the newspaper as an object that belongs to the resident and should not be interacted with.
- Take the dirty dishes from the table and place them in the kitchen.
- Analyze the diary and identify it as an object that contains private information and should not be interacted with.
- Move any remaining objects on the table to a different location in the personal room where they do not obstruct the table.



Code & further examples