Features:

- `Lr_dusty` is true when the living room is dusty
- `Gar_dusty` is true when the garage is dusty
- `Lr_dirty_floor` is true when the living room floor is dirty
- `Gar_dirty_floor` is true when the garage floor is dirty
- `Dustcloth_clean` is true when the dust cloth is clean
- `Rob_loc` is the location of the robot, with values **{Luogo}**

Rooms:

- `garage` se è polveroso è extra-polveroso
- `livingRoom` non è extra-polveroso

Actions:

- `move` > si muove da una stanza all'altra
- `dust` > spolvera la stanza in cui si trova il robot, solo se la stanza sia polverosa e il panno sia pulito
- `sweep` > il robot spazza il pavimento della stanza in cui si trova

Esercizio 1

Give the STRIPS representation for dust. [Hint: because STRIPS cannot represent conditional effects, you may need to use two separate actions that depend on the robot's location.]

> ***dust garage***:
>
> - preconditions: `Dustcloth_clean ∧ Gar_dusty ∧ Rob_loc = Garage`
> - effects: `¬ Dustcloth_clean` , `¬ Gar_dusty`

> ***dust living room***:
>
> - preconditions: `Dustcloth_clean ∧ Lr_dusty ∧ Rob_loc = lr`
> - effects: `¬ Lr_dusty`

Esercizio 2

Give the feature-based representation for lr_dusty

Rules for “living room is dusty”

> $lr\_dusty \leftarrow \neg\, lr\_dusty \wedge Lr\_dirty\_floor \wedge Act = sweep \wedge Rob\_loc = livingRoom$

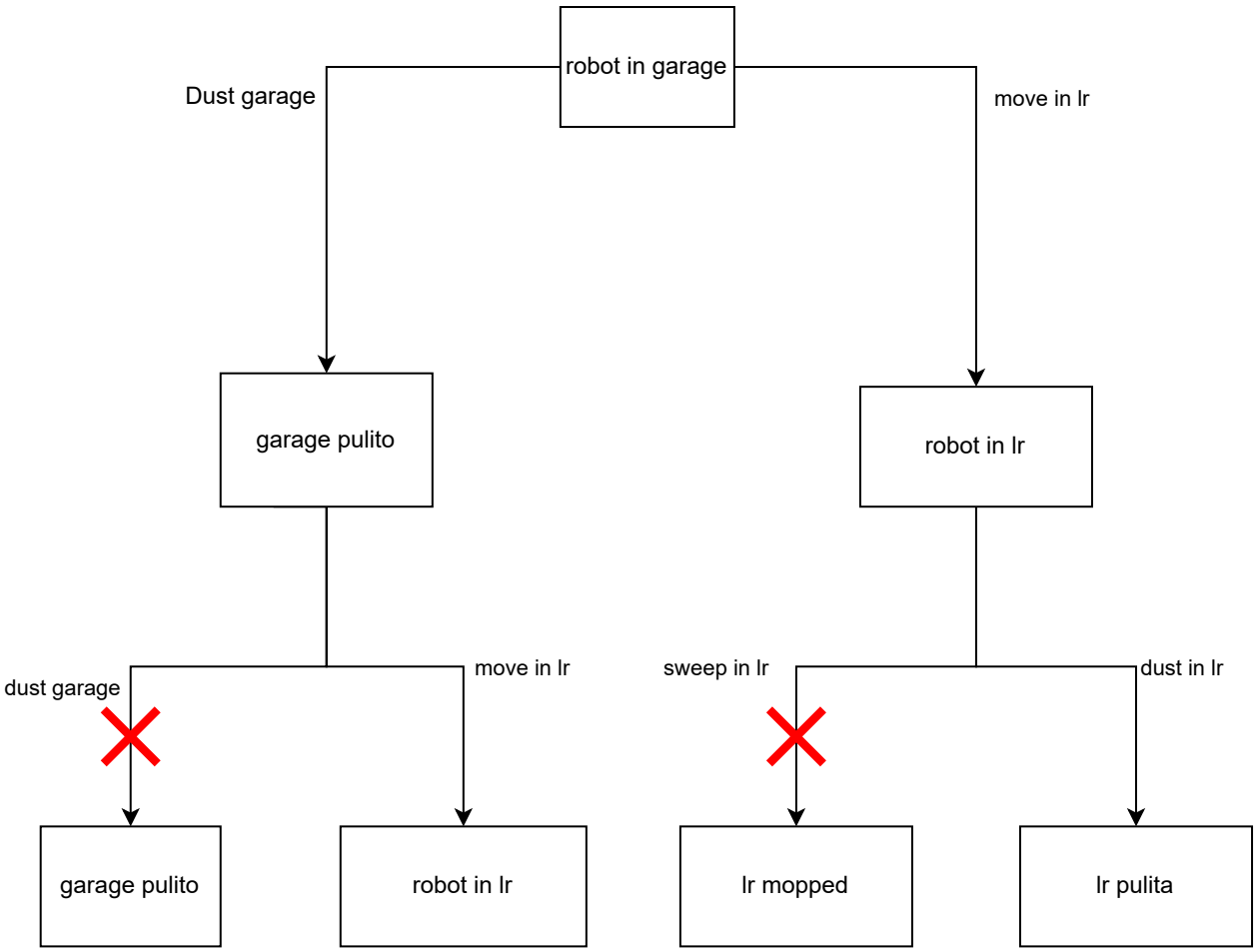
> $lr\_dusty \leftarrow lr\_dusty \wedge Rob\_loc \neq livingRoom \wedge Act \neq dust$

Esercizio 3

Suppose that the initial state is that the robot is in the garage, both rooms are dusty but have clean floors and the goal is to have both rooms not dusty. Draw the first two levels (with two actions, so the root has children and grandchildren) of a forward planner with multiple-path pruning, showing the actions (but you do not have to show the states). Show explicitly what nodes are pruned through multiple-path pruning.

Initial state:

$< garage , lr\_dusty , Gar\_dusty , \neg\, Lr\_dirty\_floor , \neg\, Gar\_dirty\_floor , Dustcloth\_clean >$



Esercizio 4

Pick two of the states at the second level (after two actions) and show what is true in those states.

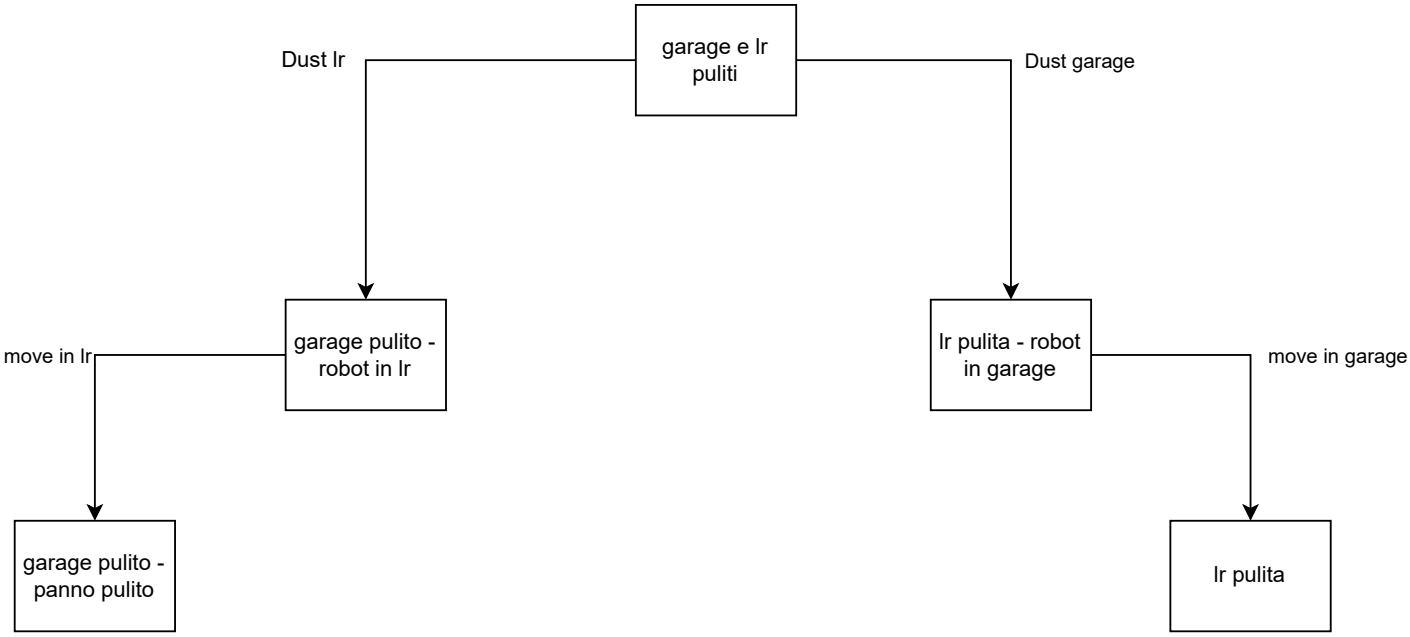
let's pick the only 2 states that are possible after 2 actions: "robot in lr", and "lr pulita"

> **robot in lr:**
>
> `< lr , lr_dusty , ¬ Gar_dusty , ¬ Lr_dirty_floor , ¬ Gar_dirty_floor , ¬ Dustcloth_clean >`

> **lr pulita:**
>
> `< lr , ¬ lr_dusty , Gar_dusty , ¬ Lr_dirty_floor , ¬ Gar_dirty_floor , ¬ Dustcloth_clean >`

Esercizio 5

Suppose that the initial state is that the robot is in the garage, both rooms are dusty but have clean floors and the goal is to have both rooms not dusty. Draw the first two levels (with two actions, so the root has children and grandchildren) of a regression planner showing the actions but you do not have to show what the nodes represent.



Esercizio 6

Pick two of the nodes at the second level (after two actions) and show what the subgoal is at those nodes.

Subgoal "garage pulito - panno pulito":

> `< garage , lr_dusty , ¬ Gar_dusty , ¬ Lr_dirty_floor , ¬ Gar_dirty_floor , Dustcloth_clean >`

Subgoal "lr pulita":

> `< lr , ¬ lr_dusty , Gar_dusty , ¬ Lr_dirty_floor , ¬ Gar_dirty_floor , Dustcloth_clean >`

Esercizio 7

Draw the CSP for a planning horizon of two. Describe each constraint by specifying which values are (in)consistent.

State variables:

1. `Lr_dusty`
2. `Gar_dusty`
3. `Lr_dirty_floor`
4. `Gar_dirty_floor`
5. `Dustcloth_clean`
6. `Rob_loc`

Each variable has 0,1,2 variations (e.g. lr_dusty$_0$, lr_dusty$_1$, and so on)

Action variables: **Action$_0$, Action$_1$**

each variable has domain = { `move in garage` , `move in lr` , `dust garage` , `dust lr` , `sweep garage` , `sweep lr` }

Actions:

- Dust actions:

> ***Dust garage***:
>
> - preconditions: `Dustcloth_clean ∧ Gar_dusty ∧ Rob_loc = Garage`
> - effects: `¬ Dustcloth_clean` , `¬ Gar_dusty`

> ***Dust lr***:
>
> - preconditions: `Dustcloth_clean ∧ Lr_dusty ∧ Rob_loc = lr`
> - effects: `¬ Lr_dusty`

- Sweep actions:

> **Sweep garage**
>
> - preconditions: `Gar_dirty_floor ∧ Rob_loc = garage`
> - effects: `¬ Gar_dirty_floor` , `Gar_dusty`

> **Sweep lr**
>
> - preconditions: `lr_dirty_floor ∧ Rob_loc = lr`
> - effects: `¬ lr_dirty_floor` , `Lr_dusty`

- Move actions:

> **Move in garage**
>
> - preconditions: `Rob_loc = lr`
> - effects: `Rob_loc = garage`

> **Move in lr**
>
> - preconditions: `Rob_loc = garage`
> - effects: `Rob_loc = lr`

From now on, we'll use the notation of the type $\texttt{Variable}_t$ to refer to the variable t, where t $\in$ {0, 1} for Action variables, and t $\in$ {0, 1, 2} for State variables.

For every t:

Precondition constraints:

- For **dust garage**:

> $\texttt{Dustcloth\_clean}_t \leftarrow \text{Action}_t = \texttt{dust garage}$
>
> $\texttt{Gar\_dusty}_t \leftarrow \text{Action}_t = \texttt{dust garage}$
>
> $\texttt{Rob\_loc}_t = \texttt{Garage} \leftarrow \text{Action}_t = \texttt{dust garage}$

- For **dust lr**:

> $\texttt{Dustcloth\_clean}_t \leftarrow \text{Action}_t = \texttt{dust lr}$
>
> $\texttt{Lr\_dusty}_t \leftarrow \text{Action}_t = \texttt{dust lr}$
>
> $\texttt{Rob\_loc}_t = \texttt{lr} \leftarrow \text{Action}_t = \texttt{dust lr}$

- For **sweep garage**:

> $\texttt{Gar\_dirty\_floor}_t \leftarrow \text{Action}_t = \texttt{sweep garage}$
>
> $\texttt{Rob\_loc}_t = \texttt{garage} \leftarrow \text{Action}_t = \texttt{sweep garage}$

- For **sweep lr**:

> $\texttt{Lr\_dirty\_floor}_t \leftarrow \text{Action}_t = \texttt{sweep lr}$
>
> $\texttt{Rob\_loc}_t = \texttt{lr} \leftarrow \text{Action}_t = \texttt{sweep lr}$

- For **move in garage**:

> $\texttt{Rob\_loc}_t = \texttt{lr} \leftarrow \text{Action}_t = \texttt{move in garage}$

- For **move in lr**:

> $\texttt{Rob\_loc}_{\,t} = \texttt{garage} \leftarrow \text{Action}_t = \texttt{move in lr}$

Effect constraints:

- For **dust garage**:

> $\neg\, \texttt{Dustcloth\_clean}_{\,t+1} \leftarrow \text{Action}_t = \texttt{dust garage}$
>
> $\neg\, \texttt{Gar\_dusty}_{\,t+1} \leftarrow \text{Action}_t = \texttt{dust garage}$

- For **dust lr**:

> $\neg\, \texttt{Dustcloth\_clean}_{\,t+1} \leftarrow \text{Action}_t = \texttt{dust lr}$
>
> $\neg\, \texttt{Lr\_dusty}_{\,t+1} \leftarrow \text{Action}_t = \texttt{dust lr}$

Frame Constraints:

- For **Lr_dusty**:

> $\texttt{Lr\_dusty}_{\,t+1} = \texttt{Lr\_dusty}_{\,t} \leftarrow \text{Action}_t \neq \texttt{dust lr}$
>
> $\texttt{Lr\_dusty}_{\,t+1} = \texttt{Lr\_dusty}_{\,t} \leftarrow \text{Action}_t \neq \texttt{sweep lr}$

- For **Gar_dusty**:

> $\texttt{Gar\_dusty}_{\,t+1} = \texttt{Gar\_dusty}_{\,t} \leftarrow \text{Action}_t \neq \texttt{dust garage}$
>
> $\texttt{Gar\_dusty}_{\,t+1} = \texttt{Gar\_dusty}_{\,t} \leftarrow \text{Action}_t \neq \texttt{sweep garage}$

- For **Lr_dirty_floor**:

> $\texttt{Lr\_dirty\_floor}_{\,t+1} = \texttt{Lr\_dirty\_floor}_{\,t} \leftarrow \text{Action}_t \neq \texttt{sweep lr}$

- For **Gar_dirty_floor**:

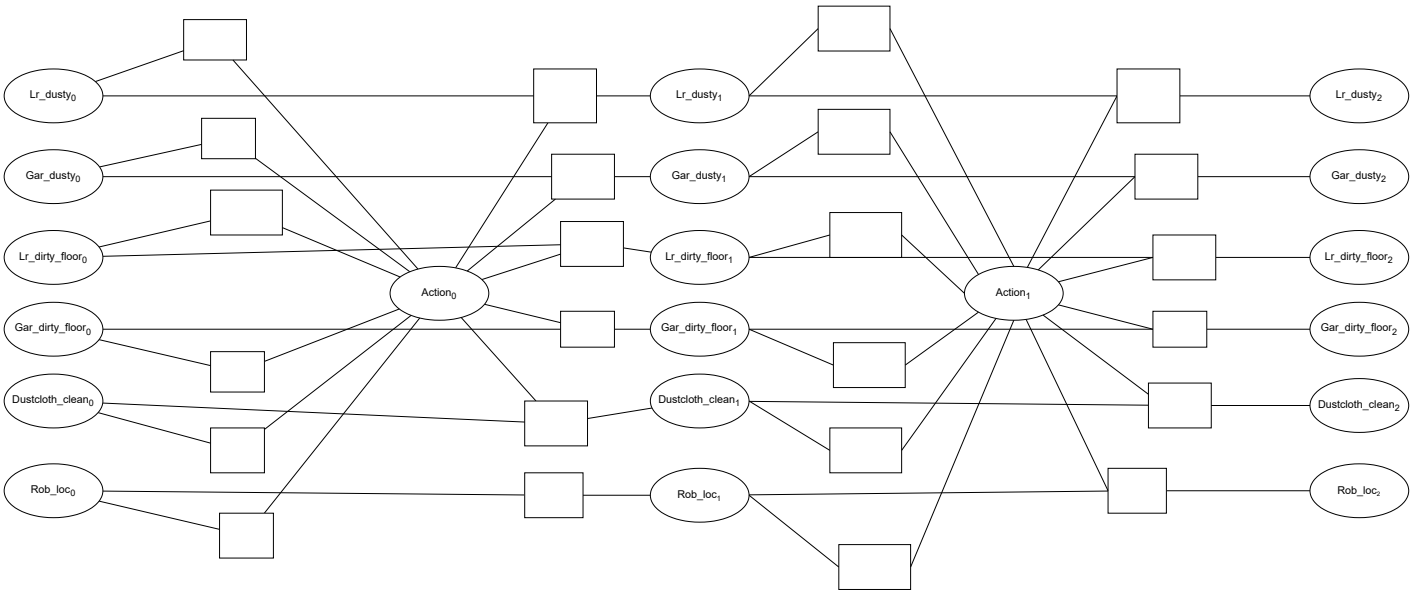
> $\texttt{Gar\_dirty\_floor}_{\,t+1} = \texttt{Gar\_dirty\_floor}_{\,t} \leftarrow \text{Action}_t \neq \texttt{sweep garage}$

- For **Dustcloth_clean**:

> $\texttt{Dustcloth\_clean}_{\,t+1} = \texttt{Dustcloth\_clean}_{\,t} \leftarrow \text{Action}_t \neq \texttt{dust garage}$

- For **Rob_loc**:

> $\texttt{Rob\_loc}_{\,t+1} = \texttt{Rob\_loc}_{\,t} \leftarrow \text{Action}_t \neq \texttt{move in garage}$
>
> $\texttt{Rob\_loc}_{\,t+1} = \texttt{Rob\_loc}_{\,t} \leftarrow \text{Action}_t \neq \texttt{move in lr}$


Lr_dusty0
Gar_dusty0
Lr_dirty_floor0
Gar_dirty_floor0
Dustcloth_clean0
Rob_loc0
Action0
Lr_dusty1
Gar_dusty1
Lr_dirty_floor1
Gar_dirty_floor1
Dustcloth_clean1
Rob_loc1
Action1
Lr_dusty2
Gar_dusty2
Lr_dirty_floor2
Gar_dirty_floor2
Dustcloth_clean2
Rob_loc2