Report on Assignment for Automated Planning: Theory and Practice

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This report is for the assignment for the final exam of Automated Planning course. The main goal of all the planning problems in the given Assignment here were to supply all the work stations with either all, or some of the contents. And the contents could be either bolts or valves or tools. In the first problem, only one robot has been supposed to act. And from the second to all of the rest of the problems, multiple robots with each having one carrier, were assigned. Here, in my domain definitions I have assumed that boxes could be reloaded. The goal of the project was to having all the workstations have been supplied with either all type of contents or some of the contents. Locations are either connected to each other or not. But the main location, which is the central_warehouse, is connected to all locations.

In all of my domains, I have assumed that locations are connected. Further manilpulation could be done to the code if needed for more complex scenarios. I have considered 3 robots, each with one carrier and varying capacities. Total boxes are 3 and total locations including central_warehouse are 3. One location has 2 workstations and the other one has one. So there are 3 workstations total. But however, central_warehouse doesn't have any workstations. I have used a generic type content here and 3 specific other content types representing bolts, valves and tools.

In the submitted archive, following are the contents:

- **Problem1: workstation**
  (command: downward --alias seq-sat-lama-2011 /root/pddl/workstation/domain1.pddl /root/pddl/workstation/problem1.pddl
)
- **Problem2: Carrier**
  (command: downward --alias seq-sat-lama-2011 /root/pddl/carrier/domain2.pddl /root/pddl/carrier/problem2.pddl

- **Problem3: htnproblem**
  (command: java -jar PANDA.jar -parser hddl domain2.hddl problem2.hddl)
- **Problem4: durativeaction**
  (command: tfd pddl/durativeaction/domain2.pddl pddl/durativeaction/problem2.pddl)
- **Problem5: plansys2_project**
  (command: ros2 launch plansys2_project plansys2_project.launch.py)

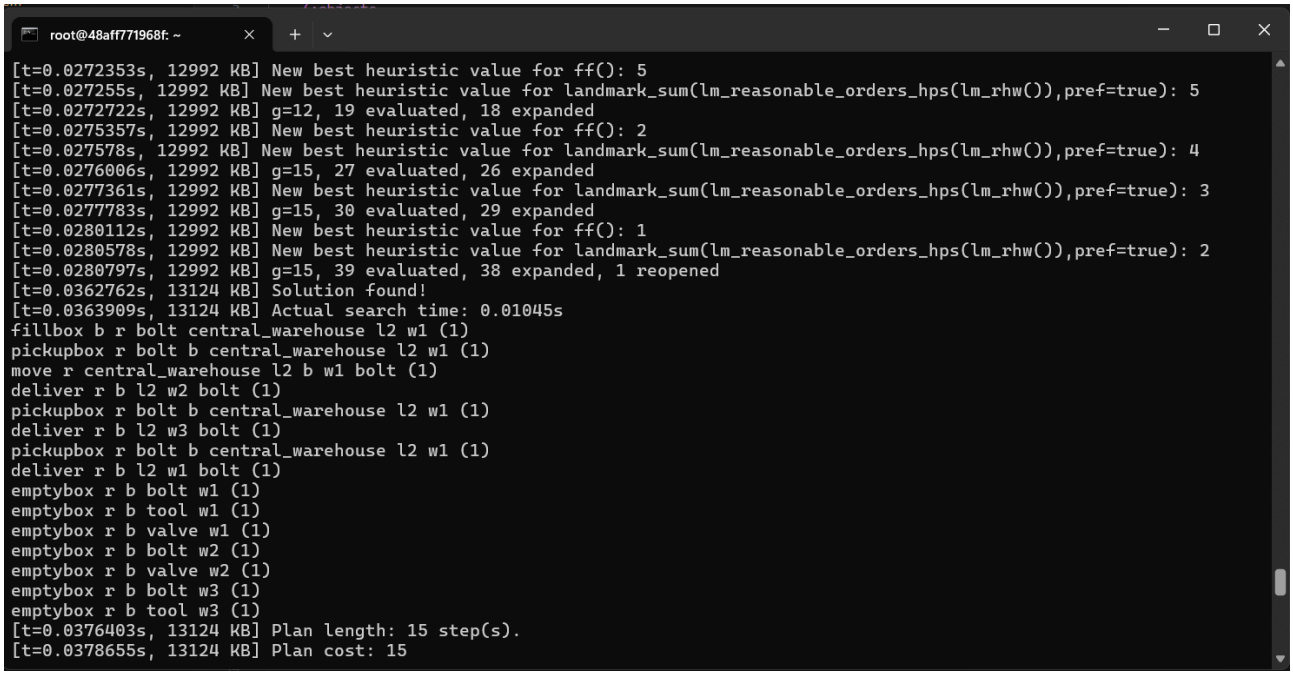
PROBLEM 1:

Domain Definition:

I have defined 16 predicates and 5 types of objects. For fulfilling the goal I have defined 6 actions. Basically the work flow for my defined domain would be:

fillbox > pickupbox > move > deliver > emptybox > return

For the compilation I have used llama algorithm using downward planner. And from the screenshot you can see the goal could be achieved and multiple solutions could be found.



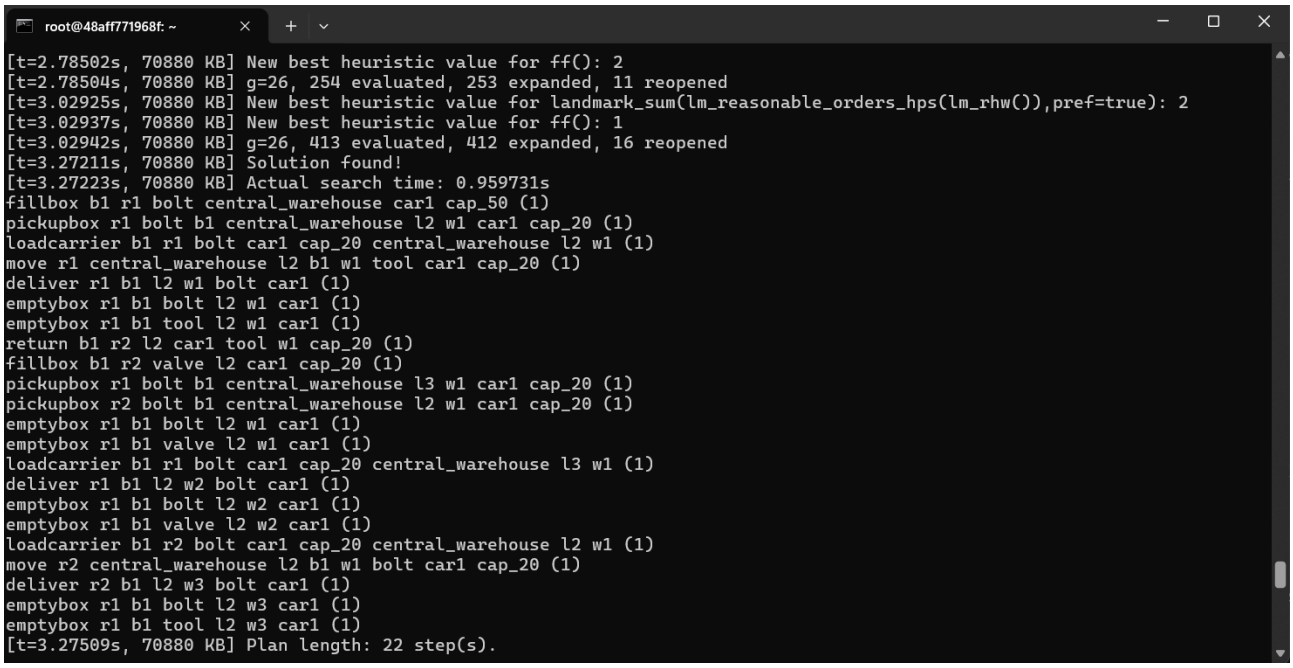
PROBLEM 2:

Domain Definition:

I have defined 22 predicates and 7 types of objects. For fulfilling the goal I have defined 7 actions. Since this problem involves a carrier for each robot, I have defined necessary types, predicates and actions for it. Basically the work flow for my defined domain would be:

fillbox > pickupbox > loadcarrier > move > deliver > emptybox > return

For the compilation I have used llama algorithm using downward planner. And from the screenshot we can see the goal could be achieved and multiple solutions could be found.



PROBLEM 3:

Domain Definition:

I have defined 20 predicates and 7 types of objects. For fulfilling the goal I have defined 6 actions with 4 tasks and 4 methods. Basically the work flow for my defined domain would be:

Tasks:

fill_up_robot > deliver_content > return_to_central_warehouse > finish_and_return

Methods:

fill_up_robot_method > deliver_method > return_robot_method > planner_complete_method

Actions:

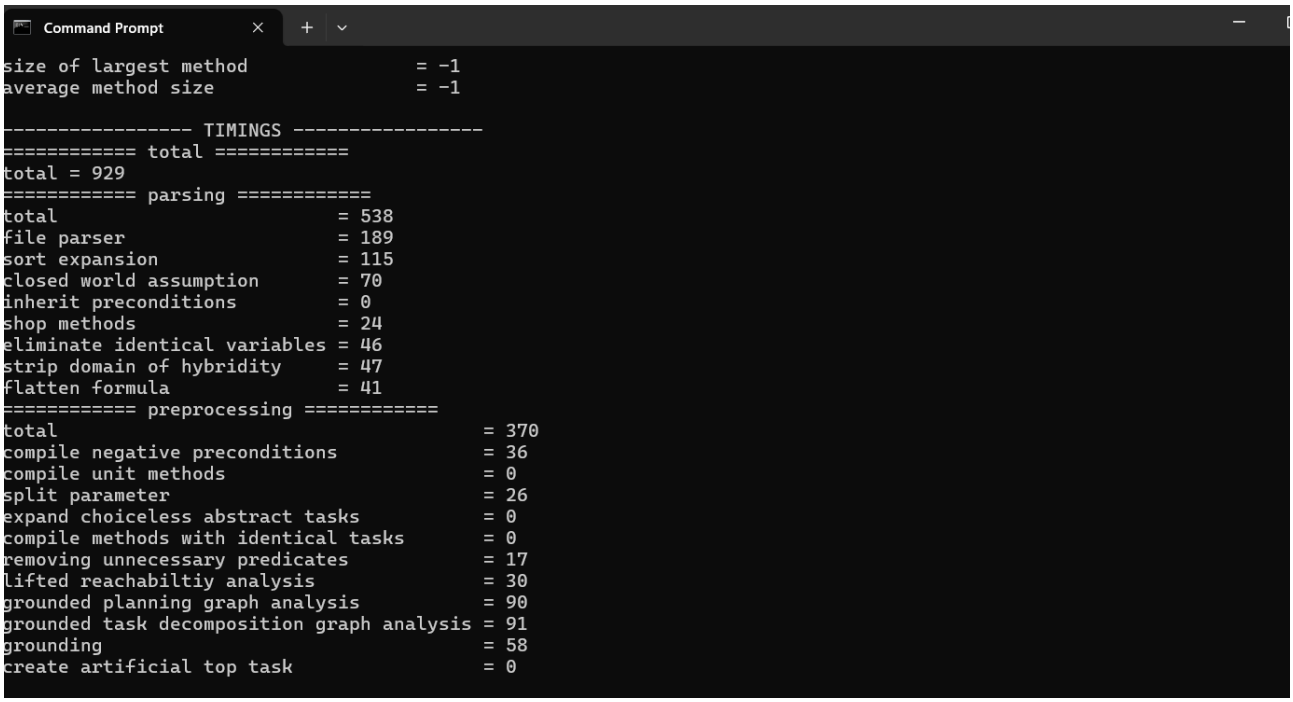
fillbox > pickupbox > loadcarrier > move > deliver > emptybox > return

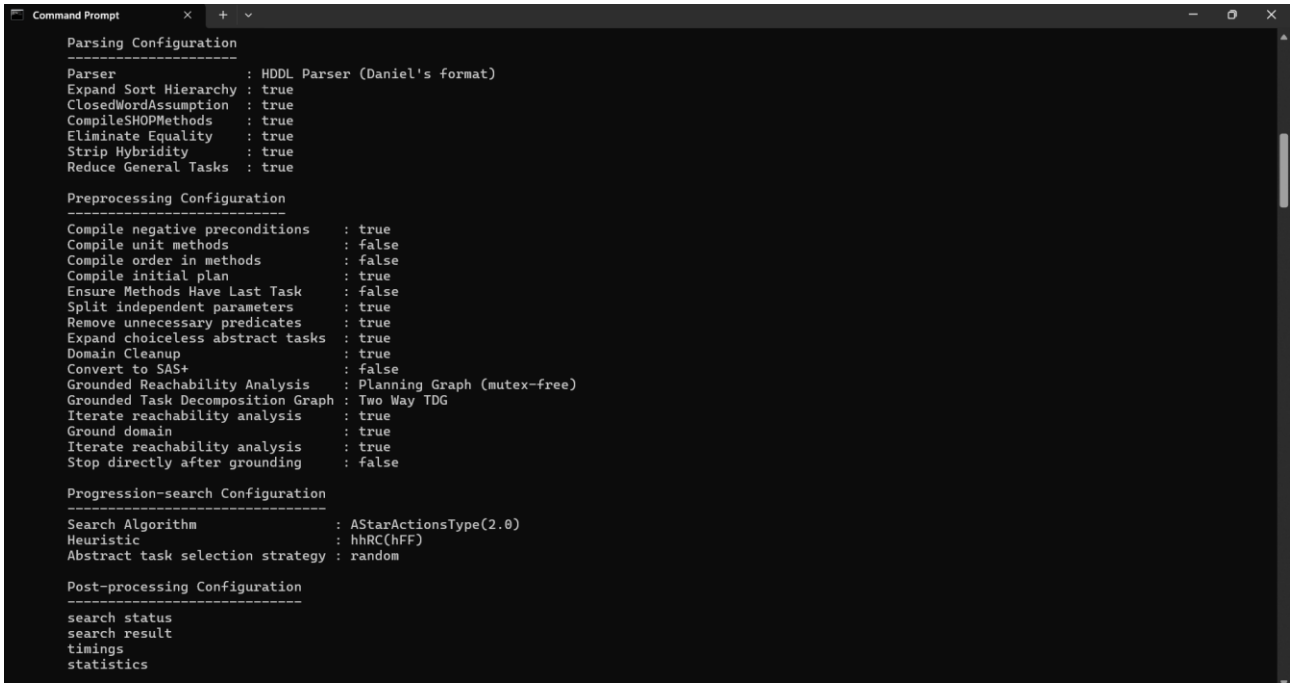
The hierarchy would be:

1. fill_up_robot > fill_up_robot_method >
   - Fillbox
   - Pickupbox
   - Loadcarrier

2. deliver_content > deliver_method >
   - Move
   - Deliver
   - Emptybox
3. return_to_central_warehouse > return_robot_method >
   - Return

For the compilation I have used PANDA planner and AStar search algorithm. And from the screenshot we can see tasks could be decomposed to methods and gradually to sub tasks, although the plan was unsolvable.


Command Prompt
size of largest method = -1
average method size = -1
----------- TIMINGS -----------
========== total ==========
total = 929
========== parsing ==========
total = 538
file parser = 189
sort expansion = 115
closed world assumption = 70
inherit preconditions = 0
shop methods = 24
eliminate identical variables = 46
strip domain of hybridity = 47
flatten formula = 41
========== preprocessing ==========
total = 370
compile negative preconditions = 36
compile unit methods = 0
split parameter = 26
expand choiceless abstract tasks = 0
compile methods with identical tasks = 0
removing unnecessary predicates = 17
lifted reachabiltiy analysis = 30
grounded planning graph analysis = 90
grounded task decomposition graph analysis = 91
grounding = 58
create artificial top task = 0


Command Prompt
Parsing Configuration
Parser : HDDL Parser (Daniel's format)
Expand Sort Hierarchy : true
ClosedWordAssumption : true
CompileSHOPMethods : true
Eliminate Equality : true
Strip Hybridity : true
Reduce General Tasks : true
Preprocessing Configuration
Compile negative preconditions : true
Compile unit methods : false
Compile order in methods : false
Compile initial plan : true
Ensure Methods Have Last Task : false
Split independent parameters : true
Remove unnecessary predicates : true
Expand choiceless abstract tasks : true
Domain Cleanup : true
Convert to SAS+ : false
Grounded Reachability Analysis : Planning Graph (mutex-free)
Grounded Task Decomposition Graph : Two Way TDG
Iterate reachability analysis : true
Ground domain : true
Iterate reachability analysis : true
Stop directly after grounding : false
Progression-search Configuration
Search Algorithm : AStarActionsType(2.0)
Heuristic : hhRC(hFF)
Abstract task selection strategy : random
Post-processing Configuration
search status
search result
timings
statistics

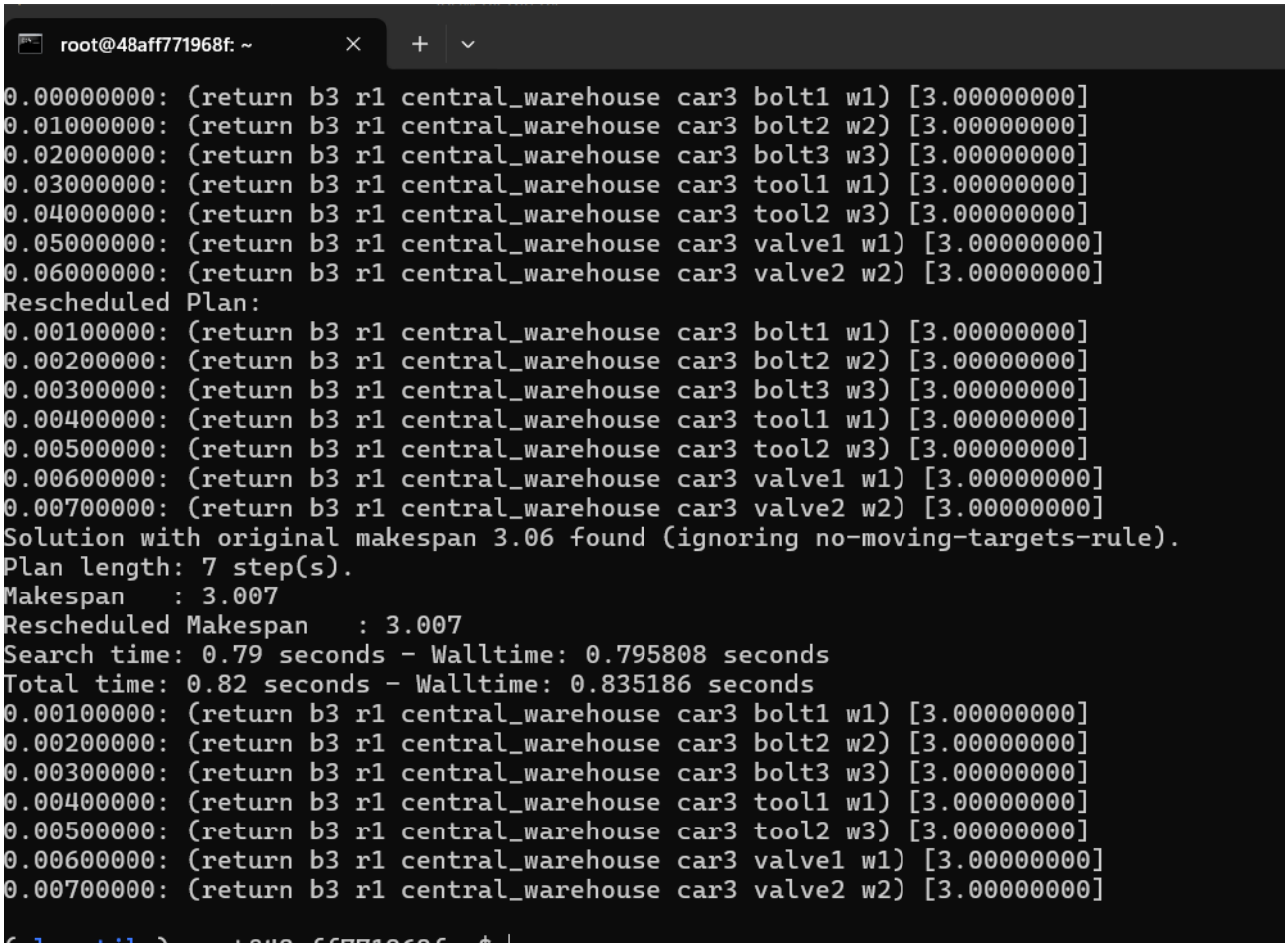
PROBLEM 4:

Domain Definition:

I have defined 16 predicates and 7 types of objects. For fulfilling the goal I have defined 6 durative actions. Basically the work flow for my defined domain would be:

fillbox > pickupbox > loadcarrier > move > deliver > emptybox > return

For the compilation I have used TFD planner and AStar search algorithm. And from the screenshot we can see the goal could be achieved and multiple solutions could be found.



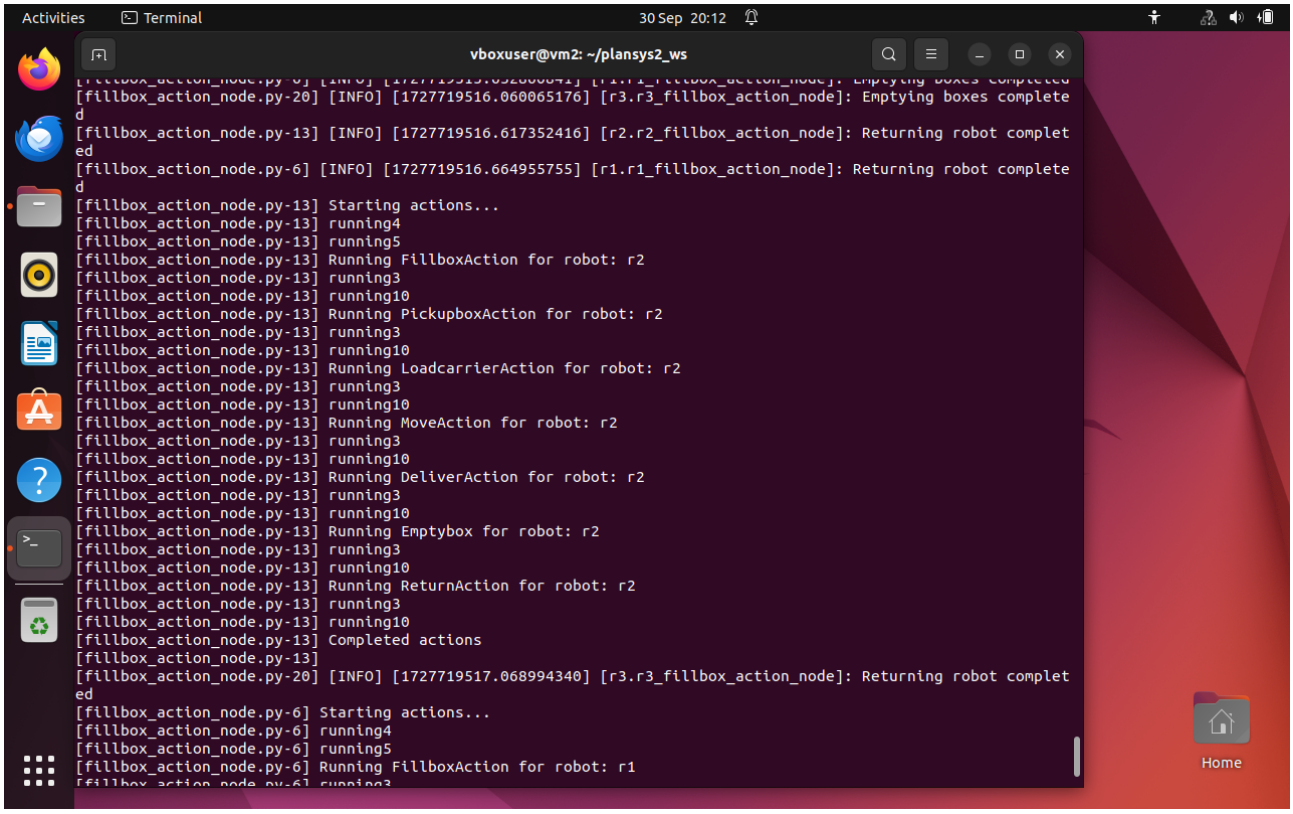
PROBLEM 5:

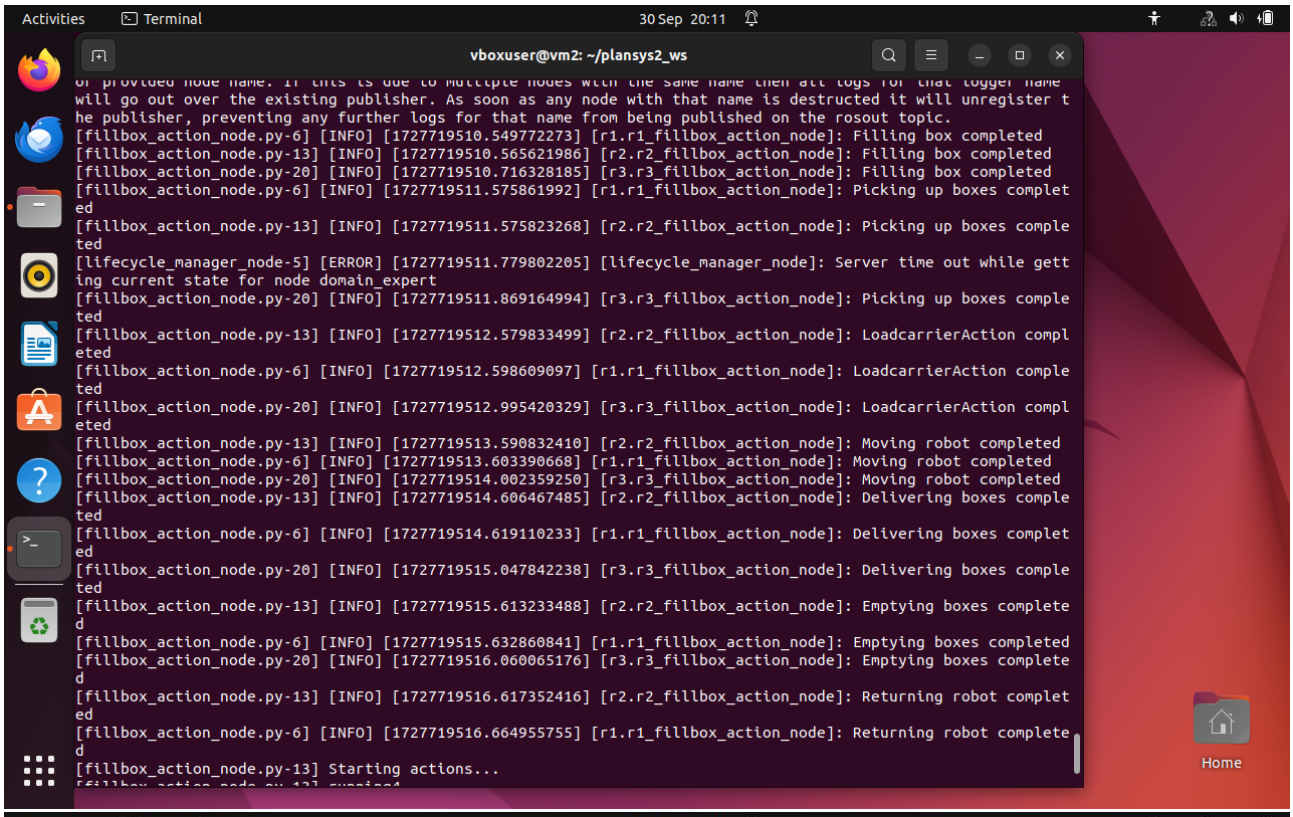
Domain Definition:

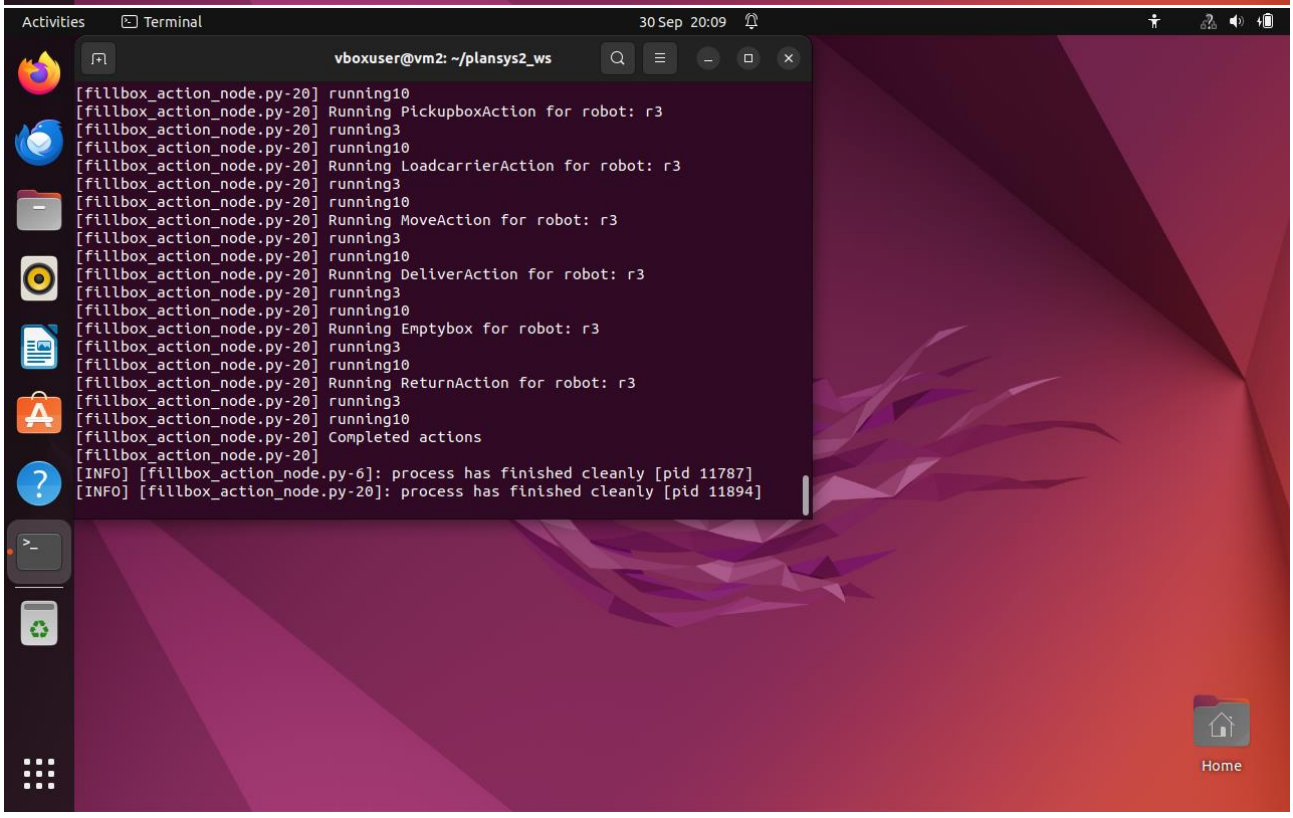
I have defined 16 predicates and 7 types of objects. For fulfilling the goal I have defined 6 durative actions. Basically the work flow for my defined domain would be:

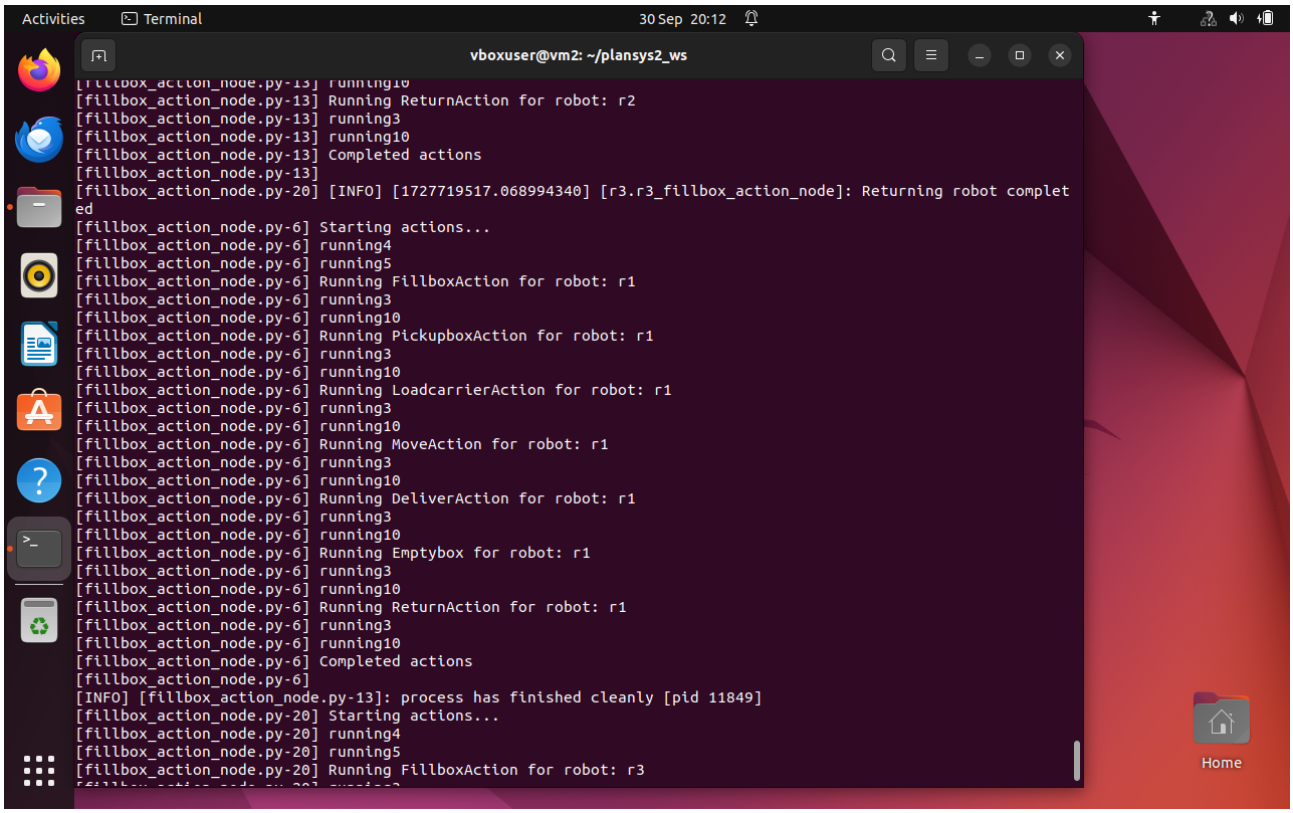
fillbox > pickupbox > loadcarrier > move > deliver > emptybox > return

For the compilation I have used TFD planner and AStar search algorithm. And for the simulation plansys2 of ROS2 has been utilized. And from the screenshot we can see the goal could be achieved and solution could be found.




Activities
Terminal
30 Sep 20:11
vboxuser@vm2: ~/plansys2_ws
will go out over the existing publisher. As soon as any node with that name is destructed it will unregister t
he publisher, preventing any further logs for that name from being published on the rosout topic.
[fillbox_action_node.py-6] [INFO] [1727719510.549772273] [r1.r1_fillbox_action_node]: Filling box completed
[fillbox_action_node.py-13] [INFO] [1727719510.565621986] [r2.r2_fillbox_action_node]: Filling box completed
[fillbox_action_node.py-20] [INFO] [1727719510.716328185] [r3.r3_fillbox_action_node]: Filling box completed
[fillbox_action_node.py-6] [INFO] [1727719511.575861992] [r1.r1_fillbox_action_node]: Picking up boxes complet
ed
[fillbox_action_node.py-13] [INFO] [1727719511.575823268] [r2.r2_fillbox_action_node]: Picking up boxes comple
ted
[lifecycle_manager_node-5] [ERROR] [1727719511.779802205] [lifecycle_manager_node]: Server time out while gett
ing current state for node domain_expert
[fillbox_action_node.py-20] [INFO] [1727719511.869164994] [r3.r3_fillbox_action_node]: Picking up boxes comple
ted
[fillbox_action_node.py-13] [INFO] [1727719512.579833499] [r2.r2_fillbox_action_node]: LoadcarrierAction compl
eted
[fillbox_action_node.py-6] [INFO] [1727719512.598609097] [r1.r1_fillbox_action_node]: LoadcarrierAction comple
ted
[fillbox_action_node.py-20] [INFO] [1727719512.995420329] [r3.r3_fillbox_action_node]: LoadcarrierAction compl
eted
[fillbox_action_node.py-13] [INFO] [1727719513.590832410] [r2.r2_fillbox_action_node]: Moving robot completed
[fillbox_action_node.py-6] [INFO] [1727719513.603390668] [r1.r1_fillbox_action_node]: Moving robot completed
[fillbox_action_node.py-20] [INFO] [1727719514.002359250] [r3.r3_fillbox_action_node]: Moving robot completed
[fillbox_action_node.py-13] [INFO] [1727719514.606467485] [r2.r2_fillbox_action_node]: Delivering boxes comple
ted
[fillbox_action_node.py-6] [INFO] [1727719514.619110233] [r1.r1_fillbox_action_node]: Delivering boxes complet
ed
[fillbox_action_node.py-20] [INFO] [1727719515.047842238] [r3.r3_fillbox_action_node]: Delivering boxes comple
ted
[fillbox_action_node.py-13] [INFO] [1727719515.613233488] [r2.r2_fillbox_action_node]: Emptying boxes complete
d
[fillbox_action_node.py-6] [INFO] [1727719515.632860841] [r1.r1_fillbox_action_node]: Emptying boxes completed
[fillbox_action_node.py-20] [INFO] [1727719516.060065176] [r3.r3_fillbox_action_node]: Emptying boxes complete
d
[fillbox_action_node.py-13] [INFO] [1727719516.617352416] [r2.r2_fillbox_action_node]: Returning robot complet
ed
[fillbox_action_node.py-6] [INFO] [1727719516.664955755] [r1.r1_fillbox_action_node]: Returning robot complete
d
[fillbox_action_node.py-13] Starting actions...
Home


Activities
Terminal
30 Sep 20:09
vboxuser@vm2: ~/plansys2_ws
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running PickupboxAction for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running LoadcarrierAction for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running MoveAction for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running DeliverAction for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running Emptybox for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Running ReturnAction for robot: r3
[fillbox_action_node.py-20] running3
[fillbox_action_node.py-20] running10
[fillbox_action_node.py-20] Completed actions
[fillbox_action_node.py-20]
[INFO] [fillbox_action_node.py-6]: process has finished cleanly [pid 11787]
[INFO] [fillbox_action_node.py-20]: process has finished cleanly [pid 11894]
Home


Activities
Terminal
30 Sep 20:12
vboxuser@vm2: ~/plansys2_ws
[fillbox_action_node.py-13] running10
[fillbox_action_node.py-13] Running ReturnAction for robot: r2
[fillbox_action_node.py-13] running3
[fillbox_action_node.py-13] running10
[fillbox_action_node.py-13] Completed actions
[fillbox_action_node.py-13]
[fillbox_action_node.py-20] [INFO] [1727719517.068994340] [r3.r3_fillbox_action_node]: Returning robot completed
[fillbox_action_node.py-6] Starting actions...
[fillbox_action_node.py-6] running4
[fillbox_action_node.py-6] running5
[fillbox_action_node.py-6] Running FillboxAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running PickupboxAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running LoadcarrierAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running MoveAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running DeliverAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running Emptybox for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Running ReturnAction for robot: r1
[fillbox_action_node.py-6] running3
[fillbox_action_node.py-6] running10
[fillbox_action_node.py-6] Completed actions
[fillbox_action_node.py-6]
[INFO] [fillbox_action_node.py-13]: process has finished cleanly [pid 11849]
[fillbox_action_node.py-20] Starting actions...
[fillbox_action_node.py-20] running4
[fillbox_action_node.py-20] running5
[fillbox_action_node.py-20] Running FillboxAction for robot: r3
Home