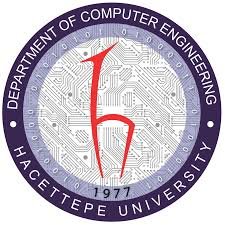
BBM405

Fundamentals of Artificial Intelligence

HW3



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## Introduction:

Our aim in this experiment use PDDL (the “Planning Domain Definition Language”) to model and solve planning problems. We have two domains at this experiment. First for gripper problem. We have robot that will transport some balls to new rooms. At second part we are going to implement Wumpus world planning. We use features of PDDL to apply Wumpus World.

## Part 1:

**gripper-domain.pddl**

|  |
| --- |
| (define (domain gripper-domain)  (:predicates  (room ?r)  (ball ?b)  (gripper ?g)  (at-robby ?r)  (at ?b ?r)  (free ?g)  (carry ?o ?g))  (:action move  :parameters (?from ?to)  :precondition (and (room ?from) (room ?to) (at-robby ?from))  :effect (and (at-robby ?to) (not (at-robby ?from))))  (:action pick  :parameters (?obj ?room ?gripper)  :precondition (and (ball ?obj) (room ?room) (gripper ?gripper) (at ?obj ?room) (at-robby ?room) (free ?gripper))  :effect (and (carry ?obj ?gripper) (not (at ?obj ?room)) (not (free ?gripper))))  (:action drop  :parameters (?obj ?room ?gripper)  :precondition (and (ball ?obj) (room ?room) (gripper ?gripper) (carry ?obj ?gripper) (at-robby ?room))  :effect (and (at ?obj ?room) (free ?gripper) (not (carry ?obj ?gripper))))) |

**gripper-problem-2.pddl**

|  |
| --- |
| (define (problem gripper-2)  (:domain gripper-domain)  (:objects rooma roomb roomc roomd ball1 ball2 ball3 ball4 left right)  (:init  (room rooma)  (room roomb)  (room roomc)  (room roomd)  (ball ball1)  (ball ball2)  (ball ball3)  (ball ball4)  (gripper left)  (gripper right)  (at-robby rooma)  (free left)  (free right)  (at ball1 rooma)  (at ball2 rooma)  (at ball3 rooma)  (at ball4 rooma))  (:goal (and  (at ball1 roomb)  (at ball2 roomc)  (at ball3 roomd)  (at ball4 roomc)))) |

**gripper-plan-2**

|  |
| --- |
| **(pick ball1 rooma right)**  **(move rooma roomb)**  **(drop ball1 roomb right)**  **(move roomb rooma)**  **(pick ball4 rooma right)**  **(move rooma roomc)**  **(drop ball4 roomc right)**  **(move roomc rooma)**  **(pick ball3 rooma right)**  **(move rooma roomd)**  **(drop ball3 roomd right)**  **(move roomd rooma)**  **(pick ball2 rooma right)**  **(move rooma roomc)**  **(drop ball2 roomc right)** |

**gripper-problem-3.pddl**

|  |
| --- |
| **(define (problem gripper-3)**  **(:domain gripper-domain)**  **(:objects rooma roomb roomc roomd rooma1 roomb1 roomc1 roomd1 rooma2 roomb2 roomc2 roomd2 rooma3 roomb3 roomc3 roomd3 rooma4 roomb4 roomc4 roomd4**  **ball1 ball2 ball3 ball4 ball5 ball6 ball7 ball8 ball9 ball10 ball11 ball12 left right)**  **(:init**  **(room rooma)**  **(room roomb)**  **(room roomc)**  **(room roomd)**  **(room rooma1)**  **(room roomb1)**  **(room roomc1)**  **(room roomd1)**  **(room rooma2)**  **(room roomb2)**  **(room roomc2)**  **(room roomd2)**  **(room rooma3)**  **(room roomb3)**  **(room roomc3)**  **(room roomd3)**  **(room rooma4)**  **(room roomb4)**  **(room roomc4)**  **(room roomd4)**  **(ball ball1)**  **(ball ball2)**  **(ball ball3)**  **(ball ball4)**  **(ball ball5)**  **(ball ball6)**  **(ball ball7)**  **(ball ball8)**  **(ball ball9)**  **(ball ball10)**  **(ball ball11)**  **(ball ball12)**  **(gripper left)**  **(gripper right)**  **(at-robby rooma)**  **(free left)**  **(free right)**  **(at ball1 rooma)**  **(at ball2 rooma)**  **(at ball3 rooma)**  **(at ball4 rooma)**  **(at ball5 rooma)**  **(at ball6 rooma)**  **(at ball7 rooma)**  **(at ball8 rooma)**  **(at ball9 rooma)**  **(at ball10 rooma)**  **(at ball11 rooma)**  **(at ball12 rooma))**  **(:goal (and**  **(at ball1 roomb)**  **(at ball2 roomc)**  **(at ball3 roomd)**  **(at ball4 rooma1)**  **(at ball5 roomb1)**  **(at ball6 roomc1)**  **(at ball7 roomd1)**  **(at ball8 roomb2)**  **(at ball9 roomc2)**  **(at ball10 roomd3)**  **(at ball11 rooma4)**  **(at ball12 roomb4)**  **)))** |

**gripper-plan-3**

|  |
| --- |
| **(pick ball12 rooma left)**  **(move rooma roomb4)**  **(drop ball12 roomb4 left)**  **(move roomb4 rooma)**  **(pick ball11 rooma left)**  **(move rooma rooma4)**  **(drop ball11 rooma4 left)**  **(move rooma4 rooma)**  **(pick ball10 rooma left)**  **(move rooma roomd3)**  **(drop ball10 roomd3 left)**  **(move roomd3 rooma)**  **(pick ball9 rooma left)**  **(move rooma roomc2)**  **(drop ball9 roomc2 left)**  **(move roomc2 rooma)**  **(pick ball8 rooma left)**  **(move rooma roomb2)**  **(drop ball8 roomb2 left)**  **(move roomb2 rooma)**  **(pick ball7 rooma left)**  **(move rooma roomd1)**  **(drop ball7 roomd1 left)**  **(move roomd1 rooma)**  **(pick ball6 rooma left)**  **(move rooma roomc1)**  **(drop ball6 roomc1 left)**  **(move roomc1 rooma)**  **(pick ball5 rooma left)**  **(move rooma roomb1)**  **(drop ball5 roomb1 left)**  **(move roomb1 rooma)**  **(pick ball4 rooma left)**  **(move rooma rooma1)**  **(drop ball4 rooma1 left)**  **(move rooma1 rooma)**  **(pick ball3 rooma left)**  **(move rooma roomd)**  **(drop ball3 roomd left)**  **(move roomd rooma)**  **(pick ball2 rooma left)**  **(move rooma roomc)**  **(drop ball2 roomc left)**  **(move roomc rooma)**  **(pick ball1 rooma right)**  **(move rooma roomb)**  **(drop ball1 roomb right)** |

## Part 2:

**wumpus-domain.pddl**

|  |
| --- |
| (define (domain wumpus-domain)  (:requirements :strips)  (:predicates  (at ?what ?square)  (adj ?square-1 ?square-2)  (pit ?square)  (wumpus-in ?square)  ;; <-> (exists ?x (and (is-wumpus ?x) (at ?x ?square) (not (dead ?x))  (have ?who ?what)  (is-agent ?who)  (is-wumpus ?who)  (is-gold ?what)  (is-arrow ?what)  (dead ?who))  (:action move-agent  :parameters (?who ?from ?to)  :precondition (and (is-agent ?who)  (at ?who ?from)  (adj ?from ?to)  (not (pit ?to))  (not (wumpus-in ?to)))  :effect (and (not (at ?who ?from))  (at ?who ?to))  )  (:action take  :parameters (?who ?what ?where)  :precondition (and (is-agent ?who)  (at ?who ?where)  (at ?what ?where))  :effect (and (have ?who ?what)  (not (at ?what ?where)))  )  (:action shoot  :parameters (?who ?where ?with-what ?victim ?where-victim)  :precondition (and (is-agent ?who)  (have ?who ?with-what)  (is-arrow ?with-what)  (at ?who ?where)  (is-wumpus ?victim)  (at ?victim ?where-victim)  (adj ?where ?where-victim))  :effect (and (dead ?victim)  (not (wumpus-in ?where-victim))  (not (have ?who ?with-what)))  )  (:action move-wumpus  :parameters (?who ?from ?to)  :precondition (and (is-wumpus ?who)  (at ?who ?from)  (adj ?from ?to)  (not (pit ?to))  (not (wumpus-in ?to)))  :effect (and (not (at ?who ?from))  (at ?who ?to)  (not (wumpus-in ?from))  (wumpus-in ?to))  )  ) |

**wumpus-problem-2.pddl**

|  |
| --- |
| **(define (problem wumpus-problem-2)**  **(:domain wumpus-domain)**  **(:objects**  **sq-1-1 sq-1-2 sq-1-3**  **sq-2-1 sq-2-2 sq-2-3**  **sq-3-1 sq-3-2 sq-3-3**  **sq-4-1 sq-4-2 sq-4-3**  **sq-5-1 sq-5-2 sq-5-3**  **the-gold the-arrow**  **agent wumpus)**  **(:init**  **(adj sq-1-1 sq-1-2) (adj sq-1-2 sq-1-1)**  **(adj sq-1-2 sq-1-3) (adj sq-1-3 sq-1-2)**    **(adj sq-2-1 sq-2-2) (adj sq-2-2 sq-2-1)**  **(adj sq-2-2 sq-2-3) (adj sq-2-3 sq-2-2)**    **(adj sq-3-1 sq-3-2) (adj sq-3-2 sq-3-1)**  **(adj sq-3-2 sq-2-3) (adj sq-3-3 sq-3-2)**    **(adj sq-4-1 sq-4-2) (adj sq-4-2 sq-4-1)**  **(adj sq-4-2 sq-4-3) (adj sq-4-3 sq-4-2)**  **(adj sq-5-1 sq-5-2) (adj sq-5-2 sq-5-1)**  **(adj sq-5-2 sq-5-3) (adj sq-5-3 sq-5-2)**    **(adj sq-1-1 sq-2-1) (adj sq-2-1 sq-1-1)**  **(adj sq-1-2 sq-2-2) (adj sq-2-2 sq-1-2)**  **(adj sq-1-3 sq-2-3) (adj sq-2-3 sq-1-3)**  **(adj sq-2-1 sq-3-1) (adj sq-3-1 sq-2-1)**  **(adj sq-2-2 sq-3-2) (adj sq-3-2 sq-2-2)**  **(adj sq-2-3 sq-3-3) (adj sq-3-3 sq-2-3)**  **(adj sq-3-1 sq-4-1) (adj sq-4-1 sq-3-1)**  **(adj sq-3-2 sq-4-2) (adj sq-4-2 sq-3-2)**  **(adj sq-3-3 sq-4-3) (adj sq-4-3 sq-3-3)**  **(adj sq-4-1 sq-5-1) (adj sq-5-1 sq-4-1)**  **(adj sq-4-2 sq-5-2) (adj sq-5-2 sq-4-2)**  **(adj sq-4-3 sq-5-3) (adj sq-5-3 sq-4-3)**  **(pit sq-2-1)**  **(pit sq-2-2)**  **(pit sq-4-1)**  **(pit sq-4-2)**    **(is-gold the-gold)**  **(at the-gold sq-5-1)**    **(is-agent agent)**  **(at agent sq-1-1)**    **(is-arrow the-arrow)**  **(have agent the-arrow)**    **(is-wumpus wumpus)**  **(at wumpus sq-3-1)**  **(wumpus-in sq-3-1))**    **(:goal (and (have agent the-gold) (at agent sq-1-1)))**  **)** |

**wumpus-plan-2**

|  |
| --- |
| **(move-agent agent sq-1-1 sq-1-2)**  **(move-agent agent sq-1-2 sq-1-3)**  **(move-agent agent sq-1-3 sq-2-3)**  **(move-agent agent sq-2-3 sq-3-3)**  **(move-agent agent sq-3-3 sq-4-3)**  **(move-agent agent sq-4-3 sq-5-3)**  **(move-agent agent sq-5-3 sq-5-2)**  **(move-agent agent sq-5-2 sq-5-1)**  **(take agent the-gold sq-5-1)**  **(move-agent agent sq-5-1 sq-5-2)**  **(move-agent agent sq-5-2 sq-5-3)**  **(move-agent agent sq-5-3 sq-4-3)**  **(move-agent agent sq-4-3 sq-3-3)**  **(move-agent agent sq-3-3 sq-2-3)**  **(move-agent agent sq-2-3 sq-1-3)**  **(move-agent agent sq-1-3 sq-1-2)**  **(move-agent agent sq-1-2 sq-1-1)** |

**wumpus-problem-3.pddl**

|  |
| --- |
| **(define (problem wumpus-problem-2)**  **(:domain wumpus-domain)**  **(:objects**  **sq-1-1 sq-1-2 sq-1-3 sq-1-4**  **sq-2-1 sq-2-2 sq-2-3 sq-2-4**  **sq-3-1 sq-3-2 sq-3-3 sq-3-4**  **sq-4-1 sq-4-2 sq-4-3 sq-4-4**  **sq-5-1 sq-5-2 sq-5-3 sq-5-4**  **the-gold the-arrow**  **agent wumpus)**  **(:init**  **(adj sq-1-1 sq-1-2) (adj sq-1-2 sq-1-1)**  **(adj sq-1-2 sq-1-3) (adj sq-1-3 sq-1-2)**  **(adj sq-1-3 sq-1-4) (adj sq-1-4 sq-1-3)**    **(adj sq-2-1 sq-2-2) (adj sq-2-2 sq-2-1)**  **(adj sq-2-2 sq-2-3) (adj sq-2-3 sq-2-2)**  **(adj sq-2-3 sq-2-4) (adj sq-2-4 sq-2-3)**    **(adj sq-3-1 sq-3-2) (adj sq-3-2 sq-3-1)**  **(adj sq-3-2 sq-2-3) (adj sq-3-3 sq-3-2)**  **(adj sq-2-3 sq-2-4) (adj sq-2-4 sq-2-3)**    **(adj sq-4-1 sq-4-2) (adj sq-4-2 sq-4-1)**  **(adj sq-4-2 sq-4-3) (adj sq-4-3 sq-4-2)**  **(adj sq-4-3 sq-4-4) (adj sq-4-4 sq-4-3)**  **(adj sq-5-1 sq-5-2) (adj sq-5-2 sq-5-1)**  **(adj sq-5-2 sq-5-3) (adj sq-5-3 sq-5-2)**  **(adj sq-5-3 sq-5-4) (adj sq-5-4 sq-5-3)**    **(adj sq-1-1 sq-2-1) (adj sq-2-1 sq-1-1)**  **(adj sq-1-2 sq-2-2) (adj sq-2-2 sq-1-2)**  **(adj sq-1-3 sq-2-3) (adj sq-2-3 sq-1-3)**  **(adj sq-1-4 sq-2-4) (adj sq-2-4 sq-1-4)**  **(adj sq-2-1 sq-3-1) (adj sq-3-1 sq-2-1)**  **(adj sq-2-2 sq-3-2) (adj sq-3-2 sq-2-2)**  **(adj sq-2-3 sq-3-3) (adj sq-3-3 sq-2-3)**  **(adj sq-2-4 sq-3-4) (adj sq-3-4 sq-2-4)**  **(adj sq-3-1 sq-4-1) (adj sq-4-1 sq-3-1)**  **(adj sq-3-2 sq-4-2) (adj sq-4-2 sq-3-2)**  **(adj sq-3-3 sq-4-3) (adj sq-4-3 sq-3-3)**  **(adj sq-3-4 sq-4-4) (adj sq-4-4 sq-3-4)**  **(adj sq-4-1 sq-5-1) (adj sq-5-1 sq-4-1)**  **(adj sq-4-2 sq-5-2) (adj sq-5-2 sq-4-2)**  **(adj sq-4-3 sq-5-3) (adj sq-5-3 sq-4-3)**  **(adj sq-4-4 sq-5-4) (adj sq-5-4 sq-4-4)**  **(pit sq-1-3)**  **(pit sq-3-2)**  **(pit sq-4-1)**  **(pit sq-5-4)**    **(is-gold the-gold)**  **(at the-gold sq-5-1)**    **(is-agent agent)**  **(at agent sq-1-1)**    **(is-arrow the-arrow)**  **(have agent the-arrow)**    **(is-wumpus wumpus)**  **(at wumpus sq-4-3)**  **(wumpus-in sq-4-3))**    **(:goal (and (have agent the-gold) (at agent sq-1-4)))**  **)** |

**wumpus-plan-3**

|  |
| --- |
| **(move-agent agent sq-1-1 sq-2-1)**  **(move-agent agent sq-2-1 sq-2-2)**  **(move-agent agent sq-2-2 sq-2-3)**  **(move-wumpus wumpus sq-4-3 sq-5-3)**  **(move-agent agent sq-2-3 sq-3-3)**  **(move-agent agent sq-3-3 sq-4-3)**  **(move-agent agent sq-4-3 sq-4-2)**  **(move-agent agent sq-4-2 sq-5-2)**  **(move-agent agent sq-5-2 sq-5-1)**  **(take agent the-gold sq-5-1)**  **(move-agent agent sq-5-1 sq-5-2)**  **(move-agent agent sq-5-2 sq-4-2)**  **(move-agent agent sq-4-2 sq-4-3)**  **(move-agent agent sq-4-3 sq-3-3)**  **(move-agent agent sq-3-3 sq-2-3)**  **(move-agent agent sq-2-3 sq-2-4)**  **(move-agent agent sq-2-4 sq-1-4)** |

**wumpus-problem-4.pddl**

|  |
| --- |
| **(define (problem wumpus-problem-3)**  **(:domain wumpus-domain)**  **(:objects**  **sq-1-1 sq-1-2 sq-1-3 sq-1-4**  **sq-2-1 sq-2-2 sq-2-3 sq-2-4**  **sq-3-1 sq-3-2 sq-3-3 sq-3-4**  **sq-4-1 sq-4-2 sq-4-3 sq-4-4**  **sq-5-1 sq-5-2 sq-5-3 sq-5-4**  **the-gold the-arrow**  **agent wumpus)**  **(:init**  **(adj sq-1-1 sq-1-2) (adj sq-1-2 sq-1-1)**  **(adj sq-1-2 sq-1-3) (adj sq-1-3 sq-1-2)**  **(adj sq-1-3 sq-1-4) (adj sq-1-4 sq-1-3)**    **(adj sq-2-1 sq-2-2) (adj sq-2-2 sq-2-1)**  **(adj sq-2-2 sq-2-3) (adj sq-2-3 sq-2-2)**  **(adj sq-2-3 sq-2-4) (adj sq-2-4 sq-2-3)**    **(adj sq-3-1 sq-3-2) (adj sq-3-2 sq-3-1)**  **(adj sq-3-2 sq-2-3) (adj sq-3-3 sq-3-2)**  **(adj sq-2-3 sq-2-4) (adj sq-2-4 sq-2-3)**    **(adj sq-4-1 sq-4-2) (adj sq-4-2 sq-4-1)**  **(adj sq-4-2 sq-4-3) (adj sq-4-3 sq-4-2)**  **(adj sq-4-3 sq-4-4) (adj sq-4-4 sq-4-3)**  **(adj sq-5-1 sq-5-2) (adj sq-5-2 sq-5-1)**  **(adj sq-5-2 sq-5-3) (adj sq-5-3 sq-5-2)**  **(adj sq-5-3 sq-5-4) (adj sq-5-4 sq-5-3)**    **(adj sq-1-1 sq-2-1) (adj sq-2-1 sq-1-1)**  **(adj sq-1-2 sq-2-2) (adj sq-2-2 sq-1-2)**  **(adj sq-1-3 sq-2-3) (adj sq-2-3 sq-1-3)**  **(adj sq-1-4 sq-2-4) (adj sq-2-4 sq-1-4)**  **(adj sq-2-1 sq-3-1) (adj sq-3-1 sq-2-1)**  **(adj sq-2-2 sq-3-2) (adj sq-3-2 sq-2-2)**  **(adj sq-2-3 sq-3-3) (adj sq-3-3 sq-2-3)**  **(adj sq-2-4 sq-3-4) (adj sq-3-4 sq-2-4)**  **(adj sq-3-1 sq-4-1) (adj sq-4-1 sq-3-1)**  **(adj sq-3-2 sq-4-2) (adj sq-4-2 sq-3-2)**  **(adj sq-3-3 sq-4-3) (adj sq-4-3 sq-3-3)**  **(adj sq-3-4 sq-4-4) (adj sq-4-4 sq-3-4)**  **(adj sq-4-1 sq-5-1) (adj sq-5-1 sq-4-1)**  **(adj sq-4-2 sq-5-2) (adj sq-5-2 sq-4-2)**  **(adj sq-4-3 sq-5-3) (adj sq-5-3 sq-4-3)**  **(adj sq-4-4 sq-5-4) (adj sq-5-4 sq-4-4)**  **(pit sq-2-2)**  **(pit sq-2-3)**  **(pit sq-2-4)**  **(pit sq-3-3)**    **(is-gold the-gold)**  **(at the-gold sq-5-4)**    **(is-agent agent)**  **(at agent sq-1-4)**    **(is-arrow the-arrow)**  **(have agent the-arrow)**    **(is-wumpus wumpus)**  **(at wumpus sq-3-4)**  **(wumpus-in sq-3-4))**    **(:goal (and (have agent the-gold) (at agent sq-1-1)))**  **)** |

**wumpus-plan-4**

|  |
| --- |
| **(move-agent agent sq-1-4 sq-1-3)**  **(move-agent agent sq-1-3 sq-1-2)**  **(move-agent agent sq-1-2 sq-1-1)**  **(move-agent agent sq-1-1 sq-2-1)**  **(move-agent agent sq-2-1 sq-3-1)**  **(move-agent agent sq-3-1 sq-4-1)**  **(move-agent agent sq-4-1 sq-4-2)**  **(move-agent agent sq-4-2 sq-4-3)**  **(move-agent agent sq-4-3 sq-4-4)**  **(move-agent agent sq-4-4 sq-5-4)**  **(take agent the-gold sq-5-4)**  **(move-agent agent sq-5-4 sq-4-4)**  **(move-agent agent sq-4-4 sq-4-3)**  **(move-agent agent sq-4-3 sq-4-2)**  **(move-agent agent sq-4-2 sq-4-1)**  **(move-agent agent sq-4-1 sq-3-1)**  **(move-agent agent sq-3-1 sq-2-1)**  **(move-agent agent sq-2-1 sq-1-1)** |

## References

- <http://users.cecs.anu.edu.au/~patrik/pddlman/wumpus.html>

- <http://www.cs.toronto.edu/~sheila/384/w11/Assignments/A3/veloso-PDDL_by_Example.pdf>

- <http://csci431.artifice.cc/notes/pddl.html>

- <http://users.cecs.anu.edu.au/~patrik/pddlman/writing.html>

- <http://editor.planning.domains>

- https://web.cs.hacettepe.edu.tr/~pinar/courses/BBM405/lectures/logical\_agents.pdf