

CSE 291 – Intro to Deep RL

How to Make a Simulation

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Logistics

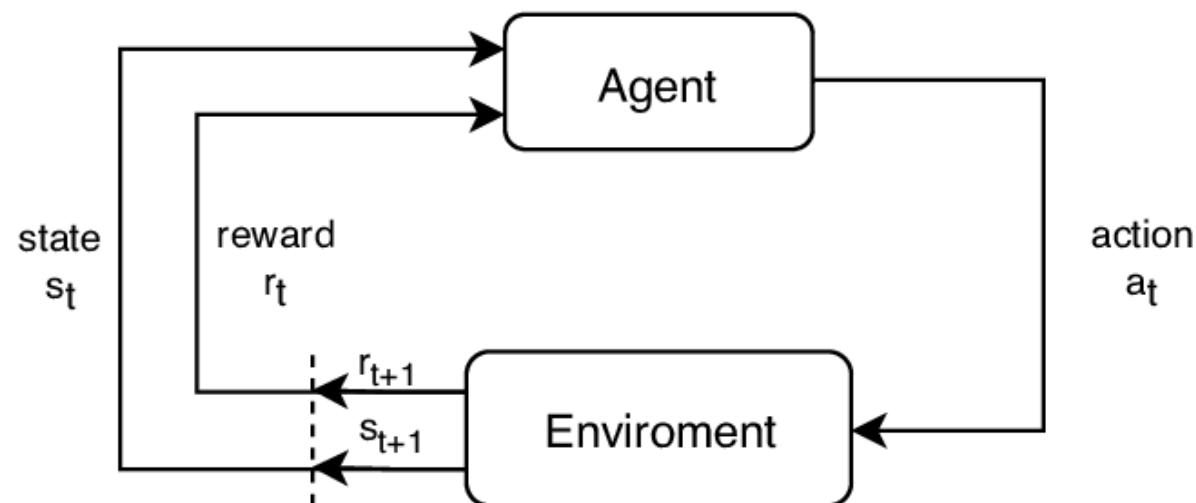
- HW 0 Due Tuesday 1/20 (late 1/22)
- HW 1 will be released Tuesday
- Get in your project groups by next Friday 1/23, signup sheet will go out
- Class participation clarifications

Recap: Why do we need simulations?

- Most tasks have many ways you can do them, e.g. “do the laundry” → how many clothes, which machine, what detergent, etc. etc.
- You usually do not know the “global” optimal solution ahead of time but usually know when you are done
- So you need to explore! Find many solutions and compare to see which is most efficient

Basic components of a simulation

- From an MDP perspective, it contains at least $\langle S, A, T \rangle$
 - S = set of all states
 - A = set of all actions
 - T = transition matrix $T: (S, A) \rightarrow S$



Basic components of a simulation

- $S = \text{set of all states}$
 - propositions that are true: you are in a house, door is open, knife in drawer
- $A = \text{set of all actions}$
 - take knife from drawer, walk through door
- $T = \text{transition matrix } T: (S, A) \rightarrow S$
 - (you are in a house & door is open, walk through door) \rightarrow you are outside

There are pre-conditions that need to be met to perform a certain action, and post-conditions that are true after

Simulation making methods

- How it changes based on why you're doing it
- If you're trying to make a fun video game
 - Is it simple? Just write the rules yourself
 - Is it complicated? Use a game engine like Unity (relatively simple) or Unreal (hard)
- Are you trying to make it easy to do AI stuff in it?

Simulation making methods

- Are you trying to make it easy to do AI stuff in it?
- Classical planning eg Zork / Ai2 THOR / Mujoco etc. – you want to have ~PDDL enablement
- LLM based simulations eg AI Dungeon – some kind of basic guardrails

PDDL – Planning Domain Definition Language

- Standard encoding for classic planning tasks
- Many specific languages for creating simulations have similarities with PDDL
- Syntax of the language isn't as important as the core concepts (most good LLMs can take care of syntactic sugar)

What's in a PDDL task?

- Objects: Things in the world that interest us.
- Predicates: Properties of objects that we are interested in; can be true or false.
- Initial state: The state of the world that we start in.
- Goal specification: Things that we want to be true.
- Actions/Operators: Ways of changing the state of the world.

2 .pddl files, domain and problem

Example

Gripper task with four balls: There is a robot that can move between two rooms and pick up or drop balls with either of his two arms. Initially, all balls and the robot are in the first room. We want the balls to be in the second room.

- Objects: The two rooms, four balls and two robot arms.
- Predicates: Is x a room? Is x a ball? Is ball x inside room y ? Is robot arm x empty?
- Initial state: All balls and the robot are in the first room. All robot arms are empty.
- Goal specification: All balls must be in the second room.
- Actions/Operators: The robot can move between rooms, pick up a ball or drop a ball.

Objects

- Rooms: rooma, roomb
- Balls: ball1, ball2, ball3, ball4
- Robot arms: left, right

In PDDL:

```
(:objects rooma roomb  
         ball1 ball2 ball3 ball4  
         left right)
```

Predicates

ROOM(x) – true iff x is a room

BALL(x) – true iff x is a ball

GRIPPER(x) – true iff x is a gripper (robot arm)

at-roddy(x) – true iff x is a room and the robot is in x

at-ball(x, y) – true iff x is a ball, y is a room, and x is in y

free(x) – true iff x is a gripper and x does not hold a ball

carry(x, y) – true iff x is a gripper, y is a ball, and x holds y

In PDDL:

```
(:predicates (ROOM ?x) (BALL ?x) (GRIPPER ?x)
             (at-roddy ?x) (at-ball ?x ?y)
             (free ?x) (carry ?x ?y))
```

Initial State

ROOM(rooma) and ROOM(roomb) are true.

BALL(ball1), ..., BALL(ball4) are true.

GRIPPER(left), GRIPPER(right), free(left) and free(right) are true.

at-roddy(rooma), at-ball(ball1, rooma), ..., at-ball(ball4, rooma) are true.

Everything else is false.

In PDDL:

```
(:init (ROOM rooma) (ROOM roomb)
      (BALL ball1) (BALL ball2) (BALL ball3) (BALL ball4)
      (GRIPPER left) (GRIPPER right) (free left) (free right)
      (at-roddy rooma)
      (at-ball ball1 rooma) (at-ball ball2 rooma)
      (at-ball ball3 rooma) (at-ball ball4 rooma))
```

Goal Specification

at-ball(ball1, roomb), ..., at-ball(ball4, roomb) must be true.

Everything else we don't care about.

In PDDL:

```
(:goal (and (at-ball ball1 roomb)
             (at-ball ball2 roomb)
             (at-ball ball3 roomb)
             (at-ball ball4 roomb)))
```

(Movement) Action/Operator

Description: The robot can move from x to y.

Precondition: ROOM(x), ROOM(y) and at-robb(y) are true.

Effect: at-robb(y) becomes true. at-robb(x) becomes false.

Everything else doesn't change.

In PDDL:

```
(:action move :parameters (?x ?y)
  :precondition (and (ROOM ?x) (ROOM ?y) (at-robb ?x))
  :effect (and (at-robb ?y) (not (at-robb ?x))))
```

How is this used for planning?

- Classic symbolic planners can read in PDDLs and give you solutions.
- There are many planners <https://planning.wiki/ref/planners/atoz> - will cover more later

Other simulator creating languages

- Complex text games often use Inform7
- Syntax is annoying so this was partially an attempt to make a more “natural language” way to make sims

Initial State

ROOM(rooma) and ROOM(roomb) are true.

BALL(ball1), ..., BALL(ball4) are true.

GRIPPER(left), GRIPPER(right), free(left) and free(right) are true.

at-roddy(rooma), at-ball(ball1, rooma), ..., at-ball(ball4, rooma) are true.

Everything else is false.

In PDDL:

```
(:init (ROOM rooma) (ROOM roomb)
      (BALL ball1) (BALL ball2) (BALL ball3) (BALL ball4)
      (GRIPPER left) (GRIPPER right) (free left) (free right)
      (at-roddy rooma)
      (at-ball ball1 rooma) (at-ball ball2 rooma)
      (at-ball ball3 rooma) (at-ball ball4 rooma))
```

Initial State

ROOM(rooma) and ROOM(roomb) are true.

BALL(ball1), ..., BALL(ball4) are true.

GRIPPER(left), GRIPPER(right), free(left) and free(right) are true.

at-roddy(rooma), at-ball(ball1, rooma), ..., at-ball(ball4, rooma) are true.

Everything else is false.

In Inform7:

Ball1 and Ball2 and Ball3 and Ball4 are in RoomA.

GripperLeft and GripperRight are in RoomA.

(Movement) Action/Operator

Description: The robot can move from x to y.

Precondition: ROOM(x), ROOM(y) and at-robb(y) are true.

Effect: at-robb(y) becomes true. at-robb(x) becomes false.

Everything else doesn't change.

In PDDL:

```
(:action move :parameters (?x ?y)
  :precondition (and (ROOM ?x) (ROOM ?y) (at-robb ?x))
  :effect (and (at-robb ?y) (not (at-robb ?x))))
```

(Movement) Action/Operator

Description: The robot can move from x to y.

Precondition: ROOM(x), ROOM(y) and at-roby(x) are true.

Effect: at-roby(y) becomes true. at-roby(x) becomes false.

Everything else doesn't change.

In Inform7:

Move to RoomB

Before moving to RoomB:

try silently opening the door

continue the action

In Class Activity!

- Go to <https://blog.zarfhome.com/2025/01/the-visible-zorker>
- Read the blog (if you haven't already)
 1. Play Zork1 until you get to a score of 35, save your transcript (cheat sheet of actions on next slide and in Gradescope assignment)
 2. Take a sequence of 5 actions and write the pseudo PDDL version Objects, Predicates, Initial State, Goal Spec, Actions – you can use <https://fareskalaboud.github.io/LearnPDDL/> as a cheat sheet
- Submit both on Gradescope under In Class Activity 1/15

You just started up a game
and now you're staring at
text and a *blinking cursor*
and you *don't know what to do!*

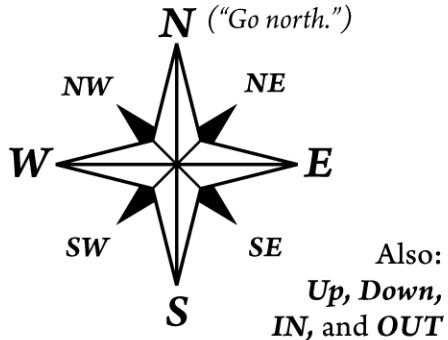


Don't panic kids—

Crazy Uncle Zarf is here to help you
get started...

You are standing in an open [field] west of a white [house],
with a boarded front [door]. There is a small [mailbox]* here.

Does the game intro suggest
ABOUT, INFO, HELP?
Try them first!



You can try all sorts of commands
on the [things] you see.

Try the commands that make sense!
Doors are for opening; buttons are for pushing;
pie is for eating. (*Mmm, pie.*)



If you meet a person, these should work:

TALK TO name
ASK name **ABOUT** something
TELL name **ABOUT** something
GIVE something **TO** name
SHOW something **TO** name

Each game has slightly different commands,
but they all look **pretty much like these**.

These commands are very common:
EXAMINE it **PUSH** it
TAKE it **PULL** it
DROP it **TURN** it
OPEN it **FEEL** it
PUT it **IN** something
PUT it **ON** something
When in doubt, examine more.

*Try opening!

“What if I only want to
type one or two letters?”



N/E/S/W/NE/SE/NW/SW: GO
in the indicated compass direction.

L: LOOK

around to see what is nearby.

X: EXAMINE

a thing in more detail.

I: take INVENTORY
of what you possess.

Z: WAIT

a turn without doing anything.

G: do the same thing AGAIN



A service of the
People's Republic of Interactive Fiction:
<http://pr-if.org>

⁺Take back one move — handy!