# Search and Planning

Exercise 1 (8 points)

Two spaceships R and B are searching for two relics $(R0, R1)$. In order to complete their mission, they must defeat their enemies $(I0, I1, I2)$ and collect the relics. The world of R and B is represented as a simple gridworld with one row and 6 columns; B can only navigate cells labelled with numbers (1, 2, 3), while R can only navigate cells labelled with letters (X, Y, Z). R and B can shoot to destroy other ships, but they must do it immediately after entering the location where the enemy is, otherwise they will be destroyed. Importantly, R and B must coordinate, and the relics can be taken only after all the enemies have been destroyed.
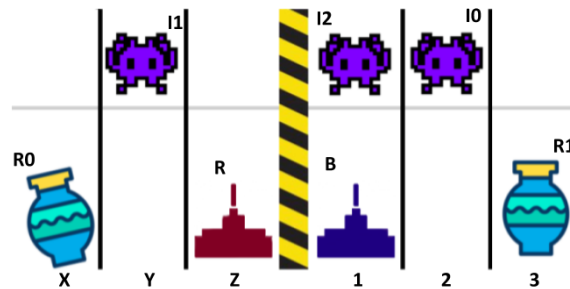
(a) Model the problem in PDDL by defining the problem and domain file.

(b) Starting from the initial state shown in the figure, define a plan that achieves the goal of having R and B holding the relics $(R0, R1)$ at X and 3, respectively; show each state in the plan, by specifying the initial state and the changes caused by each action.

(c) Draw the first 5 levels of the tree generated by forward search, showing all the actions applicable at each of the states that are traversed in the plan found in (b), without further expanding the states that do not belong to the plan.

Exercise 2 (4 points)

Define the notion of heuristics for heuristic search, providing examples. Sketch the main techniques to obtain heuristics for a given search problem.

Exercise 3 (4 points)

Discuss the difference between state-space and plan-space planning. Describe the basic approach to plan space planning (POP). Discuss the application of POP planning to the problem presented in the previous exercise.