COMP3702/COMP7702 Artificial Intelligence (Semester 2, 2020)
The LaserTank AI Environment

This document provides a high-level description of the LaserTank environment. Implementation details will be provided separately through an assignment support code repository (check Blackboard and the assignment task description for links and instructions).

Background

LaserTank is an open source computer puzzle game requiring logical thinking to solve a variety of levels, originally developed by Jim Kindley in 1995. Our version is based on the original game concept with some minor differences.

In LaserTank, a player controls a tank vehicle which can move forwards, turn clockwise and counter-clockwise, and shoot a laser which can be used to interact with special map elements. The game takes place in a 2D map divided into grid cells. The player must navigate from a **starting position** to the **flag** in as few moves as possible while avoiding "game over" conditions. The game is over if the player moves into a dangerous cell (i.e. water cells or any cell in the line of fire area of an anti-tank).

The LaserTank codebase comes as part of your assignment support code; please see the separate assignment description document for details of how to access the support code and LaserTank environment.

Game state representation

Each game state is represented as a character array, with the row and column representing the (x, y) position on the board. In this, the tile descriptions are triples of characters. (Note: this representation is for visualisation and interactive sessions only. It differs from the symbols used in the assignment support code, i.e. in `laser_tank.py`, which are needed to produce a working assignment solution). An example game map is shown below, with the tile legend given in the accompanying table:

```
XXXXXXXXXXXXXXXXXXXXXXXXXXX
XXX|/ [B]WWW(T)[L]XXXXXXXXX
XXX|\ -I--I--I-   [K][K]XXX
XXXWWWWWWWWWWWW-I-   [L]XXX
XXX|/ |/    [B]WWWXXX(T)XXX
XXXWWWWWWWWWWWW-I-[K]   XXX
XXXWWWWWWWWW      XXX[K]XXX
XXX|\ WWW[^]   XXX F [K]XXX
XXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Tile	*Representation*
Player's Tank:	`[^]`, `[v]`, `[<]` or `[>]`
Land:	‘ ‘ (triple blank space)
Flag:	’ `F` ’
Obstacle:	`XXX`
Water:	`WWW`
Bridge:	`[B]`
Brick:	`[K]`
Ice:	`-I-`
Teleport:	`(T)`
Mirrors:	`' /|'`, `'|\ '`, `' |'` or `'|/ '`
Anti-tanks	`[U]`, `[D]`, `[L]`, `[R]`

Maps contain the following tile types, with associated properties:

Player's Tank : represented by `[^]`, `[v]`, `[<]` or `[>]` depending on the direction the tank is pointing, up, down, left or right, respectively

- Represents the current position and direction of the player.
- Every valid map has exactly one player tank

Land : represented by ‘   ‘ (triple blank space)

- On land cells, the tank moves normally, advancing one position in the direction the tank is pointing.
- Land cells allow laser shots (and anti-tank shots) to pass through.
- Objects (bridges, mirrors, anti-tanks) can be pushed onto land cells with the laser.

Flag : represented by ’ `F` ’ (blank spaces before and after F)

- The player can move onto the flag cell; this solves the puzzle, ending the game.

- Every valid map has exactly one flag cell.
- The flag cell allows laser shots (and anti-tank shots) to pass through.

Obstacle : represented by `XXX`

- The player cannot move into an obstacle cell, and attempting to move into an obstacle cell results in collision.
- Obstacle cells block laser shots and anti-tank shots.

Water : represented by `WWW`

- The player cannot travel over a water cell, and moving into a water cell results in game over.
- If a bridge is pushed into a water cell with the laser, the water cell permanently transforms into a land cell.
- Water cells allow laser shots (and anti-tank shots) to pass through.

Bridge : represented by `[B]`

- The player cannot move into a bridge cell, and attempting to move into a bridge cell results in collision.
- Shooting the bridge cell with the laser causes the bridge to be pushed one position in the direction away from the laser shot (if this direction is not blocked)
- If the bridge is pushed into a water cell, the bridge is removed and the water cell is converted to land.

Brick : represented by `[K]`

- The player cannot move into a brick cell, and attempting to move into a brick cell results in collision.
- Shooting the brick cell with the laser causes the brick cell to be replaced by a land cell

Ice : represented by `-I-`

- The player can move onto an ice cell, and will continue moving forwards until a non-ice cell is reached or the next cell cannot be moved onto.
- Ice cells allow laser shots (and anti-tank shots) to pass through.
- Objects cannot be pushed onto ice cells.

Teleport : represented by `(T)`

- The player can move onto a teleport cell; this causes the player to be transported to the maps other teleport cell
- Teleport cells always exist in pairs
- Teleport cells allow laser shots (and anti-tank shots) to pass through.

Mirrors : represented by `' /|'`, `'|\ '`, `' \|'` or `'|/ '`, for the reflections up-left, up-right, down-left, or down-right, respectively (note that each has a leading or trailing blank space)

- The player cannot move into a mirror cell, and attempting to move into a mirror cell results in collision.
- Shooting the mirror cell on its diagonal side causes the laser beam to reflect 90 degrees from its original direction and continue onwards
- Shooting the mirror on one of its flat sides causes the mirror to be pushed one position in the direction away from the laser shot (if this direction is not blocked)
- If the mirror is pushed into a water cell, it is removed.

Anti-tanks : represented by `[U]`, `[D]`, `[L]`, `[R]` depending on direction they face, of up, down, left, or right, respectively

- Each anti-tank has a line of fire area which extends outwards from the direction the anti-tank is pointed in, continuing until a cell which blocks anti-tank shots is reached. The line of fire is 1 tile wide. If the player enters the line of fire of an anti-tank, the tank is destroyed resulting in game over.
- Shooting the anti-tank from the direction the anti-tank is pointed (e.g. from the left for an `[L]` anti-tank), replaces the anti-tank with a destroyed anti-tank, represented by `[X]`. Destroyed anti-tanks have no line of fire area.
- Shooting the anti-tank from any other direction causes it to be pushed one position in the direction away from the laser shot (if this direction is not blocked)
- The player cannot move into an anti-tank cell, and attempting to move into an anti-tank cell results in collision.

Interactive mode

A good way to gain an understanding of the game is to play it. You can play the game to get a feel for how it works by launching an interactive game session from the terminal with the following command:

```
$ python laser_tank.py <input_file>.txt
```

where `<input_file>.txt` is a valid testcase file (from the support code). In interactive mode, press:

- `W` to move forward,
- `D` and `A` to turn clockwise and counterclockwise, respectively,
- `spacebar` to shoot the laser,
- `R` to reset the game to the initial configuration, and
- `Q` to quit the game interactive session.

The details of your assignment task are provided in a separate assignment description document, which also contains links to the assignment support code containing the LaserTank environment.