In the name of God
Machine Learning Course (Spring 2023)
Assignment #2: Function Approximation (Pac-man Z edition Game)
Due date: 14th April

Chapter 1 from Tom Mitchell's book could be helpful through engaging with function approximation, a reduced form of learning problem, and led to a better understanding for implementing this assignment.

In this assignment, you should implement an algorithm to learn a specific edition of the Pac-Man game. This game consists of a player as Pac-man(A), zombies(Z), Pits(P), Obstacles(O), and vaccines(V) which the player must escape from zombies meanwhile try to get vaccines. Such tasks form a graph in that every board state is a node, and every move is an edge.

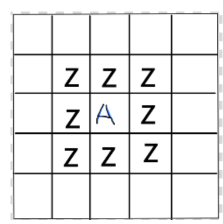
In this scenario, the player tries to find and collect the vaccines and keep himself alive from getting captured by zombies. If zombies catch the player, he loses. The player can use his gun (with 3 shots) to kill the zombies. If he gets the vaccine, he can attempt to catch a zombie to inject that into the zombie's body and heal them. At this moment zombies try to run away from the player. When no more zombies are on the board, the player goes to the exit port(E).

Game specifications:

- The game board is a 15x10 rectangle.
- The game map contains:

  4 zombies, 10 obstacles, 1 vaccine, 1 exit port, 1 Pit.

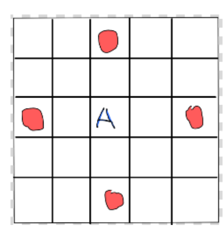
- Both zombies and player can only move up, down, right, and left.
- Both zombies and player must not fall into the pit. The player will game over but the zombie will regenerate to a random place with a negative point.
- Both can't pass the obstacles; they must turn over.
- The player will die if zombies be placed in his surroundings (in one of the rectangles that surround him)
- The player must try to find a vaccine and then go to the zombies. When the player wants to use a vaccine against zombies to cure them (once at a time) must be in the same situation as the photo.



- The player could carry one vaccine at a time. The new vaccine will randomly appear on the map after each use by the player. Only 4 vaccines can be regenerated one by one till the end of the game.

- The shooting mechanism could be worked whenever zombies are placed in these situations by the player and he only has 3 shots.

  fire could go through obstacles and the pit.



- Be aware that killing zombie have lesser points than curing them with vaccines.

In the name of God
Machine Learning Course (Spring 2023)
Assignment #2: Function Approximation (Pac-man Z edition Game)
Due date: 14th April

The goal is to find the optimal state where all zombies are cured with vaccinations or kill them and after that player proceeds to the exit port to end the game with a maximum score. Meanwhile, zombies must act intelligently and try to catch the player with a learning algorithm as well.

We can define a function $V: S \rightarrow \mathbb{R}$ that assigns to every state a value and, based on V find the best move for each state. If we can find V, the problem is solved, but only a few pairs $< s, V(s) >$ are available.

Many states do not have a V value. Therefore, we need to approximate this function through these points (training examples). Due to the graph structure of the problem, it is possible to approximate the values of states with unknown values states, and approximated values can be used to find better approximations. Therefore, for states whose values are unknown, approximated successor state's value should be used.

Part A: Implement an algorithm to learn how to play the Pac-Man Z version using function approximation.

The following steps will help you:

1. Choose linear representation for $\hat{V}$: $\hat{V}(\vec{x}) = \hat{w}^T \vec{x}$.
2. Find some good features ($\vec{x}$) to describe the states of the game.
3. Initialize all coefficients ($\hat{w}$) in $\hat{V}$ by zero.
4. Start with a random board state (a random place for all items on the map).

In each non-terminal state (S_t), choose your move based on $\hat{V}$ as follows: Among the moves, both agents (player and zombies) can make in their current state, choose the one that leads to the highest state value (the value of the successors of the current state).

Call these chosen successor state $S_{t+1}$and assign $V_{\text{train}}(s_t) = \hat{V}(s_{t+1})$. If S_t is a terminal state, assign $V_{\text{train}}(S_t) = \hat{V}(S)$

In the name of God

Machine Learning Course (Spring 2023)

Assignment #2: Function Approximation (Pac-man Z edition Game)

Due date: 14th April

		O							
			Z				A		
		V							
	Z			Z				O	
		O							
			O			O			
			O						
					P			Z	
	E			O			O		
		O				O			

5. Set the value of the state as follows: (you may find other values by yourself)

$V_{\text{train}}(S_t)$= -1000 if the player is captured by zombies.

$V_{\text{train}}(S_t)$= -1000 if the player falls into the pit.

6. Now you have a new example: $<S_t, V_{\text{train}}(s_t)>$. Based on this example update $\hat{w}$ as follows:

$$w_i = w_i + \alpha \, (V_{\text{train}}(s_t) - \hat{V}(s_t).) \, x_i$$

Assign a small value for α. Once you train the algorithm and find the weights, use these weights to play the game. (Save these codes in a separate file).

Part B: Write a player agent and a zombie agent code to play the game based on the last part (Save this in a separate file). Moreover, report your best score.

In the name of God
Machine Learning Course (Spring 2023)
Assignment #2: Function Approximation (Pac-man Z edition Game)
Due date: 14th April

Part C (Optional Part):

1. The best agent (implementation) that can reach the most score is given extra scores.
2. Provide a graphical playing game for your implementation.

Notes:

- Pay extra attention to the due date. It will not extend.
- Be advised that submissions after the deadline would not grade.
- Prepare your entire report in PDF format and include the figures and results.
- Submit your assignment using a zipped file with the name “StdNum_FirstName_LastName”.zip
- Using other students’ codes or the codes available on the internet will lead to zero.