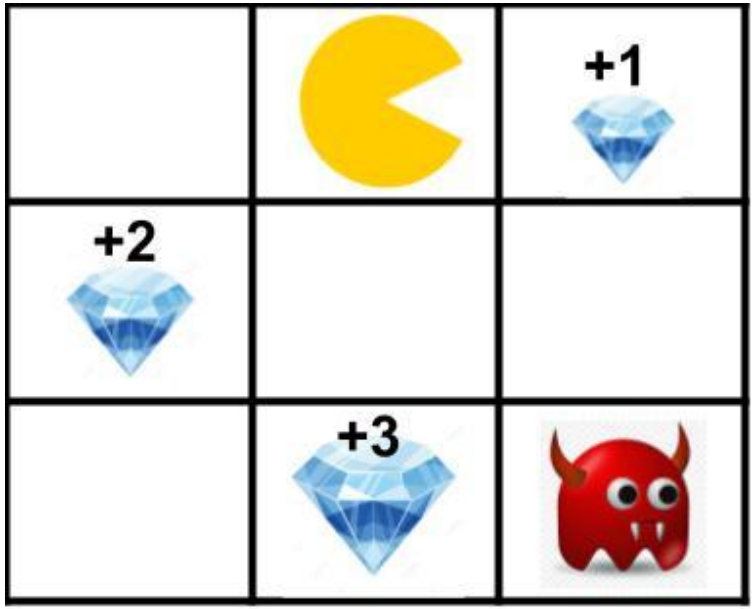
In a diamond-hunting game, Pacman wants to collect diamonds without being eaten by the ghost.

On Pacman's turn, Pacman moves to one of the four neighbouring cells (left, right, up, or down). If moving in a direction would lead Pacman out of the grid, that direction is not allowed.
On the Ghost's turn, similarly, it moves to one of the four neighbouring cells without leaving the grid. It cannot move to a diamond cell.

Staying still is not allowed by either player.
The game terminates if Pacman collects all the diamonds, or, is eaten by the ghost (in which case Pacman gets a penalty of -50).



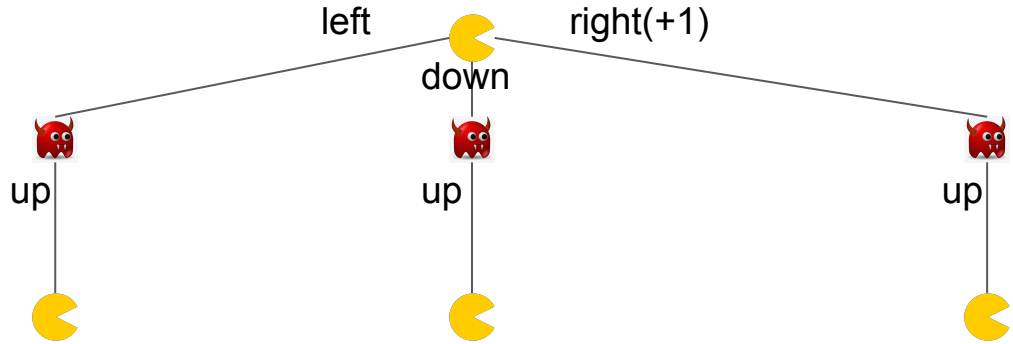
Q1: Draw a game tree with two moves for each player along with Pacman's score at each leaf node of the tree. Draw only the legal moves. The first move is given.

Q2: Compute the minimax value at each node of this search tree. What is the best action for the Pacman and what is the associated utility?

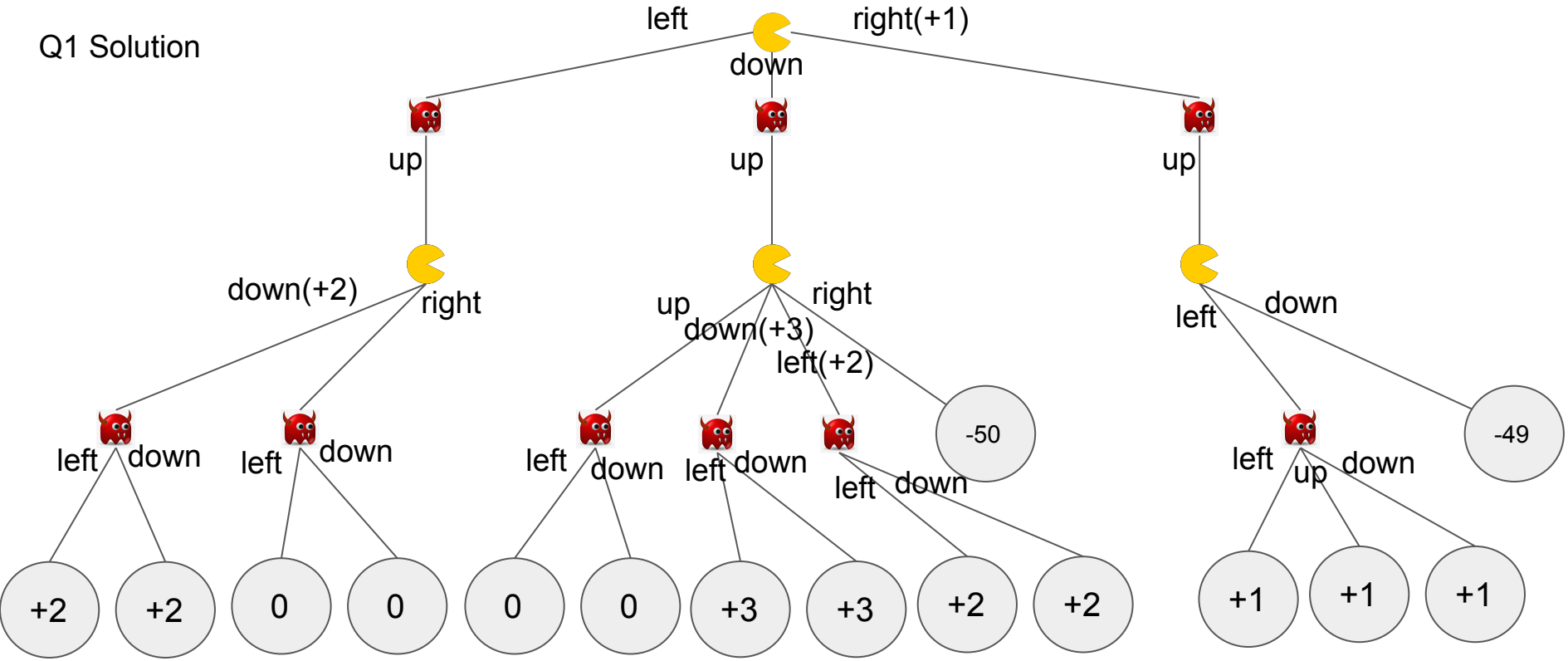
Q3: If each ghost move incurs a -1 cost, will it affect our Pacman's decision? If yes, how?

Q4: What if each ghost move incurs a -100 cost?

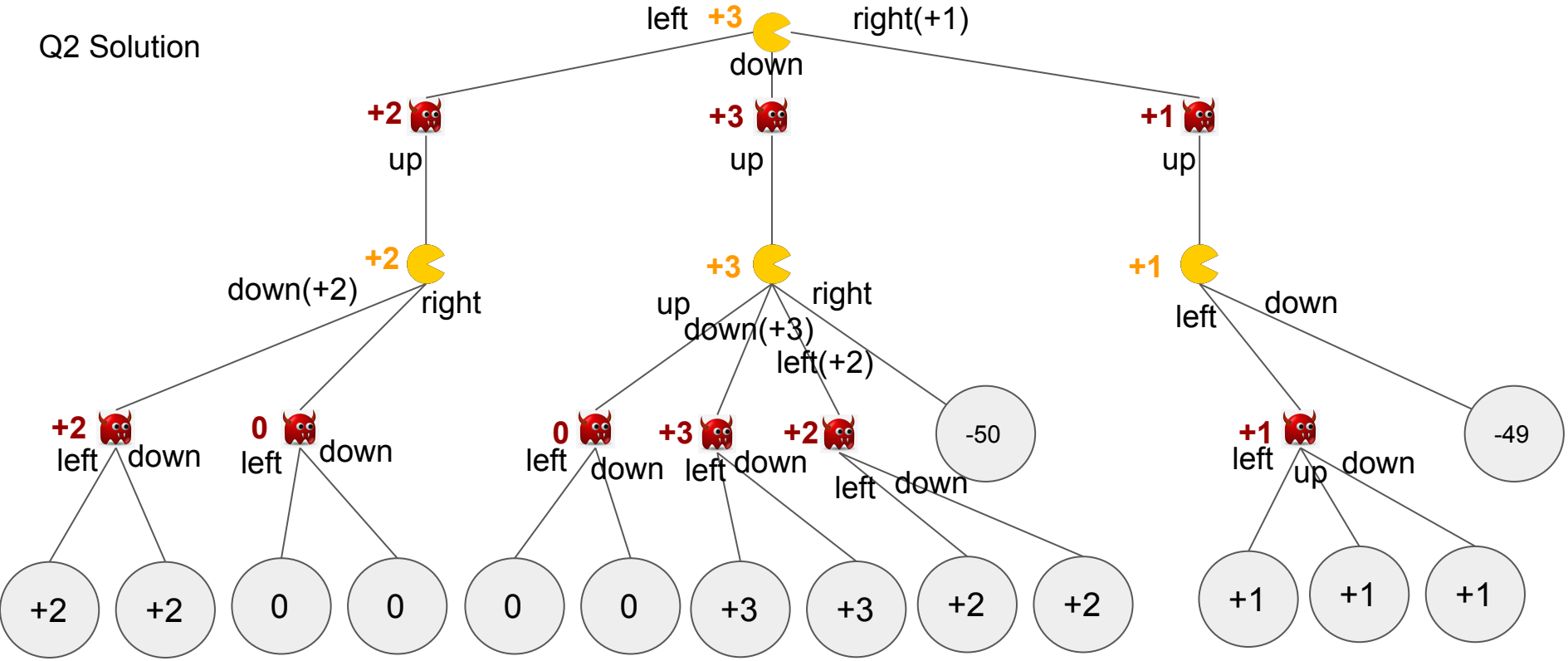
Q1



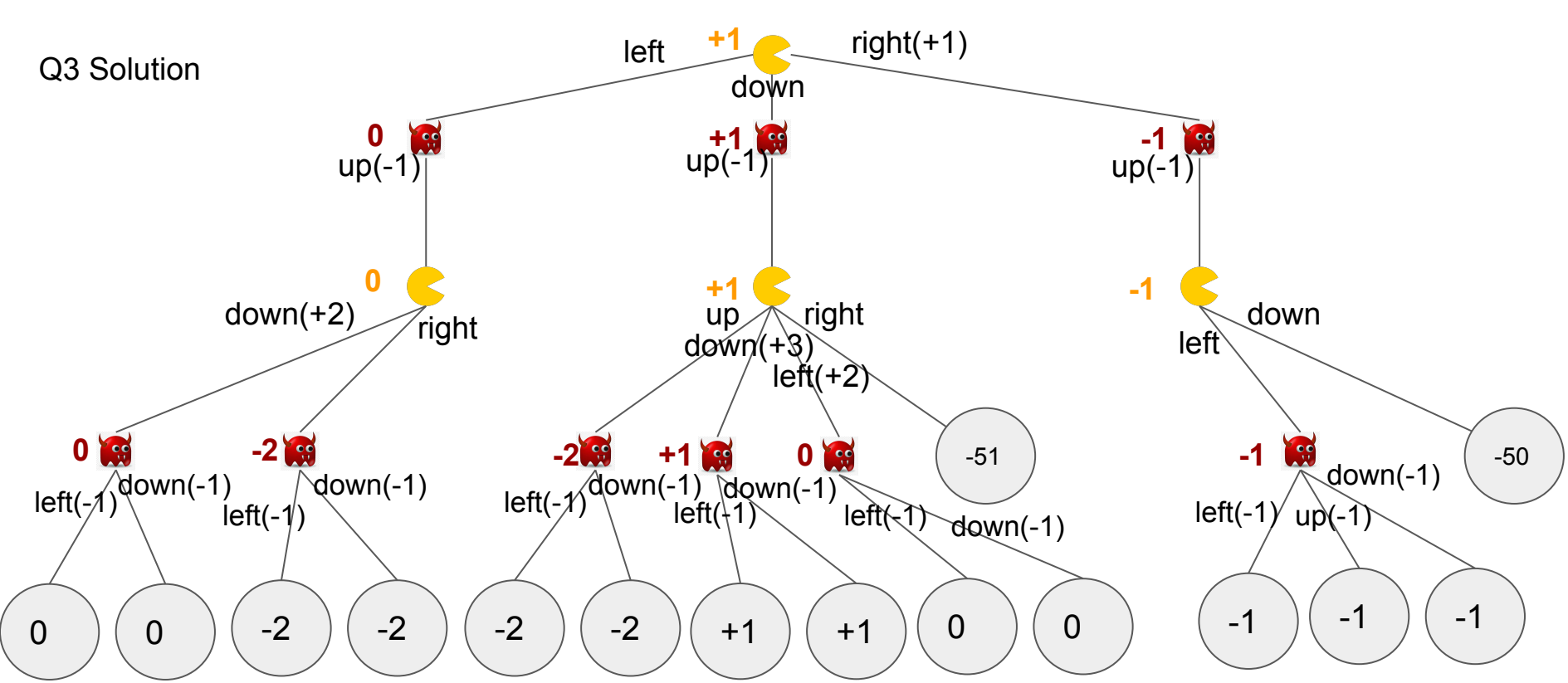
Q1 Solution


left
down
right(+1)
up
up
up
down(+2)
right
up
down(+3)
right
left(+2)
left
down
left
down
left
down
left
down
left
down
left
down
left
up
down
-50
-49
+2
+2
0
0
0
0
+3
+3
+2
+2
+1
+1
+1

Q2 Solution

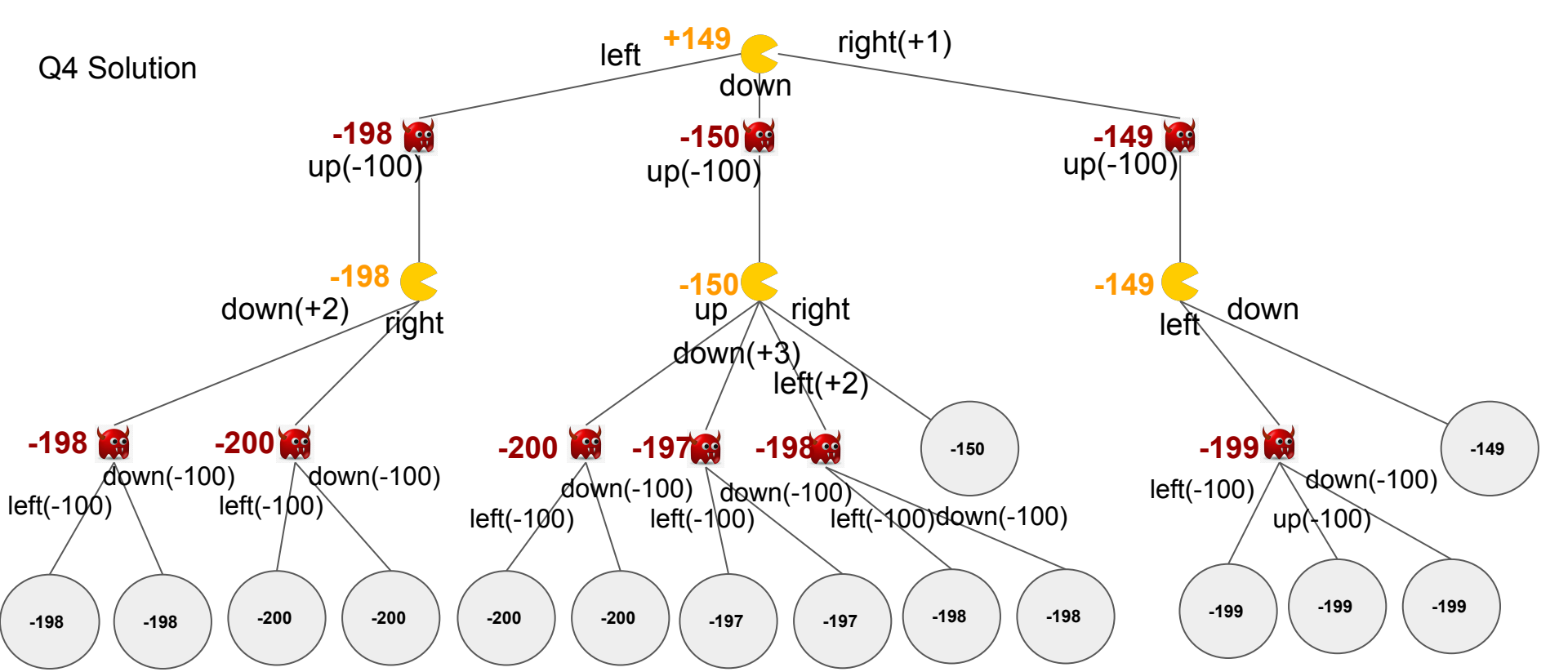


The best action is to go “down” with a utility of +3.



The new search tree is like this. No it does not affect our Pacman's choice of action; its best action is still "down" but with a utility of +1.

But, if we were to draw a deeper search tree, such a per-step cost will make Pacman prefer a shorter path, effectively preventing Pacman from "lingering" or "thrashing".



This new cost does make a difference!
The best action now is to go “right” with a utility of -149; Our pacman chooses to run into the ghost to prevent the ghost from making the second move, hence avoiding the -100 penalty, while still manages to collect that +1 diamond before it dies.