

**Code**

```
/*
Existing Game Code Here
*/

int action[21];

void dynamic_programming(void)
{
    double gamma = 0.9;

    double value[21];
    value[20] = -10;
    value[19] = 10;
    value[18] = 10;

    action[20] = 0;
    action[19] = 1;
    action[18] = 2;

    for (int i = 17; i >= 0; i--)
    {
        double add_one = fmin(value[i + 2], value[i + 3]);
        double add_two = fmin(value[i + 3], value[i + 4]);

        value[i] = gamma * fmax(add_one, add_two);
        action[i] = add_one > add_two ? 1 : 2;
    }

    printf("%-5s | %-10s | %s\n", "Score", "Value", "Action");
    for (int i = 0; i <= 20; i++)
    {
        printf("%-5d | %-10f | %d\n", i, value[i], action[i]);
    }
}

int computer(void)
{
    printf("We are at %-2d Computer adds %d \n", score, action[score]);
    return action[score];
}

/*
Existing Game Code Here
*/

int main(void)
{
    // Create optimal action lookup table before playing the game
    dynamic_programming();

    /*
    Existing Game Code Here
    */
}
```

**Optimal Action Lookup Table**

Score	Value	Action
0	5.314410	2
1	5.314410	1
2	-5.314410	2
3	5.904900	2
4	5.904900	1
5	-5.904900	2
6	6.561000	2
7	6.561000	1
8	-6.561000	2
9	7.290000	2
10	7.290000	1
11	-7.290000	2
12	8.100000	2
13	8.100000	1
14	-8.100000	2
15	9.000000	2
16	9.000000	1
17	-9.000000	1
18	10.000000	2
19	10.000000	1
20	-10.000000	0

**Sample Games**

Who goes first: you=1 computer=2 ? 1  
We are at 0 , add 1 or 2 ? 2  
We are at 2 Computer adds 2  
We are at 4 , add 1 or 2 ? 1  
We are at 5 Computer adds 2  
We are at 7 , add 1 or 2 ? 1  
We are at 8 Computer adds 2  
We are at 10, add 1 or 2 ? 2  
We are at 12 Computer adds 2  
We are at 14, add 1 or 2 ? 1  
We are at 15 Computer adds 2  
We are at 17, add 1 or 2 ? 2  
We are at 19 Computer adds 1  
I WIN !!

Who goes first: you=1 computer=2 ? 1  
We are at 0 , add 1 or 2 ? 2  
We are at 2 Computer adds 2  
We are at 4 , add 1 or 2 ? 1  
We are at 5 Computer adds 2  
We are at 7 , add 1 or 2 ? 1  
We are at 8 Computer adds 2  
We are at 10, add 1 or 2 ? 1  
We are at 11 Computer adds 2  
We are at 13, add 1 or 2 ? 1  
We are at 14 Computer adds 2  
We are at 16, add 1 or 2 ? 1  
We are at 17 Computer adds 2  
We are at 19, add 1 or 2 ? 1  
YOU WIN !!