robo rally

May 25, 2020

1 Robo Rally

[1]:
```
import random as rd
import numpy aas np
import math
import matplotlib.pyplot as plt
%matplotlib inline
```

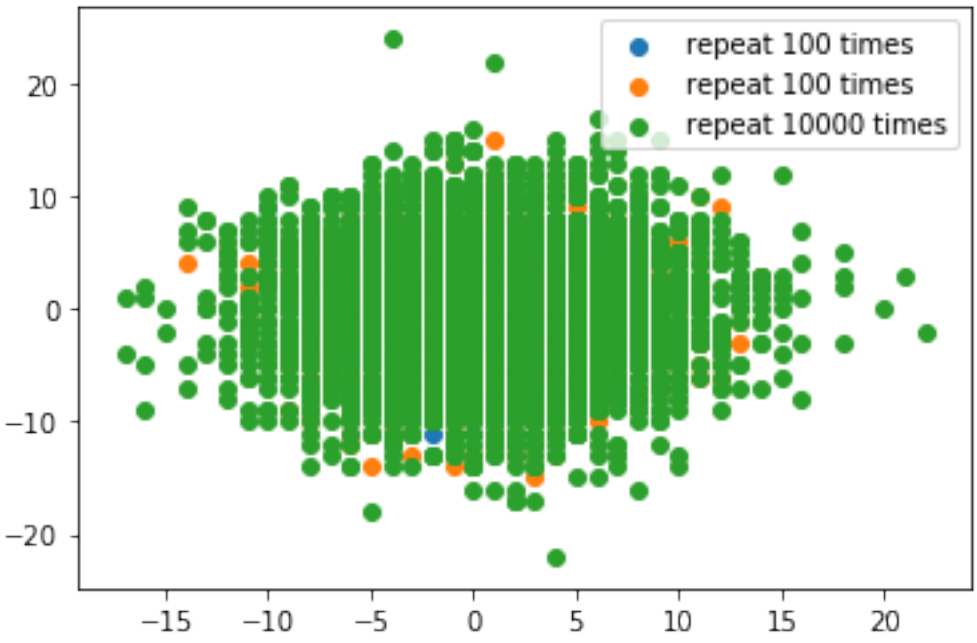
2 Original game

[2]:
```
def roborally(x=0,y=0,limit=100):
    a
    Move=['G','R','L']
    #G move 1 ,R turn right ,L turn left
    K=rd.randrange(5,limit,1)
    #k instructions ranging farom 5 to 100
    N,E,S,W=0,1,2,3
    dir= E
    #initial direction East
    seq=[]

    for i in range(K):
        seq.append(rd.choice(Move))
    #print(seq)

    for m in seq:
        if m == 'R':
            dir = (dir + 1)%4
        elif m == 'L':
            dir = (4 + dir - 1)%4
        else:    # if move == 'G'
                if dir == N:
                    y += 1
                elif dir == E:
                    x += 1
```

```
            elif dir == S:
                y -= 1
            else:
                x -= 1
    return [x,y]
```

2.1 Visualize the spread of robot's ending position

[39]:
```
test=[100,1000,10000]
rest=np.array([roborally() for i in range(test[0])])
x,y=rest.T
rest1=np.array([roborally() for i in range(test[1])])
x1,y1=rest1.T
rest2=np.array([roborally() for i in range(test[2])])
x2,y2=rest2.T
plt.scatter(x, y,label='repeat 100 times')
plt.scatter(x1, y1,label='repeat 100 times')
plt.scatter(x2, y2,label='repeat 10000 times')
plt.legend()
plt.show()
```



[42]:
```
rest=np.array([roborally() for i in range(100000)])
x,y=rest.T
print(max(abs(x)),max(abs(y)))
```

```
23 24
```

[43]:
```
#repeat 1000000 times
rest=np.array([roborally() for i in range(1000000)])
x,y=rest.T
print(max(abs(x)),max(abs(y)))
```

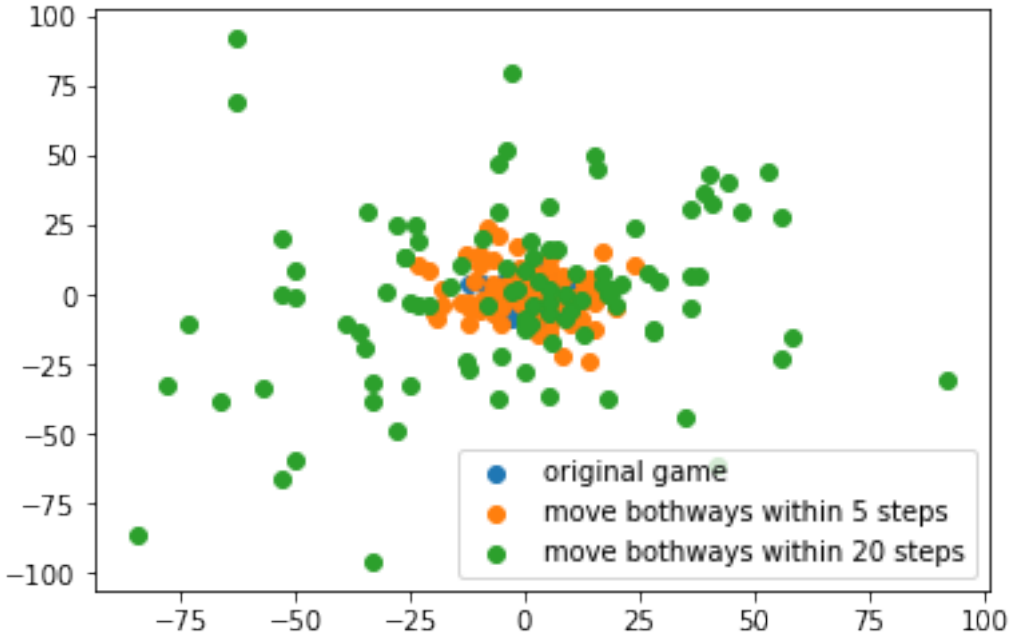
```
30 28
```

If we repeat the game 1000000 times,the range may extend to above 24-30 range. Thus the probabilty of the robot falling off the board does depend on the size of the board.

3 Extended project 1 : move more than 1 step is allowed

[3]:
```
def roborally1(x=0,y=0,limit=100,step=5):

    Move=['G','R','L']
    #G move 1 ,R turn right ,L turn left
    K=rd.randrange(5,limit,1)
    #k instructions ranging from 5 to 100
    N,E,S,W=0,1,2,3
    dir= E
    #initial direction East
    seq=[]

    for i in range(K):
        seq.append(rd.choice(Move))
    #print(seq)

    for m in seq:
        s=rd.randrange(-step,step,1)
        #move forward or backward more than one
        if m == 'R':
            dir = (dir + 1)%4
        elif m == 'L':
            dir = (4 + dir - 1)%4
        else:    # if move == 'G'
                if dir == N:
                    y += s
                elif dir == E:
                    x += s
                elif dir == S:
                    y -= s
                else:
                    x -= s
    return [x,y]
```

[15]:
```
test=100
rest=np.array([roborally() for i in range(test)])
x,y=rest.T
rest1=np.array([roborally1() for i in range(test)])
x1,y1=rest1.T
rest2=np.array([roborally1(step=20) for i in range(test)])
x2,y2=rest2.T
plt.scatter(x, y,label='original game')
plt.scatter(x1, y1,label='move bothways within 5 steps')
plt.scatter(x2, y2,label='move bothways within 20 steps')
plt.legend()
plt.show()
```



Obviously larger the step size , wider the range.

4 Extended project 2 : rotation less than a quarter is allowed

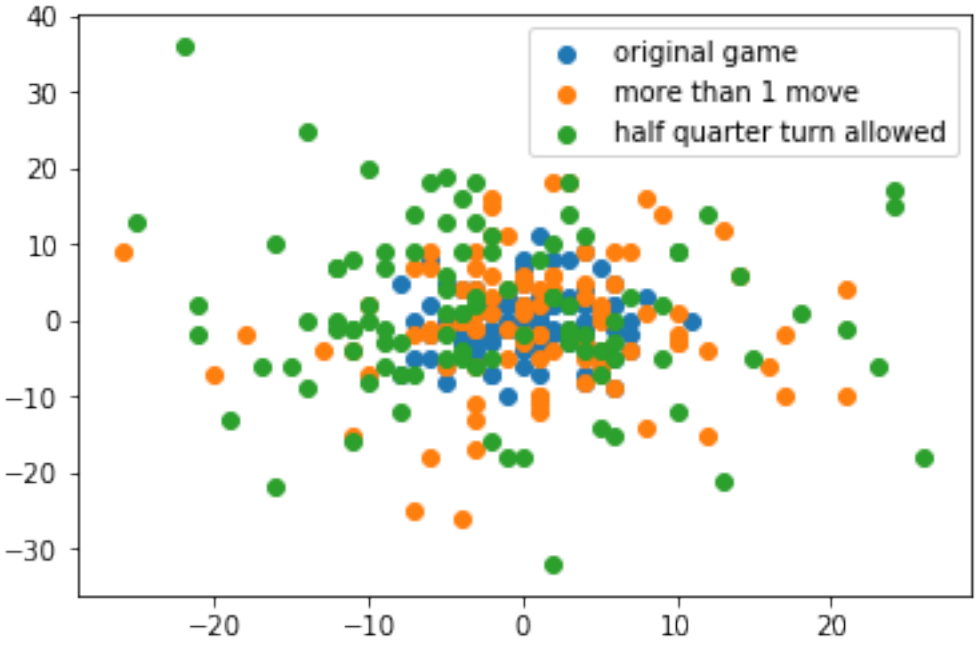
[23]:
```
def roborally2(x=0,y=0,limit=100,step=5):

    Move=['G','R','L']
    #G move 1 ,R turn right ,L turn left
    K=rd.randrange(5,limit,1)
    #k instructions ranging from 5 to 100
    N,NE,E,SE,S,SW,W,NW=0,1,2,3,4,5,6,7
```

```
    dir= E
    #initial direction East
    seq=[]

    for i in range(K):
        seq.append(rd.choice(Move))
    #print(seq)

    for m in seq:
        s=rd.randrange(-step,step,1)
        #move both ways more than 1
        if m == 'R':
            dir = (dir + 1)%8
        elif m == 'L':
            dir = (8 + dir - 1)%8
        else:    # if move == 'G'
                if dir == N:
                    y += s
                elif dir == E:
                    x += s
                elif dir == S:
                    y -= s
                elif dir == W:
                    x -= s
                elif dir == NE:
                    y += s
                    x += s
                elif dir == SE:
                    y -=s
                    x +=s
                elif dir == SW:
                    y-=s
                    x-=s
                else :
                    y+=s
                    x-=s
    return [x,y]
```

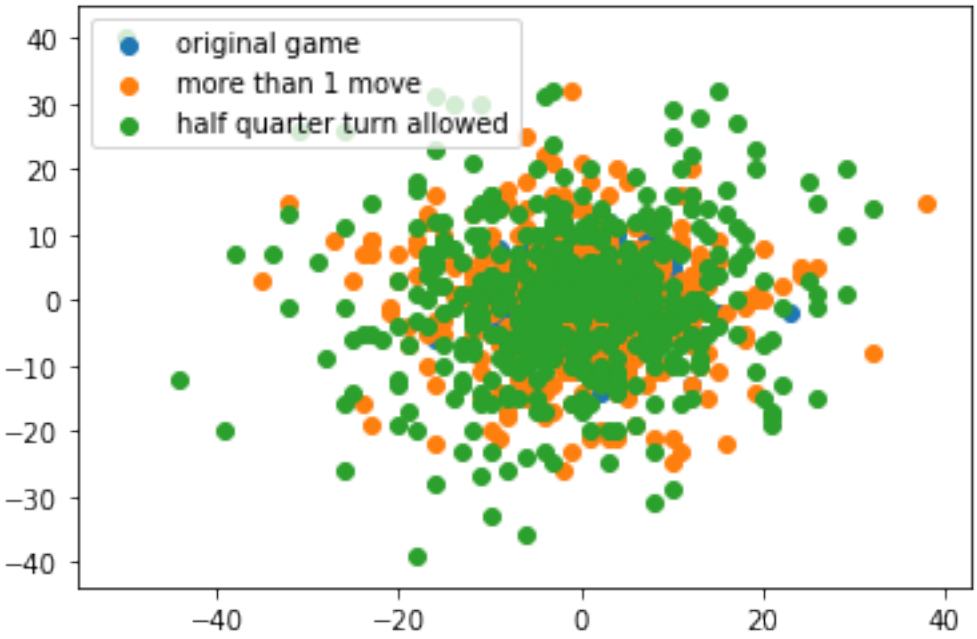
4.1 Visualize the spread of ending positions of three scenarios

[24]:
```
test=100
rest=np.array([roborally() for i in range(test)])
x,y=rest.T
rest1=np.array([roborally1() for i in range(test)])
x1,y1=rest1.T
rest2=np.array([roborally2() for i in range(test)])
```

```
x2,y2=rest2.T
plt.scatter(x, y,label='original game')
plt.scatter(x1, y1,label='more than 1 move')
plt.scatter(x2, y2,label='half quarter turn allowed')
plt.legend()
plt.show()
```



[25]:
```
test=500
rest=np.array([roborally() for i in range(test)])
x,y=rest.T
rest1=np.array([roborally1() for i in range(test)])
x1,y1=rest1.T
rest2=np.array([roborally2() for i in range(test)])
x2,y2=rest2.T
plt.scatter(x, y,label='original game')
plt.scatter(x1, y1,label='more than 1 move')
plt.scatter(x2, y2,label='half quarter turn allowed')
plt.legend()
plt.show()
```



With the same step size, smaller the rotation angle ,wider the move range.

5 Extended project 3: See the probability of hitting the hazard/ taget

5.0.1 Set random target within chosen range

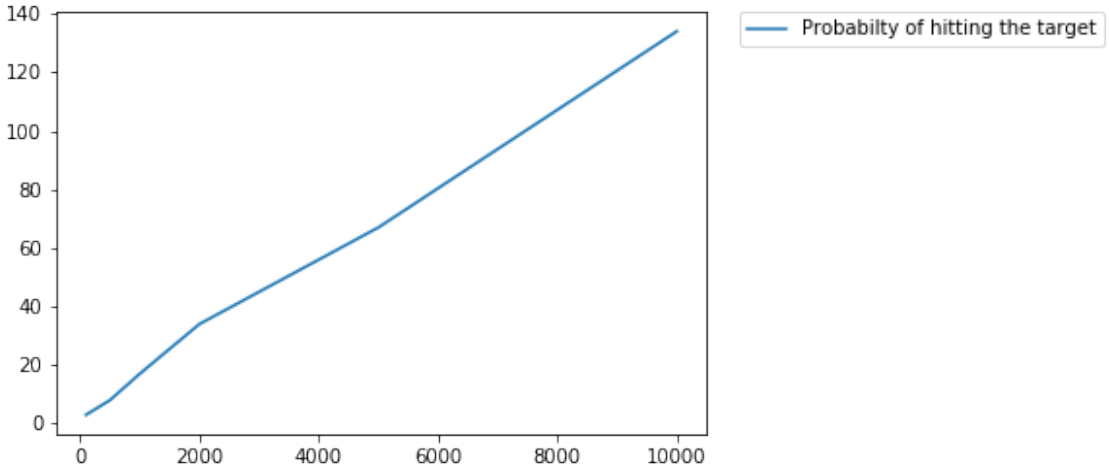
[109]:
```
def roborally_process(x=0,y=0,limit=100,step=5,r=15):
    #r stands for target/hazard range
    a,b=rd.randrange(-r,r,1),rd.randrange(-r,r,1)
    Move=['G','R','L']
    #G move 1 ,R turn right ,L turn left
    K=rd.randrange(5,limit,1)
    #k instructions ranging from 5 to 100
    N,E,S,W=0,1,2,3
    dir= E
    #initial direction East
    seq=[]

    for i in range(K):
        seq.append(rd.choice(Move))
    #print(seq)

    for m in seq:
```

```
        s=rd.randrange(-step,step,1)
        #move forward or backward more than one
        if m == 'R':
            dir = (dir + 1)%4
        elif m == 'L':
            dir = (4 + dir - 1)%4
        else:    # if move == 'G'
                if dir == N:
                    y += s
                elif dir == E:
                    x += s
                elif dir == S:
                    y -= s
                else:
                    x -= s
        if x==a and y== b:
            return 1
    return 0
```

[135]:
```
repeat=[100,500,1000,2000,5000,10000]
ans=[]
for i in range(len(repeat)):
    sum=0
    for i in range(repeat[i]):
        sum+=roborally_process(limit=100)
    ans.append(sum)
prob=[]
for i in range(len(repeat)):
    prob.append(ans[i]/repeat[i])
np.mean(prob)
```

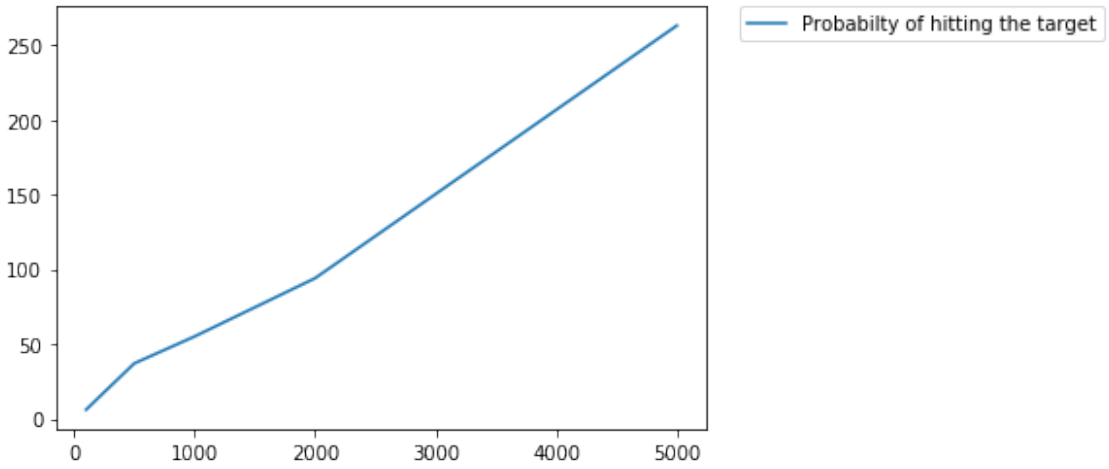
[135]:
```
0.0178
```

[136]:
```
plt.plot(repeat,ans,label='Probabilty of hitting the target')
plt.legend(bbox_to_anchor=(1.05, 1), loc='upper left', borderaxespad=0.)

plt.show()
```



5.0.2 If each game with 100 sequence of moves,the probabilty of hitting the target is 0.0178

[126]:
```
repeat=[100,500,1000,2000,5000]
ans=[]
for i in range(len(repeat)):
    sum=0
    for i in range(repeat[i]):
        sum+=roborally_process(limit=1000)
    ans.append(sum)

plt.plot(repeat,ans,label='Probabilty of hitting the target')
plt.legend(bbox_to_anchor=(1.05, 1), loc='upper left', borderaxespad=0.)

plt.show()
```



[134]:
```
prob=[]
for i in range(len(repeat)):
    prob.append(ans[i]/repeat[i])
np.mean(prob)
```

[134]:
```
0.057719999999999994
```

If each game with 1000 sequence of moves,the probabilty of hitting the target is 0.05771

We can see more frequent the moves,higer the chance of hitting target or hazard

[ ]:
```

```