



# Farzad Azizi Zade

Mini SLAM Project



$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
1	-1			
-1	1			

$-5$   
 $5$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0 \rightarrow x_1$

$x_1 = x_0 + 5$

$x_0 - x_1 = -5$

$x_1 - x_0 = 5$

$x_1 \rightarrow x_2 \quad -4$

$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
1	-1			
-1	2	-1		
	-1	1		

$-5$   
 $9$   
 $-4$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0 \rightarrow x_1$

$x_1 = x_0 + 5$

$x_0 - x_1 = -5$

$x_1 - x_0 = 5$

$x_1 \rightarrow x_2 \quad -4$

$x_1 - x_2 = 4$

$x_2 - x_1 = -4$

$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
1	-1			
-1	2	-1		
	-1	1		

$-5$   
 $9$   
 $-4$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0 \rightarrow x_1$

$x_1 = x_0 + 5$

$x_0 - x_1 = -5$

$x_1 - x_0 = 5$

$x_1 \rightarrow x_2 \quad -4$

$x_1 - x_2 = 4$

$x_2 - x_1 = -4$

$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
1	-1			
-1	3	-1		
	-1	1		

$-5$   
 $0$   
 $-4$   
 $9$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0 \rightarrow x_1$

$x_1 = x_0 + 5$

$x_0 - x_1 = -5$

$x_1 - x_0 = 5$

$x_1 \rightarrow x_2 \quad -4$

$x_1 - x_2 = 4$

$x_2 - x_1 = -4$

$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
Red	Red		Blue	
Red	Red	Green	Purple	Purple
	Green	Green	Orange	Orange
			Blue	
			Purple	Orange

$-5$   
 $9$   
 $-4$   
 $0$   
 $9$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

Color code

- Move  $x_0$  to  $x_1$
- Move  $x_1$  to  $x_2$
- Measure  $L_0$  from  $x_0$
- Measure  $L_1$  from  $x_2$
- Measure  $L_0$  and  $L_1$  from  $x_1$

$x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

$x_0$	$x_1$	$x_2$	$L_0$	$L_1$
Green	Green	Green	Green	Green
Green	Green	Green	Green	Green
Green	Green	Green	Green	Green
Green	Green	Green	Green	Green
Green	Green	Green	Green	Green

$-5$   
 $0$   
 $-4$   
 $9$   
 $x_0$   
 $x_1$   
 $x_2$   
 $L_0$   
 $L_1$

How MANY OF THE 30 ARE NEVER TOUCHED?

8

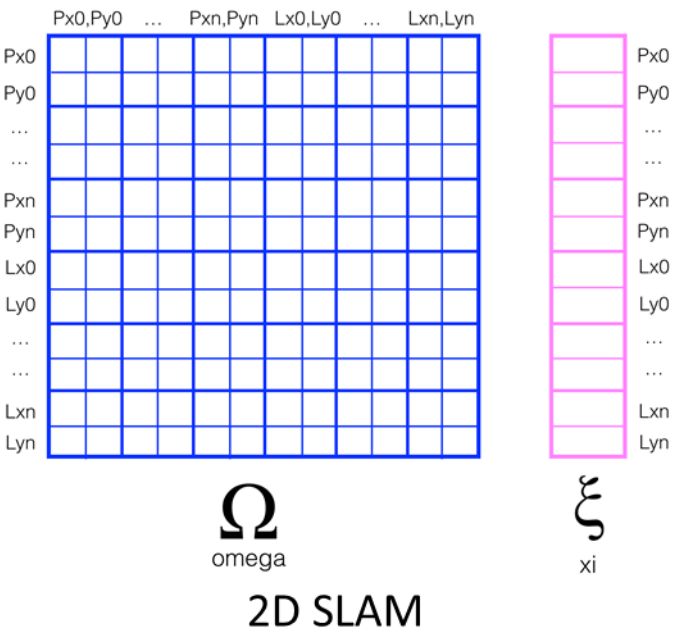
How to find 8 unknowns?

Answer:

$$\mu = \Omega^{-1} \cdot \xi$$

MU:

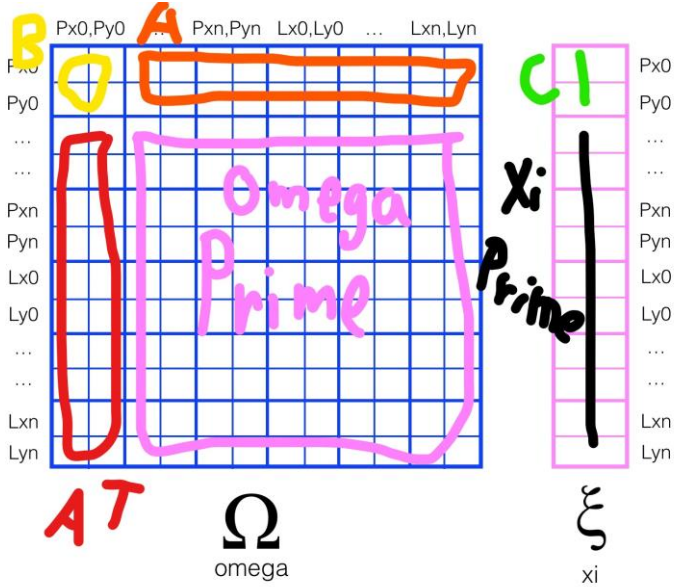
contain the estimated robot poses (this is the **localization** part of SLAM) and the estimated location of the landmarks (which is the **mapping**).



That's why we need to  
 $\text{dimx} += 1$   
 $\text{dimy} += 1$  when we  
move or have a new  
landmark

Each step the  
pink area will  
be updated

$B = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$



$$\begin{aligned} \text{Omega} &= \text{Omega\_Prime} - A^T * B^{-1} * A \\ \text{xi} &= \text{xi\_Prime} - A^T * B^{-1} * C \end{aligned}$$

$$A^{-1} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1} = \frac{1}{ad - bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

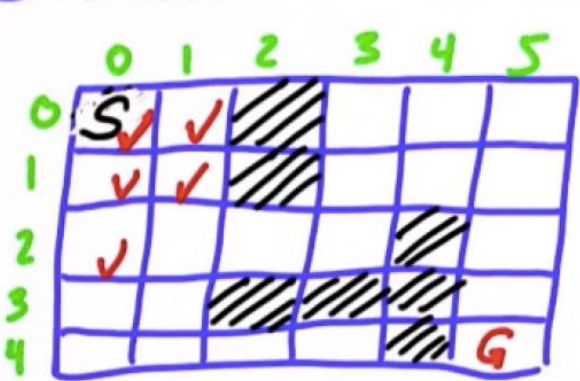
2	4	-1
-10	5	11
18	-7	6

 $\rightarrow$ 

2	-10	18
4	5	-7
-1	11	6



# SEARCH - PATH PLANNING



UP  
↑  
LEFT ← R → RIGHT  
↓  
DOWN

OPEN = ~~[0,0]~~ 0  
         ~~[1,0]~~ 1    [0,1] 1  
         [2,0] 2    [1,1] 2

g-Value

```
grid = [[0, 0, 1, 0, 0, 0],  
        [0, 0, 1, 0, 0, 0],  
        [0, 0, 0, 0, 1, 0],  
        [0, 0, 1, 1, 1, 0],  
        [0, 0, 0, 0, 1, 0]]
```





S	/				
✓	/				
✓	/				
✓	/				
✓	⊙	✓	✓	0	G

$f = g + h(x,y)$

$h(x,y) \leq$

~~$[0,0] 0.8$~~

~~$[4,1] 5.8$~~

~~$[4,2] 4.8$~~

$[3,2] 7.11$

$[3,3] 8.11$

~~$[4,3] 4.8$~~

$[4,4] 8.9$

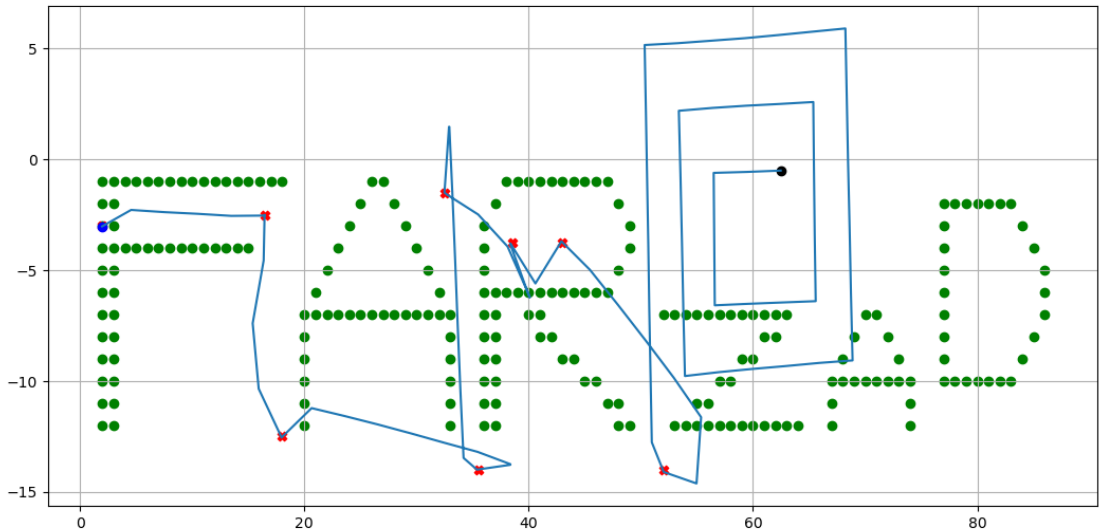
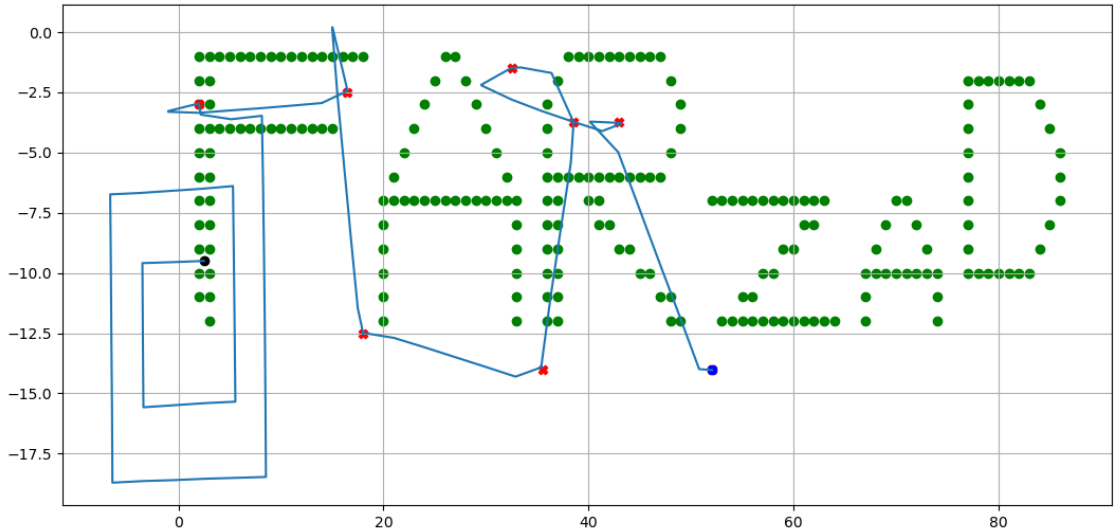
9	8	7	6	5	4
8	7	6	5	4	3
7	6	5	4	3	2
6	5	4	3	2	1
5	4	3	2	1	0

S	/				
/					
/					
/					
/					
					G

```
grid = [[0, 1, 0, 0, 0, 0],
        [0, 1, 0, 0, 0, 0],
        [0, 1, 0, 0, 0, 0],
        [0, 1, 0, 0, 0, 0],
        [0, 0, 0, 0, 0, 0]]
```

$[0, -1, -1, -1, -1, -1]$
$[1, -1, -1, -1, -1, -1]$
$[2, -1, -1, -1, -1, -1]$
$[3, -1, -1, -1, -1, -1]$
$[4, 5, 6, 7, 8, 9]$

$[0, -1, -1, -1, -1, -1]$
$[1, -1, 12, -1, -1, -1]$
$[2, -1, 9, 13, -1, -1]$
$[3, -1, 7, 10, 14, -1]$
$[4, 5, 6, 8, 11, 15]$



The Best Score is :

part A score: 100.00  
part B score: 88.89  
score: 92.56

**THE END**

**Thanks for your Time and Consideration**



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Mini SLAM Project

Main Resource  
[Artificial Intelligence for Robotics | Udacity](#)