

# Robotics

## Problem Sheet 7

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### Notes

The homework serves as preparation for the exams. It is strongly recommended that you solve them before the given deadline - but you do not need to hand them in. Feel free to work on the problems as a group - this is even recommended.

### 1 Problem

Given 4 beacons  $b_i$  at 4 known positions  $(x_i, y_i)$  in the plane as follows:

i=	$x_i$	$y_i$
1	35	40
2	12	23
3	7	18
4	9	9

A robot  $r$  at an unknown position  $p_r = (x_r, y_r)$  has a sensor to measure the distances to the beacons. Use multilateration to determine  $p_r$  when the ranges  $D(b_i, r)$  between all beacons and the robot are as follows:

	$b_1$	$b_2$	$b_3$	$b_4$
$D(b_i, r)$	37	9	2	10

### 2 Problem

Given a sensor network with 4 nodes  $p_i$  at 4 positions  $(x_i, y_i)$  in the plane. The ranges  $D(p_i, p_j)$  between the nodes are given as follows:

$D(p_i, p_j)$	$p_1$	$p_2$	$p_3$	$p_4$
$p_1$	0.00	50.00	44.72	31.62
$p_2$	50.00	0.00	60.83	22.36
$p_3$	44.72	60.83	0.00	58.31
$p_4$	31.62	22.36	58.31	0.00

Determine the 4 positions  $(x_i, y_i)$  of the nodes via MDS using the step by step algorithm from the lecture, i.e.,:

- compute a suited matrix A from the distance matrix D
- double center A (getting B)
- use SVD on B
- find a good rank approximation B'
- get the locations X