Solutions to exercises from Lecture 5 Swarm robotics 2

TEK5010 Multiagent systems 2020

Question 1

a) Explain and characterize the **voter model**:

A robot i considers its neighbours' opinions o_j with $j \in \mathcal{N}_i$ (without i) and picks a neighbour j at random and switches to its opinion.

Typically, the k-nearest neighbours are evaluated.

- Very simple model
- High accuracy
- Slow convergence

b) Explain and characterize the **majority rule:**

A robot i considers its neighbourhood group $\mathcal{G}_i$ (including i) and counts the occurrence w_j of each option in O. The robot them switches its opinion to the most frequent option O_k with $k = \text{argmax}\, w_j$, that is, the majority within its group.

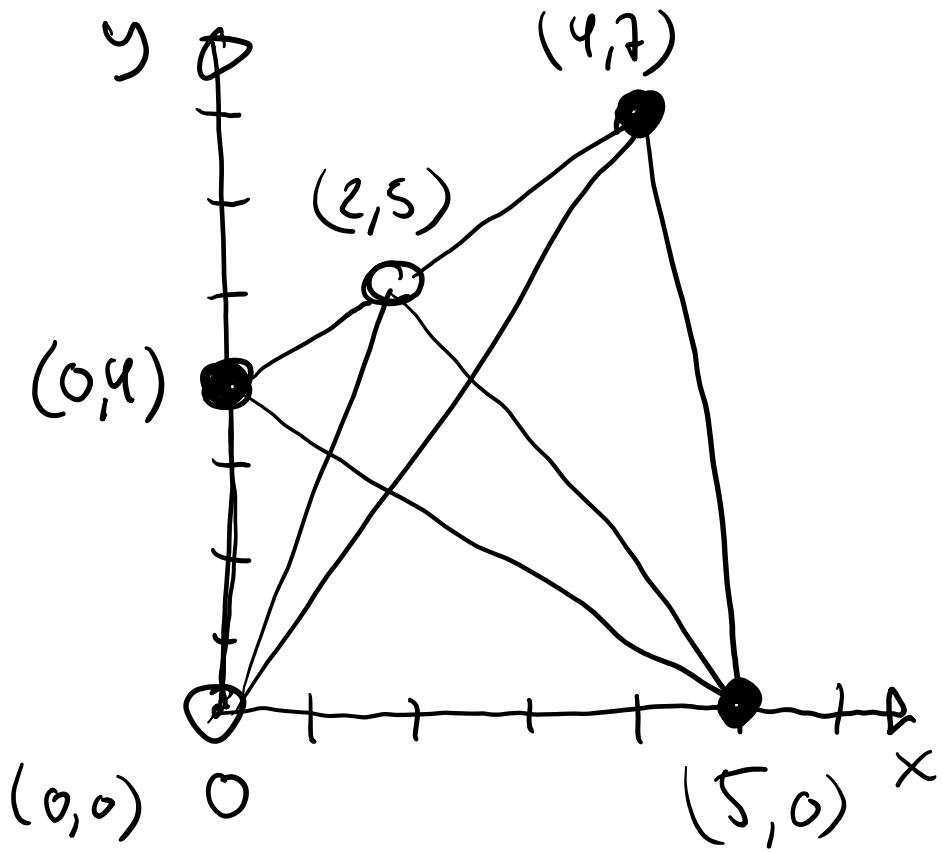
Also here, the k-nearest neighbours are typically evaluated.

- Fast convergence
- Less accurate than the voter model

Notes

- Accuracy is the probability of system converging to the majority of initial states or reproducing the initial frequencies?
- Convergence is the number of iterations in the consensus process or the complexity of algorithm in terms of big $\mathcal{O}$-notation?
- Simultaneously or sequentially update of individuals?
- K-nearest neighbours or within distance d?

c) One iteration of consensus process



○ $s = 0$

● $s = 1$

Distance matrix

	(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	s_0
(0,0)	∞	5	8,1	5,4	4	0
(5,0)	5	∞	7,1	5,8	6,4	1
(4,7)	8,1	7,1	∞	2,8	5	1
(2,5)	5,4	5,8	2,8	∞	2,2	0
(0,4)	4	6.4	5	2,2	∞	1

* Voter model, let's use $h = 3$

Distance matrix #0

	(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_0
(0,0)	∞	5	8,1	5,4	4	0
(5,0)	5	∞	7,1	5,8	6,4	1
(4,7)	8.1	7,1	∞	2,8	5	1
(2,5)	5,4	5,8	2,8	∞	2,2	0
,4)	4	6,4	5	2,2	∞	1

#1 simultaneously

(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_1
(1)	0	X	0	0	1
1	(1)	1	X	X	1
X	x	(1)	1	1	1
0	0	0	(1)	0	1
1	1	1	1	(0)	0

* Voter model, let's use $k = 3$

Distance matrix #0

	(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_0
(0,0)	∞	5	8,1	5,4	4	0
(5,0)	5	∞	7,1	5,8	6,4	1
(4,7)	8.1	7,1	∞	2,8	5	1
(2,5)	5,4	5,8	2,8	∞	2,2	0
,4)	4	6,4	5	2,2	∞	1

#1 sequentially

(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_1
1	1	X	1	1	1
1	1	1	X	X	1
X	X	0	0	0	0
0	0	0	1	1	1
1	1	1	1	1	1

* Majority rule, let's use $h = 3+1$

Distance matrix #0

	(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_0
(0,0)	∞	5	8,1	5,4	4	0
(5,0)	5	∞	7,1	5,8	6,4	1
(4,7)	8.1	7,1	∞	2,8	5	1
(2,5)	5,4	5,8	2,8	∞	2,2	0
,4)	4	6,4	5	2,2	∞	1

#1 simultaneously

(0,0)	(5,0)	(4,7)	(2,5)	(0,4)	S_1
0	0	X	0	0	1
1	1	1	X	X	1
X	x	1	1	1	1
0	0	0	0	0	0
1	1	1	1	1	1
$f_0=\frac{1}{2}$	$f_0=\frac{1}{2}$	$f_0=\frac{1}{4}$	$f_0=\frac{1}{2}$	$f_0=\frac{1}{2}$	
$f_1=\frac{1}{2}$	$f_1=\frac{1}{2}$	$f_1=\frac{3}{4}$	$f_1=\frac{1}{2}$	$f_1=\frac{1}{2}$	