

## Cognitive Robotics

### Assignment 7

- 7.1) Consider two features  $f_1$  and  $f_2$  extracted from an observation  $z_t$ , and a map  $m_t = (l_1, l_2, l_3)$  with three landmarks. An assignment  $\Psi$  associates each observed feature  $f_i$  to a map landmark  $l_j$ , or marks it as a false detection or as a new landmark.

(a) Write down all possible assignments for the two observed features  $f_1$  and  $f_2$  and the three map landmarks  $l_1 \dots l_3$ . Note that in an assignment an observed feature can be associated to at most one map landmark.

6 points

(b) Suppose now that for a given assignment, every observed feature marked as a new landmark is added to the map. For each map  $m_{t+1}$  derived from the assignments in (a), write down all possible assignments for a single feature  $f_3$  extracted from the observation  $z_{t+1}$ .

4 points

- 7.2) In bearing-only SLAM, the initialization of new landmarks (mean, covariance) is difficult, because the robot can only measure the angle between its orientation and the landmark, but not the landmark distance.  
Find a method in the literature that has been proposed to overcome the 'delayed initialization' problem. (Hint: Perform undelayed initialization).

5 points

- 7.3) Consider FastSLAM with a 6D robot pose (3 position coordinates, 3 rotation coordinates) and  $M$  3D landmark positions. How many independent variables are needed to represent the state and its uncertainty?

5 points