Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
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Sheet 11

Topic: Exploration, SLAM

Submission deadline: July 26, 2011

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Exercise 1: Pursuit Evasion Problem

Suppose a certain number of robots are chasing a moving intruder through a known, bounded environment. The robots have omni-vision and can detect the intruder at any distance if the intruder is in the line-of-sight. Can you draw an environment where k robots can succeed in finding the intruder in finite time, but $k-1$ robots cannot? Draw such an environment for $k = 2$, $k = 3$, and $k = 4$ robots. Describe the successful search strategy for k robots and explain why $k-1$ robots could not accomplish the task.

Exercise 2: Entropy

1. Compute the entropy $H(p)$ in bits (therefore use $\log_2$) of the following discrete distribution p:

$p(x_1)$	$p(x_2)$	$p(x_3)$	$p(x_4)$
0.04	0.06	0.2	0.7

2. Prove that the entropy of a grid map cell $m_{x,y}$ is maximal for $p(m_{x,y}) = 0.5$.

3. Consider a discrete uniform distribution of a random variable with n possible outcomes. Prove that the entropy of the distribution decreases if you change the distribution by increasing the probability of a single event and accordingly reducing the probability of another event.

Exercise 3: Factoring the SLAM posterior

The full SLAM posterior can be written in the factored form:

$$p(x_{1:t}, m | z_{1:t}, u_{0:t-1}) = p(x_{1:t} | z_{1:t}, u_{0:t-1}) \prod_{n=1}^{N} p(m_n | x_{1:t}, z_{1:t}) \tag{1}$$

In the second factor of the factorization, the landmarks are supposed to be independent given the complete trajectory $x_{1:t}$ and the observations $z_{1:t}$. Is it possible to condition the map on the most recent pose x_t only? That is:

$$p(x_{1:t}, m|z_{1:t}, u_{0:t-1}) = p(x_{1:t}|z_{1:t}, u_{0:t-1}) \prod_{n=1}^{N} p(m_n|x_t, z_{1:t}) \tag{2}$$

Explain your answer.