Lehrstuhl für STEUERUNGS- UND REGELUNGSTECHNIK Technische Universität München Prof. Dongheui Lee	**MACHINE LEARNING IN ROBOTICS** Exercises : Markov processes

Exercise 1

A protocol for data transmission shall be analysed using a Markov chain with 3 states. The probability for the transition from $state1$ (*check interface for incoming data*) to $state2$ (*check address*) is 0.1. The address is correct with probability 0.4. In this case, there is a transition to $state3$ (*message received*). Otherwise, the system returns to $state1$. If a message was received and there is no further message (probability 0.7), the system leaves $state3$ and enters in the $state1$. If there is a further message, it enters in the $state2$.

a) Specify the matrix of transition probabilities.

b) Draw the corresponding Markov chain.

c) What is the probability for the system to be in $state1$?

Exercise 2

An urn contains N balls, consisting of some white and some black balls. At each stage, a coin is flipped with a probability $p,\ 0 < p < 1$, of landing heads. If head appears, then a ball is chosen at random from the urn and is replaced by a white ball; if tail appears, then a ball is chosen from the urn and is replaced by a black ball. Let X_n denote the number of white balls in the urn after the n-th stage.

a) Is $X_n,\ n \geq 0$ a Markov chain? If so, explain why.

b) Compute the probabilities $P(X_{n+1} = X_n + 1|X_n)$, $P(X_{n+1} = X_n|X_n)$ and $P(X_{n+1} = X_n - 1|X_n)$ that define the described system.