

# Statistical Mechanics WS 2013/14 Sheet 0

Please hand in your solutions before the Monday lecture at 10:15

## Problem 1 Normal Distribution (20 points)

The following data set shows the distribution of hair length in a sample  $N = 731$  Japanese monkeys:

Hair Length $x_i$ in mm	nr. of apes $n_i$	$P(x_i)$ in 1/mm
10	5	
15	15	
20	25	
25	30	
30	140	
35	150	
40	160	
45	110	
50	55	
55	20	
60	20	
65	1	

Table 1: data adapted from *A Preliminary Study on Hair Length in the Japanese Monkey (Macaca fuscata fuscata)* by H. Inagaki

- Find the probability density  $P(x_i)$  for hair lengths  $x_i = 5, 10, 15, \dots, 65$  mm so that  $P(x_i)\Delta x$  equals the probability to find a monkey with hair length in the interval  $[x_i, x_i + \Delta x]$ . The size of the bins is  $\Delta x = 5$ mm.
- Estimate the mean value  $\mu = \langle x \rangle$  and the standard deviation  $\sigma = \sqrt{\langle (x - \mu)^2 \rangle}$  from the sample.
- Assuming that the probability distribution is normal, how probable is it to find a monkey with hair length larger than 50 mm?

## Problem 2 Binomial Distribution (20 points)

There will be 10 exercise sheets in this semester. Some error creeps in on an exercise sheet with probability  $p = \frac{1}{3}$ .

- What is the probability that there is an error on this particular sheet?
- What is the probability that only 1 of the sheets contains an error?
- What is the probability that exactly 3 sheets contain errors?
- What is the probability that at least 50% of the sheets do not contain any error?
- What is the probability of 3 faulty sheets in a row if all other sheets are correct?

## Problem 3 Poisson Distribution (20 points)

A gas station has 2 pumps where it can serve clients at the same time. On average 2 cars stop every hour for a refuelling. Refuelling takes 5 minutes. How probable is it that a client has to wait because all pumps are occupied? In other words: What is the probability that more than 2 cars arrive within 5 minutes?

## Problem 4 Car or Goats (20 points)

Suppose you're on a game show, and you're given the choice of three doors: Behind one door is a car; behind the others, goats. You pick a door, say No. 1, and the host, who knows what's behind the doors, opens another door, say No. 3, which has a goat. He then says to you, "Do you want to pick door No. 2?" Is it to your advantage to switch your choice?