Communications and Transport Systems
Department of Science and Technology **2022/2023**
Linköping University

Christiane Schmidt

Design and Analysis of Algorithms Part 2 - Approximation and Online Algorithms homework 1, 13.12.2022

Problem 1 (Bin-Packing):
Consider the Bin-Packing Problem:
Given: A list of nonnegative numbers $a_1, \ldots, a_n \leq 1$
Task: Find a $k \in \mathbb{N}$ and an assignment $f : \{1, \ldots, n\} \to \{1, \ldots, k\}$ with $\sum_{i:f(i)=j} a_i \leq 1$ for all $j \in \{1, \ldots, k\}$ such that k is minimum. That is, you try to pack the numbers in bins of size 1, and you want to pack them in as few bins as possible.
Show that the Bin-Packing problem is NP-complete.

Problem 2 (Rectangle Packing by Reduction from Bin-Packing):
Consider the Rectangle Packing problem from the lecture. Show that the problem is NP-complete by a reduction from Bin-Packing.

Problem 3 (Multiprocessor Scheduling):
Given:

- n jobs with processing times $a_1, a_2, \ldots, a_n$
- p processors (each sequential and identical)

Task: Assign jobs to processory to minimize the maximum completion time, the so called *makespan*.
(Decision version: Can all processors finish by $\leq t$?)
Show that the Multiprocessor Scheduling problem is NP-complete by

(a) A reduction from Partition

(b) A reduction from 3-Partition

(c) What result do we get from (b) that we do not get from (a)?