**ADD to the section on Partition**

# 1 SRP

DONE

Alfonsín [?] looked at variants of SUBSETSUM. We look at one of them. The basic idea is that instead of being able to use $a_i$ just once, you can use it $\leq r_i$ times where $r_i$ is part of the input.

**Problem 1.1** SRP *(Subset Sum with Repetition) INSTANCE: : Positive integers* $a_1, \ldots, a_n$ *and* $r_1, \ldots, r_n$ *and a target* $t$*. QUESTION: : Does there exist* $0 \leq x_i \leq r_i$ *such that* $\sum_{i=1}^{n} x_i a_i = t$*.*

**Exercise 1.2**

1. Show that SRP is NP-complete.
2. Show that SUBSETSUM restricted to the case where the elements are superincreasing (every element is greater than or equal to the sum of all of the previous elements) is in P.
3. Show that SRP restricted to the case where the elements are superincreasing is NP-complete.
4. Show that SRP restricted to the case where the elements are superincreasing and $(\forall i)[r_i \in \{1, 2\}]$ is NP-complete.

# 2 Other Stuff

NOT GOING TO DO

The k-Subset-Sum problem is whether the multiset has a subset of size exactly $k$ which sums to the target. This problem is also weakly NP-hard.

The Bin Packing problem is similar to the multiprocessor scheduling problem. In the multi processor scheduling problem you are given a number of processors $p$ and need to know if it is possible to finish before the given time limit. In the bin packing problem, you are given only a time limit (volume of the bins) and need to figure out how many processors (number of bins) you need to finish in time. Obviously this is also NP-complete, because you can reduce the multiprocessor scheduling problem to it by just adjusting the time limit until you get the right number of bins.

The Multi-Subset-Sum problem is given a multiset of integers and a target, what is the maximum number of disjoint subsets that sum to the target. This is strongly NP-hard, by a reduction from 3PART.

4Partition is the same as 3Partition but with $\frac{n}{4}$ sets instead of $\frac{n}{3}$. It is also NP-complete because 3PART can be reduced to it.

## 3 Packing Triangles

DONE

Chou [?] studied the problems of (1) packing triangles into a rectangle $(\mathrm{TRI}-\mathrm{RECTPACKING})$ and (2) packing triangles into a triangle $(T\mathrm{TRI}-\mathrm{TRIPACKING})$. The triangles cannot be rotated.

**Exercise 3.1**

1. Show that $\mathrm{TRI}-\mathrm{RECTPACKING}$, restricted to right triangles by, is NP-hard. *Hint:* Use a reduction from thPARTION.

2. Show that $\mathrm{TRI}-\mathrm{TRIPACKING}$, restricted to triangles being right or equilateral, is NP-hard. *Hint:* Use a reduction from thPARTION.

3. Show that $\mathrm{TRI}-\mathrm{TRIPACKING}$, restricted to triangles being equilateral, is NP-hard. *Hint:* Use a reduction from fourPART.