Research Institute for Discrete Mathematics
Approximation Algorithms
Summer Term 2013

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Programming Exercise

Exercise P.1:
Implement the Knapsack Approximation Scheme.

Input and Output

Input The input will be read from file. The first line contains the numbers $n, W \in \mathbb{N} \cup \{0\}$ of items followed by $\varepsilon > 0$ in decimal notation. The file contains n further lines describing c_i w_i. The first index of our numbering for (c_i, w_i) is $i = 0$. An example might look like this:

```
3 10 0.04
2 6
9 5
8 3
```

Here we have $n = 3$, $W = 10$, $\varepsilon = \frac{1}{25}$, $c_0 = 2$, $w_0 = 6$, $c_1 = 9$, $w_1 = 5$, $c_2 = 8$ and $w_2 = 3$.

Output Your program should compute a $(1+\varepsilon)$-approximation $S \subseteq \{0, \ldots, n-1\}$. Afterwards the indices in S should be printed separated by single spaces in increasing order followed by a newline character. Trailing whitespace should be avoided. In the above example, the correct output would be

```
1 2
```

Further Specifications

- Your code has to compile on linux using `g++/gcc` version 4.4 for `ISO 99 C/C++` with compilerflags `-O2 -pedantic -Wall -Wextra -Wno-long-long` without warnings and errors.
- Third party libraries except from `STL` are prohibited.

- Your code has to run without errors or failures. Additionally it must not result in memory errors as reported by the standard tool `valgrind`.
- In case of nested directories, provide a Makefile for `gnu make` version 3.82.
- You have to document your solution appropriately and safeguard correctly against occuring errors (e.g. during `malloc`).
- Your solution must achieve the proven theoretical running time $O\big(n^2 \cdot \frac{1}{\varepsilon}\big)$ in practice.
- Solutions missing out in one or more of the above criteria will not be rewarded with all 16 points even if their output is correct.

Read in and Instances

- You may freely use or modify the sample code provided online at `http://www.or.uni-bonn.de/lectures/ss13/approximation_uebung_ss13.html` to read input files meeting the specifications stated above.
- Further instances to test on will be made available online as well.

(16 points)

In case of questions feel free to ask.

Please return your solutions before the lecture on Tuesday, **May 28st, 2:15 PM**, by mail to `ochsendorf@or.uni-bonn.de`.