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Lower bounds for online bin packing problems (survey)

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The classical bin packing problem requires to pack n elements with sizes a_i, $0 \leq a_i \leq 1$ for $i = 1, ..., n$, into a minimum number of unit capacity bins. The problem is well known to be NP-hard. Therefore a lot of (polynomial time) approximation algorithms have been defined and analysed. We will consider the class of online algorithms where the items appear one after the other, and the algorithm has to place the items immediately and irrevocably without knowing anything about the subsequent items. One possibility to measure the effciency of an algorithm to give its asymptotic competitive ratio (ACR) which is given as follows. Let A be an arbitrary approximation algorithm, and let I be an instance of the given problem. Let A(I) and OPT(I) denote the solution of A and the optimal solution, respectively. The ACR is defned as follows: $R_A^\infty = \limsup_{k\to\infty} \{\max_I \{A(I)/k : \mathrm{OPT}(I) = k\}\}$.

It is clear that online algorithms do not have enough information to produce a good packing. So the question in hand: how good can an online algorithm possibly be? In this talk we will discuss the history of lower bounds for the effciency of online bin packing algorithms.

We start with a simple example showing that for any online bin packing algorithm A we have $R_A^\infty \geq 4/3$. Then using the so-called Salzer-sequences we give combinatorial proofs to verify that $R_A^\infty \geq 1.5364$. Introducing an LP formulation van Vliet (1994) improved the lower bound to 1.5401. It was an open question for a long time whether van Vliet's result can be proved in a purely combinatorial way. In 2012 we gave a positive answer to this question. Moreover, we managed to improve the lower bound to 1.5403 by using a different proof technique which is interesting in its own right, and also can be extended to arrive at an improved improved lower bound for a class of semi-online bin packing algorithms.

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