Acta Cybernetica **18** (2007) 47–60.

A Classification Scheme for Bin Packing Theory

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Abstract

Classifications of published research place new results in a historical context and in so doing identify open problems. An example in wide use classifies results in scheduling theory according to a scheme originated by Graham, Lawler, Lenstra and Rinnooy Kan [10]. A similar effort was made by Dyckhoff [6] for cutting and packing problems. Such classification schemes can be combined with comprehensive bibliographies, e.g., the one provided for scheduling theory by Bruckner[1]. This paper describes a novel classification scheme for bin packing which is being applied by the authors to an extensive (and growing) bibliography of the theory. Problem classifications are supplemented by compact descriptions of the main results and of the corresponding algorithms. The usefulness of the scheme is extended by an online search engine. With the help of this software, one is easily able to determine whether results already exist for applications that appear to be new, and to assist in locating the cutting edge of the general theory.

1 Introduction

For given positive reals $a_1, \ldots, a_n$ and $b_1, b_2, \ldots$, classical bin packing algorithms partition some subset of $\{a_1, \ldots, a_n\}$ into blocks $B_1, B_2, \ldots, B_j$ such that the *levels* $\ell(B_i) := \sum_{a_k \in B_i} a_k$ satisfy the sum constraints $\ell(B_i) \le b_i$, $1 \le i \le j$. This definition embraces several packing problems, depending on the way the subset of the a_i's and the integer j are chosen. In bin packing terms, the a_i are called *items*, the blocks B_i are called *bins* with respective *capacities* or *sizes* b_i, and the partitions are called *packings*; the notion of packing items into a sequence of initially empty bins helps visualize algorithms for constructing partitions. It is also helpful in classifying algorithms according to the various constraints under which they must operate in practice. The items are normally given in the form of a sequence or *list* $L = (a_1, \ldots, a_n)$, although the ordering in many cases will not have any significance. To economize on notation, we adopt the harmless abuse whereby a_i denotes both the name and the size of the i-th item. The generic symbol for packing is $\mathcal{P}$; the

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[1]Available at http://www.mathematik.uni-osnabrueck.de/research/OR/class/