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Generalized Bin Packing Problems

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This is a summary of the author PhD thesis supervised by Roberto Tadei and defended on February, 28, 2013 at Politecnico di Torino. The thesis is written in English and is available from the author upon request at mauro.baldi@polito.it. This work deals with a new family of packing problems named Generalized Bin Packing Problems.

Packing problems make up a fundamental topic of combinatorial optimization. Their importance is confirmed both by their wide range of scientific and technological applications they are able to address and by their theoretical implications. In fact, they are exploited in many fields such as computer science and technologies, industrial applications, transportation and logistics, and telecommunications. From a theoretical perspective, packing problems often appear as sub-problems in order to iteratively solve bigger problems. Although packing problems play a fundamental role in all these settings, there is a gap in terms of comprehensive study in the literature. In fact, the joint presence of both compulsory and non-compulsory items has not been considered yet. This particular setting arises in many real-life applications, not yet addressed or only partially addressed by the current state-of-the-art packing problems. Furthermore, little has been done in terms of unified methodologies, and different techniques have been used in order to solve packing problems with different objective functions. In particular, none of these techniques is able to address the presence of compulsory and non-compulsory items at the same time. In order to overcome a noteworthy portion of this gap, we formulated a new packing problem, named the Generalized Bin Packing Problem (GBPP), characterized by both compulsory and non-compulsory items, and multiple item and bin attributes. Packing problems have also been studied within stochastic settings where the items are affected by uncertainty. In these settings, there are fundamentally two kinds of stochasticity concerning the items: 1) stochasticity of the item attributes, where one attribute is affected by uncertainty and modeled as a random variable or 2) stochasticity of the item availability, i.e., the

items are not known a priori but they arrive on-line in an unpredictable way to a decision maker. Although packing problems have been studied according to these stochastic variants, the GBPP with uncertainty on the items is still an open problem. Therefore, we have also studied two stochastic variants of the GBPP, named the Stochastic Generalized Bin Packing Problem (S-GBPP) and the On-line Generalized Bin Packing Problem (OGBPP). Our main results concern the development of models and unified methodologies of these new packing problems, making up, as done for the Vehicle Routing Problem (VRP) with the definition of the so called Rich Vehicle Routing Problems, a new family of advanced packing problems named Generalized Bin Packing Problems.