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2D Packaging Problem using Swarm Intelligence

Vidya Shingade , Shital Kumbhar, Sonali Khandve.

B.E Student, Department of Computer Engineering, MIT AOE, Alandi, Pune, Maharashtra, India

ABSTRACT: We consider the NP-complete problem of finding an enclosing rectangle of minimum area that will contain a given a set of rectangles. We present two different constraint satisfaction formulations of this problem. The first searches a space of absolute placements of rectangles in the enclosing rectangle, while the other searches a space of relative placements between pairs of rectangles. Both approaches dramatically out perform previous approaches to optimal rectangle packing. For problems where the rectangle dimensions have low precision, such as small integers, absolute placement is generally more efficient, whereas for rectangles with high-precision dimensions, relative placement will be more effective. Two-dimensional packing problems are a class of optimization problems in mathematics which involve attempting to pack objects together in the packing region as densely as possible. There are many variations of this problem, such as two-dimensional packing, linear packing, packing by weight, height

KEYWORDS*:* Rectangle packingConstraint satisfaction,Search global best position, global second best position, personal best position.

I. INTRODUCTION

Packing problems are very often in the real world and industries. Many solutions are already provided to solve such problems. Two dimensional rectangle packing problem is one of the most important problem. The main problem discussed here is rectangle packing problem which is occurred very frequently in the industry. Different types of conventional, heuristic and metaheuristic methods are discussed to efficiently solve the problem.Packing problems are very often in the real world and industries. Many solutions are already provided to solve such problems. Two dimensional rectangle packing problem is one of the most important problem.The packing problem tested with the hybrid *GA* approach is the two dimensional Bin-Packing problem. The bin-packing problem (*2D-BPP*) is concerned with packing different sized objects into fixed sized, in general for two-dimensional bins, using as few bins as possible. The two-dimensional bin-packing problem *(2D-BPP)* and its multi-dimensional variants have many practical applications as packing objects in boxes, stock cutting, filling up containers, loading trucks with weight capacity, multiprocessor scheduling, production planning

II. LITERATURE SERVEY

The literature survey regarding which methodolgy should be applied was taken considering the following existing algorithms and models.

A. Richard E. Korf Michael D. Moffitt Martha E. Pollack presented Optimal rectangle packing. The first searches a space of absolute placements of rectangles in the enclosing rectangle, while the other searches a space of relative placements between pairs of rectangles. Both approaches dramatically outperform previous approaches to optimal rectangle packing. For problems where the rectangle dimensions have low precision, such as small integers, absolute placement is generally more efficient, whereas for rectangles with high-precision dimensions, relative placement will be more effective.

B. Young-Bin Shin, Eisuke Kita presented Solving two-dimensional packing problem using particle swarm optimization. The problem is solved by two algorithms, original and improved PSOs. In the original PSO, the particle position vector is updated by the best particle position in all particles (global best particle position) and the best position in previous positions of each particle (personal best position). The improved PSO utilizes, in addition to them,

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the second best particle position in all particles (global second best particle position) in the stochastic way. In the numerical example, the algorithms are applied to three problems. The results show that the improved PSO can pack more items than the original PSO and therefore, number of the successful simulations is also improved.

C. Carlos A. Coello Coello presented Handling Multiple ObjectivesWith Particle Swarm Optimization.This paper presents an approach in which Pareto dominance is incorporated into particle swarm optimization (PSO) in order to allow this heuristic to handle problems with several objective functions.

III. RECTANGLE PACKAGING PROBLEM

In these problems both the objects to be packed and the container in which they will be packed are rectangles. So the container can be called as bounding box of rectangle shaped and the objects to be packed inside the bounding box will also be rectangle shaped. Oriented & un-oriented rectangle packing are the categories where in oriented type rectangle position is fixed whereas in un-oriented individual rectangle can be rotated by 90 degrees. There is only one condition about the placement of rectangles i.e. all the sides of rectangles must be parallel with the sides of bounding box and overlapping is not permitted. Rectangle packing has several practical applications. One is the design of VLSI circuits, where rectangular circuit blocks are assigned to physical regions of a rectangular chip. Another is loading a set of rectangular objects onto a cargo pallet, without stacking. yet another application is cutting a set of rectangles from rectangular piece of stock material and many more. There are two important problems here, first one is the containment problem in which rectangle shaped bounding box and also rectangle shaped items.

IV. PROPOSED ALGORITHM

I) For each particle:
    Initialize particle

II) Do:
  a) For each particle:
    1) Calculate fitness value
    2) If the fitness value is better than the best fitness value (pBest) in history
    3) Set current value as the new pBest
    End
  b) For each particle:
    1) Find in the particle neighborhood, the particle with the best fitness
    2) Calculate particle velocity according to the velocity equation (1)
    3) Apply the velocity constriction
    4) Update particle position according to the position equation (2)
    5) Apply the position constriction
    End
  While maximum iterations or minimum error criteria is not attained

In the initialization step, the position in each dimension is initialized randomly. Velocities can be initialized randomly or set to 0.

Fitness function:
The fitness value is initialized with the height of the initial rectangle. The input parameters are chromosome widths and heights and initial rectangle width. In order to evaluate this function we need to posi-tion the rectangles with *BLF* algorithm and compute the maximal value of the height coordinate, y. *Selection* function is based on elitism. At each step are chosen the best k individuals to be transferred in the next generation. The operation involves choosing a random number of pairs of genes and their interchange. Thefunction return a new possible solution from two given solution. The input parameters are two chromosomes and the output is the new solution.

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Choose randomly a cutting point, c < solution length.
• It copies itself to the first c positions of the second chromosome in solution.
• For each value of position j < c the solution is looking for its position in the first series and swapped with the value j in the same row position.
• Finally the last n c chromosomes copies itself to the solution of the first chromosome.

```
Procedure Fitness(widths, heights, maximum)
begin
order widths and heights of chromosome specifications
calculate x and y arrays using BLF procedure
fit = x1 + height1;
for (i = 2 to number of rectangles)
if (xi + heighti > fit) fit = xi + heighti;
end if
end for
return fit
end
```

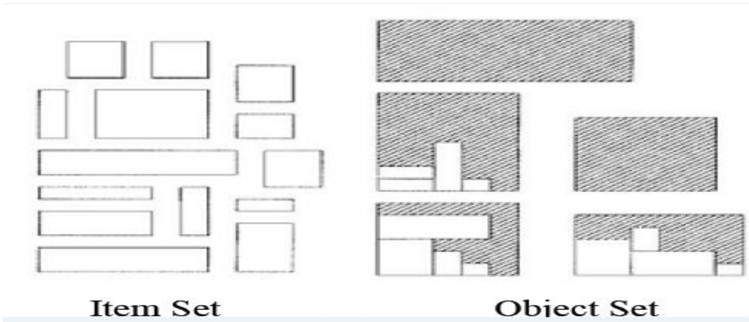
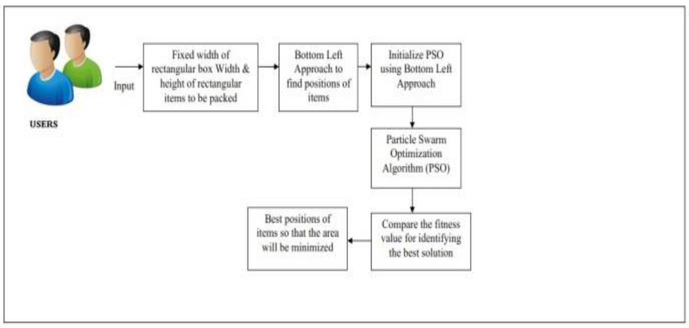


Fig 1:Packing Problem

In Rectangle Packing we have to pack (or cut) a set of small rectangles (pieces) into bin of fixed but unlimited length. The aim is to minimize the length to which the bin is filled. This involves thepacking of rectangles where their sides are always parallel to the x and y axis. The problem can exist with sheets of limited or unlimited height.

V. ARCHITECTURE



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In this architecture, user give input as height and width of the object,then next the position of the object can be findoutthennext PSO algorithm can be applied to findout optimize size of objectand compare the fitness value for identify the solution,then finally object can be placed into the given area.

VI. CONCLUSION

The application of PSO for solving two-dimensional packing problems was presented in this study. Since the storage and the ship cabin are designed so that their sizes are equal to the integral multipleof the container sizes, usually it is assumed that the items are placed every certain intervals. The problem was solved by the original and improved PSOs. In the original PSO, the particle position vectors are updated by the global and the personal best positions. The improved PSO utilizes, in addition to them, the global second best position of all particles. The use of the global second best position is determined in the probabilistic way.

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