Fake Title:   
Using PCGTSP Algorithm for Solving Segment Cutting Problems

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*Keywords*: Include a list of 5-10 keywords.

1. INTRODUCTION

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# 2. SECTION

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# 3. NUMERICAL EXPERIMENTS

## 3.1. Experimental setup

For the purpose of evaluting algorithmsperformance, the special nesting plan was used, containing 19 plain parts and 24 contours, see Fig. 1. Position if 224 feasible pierce points are also depicted along the contours.



Figure 1. Original nesting plan.

To modify set of cutting segments for the nesting plan, two bridges were added, as seen at Fig. 2, yielding 17 parts bounded by 22 contours. Thus, two new complex parts appeared, marked with figures 1 and 2 at Fig. 2.



Figure 2. Position of two bridges

Further, another four bridges were created at the original nesting plan, see Fig. 3, yielding 15 parts and 20 contours. Three new complex parts are also marked with figures 1, 2, and 3, where part 1 is identical to that of Fig. 2, while part 2 is slightly bigger.



Figure 3. Position of four bridges.

All three instances were solved to optimality with two algorithms: DP (Dynamic programming) scheme, see Chentsov et al. (2018), which is proven to find optimal solution for problem instances below 33 contours; new problem-specific Branch-and-Bound algorithm, see. Khachay et al. (2021), pre-seeded with solution by PCGLNS heuristics, see Khachay et al. (2020).

## 3.2. Results

All the problem instances were successfully solved by both algorithms. Solution of original instance without bridges are on Fig. 4 for DP and Fig. 5 for B-n-B.



Figure 4. Solution of 24 contours instance with DP.



Figure 5. Solution of 24 contours instance with B-n-B.

Solutions of the second instance of 22 contours and 17 parts are on Fig. 6 and Fig. 7 respectively for DP and B-n-B algorithms. Note the two paths are almost identical in this case.



Figure 6. Solution of 22 contours instance with DP.



Figure 7. Solution of 22 contours instance with B-n-B.

And finally, solutions of smallest 20 contours instance are at Fig. 8 and Fig. 9.



Figure 8. Solution of 20 contours instance with DP.



Figure 9. Solution of 20 contours instance with B-n-B.

All the solutions are summarized in Table 1. For each algorithm and problem instance time is specified in minutes and seconds. For DP solution length two values provided: air move length and full route length without contours, i.e., air move length with lead-in and lead-out. For B-n-B solution, two lengths are integer one (since current implementation of algorithms uses integer calculus) and its exact floating-point value.

Table 1. Solutions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Problem instance** | | **DP** | | **B-n-B** | |
| **Contours** | **Parts** | **Time (s)** | **Route (mm)** | **Time (s)** | **Route (mm)** |
| 24 | 19 | 42’12 | 5340.12 5820.12 | 4.5 | 5411 5411.16 |
| 22 | 17 | 4’01 | 5259.65 5679.65 | 4.1 | 5380 5382.02 |
| 20 | 15 | 2’14 | 4709.12 5109.12 | 3.6 | 4782 4786.55 |

## 3.3. Discussion

# 6. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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