Project Group 9

CARGO LOAD

Department of Data Science and Knowledge Engineering

Samuel Kopp, Jordan Peshev, Barbara Futyma, Blazej Dolicki, Yvar Hulshof and Stijn van den Berg

TIMELINE

- INTRODUCTION
- BACKTRACKING ALGORITHM
- D&C ALGORITHM
- MAXIMAL LAYER ALGORITHM
- EXPERIMENTS
- CONCLUSION

INTRODUCTION

TERMS AND PROBLEM DEFINITION

- Container
- Value density of a parcel
- CLP

BACKTRACKING ALGORITHM

- First algorithm: simple backtracking
- Option to run for specified amount of time
- Backtracking: parcel level and container level
- Parcel ordering: by type or randomly
- Greedy variation: first found configuration is used
- Results: greedy only marginally worse than non-greedy version

Divide and conquer

- General idea (used in various applications)
    1. Divide a problem in several smaller subproblems.
    2. Solve each subproblem.
    3. Combine the results of all subproblems.

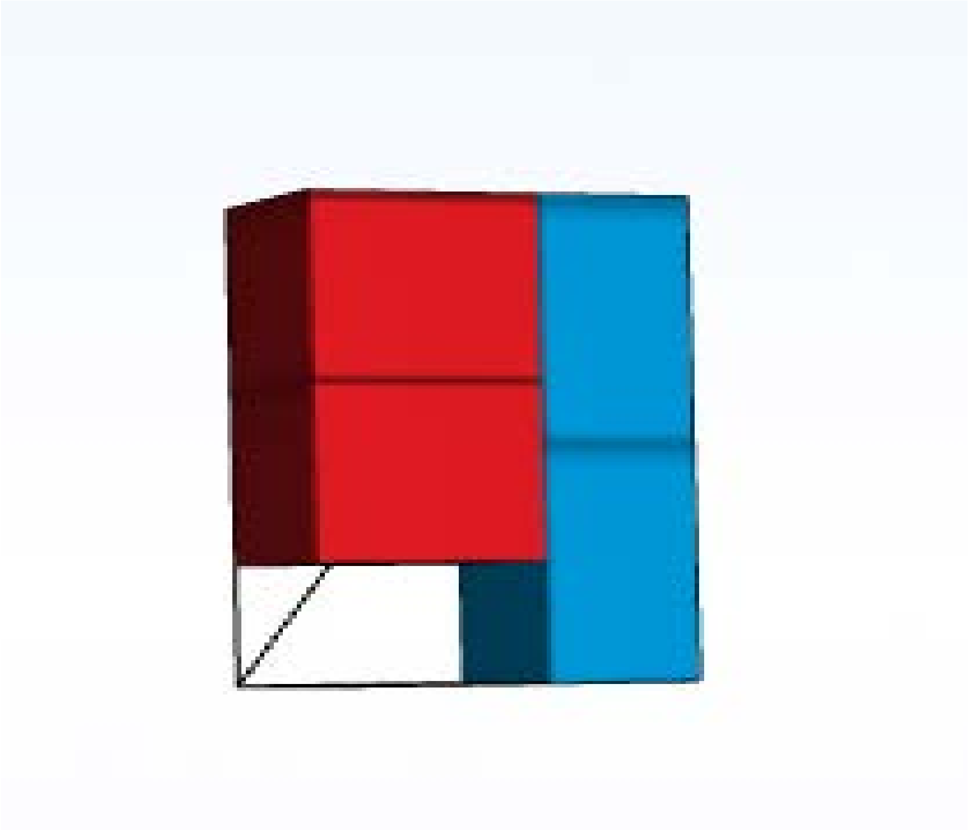
1. Divide the whole cargo space in smaller, equal subspaces.

- Subspaces in this specific case*:
  - 3 x 2 x 5
  - 3 x 4 x 5
  - 3 x 8 x 5
  - 11 x 2 x 5
  - . . .

*however, the programme generates subspaces for a container with arbitrary dimensions

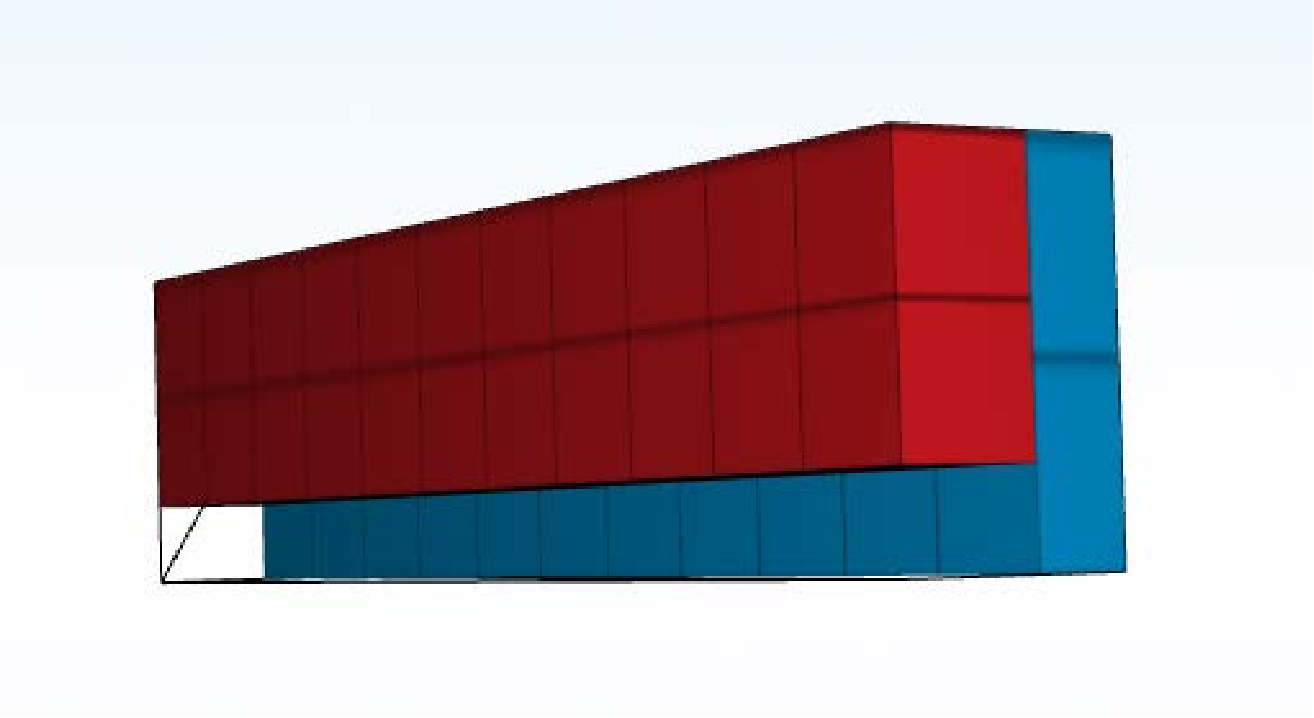
2. Solve each of the subspaces with backtracking.

E.g. solution for subspace 3 x 8 x 5

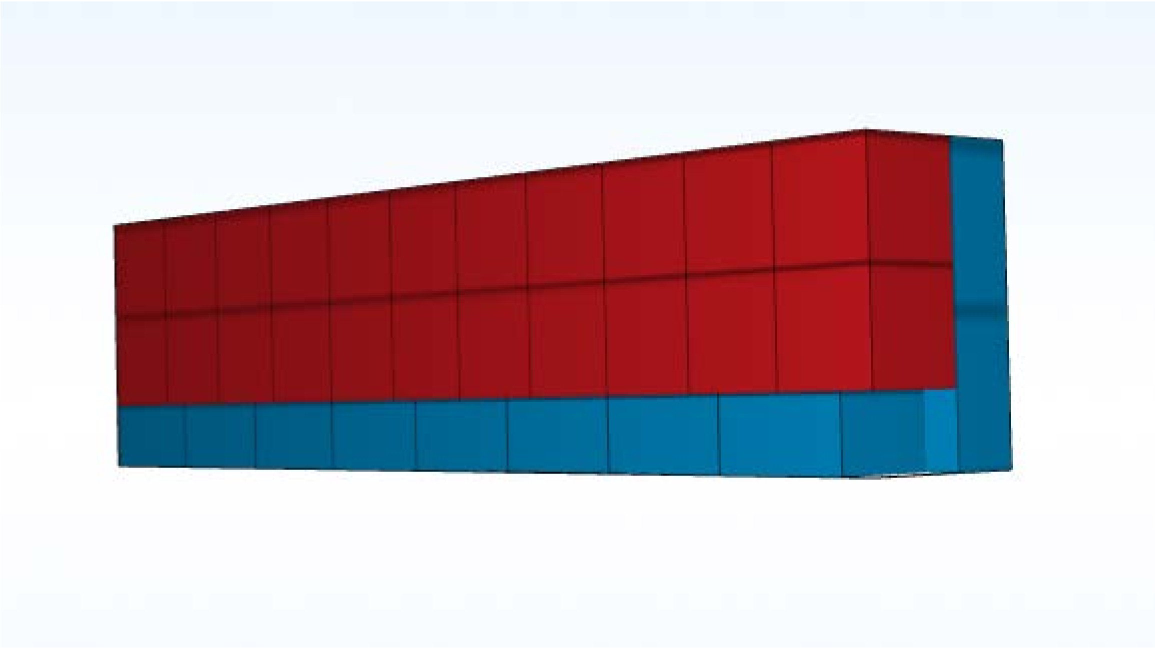


3. Fill cargo with as much copies of each subspace as possible.

E.g. solution for subspace 3 x 8 x 5 copied 11 times



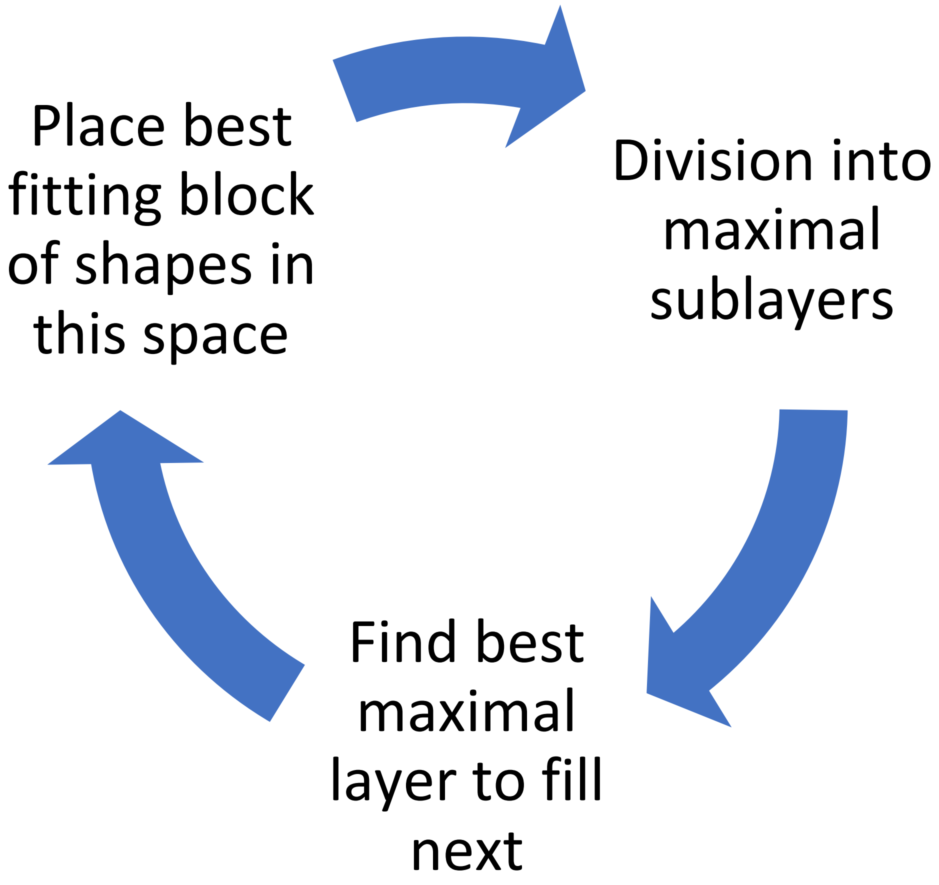
4. Fill the remaining space with parcels that are still left.



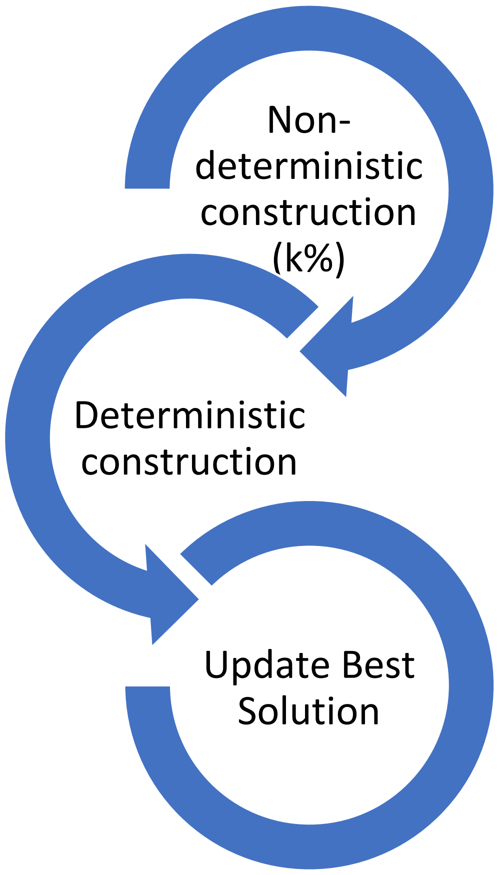
5. See which subspace generates the best result (highest value).

EMPTY MAXIMUM LAYER(EML) ALGORITHM

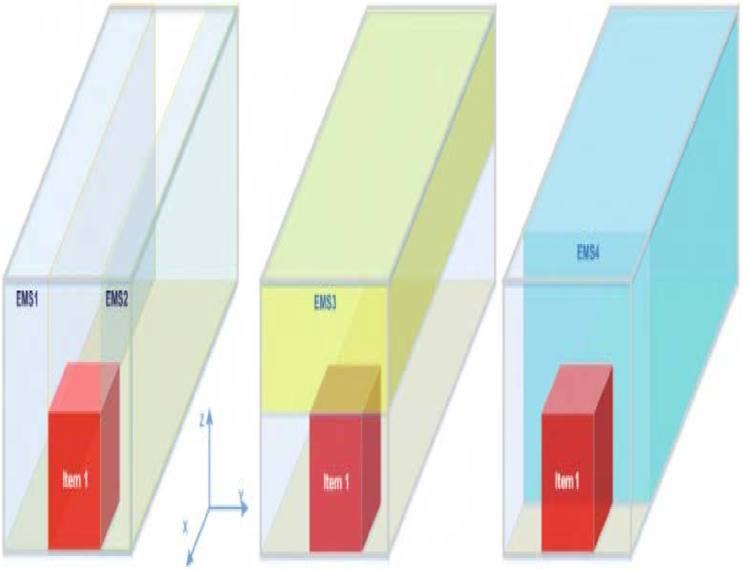
Constructive Phase



Improvement Phase

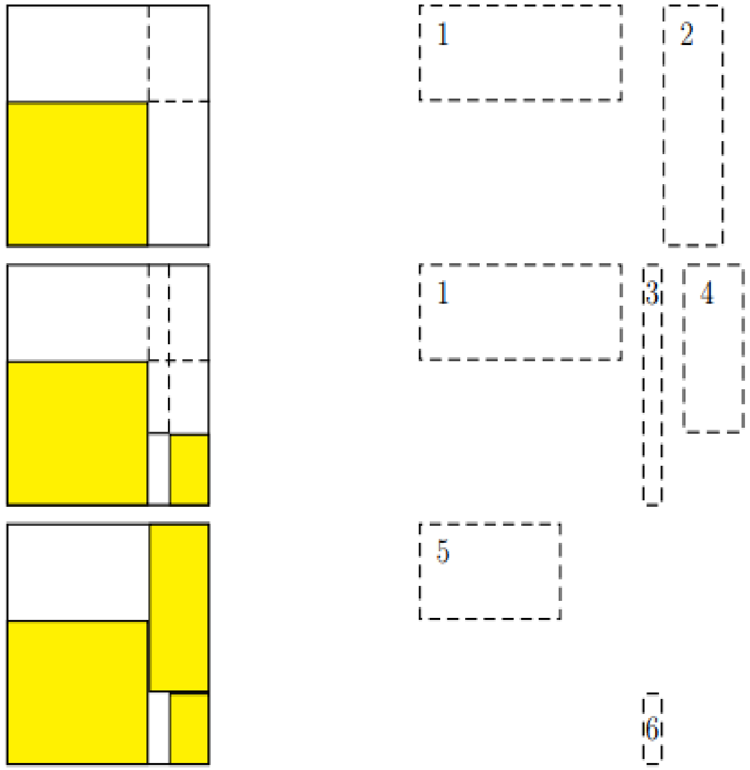


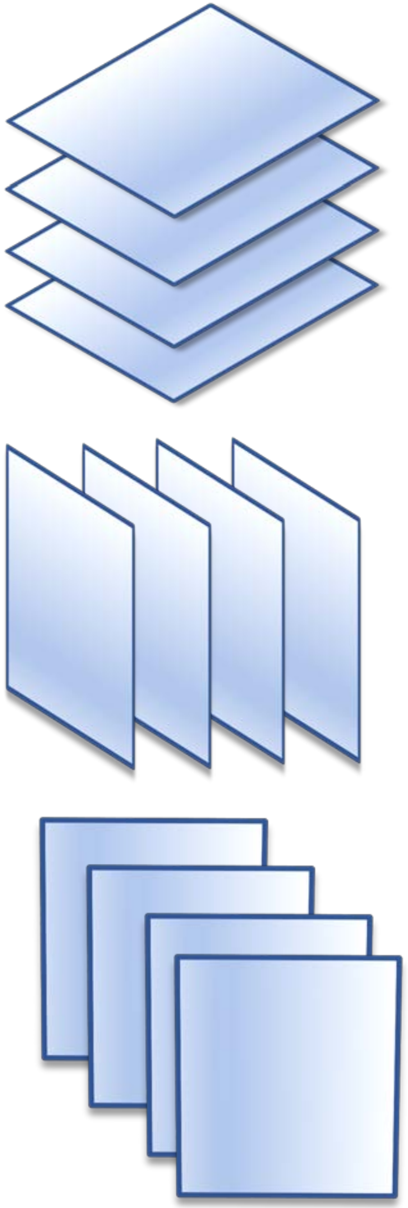
MAXIMAL SPACES



F.Parreno(2008)

MAXIMAL LAYERS





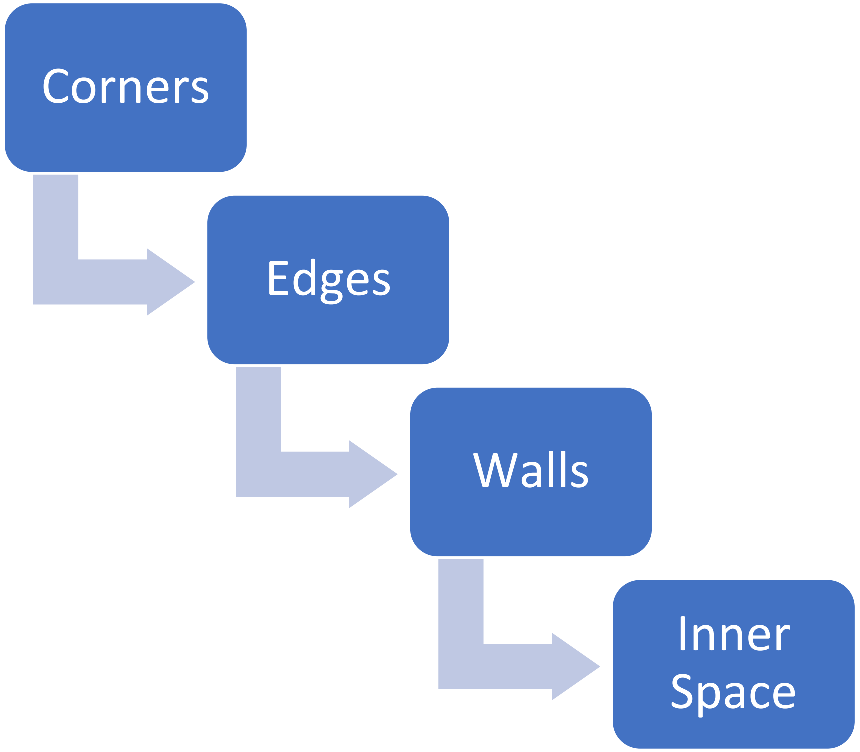
+ $O(3n^3)$ – dynamic programming
+ Pentominoes are flat, can be tiled to rectangles

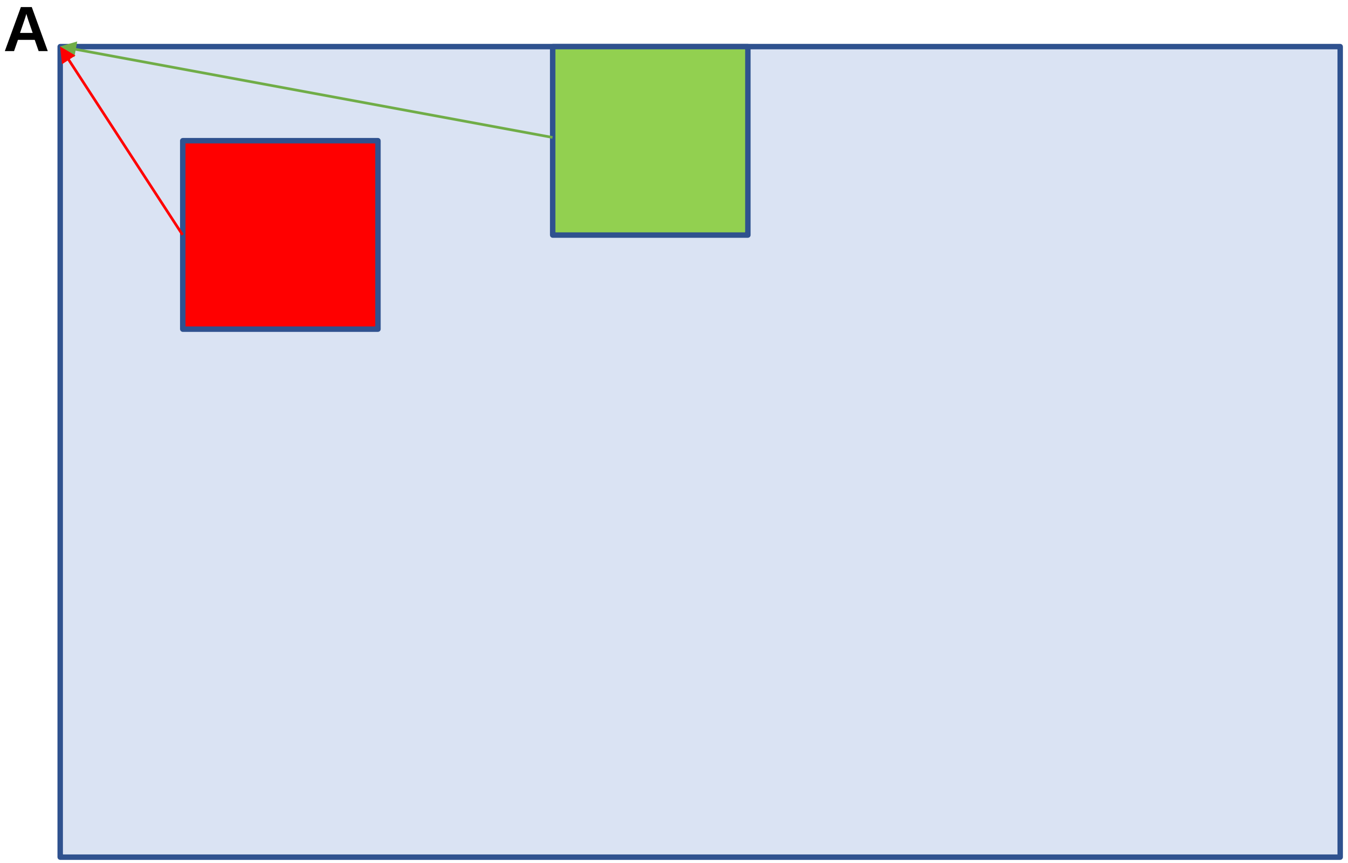
BEST MAXIMUM LAYER

d(S) = min{d(a, c), a vertex of S, c vertex of container C}

distance is compared in lexicographical order

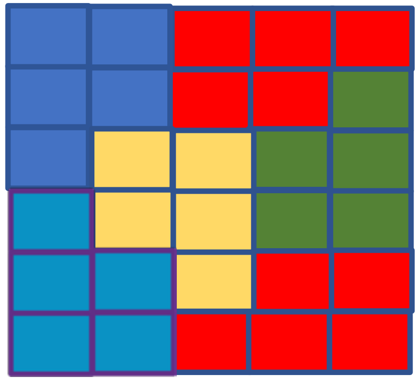
Ex: (0,6,6) is smaller than (1,1,1)

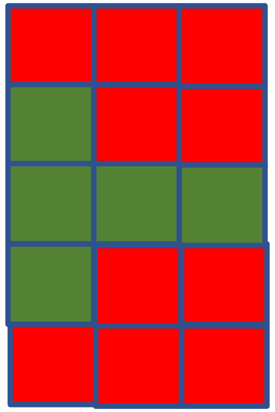


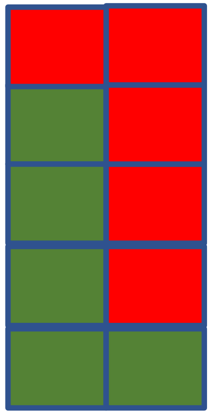


PLACE BEST FITTING BLOCK IN EML

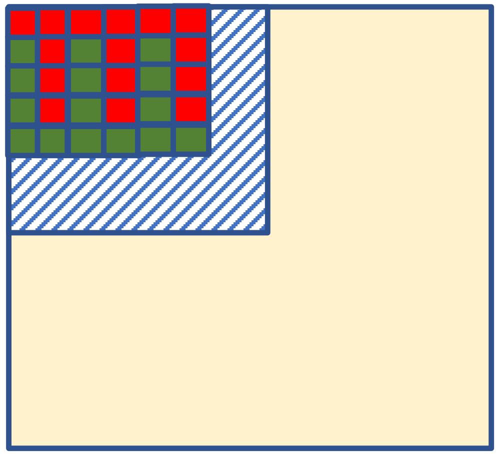
Block of pentominoes:

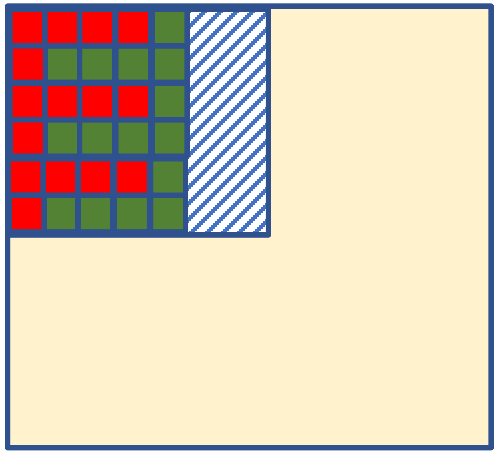






Configurations(Block of Blocks):





Constraint: number of available pieces of this type

Selection Criteria: Increase in volume or value
Alternative: Best fit in space

Tie Breaker: number of shapes used for this block

IMPROVEMENT STRATEGY

```
for k=1,…, Max_Iterations do
        Solution←Randomized_Construction
        Update_Solution(Solution,Best_Solution)
end
return Best_Solution
```

Ex:
→ choose random of 80% best configurations (Step 3.)
for 20% of the construction

+ Flexibility
+ Wider search spectrum
+ Can be combined with local search(s. GRASP)

ALGORITHM PERFORMANCE

Backtracking

Run for [s]	Packing order	A: infinite B: infinite C: infinite	A: 100 B: 0 C: 0	A: 0 B: 100 C: 0	A: 0 B: 0 C: 100
0	by value	**230**	192	192	110
0	by value/volume ratio	192	192	192	110
10	by value	**230**	192	196	110
10	by value/volume ratio	196	192	196	110

Backtracking

Using random parcel ordering

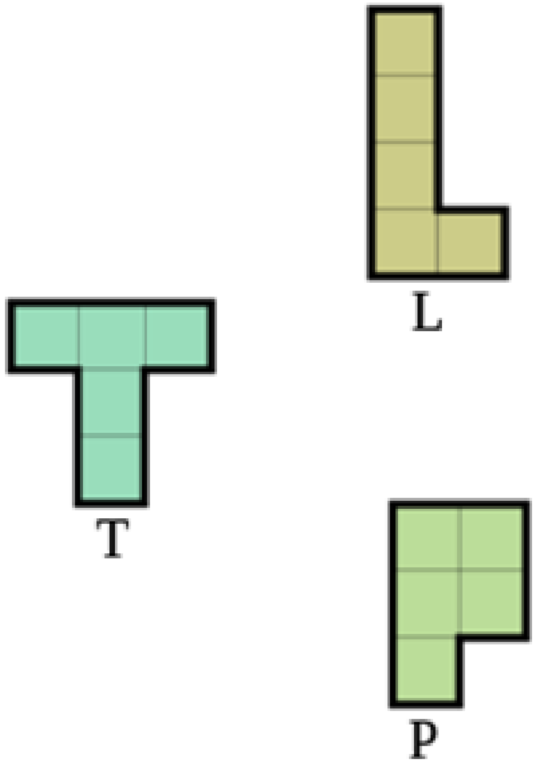
Run for [s]	A: infinite B: infinite C: infinite	A: 100 B: 0 C: 0	A: 0 B: 100 C: 0	A: 0 B: 0 C: 100
0	179/176/187	192	176	110
10	196/194/200	192	176	110
30	200/201/202	192	176	110

Divide & Conquer

Run for [s]	Packing order	A: infinite B: infinite C: infinite	A: 100 B: 0 C: 0	A: 0 B: 100 C: 0	A: 0 B: 0 C: 100
0	by value	**230**	192	192	110
0	by value/volume ratio	192	192	192	110
10	by value	**230**	192	200	110
10	by value/volume ratio	216	192	200	110

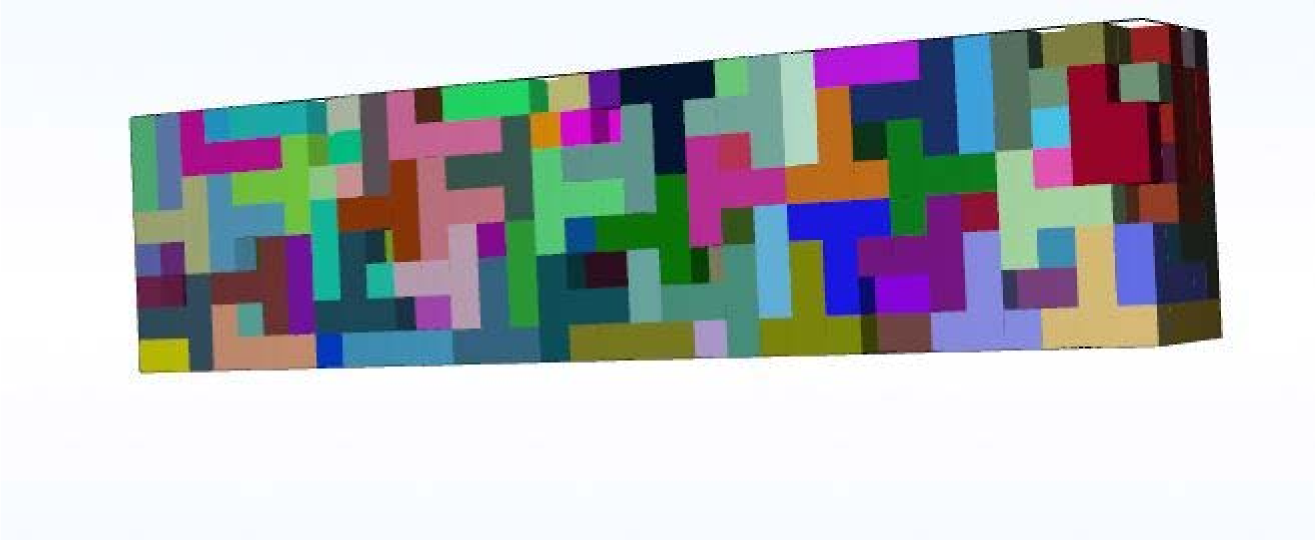
EXPERIMENTS

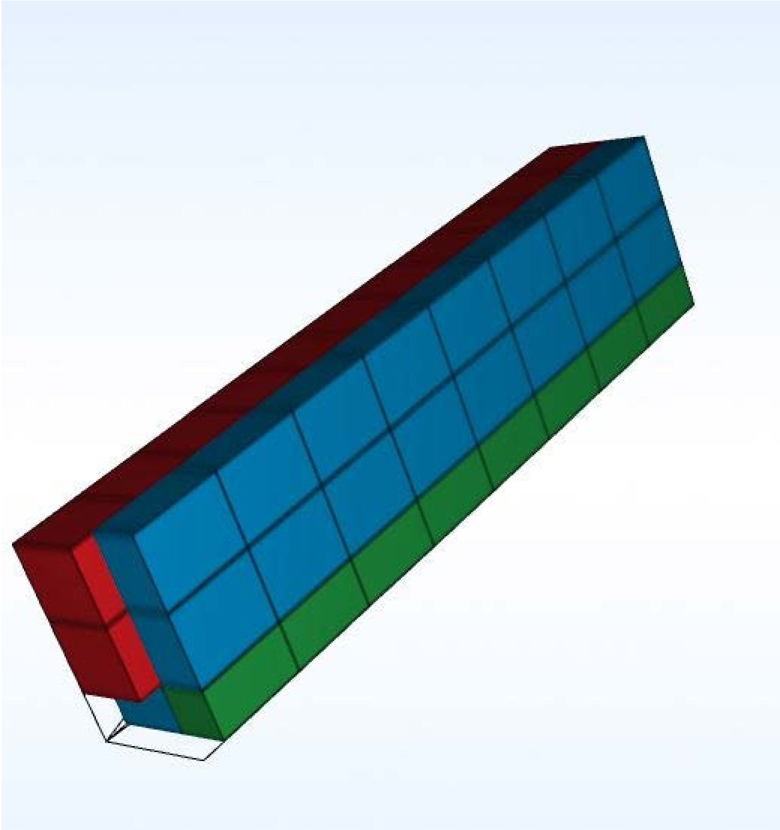
- Changing dimensions of the container,
- Specified amount of parcels,
- Increasing size of the container eight times,
- Filling the container with pentominoes.



3D Design

- JavaFX 3D
- Custom class box that uses triangle mesh





CONCLUSION

- Is it possible to fill the complete cargo space with A, B and/or C parcels, without having any gaps?
- If parcels of type A, B and C represent values of 3, 4 and 5 units respectively, then what is the maximum value that you can store in your cargo-space?

CONCLUSION

Pentomino questions:

- Is it possible to fill the complete cargo space with L, P and/or T parcels, without having any gaps?
- If parcels of type L, P and T represent values of 3, 4 and 5 units respectively, then what is the maximum value that you can store in your cargo-space?

CONCLUSION

Division of NP-hard Problems into Sub-Problems

+ heuristics → missing results of EML

+ Non-deterministic improvement strategies

•THANK YOU!

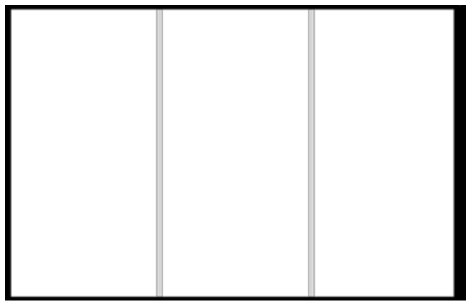
- ANY QUESTIONS?

- CARGO LOAD
- Department of Data Science and Knowledge Engineering
- Group 9

Possible question: „But we know how many times a certain subspace can be placed in the solver… So why the method checks if a subspace fit? ”

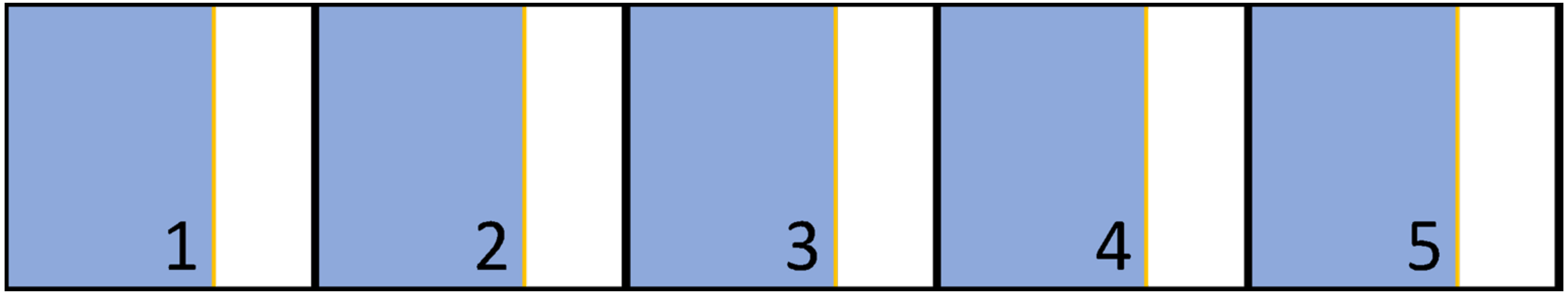
Doesn’t matter if a subspace can be entirely filled, but in **some cases** that approach brings **better results**. For example:

The whole capacity of a subspace



Part of a subspace actually filled with parcels

What happens when the subspaces are inserted one after another?



What if the subspaces are inserted in the first place where they fit?
More subspaces can be included.