RMIT UNIVERSITY
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Smart Mixed Case Palletizing Application

Team Unemployed
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Background and motivation

- Global e-commerce share of retail sales grew from **12%** in 2019 to **17.3%** in 2024.
- Growth in e-commerce increases demand for optimized warehousing and logistics.
- **Palletizing** is a key process for arranging similar or different-sized boxes on a pallet for storage or delivery.
- Manual palletizing is often time-consuming, error-prone, and inefficient.
- Automation can reduce human errors and improve calculation accuracy in pallet arrangement.

Objectives

- **Develop Smart Mixed Case Palletizing** (SMCP), an automated system for pallet stacking.
  - Uses algorithms to calculate optimal, stable stacking arrangements.
  - Considers box dimensions and weight for stacking decisions.
  - Aims to maximize pallet utilization and reduce manual labor.
  - Creating ABBP, a cross-platform GUI application for optimized box stacking and visualization of pallet layouts

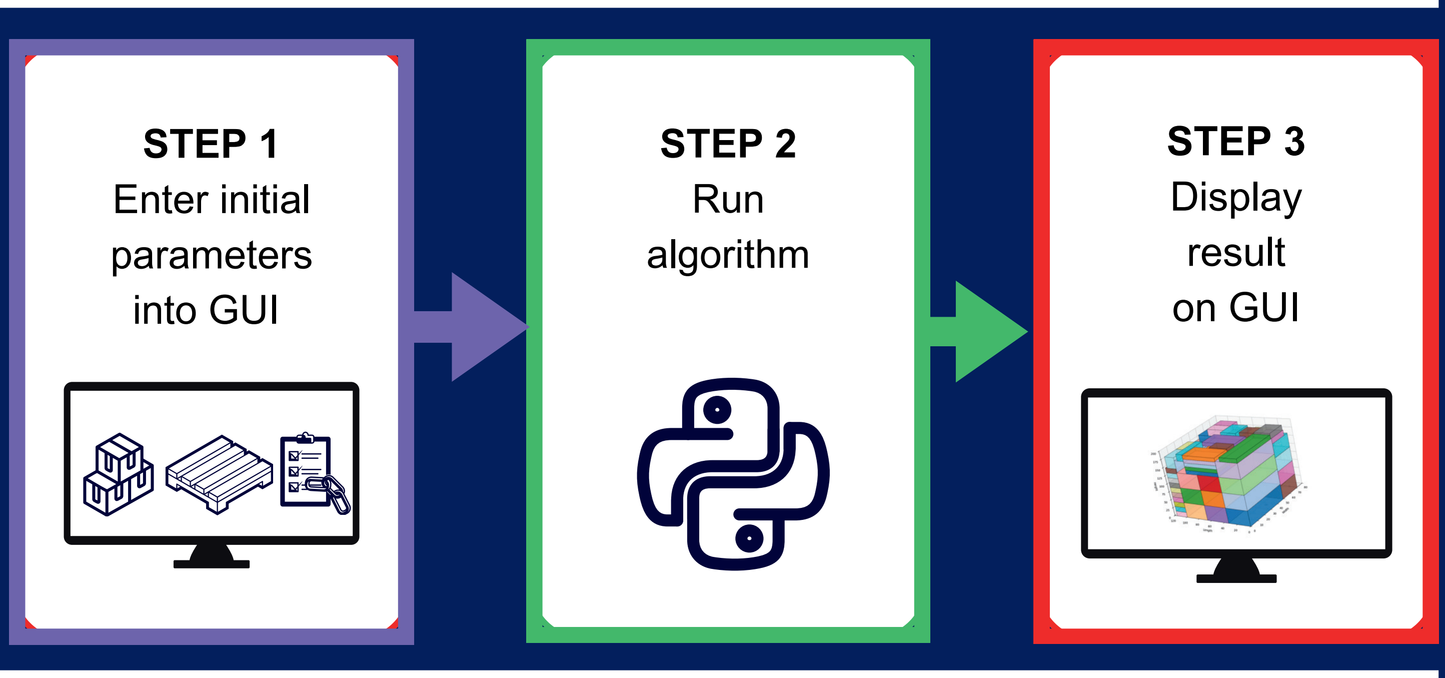
Methodology

ALGORITHM

- Built in Python using a **heuristic** place method and **genetic algorithm**.
- Applies dimension, weight, and overhang constraints.
- **Fitness score** measures compactness, optimization, and stability.

GUI

- Inputs box and pallet dimensions.
- Displays 3D pallet layout and box placement order.



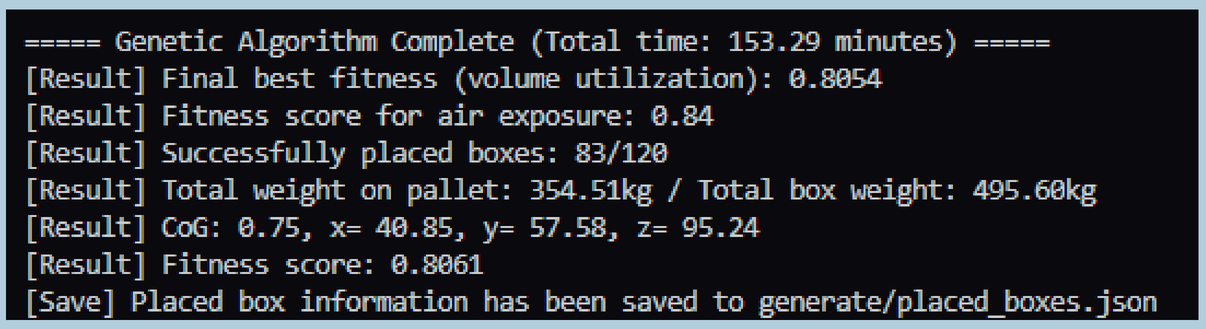
STEP 1
Enter initial parameters into GUI

STEP 2
Run algorithm

STEP 3
Display result on GUI

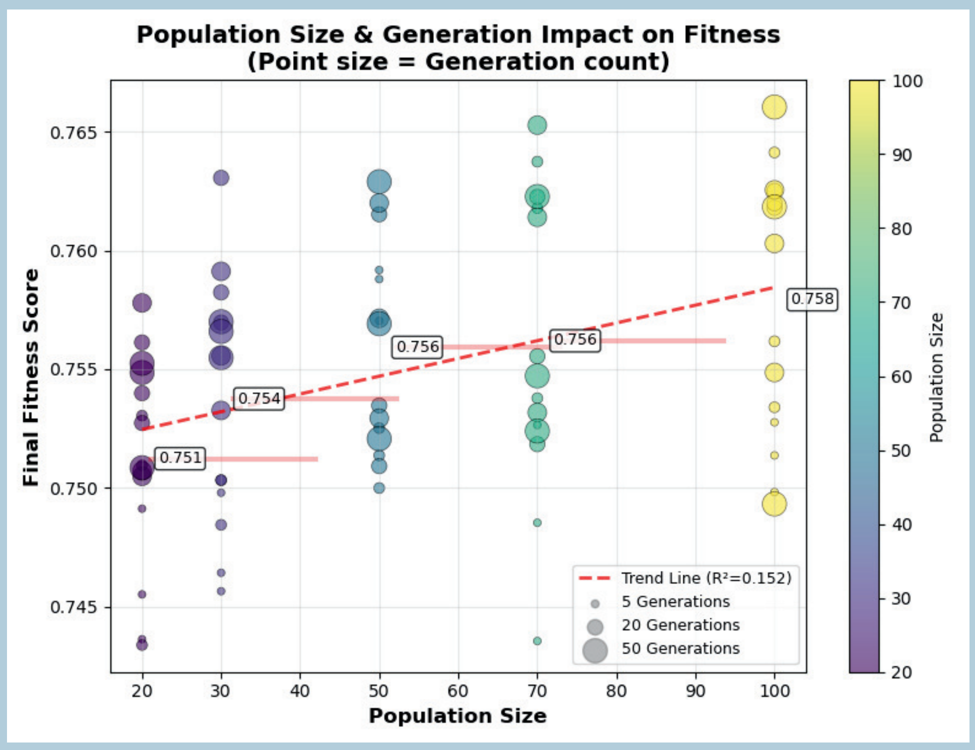
Experiments & Results

Running the algorithm with an initial population of **100 individuals** and **150 generations**, the results are displayed as follows:

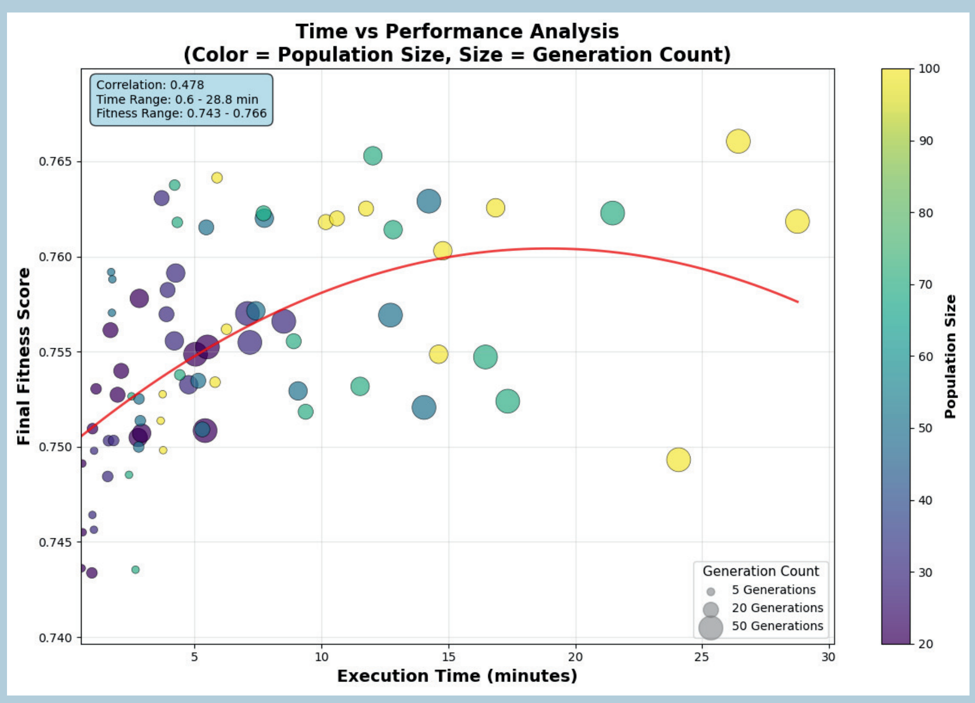


```
===== Genetic Algorithm Complete (Total time: 153.29 minutes) =====
[Result] Final best fitness (volume utilization): 0.8054
[Result] Fitness score for air exposure: 0.84
[Result] Successfully placed boxes: 83/120
[Result] Total weight on pallet: 354.51kg / Total box weight: 495.60kg
[Result] CoG: 0.75, x= 40.85, y= 57.58, z= 95.24
[Result] Fitness score: 0.8061
[Save] Placed box information has been saved to generate/placed_boxes.json
```

Running the algorithm with **varying** numbers of **generations** and **population sizes** yields the following results:

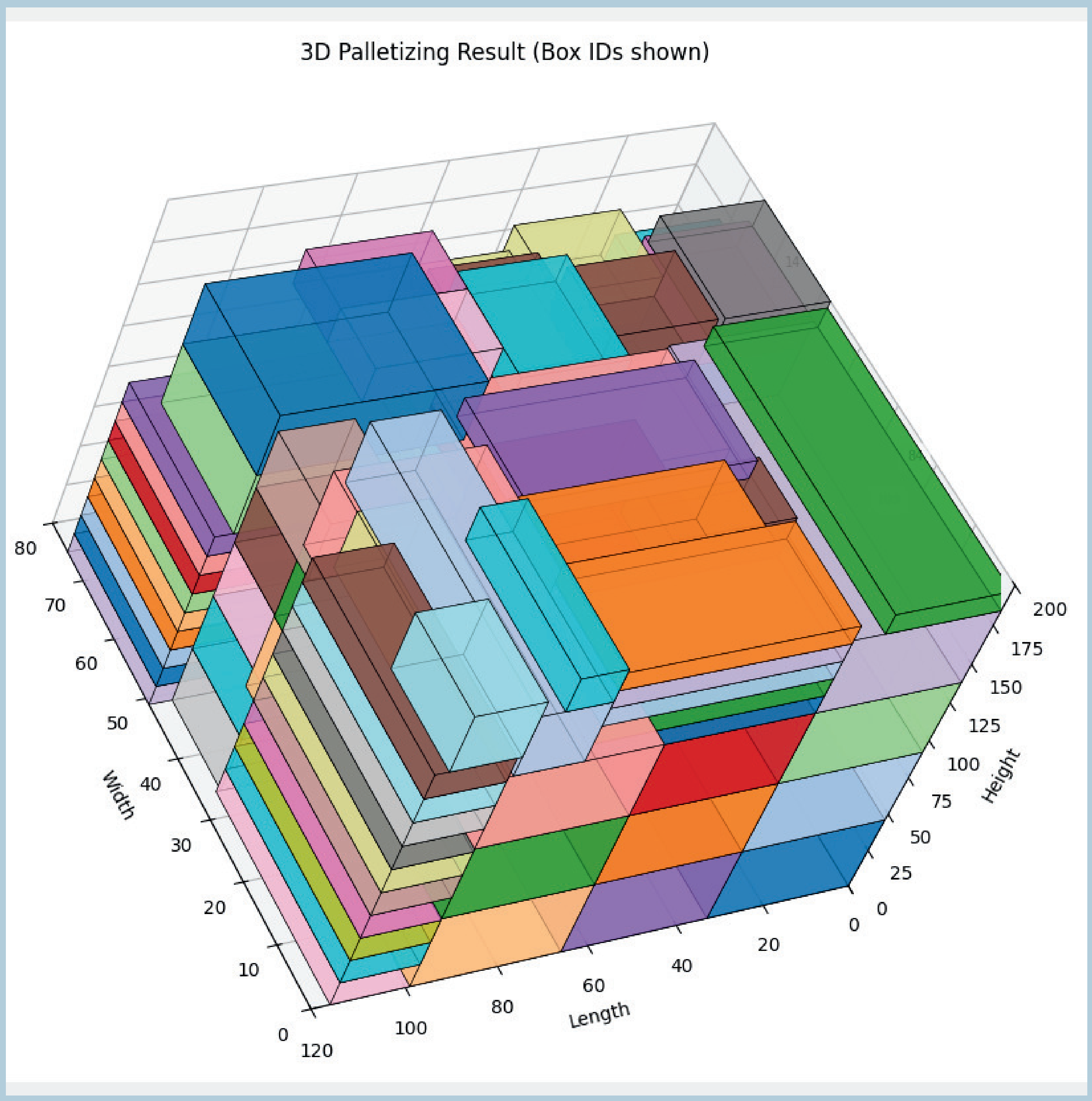


A scatter plot with Population Size on the X-axis and Final Fitness Score on the Y-axis, where point size represents Generation count.



A scatter plot with Execution Time on the X-axis and Final Fitness Score on the Y-axis, where color represents Population Size and point size represents Generation count.

3D Palletizing Results



Conclusion

The quality of the output is directly influenced by the chosen number of **generations** and **population** size. **Higher values** generally yield **better results** but require more **processing time**. According to the produced graphs, the most efficient number of generations and population size is **20** and **50** respectively. Note that the criteria for efficiency above includes fitness score and processing time. Additionally, the GUI display functions effectively, providing a clear and intuitive visualization of the outcomes.