COMP 5560 (EC), Fall 2024
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Report for Assignment 1d
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1.Parameters used, for tuning 5 runs I sat num_childrean (lambda) = 100 but it took 10h to run both cells, and I tried to use num_childrean = 100 for 30 runs (EA), but it took 16 hours running and it never finished so I had to speed the running time by change num_childrean from 100 to 400, I tried 250 it kept running for 6h and It never finished so I had to make it higher to speed thing up.

a. For with crowding - green_Crowdin_config.txt

```
[ea]
mu = 1000
num_children = 400
mutation_rate = 0.05
parent_selection = k_tournament_with_replacement
survival_selection = k_tournament_without_replacement
# Don't touch this
individual_class = LinearGenotype

[recombination_kwargs]
method = uniform

[parent_selection_kwargs]
k = 2

[survival_selection_kwargs]
k = 3

[fitness_kwargs]
crowding = True
yellow = False
# Don't touch this
failure_fitness = ${problem:failure_fitness}

[mutation_kwargs]
bonus = False
# Don't touch this
bounds = ${problem:bounds}

# Don't touch any of these
[problem]
visible_margin = 3
failure_fitness = -1
minimize_area = False
bounds = ((0, 50), (0, 15))
shapes = [[(-2, 1), (-2, 0), (-1, 0), (-2, -1), (0, 0), (1, 0), (2, 0), (0, 1), (1, 1), (0, 2), (3, 0
-1), (0, 0), (1, -1), (0, 1), (0, 2), (2, -1), (-1, -1), (-1, 1)], [(1, 0), (0, 0), (0, 1), (1, -1),
(1, 1), (0, 2), (0, -2), (0, 3), (0, -3), (1, -2), (1, 3), (1, -3), (1, 2)], [(0, -1), (0, 0), (0, 1)
```

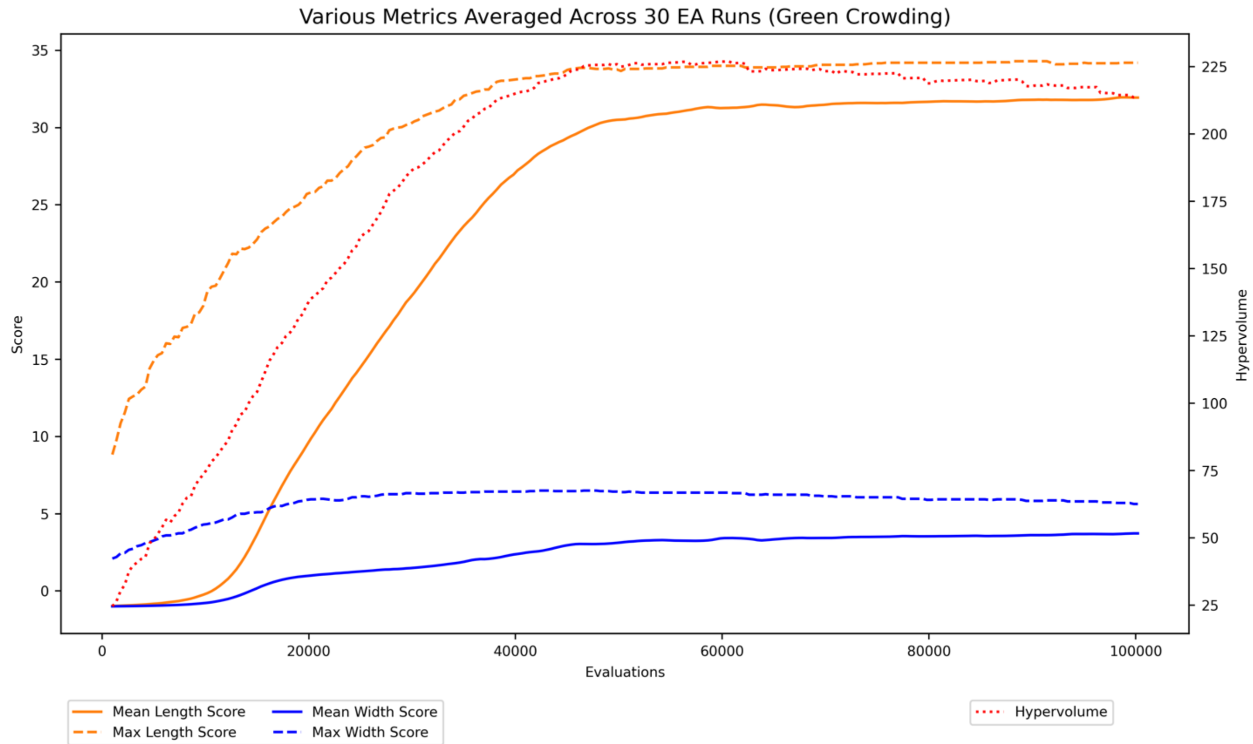
b. for with no crowding – green_no_crowding_config.txt

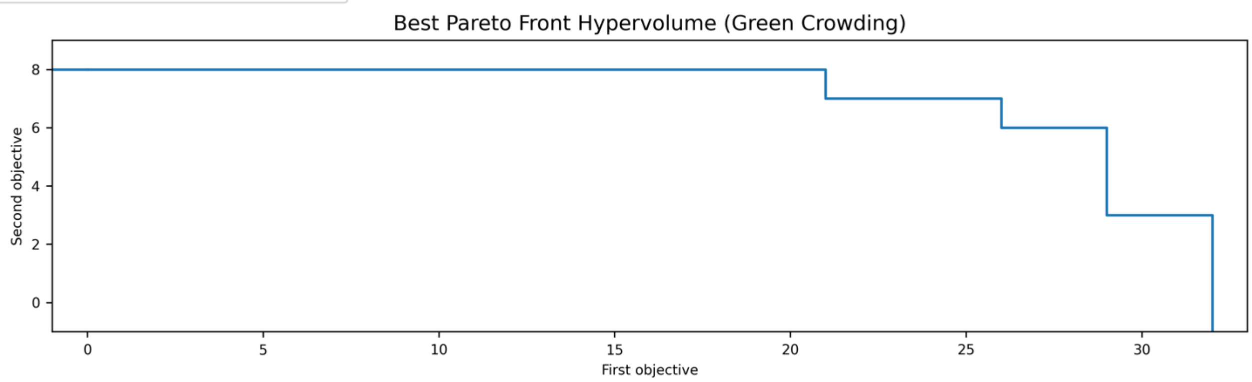
```
[ea]
mu = 1000
num_children = 400
mutation_rate = 0.05
parent_selection = k_tournament_with_replacement
survival_selection = k_tournament_without_replacement
# Don't touch this
individual_class = LinearGenotype

[recombination_kwargs]
method = uniform

[parent_selection_kwargs]
k = 2

[survival_selection_kwargs]
k = 3

[fitness_kwargs]
crowding = False
yellow = False
# Don't touch this
failure_fitness = ${problem:failure_fitness}

[mutation_kwargs]
bonus = False
# Don't touch this
bounds = ${problem:bounds}

# Don't touch any of these
[problem]
visible_margin = 3
failure_fitness = -1
minimize_area = False
bounds = ((0, 50), (0, 15))
shapes = [[(-2, 1), (-2, 0), (-1, 0), (-2, -1), (0, 0), (1, 0), (2, 0), (0, 1), (1, 1), (0, 2), (3, 0
-1), (0, 0), (1, -1), (0, 1), (0, 2), (2, -1), (-1, -1), (-1, 1)], [(1, 0), (0, 0), (0, 1), (1, -1),
(1, 1), (0, 2), (0, -2), (0, 3), (0, -3), (1, -2), (1, 3), (1, -3), (1, 2)], [(0, -1), (0, 0), (0, 1)
```

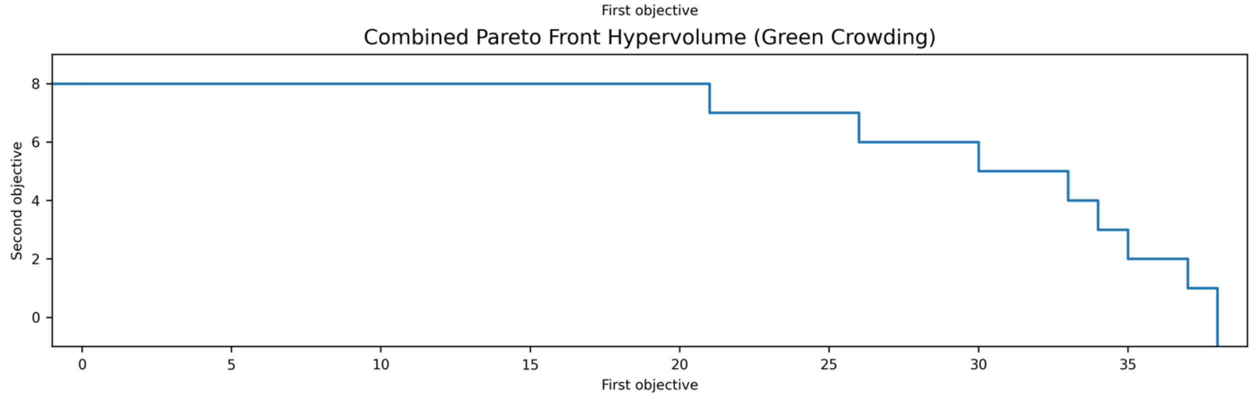
2- plots and combined Pareto front for green trial

For With crowding

a.1 Plots for 30 runs with crowding (with Crowding – green)

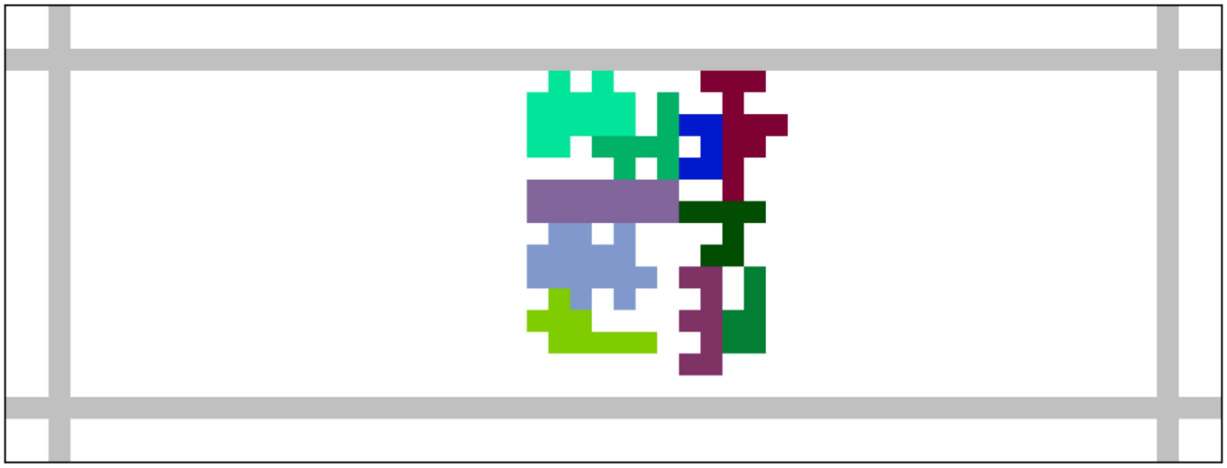




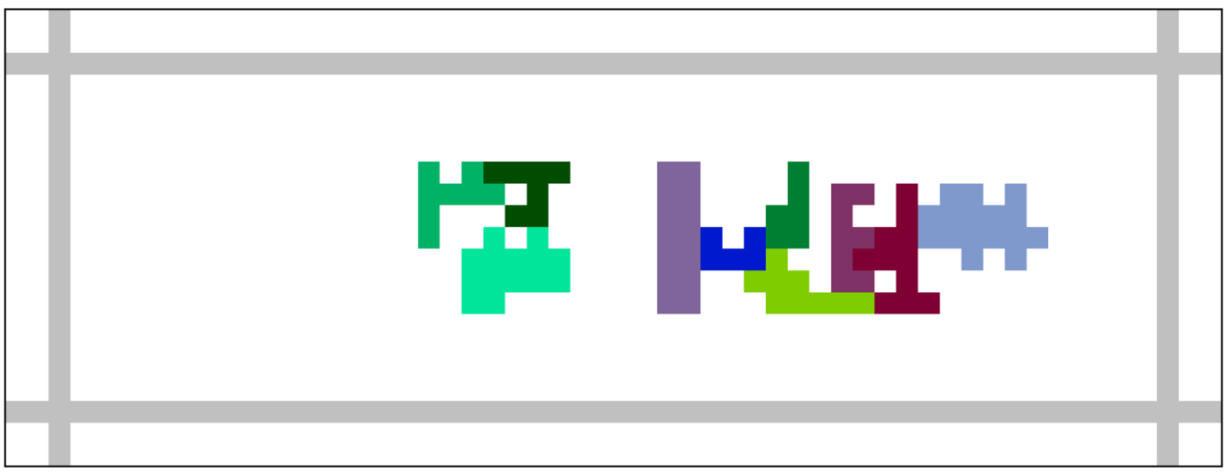


a.2 Combined Pareto Front (with crowding green)

1-Best Length

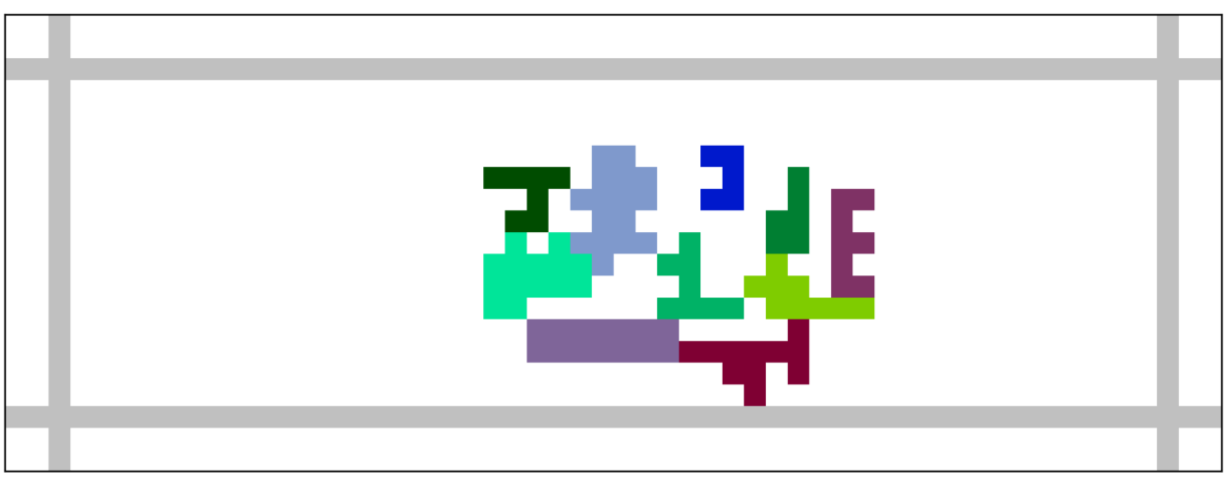


2-Best width

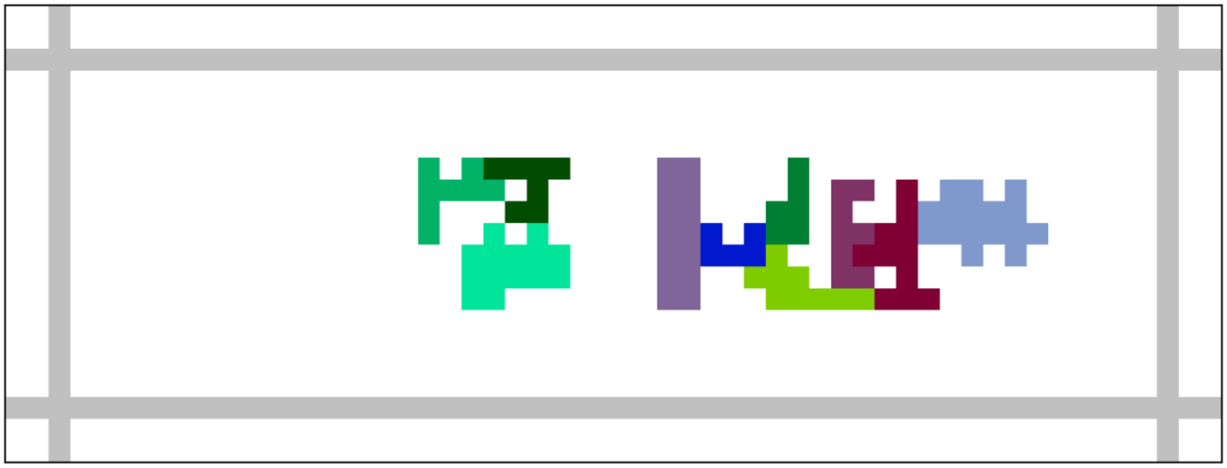


a.3 Best Front (with crowding-green)

1-Best Length

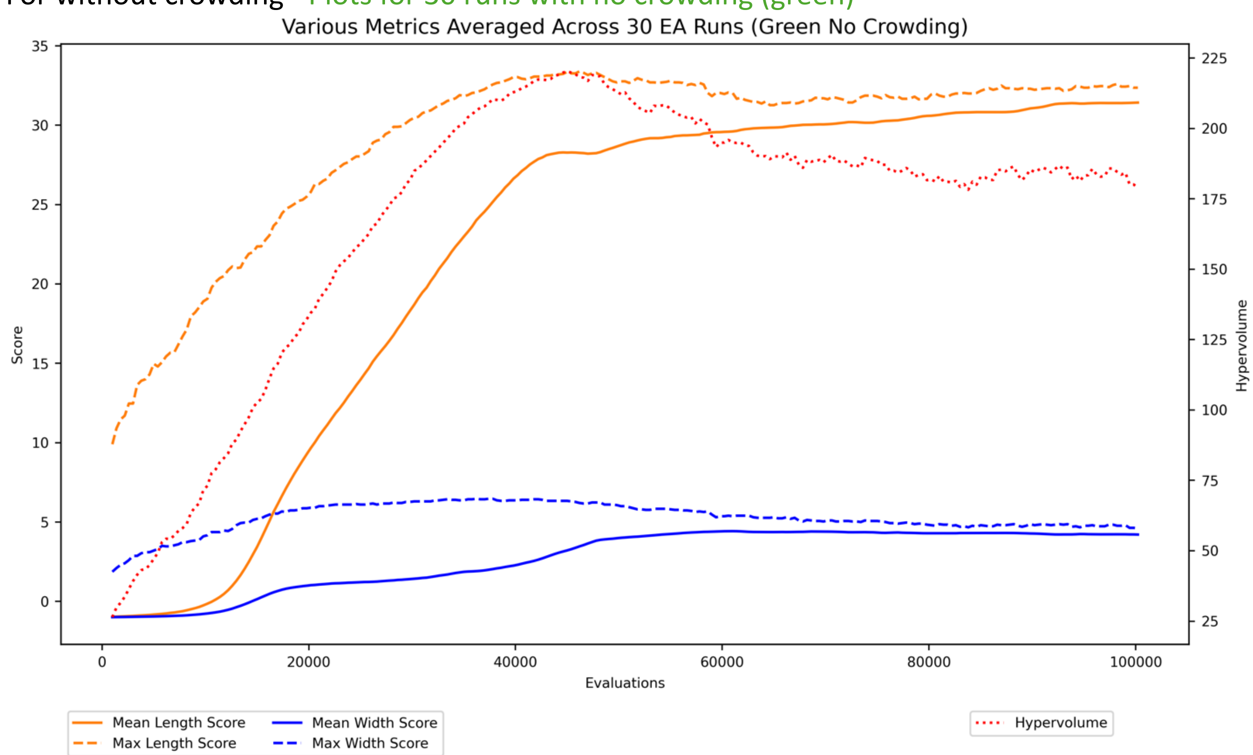


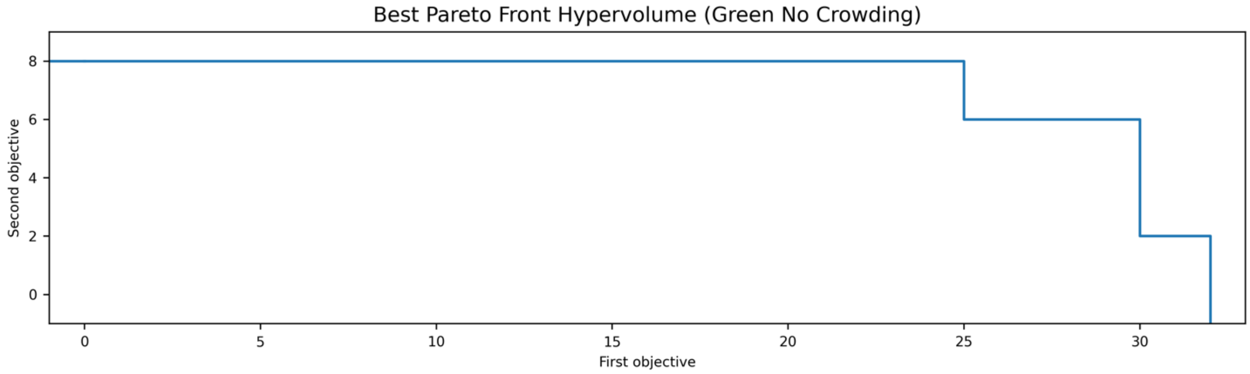
2-Best Width

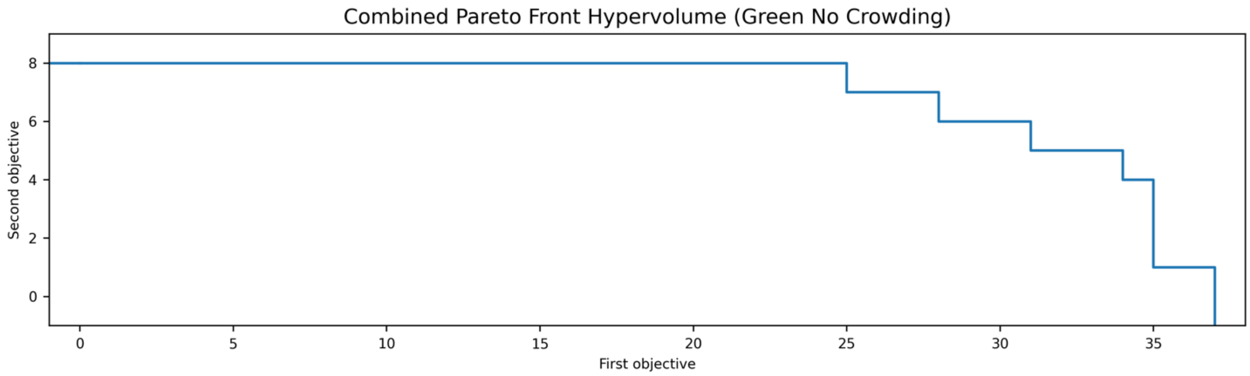


For without crowding – green

B. For without crowding - Plots for 30 runs with no crowding (green)

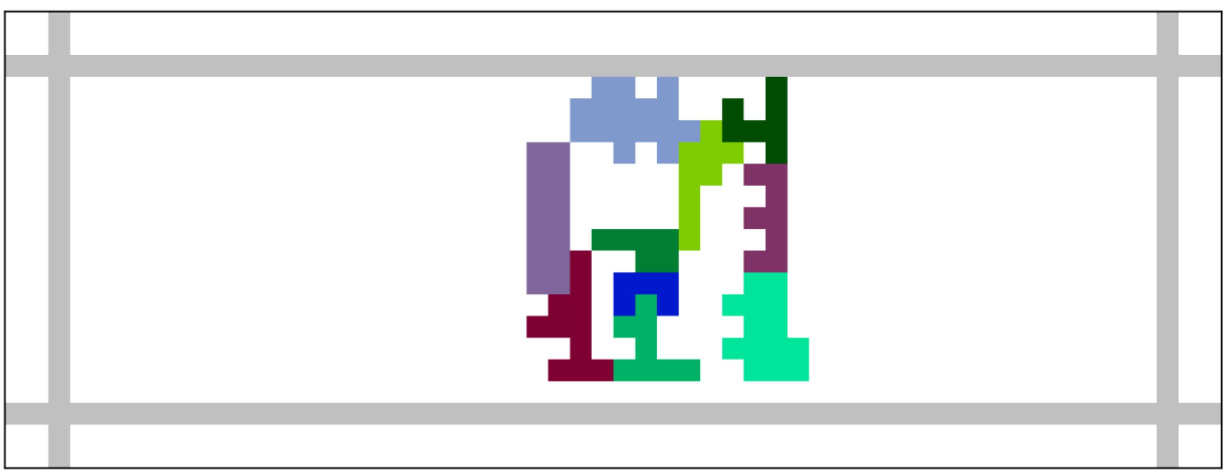




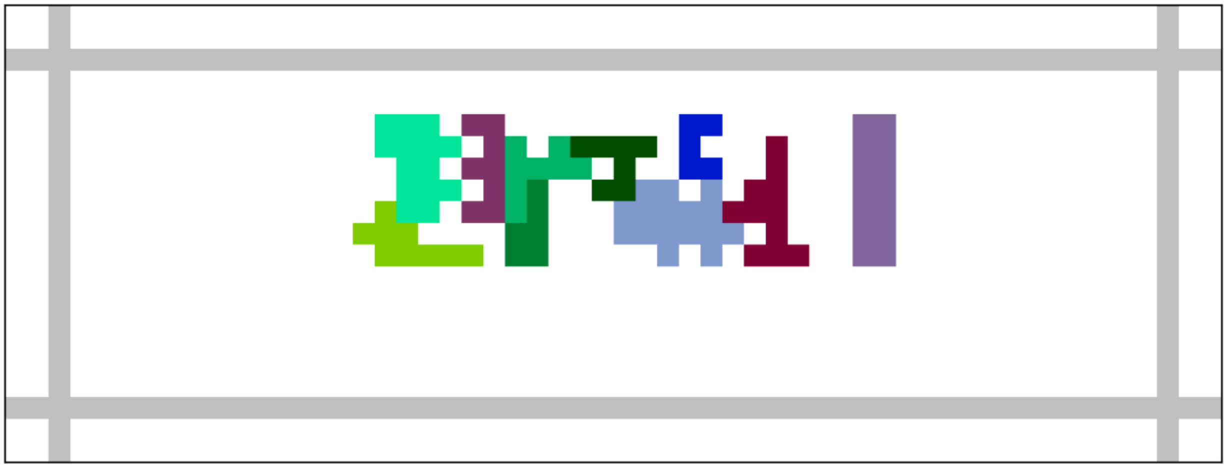


Combined Front (without crowding -- green)

1- Best Length

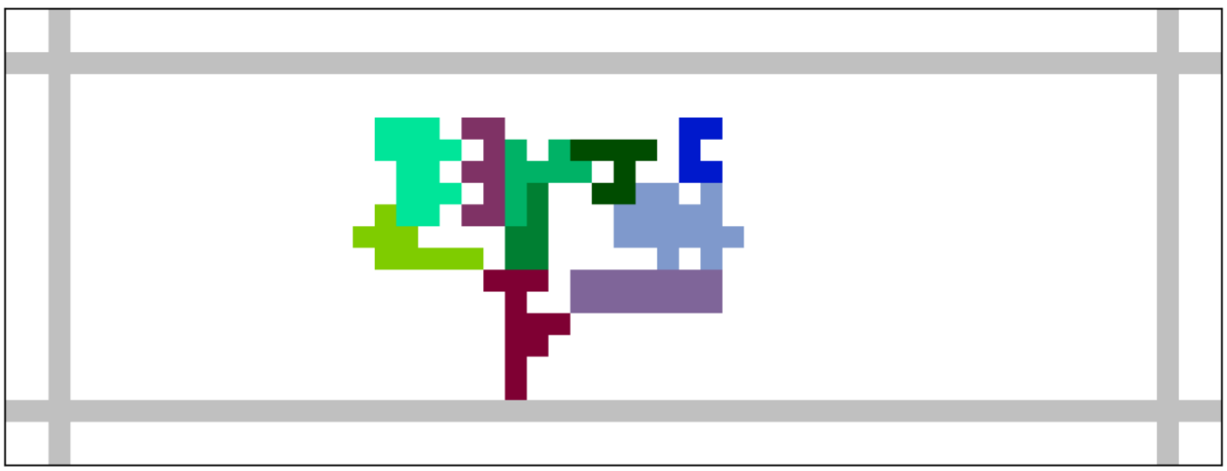


2- Best Width



Best Front (Without Crowding - green)

1- Best Length



2- Best Width

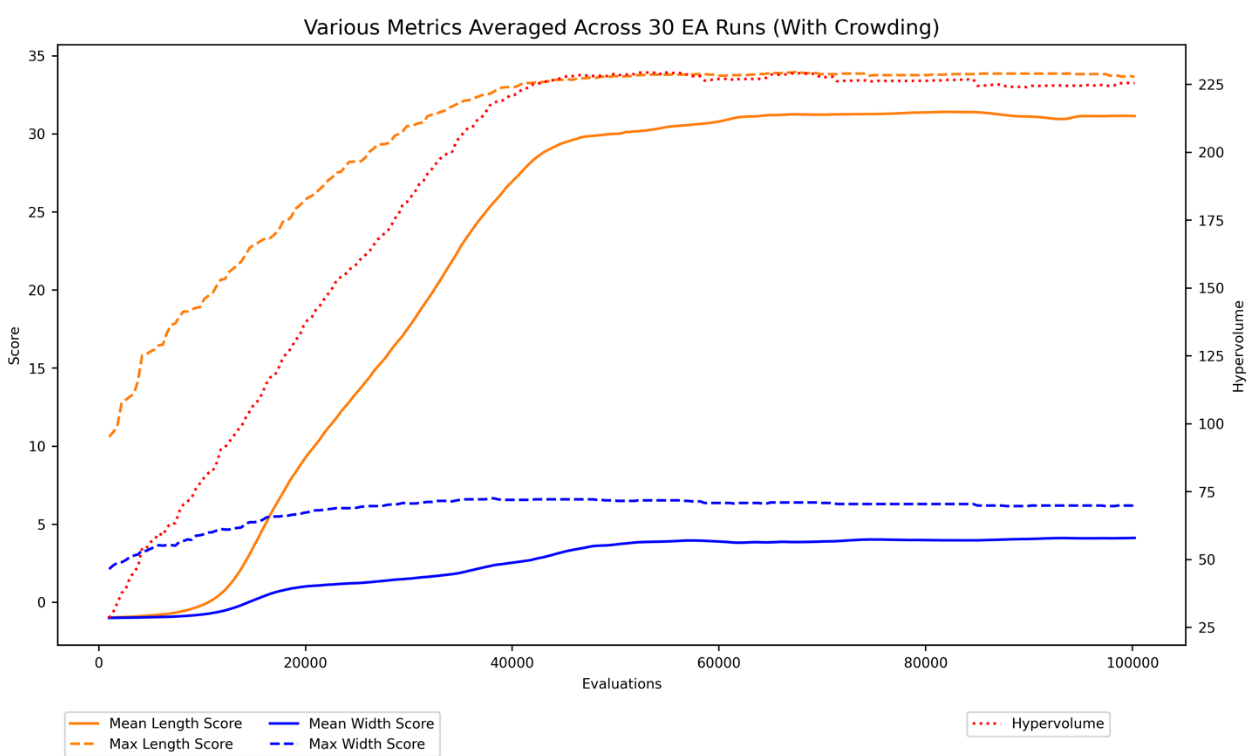
Statical analysis (green)

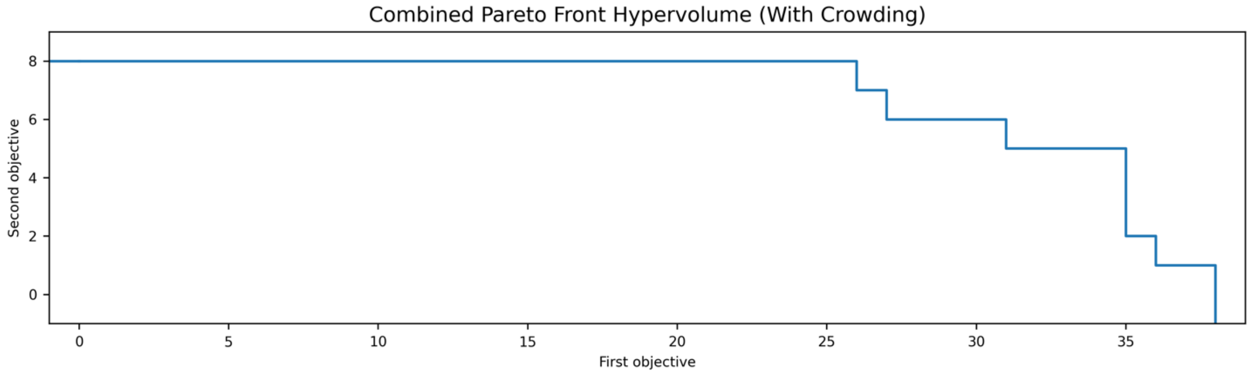
```
Number of samples: 30
data/1d/green_crowding/hypervolume_per_run.txt mean: 213.6
data/1d/green_crowding/hypervolume_per_run.txt stdv: 31.05012632546905
data/1d/green_no_crowding/hypervolume_per_run.txt mean: 178.96666666666667
data/1d/green_no_crowding/hypervolume_per_run.txt stdv: 48.09292967846179
p-value: 0.001724954543288306
```

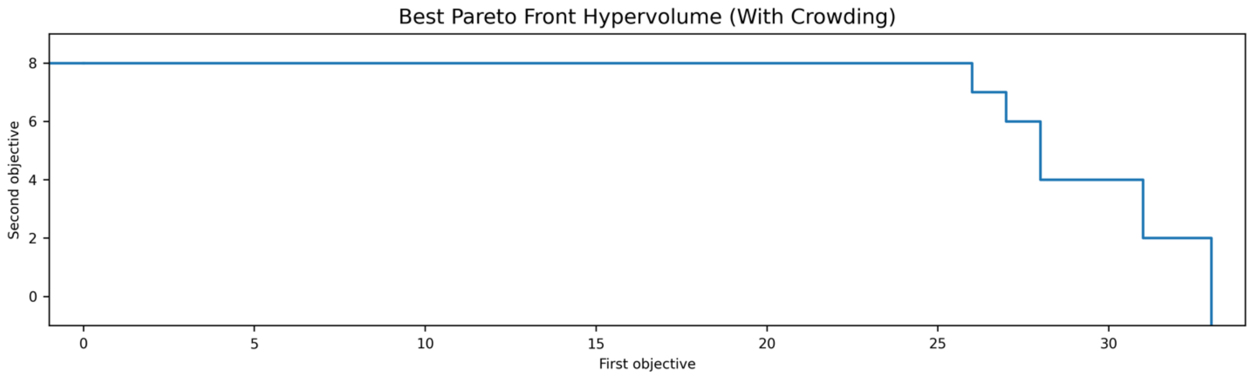
The analysis indicts that enabling crowding in the algorithm led to much better results than no crowding, since the average Hypervolume for with crowding is 213.6 and for no crowding is 178.96, that tell us that the experiment with crowding performed better than with no crowding. P-value = 0.0017249 which is much lower than the cutoff value alpha of 0.005 and that means that the difference between the two experiment is statistically significant.
The clear difference in hypervolumes (with a p-value of 0.00172) shows that using crowding in the algorithm helps improve the diversity and quality of the solutions.

Also, From the Plots and the Picture above we can tell that with crowding experiment better than without crowding.

Plots With Crowding (Yellow)

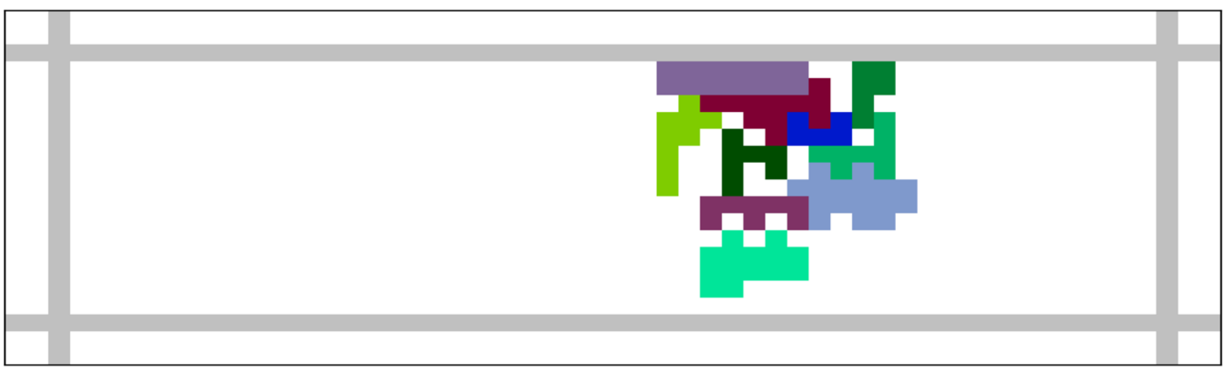




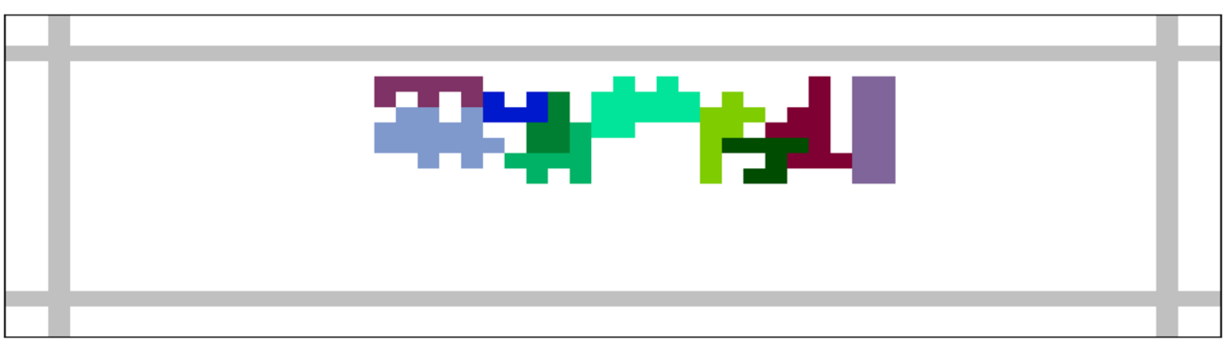


Combined Front

1- Best Length

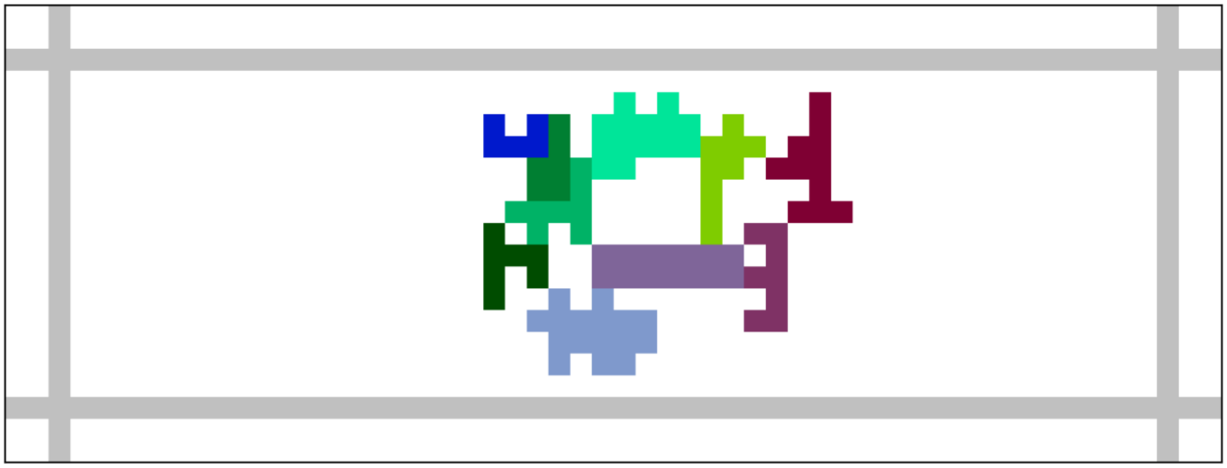


2- best Width

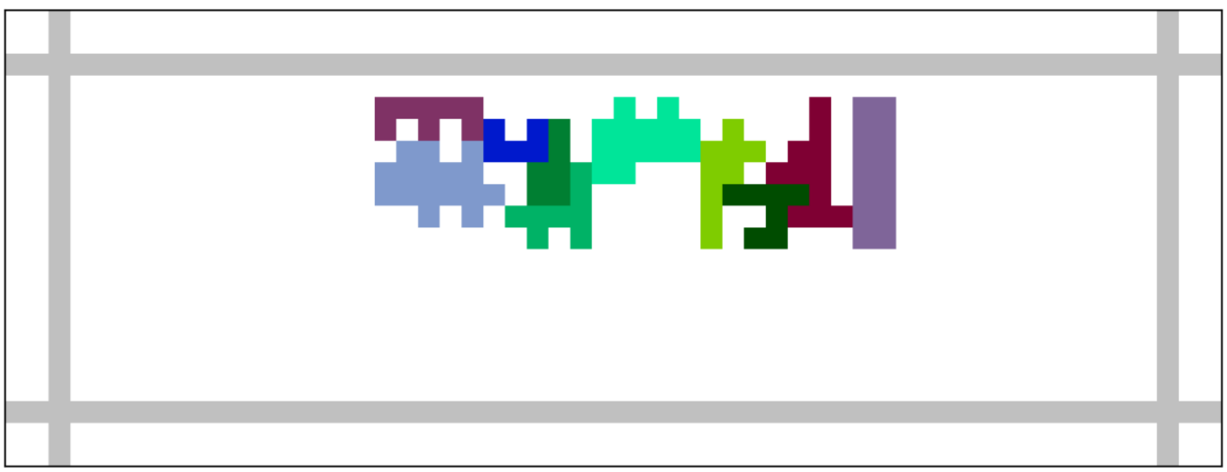


Pareto Front

1- Best Length

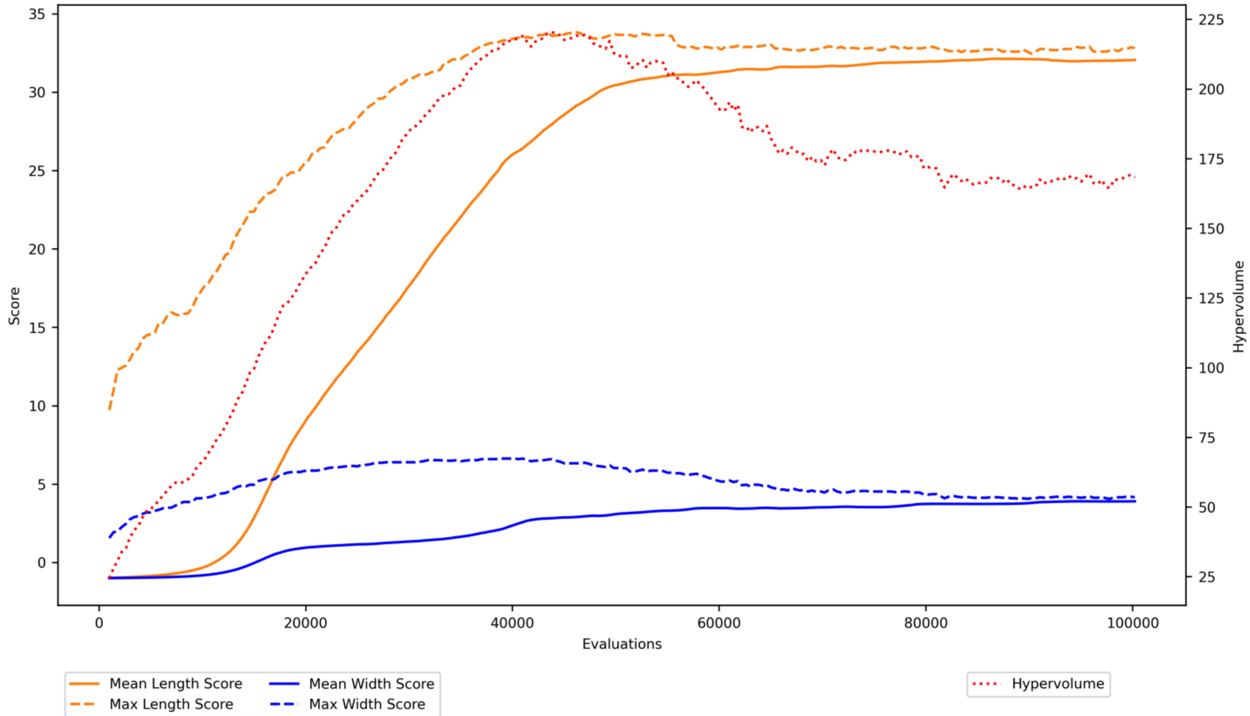


2- Best Width

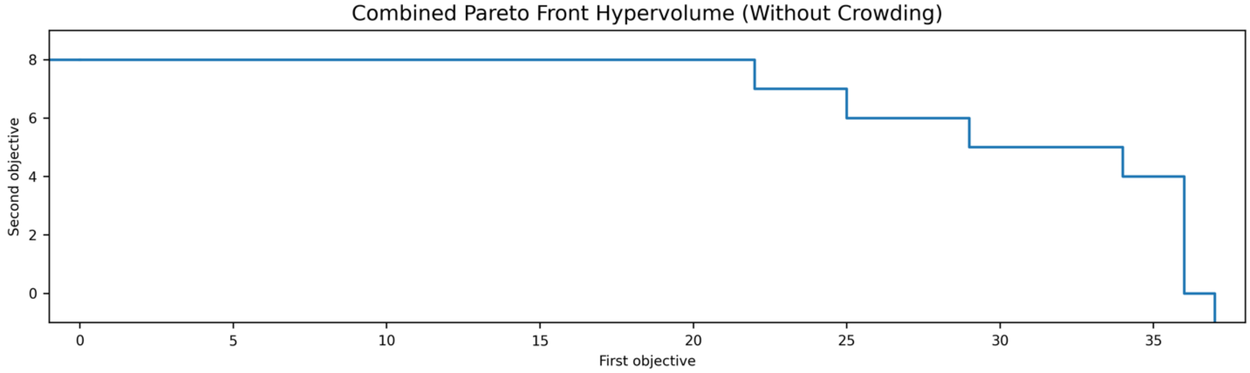


Plots With No Crowding (Yellow)

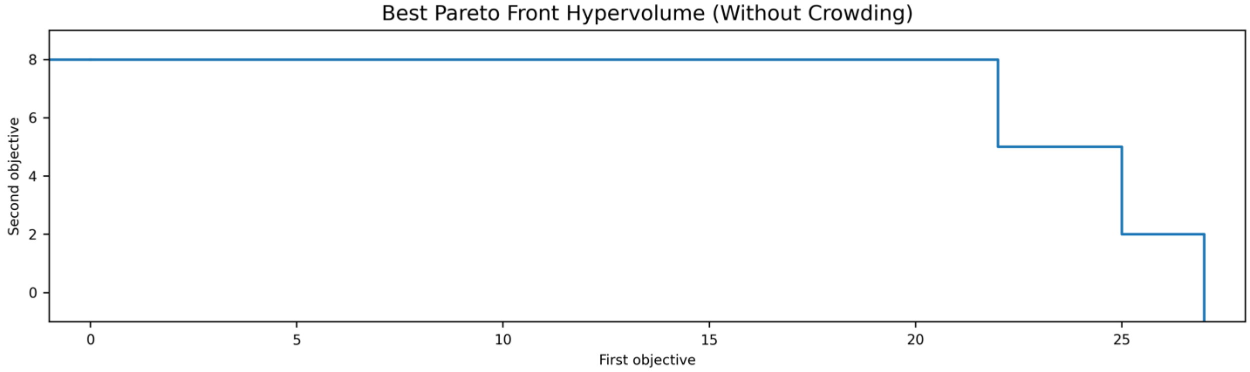
Various Metrics Averaged Across 30 EA Runs (Without Crowding)



Combined Pareto Front Hypervolume (Without Crowding)



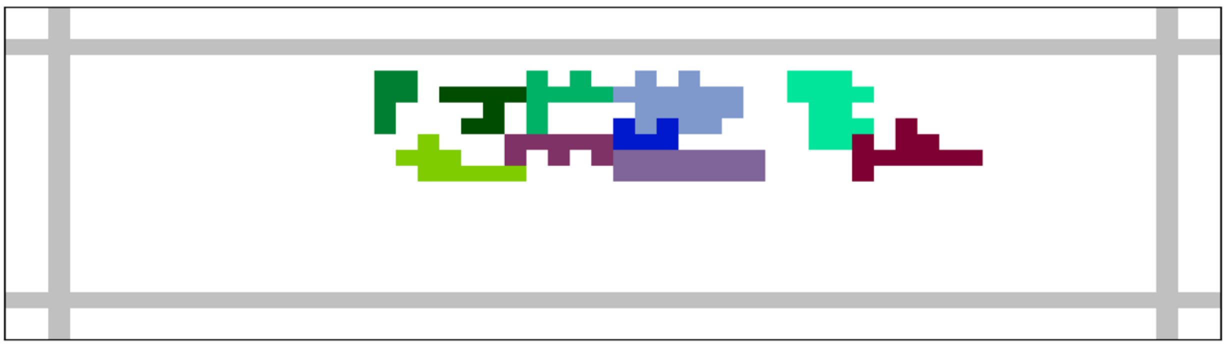
Best Pareto Front Hypervolume (Without Crowding)



Combined Front

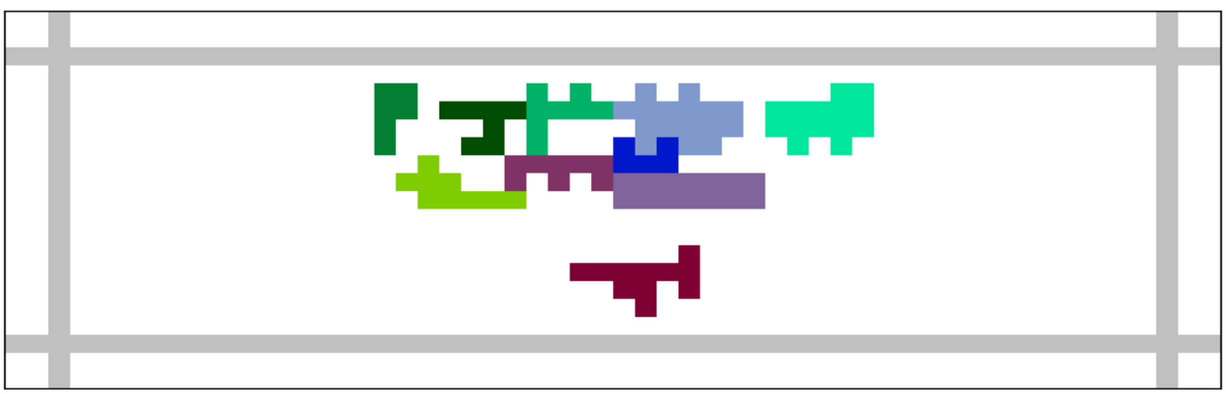
1- Best length

2- Best Width

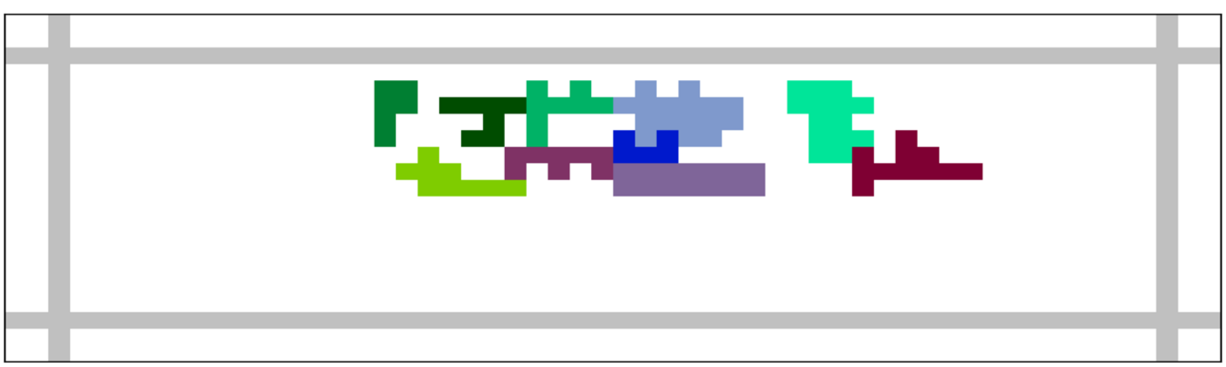


Best Front

1- Best Length



2- Best width



From the Picture above we can tell that the experiment with crowding in better than without crowding, now lets look at the statical analysis.

```
Number of samples: 30
data/1d/yellow/with_crowding/hypervolume_per_run.txt mean: 225.53333333333333
data/1d/yellow/with_crowding/hypervolume_per_run.txt stdv: 34.48911205836869
data/1d/yellow/without_crowding/hypervolume_per_run.txt mean: 168.4
data/1d/yellow/without_crowding/hypervolume_per_run.txt stdv: 42.0997174206259
p-value: 3.895366856148652e-07
```

The analysis indicts that enabling crowding in the algorithm led to much better results than no crowding, since the average Hypervolume for with crowding is 225.53 and for no crowding is 168.4, that tell us that the experiment with crowding performed better than with no crowding. P-value = 3.895 e-07 which is much lower than the cutoff value alpha of 0.005 and that means that the difference between the two experiment is statistically significant.
The clear difference in hypervolumes shows that using crowding in the algorithm helps improve the diversity and quality of the solutions.

Now if we compare between yellow with and green with crowding, we can tell that yellow with crowding has performed better since the average hypervolume for yellow is 225.5
And between yellow and green with no crowding, Green has performed better since it has average hypervolume of 178.96

We can also tell by looking at the plots that yellow was crowding has performed better than green
And green without crowding has performed better than yellow.