

Algorytmy Metaheurystyczne - Lista nr 1

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Cel

Celem zadania jest sprawdzenie skuteczności heurystyki Local Search na przykładzie euklidesowego problemu komiwojażera oraz zbadanie wpływu wyboru rozwiązania początkowego i metody generowania otoczenia na jakość rozwiązania.

Local Search

Invert

Otoczeniem rozwiązania reprezentowanego przez permutację π jest zbiór rozwiązań uzyskanych przy użyciu pojedynczego ruchu $invert(\pi, i, j)$, który zamienia kolejność wierzchołków od i -tego do j -tego.

Własność invert

Invert "rozplątuje" pętle w cyklu. Pętle takie są nieoptymalne.



Wybór rozwiązania początkowego

1. rozwiązanie zbudowane na podstawie MST
2. rozwiązanie wygenerowane w sposób losowy

Przegląd sąsiedztwa

1. przeglądanie całego sąsiedztwa (rozmiar: $O(n^2)$)
2. przeglądanie n losowo wybranych sąsiadów (rozmiar: $O(n)$)

Generowanie najlepszego kandydata

Gdy rozwiązaniem początkowym jest rozwiązanie generowane na podstawie MST to \sqrt{n} razy generujemy takie rozwiązanie zaczynając od losowego wierzchołka drzewa a następnie używamy go jako startowego w algorytmie Local Search.

Gdy rozwiązaniem początkowym jest rozwiązanie losowe to n razy powtarzamy losowanie rozwiązania oraz poprawianie go algorymem Local Search. W przypadku $n > 1000$ procedurę powtarzamy tylko 100 razy.

W każdym przypadku jako wynik wybieramy rozwiązanie o najmniejszej wadze.

Wyniki

Oznaczenia metod generujących kandydatów:

- LS1 - algorytm Local Search startujący z rozwiązania wygenerowane z losowego wierzchołka MST i przeglądający całe otoczenie w każdej iteracji
- LS2 - algorytm Local Search startujący z losowego rozwiązania i przeglądający całe otoczenie w każdej iteracji
- LS3 - algorytm Local Search startujący z losowego rozwiązania i przeglądający n losowych sąsiadów w każdej iteracji

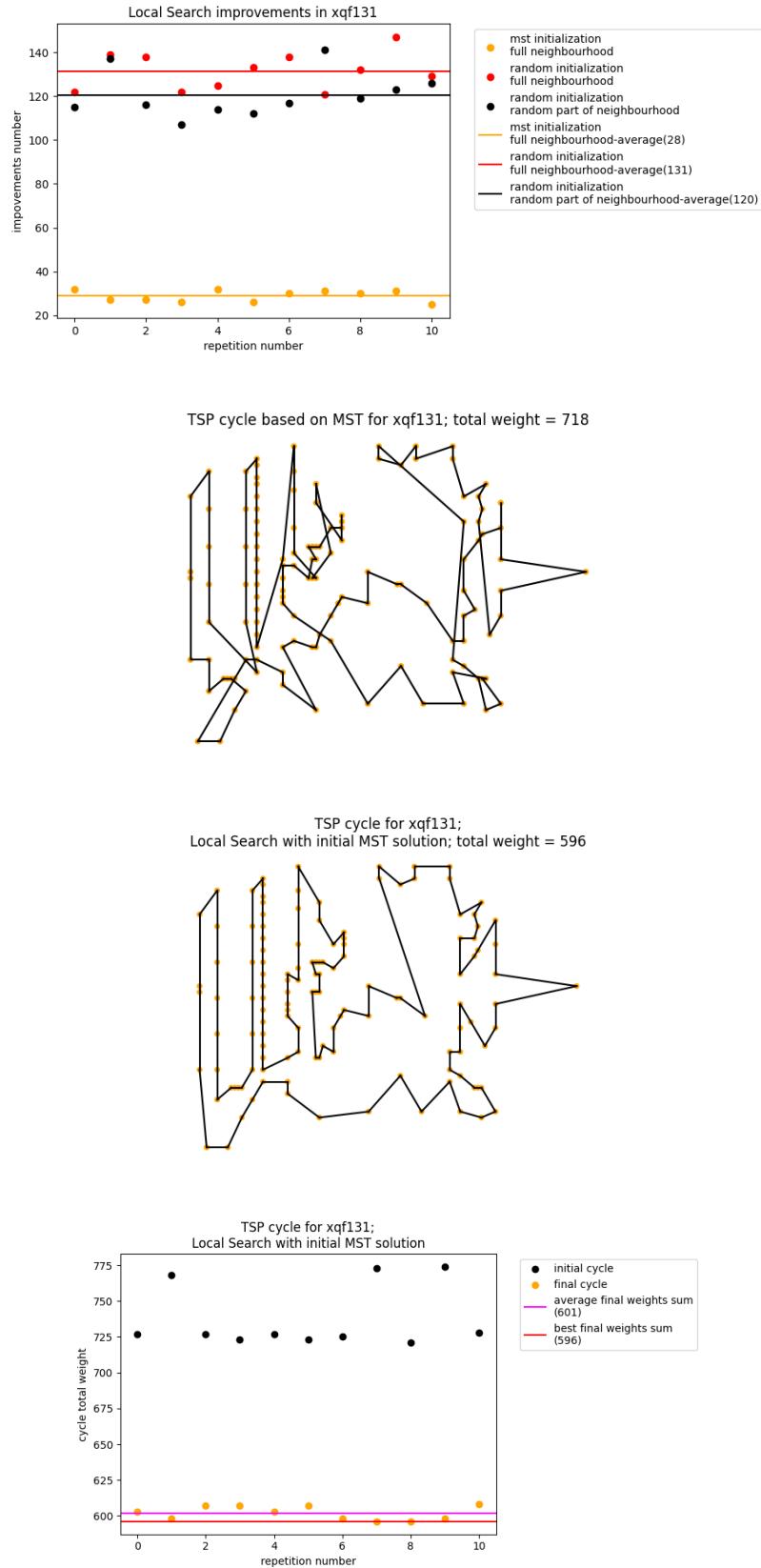
| Przykład | Suma wag rozwiązania optymalnego | Suma wag kandydata opartego o MST | Suma wag najlepszego rozwiązania LS1 | Suma wag najlepszego rozwiązania LS2 | Suma wag najlepszego rozwiązania LS3 |
|----------|----------------------------------|-----------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| xqf131 | 564 | 718 | 596 | 578 | 880 |
| xqg237 | 1019 | 1445 | 1067 | 1062 | 1676 |
| pma343 | 1368 | 1883 | 1436 | 1424 | 2312 |
| pka379 | 1332 | 1855 | 1398 | 1399 | 2271 |
| bcl380 | 1621 | 2319 | 1711 | 1728 | 3095 |
| pbl395 | 1281 | 1871 | 1351 | 1359 | 2390 |
| pbk411 | 1343 | 1935 | 1421 | 1426 | 2521 |
| pbn423 | 1365 | 1918 | 1453 | 1454 | 2473 |
| pbm436 | 1443 | 2119 | 1532 | 1535 | 2685 |
| xql662 | 2513 | 3691 | 2661 | 2707 | 4926 |
| xit1083 | 3558 | 5190 | 3803 | 3919 | 7256 |
| icw1483 | 4416 | 6754 | 4757 | 4839 | 9293 |
| djc1785 | 6115 | 8908 | 6477 | 6697 | 12617 |
| dcb2086 | 6600 | 9777 | 7107 | 7313 | 14780 |
| pds2566 | 7643 | 11427 | 8182 | 8506 | 17506 |

| Przykład | Rozwiązania LS1 | | | Rozwiązania LS2 | | | Rozwiązania LS3 | | |
|----------|-----------------|----------|---------|-----------------|----------|---------|-----------------|----------|---------|
| | liczba popraw | suma wag | | liczba popraw | suma wag | | liczba popraw | suma wag | |
| | | średnia | minimum | | średnia | minimum | | średnia | minimum |
| xqf131 | 28.8 | 601.9 | 596 | 133.3 | 612.4 | 578 | 111.9 | 1044.4 | 880 |
| xqg237 | 37.0 | 1083.7 | 1067 | 260.5 | 1115.8 | 1062 | 225.2 | 2090.4 | 1676 |
| pma343 | 75.8 | 1450.3 | 1436 | 403.5 | 1484.7 | 1424 | 366.3 | 2835.0 | 2312 |
| pka379 | 78.9 | 1416.3 | 1398 | 448.7 | 1445.9 | 1399 | 408.9 | 2769.7 | 2271 |
| bcl380 | 62.7 | 1749.3 | 1711 | 446.7 | 1817.5 | 1728 | 374.2 | 3827.0 | 3095 |
| pbl395 | 80.0 | 1371.5 | 1351 | 458.8 | 1429.0 | 1359 | 387.4 | 2952.4 | 2390 |
| pbk411 | 81.6 | 1437.9 | 1412 | 483.7 | 1488.5 | 1426 | 406.6 | 3162.3 | 2512 |
| pbn423 | 72.3 | 1473.9 | 1453 | 497.0 | 1521.6 | 1454 | 419.8 | 3200.2 | 2473 |
| pbm436 | 97.85 | 1562.5 | 1543 | 512.8 | 1612.0 | 1535 | 433.4 | 3363.1 | 2685 |
| xql662 | 122.6 | 2690.4 | 2661 | 811.4 | 2813.3 | 2707 | 697.2 | 6035.1 | 4926 |
| xit1083 | 191.6 | 3847.2 | 3803 | 1383.7 | 4021.2 | 3919 | 1212.0 | 9052.2 | 7256 |
| icw1483 | 278.8 | 4809.8 | 4757 | 1929.4 | 4990.5 | 4839 | 1695.5 | 11436.9 | 9293 |
| djc1785 | 382.6 | 6533.8 | 6477 | 2348.9 | 6872.1 | 6697 | 2065.4 | 15529.9 | 12617 |
| dcb2086 | 390.9 | 7154.2 | 7107 | 2796.6 | 7457.8 | 7313 | 2457.2 | 17776.7 | 7107 |
| pds2566 | 457.3 | 8271.4 | 8182 | 3485.9 | 8701.8 | 8506 | 3052.0 | 21375.1 | 17506 |

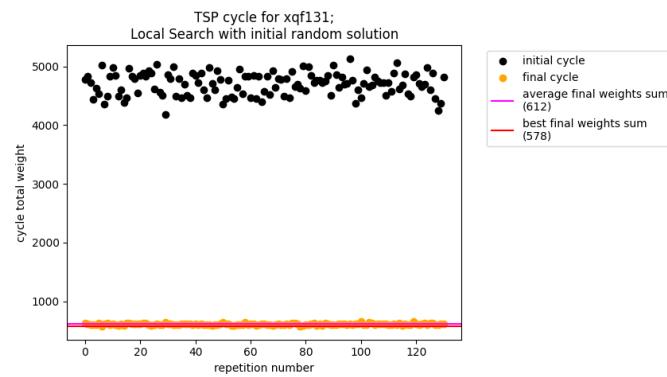
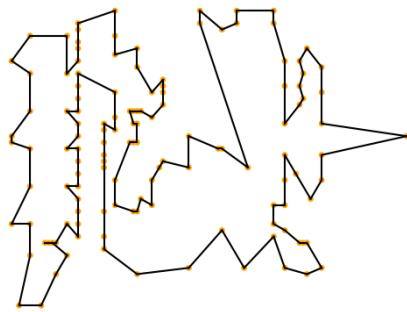
Tabela 1: Podsumowanie działania Local Search dla problemu komiwojażera.

Grafy

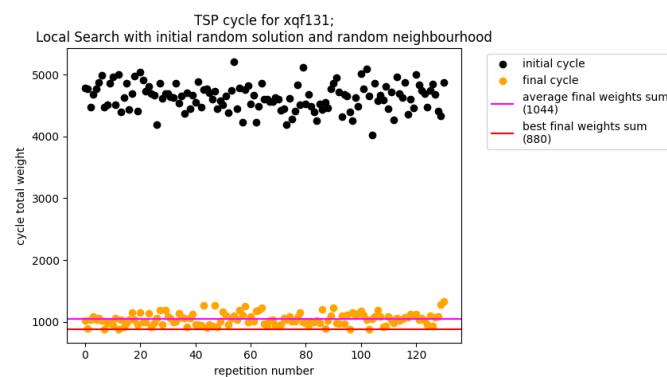
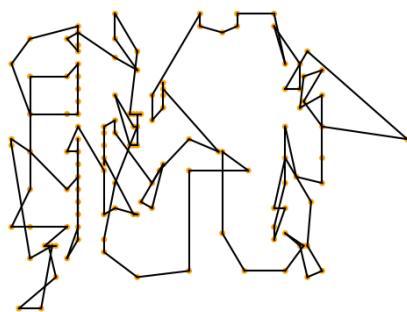
0.1 xqf131



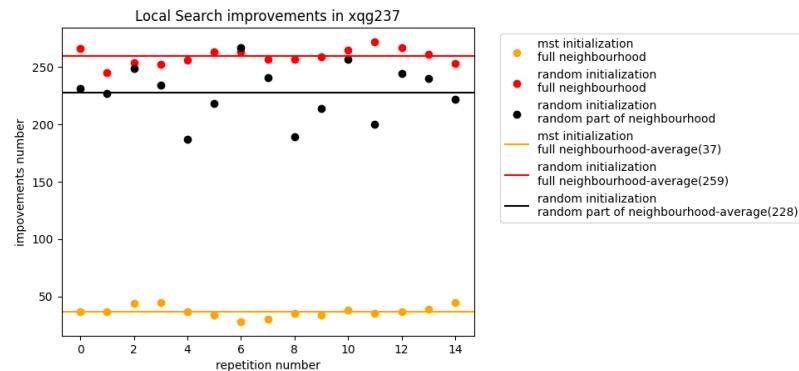
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Local Search with initial random solution; total weight = 578



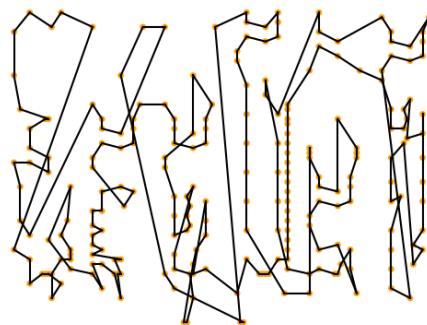
TSP cycle for xqf131;
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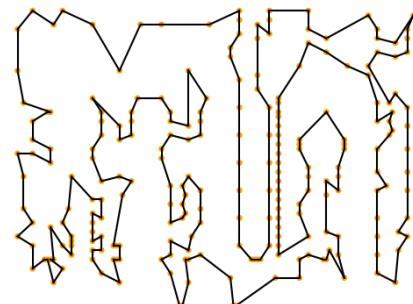
0.2 xqg237



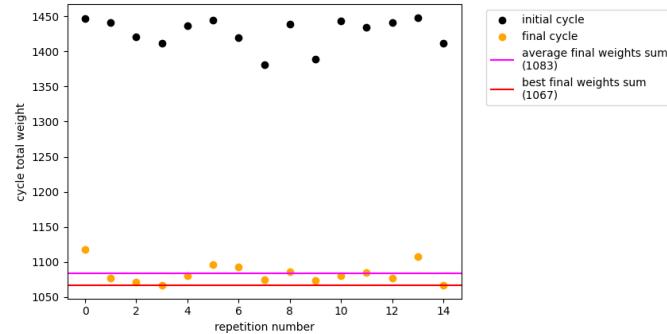
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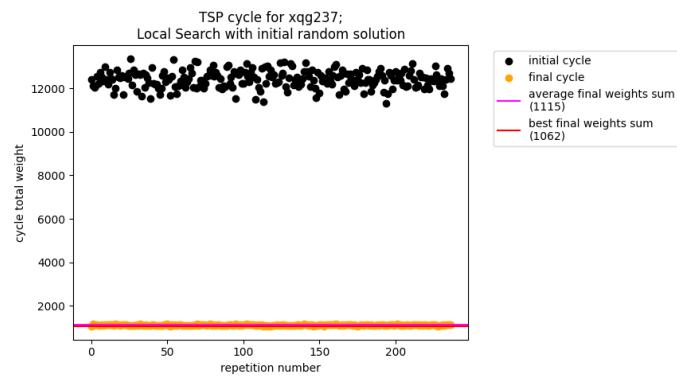
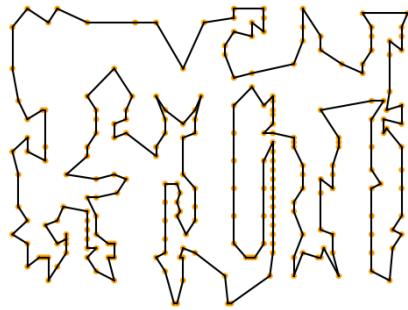
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Local Search with initial MST solution; total weight = 1067



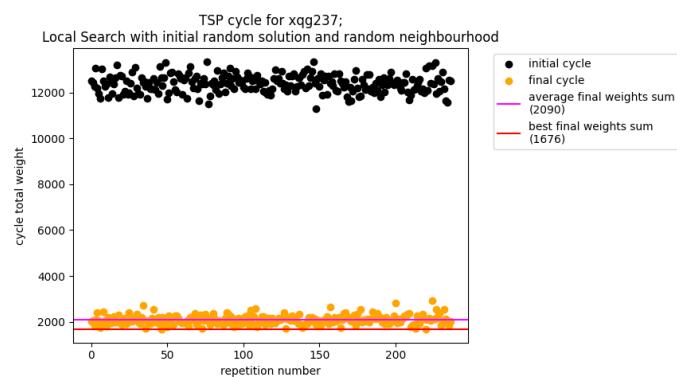
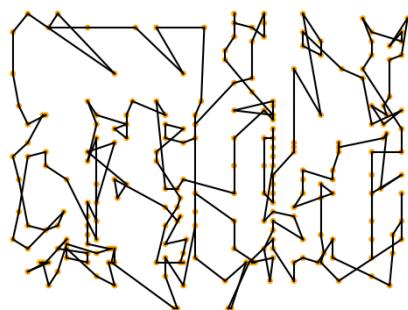
TSP cycle for xqg237;
Local Search with initial MST solution



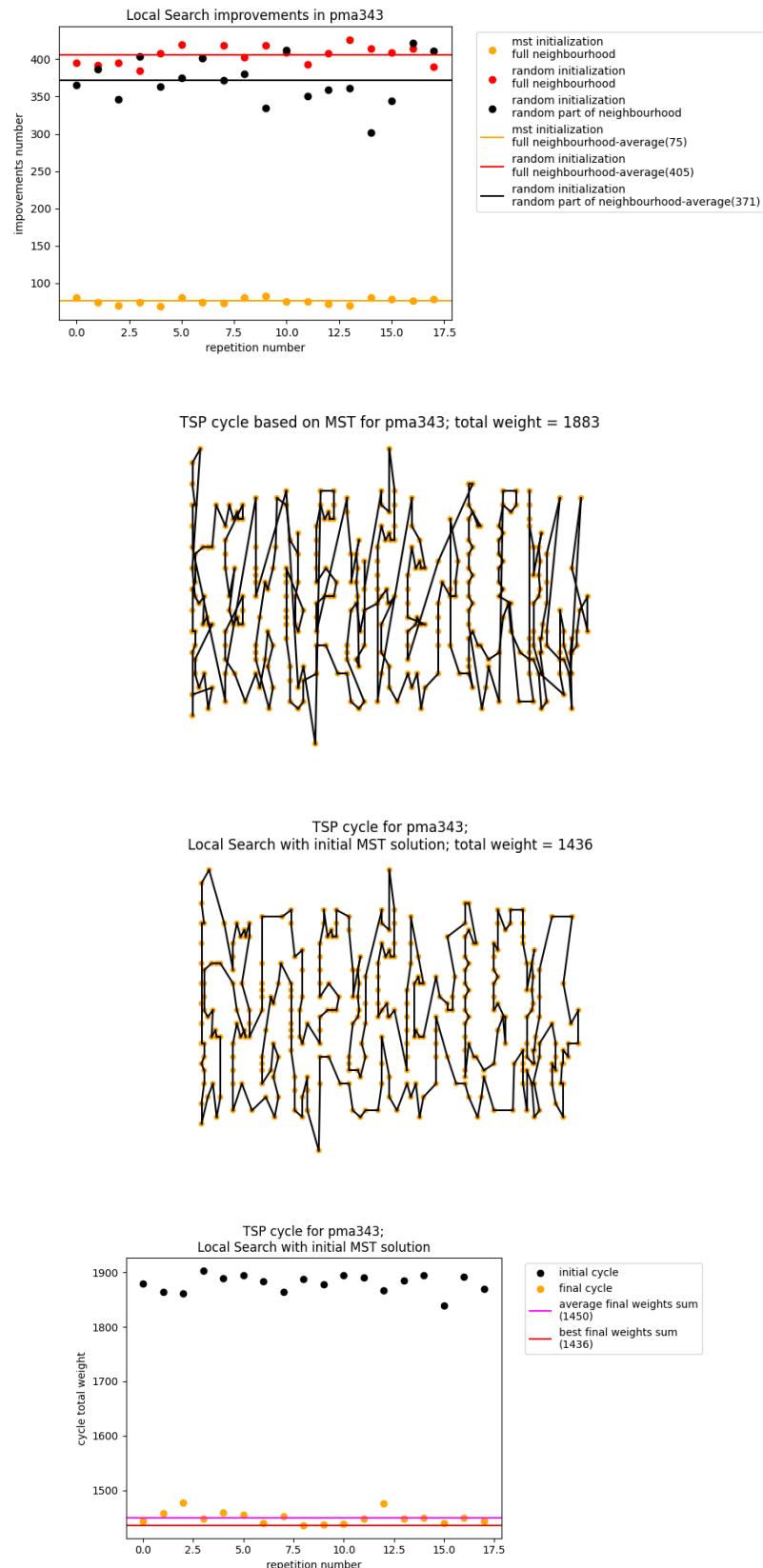
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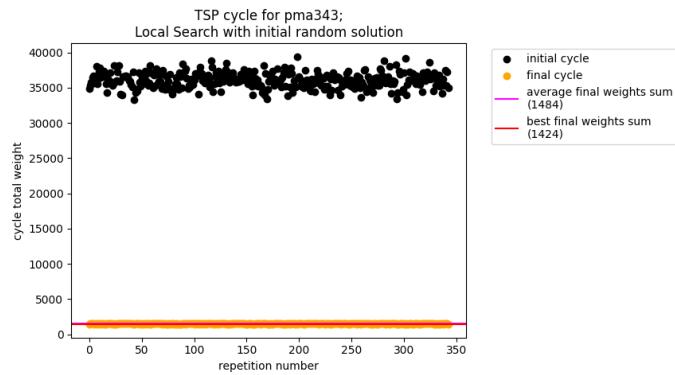
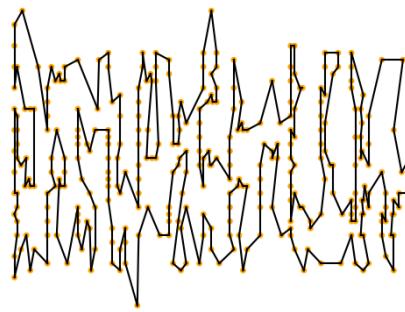
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Local Search with initial random solution and random neighbourhood; total weight = 1676



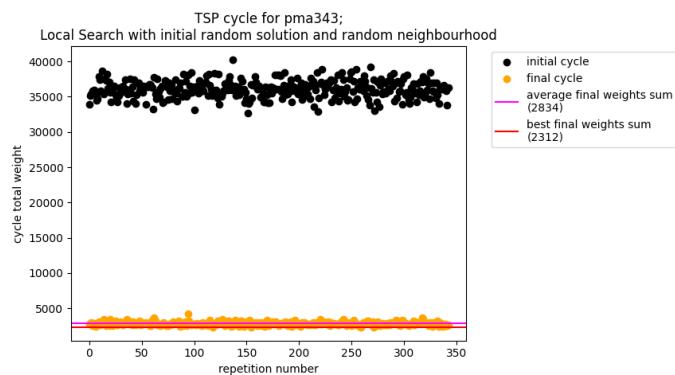
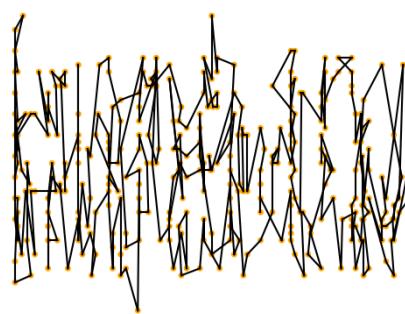
0.3 pma343



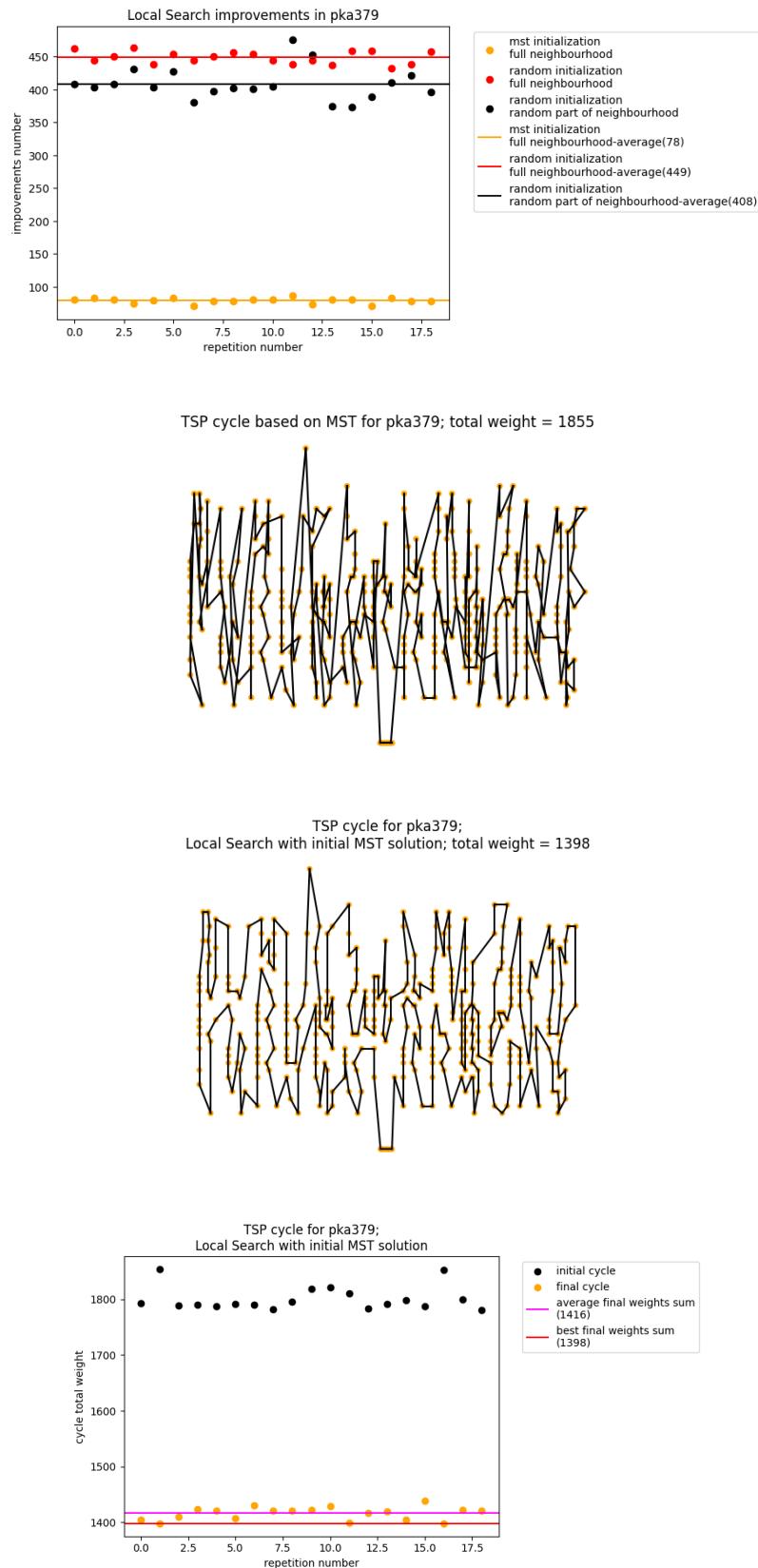
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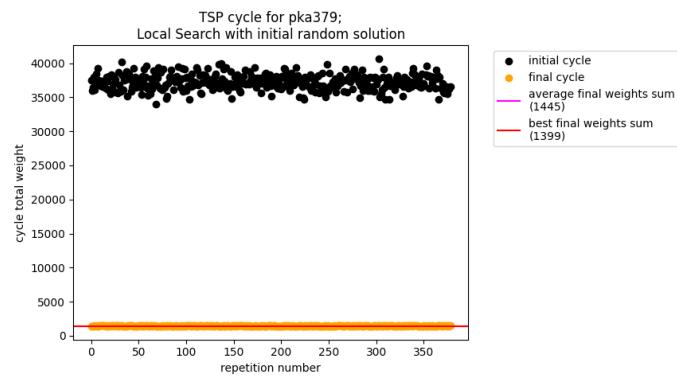
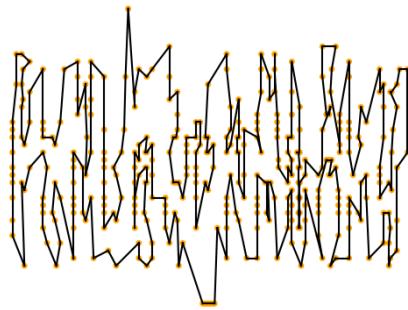
TSP cycle for pma343;
Local Search with initial random solution and random neighbourhood; total weight = 2312



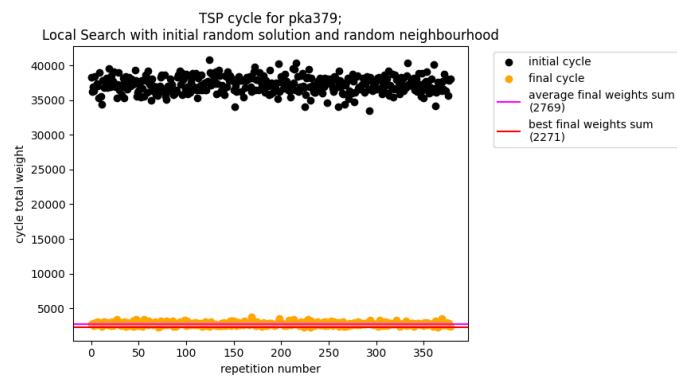
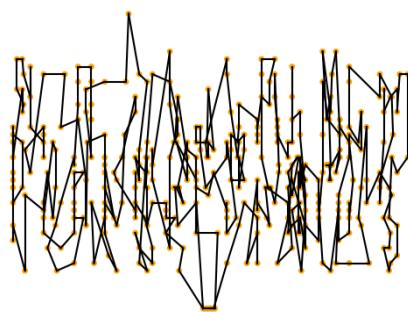
0.4 pka379



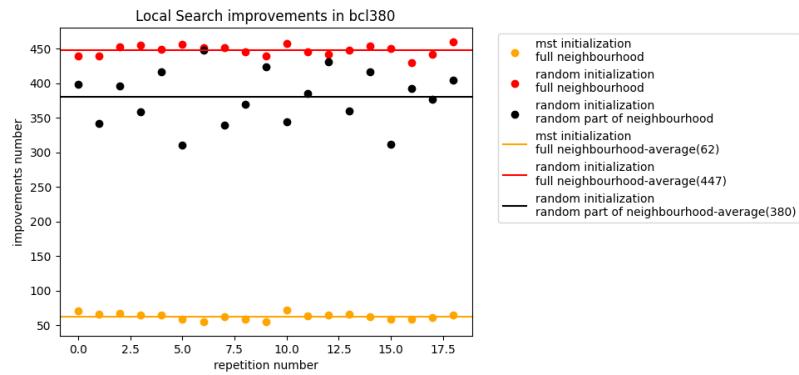
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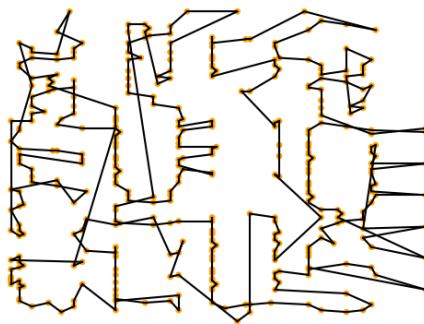
TSP cycle for pka379;
Local Search with initial random solution and random neighbourhood; total weight = 2271



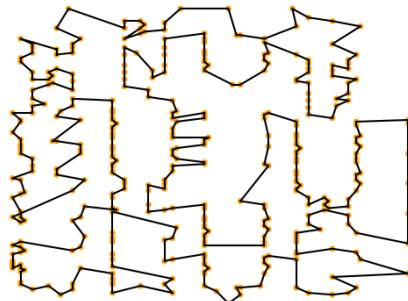
0.5 bcl380



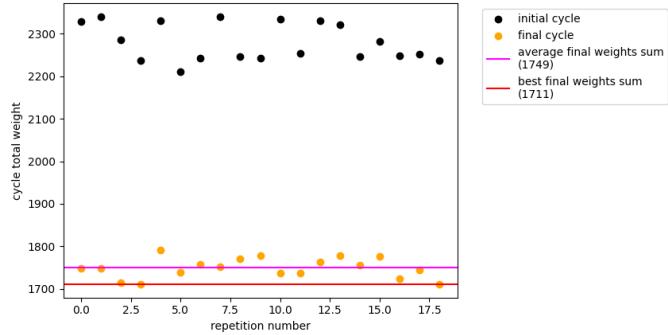
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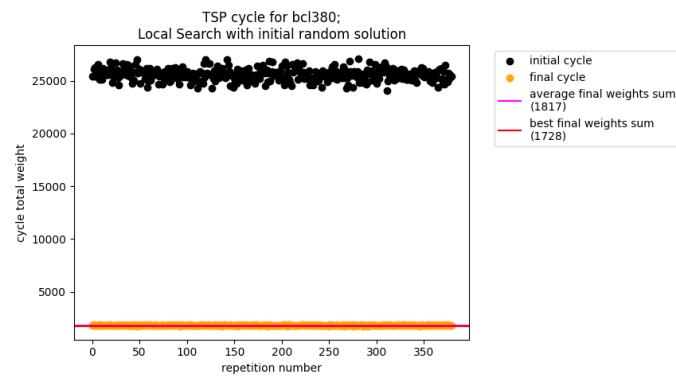
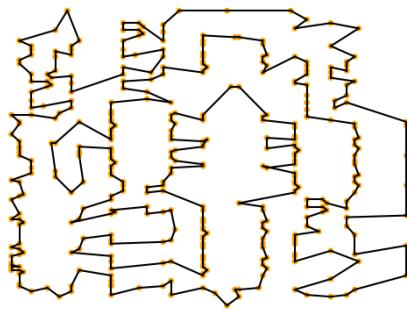
TSP cycle for bcl380;
Local Search with initial MST solution; total weight = 1711



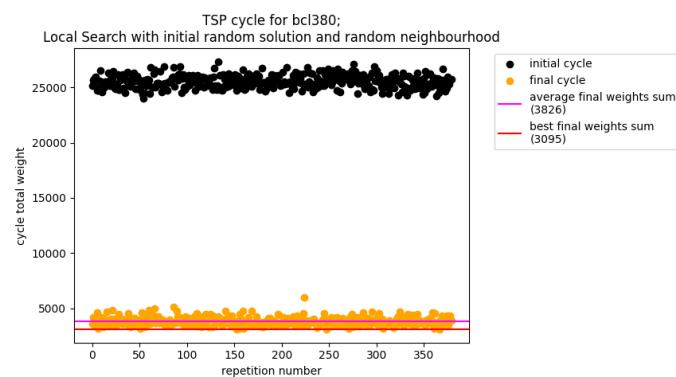
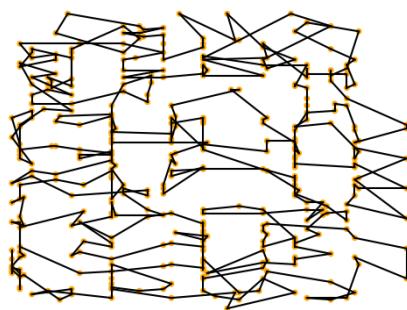
TSP cycle for bcl380;
Local Search with initial MST solution



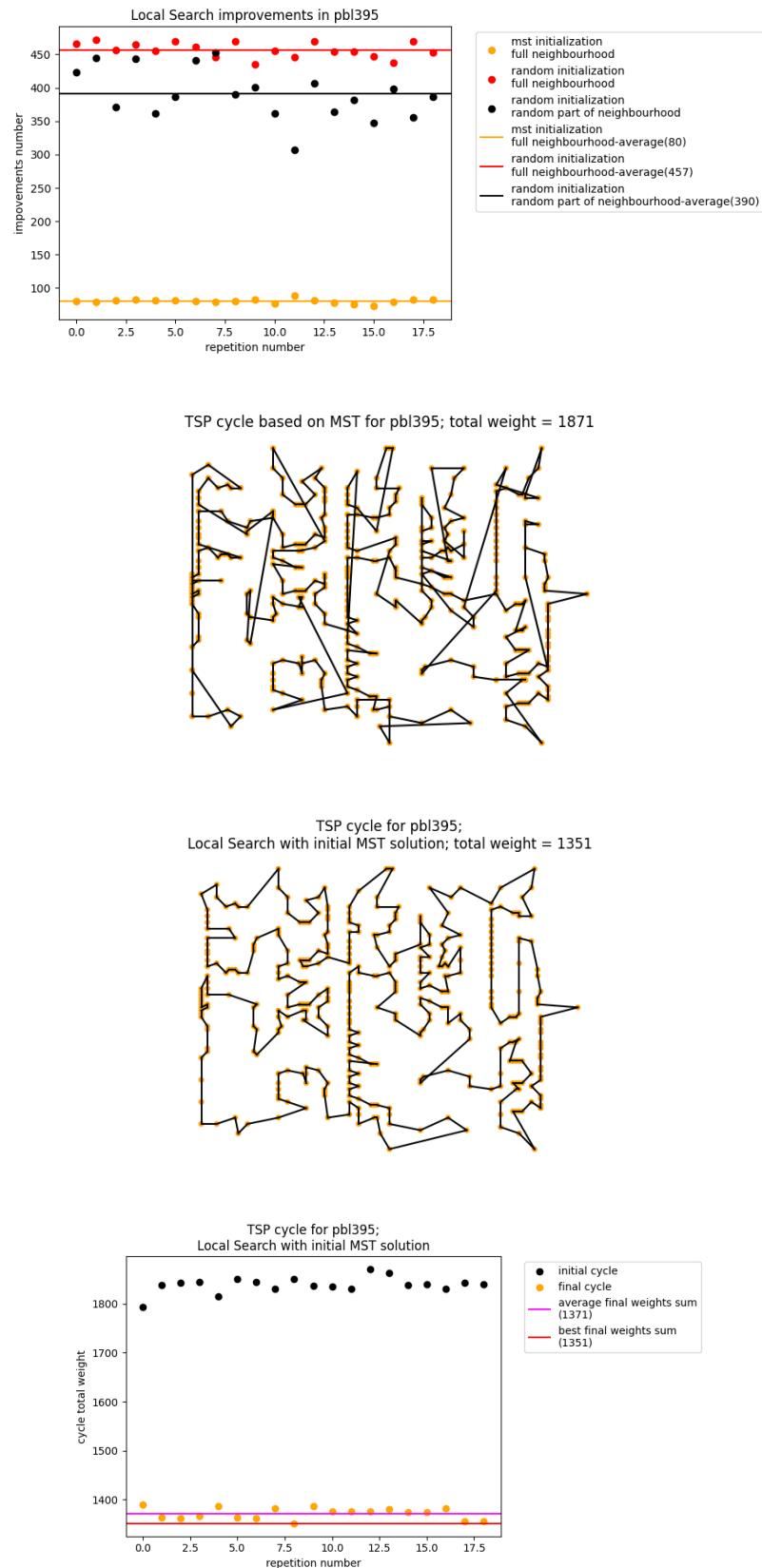
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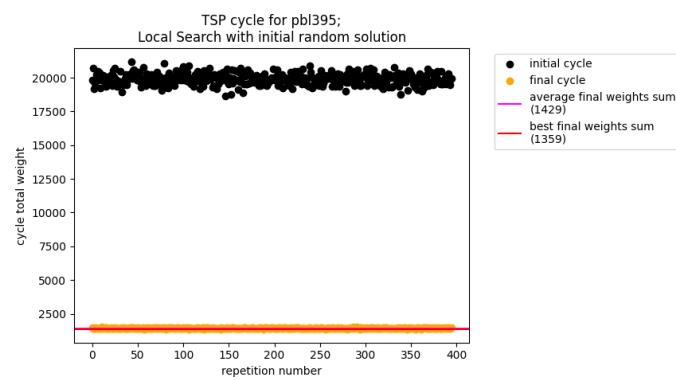
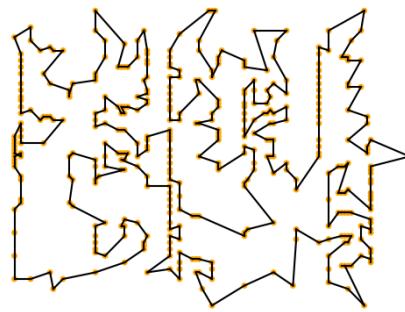
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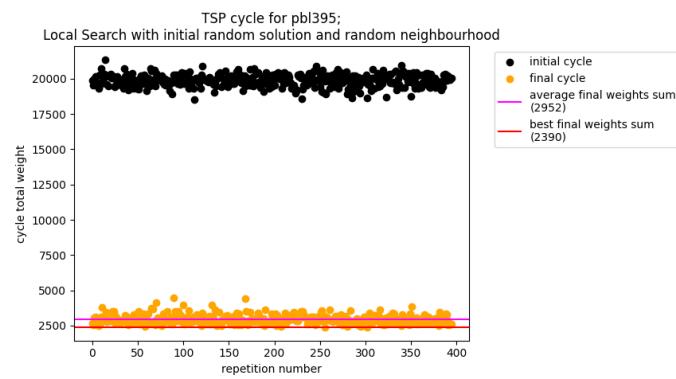
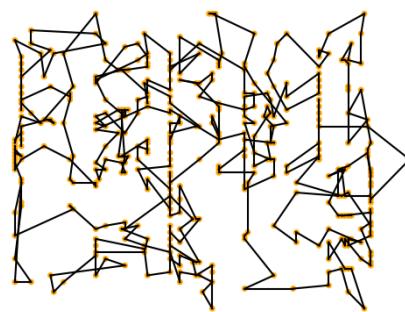
0.6 pbl395



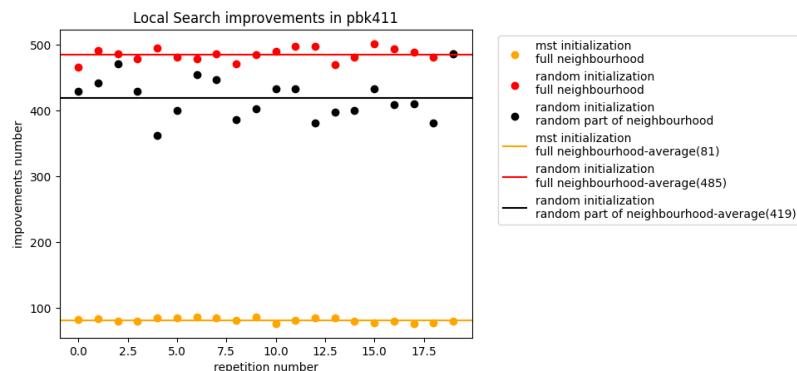
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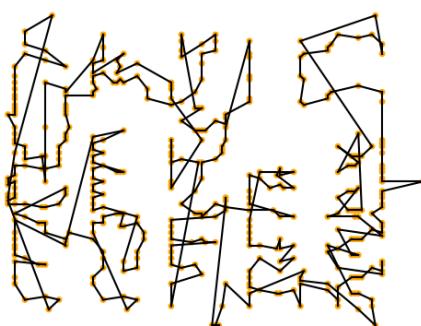
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Local Search with initial random solution and random neighbourhood; total weight = 2390



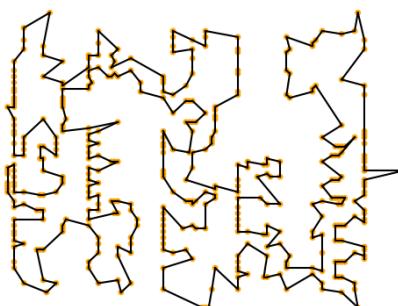
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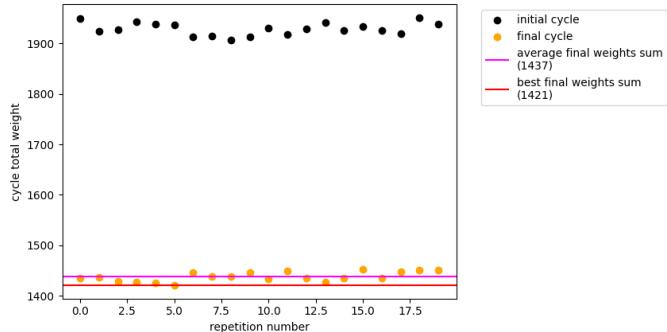
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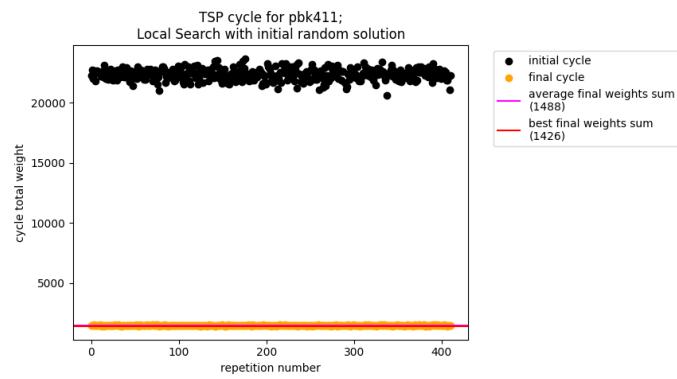
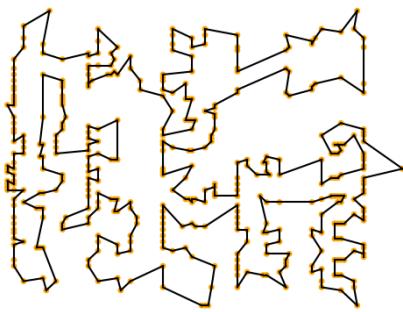
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Local Search with initial MST solution; total weight = 1421



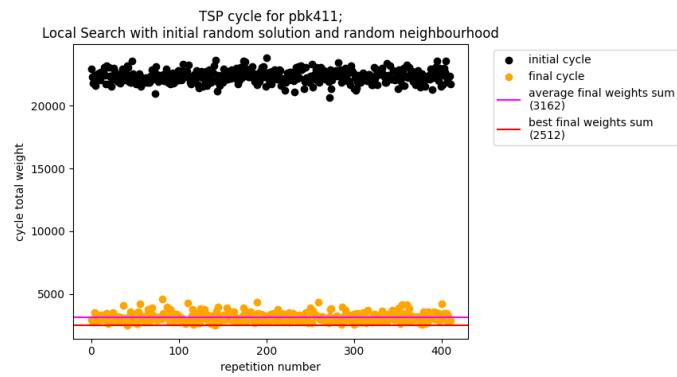
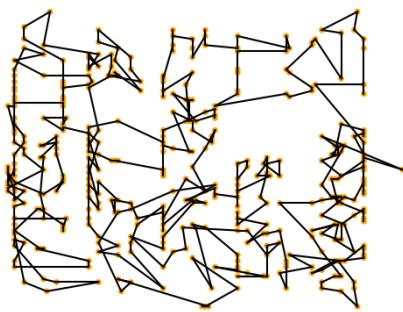
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Local Search with initial MST solution



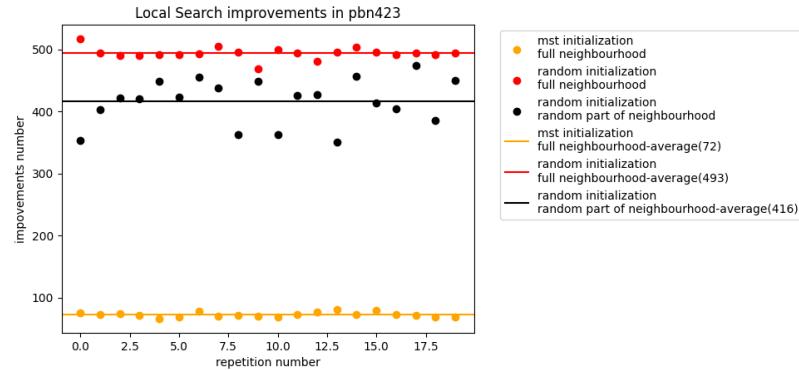
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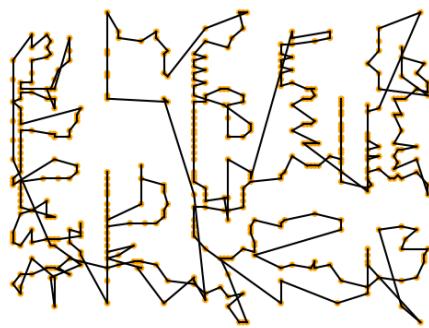
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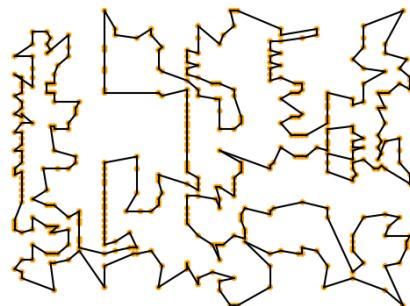
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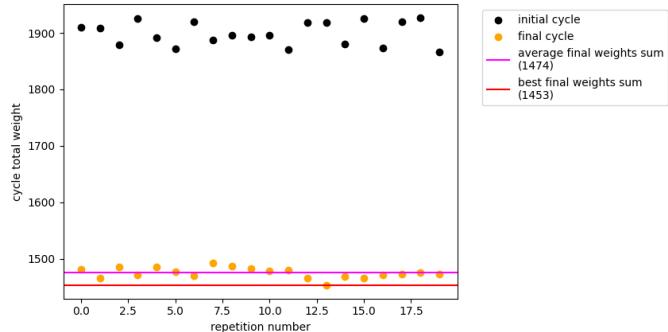
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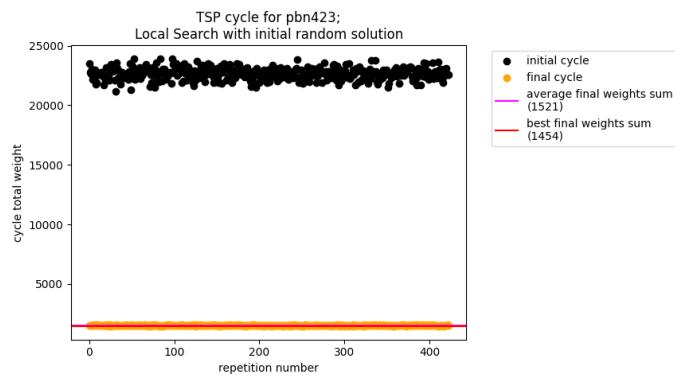
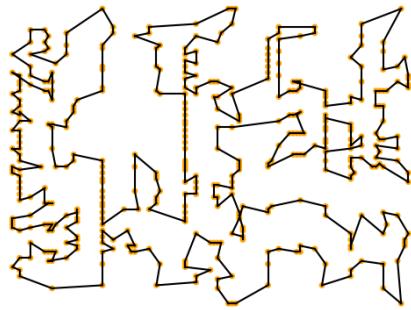
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Local Search with initial MST solution; total weight = 1453



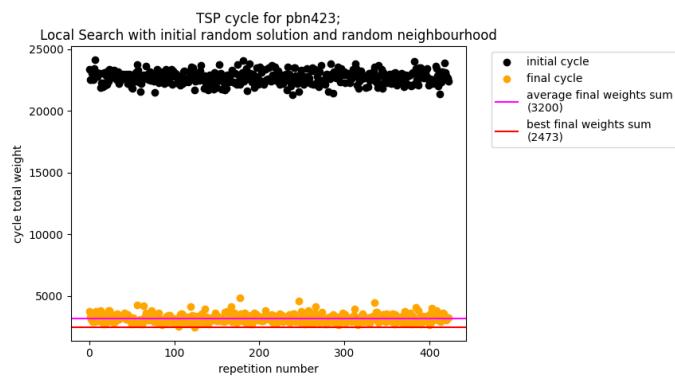
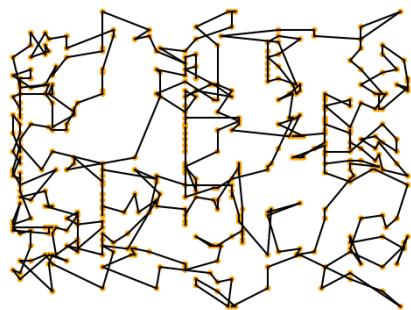
TSP cycle for pbn423;
Local Search with initial MST solution



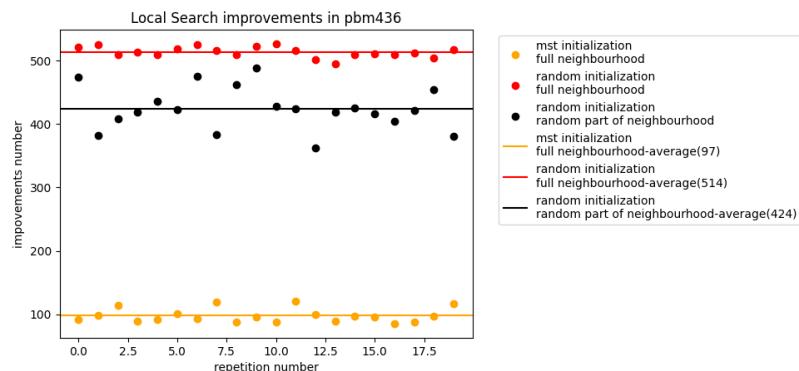
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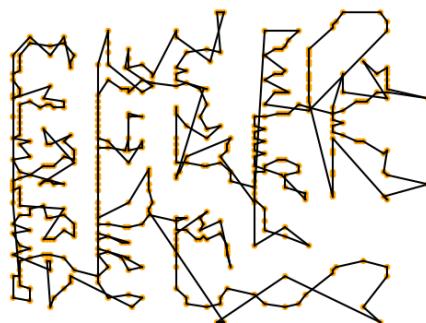
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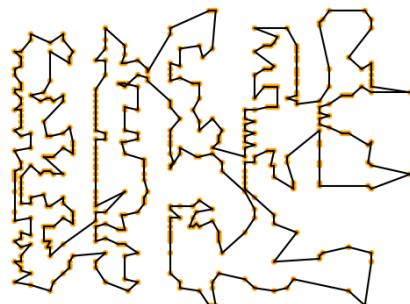
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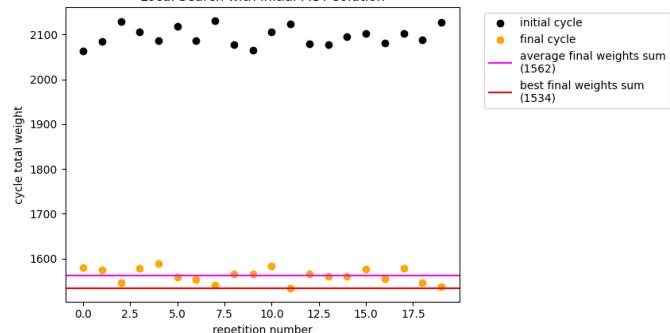
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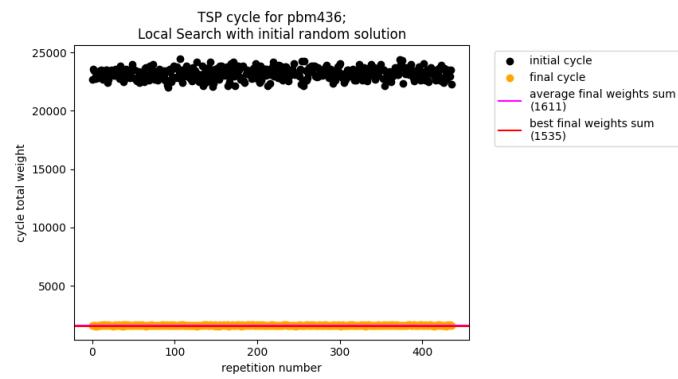
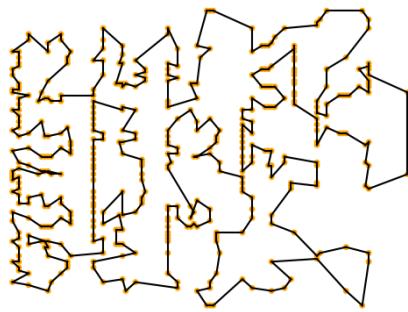
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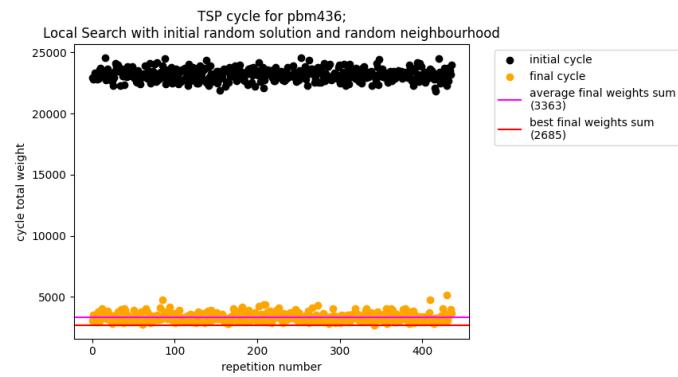
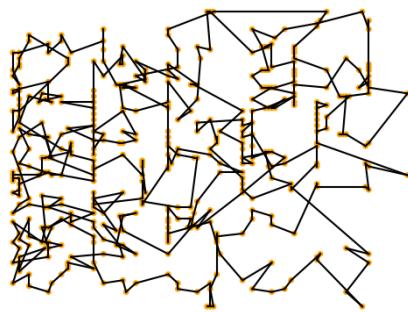
TSP cycle for pbm436;
Local Search with initial MST solution



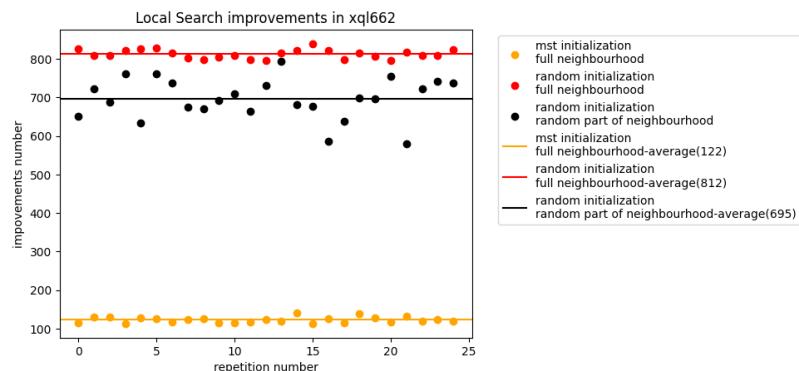
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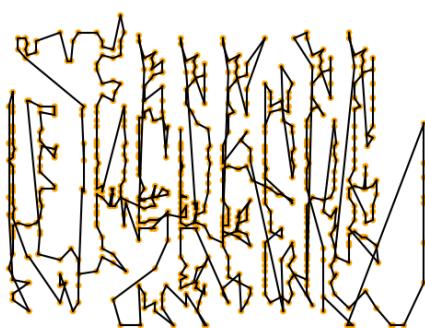
TSP cycle for pbm436;
Local Search with initial random solution and random neighbourhood; total weight = 2685



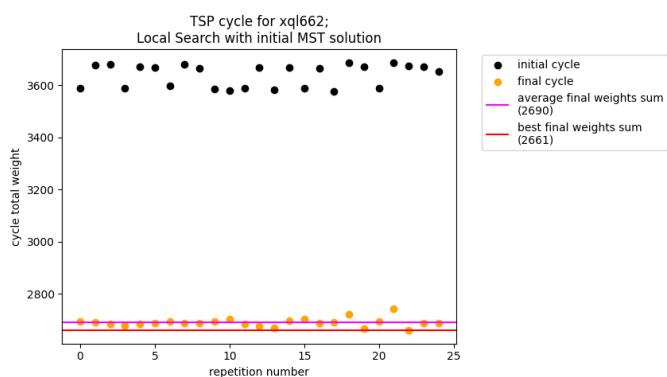
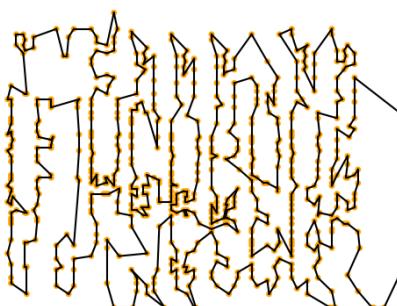
0.10 xql662



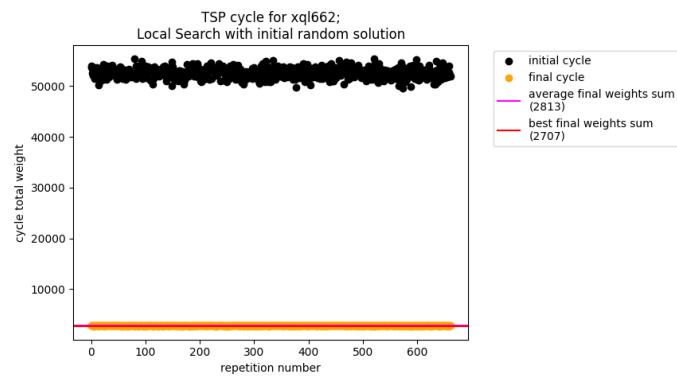
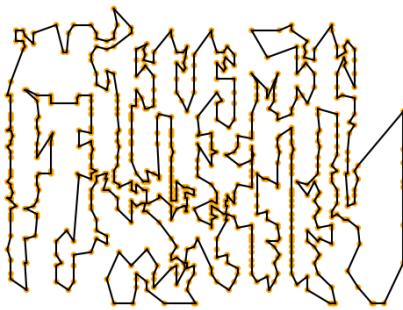
TSP cycle based on MST for xql662; total weight = 3691



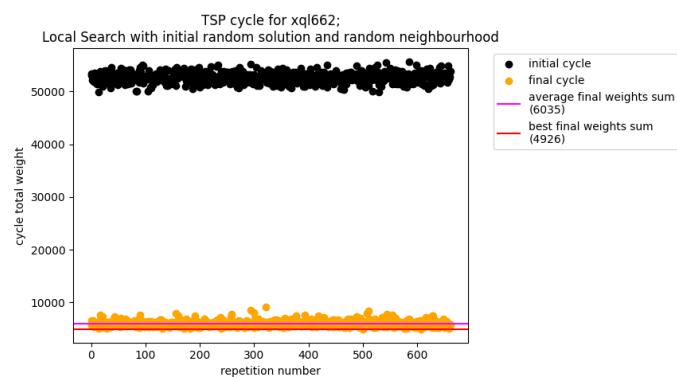
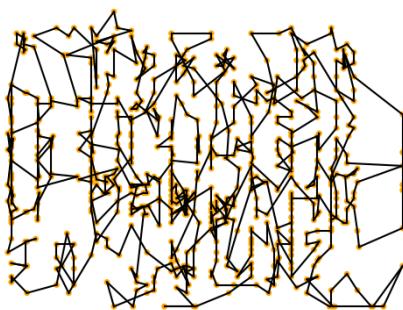
TSP cycle for xql662;
Local Search with initial MST solution; total weight = 2661



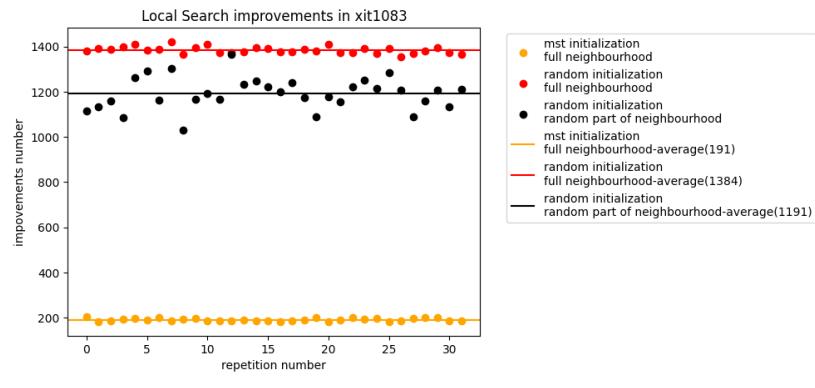
TSP cycle for xql662;
Local Search with initial random solution; total weight = 2707



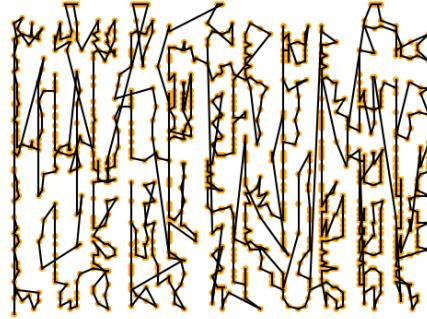
TSP cycle for xql662;
Local Search with initial random solution and random neighbourhood; total weight = 4926



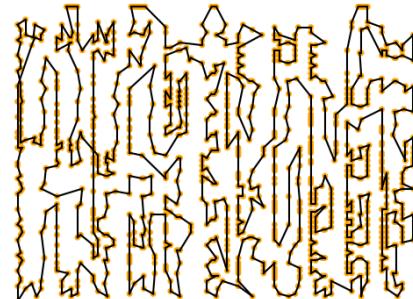
0.11 xit1083



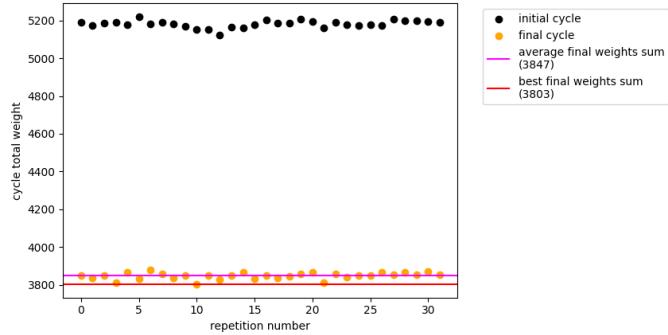
TSP cycle based on MST for xit1083; total weight = 5190



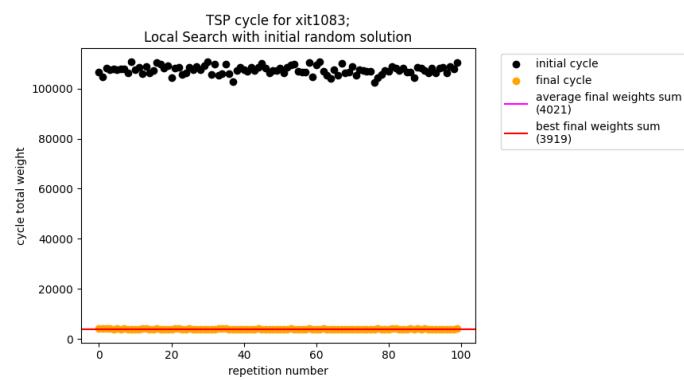
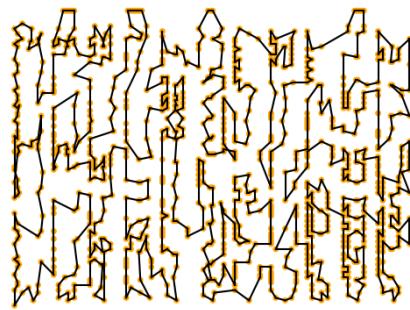
TSP cycle for xit1083;
Local Search with initial MST solution; total weight = 3803



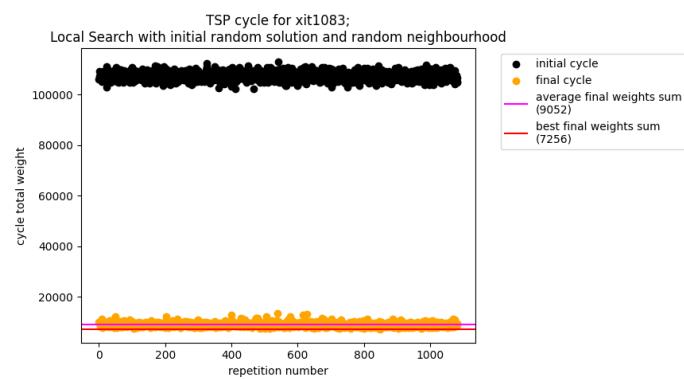
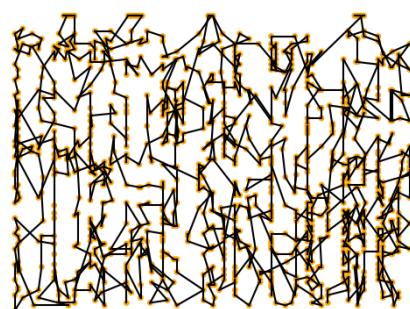
TSP cycle for xit1083;
Local Search with initial MST solution



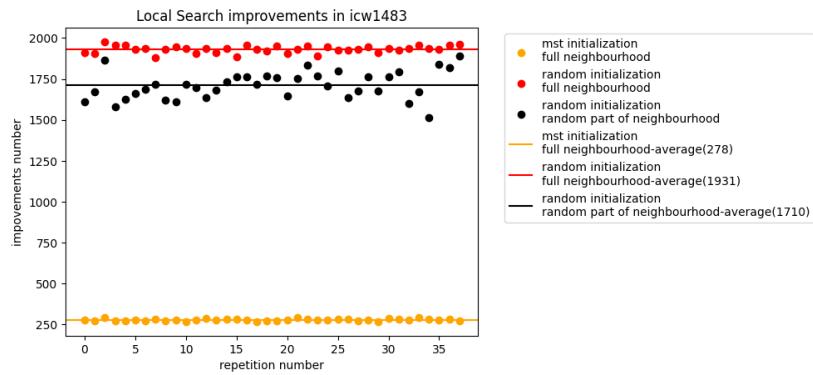
TSP cycle for xit1083;
Local Search with initial random solution; total weight = 3919



TSP cycle for xit1083;
Local Search with initial random solution and random neighbourhood; total weight = 7256



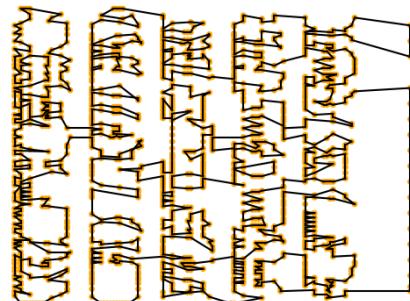
0.12 icw1483



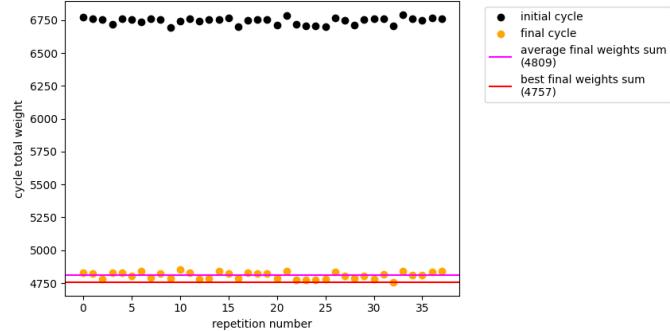
TSP cycle based on MST for icw1483; total weight = 6754



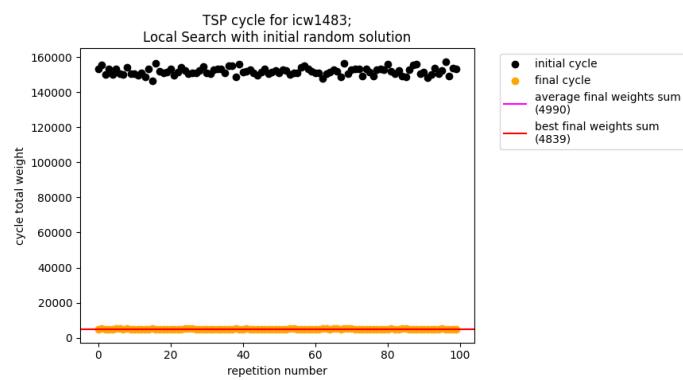
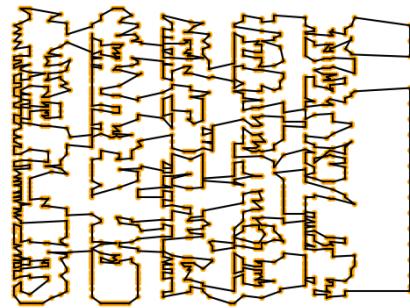
TSP cycle for icw1483;
Local Search with initial MST solution; total weight = 4757



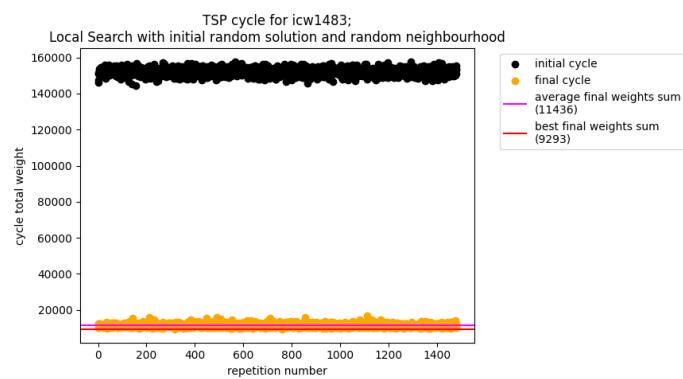
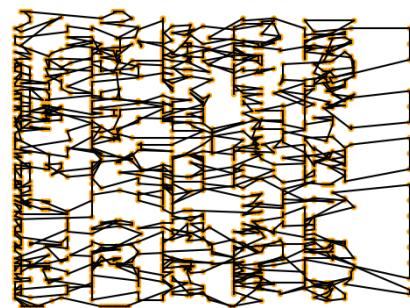
TSP cycle for icw1483;
Local Search with initial MST solution



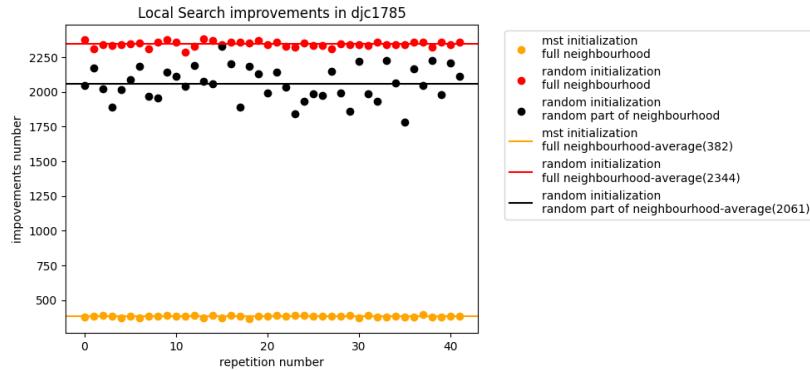
TSP cycle for icw1483;
Local Search with initial random solution; total weight = 4839



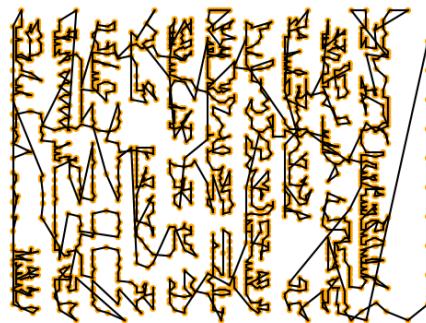
TSP cycle for icw1483;
Local Search with initial random solution and random neighbourhood; total weight = 9293



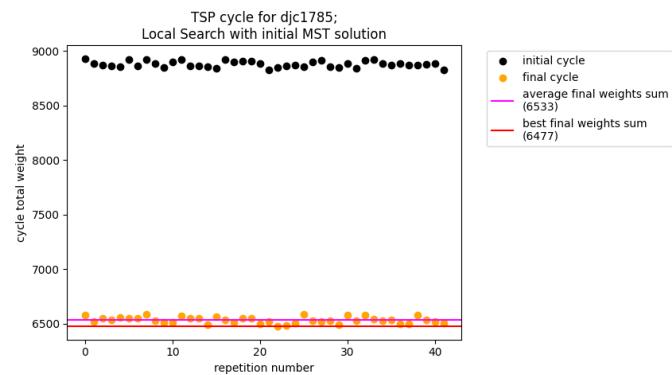
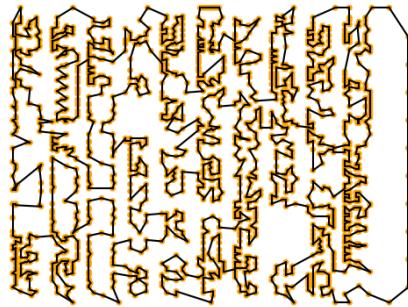
0.13 djc1785



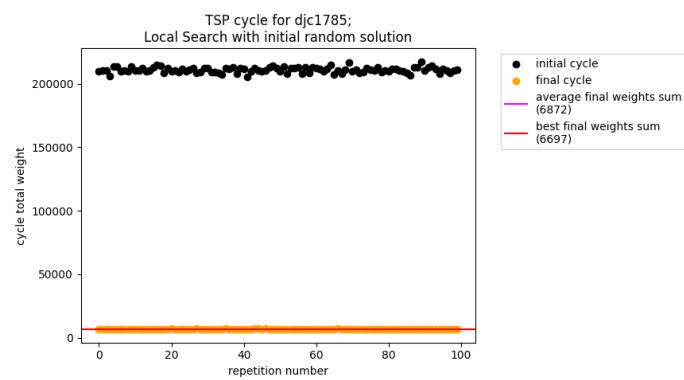
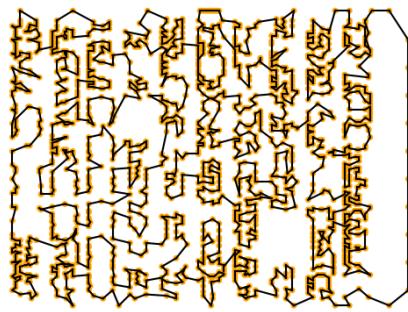
TSP cycle based on MST for djc1785; total weight = 8908



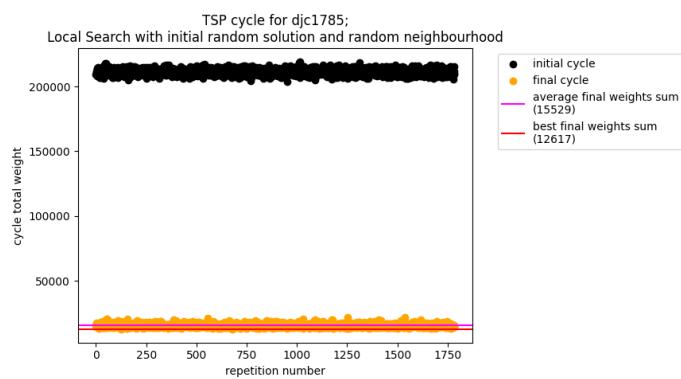
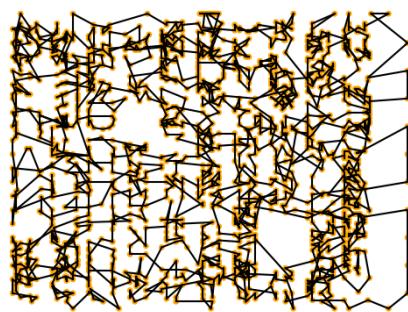
TSP cycle for djc1785;
Local Search with initial MST solution; total weight = 6477



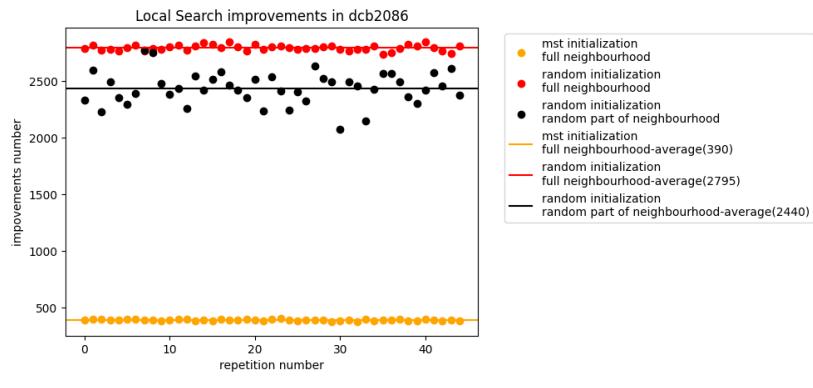
TSP cycle for djc1785;
Local Search with initial random solution; total weight = 6697



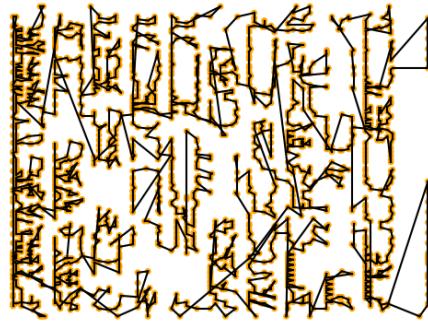
TSP cycle for djc1785;
Local Search with initial random solution and random neighbourhood; total weight = 12617



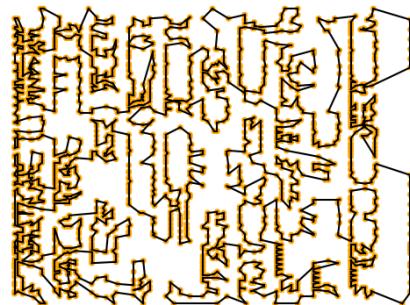
0.14 dcb2086



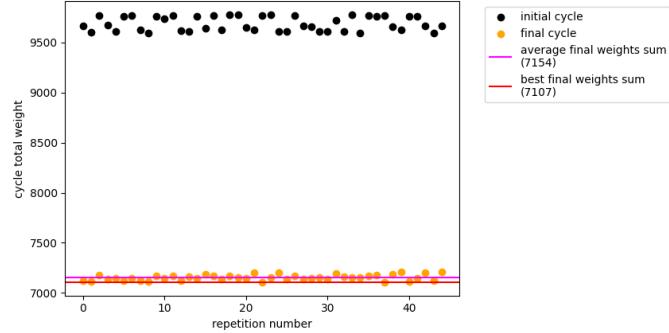
TSP cycle based on MST for dcb2086; total weight = 9777



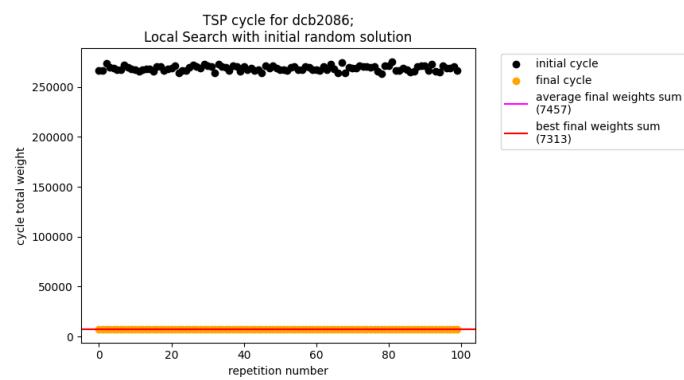
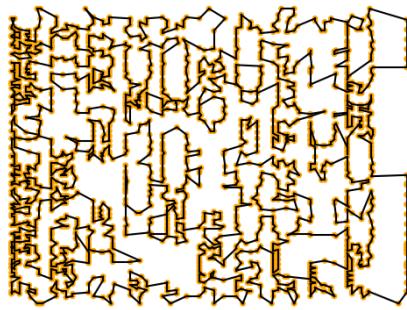
TSP cycle for dcb2086;
Local Search with initial MST solution; total weight = 7107



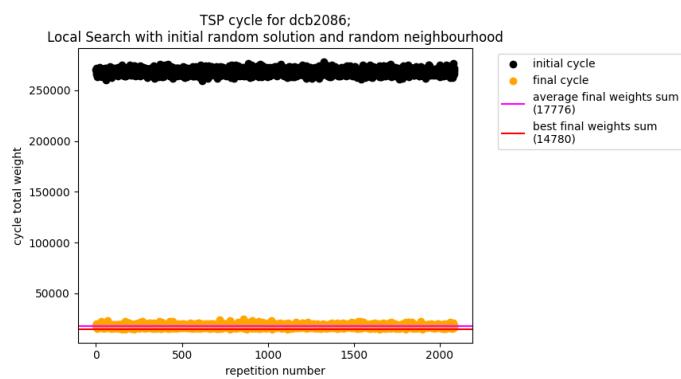
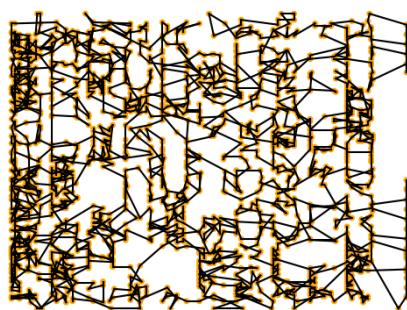
TSP cycle for dcb2086;
Local Search with initial MST solution



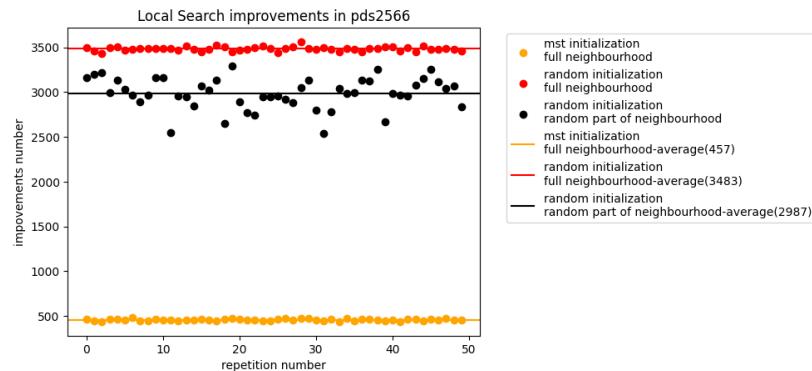
TSP cycle for dcb2086;
Local Search with initial random solution; total weight = 7313



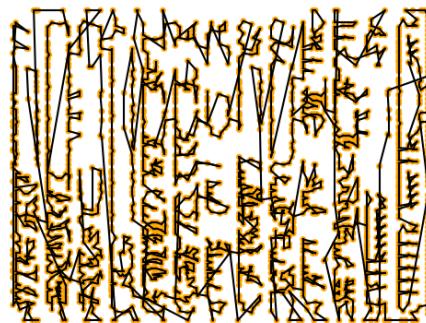
TSP cycle for dcb2086;
Local Search with initial random solution and random neighbourhood; total weight = 14780



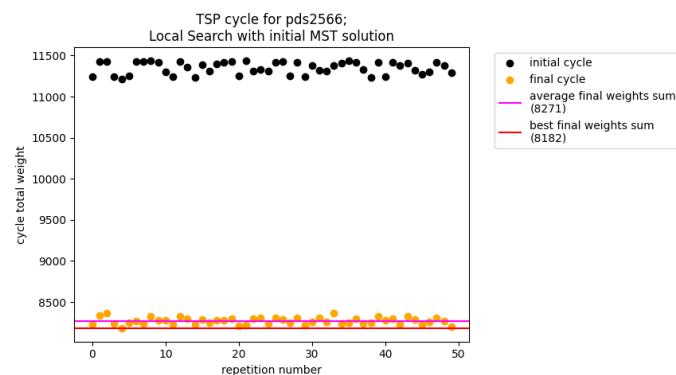
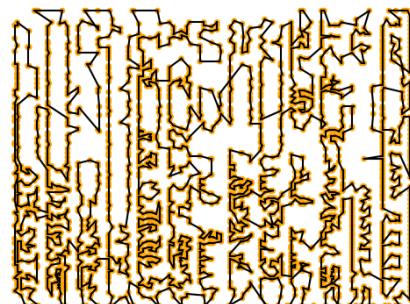
0.15 pds2566



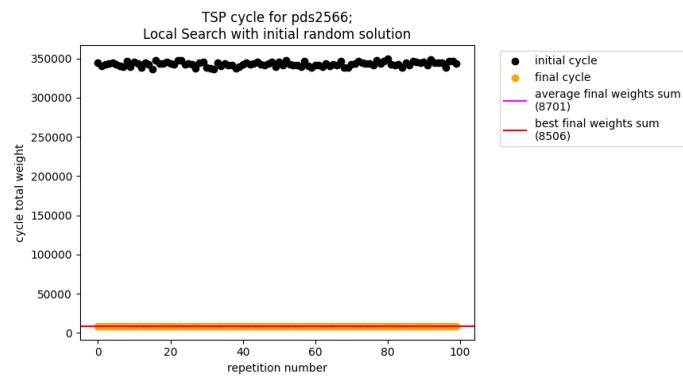
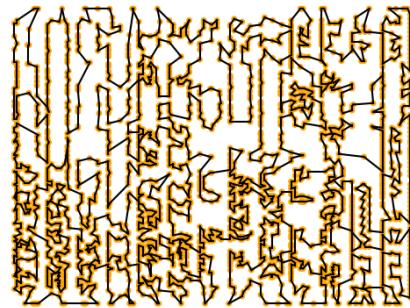
TSP cycle based on MST for pds2566; total weight = 11427



TSP cycle for pds2566;
Local Search with initial MST solution; total weight = 8182



TSP cycle for pds2566;
Local Search with initial random solution; total weight = 8506



TSP cycle for pds2566;
Local Search with initial random solution and random neighbourhood; total weight = 17506

