# Assignment 4

Runar Fosse

I've now use 4 different operators. Multi-outsource, Constant-best-insert, Low-best-insert and High-best-insert.

Multi-outsource selects a random number of non-outsourced calls and outsources them.

Constant-best-insert selects 1 to 10 randomly selected calls, checks every position within every vehicle, and places them in positions such that the resulting solution is as cheap as possible.

Low-best-insert does the same as Constant-best-insert, only for a random number of calls, between 1 and 10% of the total number of calls in the given problem.

High-best-insert is very similar, but picks a random number between 5% and 20% of the total number of calls in the given problem.

| Instance: Call_7_Vehicle_3 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 1410480.20 | 1134176.00 | 65.022906 % | 1.646 s |
| Local Search 1-insert | 1225532.80 | 1134176.00 | 65.022906 % | 0.336 s |
| Simulated Annealing 1-insert | 1134176.00 | 1134176.00 | 65.022906 % | 0.267 s |
| SA-new operators (equal weights) | 1134176.00 | 1134176.00 | 65.022906 % | 1.150 s |
| SA-new operators (tuned weights) | 1134176.00 | 1134176.00 | 65.022906 % | 1.479 s |
| Best solution: [4, 4, 2, 2, 0, 7, 7, 0, 1, 5, 5, 3, 3, 1, 0, 6, 6] | | | | |

| Instance: Call_18_Vehicle_5 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 5823937.20 | 4813395.00 | 46.277767 % | 0.992 s |
| Local Search 1-insert | 2826767.30 | 2374420.00 | 73.499132 % | 0.450 s |
| Simulated Annealing 1-insert | 2602245.20 | 2374420.00 | 73.499132 % | 0.441 s |
| SA-new operators (equal weights) | 2375502.40 | 2374420.00 | 73.499132 % | 5.126 s |
| SA-new operators (tuned weights) | 2376960.80 | 2374420.00 | 73.499132 % | 5.013 s |
| Best solution: [4, 4, 15, 15, 11, 11, 16, 16, 0, 6, 6, 5, 18, 5, 14, 17, 17, 14, 18, 0, 9, 8, 8, 9, 13, 13, 0, 7, 7, 3, 3, 10, 1, 10, 1, 0, 12, 12, 0, 2, 2] | | | | |

| Instance: Call_35_Vehicle_7 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 17986369.00 | 14373301.00 | 21.832494 % | 1.208 s |
| Local Search 1-insert | 7181838.70 | 6076993.00 | 66.950989 % | 0.583 s |
| Simulated Annealing 1-insert | 5710323.50 | 5208574.00 | 71.673783 % | 0.637 s |
| SA-new operators (equal weights) | 5213936.70 | 4938647.00 | 73.141750 % | 25.026 s |
| SA-new operators (tuned weights) | 5370564.80 | 5007354.00 | 72.768095 % | 20.065 s |
| Best solution: [34, 23, 23, 14, 34, 17, 14, 17, 27, 27, 22, 22, 25, 25, 0, 15, 15, 11, 11, 7, 7, 28, 28, 29, 29, 0, 19, 19, 24, 24, 33, 33, 5, 5, 2, 2, 20, 20, 0, 4, 4, 16, 16, 3, 3, 1, 21, 21, 1, 31, 31, 0, 9, 6, 9, 35, 6, 13, 35, 13, 26, 32, 32, 26, 0, 8, 30, 30, 18, 18, 8, 0, 12, 12, 10, 10, 0] | | | |

| Instance: Call_80_Vehicle_20 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 46770347.00 | 46770347.00 | 0.000000 % | 2.235 s |
| Local Search 1-insert | 16717960.80 | 14829767.00 | 68.292373 % | 2.534 s |
| Simulated Annealing 1-insert | 17164938.80 | 14732724.00 | 68.499862 % | 2.576 s |
| SA-new operators (equal weights) | 11564588.80 | 10766591.00 | 76.979878 % | 167.251 s |
| SA-new operators (tuned weights) | 11589600.60 | 10843726.00 | 76.814955 % | 130.641 s |
| Best solution: [41, 70, 41, 11, 11, 62, 62, 70, 20, 20, 7, 7, 50, 14, 14, 50, 0, 54, 63, 63, 54, 0, 18, 18, 65, 12, 65, 72, 72, 12, 0, 66, 66, 0, 71, 71, 49, 49, 77, 77, 0, 64, 64, 67, 42, 67, 3, 3, 42, 16, 16, 0, 68, 34, 79, 34, 69, 68, 48, 79, 69, 48, 56, 56, 0, 22, 22, 26, 37, 37, 26, 0, 8, 8, 5, 5, 17, 27, 27, 17, 33, 33, 0, 15, 15, 51, 23, 23, 55, 55, 28, 28, 58, 51, 58, 0, 4, 4, 61, 74, 61, 74, 80, 80, 10, 10, 0, 1, 29, 29, 1, 0, 25, 25, 9, 45, 45, 9, 2, 2, 24, 24, 0, 43, 43, 0, 57, 57, 46, 46, 75, 75, 0, 32, 21, 32, 21, 0, 53, 30, 30, 53, 76, 44, 44, 76, 0, 38, 38, 59, 59, 78, 78, 0, 39, 35, 35, 39, 19, 19, 47, 47, 6, 6, 0, 60, 40, 60, 40, 13, 13, 31, 36, 73, 31, 52, 36, 52, 73, 0] | | | |

| Instance: Call_130_Vehicle_40 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 76627567.00 | 76627567.00 | 0.000000 % | 3.671 s |
| Local Search 1-insert | 27005805.00 | 24953712.00 | 67.435072 % | 7.316 s |
| Simulated Annealing 1-insert | 27155019.30 | 24305693.00 | 68.280745 % | 6.171 s |
| SA-new operators (equal weights) | 17692255.50 | 16885231.00 | 77.964548 % | 601.452 s |
| SA-new operators (tuned weights) | 17458894.40 | 16994489.00 | 77.821965 % | 448.669 s |
| Best solution: [3, 1, 3, 9, 9, 81, 1, 94, 94, 12, 81, 12, 0, 60, 60, 73, 67, 109, 109, 73, 67, 0, 115, 69, 69, 115, 39, 39, 0, 84, 50, 82, 50, 82, 84, 65, 56, 56, 65, 0, 114, 58, 114, 58, 117, 117, 0, 96, 96, 55, 55, 118, 118, 59, 7, 7, 59, 64, 64, 0, 34, 34, 62, 62, 17, 48, 48, 17, 0, 5, 5, 29, 95, 29, 95, 63, 83, 83, 63, 0, 80, 80, 10, 53, 30, 10, 53, 30, 0, 15, 15, 16, 16, 41, 41, 4, 4, 92, 68, 70, 92, 70, 68, 20, 20, 0, 74, 61, 61, 74, 0, 98, 98, 129, 129, 0, 121, 121, 97, 97, 0, 105, 105, 54, 54, 0, 11, 11, 0, 88, 88, 22, 22, 0, 123, 42, 123, 42, 25, 25, 110, 36, 110, 77, 36, 77, 0, 103, 103, 23, 23, 107, 107, 26, 26, 0, 102, 102, 108, 108, 122, 125, 125, 127, 122, 127, 0, 33, 33, 0, 27, 49, 27, 49, 40, 24, 24, 40, 0, 87, 87, 128, 128, 0, 85, 85, 111, 104, 111, 104, 0, 21, 32, 32, 21, 52, 35, 52, 35, 0, 75, 89, 89, 75, 0, 38, 38, 31, 51, 51, 31, 0, 6, 44, 6, 44, 0, 2, 2, 130, 120, 120, 130, 28, 46, 46, 28, 71, 14, 71, 14, 0, 72, 112, 112, 72, 0, 0, 119, 119, 0, 93, 93, 0, 126, 45, 126, 45, 78, 78, 0, 106, 66, 66, 106, 0, 8, 90, 90, 8, 0, 13, 101, 13, 101, 0, 100, 100, 79, 43, 79, 43, 0, 19, 19, 47, 91, 47, 57, 91, 57, 0, 113, 18, 18, 113, 0, 86, 86, 124, 99, 99, 124, 116, 37, 116, 76, 37, 76, 0] | | | |

| Instance: Call_300_Vehicle_90 | | | | |
|---|---|---|---|---|
| | Average objective | Best objective | Improvement (%) | Running time |
| Random Search | 170784643.00 | 170784643.00 | 0.000000 % | 8.944 s |
| Local Search 1-insert | 71054331.20 | 67580835.00 | 60.429208 % | 24.332 s |
| Simulated Annealing 1-insert | 71107759.80 | 67246387.00 | 60.625039 % | 23.887 s |
| SA-new operators (equal weights) | 38590269.20 | 37965140.00 | 77.770168 % | 11053.443 s |
| SA-new operators (tuned weights) | 39096420.30 | 38617010.00 | 77.388476 % | 5974.131 s |

Best solution: [217, 217, 0, 214, 111, 214, 111, 281, 281, 0, 241, 29, 29, 246, 246, 236, 266, 236, 266, 241, 0, 55, 55, 0, 273, 200, 200, 273, 0, 96, 96, 23, 23, 211, 211, 0, 155, 155, 118, 118, 62, 181, 62, 124, 124, 181, 0, 280, 300, 300, 280, 0, 179, 103, 103, 179, 0, 15, 15, 271, 271, 0, 46, 59, 46, 59, 298, 298, 0, 110, 110, 129, 129, 0, 245, 245, 0, 126, 126, 0, 54, 54, 0, 158, 207, 158, 207, 288, 72, 72, 3, 3, 288, 0, 32, 53, 53, 32, 0, 141, 182, 148, 141, 182, 148, 0, 0, 67, 61, 109, 61, 164, 164, 109, 67, 80, 80, 0, 278, 278, 0, 233, 233, 41, 41, 194, 194, 235, 235, 258, 258, 0, 222, 222, 293, 209, 209, 293, 14, 102, 102, 14, 0, 36, 37, 224, 36, 224, 37, 0, 0, 10, 92, 92, 10, 84, 17, 17, 84, 0, 83, 83, 0, 206, 206, 195, 195, 0, 133, 133, 279, 279, 0, 0, 180, 180, 193, 193, 127, 127, 170, 170, 16, 16, 34, 50, 187, 34, 50, 187, 0, 188, 188, 9, 165, 9, 165, 0, 274, 274, 119, 119, 4, 4, 282, 282, 186, 18, 186, 18, 0, 68, 26, 68, 44, 44, 26, 5, 5, 166, 166, 0, 71, 71, 205, 205, 97, 97, 0, 244, 244, 94, 220, 94, 131, 131, 42, 275, 275, 220, 42, 267, 267, 0, 137, 137, 156, 156, 0, 114, 171, 79, 95, 95, 79, 114, 171, 197, 197, 0, 19, 19, 0, 143, 143, 185, 210, 98, 210, 98, 294, 185, 294, 27, 27, 296, 296, 0, 276, 276, 52, 52, 192, 192, 107, 107, 106, 106, 0, 136, 208, 136, 208, 49, 257, 257, 49, 253, 253, 0, 48, 264, 48, 287, 287, 264, 154, 63, 154, 63, 0, 218, 218, 230, 230, 189, 189, 0, 150, 150, 149, 149, 196, 90, 196, 90, 0, 250, 7, 7, 250, 204, 204, 100, 100, 161, 161, 0, 277, 123, 277, 74, 123, 74, 202, 202, 0, 242, 242, 167, 167, 285, 285, 251, 251, 0, 232, 39, 39, 232, 70, 11, 11, 70, 20, 20, 0, 152, 249, 249, 152, 101, 22, 101, 22, 0, 138, 138, 65, 65, 229, 229, 0, 121, 121, 261, 40, 261, 40, 58, 157, 58, 56, 157, 130, 56, 130, 0, 215, 35, 240, 35, 215, 240, 75, 75, 153, 153, 8, 8, 0, 221, 91, 221, 91, 132, 132, 0, 24, 24, 108, 108, 0, 172, 172, 234, 234, 21, 163, 21, 163, 0, 105, 295, 105, 295, 290, 290, 120, 120, 198, 198, 0, 237, 237, 262, 122, 262, 115, 122, 292, 292, 115, 0, 248, 82, 248, 82, 159, 159, 81, 184, 73, 81, 184, 73, 0, 263, 269, 269, 263, 256, 256, 99, 12, 99, 12, 0, 216, 255, 216, 6, 255, 6, 85, 85, 190, 190, 0, 134, 134, 76, 268, 268, 76, 0, 223, 223, 0, 272, 212, 272, 212, 0, 299, 69, 69, 299, 13, 13, 0, 239, 239, 0, 31, 176, 176, 31, 0, 30, 104, 30, 231, 231, 104, 0, 247, 228, 247, 33, 33, 228, 0, 238, 238, 0, 213, 145, 145, 213, 0, 57, 270, 286, 286, 57, 270, 28, 51, 28, 2, 51, 2, 0, 183, 259, 183, 283, 283, 259, 0, 147, 147, 38, 38, 0, 174, 284, 174, 284, 0, 43, 144, 144, 203, 43, 177, 226, 226, 203, 177, 0, 66, 1, 89, 66, 89, 1, 0, 169, 291, 169, 291, 160, 191, 160, 139, 139, 191, 0, 162, 151, 151, 162, 0, 199, 125, 125, 112, 112, 199, 0, 116, 116, 93, 140, 93, 140, 0, 86, 86, 243, 243, 297, 60, 146, 146, 60, 297, 0, 201, 178, 178, 201, 0, 25, 25, 45, 289, 45, 289, 0, 265, 88, 265, 219, 227, 219, 227, 88, 0, 254, 175, 254, 175, 0, 135, 135, 77, 64, 77, 64, 0, 168, 168, 142, 142, 47, 47, 113, 117, 113, 117, 0, 225, 87, 225, 87, 128, 173, 173, 128, 252, 252, 0, 78, 78, 260, 260, 0]