

인공지능 HW4

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목차

1. 샘플 분석

- 1 Greedy Algorithm
- 2 Hill Climbing Algorithm

2. 알고리즘 개선

- 1 Greedy Algorithm
- 2 Hill Climbing Algorithm

샘플 분석 – Greedy Algorithm data1

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jupyter TSP_Greedy Last Checkpoint: 지난주 일요일 오후 10:15 (unsaved changes) Logout

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cost_arr = path_cost(path_map, best_path)
best_cost = cost_arr.sum()

# Draw Route
if PLOT_MODE:
    plt.close()
    figure, ax = plt.subplots()
    plt.scatter(coord_list[:, 0], coord_list[:, 1], c='yellow', s=10)
    plt.title('City Route')
    coord_path = coord_list
    coord_path = np.append(coord_path, coord_path[best_path[0], :].reshape(1, 2), axis=0)
    coord_path[:, :] = coord_path[best_path, :]
    lines, = ax.plot(coord_path[:, 0], coord_path[:, 1], 'k--')
    figure.canvas.draw()
    figure.canvas.flush_events()

return best_path, best_cost
```

Main

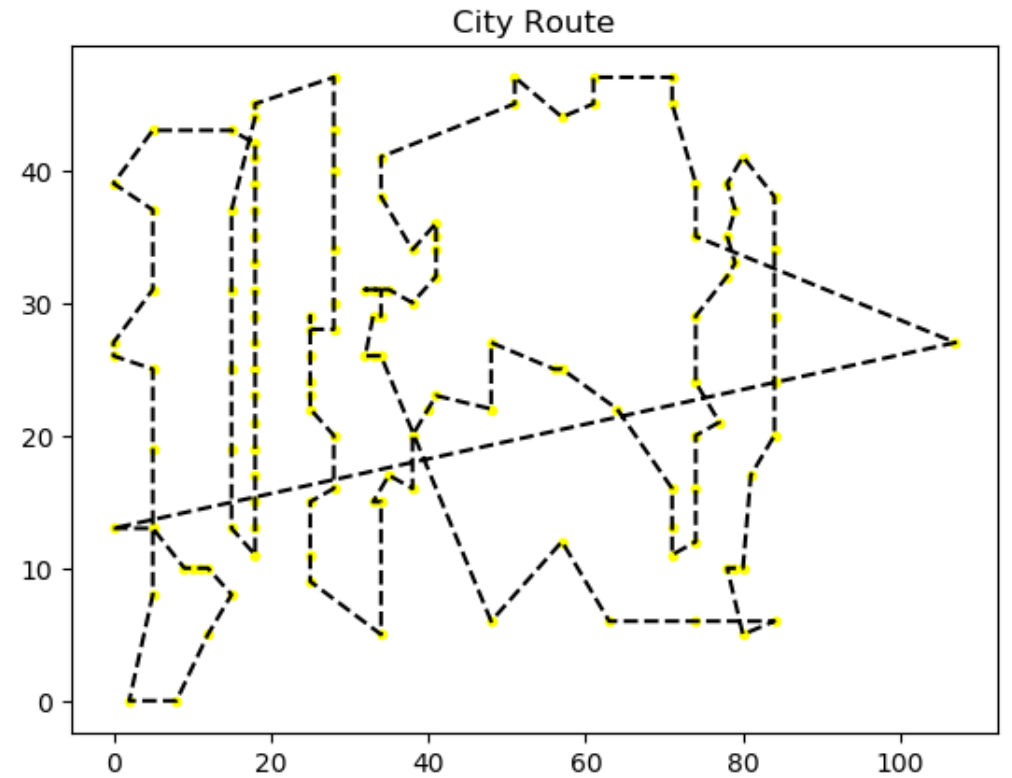
```
In [4]: # Step 1
try:
    coord_list = fileloader()
except Exception as e:
    print('예외 발생', e)
    sys.exit()

start_time = time.time()

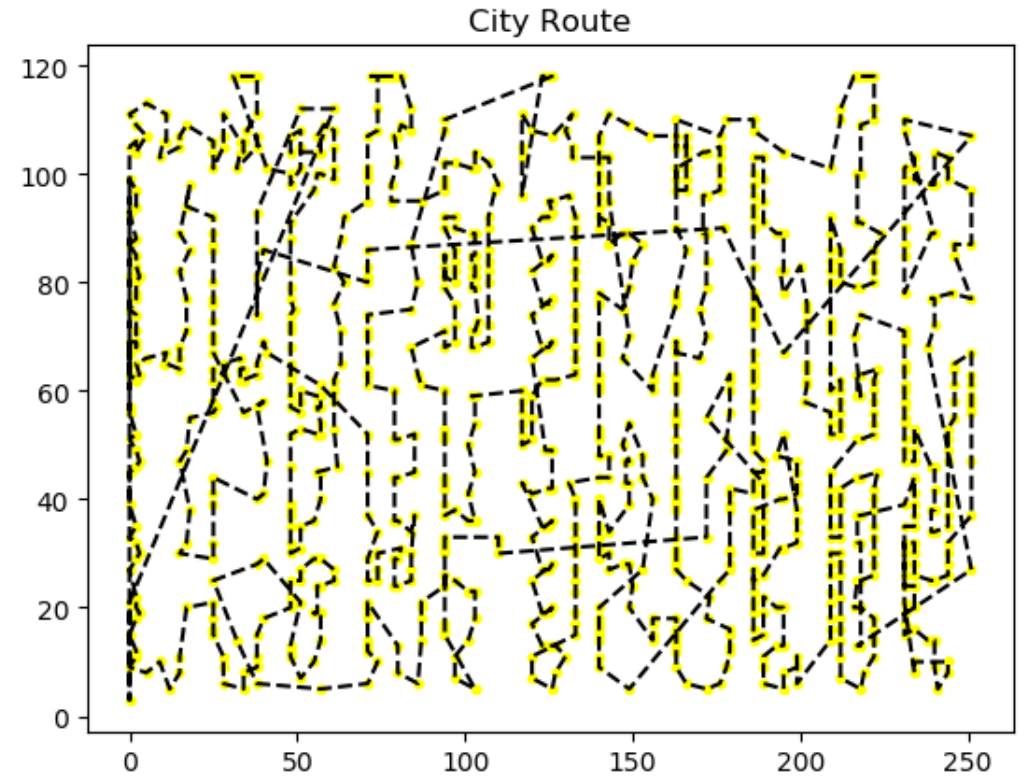
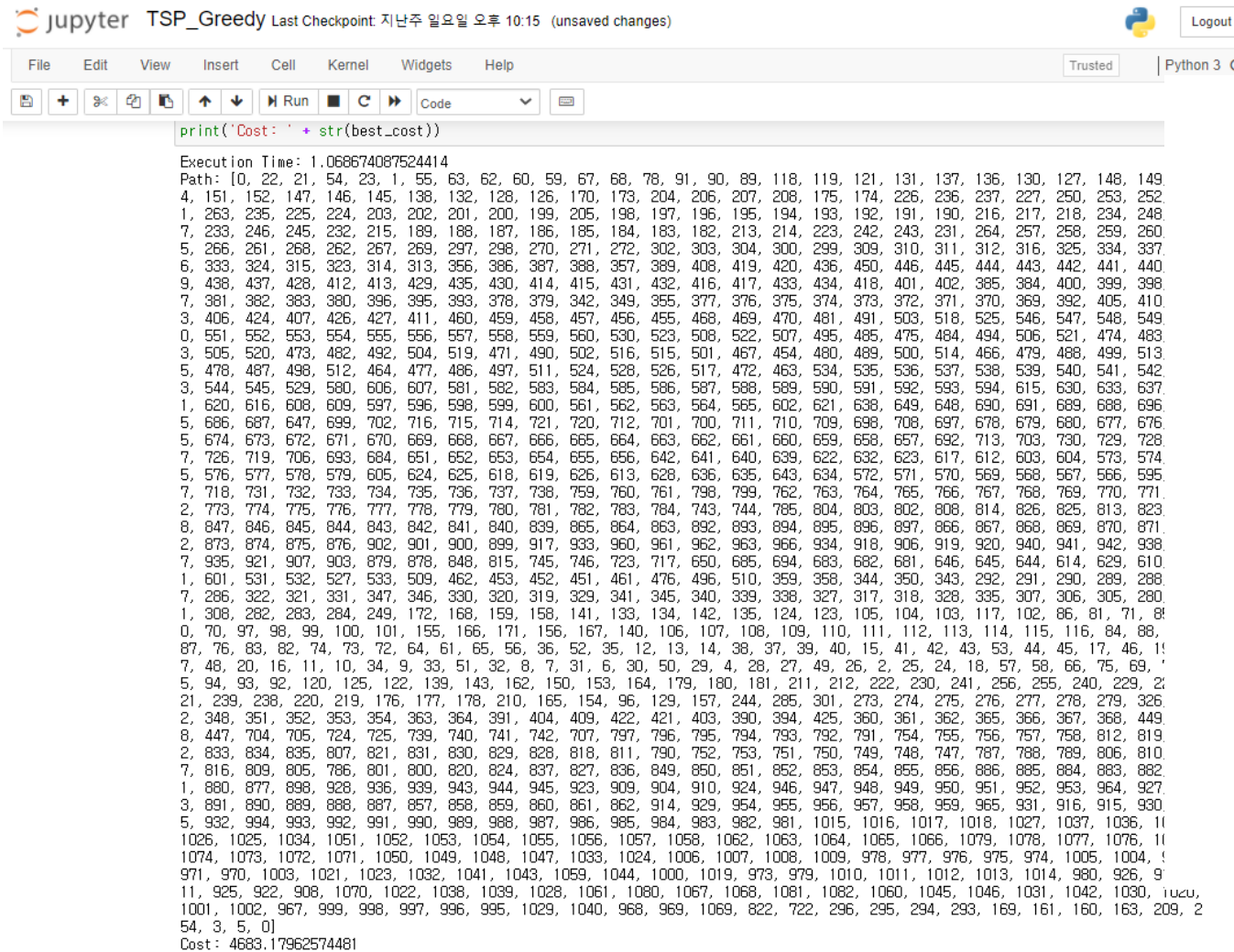
# Step 2
best_path, best_cost = greedy(coord_list)

print('Execution Time: ' + str(time.time() - start_time))
print('Path: ' + str(best_path.tolist()))
print('Cost: ' + str(best_cost))

Execution Time: 1.1107869148254395
Path: [0, 5, 13, 14, 15, 16, 24, 17, 12, 4, 11, 6, 7, 1, 2, 8, 9, 3, 10, 23, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 2,
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2, 89, 90, 94, 95, 96, 103, 102, 110, 109, 130, 0]
Cost: 687.7892183230354
```



샘플 분석 – Greedy Algorithm data2



샘플 분석 - Greedy Algorithm data3

jupyter TSP_Greedy Last Checkpoint: 지난주 일요일 오후 10:15 (autosaved)

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Code

```
print('배치 실행', e)
sys.exit()

start_time = time.time()

# Step 2
best_path, best_cost = greedy(coord_list)

print('Execution Time: ' + str(time.time() - start_time))
print('Path: ' + str(best_path.tolist()))
print('Cost: ' + str(best_cost))
```

Execution Time: 1.510254144668579

Path: [0, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 1, 49, 70, 75, 83, 103, 153, 172, 178, 186, 215, 221, 281, 288, 289, 236, 237, 238, 239, 240, 291, 290, 317, 338, 371, 370, 337, 316, 368, 360, 395, 400, 401, 407, 412, 442, 441, 440, 439, 4, 38, 437, 481, 498, 515, 535, 536, 499, 537, 500, 501, 516, 538, 539, 517, 502, 482, 483, 450, 451, 452, 453, 454, 485, 486, 48, 7, 455, 456, 457, 458, 459, 460, 488, 504, 518, 544, 543, 550, 542, 503, 541, 558, 560, 561, 545, 505, 562, 570, 625, 626, 62, 7, 628, 629, 630, 631, 632, 633, 634, 571, 635, 636, 637, 639, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 58, 4, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 648, 647, 646, 644, 643, 676, 696, 722, 72, 3, 697, 698, 724, 725, 699, 700, 726, 727, 701, 678, 702, 679, 703, 680, 728, 762, 761, 760, 759, 758, 757, 756, 755, 721, 67, 5, 674, 720, 752, 719, 673, 642, 641, 640, 671, 693, 717, 718, 694, 672, 670, 692, 716, 751, 715, 669, 714, 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204, 185, 187, 188, 105, 104, 84, 85, 86, 87, 107, 1, 06, 4, 5, 3, 2, 82, 101, 143, 102, 142, 141, 140, 139, 98, 81, 99, 100, 97, 96, 137, 138, 136, 135, 94, 95, 93, 92, 133, 134, 132, 131, 90, 91, 194, 193, 195, 196, 241, 242, 243, 244, 245, 246, 197, 198, 199, 200, 322, 343, 378, 461, 462, 463, 464, 46, 5, 466, 467, 490, 507, 519, 547, 506, 546, 564, 548, 520, 491, 492, 508, 521, 522, 552, 566, 523, 509, 493, 494, 510, 524, 52, 5, 511, 495, 471, 472, 426, 425, 424, 423, 422, 421, 420, 469, 468, 419, 418, 416, 415, 414, 413, 389, 390, 391, 473, 526, 55, 3, 549, 470, 551, 774, 819, 779, 781, 782, 783, 784, 785, 786, 787, 820, 821, 822, 823, 791, 792, 793, 794, 795, 796, 797, 82, 4, 825, 798, 799, 826, 827, 828, 838, 845, 853, 864, 863, 852, 869, 862, 851, 844, 861, 860, 850, 843, 871, 879, 878, 877, 85, 9, 849, 842, 841, 848, 858, 857, 856, 847, 840, 788, 789, 790, 753, 649, 650, 651, 601, 602, 652, 653, 654, 603, 568, 533, 53, 4, 478, 479, 480, 435, 406, 399, 398, 397, 366, 367, 365, 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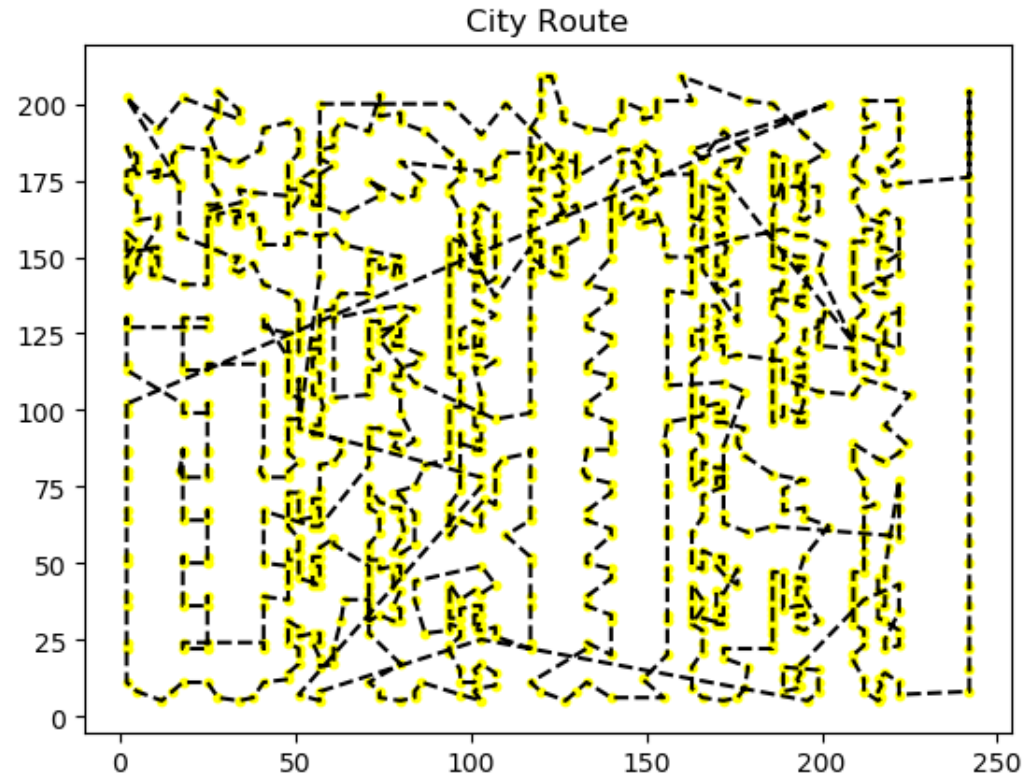
jupyter TSP_Greedy Last Checkpoint: 지난주 일요일 오후 10:15 (autosaved)

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Code

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샘플 분석 – Greedy Algorithm data3










느낀점

- 처음 greedy algorithm을 접했을 때는 너무나도 당연해 보였고 단순해서 실생활에 적용되는 예시는 없다고 생각했다.
- 위 예시와 같이 real world에서는 오히려 NP hard인 경우가 많아서 Greedy 방식이 오히려 훌륭한 접근 방법이 될 수 있다는 것을 깨달았다.
- 또한 best answer을 찾는 것 보다는 time을 줄이면서 optimal한 solution을 찾는 방식이 실제로 더 의미있는 접근이라는 것을 느꼈다.

샘플 분석 – Hill Climbing Algorithm data1

jupyter TSP_HillClimbing (unsaved changes)  Logout

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       Code

```
return best_path, best_cost
```

Main

```
In [6]: # Initialization #####
initialize = initialize_greedy
#initialize = initialize_random
#####

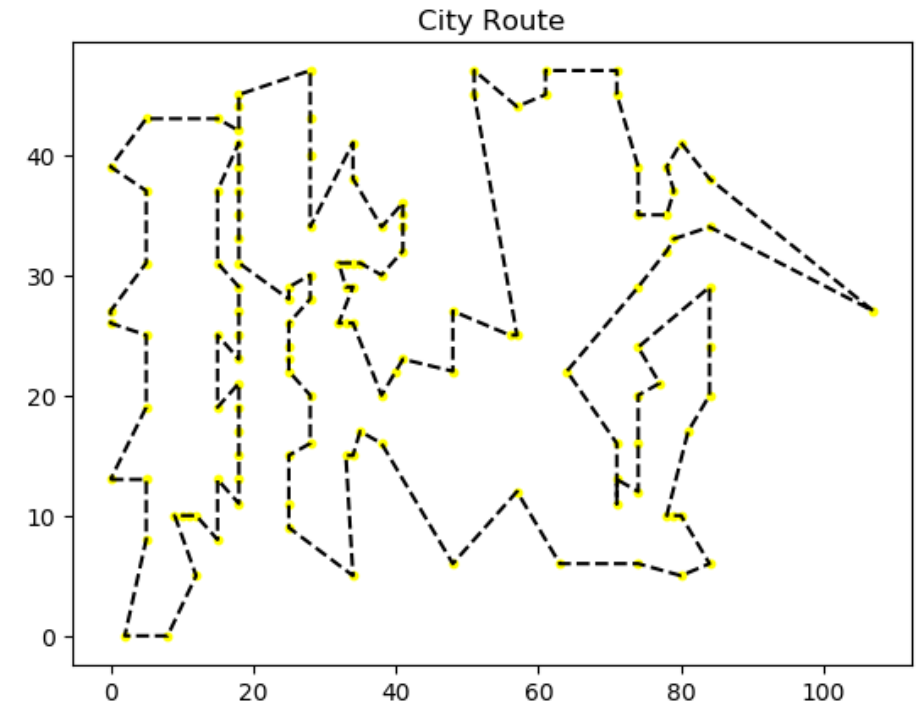
# Step 1
try:
    coord_list = fileloader()
except Exception as e:
    print('예외 발생', e)
    sys.exit()

start_time = time.time()
# Step 2
path_map, path = initialize(coord_list, FIRST_IDX)

# Step 3
best_path, best_cost = hill_climbing(path_map, path, coord_list)

print('Execution Time: ' + str(time.time() - start_time))
print('Path: ' + str(best_path.tolist()))
print('Cost: ' + str(best_cost))

Execution Time: 23.665210008621216
Path: [0, 5, 11, 4, 12, 17, 13, 14, 15, 16, 24, 18, 25, 26, 27, 28, 29, 30, 19, 20, 31, 32, 33, 34, 21, 22, 40, 39, 36, 37, 3
6, 35, 50, 51, 56, 55, 49, 48, 47, 46, 54, 53, 45, 44, 52, 73, 63, 67, 74, 76, 88, 92, 97, 111, 122, 129, 120, 117, 113, 123,
124, 125, 126, 107, 112, 106, 105, 104, 100, 99, 101, 98, 108, 114, 118, 127, 130, 128, 121, 116, 119, 115, 109, 110, 102, 10
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59, 60, 43, 42, 41, 23, 10, 3, 9, 8, 2, 1, 7, 6, 0]
Cost: 607.6872597066667
```



In []: 

샘플 분석 – Hill Climbing Algorithm data2

```
jupyter TSP_HillClimbing (autosaved) Logout
```

```
File Edit View Insert Cell Kernel Widgets Help Trusted Python 3
```

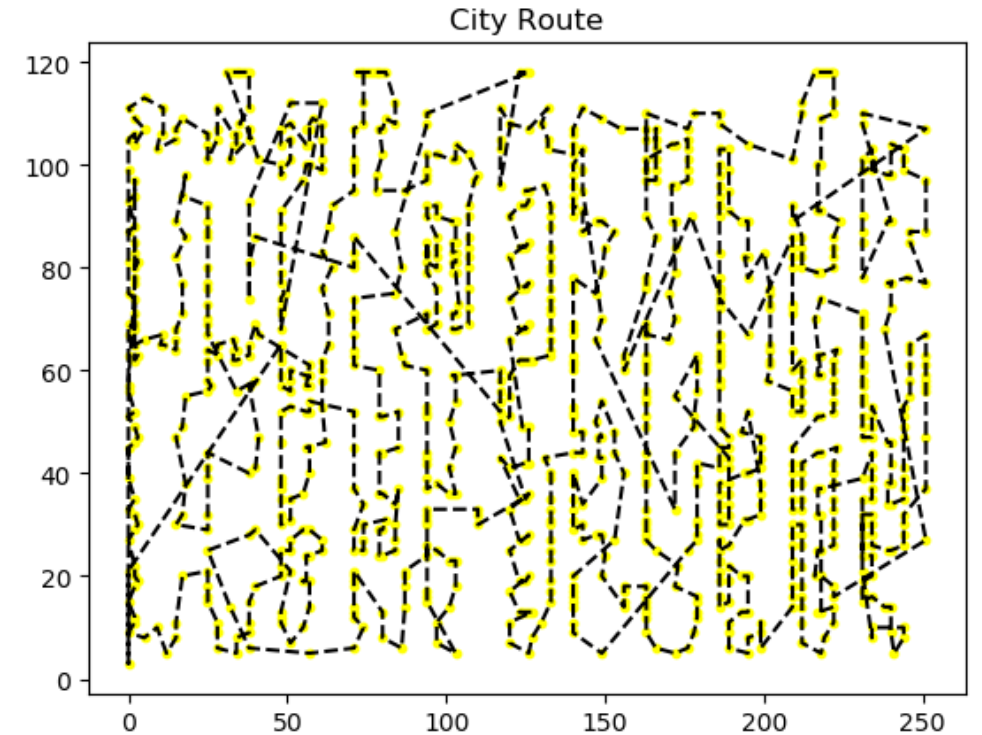
```
Code
```

```
print(Path)
print('Cost: ' + str(best_cost))
```

Execution Time: 73.61358094215393

Path: [0, 22, 21, 54, 23, 1, 55, 63, 62, 60, 59, 67, 68, 78, 91, 90, 89, 118, 119, 121, 131, 137, 136, 130, 127, 148, 149, 14, 4, 151, 152, 147, 146, 145, 138, 132, 128, 126, 170, 173, 204, 206, 207, 174, 175, 208, 226, 236, 237, 227, 250, 253, 252, 25, 1, 263, 235, 225, 224, 203, 202, 201, 200, 199, 205, 198, 197, 196, 195, 254, 209, 163, 160, 161, 169, 293, 294, 295, 296, 45, 6, 457, 458, 459, 460, 411, 427, 426, 407, 424, 406, 423, 410, 405, 392, 369, 370, 371, 372, 373, 374, 375, 376, 377, 355, 34, 9, 342, 379, 378, 393, 395, 396, 380, 383, 382, 381, 397, 398, 399, 400, 384, 385, 402, 401, 418, 434, 433, 417, 416, 432, 43, 1, 415, 414, 430, 435, 429, 413, 412, 428, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 450, 436, 420, 419, 408, 389, 35, 7, 388, 387, 386, 356, 313, 314, 323, 315, 324, 333, 336, 337, 334, 325, 316, 312, 311, 310, 309, 299, 300, 304, 303, 302, 27, 2, 271, 270, 298, 297, 269, 267, 262, 268, 261, 266, 265, 260, 259, 258, 257, 264, 231, 243, 242, 223, 214, 213, 182, 183, 18, 4, 185, 186, 187, 188, 189, 215, 232, 245, 246, 284, 283, 282, 308, 281, 280, 305, 306, 307, 335, 328, 318, 317, 327, 338, 33, 9, 340, 345, 341, 329, 319, 320, 330, 346, 347, 331, 321, 322, 286, 287, 288, 289, 290, 291, 292, 343, 350, 344, 358, 359, 51, 0, 496, 476, 461, 451, 452, 453, 462, 509, 533, 527, 532, 531, 562, 563, 564, 565, 602, 621, 638, 649, 648, 690, 691, 689, 68, 8, 696, 695, 686, 687, 647, 699, 702, 716, 715, 714, 721, 720, 712, 701, 700, 711, 710, 709, 698, 708, 697, 678, 679, 680, 67, 7, 676, 675, 674, 673, 672, 671, 670, 669, 668, 667, 666, 665, 664, 663, 662, 661, 660, 659, 658, 657, 692, 713, 703, 730, 72, 9, 728, 727, 726, 719, 706, 693, 684, 651, 652, 653, 654, 655, 656, 642, 641, 640, 639, 622, 632, 623, 617, 612, 603, 604, 57, 3, 574, 575, 576, 577, 578, 579, 605, 624, 625, 618, 619, 626, 613, 628, 636, 635, 643, 634, 572, 571, 570, 569, 568, 567, 56, 6, 595, 627, 718, 731, 732, 733, 734, 735, 736, 737, 738, 759, 760, 761, 798, 799, 762, 763, 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984, 983, 982, 981, 1015, 1016, 1017, 1018, 1027, 103, 7, 1036, 1035, 1026, 1025, 1034, 1051, 1052, 1053, 1054, 1055, 1056, 1057, 1058, 1062, 1063, 1064, 1065, 1066, 1079, 1078, 107, 7, 1076, 1075, 1074, 1073, 1072, 1071, 1050, 1049, 1048, 1047, 1033, 1024, 1006, 1007, 1008, 1009, 978, 977, 976, 975, 974, 10, 05, 1004, 972, 971, 970, 1003, 1021, 1023, 1032, 1041, 1043, 1059, 1044, 1000, 1019, 973, 979, 1010, 1011, 1012, 1013, 1014, 9, 80, 926, 912, 911, 925, 922, 908, 943, 939, 936, 928, 898, 877, 880, 881, 882, 883, 884, 885, 886, 886, 856, 855, 854, 853, 852, 85, 1, 850, 849, 836, 827, 837, 824, 820, 800, 801, 786, 805, 809, 816, 817, 810, 806, 789, 788, 787, 747, 748, 749, 750, 751, 75, 3, 752, 790, 811, 818, 828, 829, 830, 831, 821, 807, 835, 834, 833, 832, 819, 812, 758, 757, 756, 754, 791, 792, 793, 79, 4, 795, 796, 797, 707, 742, 741, 740, 739, 725, 724, 705, 704, 614, 629, 610, 611, 601, 561, 600, 599, 598, 596, 597, 609, 60, 8, 616, 620, 631, 637, 633, 630, 615, 594, 593, 592, 591, 590, 589, 588, 587, 586, 585, 584, 583, 582, 581, 607, 606, 580, 52, 9, 545, 544, 543, 542, 541, 540, 539, 538, 537, 536, 534, 528, 526, 517, 472, 463, 524, 511, 497, 486, 477, 464, 512, 49, 8, 487, 478, 465, 513, 499, 488, 479, 466, 514, 500, 455, 468, 469, 470, 481, 491, 503, 518, 525, 546, 547, 548, 549, 550, 55, 1, 552, 553, 554, 555, 556, 557, 558, 559, 560, 530, 523, 508, 522, 507, 495, 485, 475, 484, 494, 506, 521, 474, 483, 493, 50, 5, 520, 473, 482, 492, 504, 519, 471, 490, 502, 516, 515, 501, 467, 454, 480, 489, 447, 448, 449, 368, 367, 366, 365, 362, 36, 1, 360, 425, 394, 390, 403, 421, 422, 409, 404, 391, 364, 363, 354, 353, 352, 351, 348, 332, 326, 279, 278, 277, 276, 275, 27, 4, 273, 301, 285, 244, 157, 129, 96, 154, 165, 210, 178, 177, 176, 219, 220, 238, 239, 221, 228, 229, 240, 255, 256, 241, 230, 222, 212, 211, 181, 180, 179, 164, 153, 150, 162, 143, 139, 122, 125, 120, 92, 93, 94, 95, 79, 69, 75, 66, 58, 57, 18, 24, 25, 2, 26, 49, 27, 28, 4, 29, 50, 30, 6, 31, 7, 8, 32, 51, 33, 9, 34, 10, 11, 41, 42, 43, 53, 44, 45, 17, 46, 19, 47, 48, 35, 52, 36, 56, 65, 61, 64, 72, 73, 74, 82, 83, 76, 87, 77, 88, 84, 116, 115, 114, 113, 112, 111, 110, 109, 108, 107, 106, 140, 167, 1, 56, 171, 166, 155, 101, 100, 99, 98, 97, 70, 80, 85, 71, 81, 86, 102, 117, 103, 104, 105, 123, 124, 135, 142, 134, 133, 141, 1, 58, 159, 168, 172, 249, 233, 247, 248, 234, 218, 217, 216, 190, 191, 192, 193, 194, 3, 5, 12, 13, 14, 37, 38, 39, 40, 15, 16, 20, 0]

Cost: 4644.101381584799



샘플 분석 – Hill Climbing Algorithm data3

```
Jupyter TSP_HillClimbing (autosaved) [Log]
File Edit View Insert Cell Kernel Widgets Help Trusted Python
[Icons] + < > Run C Code v [Icon]

start_time = time.time()
# Step 2
path_map, path = initialize(coord_list, FIRST_IDX)

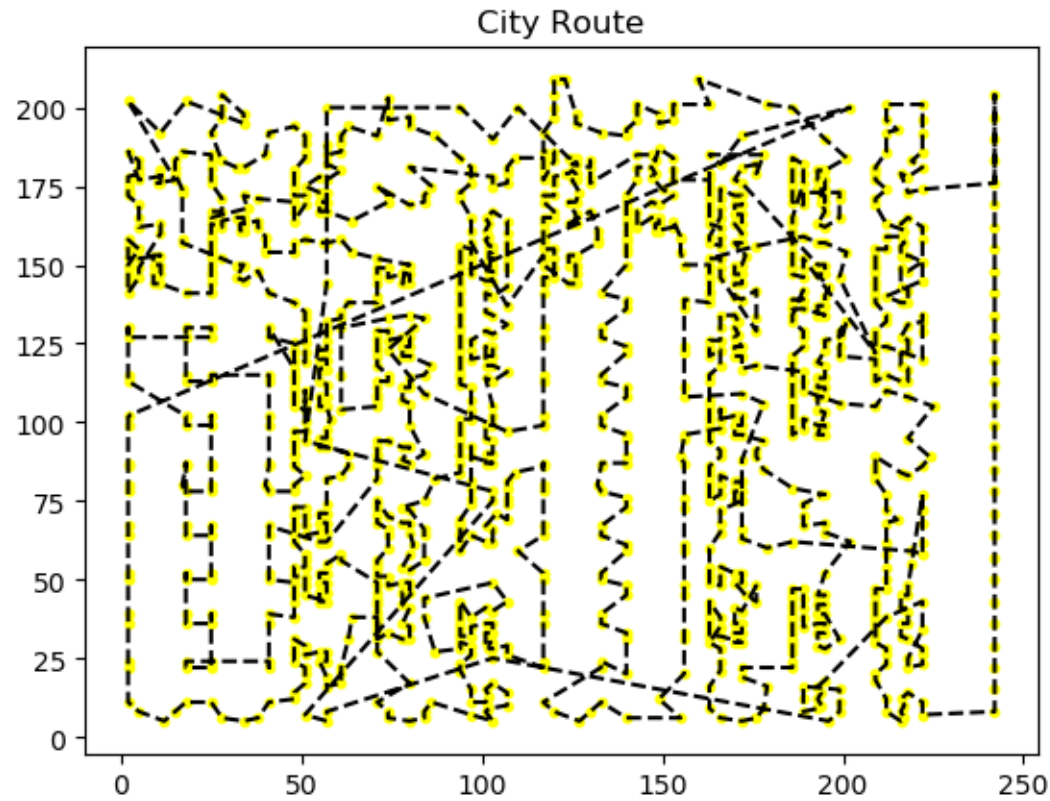
# Step 3
best_path, best_cost = hill_climbing(path_map, path, coord_list)

print('Execution Time: ' + str(time.time() - start_time))
print('Path: ' + str(best_path.tolist()))
print('Cost: ' + str(best_cost))

Execution Time: 43.05897378921509
Path: [0, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 1, 49, 70, 75, 83, 103, 153, 172, 178, 186, 215, 221, 281, 288,
289, 236, 237, 238, 239, 240, 291, 290, 317, 338, 371, 370, 337, 316, 368, 360, 395, 400, 401, 407, 412, 442, 441, 440, 439, 4
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7, 628, 629, 630, 631, 632, 633, 634, 571, 635, 636, 637, 639, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 58
4, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 648, 647, 646, 644, 643, 676, 696, 722, 72
3, 697, 698, 724, 725, 699, 700, 726, 727, 701, 678, 702, 679, 703, 680, 728, 762, 761, 760, 759, 758, 757, 756, 755, 721, 67
5, 674, 720, 752, 719, 673, 642, 641, 640, 671, 693, 717, 718, 694, 672, 670, 692, 716, 751, 715, 669, 714, 713, 748, 712, 69
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8, 739, 557, 556, 569, 607, 608, 656, 655, 606, 605, 645, 638, 668, 695, 677, 729, 754, 750, 710, 687, 740, 661, 565, 563, 55
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466, 467, 490, 507, 519, 547, 506, 546, 564, 548, 520, 491, 492, 508, 521, 522, 552, 566, 523, 509, 493, 494, 510, 524, 525, 5
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5, 798, 799, 826, 827, 828, 838, 845, 853, 864, 863, 852, 869, 862, 851, 844, 861, 860, 850, 843, 871, 879, 878, 877, 859, 84
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8
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[illegible]

샘플 분석 – Hill Climbing Algorithm data3



느낀점

- 처음 greedy algorithm을 접했을 때는 너무나도 당연해 보였고 단순해서 실생활에 적용되는 예시는 없다고 생각했다.
- 위 예시와 같이 real world에서는 오히려 NP hard인 경우가 많아서 Greedy 방식이 오히려 훌륭한 접근 방법이 될 수 있다는 것을 깨달았다.
- 또한 best answer을 찾는 것 보다는 time을 줄이면서 optimal한 solution을 찾는 방식이 실제로 더 의미있는 접근이라는 것을 느꼈다.

알고리즘 개선 – Greedy Algorithm

- for idx in range(len(nearest_list)):
- Nearest city에서 가까운 도시들은 순차적으로 탐색하는 부분인데 nearest_list 의 length가 언제나 cnt_cities로 고정임에도 불구하고 len 함수를 이용해서 구해주었기 때문에
- for idx in range(cnt_cities): 로 바꾸어 주었다.
- Path 와 best cost는 동일하므로 생략!

Greedy Time improvement for data 1,2,3

Execution Time: 1.355379581451416

Path: [8, 9, 3, 2, 1, 7, 6, 20, 21, 35, 34, 33, 32, 31, 30, 19, 29, 28, 27, 18, 26, 25, 16, 15, 14, 13, 5, 0, 11, 17, 24, 45, 46, 47, 48, 49, 50, 51, 36, 37, 22, 38, 39, 40, 41, 23, 42, 43, 10, 58, 59, 60, 57, 56, 55, 61, 64, 68, 65, 62, 66, 70, 75, 6, 9, 54, 53, 44, 52, 63, 67, 74, 77, 80, 81, 78, 79, 71, 72, 85, 84, 83, 82, 87, 86, 76, 73, 12, 4, 88, 92, 91, 93, 98, 89, 90, 94, 95, 96, 102, 103, 110, 109, 108, 107, 106, 101, 100, 99, 97, 104, 105, 112, 123, 113, 117, 120, 111, 122, 129, 124, 125, 14, 118, 115, 119, 116, 121, 128, 127, 126, 130, 8]

Cost: 817.165980543512

Execution Time: 1.80916428565979

Path: [8, 32, 51, 33, 9, 34, 10, 11, 35, 52, 12, 36, 56, 37, 13, 14, 38, 39, 40, 15, 41, 42, 43, 53, 16, 44, 45, 61, 64, 65, 7, 2, 73, 74, 86, 81, 71, 7, 31, 6, 30, 50, 29, 4, 28, 3, 27, 49, 26, 2, 25, 24, 18, 57, 58, 70, 80, 85, 99, 100, 101, 102, 117, 103, 104, 105, 106, 107, 108, 82, 83, 76, 87, 77, 46, 17, 19, 47, 48, 20, 21, 0, 22, 54, 59, 84, 112, 111, 110, 109, 124, 123, 133, 141, 134, 142, 135, 140, 156, 167, 158, 159, 172, 168, 160, 161, 113, 114, 115, 116, 88, 89, 90, 91, 118, 119, 127, 130,

Execution Time: 2.1284632682800293

Path: [8, 9, 7, 38, 39, 10, 11, 12, 13, 40, 41, 14, 15, 16, 17, 53, 52, 56, 51, 55, 61, 50, 54, 60, 6, 62, 57, 63, 64, 65, 42, 43, 44, 18, 19, 20, 21, 22, 45, 46, 58, 66, 59, 67, 68, 71, 78, 79, 77, 76, 88, 108, 109, 110, 111, 112, 113, 114, 115, 116, 1, 17, 118, 119, 120, 121, 122, 123, 124, 146, 145, 144, 155, 158, 164, 154, 163, 174, 179, 180, 181, 182, 165, 159, 160, 166, 15, 6, 161, 167, 147, 148, 125, 126, 127, 128, 72, 73, 74, 47, 48, 23, 69, 80, 129, 149, 157, 162, 169, 168, 173, 176, 175, 177, 2, 25, 224, 223, 222, 191, 107, 87, 86, 5, 4, 3, 2, 85, 84, 106, 105, 104, 82, 101, 102, 143, 0, 37, 36, 35, 34, 33, 100, 99, 14, 2, 141, 140, 139, 81, 98, 97, 96, 138, 137, 184, 202, 203, 204, 185, 187, 188, 189, 190, 220, 278, 277, 276, 275, 219, 218, 21

실제로 실행시간이 상당히 짧아진 것을 볼 수 있다.

알고리즘 개선 – Greedy Algorithm

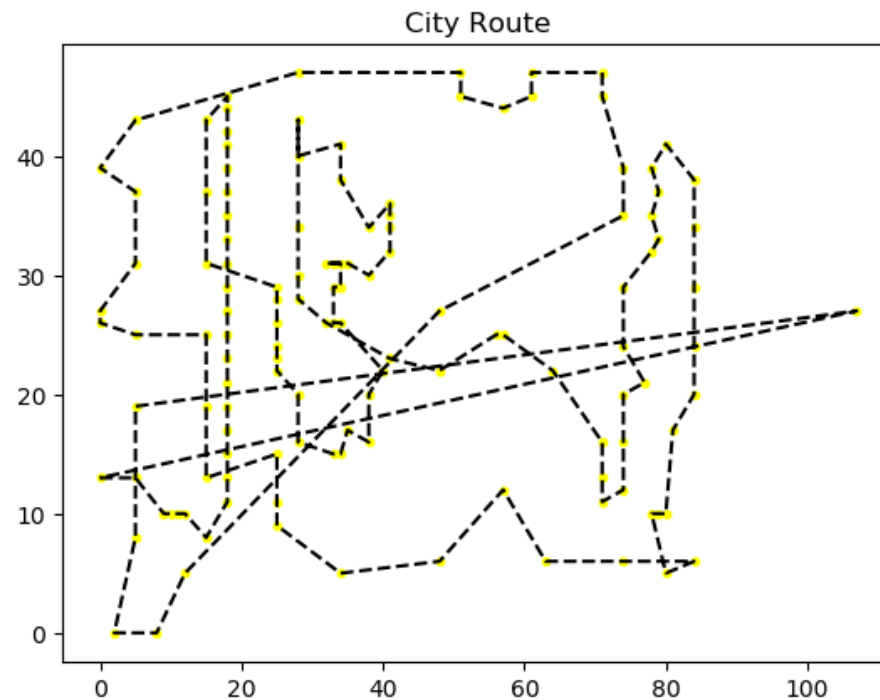
- Greedy한 접근방식으로 생각하다가 가장 가까운 점을 선택하는 방식이 아닌 가장 가까운 점과 그 점에서 갈 수 있는 가장 가까운 점을 선택하여 점은 2개씩 선택하는 방법을 시도
- 실제 간단한 test data를 만들어서 원인을 분석해본 결과 두개씩 선택해나갈 경우 상당히 비효율적인 선택을 하는 경우가 생겼다.
- 결론 : 1개씩 선택하는 것보다 좋지않은 결과물 도출

Greedy efficiency improve data 1

Execution Time: 1.6196608543395996

Path: [0, 5, 13, 14, 15, 16, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 23, 22, 21, 51, 5, 0, 49, 48, 47, 46, 54, 53, 63, 67, 74, 76, 77, 80, 68, 64, 65, 69, 70, 66, 62, 75, 78, 82, 83, 84, 85, 79, 71, 72, 58, 59, 57, 56, 55, 61, 81, 86, 91, 93, 98, 101, 100, 99, 104, 105, 106, 112, 107, 108, 114, 118, 115, 119, 116, 121, 128, 127, 126, 125, 124, 123, 120, 117, 113, 122, 129, 111, 97, 92, 88, 73, 52, 44, 45, 18, 19, 20, 7, 1, 2, 8, 9, 3, 10, 60, 90, 89, 94, 95, 96, 103, 102, 110, 109, 87, 17, 12, 4, 11, 6, 130, 0]

Cost: 1241.8468105543288

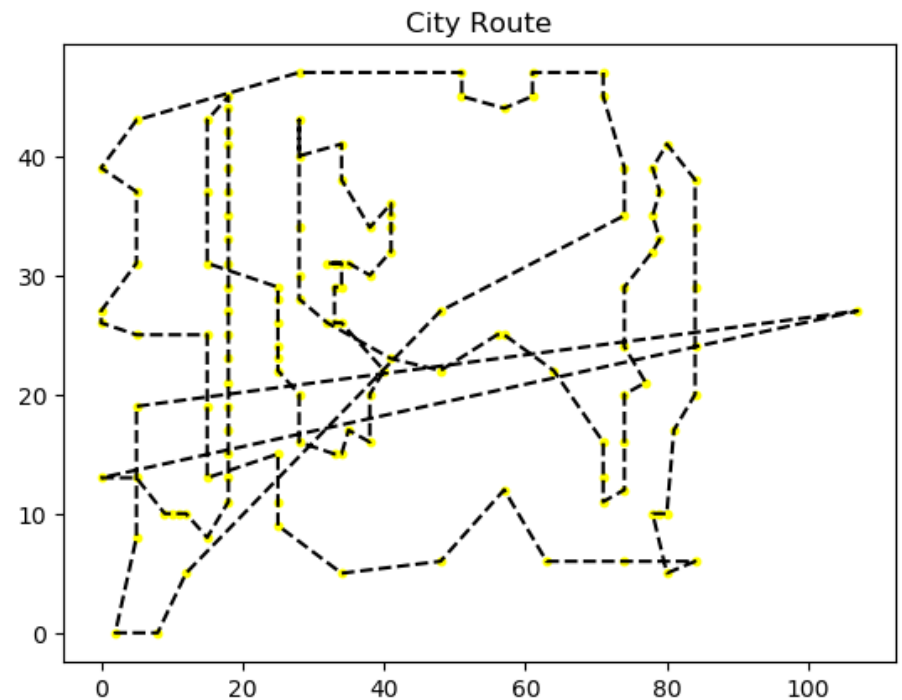


Greedy efficiency improve data 2

Execution Time: 35.14808773994446

Path: [0, 22, 21, 23, 1, 55, 54, 60, 62, 68, 67, 78, 63, 91, 90, 118, 119, 131, 137, 136, 130, 148, 149, 144, 151, 152, 147, 1
46, 145, 138, 132, 128, 126, 121, 89, 88, 84, 77, 87, 113, 114, 115, 116, 112, 111, 110, 109, 108, 107, 106, 105, 123, 124, 13
4, 142, 141, 133, 158, 159, 172, 168, 196, 197, 198, 205, 199, 200, 201, 202, 203, 204, 173, 206, 225, 235, 236, 226, 227, 23
7, 250, 253, 252, 251, 263, 224, 207, 208, 175, 174, 170, 163, 169, 161, 160, 135, 156, 167, 192, 193, 194, 195, 218, 217, 21
6, 215, 232, 245, 246, 247, 248, 234, 233, 249, 260, 259, 258, 257, 243, 231, 242, 223, 214, 184, 185, 186, 183, 182, 212, 21
1, 181, 180, 179, 210, 221, 228, 229, 240, 241, 230, 222, 213, 256, 255, 279, 278, 277, 276, 275, 274, 273, 301, 332, 326, 35
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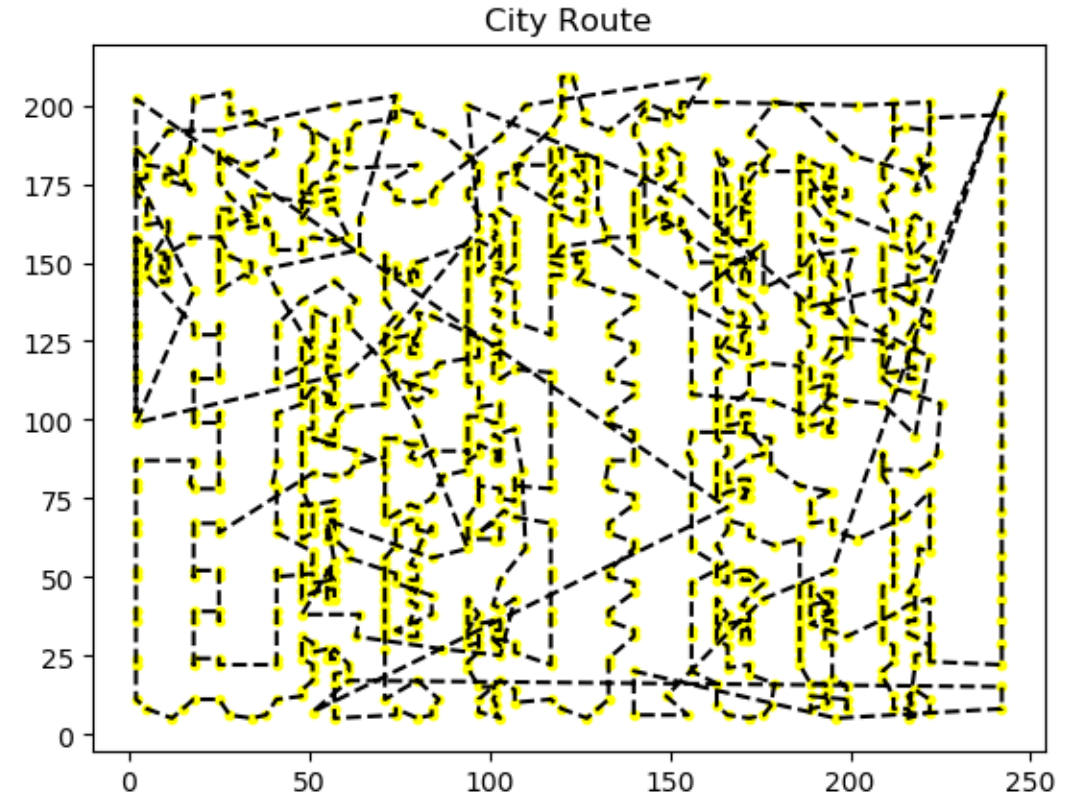
Cost: 7724.741645227165



Greedy efficiency improve data 3

- Execution Time: 119.09821057319641
- Cost: 11264.2433264461

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알고리즘 개선 – Hill Climbing

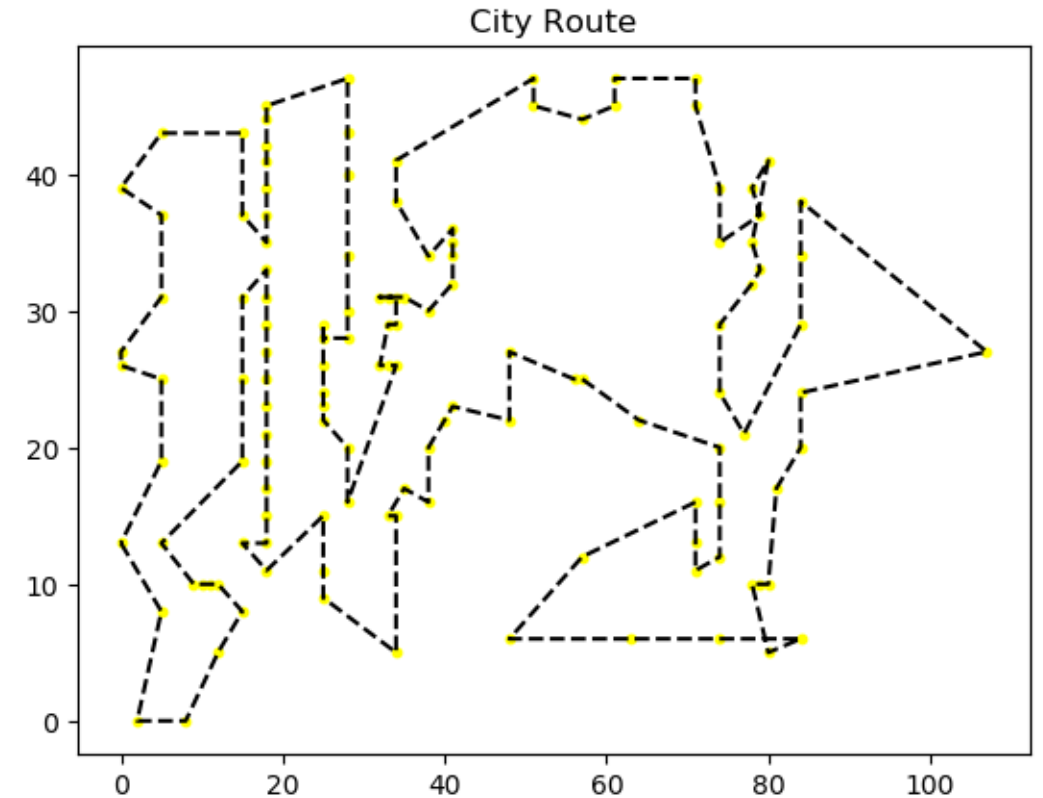
- Greedy와 마찬가지로 `len(nearest_list)` 부분이 언제나 같은 값임에도 불구하고 함수를 매번 호출하고 있기 때문에
- `Cnt_cities`로 그 값을 변화시켜 time reducing을 해준다.
- Random적 요소가 들어있기 때문에 fig는 생략하지 않는다.
- Greedy 에서도 효과가 있었기 때문에 HillClimbing 에서도 improvement가 똑같이 있을것이다.

HC Time improvement for data 1

Execution Time: 11.995994091033936

Path: [0, 11, 4, 12, 17, 24, 16, 15, 14, 13, 5, 19, 20, 21, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 18, 25, 45, 44, 52, 7
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Cost: 617.6693527856453

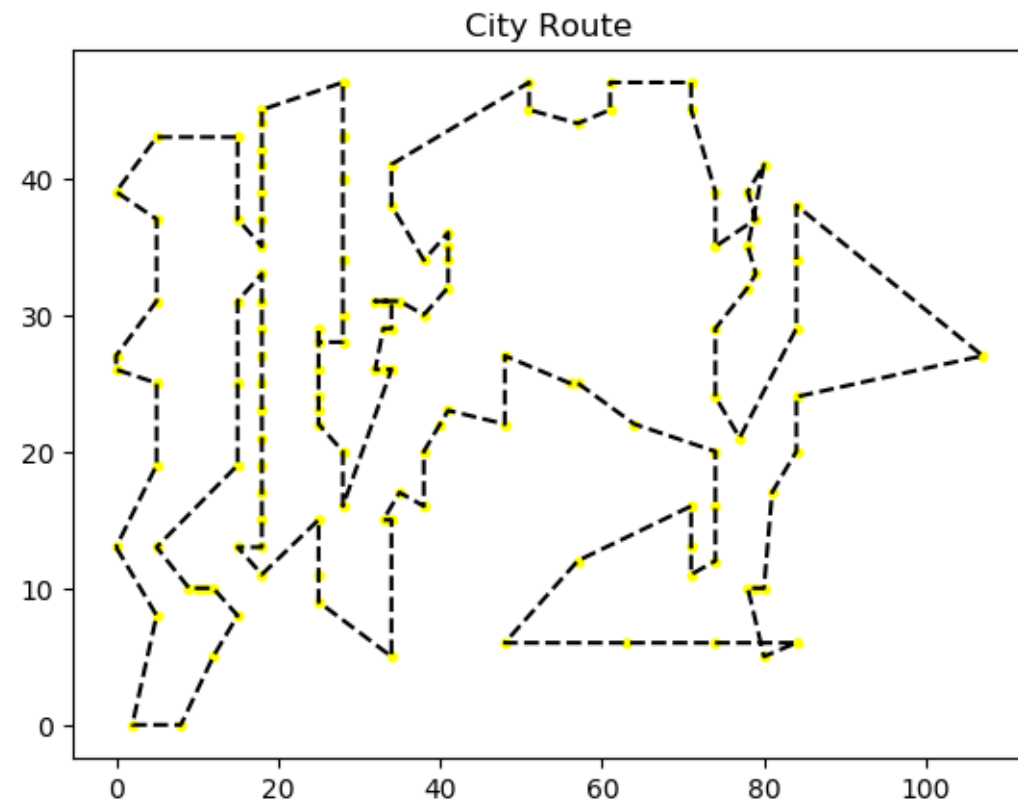


HC Time improvement for data 2

Execution Time: 19.850922107696533

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Cost: 4671.060069617785



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Execution Time: 36.023303747177124

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