

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

1887	1889	617
89	90	621
86	440	629
1821	1989	638
864	1004	642
1555	1972	642
1691	1983	643
1908	1992	650
1855	1990	652
1463	1464	666
541	1923	669
87	516	693
20	513	733
656	1937	733
1696	1824	740
1749	1987	742
1001	1890	774
706	1004	779
865	866	780
1637	1908	780
83	90	842
565	1927	999
1674	1982	1013
798	1943	1031
1347	1967	1032
1593	1927	1178
1091	1957	1205
22	96	1208
1395	1929	1252
83	487	1395
1890	1991	3703

Total distance with adjacency matrix: 371466

Memory use: 96.45 MB

neilinho@MacBookPro M1Max problem1 %

1887	1889	617
89	90	621
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The total distance for linked list is: 371466

Memory use: 61.91 MB

peilinha@MacBookPro_M1Max problem1 %

Merge Graph:

```
__Node object at 0x11d6bfb80>, <__main__Node object at 0x11d6bfd60>, <__main__Node object at 0x11d6c1640>, <__main__Node object at 0x11d6c1760>, <__main__Node object at 0x11d6c30a0>, <__main__Node object at 0x11d6c31c0>, <__main__Node object at 0x11d6c39a0>, <__main__Node object at 0x11d6c3b20>, <__main__Node object at 0x11d6c6400>, <__main__Node object at 0x11d6c6580>, <__main__Node object at 0x11d6c6e20>, <__main__Node object at 0x11d6c6fa0>, <__main__Node object at 0x11d6c8940>, <__main__Node object at 0x11d6c8ac0>, <__main__Node object at 0x11d6ca3a0>, <__main__Node object at 0x11d6ca580>, <__main__Node object at 0x11d6cae80>, <__main__Node object at 0x11d6cafa0>, <__main__Node object at 0x11d6cd8e0>, <__main__Node object at 0x11d6cda60>, <__main__Node object at 0x11d6ce460>, <__main__Node object at 0x11d6ce640>, <__main__Node object at 0x11d6cedc0>, <__main__Node object at 0x11d6d16a0>, <__main__Node object at 0x11d6d1820>, <__main__Node object at 0x11d6d3160>, <__main__Node object at 0x11d6d32e0>, <__main__Node object at 0x11d6d3b80>, <__main__Node object at 0x11d6d3d00>, <__main__Node object at 0x11d6d55e0>, <__main__Node object at 0x11d6d5760>, <__main__Node object at 0x11d6d8220>, <__main__Node object at 0x11d6d83a0>, <__main__Node object at 0x11d6d8b80>, <__main__Node object at 0x11d6d8d00>, <__main__Node object at 0x11d6da640>, <__main__Node object at 0x11d6da7d0>, <__main__Node object at 0x11d6dafa0>, <__main__Node object at 0x11d6dc820>, <__main__Node object at 0x11d6dc940>, <__main__Node object at 0x11d6de1c0>, <__main__Node object at 0x11d6de400>, <__main__Node object at 0x11d6deca0>, <__main__Node object at 0x11d6dedc0>, <__main__Node object at 0x11d6e14c0>, <__main__Node object at 0x11d6e15e0>, <__main__Node object at 0x11d6e1d60>, <__main__Node object at 0x11d6e1e80>, <__main__Node object at 0x11d6e3640>, <__main__Node object at 0x11d6e3760>, <__main__Node object at 0x11d6e3dc0>, <__main__Node object at 0x11d6e3f80>, <__main__Node object at 0x11d6e5580>, <__main__Node object at 0x11d6e56a0>, <__main__Node object at 0x11d6e5ca0>, <__main__Node object at 0x11d6e5d60>, <__main__Node object at 0x11d6e83a0>, <__main__Node object at 0x11d6e84c0>, <__main__Node object at 0x11d6e8b80>, <__main__Node object at 0x11d6e8ca0>, <__main__Node object at 0x11d6e9220>, <__main__Node object at 0x11d6e9340>, <__main__Node object at 0x11d6e9940>, <__main__Node object at 0x11d6e9a60>, <__main__Node object at 0x11d6ec0a0>, <__main__Node object at 0x11d6ec1c0>, <__main__Node object at 0x11d6ec760>, <__main__Node object at 0x11d6ec880>, <__main__Node object at 0x11d6ece20>, <__main__Node object at 0x11d6ecee0>, <__main__Node object at 0x11d6ef000>
```

Memory use: 98.17 MB

peilinha@MacBookPro_M1Max problem1 %

The analysis of the memory usage:

The memory usage of adjacency matrix is 96.45MB and the usage of linked list is 61.91MB.

Because for a Graph (V, E) , the space complexity using two-dimensional matrix is $O(n^2)$, the space complexity using linked list is $O(n)$. Using linked list use much less memory than using adjacency matrix, especially when the number of nodes is huge, and graph is sparse. The linked list can only store existing edges, but adjacency list must store n^2 edges even if there is no edge between two nodes.