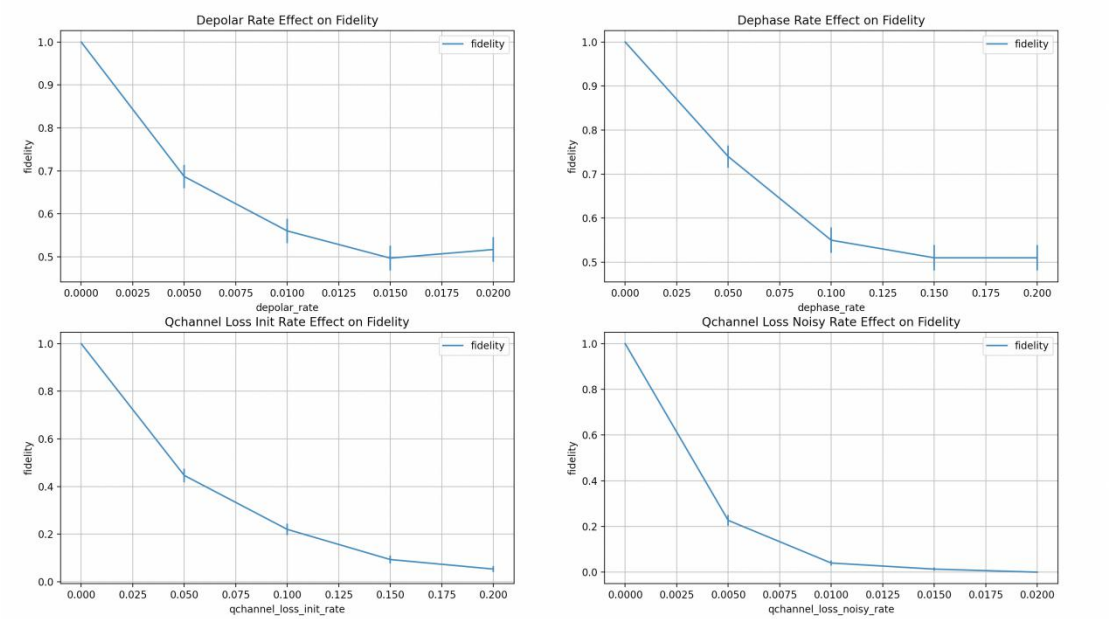
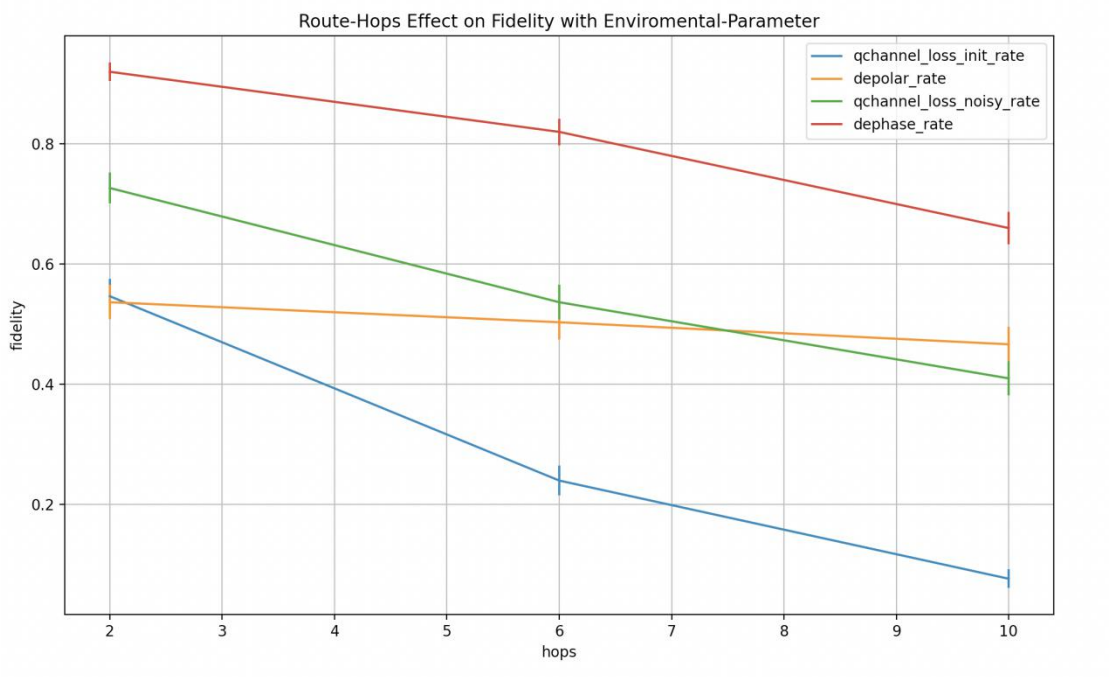
environmental_parameter_effect_test.py



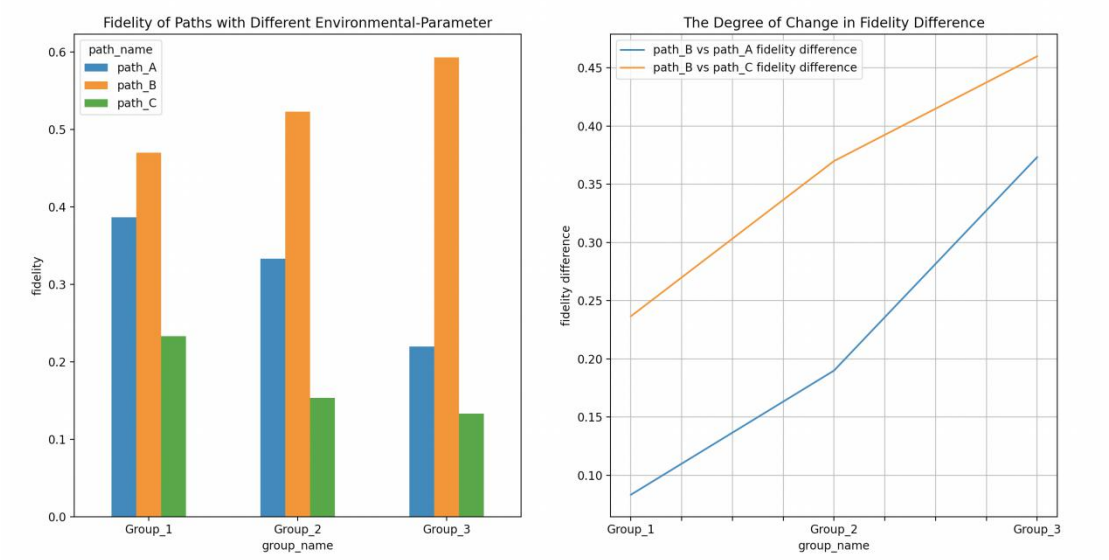

```
depolar_rate fidelity
   depolar_rate  fidelity       sem
0         0.000  1.000000  0.000000
1         0.005  0.686667  0.026825
2         0.010  0.560000  0.028707
3         0.015  0.496667  0.028915
4         0.020  0.516667  0.028900
dephase_rate fidelity
   dephase_rate  fidelity       sem
0          0.00      1.00  0.000000
1          0.05      0.74  0.025367
2          0.10      0.55  0.028771
3          0.15      0.51  0.028910
4          0.20      0.51  0.028910
qchannel_loss_init_rate fidelity
   qchannel_loss_init_rate  fidelity       sem
0                     0.00  1.000000  0.000000
1                     0.05  0.446667  0.028751
2                     0.10  0.220000  0.023956
3                     0.15  0.093333  0.016823
4                     0.20  0.053333  0.012995
qchannel_loss_noisy_rate fidelity
   qchannel_loss_noisy_rate  fidelity       sem
0                     0.000  1.000000  0.000000
1                     0.005  0.226667  0.024213
2                     0.010  0.040000  0.011333
3                     0.015  0.013333  0.006633
4                     0.020  0.000000  0.000000
```

route_hops_effect_test.py



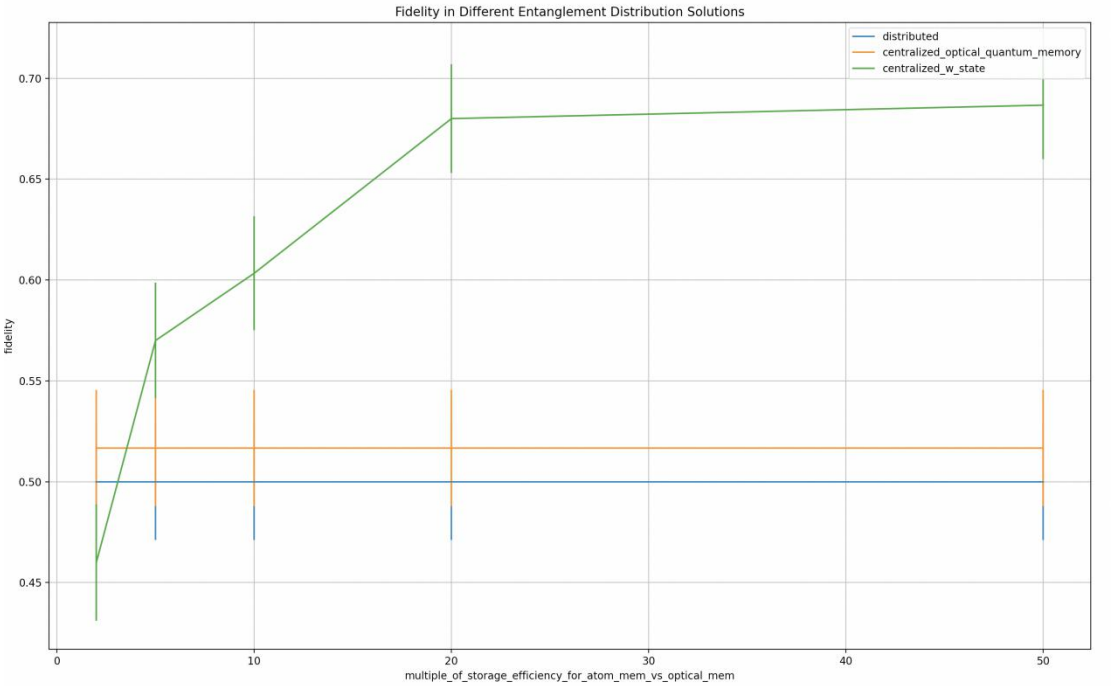

```
qchannel_loss_init_rate(fidelity)
   hops  fidelity       sem
0     2  0.546667  0.028790
1     6  0.240000  0.024699
2    10  0.076667  0.015387
depolar_rate(fidelity)
   hops  fidelity       sem
0     2  0.536667  0.028838
1     6  0.503333  0.028915
2    10  0.466667  0.028851
qchannel_loss_noisy_rate(fidelity)
   hops  fidelity       sem
0     2  0.726667  0.025774
1     6  0.536667  0.028838
2    10  0.410000  0.028443
dephase_rate(fidelity)
   hops  fidelity       sem
0     2      0.92  0.015689
1     6      0.82  0.022218
2    10      0.66  0.027395
```

path_with_different_environmental_parameter_effect_test.py




```
fidelity data
path_name     path_A    path_B    path_C
group_name
Group_1     0.386667  0.470000  0.233333
Group_2     0.333333  0.523333  0.153333
Group_3     0.220000  0.593333  0.133333

group_1_sem,path_A,path_B,path_C
0    0.028163
1    0.028864
2    0.024460
Name: sem, dtype: float64

group_2_sem,path_A,path_B,path_C
0    0.027262
1    0.028884
2    0.020837
Name: sem, dtype: float64

group_3_sem,path_A,path_B,path_C
0    0.023956
1    0.028408
2    0.019659
Name: sem, dtype: float64

fidelity_difference_data_path_B_vs_path_A
  group_name  fidelity_difference
0    Group_1             0.083333
1    Group_2             0.190000
2    Group_3             0.373333

fidelity_difference_data_path_B_vs_path_C
  group_name  fidelity_difference
0    Group_1             0.236667
1    Group_2             0.370000
2    Group_3             0.460000
```

entanglement_distribution_solution_test.py

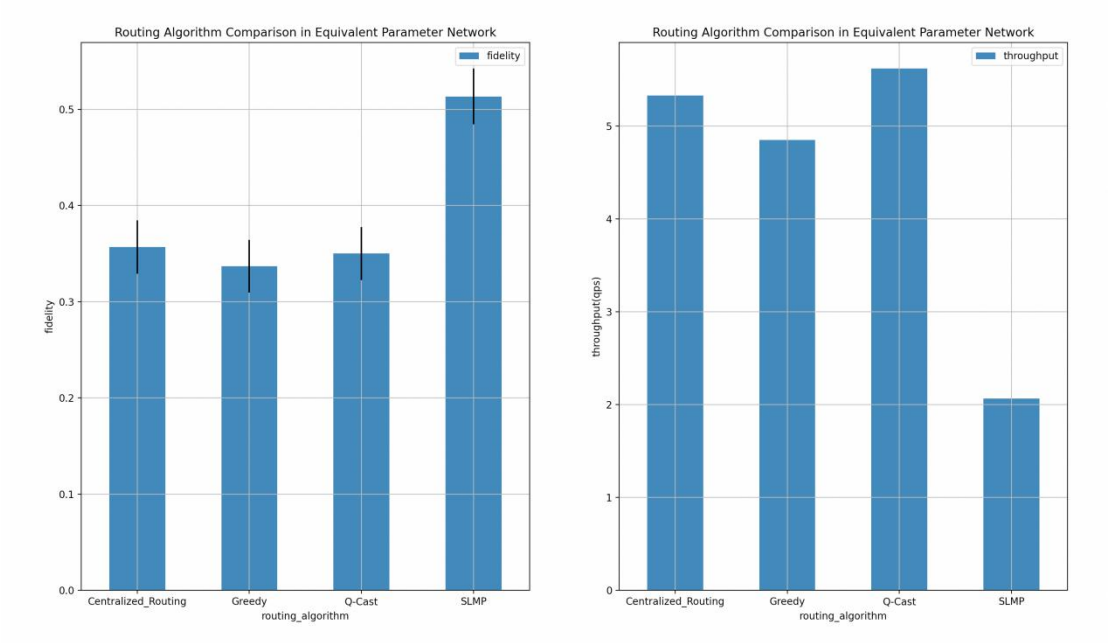


	multiple_of_storage_efficiency_for_atom_mem_vs_optical_mem	fidelity	sem
0	2	0.5	0.028916
1	5	0.5	0.028916
2	10	0.5	0.028916
3	20	0.5	0.028916
4	50	0.5	0.028916

	multiple_of_storage_efficiency_for_atom_mem_vs_optical_mem	fidelity	sem
0	2	0.516667	0.0289
1	5	0.516667	0.0289
2	10	0.516667	0.0289
3	20	0.516667	0.0289
4	50	0.516667	0.0289

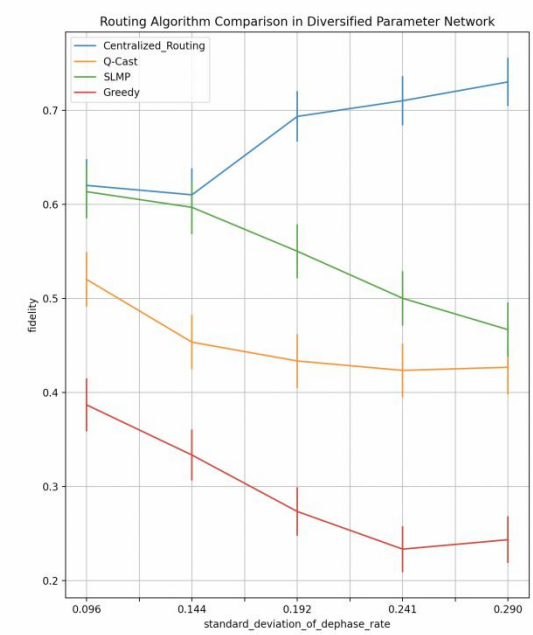
	multiple_of_storage_efficiency_for_atom_mem_vs_optical_mem	fidelity	sem
0	2	0.460000	0.028823
1	5	0.570000	0.028631
2	10	0.603333	0.028291
3	20	0.680000	0.026977
4	50	0.686667	0.026825

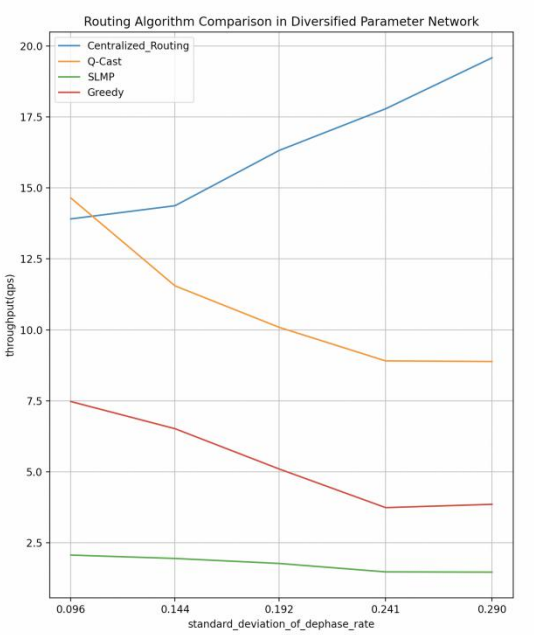
routing_algorithm_comparison_equivalent_parameter_network.py




```
#### Complete to teleport target qubit ####
     routing_algorithm  fidelity       sem
0  Centralized_Routing  0.356667  0.027702
1              Greedy  0.336667  0.027329
2              Q-Cast  0.350000  0.027584
3                SLMP  0.513333  0.028905
     routing_algorithm  entanglement_pair_consumption
0  Centralized_Routing                      5.000000
1              Greedy                      5.000000
2              Q-Cast                      5.076667
3                SLMP                     33.000000
     routing_algorithm  throughput
0  Centralized_Routing    5.332356
1              Greedy    4.851366
2              Q-Cast    5.621357
3                SLMP    2.065394
```

routing_algorithm_comparison_diversified_parameter_network_dephase.py



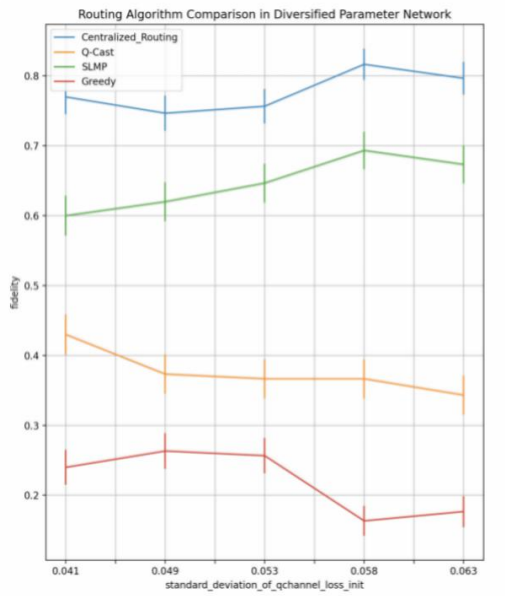


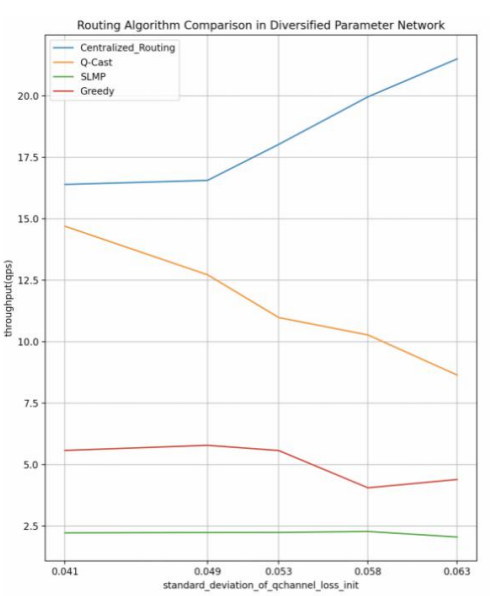

```
  standard_deviation_of_dephase_rate  fidelity       sem
0                              0.096  0.620000  0.028071
1                              0.144  0.610000  0.028207
2                              0.192  0.693333  0.026667
3                              0.241  0.710000  0.026242
4                              0.290  0.730000  0.025675
  standard_deviation_of_dephase_rate  fidelity       sem
0                              0.096  0.520000  0.028893
1                              0.144  0.453333  0.028790
2                              0.192  0.433333  0.028658
3                              0.241  0.423333  0.028574
4                              0.290  0.426667  0.028603
  standard_deviation_of_dephase_rate  fidelity       sem
0                              0.096  0.613333  0.028163
1                              0.144  0.596667  0.028370
2                              0.192  0.550000  0.028771
3                              0.241  0.500000  0.028916
4                              0.290  0.466667  0.028851
  standard_deviation_of_dephase_rate  fidelity       sem
0                              0.096  0.386667  0.028163
1                              0.144  0.333333  0.027262
2                              0.192  0.273333  0.025774
3                              0.241  0.233333  0.024460
4                              0.290  0.243333  0.024815
  standard_deviation_of_dephase_rate  entanglement_pair_consumption
0                              0.096                           6.0
1                              0.144                           6.0
2                              0.192                           6.0
3                              0.241                           6.0
4                              0.290                           6.0
  standard_deviation_of_dephase_rate  entanglement_pair_consumption
0                              0.096                      5.030000
1                              0.144                      5.056667
2                              0.192                      5.030000
3                              0.241                      5.033333
4                              0.290                      5.036667
  standard_deviation_of_dephase_rate  entanglement_pair_consumption
0                              0.096                          33.0
1                              0.144                          33.0
2                              0.192                          33.0
3                              0.241                          33.0
4                              0.290                          33.0
  standard_deviation_of_dephase_rate  entanglement_pair_consumption
0                              0.096                           5.0
1                              0.144                           5.0
2                              0.192                           5.0
3                              0.241                           5.0
4                              0.290                           5.0
```

```
   standard_deviation_of_dephase_rate  throughput
0                               0.096   13.906511
1                               0.144   14.371614
2                               0.192   16.318798
3                               0.241   17.784659
4                               0.290   19.580231
   standard_deviation_of_dephase_rate  throughput
0                               0.096   14.646480
1                               0.144   11.550459
2                               0.192   10.089395
3                               0.241    8.907182
4                               0.290    8.887015
   standard_deviation_of_dephase_rate  throughput
0                               0.096    2.071390
1                               0.144    1.952029
2                               0.192    1.775634
3                               0.241    1.479225
4                               0.290    1.470419
   standard_deviation_of_dephase_rate  throughput
0                               0.096    7.477342
1                               0.144    6.521250
2                               0.192    5.101319
3                               0.241    3.741859
4                               0.290    3.858137
```

```
Centralized_Routing Time Cost:
0.003710651397705078
Q-Cast Time Cost:
0.0009645462036132812
SLMP Time Cost:
0.138844557762146
Greedy Time Cost:
0.00014524459838867189
```

routing_algorithm_comparison_diversified_parameter_network_loss_init.py



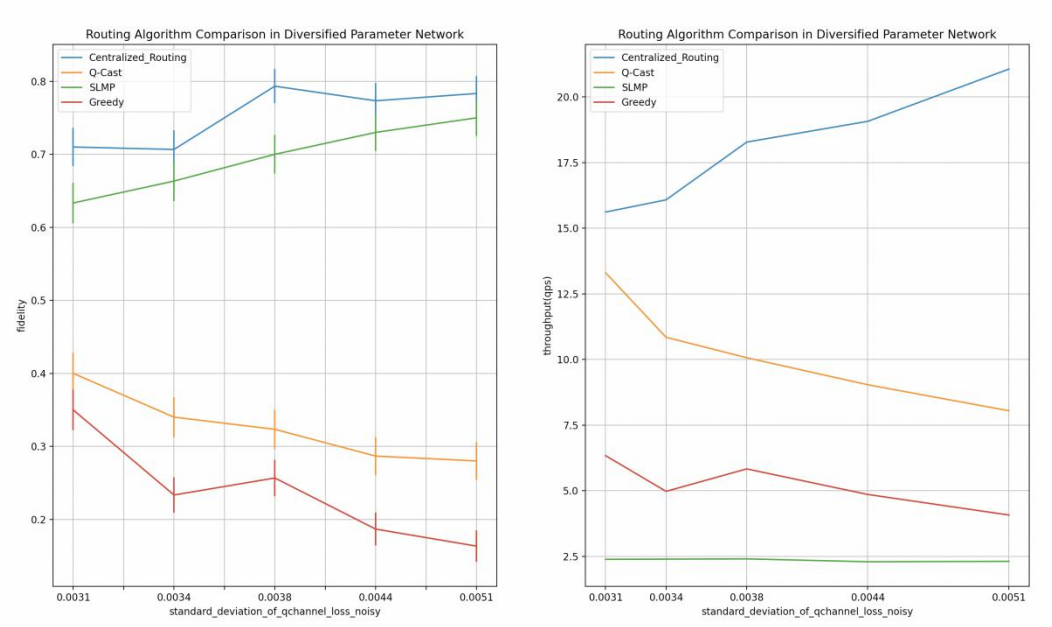



```
  standard_deviation_of_qchannel_loss_init  fidelity       sem
0                                    0.041  0.770000  0.024337
1                                    0.049  0.746667  0.025152
2                                    0.053  0.756667  0.024815
3                                    0.058  0.816667  0.022377
4                                    0.063  0.796667  0.023276
  standard_deviation_of_qchannel_loss_init  fidelity       sem
0                                    0.041  0.430000  0.028631
1                                    0.049  0.373333  0.027972
2                                    0.053  0.366667  0.027869
3                                    0.058  0.366667  0.027869
4                                    0.063  0.343333  0.027460
  standard_deviation_of_qchannel_loss_init  fidelity       sem
0                                    0.041  0.600000  0.028332
1                                    0.049  0.620000  0.028071
2                                    0.053  0.646667  0.027644
3                                    0.058  0.693333  0.026667
4                                    0.063  0.673333  0.027123
  standard_deviation_of_qchannel_loss_init  fidelity       sem
0                                    0.041  0.240000  0.024699
1                                    0.049  0.263333  0.025471
2                                    0.053  0.256667  0.025260
3                                    0.058  0.163333  0.021379
4                                    0.063  0.176667  0.022056
  standard_deviation_of_qchannel_loss_init  entanglement_pair_consumption
0                                    0.041                            6.0
1                                    0.049                            6.0
2                                    0.053                            6.0
3                                    0.058                            6.0
4                                    0.063                            6.0
  standard_deviation_of_qchannel_loss_init  entanglement_pair_consumption
0                                    0.041                       5.103333
1                                    0.049                       5.180000
2                                    0.053                       5.166667
3                                    0.058                       5.200000
4                                    0.063                       5.226667
  standard_deviation_of_qchannel_loss_init  entanglement_pair_consumption
0                                    0.041                           33.0
1                                    0.049                           33.0
2                                    0.053                           33.0
3                                    0.058                           33.0
4                                    0.063                           33.0
  standard_deviation_of_qchannel_loss_init  entanglement_pair_consumption
0                                    0.041                            5.0
1                                    0.049                            5.0
2                                    0.053                            5.0
3                                    0.058                            5.0
4                                    0.063                            5.0
```

```
   standard_deviation_of_qchannel_loss_init  throughput
0                                    0.041   16.390104
1                                    0.049   16.554333
2                                    0.053   18.020632
3                                    0.058   19.953882
4                                    0.063   21.493634
   standard_deviation_of_qchannel_loss_init  throughput
0                                    0.041   14.691317
1                                    0.049   12.716881
2                                    0.053   10.975103
3                                    0.058   10.269451
4                                    0.063    8.638522
   standard_deviation_of_qchannel_loss_init  throughput
0                                    0.041    2.220766
1                                    0.049    2.234594
2                                    0.053    2.237709
3                                    0.058    2.277512
4                                    0.063    2.051153
   standard_deviation_of_qchannel_loss_init  throughput
0                                    0.041    5.570306
1                                    0.049    5.780579
2                                    0.053    5.566524
3                                    0.058    4.051498
4                                    0.063    4.389820
```

```
Centralized_Routing Time Cost:
0.0040203571319580075
Q-Cast Time Cost:
0.0009561061859130859
SLMP Time Cost:
0.13164684534072876
Greedy Time Cost:
0.0001415252685546875
```

routing_algorithm_comparison_diversified_parameter_network_loss_noisy.py



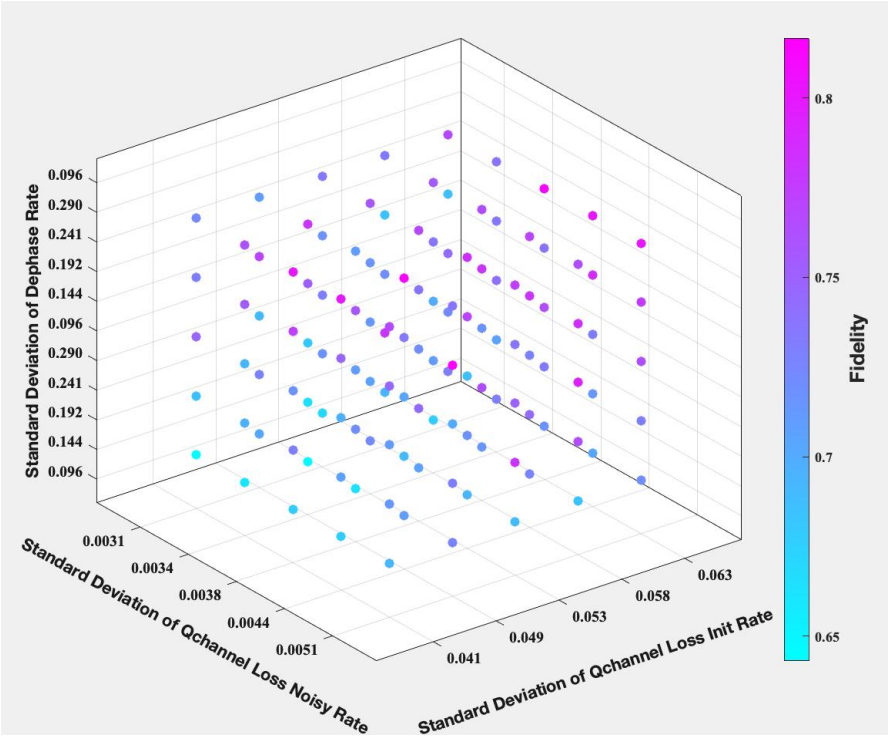

```
  standard_deviation_of_qchannel_loss_noisy  fidelity       sem
0                                    0.0031  0.710000  0.026242
1                                    0.0034  0.706667  0.026330
2                                    0.0038  0.793333  0.023417
3                                    0.0044  0.773333  0.024213
4                                    0.0051  0.783333  0.023825
  standard_deviation_of_qchannel_loss_noisy  fidelity       sem
0                                    0.0031  0.400000  0.028332
1                                    0.0034  0.340000  0.027395
2                                    0.0038  0.323333  0.027051
3                                    0.0044  0.286667  0.026152
4                                    0.0051  0.280000  0.025966
  standard_deviation_of_qchannel_loss_noisy  fidelity       sem
0                                    0.0031  0.633333  0.027869
1                                    0.0034  0.663333  0.027329
2                                    0.0038  0.700000  0.026502
3                                    0.0044  0.730000  0.025675
4                                    0.0051  0.750000  0.025042
  standard_deviation_of_qchannel_loss_noisy  fidelity       sem
0                                    0.0031  0.350000  0.027584
1                                    0.0034  0.233333  0.024460
2                                    0.0038  0.256667  0.025260
3                                    0.0044  0.186667  0.022534
4                                    0.0051  0.163333  0.021379
  standard_deviation_of_qchannel_loss_noisy  entanglement_pair_consumption
0                                    0.0031                           6.0
1                                    0.0034                           6.0
2                                    0.0038                           6.0
3                                    0.0044                           6.0
4                                    0.0051                           6.0
  standard_deviation_of_qchannel_loss_noisy  entanglement_pair_consumption
0                                    0.0031                      5.063333
1                                    0.0034                      5.136667
2                                    0.0038                      5.216667
3                                    0.0044                      5.273333
4                                    0.0051                      5.290000
  standard_deviation_of_qchannel_loss_noisy  entanglement_pair_consumption
0                                    0.0031                          33.0
1                                    0.0034                          33.0
2                                    0.0038                          33.0
3                                    0.0044                          33.0
4                                    0.0051                          33.0
  standard_deviation_of_qchannel_loss_noisy  entanglement_pair_consumption
0                                    0.0031                           5.0
1                                    0.0034                           5.0
2                                    0.0038                           5.0
3                                    0.0044                           5.0
4                                    0.0051                           5.0
  standard_deviation_of_qchannel_loss_noisy  throughput
0                                    0.0031   15.617347
1                                    0.0034   16.083621
2                                    0.0038   18.284055
3                                    0.0044   19.074036
4                                    0.0051   21.064401
  standard_deviation_of_qchannel_loss_noisy  throughput
0                                    0.0031   13.305993
1                                    0.0034   10.848833
2                                    0.0038   10.069599
3                                    0.0044    9.039730
4                                    0.0051    8.049529
  standard_deviation_of_qchannel_loss_noisy  throughput
0                                    0.0031    2.389133
1                                    0.0034    2.397641
2                                    0.0038    2.406712
3                                    0.0044    2.298262
4                                    0.0051    2.313359
  standard_deviation_of_qchannel_loss_noisy  throughput
0                                    0.0031    6.339000
1                                    0.0034    4.979334
2                                    0.0038    5.834878
3                                    0.0044    4.860543
4                                    0.0051    4.077622
```

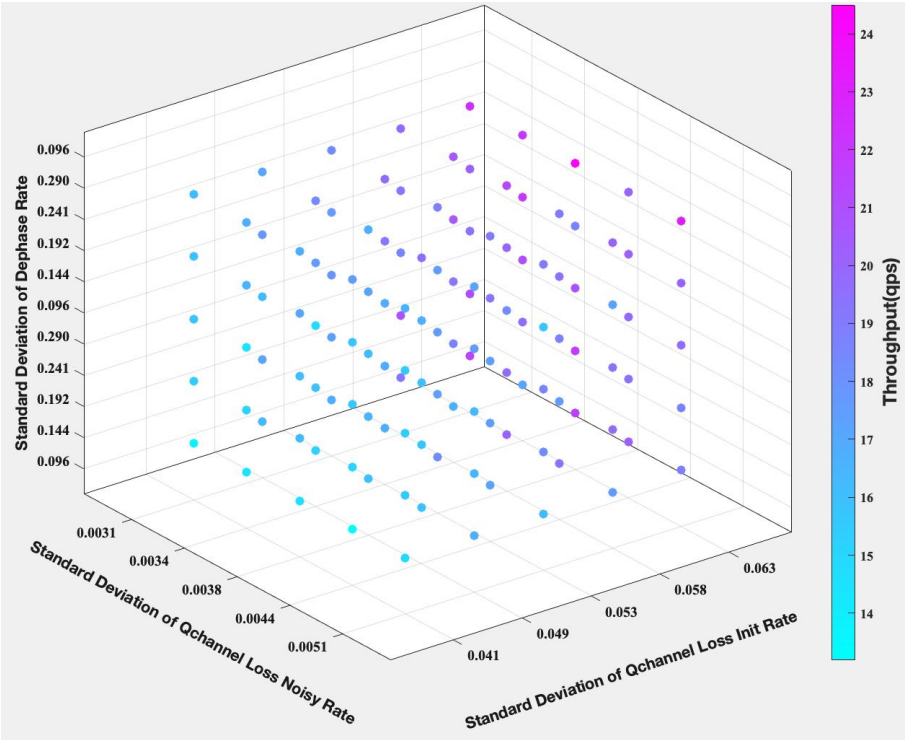
```
Centralized_Routing Time Cost:
0.0036687850952148438
Q-Cast Time Cost:
0.0009767532348632813
SLMP Time Cost:
0.1324252529144287
Greedy Time Cost:
0.00014963150024414063
```

3d_heat_map_centralized_routing.py

###
Because the data can only be grouped by one dimension, manually combine qchannel_loss_noisy and dephase_rates, and run the experiment 25 times to get data.

There is too much data for this experiment, so we only give the 3d heat map.
###





integrated_example.py

you can change the parameter here to obeserve the teleport result,depolar_rate(0~1),dephase_rate(0~1),qchannel_loss_init(0~1),qchannel_loss_noisy (0~n(No more than 0.2（noisy_limitation in this topo）is recommended),dB/km)

notice: this code set all devices parameter with same value, if you want different values in different devices ,you can define the arrays by yourself.

"""

there are some recommand values to check this programe:

if you want to see a success quantum communication example , please use the parameters:

```
for i in range(29):
    depolar_rates.append(0)
for i in range(29):
    dephase_rates.append(0)
for i in range(32):
    qchannel_loss_init.append(0)
for i in range(32):
    qchannel_loss_noisy.append(0)
```

if you want to see a how the distribution failed due to the bad link_state , please use the parameters:

```
for i in range(29):
    depolar_rates.append(0)
for i in range(29):
    dephase_rates.append(0)
for i in range(32):
    qchannel_loss_init.append(1)
for i in range(32):
    qchannel_loss_noisy.append(0.2)
```

if you want to see a how the swapping failed due to bad device parameter , please use the parameters:

```
for i in range(29):
    depolar_rates.append(1)
for i in range(29):
    dephase_rates.append(1)
for i in range(32):
    qchannel_loss_init.append(0)
for i in range(32):
    qchannel_loss_noisy.append(0)
```

if you want to see a relative random result , please use the parameters:

```
for i in range(29):
    depolar_rates.append(0.01)
for i in range(29):
    dephase_rates.append(0.01)
for i in range(32):
    qchannel_loss_init.append(0.01)
for i in range(32):
    qchannel_loss_noisy.append(0.001)
```

if you want to check how the routing algorithm(score evaluation) select the optimal path(not have to be shortest path) due to the parameter, please define the arrays with different values by yourself:

such as :

depolar_rates = [0.004,0.005,0.001,0.002,0.009,0.008,0.009,0.003,0.001,0.008,0.006,0.001,0.008,0.006,0.003,0.003,0.002,0.004,0.005,0.006,0.003,0.002,0.005,0.009,0.006,0.001,0.002,0.004,0.006]

dephase_rates = [0.09,0.35,0.03,0.03,0.35,0.35,0.11,0.03,0.03,0.09,0.03,0.03,0.02,0.14,0.07,0.02,0.03,0.04,0.02,0.05,0.06,0.02,0.09,0.04,0.03,0.03,0.05,0.06,0.07]

qchannel_loss_init = [0.008,0.021,0.002,0.001,0.002,0.002,0.017,0.008,0.015,0.020,0.030,0.002,0.003,0.005,0.002,0.024,0.004,0.006,0.008,0.007,0.002,0.047,0.010,0.053,0.003,0.002,0.008,0.002,0.004,0.034,0.011,0.001]

qchannel_loss_noisy = [0.0006,0.0004,0.0004,0.0003,0.0002,0.0003,0.0015,0.0005,0.0003,0.0022,0.0033,0.0001,0.0003,0.0003,0.0004,0.0026,0.0003,0.0004,0.0006,0.0004,0.0003,0.0046,0.0012,0.0057,0.0002,0.0001,0.0006,0.0005,0.0003,0.0035,0.0014,0.0001]

"""