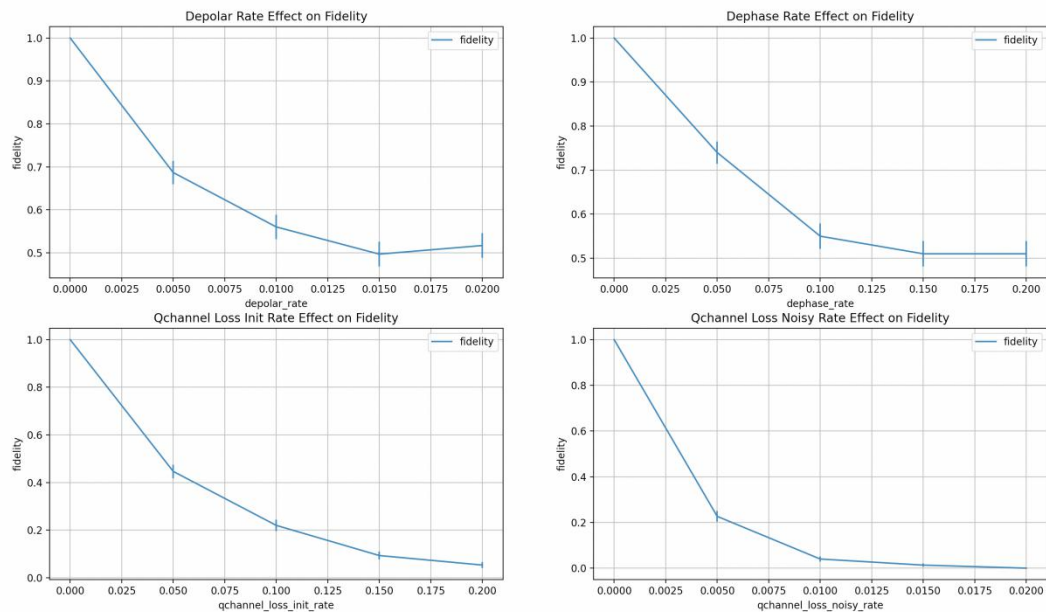


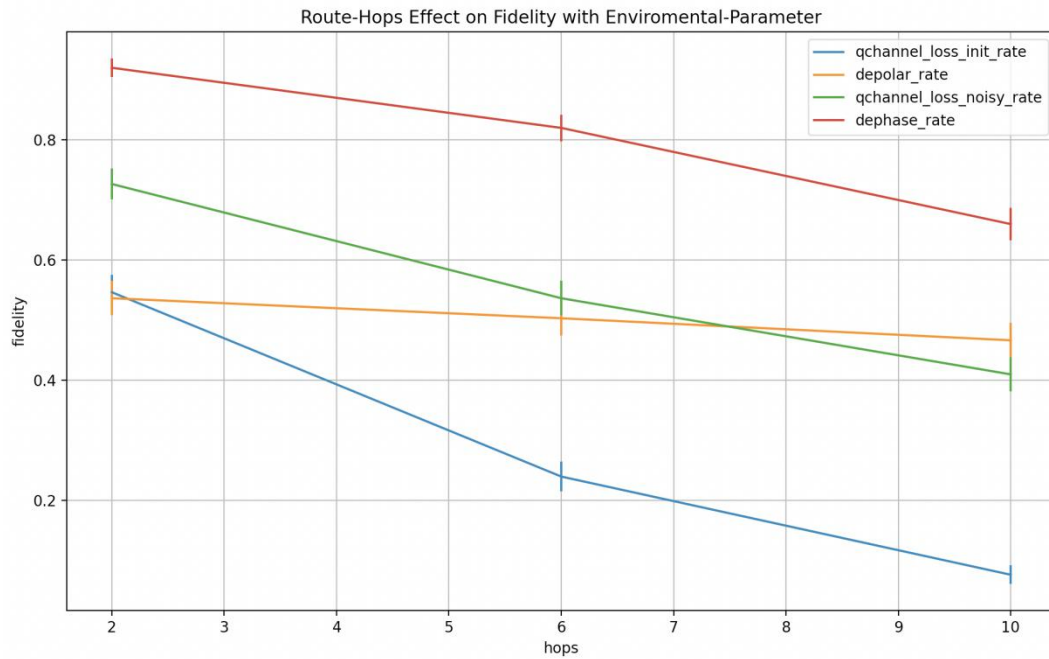
# environmental\_parameter\_effect\_test.py



```

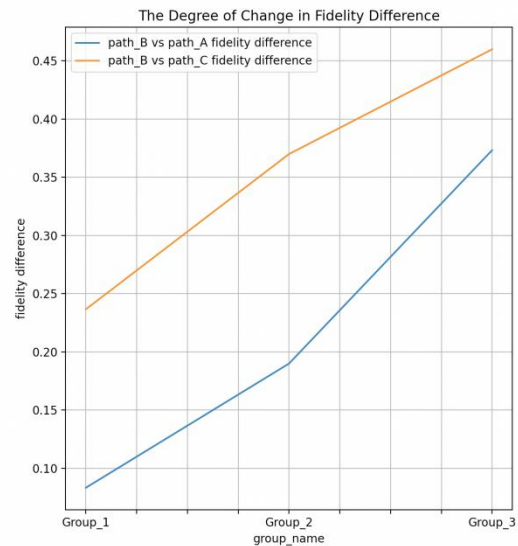
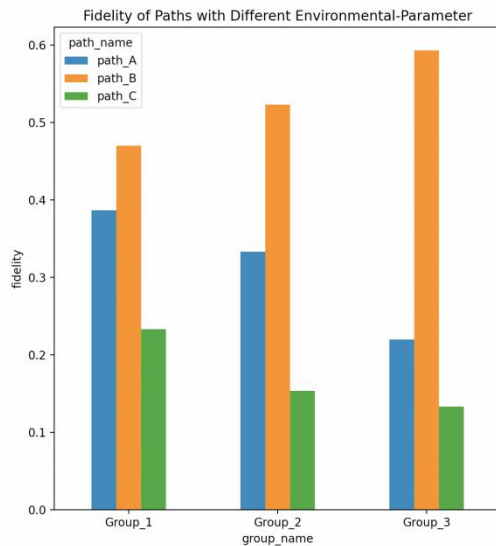
depolar_rate fidelity
  depolar_rate  fidelity      sem
0          0.000  1.000000  0.000000
1          0.005  0.686667  0.026825
2          0.010  0.560000  0.028707
3          0.015  0.496667  0.028915
4          0.020  0.516667  0.028900
dephase_rate fidelity
  dephase_rate  fidelity      sem
0           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
```

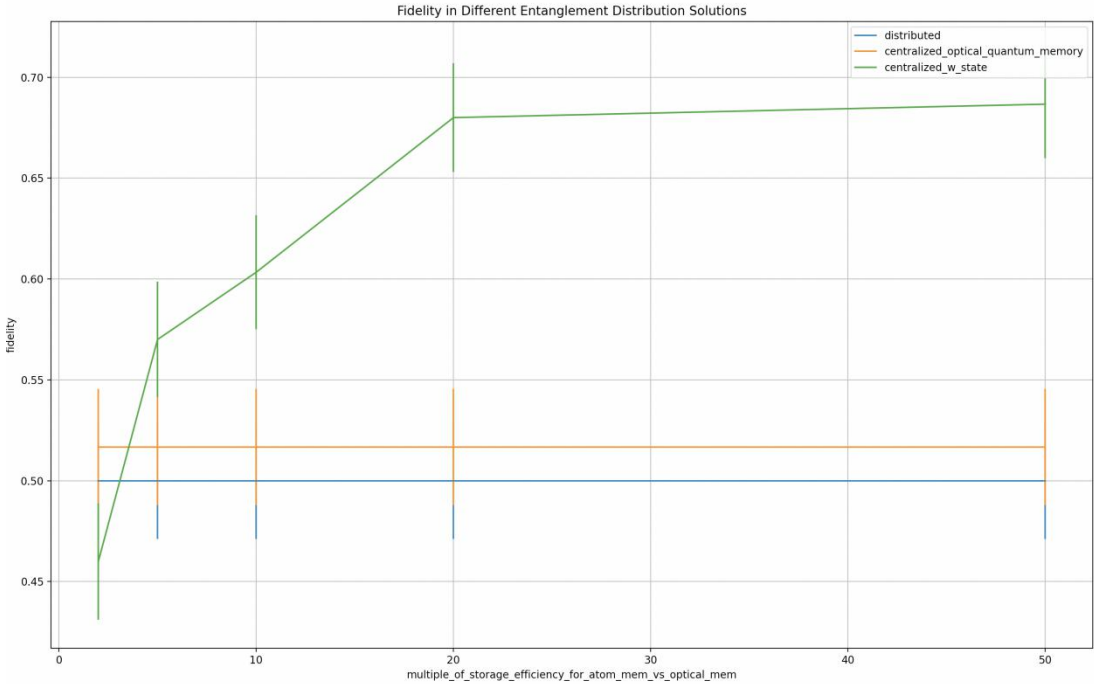
```
group_2_sem,path_A,path_B,path_C
0    0.027262
1    0.028884
2    0.020837
Name: sem, dtype: float64
```

```
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
```

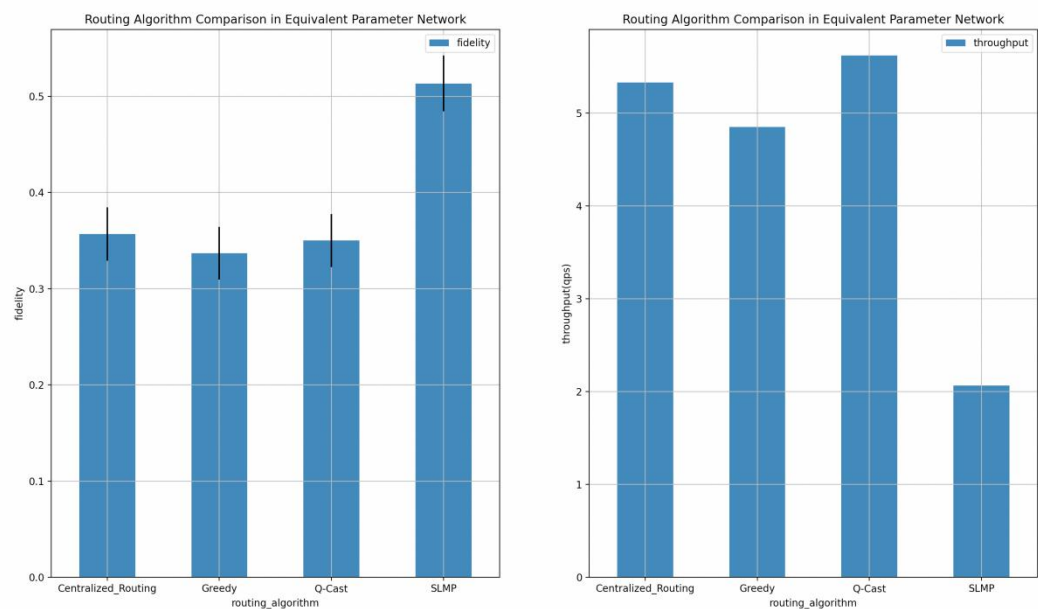
```
fidelity_difference_data_path_B_vs_path_C
group_name  fidelity_difference
0    Group_1                0.236667
1    Group_2                0.370000
2    Group_3                0.460000
```

# 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

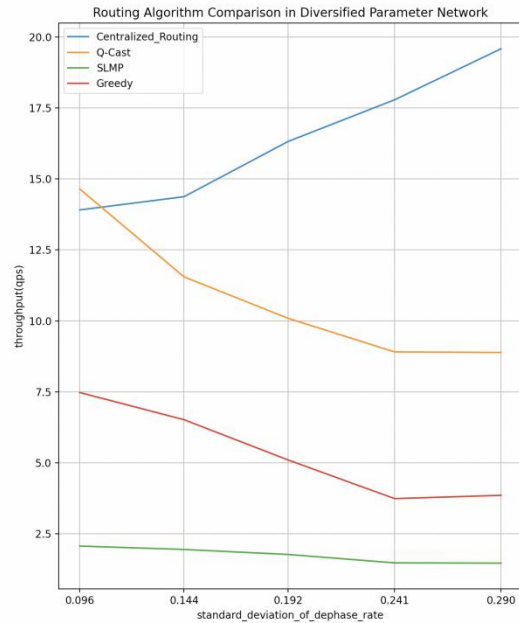
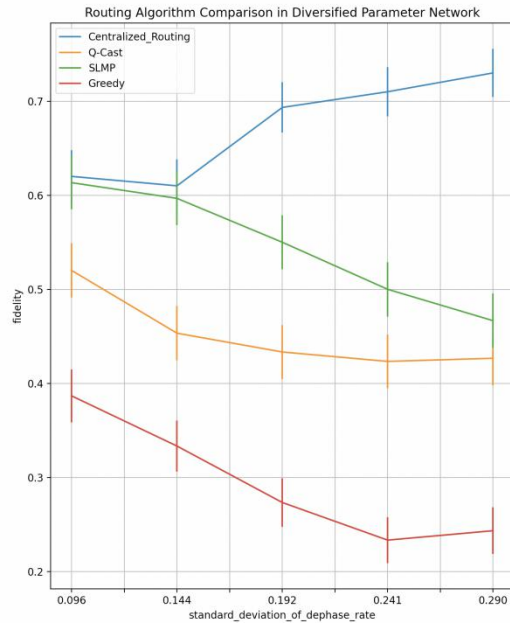
routing\_algorithm\_comparison\_equivalent\_parameter\_network.py



```
##### Complete teleportation process #####
#### 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 0.028095
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 0.024015
standard_deviation_of_dephase_rate    entanglement_pair_consumption
0 0.096 5.030000
1 0.144 5.056667
2 0.192 5.038000
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 8.87015
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

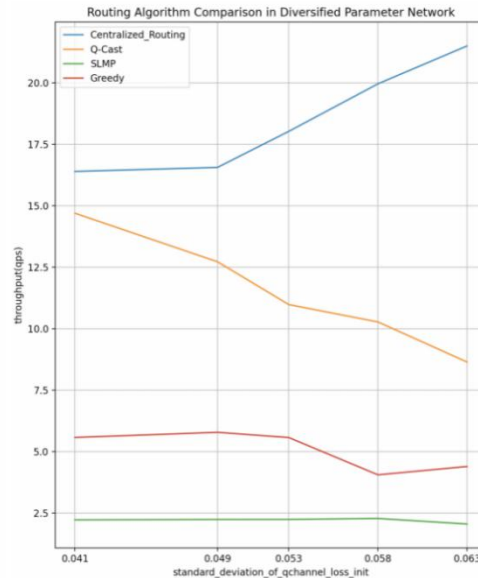
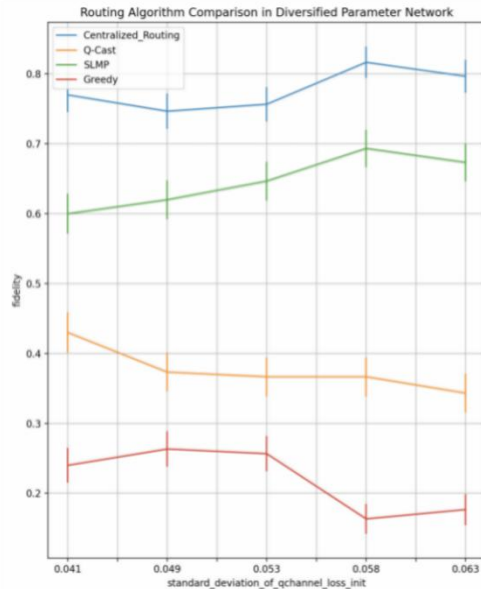
```

```

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 0.027468
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

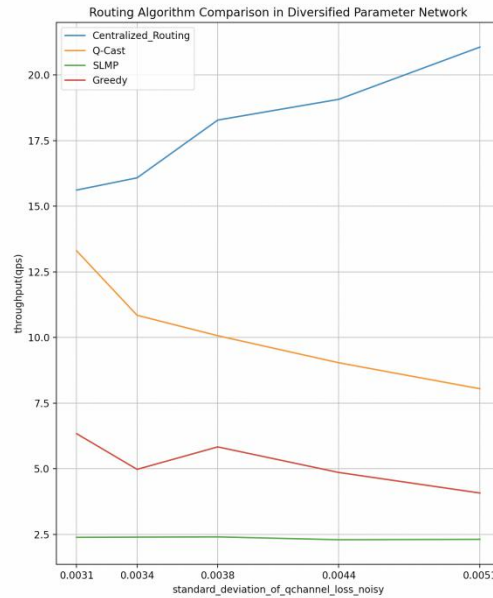
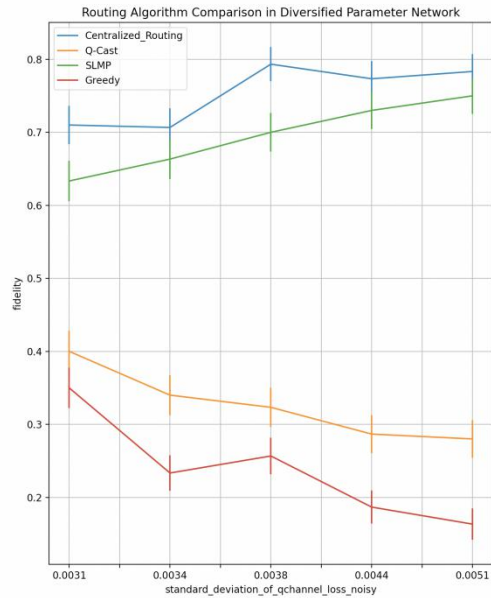
```

```

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
0.0031 0.710000 0.026242
0.0034 0.706667 0.026330
0.0038 0.793333 0.023417
0.0044 0.773333 0.024213
0.0051 0.783333 0.023825
standard_deviation_of_qchannel_loss_noisy fidelity sem
0.0031 0.400000 0.028332
0.0034 0.340000 0.027395
0.0038 0.323333 0.027051
0.0044 0.286667 0.026152
0.0051 0.280000 0.025966
standard_deviation_of_qchannel_loss_noisy fidelity sem
0.0031 0.633333 0.027869
0.0034 0.663333 0.027329
0.0038 0.700000 0.026502
0.0044 0.730000 0.025675
0.0051 0.750000 0.025042
standard_deviation_of_qchannel_loss_noisy fidelity sem
0.0031 0.350000 0.027584
0.0034 0.233333 0.024460
0.0038 0.256667 0.025260
0.0044 0.186667 0.022534
0.0051 0.163333 0.021379
standard_deviation_of_qchannel_loss_noisy entanglement_pair_consumption
0.0031 6.0
0.0034 6.0
0.0038 6.0
0.0044 6.0
0.0051 6.0
standard_deviation_of_qchannel_loss_noisy entanglement_pair_consumption
0.0031 5.063333
0.0034 5.136667
0.0038 5.216667
0.0044 5.273333
0.0051 5.290000
standard_deviation_of_qchannel_loss_noisy entanglement_pair_consumption
0.0031 33.0
0.0034 33.0
0.0038 33.0
0.0044 33.0
0.0051 33.0
standard_deviation_of_qchannel_loss_noisy entanglement_pair_consumption
0.0031 5.0
0.0034 5.0
0.0038 5.0
0.0044 5.0
0.0051 5.0
standard_deviation_of_qchannel_loss_noisy throughput
0.0031 15.617347
0.0034 16.083621
0.0038 18.284055
0.0044 19.074036
0.0051 21.064401
standard_deviation_of_qchannel_loss_noisy throughput
0.0031 13.305993
0.0034 10.848833
0.0038 10.069599
0.0044 9.039730
0.0051 8.049529
standard_deviation_of_qchannel_loss_noisy throughput
0.0031 2.389133
0.0034 2.307641
0.0038 2.406712
0.0044 2.298262
0.0051 2.313359
standard_deviation_of_qchannel_loss_noisy throughput
0.0031 6.339000
0.0034 4.979334
0.0038 5.834878
0.0044 4.860543
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
```



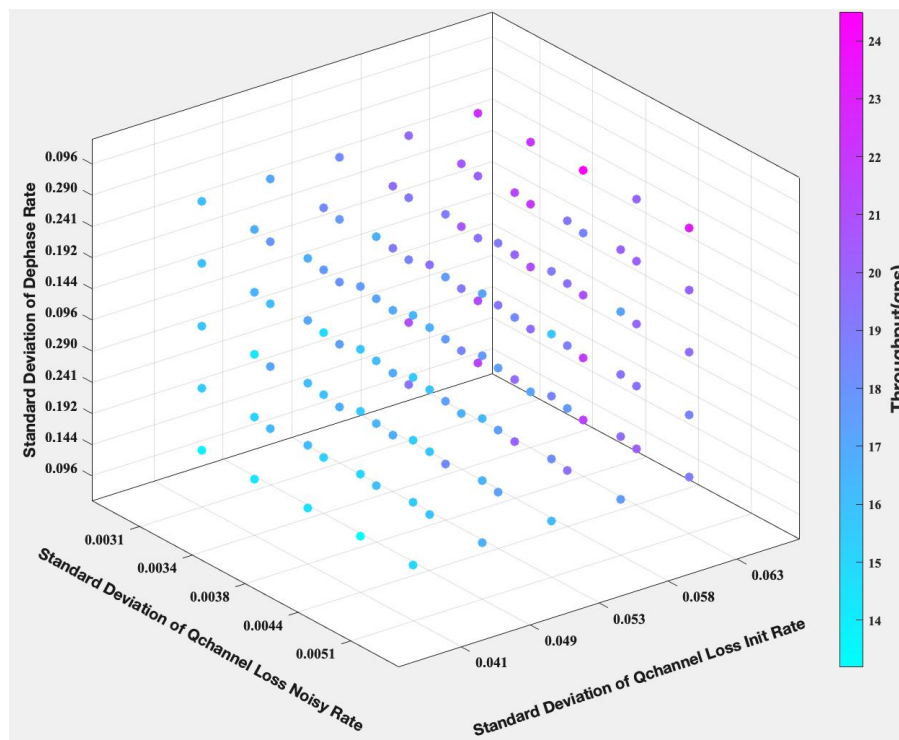
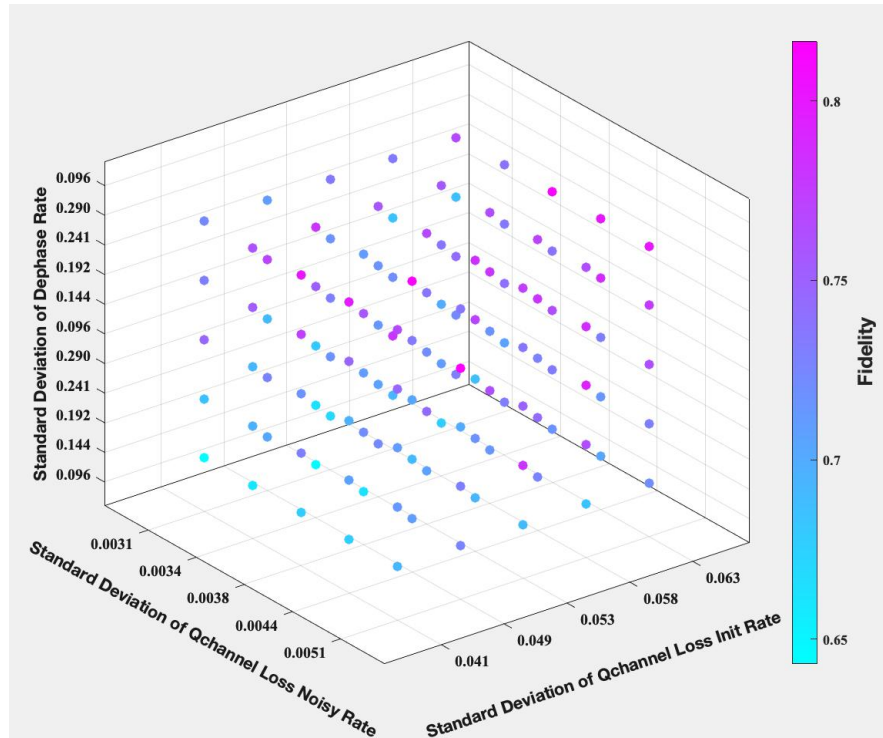
## 3d\_heat\_map\_centralized\_routing.py

###

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.

###



## noisy\_limitation\_test.py

```
qchannel_loss_noisy  0.00  0.05  0.10  0.15  0.20  0.25  0.30
group
1                   1.0  0.33  0.07  0.05  0.0  0.0  0.0
```

## integrated\_example.py

### you can change the parameter here to observe 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 recommend values to check this program:

#### 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 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 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 =
[0.09,0.35,0.03,0.03,0.35,0.35,0.11,0.03,0.03,0.09,0.03,0.03,0.02,0.14,0.07,0.02,0.03,0.0
4,0.02,0.05,0.06,0.02,0.09,0.04,0.03,0.03,0.05,0.06,0.07]
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 =
[0.0006,0.0004,0.0004,0.0003,0.0002,0.0003,0.0015,0.0005,0.0003,0.0022,0.0033,0.000
1,0.0003,0.0003,0.0004,0.0026,0.0003,0.0004,0.0006,0.0004,0.0003,0.0046,0.0012,0.00
57,0.0002,0.0001,0.0006,0.0005,0.0003,0.0035,0.0014,0.0001]
"""

```