Simulation Results steps

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1 First Step

Table 2: Step 1 results after 100 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	$\overline{V_Q}$
No	No	3000	3000	0.03	0.99	0.98879	390
minextendrc	No	3000	3000	0.03	0.96	0.9404637	1582
$\operatorname{minextendrc}$	Yes	3000	3000	0.03	0.98	0.9675513	1038
$\min extend$	No	3000	3000	0.03	0.98	0.944128	1264
$\min extend$	Yes	3000	3000	0.03	0.98	0.9585909	834
base	No	3000	3000	0.03	0.97	0.92331	1062
base	Yes	3000	3000	0.03	0.98	0.9568084	780

Table 3: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS	Parallelism	# meet. in between
No	No	5	78	84	0	0.0714	0
minextendrc	No	7	226	237	17	0.0464	3
$\operatorname{minextendrc}$	Yes	6	173	174	10	0.0057	2
\min extend	No	8	158	228	16	0.3070	1
\min extend	Yes	6	139	165	9	0.1576	0
base	No	6	177	228	16	0.2237	
base	Yes	6	130	147	7	0.1156	

Parallelism: $1 - \frac{depth}{\#gates}$

1.1 Routing comparison

1.1.1 No initial placement

With Resource constraints

```
... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=10
             path from source[1]=[2]
2
             path from target[2]=[1->5] implying:
     \hookrightarrow swap(q1,q5)
     ... the minimally extending path with swaps is:
        cycleExtend=9
5
             path from source[1]=[3]
             path from target[2]=[2->0] implying:
     \hookrightarrow swap(q2,q0)
     ... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=20
             path from source[3]=[4->7->5] implying:
         swap(q4,q7) swap(q7,q5)
9
            path from target[3]=[3->0->2] implying:
     \hookrightarrow swap(q3,q0) swap(q0,q2)
     ... the minimally extending path with swaps is:
10
     path from source[1]=[0]
11
             path from target[2]=[5->2] implying:
12
     \hookrightarrow swap(q5,q2)
13
     ... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=12
            path from source[2]=[7->5] implying:
14
        swap(q7,q5)
            path from target[2]=[0->2] implying:
15
     \hookrightarrow swap(q0,q2)
     ... the minimally extending path with swaps is:
16
          cycleExtend=9
             path from source[1]=[5]
17
             path from target[2] = [0 -> 2] implying:
18
     \hookrightarrow swap(q0,q2)
19
     ... the minimally extending path with swaps is:
         cycleExtend=9
             path from source[1]=[5]
20
21
            path from target[2]=[0->2] implying:
     \hookrightarrow swap(q0,q2)
22
     ... the minimally extending path with swaps is:
     23
             path from source[1]=[0]
             path from target[2]=[5->2] implying:
24
          swap(q5,q2)
     ... the minimally extending path with swaps is:
25
        cycleExtend=13
            path from source[2]=[0->2] implying:
26
         swap(q0,q2)
            path from target[2]=[7->5] implying:
27
     \hookrightarrow swap(q7,q5)
     ... the minimally extending path with swaps is:
28
     \hookrightarrow cycleExtend=10
             path from source[1]=[2]
29
             path from target[2]=[3->0] implying:
30
        swap(q3,q0)
     ... the minimally extending path with swaps is:
31
         cycleExtend=10
             path from source[1]=[2]
32
33
             path from target[2]=[3->0] implying:
     \hookrightarrow swap(q3,q0)
     ... the minimally extending path with swaps is:
34
        cycleExtend=10
             path from source[1]=[7]
35
36
             path from target[2]=[2->5] implying:
          swap(q2,q5)
```

Without Resource constraints

```
... the minimally extending path with swaps is:
 1
      \hookrightarrow cycleExtend=10
             path from source [1] = [2]
 2
 3
             path from target[2]=[1->5] implying:
      \hookrightarrow swap(q1,q5)
     ... the minimally extending path with swaps is:
 4
          cycleExtend=0
             path from source[2]=[3->0] implying:
 5
          swap(q3,q0)
             path from target[1]=[2]
     ... the minimally extending path with swaps is:
      path from source [3]=[4->1->5] implying:
          swap(q4,q1) swap(q1,q5)
 9
             path from target[2]=[0->2] implying:
      \hookrightarrow swap(q0,q2)
10
     ... the minimally extending path with swaps is:
         cycleExtend=0
              path from source [3] = [3 -> 6 -> 8] implying:
11
          swap(q3,q6) swap(q6,q8)
12
             path from target[1]=[5]
     ... the minimally extending path with swaps is:
1.3
         cycleExtend=10
14
              path from source[1]=[1]
             path from target[2]=[8->5] implying:
1.5
      \hookrightarrow swap(q8,q5)
     ... the minimally extending path with swaps is:
16
         cycleExtend=10
             path from source[1]=[1]
17
             path from target[2]=[8->5] implying:
18
      \hookrightarrow swap(q8,q5)
19
     ... the minimally extending path with swaps is:
      \hookrightarrow cycleExtend=10
20
              path from source[1]=[1]
             path from target[2]=[8->5] implying:
21
      \hookrightarrow \quad \mathtt{swap}(\,\mathtt{q8}\,\mathtt{,q5}\,)
22
     ... the minimally extending path with swaps is:
          cycleExtend=10
             path from source[1]=[8]
23
24
             path from target[2]=[1->5] implying:
      \hookrightarrow swap(q1,q5)
     ... the minimally extending path with swaps is:
25
          cvcleExtend=0
             path from source[1]=[8]
26
             path from target[2]=[2->6] implying:
27
      \hookrightarrow swap(q2,q6)
28
     ... the minimally extending path with swaps is:
          cycleExtend=8
             path from source[1]=[8]
29
             path from target[3]=[0->2->5] implying:
30
      \rightarrow swap(q0,q2) swap(q2,q5)
     ... the minimally extending path with swaps is:
31
          cycleExtend=4
             path from source[1]=[8]
32
             path from target[2]=[2->6] implying:
      \hookrightarrow swap(q2,q6)
34
     ... the minimally extending path with swaps is:
         cycleExtend=2
             path from source[2]=[1->5] implying:
35
          swap(q1,q5)
             path from target[1]=[8]
36
```

1.1.2 With initial placement

With Resource constraints

```
... Virt2Real(v->r) ... result Virt2Real map of
     \hookrightarrow InitialPlace before adding unused virtual
     \hookrightarrow qubits and unused locations : (0->10)
         (1->4) (2->1) (3->5) (4->7) (5->2147483647)
     \hookrightarrow (6->2147483647) (7->2147483647)
     \hookrightarrow (8->2147483647) (9->2147483647)
         (10->2147483647) (11->2147483647)
          (12->2147483647) (13->2147483647)
         (14->2147483647) (15->2147483647)
         (16->2147483647)
     ... Virt2Real(v->r) ... final result Virt2Real
     \hookrightarrow map of InitialPlace: (0->10) (1->4) (2->1)
          (3->5) (4->7) (5->0) (6->2) (7->3) (8->6)
     \hookrightarrow (14->14) (15->15) (16->16)
     ... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=10
             path from source[1]=[4]
             path from target[2]=[10->7] implying:
5
     \hookrightarrow swap(q10,q7)
     ... the minimally extending path with swaps is:
6
     \hookrightarrow cycleExtend=10
             path from source[1]=[4]
             path from target[2]=[10->7] implying:
8
     \hookrightarrow swap(q10,q7)
9
     ... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=10
             path from source[1]=[4]
10
             path from target[2]=[10->7] implying:
11
     \hookrightarrow swap(q10,q7)
     ... the minimally extending path with swaps is:
12
          cycleExtend=10
13
             path from source[1]=[10]
             path from target[2]=[4->7] implying:
14
        swap(q4,q7)
     ... the minimally extending path with swaps is:
15
     \hookrightarrow cycleExtend=10
16
             path from source[1]=[10]
             path from target[2]=[5->8] implying:
17
     \hookrightarrow swap(q5,q8)
     ... the minimally extending path with swaps is:
18
          cvcleExtend=10
             path from source[2]=[10->8] implying:
19
          swap(q10,q8)
             path from target[2]=[1->5] implying:
20
         swap(q1,q5)
     ... the minimally extending path with swaps is:
21
     \hookrightarrow cycleExtend=10
             path from source[1]=[8]
22
             path from target[2]=[7->5] implying:
23
     \hookrightarrow swap(q7,q5)
     ... the minimally extending path with swaps is:
24
     \hookrightarrow cycleExtend=12
             path from source[2]=[4->1] implying:
25
          swap(q4.q1)
           path from target[2]=[8->5] implying:
26
     \hookrightarrow swap(q8,q5)
```

Without Resource constraints

```
1 ... Virt2Real(v->r) ... result Virt2Real map of
     \hookrightarrow \quad \hbox{InitialPlace before adding unused virtual} \quad
          qubits and unused locations : (0->10)
          (1->4) (2->1) (3->5) (4->7) (5->2147483647)
          (6->2147483647) (7->2147483647)
      \hookrightarrow (8->2147483647) (9->2147483647)
          (10->2147483647) (11->2147483647)
          (12->2147483647) (13->2147483647)
          (14->2147483647) (15->2147483647)
     2 ... Virt2Real(v->r) ... final result Virt2Real
     \hookrightarrow map of InitialPlace: (0->10) (1->4) (2->1)
          (3->5) (4->7) (5->0) (6->2) (7->3) (8->6)
          (9->8) (10->9) (11->11) (12->12) (13->13)
     ... the minimally extending path with swaps is:
     \hookrightarrow cycleExtend=10
             path from source[1]=[4]
             path from target[2]=[10->7] implying:
 5
     \hookrightarrow swap(q10,q7)
     ... the minimally extending path with swaps is:
 6
     \hookrightarrow cycleExtend=10
             path from source[1]=[4]
             path from target[2]=[10->7] implying:
 8
     \hookrightarrow swap(q10,q7)
9
     ... the minimally extending path with swaps is:
      \hookrightarrow cycleExtend=10
             path from source [1] = [4]
10
1.1
             path from target[2]=[10->7] implying:
     \hookrightarrow swap(q10,q7)
12
     ... the minimally extending path with swaps is:
      \hookrightarrow cycleExtend=10
13
             path from source[1]=[10]
             path from target[2]=[4->7] implying:
14
     \hookrightarrow swap(q4,q7)
     ... the minimally extending path with swaps is:
1.5
      \hookrightarrow cycleExtend=0
16
             path from source[1]=[10]
             path from target[2]=[5->8] implying:
17
     \hookrightarrow swap(q5,q8)
     ... the minimally extending path with swaps is:
18
         cvcleExtend=8
             path from source[1]=[10]
19
             path from target[3]=[1->5->7] implying:
20
      \rightarrow swap(q1,q5) swap(q5,q7)
     ... the minimally extending path with swaps is:
21
         cycleExtend=4
             path from source[1]=[10]
22
             path from target[2]=[5->8] implying:
      \hookrightarrow swap(q5,q8)
     ... the minimally extending path with swaps is:
24
      \hookrightarrow cycleExtend=2
             path from source[2]=[4->7] implying:
25
          swap(q4,q7)
             path from target[1]=[10]
26
```

Table 4: Step 1 results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	$\overline{V_Q}$
No	No	3000	3000	0.03	0.96	0.97823066	390
minextendrc	No	3000	3000	0.03	0.929	0.92937318	1582
$\operatorname{minextendrc}$	Yes	3000	3000	0.03	0.939	0.94685216	1038
$\operatorname{minextend}$	No	3000	3000	0.03	0.947	0.9312172	1264
$\operatorname{minextend}$	Yes	3000	3000	0.03	0.949	0.94748374	834
base	No	3000	3000	0.03	0.932	0.906571	1062
base	Yes	3000	3000	0.03	0.9509	0.9459456	780

2 1000 iterations

3 10000 iterations

Table 5: Step 1 results after 10000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
No	No	3000	3000	0.03	0.961	0.980342528	390
minextendrc	No	3000	3000	0.03	0.9372	0.937136544	1582
$\operatorname{minextendrc}$	Yes	3000	3000	0.03	0.9435	0.951650597	1038
$\min extend$	No	3000	3000	0.03	0.9519	0.93665818	1264
$\min extend$	Yes	3000	3000	0.03	0.9556	0.954629151	834
base	no	3000	3000	0.03	0.9417	0.9156453	1062
base	yes	3000	3000	0.03	0.953	0.95037428	780

3.1 Conclusions

3.1.1 Probability of success

Mapper	Init. place	100 it.	1000 it.	10000 it.	Diff 100-1000	Diff 1000-10000
No	No	0.99	0.96	0.961	-0.0300	0.0010
minextendrc	No	0.96	0.929	0.9372	-0.0310	0.0082
$\operatorname{minextendrc}$	Yes	0.98	0.939	0.9435	-0.0410	0.0045
$\min extend$	No	0.98	0.947	0.9519	-0.0330	0.0049
$\min extend$	Yes	0.98	0.949	0.9556	-0.0310	0.0066
base	No	0.97	0.932	0.9417	-0.0380	0.0097
base	Yes	0.98	0.9509	0.953	-0.0291	0.0021

Iterations comparison	Mean diff
100-1000	-0.0333
1000-10000	0.0053

3.1.2 Fidelity

Mapper	Init. place	100 it.	1000 it.	10000 it.	Diff 100-1000	Diff 1000-10000
No	No	0.98879	0.97823066	0.980342528	-0.0106	0.0021
minextendrc	No	0.9404637	0.92937318	0.937136544	-0.0111	0.0078
$\min extendrc$	Yes	0.9675513	0.94685216	0.951650597	-0.0207	0.0048
$\min extend$	No	0.944128	0.9312172	0.93665818	-0.0129	0.0054
$\min extend$	Yes	0.9585909	0.94748374	0.954629151	-0.0111	0.0071
base	No	0.92331	0.906571	0.9156453	-0.0167	0.0091
base	Yes	0.9568084	0.9459456	0.95037428	-0.0109	0.0044

Iterations comparison	Mean diff
100-1000	-0.0134
1000-10000	0.0058

4 Simplest benchmarks results