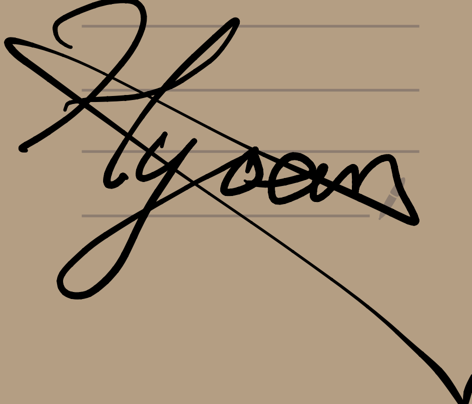
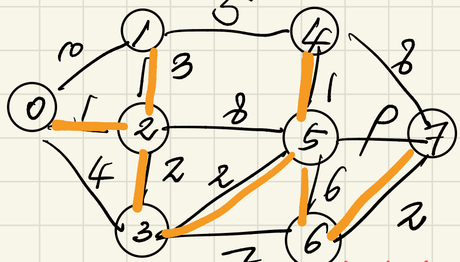
Bit TSP MST





	①	②	③	④	⑤	⑥	~~⑦~~	~~⑧~~	⑨					
w	1	1	2	2	2	3	4	5	6	7	8	8	9	10
s	0	4	2	3	6	1	0	1	5	3	4	2	5	0
e	2	5	3	5	7	2	3	4	6	6	7	5	7	1

i	0	1	2	3	4	5	6	7
p[i]	0	~~1~~ 0	~~2~~ 0	~~3~~ 0	~~4~~ 0	~~5~~ 4	~~6~~ 0	~~7~~ 6
R[i]	~~1~~ ~~2~~ ~~3~~ ~~7~~ 6	1	1	1	~~1~~ 2	1	~~1~~ 2	1

① union(0, 2)

0 = find(0)

2 = find(2)

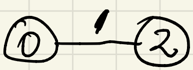
if R[0] < R[2]

R[2] += R[0]

p[0] = 2

else R[0] += R[2]

p[2] = 0



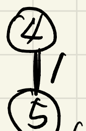
② union(4, 5)

4 = find(4)

5 = find(5)

R[4] += R[5]

p[5] = 4



③ union(2, 3)

0 = find(2)

3 = find(3)

R[0] += R[3]

p[3] = 0

④ union(3, 5)

0 = find(3)

4 = find(5)

R[0] += R[4]

p[4] = 0

⑤ union(6, 7)

6 = find(6)

7 = find(7)

R[6] += R[7]

p[7] = 6

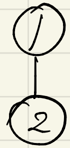
⑥ union(1, 2)

1 = find(1)

0 = find(2)

R[0] += R[1] = 6

p[1] = 0



⑦ union(0, 3)

X [0 = find(0)

0 = find(3)

⑧ union(1, 4)

X [0 = find(1)

0 = find(4)

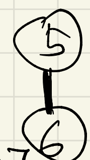
⑨ union(5, 6)

0 = find(5)

6 = find(6)

R[0] += R[6] = 7

p[6] = 0

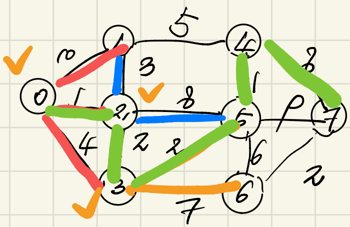


|V|−1 까지

$\sum dist = 1 + 1 + 2 + 2 + 2 + 3 + 6$

$= 10 + 7 = 17$

Kruskal



0⇒7

adj

from	to				
0	1	2	3		
1	0	2	4		
2	0	1	3	5	
3	0	2	5	6	
4	1	5	7		
5	2	3	4	6	7
6	3	5	7		
7	4	5	6		

i	0	1	2	3	4	5	6	7
v[i]	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	F	~~F~~ T
d[i]	∞ 0	~~∞~~ ~~10~~ 4	~~∞~~ 1	~~∞~~ ~~4~~ 3	~~∞~~ 10	~~∞~~ 9	∞ 15	∞ 18

dijkstra

que (0 0)
v w

while(!que)

① (0 0) = que.
v[v=0]=T

for next : adj[v=0]
if(v[next.v]) (2 1)(3 4)(1 10)
1 d[2] > d[0]+1
4 d[3] > d[0]+4
10 d[1] > d[0]+10
que.((2 1)(3 4)(1 10))

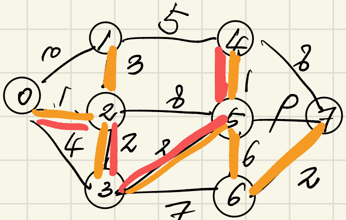
② (2 1) = que
v[v=2]=T
for next : adj[2] (0 1)(3 2)(1 3)(5 8)
if(v[next.v])
4 d[3] > d[2]+2
10 d[1] > d[2]+3
∞ d[5] > d[2]+8
que((3 3)(1 4)(5 9))

③ (3,3) v[3]=T
for next : adj[3] (3 0 4)(3 2 2)(3 5 2)(3 6 7)
9 d[5] > d[3]+2
∞ d[6] > d[3]+7
(5 5)(6 10)

④ (5,5) = que.
v[v=5]=T
for next : adj[5] (5 4 1)(5 2 8)(5 3 2)(5 4 ...)(5 7 ...)
if(v[next])
∞ d[4] > d[5]+1
∞ d[6] > d[5]+6
∞ d[7] > d[5]+9
que((4 10)(6 15)(7 18))

⑤ (4,10) = que
v[4]=T
for next : adj[4] (4 5 1)(4 1 5)(4 7 8)
if next
4 d[1] > d[4]+5
18 d[7] > d[4]+8
que:((1 4)(7 18))

⑥ (1 4) = que
v[1]=T for next
⑦ (7 8) = q
v[7]=T



Prim

fm to

adj					
0	1	2	3		
1	0	2	4		
2	0	1	3	5	
3	0	2	5	6	
4	1	5	7		
5	2	3	4	6	7
6	3	5	7		
7	4	5	6		

i	0	1	2	3	4	5	6	7
	1	6	2	3	5	4	7	8
v[i]	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	~~F~~ T	F	F

que(0)

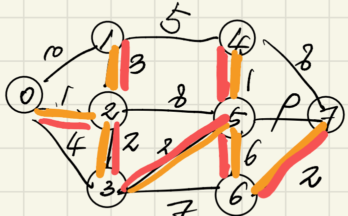
1. while !que
   from 0 = que.
   v[0] = T
   for(E : adj[0])
   pq.add(E) pq
   w(!pq)
   E g = pq.poll() 2
   if(!v[E.to])
   que(2). que 2
   mst
   break

2. while(!que)
   from 2 = que.poll()
   v[2] = T
   for E : adj[2]
   pq.add(E)
   pq
   while(!pq)
   E p = pq.poll()
   if(!v[p.to]) !v[3]
   que(3)
   mst
   break

3. while(!que)
   from 3 = que.poll();
   v[3] = T
   for E : adj[3]
   pq.add(E)
   while(!pq)
   E p = pq.poll()
   if(!v[p.to])
   pq
   que(5)
   mst
   break

4. w(!que)
   from 5 = que
   v[5] = T
   for E : adj[5]
   pq
   while(!pq)
   E p = pq.poll
   que(4)
   mst
   break.

5. w(!que)
   from 4 = que.
   v[4] = T
   for E : adj[4]
   pq
   while(!pq)
   E e = pq.poll
   if(!v[1])
   que(1)
   mst
   break



frm to

adj
0 — 1 2 3
1 — 0 2 4
2 — 0 1 3 5
3 — 0 2 5 6
4 — 1 5 7
5 — 2 3 4 6 7
6 — 3 5 7
7 — 4 5 6

i 0 1 2 3 4 5 6 7
v[i] F F F F F F F F
T T T T T T T

v[7]

pq
2 0 4 5 3 4 5 5 0
1 3 8 6 6 7 2 7 1
2 2 4 5 6 7 8 8 9 10

⑥ while(!q.e)
fu i = q.poll()
~~v[i] = T~~
for E e : adj[i]
while(!pq)
E e = pq.poll()
if v[3]
q.e(6)

mST
5
6
6

⑦ while(!q.e)
fu 6 = q.poll()
~~v[6] = T~~
for E e : adj[6]
pq(e)

pq
6 3 4 5 5 0
7 6 7 2 7 1
2 7 8 8 9 10

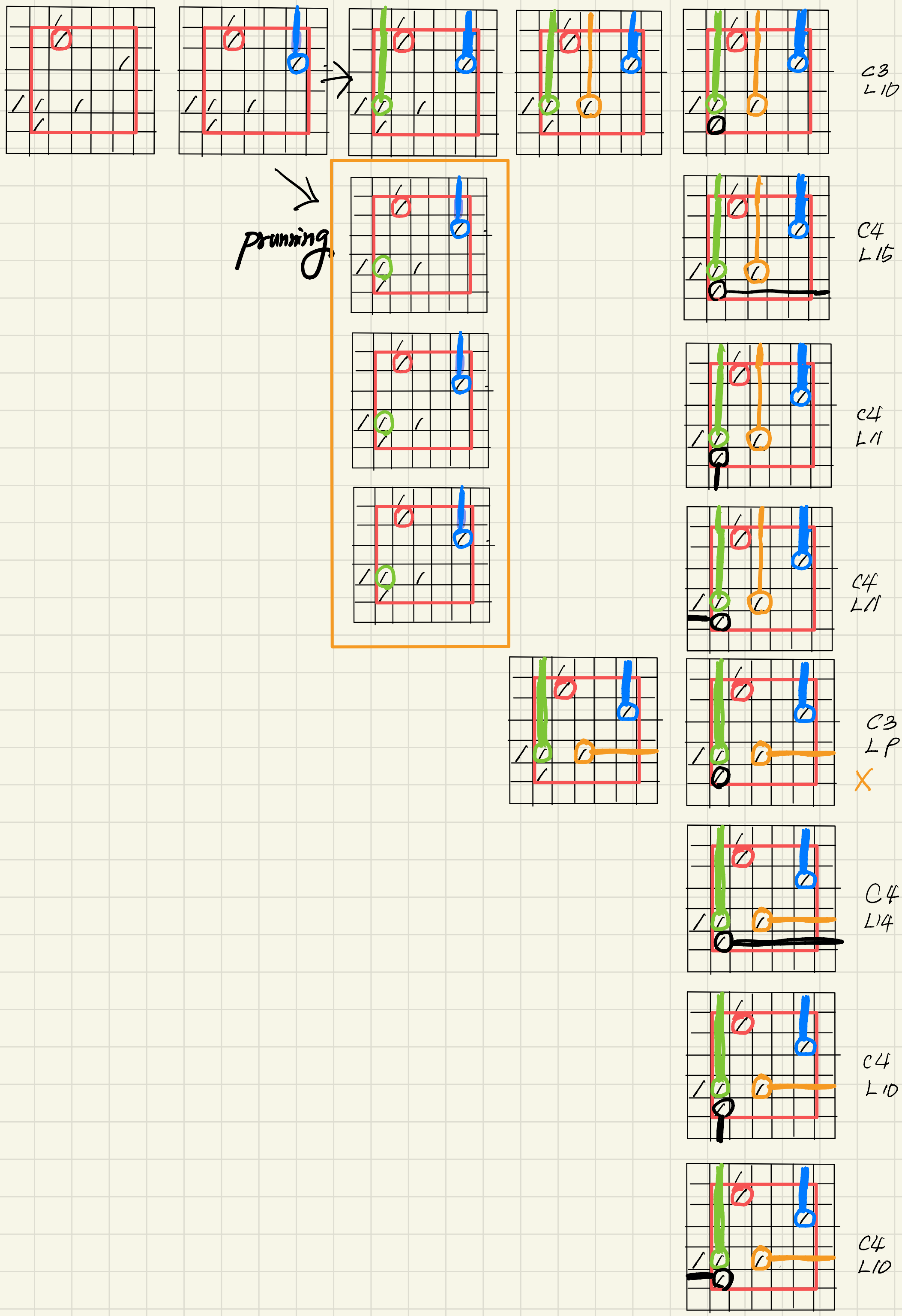
while(!pq)
E e = pq.poll
if !v[7]
q(7)

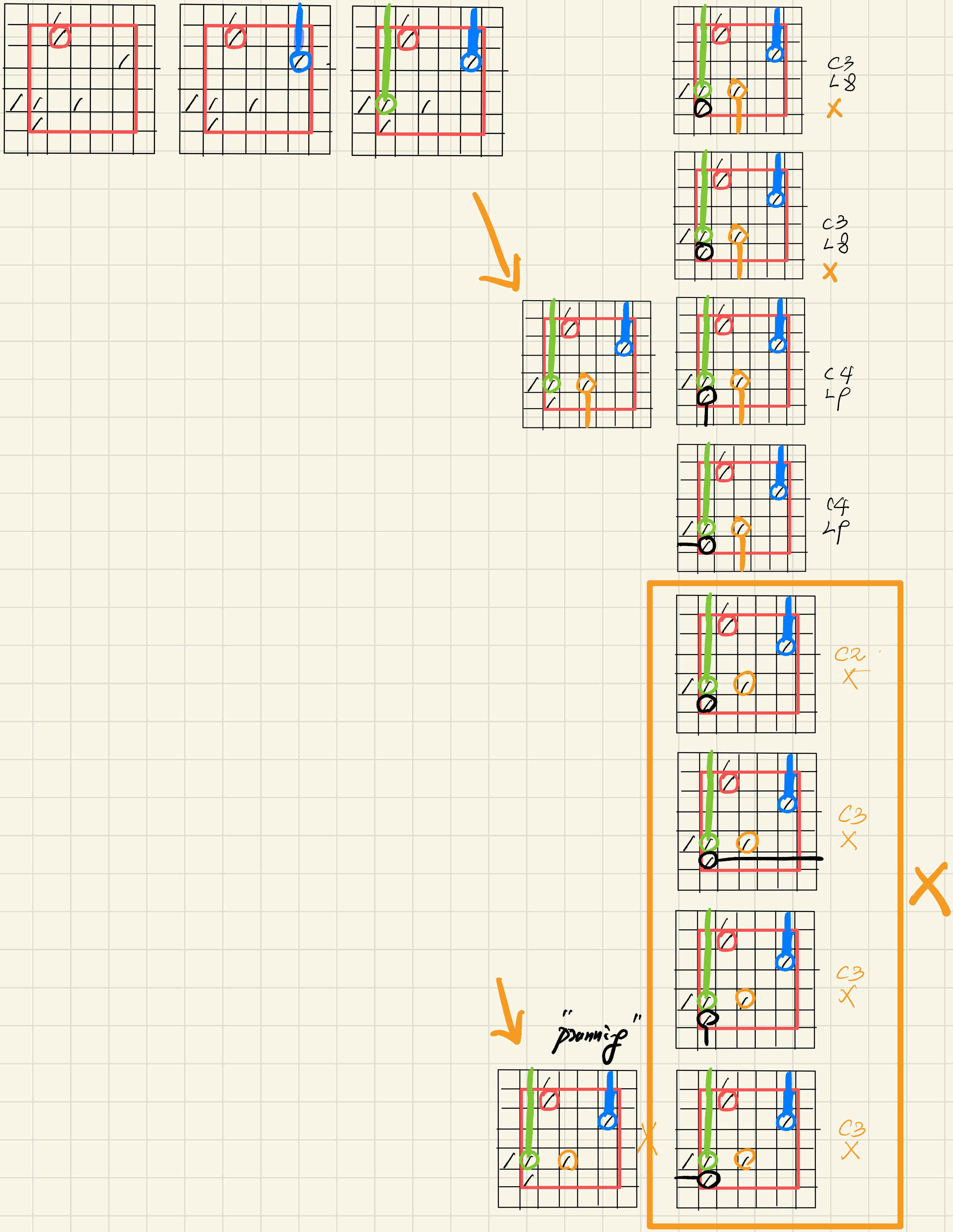
mST

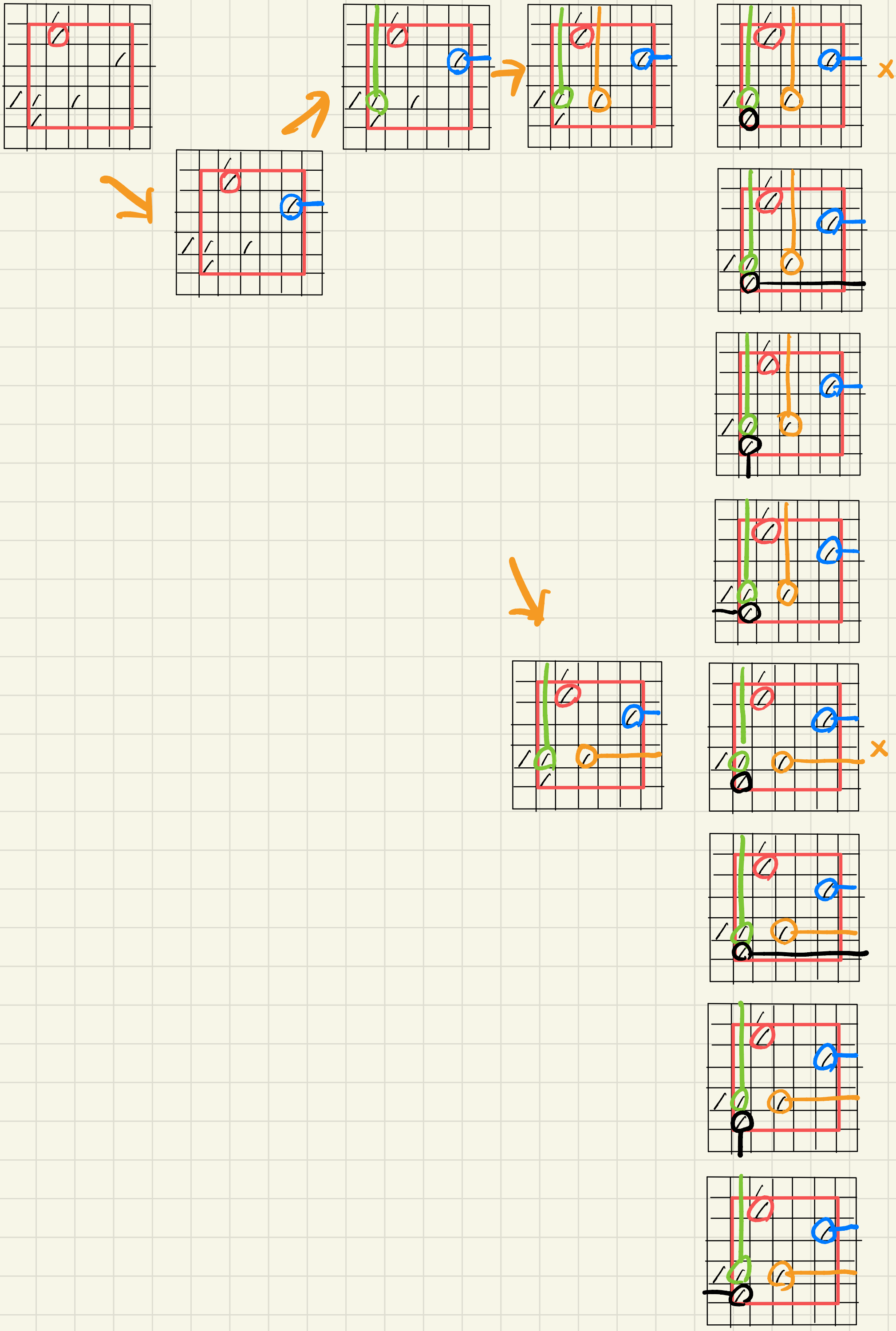
0 2 1
2 3 2
1 2 2
4 5 2
4 1 2

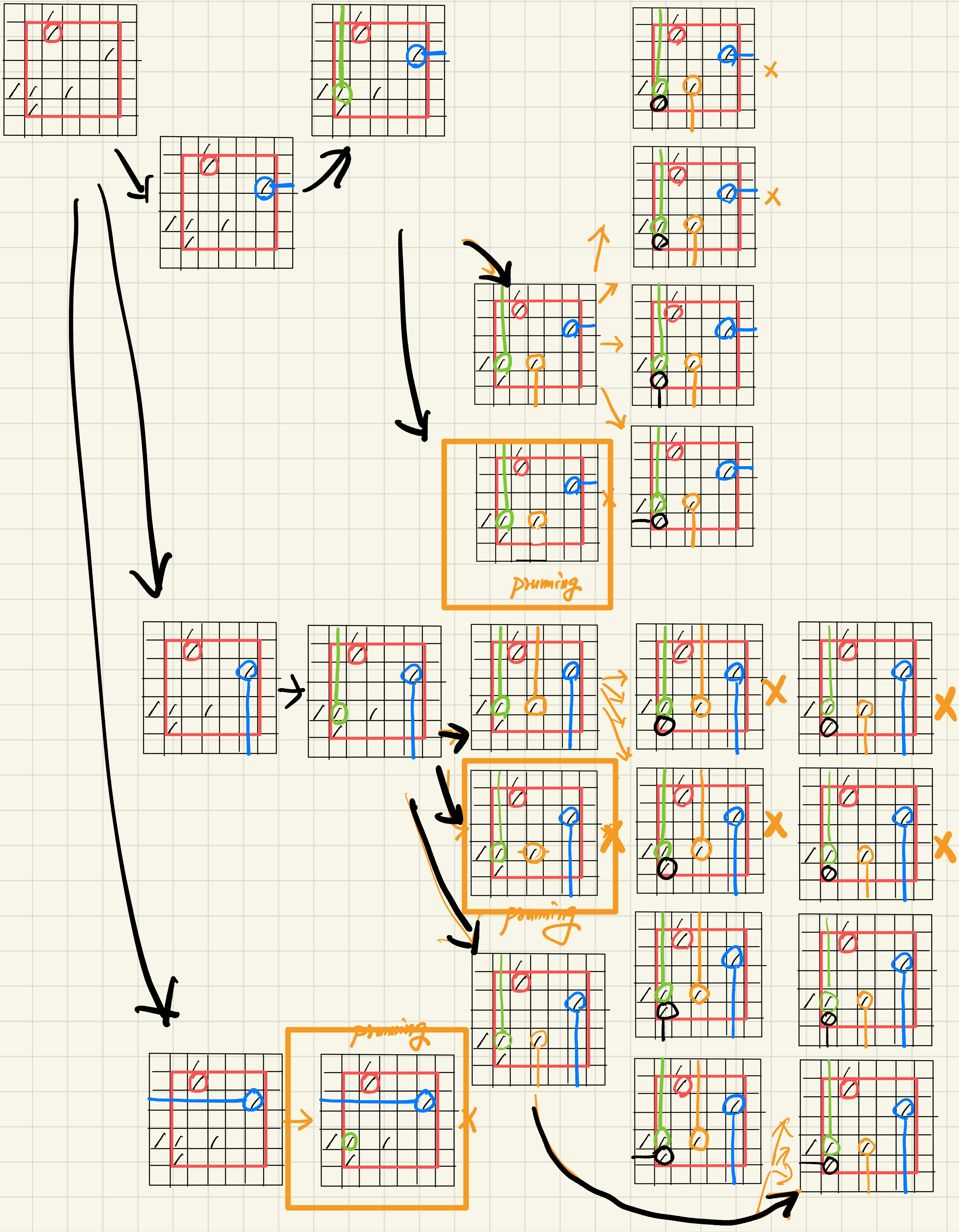
5 6
6 7
6 2

⑧ while(!q.e)
fu 7 = q.poll
~~v[7] = T.~~
end

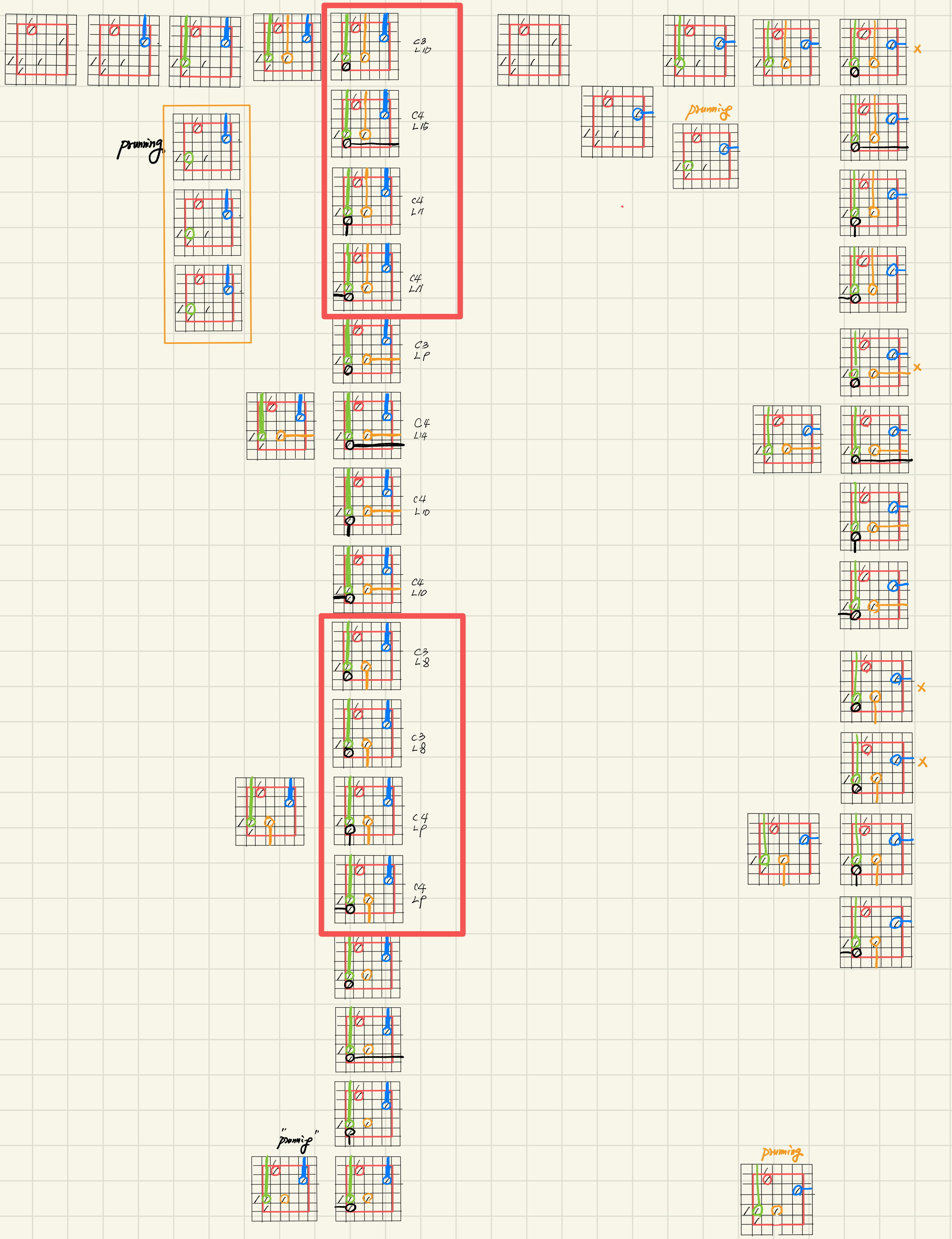

pruning
C3
L10
C4
L15
C4
L11
C4
L11
C3
LP
X
C4
L14
C4
L10
C4
L10


C3
L8
C3
L8
C4
LP
C4
LP
"planning"
C2
C3
C3
C3

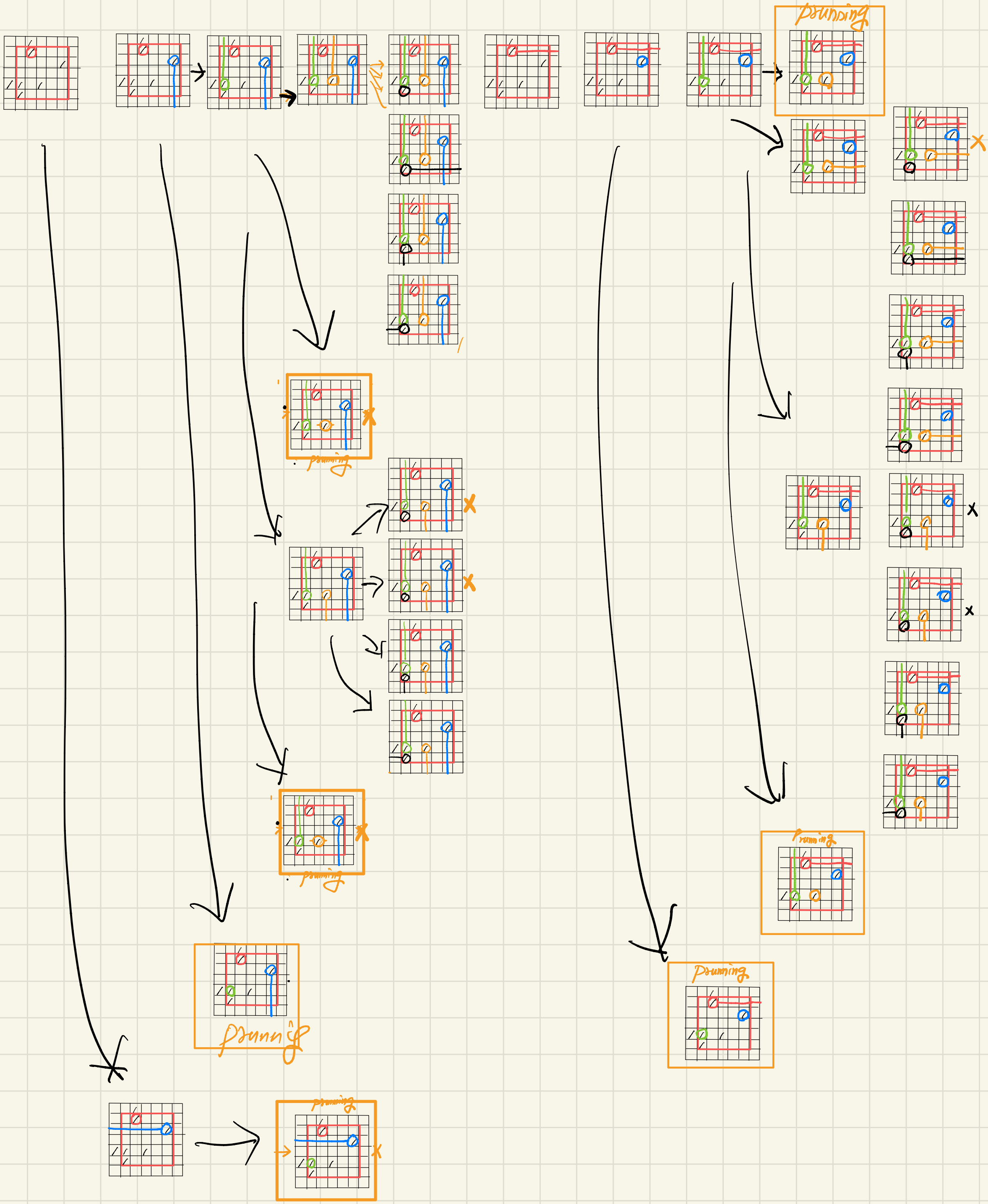


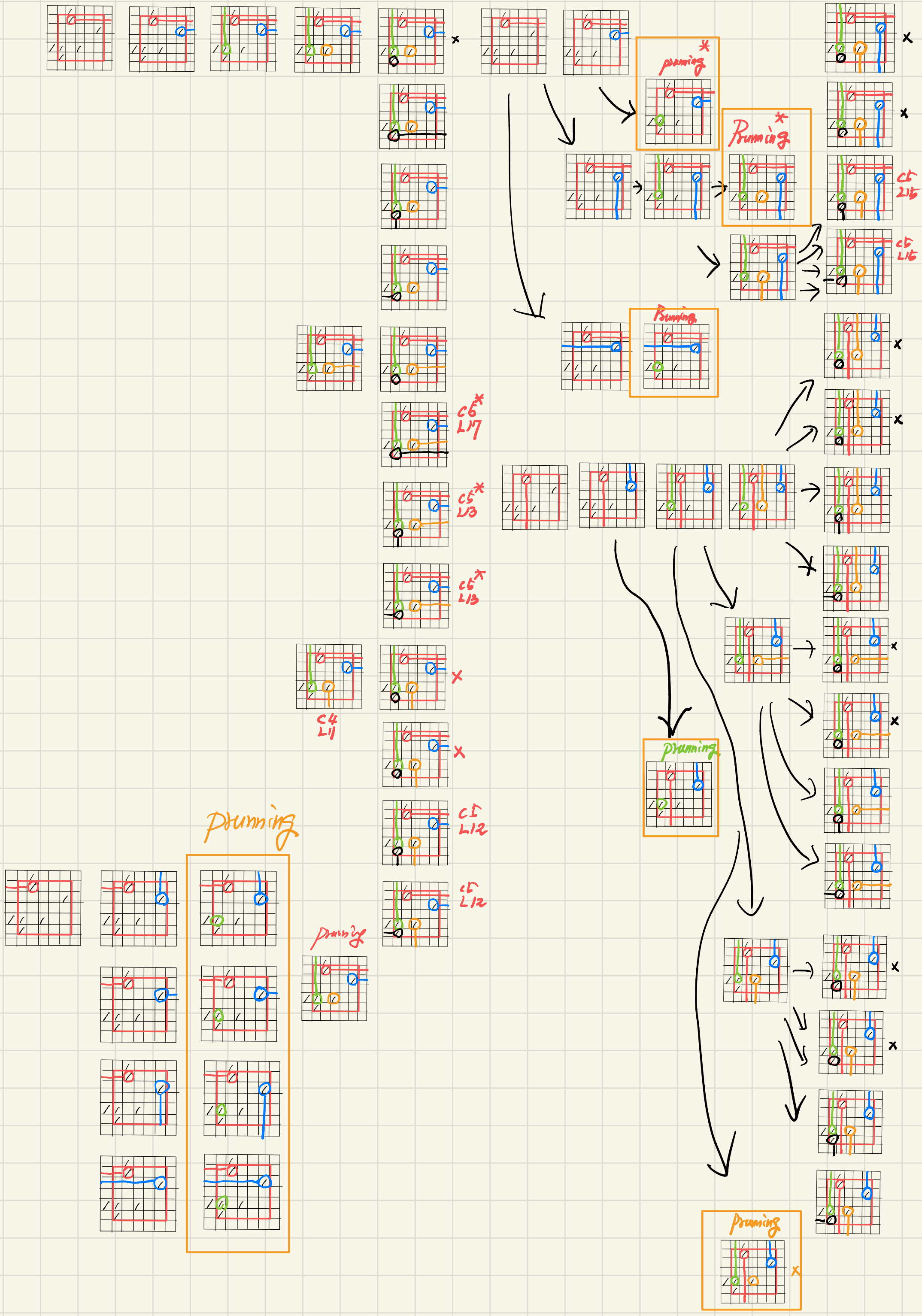


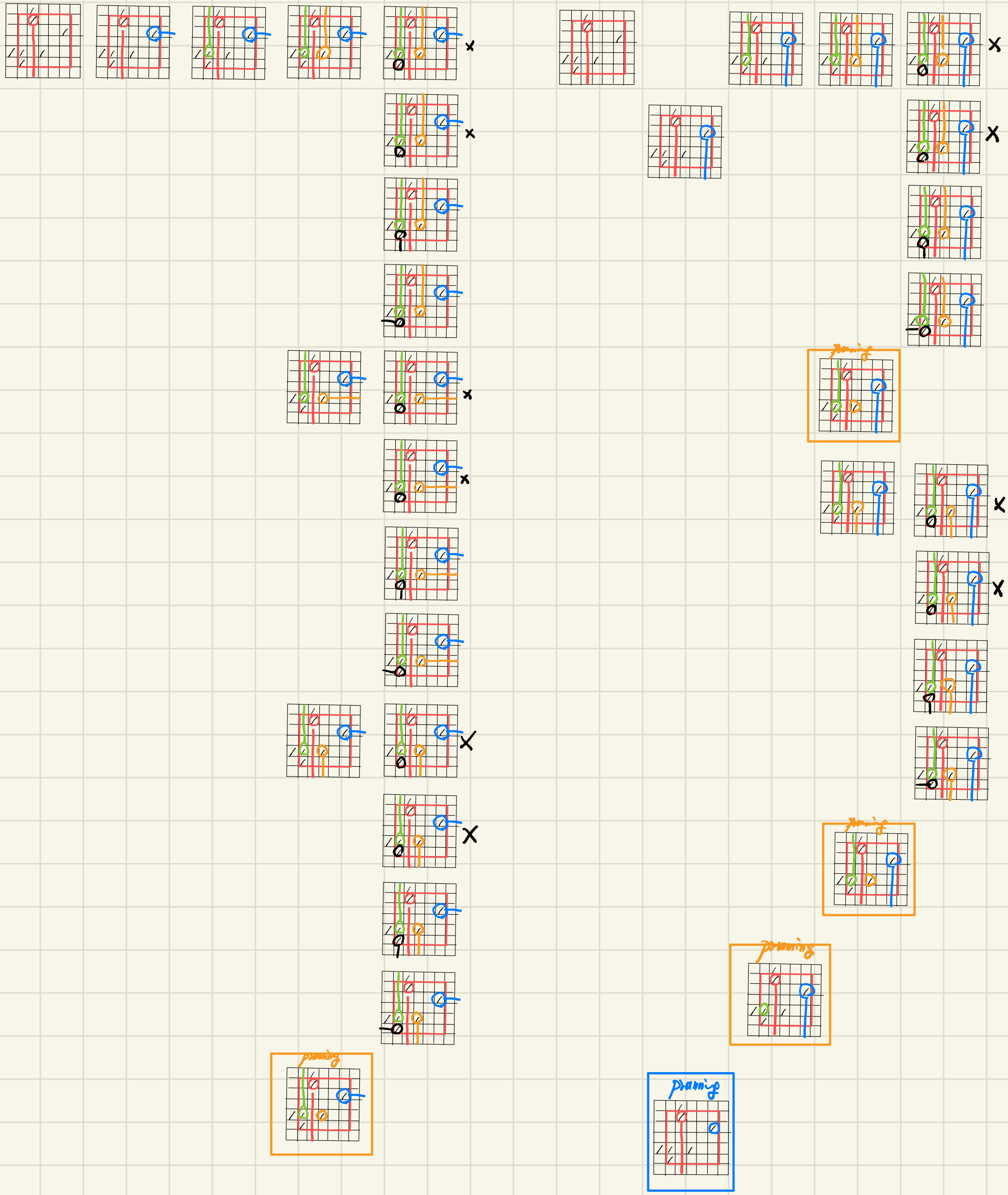
pruning
pruning
pruning



pruning
C3 L10
C4 L15
C4 L11
C4 L11
C4 L14
C4 L10
C4 L10
C3 L8
C3 L8
pruning
pruning
"pruning"
pruning


Pruning
pruning
Pruning
Pruning
pruning
pruning
pruning
pruning


pruning
Pruning
c5 L15
c5 L16
Pruning
c6 L17
c5 L13
c6 L13
c4 L11
c5 L12
c5 L12
pruning
Pruning
pruning
pruning
Pruning


pruning
pruning
pruning
pruning
pruning

res = tsp(1, 0)

f=0

~~1 8 1~~	~~f=0~~
1 8 10	1
1 8 100	2
1 8 1000	3
1 8 10000	4

1P

res = tsp(11, 1) + D[0][1] AB1 18

res = tsp(101, 2) + D[0][2] AC8

res = tsp(1001, 3) + D[0][3] AD7

res = tsp(10001, 4) + D[0][4] AE3

DP[1][0] =

DP[3][1] = 18 f=0,1

[1] res = tsp(111, 2) + D[1][2] 15 BC6

[2] res = tsp(1011, 3) + D[1][3] 14 BD4

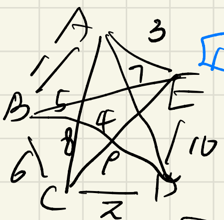
[3] res = tsp(10011, 4) + D[1][4] 18 BE5

f = 0,1,2 101

[4] res = tsp(111, 1) + D[2][1] CB6

[5] res = tsp(1101, 3) + D[2][3] CD2

DP[5][2] [6] res = tsp(10101, 4) + D[2][4] CEP



[1] f=0,1,2 DP[7][2]=15

res = tsp(1111, 3) + D[2][3] 15 13+ CD2

res = tsp(10111, 4) + D[2][4] 26 17 CEP

[2] f=0,1,3 2, 4 12 DC2

14 res = tsp(1111, 2) + D[3][2]

DP[11][3]=14 27 res = tsp(11011, 4) + D[3][4] 17

[3] f=0,1,4 2, 3 DE10

res = tsp(10111, 2) + D[4][2] 18 P

DP[19][4] = 18 res = tsp(11011, 3) + D[4][3] 20 10 ED10

f=0,1,2,3 DP[15][3]=13 DE10 EA3 CEP

res = tsp(11111, 4) + D[3][4] + D[4][0] DEA=13

f=0,1,2,4 DP[23][4]=17 ED10 DA7

res = tsp(11111, 3) + D[4][3] + D[3][0] EDA=17

f=0,1,3,2 4 DP[15][2]=12 CEP EA3

res = tsp(11111, 4) + D[2][4] + D[4][0] CEA=12

f=0,1,3,4 2 DP[27][4]=17 ECP CA8

ECP res = tsp(11111, 2) + D[4][2] + D[2][0] ECA=17

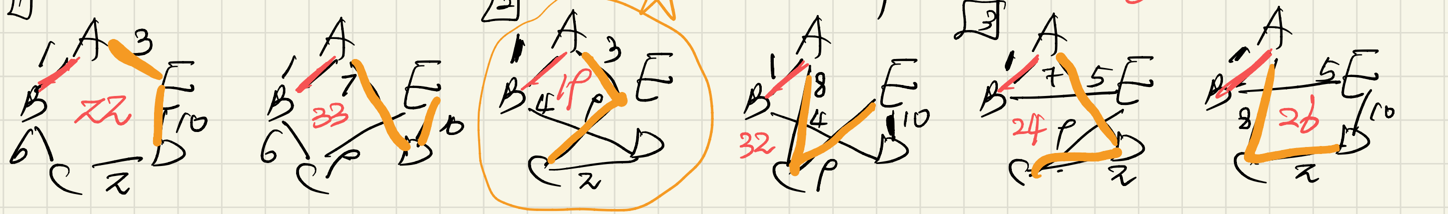
f=0,1,4,2 3 DP[23][2]=P CD2 DA7

res = tsp(11111, 3) + D[2][3] + D[3][0] CDA=P

f=0,1,4,3 2 DP[27][3] DC2 CA8

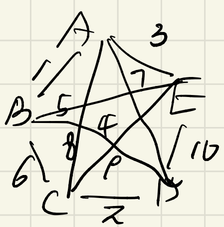
res = tsp(11111, 2) + D[3][2] + D[2][0] 10 DCA=10

[1] [2] [3]



$res = tsp(1, 0)$

$f=0$	~~1 8 1~~	~~$f=0$~~
	1 8 10	1
	1 8 100	2
	1 8 1000	3
	1 8 10000	4



1P ☆ $res = tsp(11, 1) + D[0][1]$ AB 1 — 18

☆☆ $res = tsp(101, 2) + D[0][2]$ AC 8 — 25, 17

$res = tsp(1001, 3) + D[0][3]$ AD 7

$res = tsp(10001, 4) + D[0][4]$ AE 3

$dp[5][2] = 17$

$\boxed{4}$ $res = tsp(111, 1) + D[2][1]$ CB 6 — 28, 22

$\boxed{5}$ $res = tsp(1101, 3) + D[2][3]$ CD 2 — 17, 15

$\boxed{6}$ $res = tsp(10101, 4) + D[2][4]$ CE P — 24, 15

$dp[7][1] = 22$

$f = 0, 2, 1 \quad 3, 4, 13$

$\boxed{4}$ $res = tsp(1111, 3) + D[1][3]$ BDP — 22

$res = tsp(10111, 4) + D[1][4]$ BE 5 — 20, 17

$f = 0, 2, 3, 1, 4$

$\boxed{5}$ $res = tsp(1111, 1) + D[3][1]$ — 15, 8, 7

$res = tsp(11101, 4) + D[3][4]$ — 16, 6, 10

$\boxed{6}$ $f = 0, 2, 4, \quad 1, 3$

$res = tsp(10111, 1) + D[4][1]$ EB 5 — 16, 11

$res = tsp(11101, 3) + D[4][3]$ ED 10 — 15, 5

$dp[13][3] = 15$

$dp[21][4] = 15$

DEA = 13

$dp[15][3] = 13$

$res = tsp(11111, 4) + D[3][4] + D[4][0]$ DE 10, EA 3

$res = tsp(11111, 3) + D[4][3] + D[3][0]$ EDA = 17, ED 10, DA 7

$dp[23][4] = 17$

$dp[15][1] = 8$

$res = tsp(11111, 4) + D[1][4] + D[4][0]$ BE 5, EA 3, BEA = 8

$res = tsp(11111, 1) + D[4][1] + D[1][0]$ EB 5, BA 1

$dp[29][4] = 6$

EBA = 6

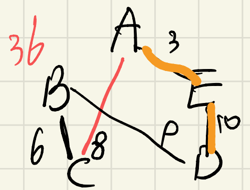
$dp[23][5] = 11$

$res = tsp(11111, 3) + D[1][3] + D[3][0]$ BD 4, DA 7, BDA = 11

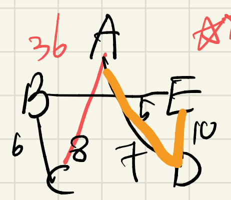
$res = tsp(11111, 1) + D[3][1] + D[1][0]$ DB 4, BA 1, DBA = 5

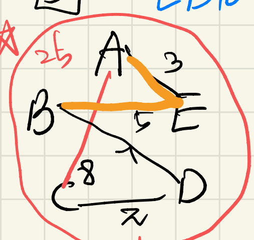
$dp[29][3] = 5$

$\boxed{4}$

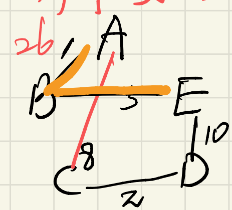


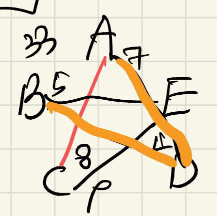
$\boxed{5}$ ☆☆

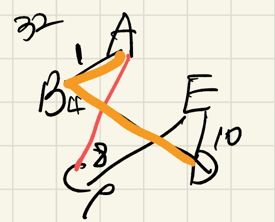




$\boxed{6}$

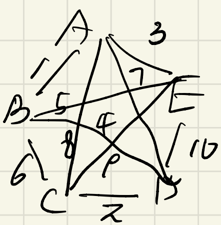






res = fsp(1, 0)

f=0 ~~1 8 1~~ f=0
1 8 10 1
1 8 100 2
1 8 1000 3
1 8 10000 4



1P res = fsp(11, 1) + D[0][1] 18 AB 1

res = fsp(101, 2) + D[0][2] 25 17 AC 8

res = fsp(1001, 3) + D[0][3] 23 16 AD 7

res = fsp(10001, 4) + D[0][4] AE 3

fo3 124

7 res = fsp(1011, 1) + D[3][1] 22 18 DB 4

8 res = fsp(1101, 2) + D[3][2] 16 14 DC 2

9 res = fsp(11001, 4) + D[3][4] 26 16 DE 10

DP[25][2] = 12 CEA = 12 CEP

7 for 031 24 12 BC 6

res = fsp(1111, 2) + D[1][2] 18

DP[11][1] = 18

res = fsp(11011, 4) + D[1][4] 22 17 BE 5

8 for 032 14 8 CB 6

res = fsp(1111, 1) + D[2][1] 14

DP[13][2] = 14

res = fsp(11101, 4) + D[2][4] 15 6 CEP

9 f034 12 EB 5

res = fsp(11011, 1) + D[4][1] 18 14

DP[25][4] = 16

res = fsp(11101, 2) + D[4][2] 16 7 P

f0312 EA 3

res = fsp(11111, 4) + D[2][4] + D[4][0] 12

res = fsp(11111, 2) + D[4][2] + D[2][0] CA 8

17 DP[27][4] = 17 ECP ECA = 17 BE 5 EA 3

DP[15][1] = 8

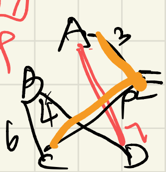
~~res = fsp(11111, 4) + D[1][4] + D[4][0]~~ 2 5 3

res = fsp(11111, 1) + D[4][1] + D[1][0] EBA 6

res = fsp(11111, 2) + D[1][2] + D[2][0] 14 BC 6 CA 8

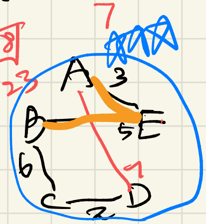
res = fsp(11111, 1) + D[2][1] + D[1][0] 7 CB 6 BA 1

7 28



33

8 23



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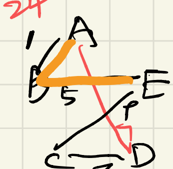
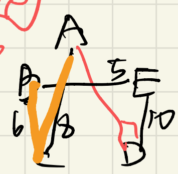


9 36



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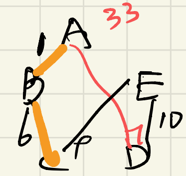


res = tsp(1, 0)

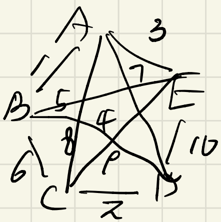
f=0 ~~1 8 1~~ ~~f=0~~

1 8 10 1

1 8 100 2

1 8 1000 3

1 8 10000 4



1P res = tsp(11, 1) + D[0][1] AB1 18

25 res = tsp(101, 2) + D[0][2] AC8 17

23 res = tsp(1001, 3) + D[0][3] AD7 16

1P res = tsp(10001, 4) + D[0][4] AE3 16

f=0,4 1 2 3

[10] res = tsp(10011, 1) + D[4][1] 14 EB5 1P

[11] res = tsp(10101, 2) + D[4][2] 7 EC P 16

[12] res = tsp(11001, 3) + D[4][3] P ED10 1P

f=0,4,1 2,3

[10] res = tsp(10111, 2) + D[1][2] 15 P BC6

res = tsp(11011, 3) + D[1][3] 14 10 BD4

res = tsp(11111, 3) + D[2][3] + D[3][0] P CD2 DA7

res = tsp(11111, 2) + D[3][2] + D[2][0] 10 DC2 CA8

f=0,4,2 1,3

[11] res = tsp(10111, 1) + D[2][1] 17 11 CB6

res = tsp(11101, 3) + D[2][3] 7 5 CD2

res = tsp(11111, 3) + D[1][3] + D[3][0] 4 BD4 DA7

res = tsp(11111, 1) + D[3][1] + D[1][0] 5 DB4 BA1

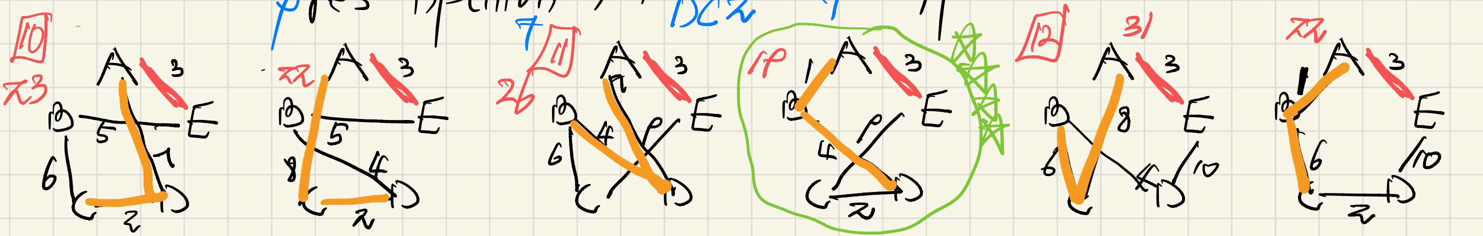
f=0,4,3 1,2

[12] 18 res = tsp(11011, 1) + D[3][1] 14 DB4

P res = tsp(11101, 2) + D[3][2] 7 DC2

res = tsp(11111, 2) + D[1][2] + D[2][0] 14 BC6 CA8

res = tsp(11111, 1) + D[2][1] + D[1][0] 7 CB6 BA1



DEA
DEA
CEA
CDA

EDA
EDA
~~ECA~~
~~DCA~~

CEA
BEA
BEA
BDA

ECA
EBA
EBA
DBA

CDA
BDA
BCA
BCA

~~DCA~~
DBA
CBA
CBA