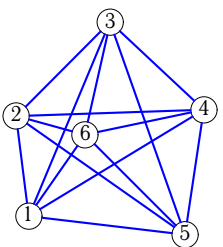


# Алгоритм отжига

Найти длину гамильтонова цикла  $S_4$  в полном графе  $K_6$  после четырех циклов решения задачи методом отжига. Даны расстояния  $L_{i,j}$  между вершинами. Даны также: начальная последовательность вершин  $L_0$ , последовательность замен вершин  $Z$  и выпавшие при этом вероятности перехода  $P_k$ ,  $k = 1, \dots, 4$ . Переход на худшее ( $\Delta S_k = S_k - S_{k-1} > 0$ ) решение допустим, если  $P_* = 100e^{-\Delta S_k/T_k} > P_k$ , где снижение температуры происходит по закону  $T_{k+1} = 0.5T_k$  от  $T_1 = 100$ .

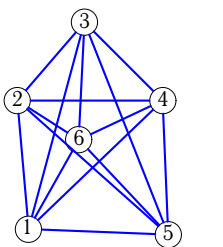
**Задача 13.1.** 3



Ребро	$L_{i,j}$
1-2	19
1-3	39
1-4	38
1-5	29
1-6	18
2-3	25
2-4	35
2-5	39
2-6	13
3-4	24
3-5	42
3-6	21
4-5	24
4-6	23
5-6	26

$V = [1, 4, 3, 5, 6, 2, 1]$ .  
 $Z = [V_5 \rightleftharpoons V_6], [V_2 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2]$ .  
 $P = 50, 62, 50, 74$ .

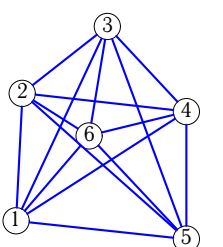
**Задача 13.2.** 3



Ребро	$L_{i,j}$
1-2	24
1-3	40
1-4	35
1-5	26
1-6	19
2-3	19
2-4	27
2-5	38
2-6	13
3-4	21
3-5	43
3-6	22
4-5	25
4-6	17
5-6	24

$V = [1, 3, 5, 4, 6, 2, 1]$ .  
 $Z = [V_2 \rightleftharpoons V_3], [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6]$ .  
 $P = 29, 55, 45, 59$ .

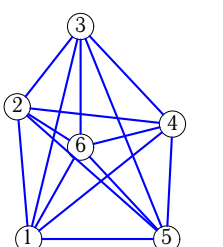
**Задача 13.3.** 3



Ребро	$L_{i,j}$
1-2	24
1-3	40
1-4	38
1-5	32
1-6	21
2-3	20
2-4	31
2-5	41
2-6	15
3-4	22
3-5	42
3-6	21
4-5	24
4-6	19
5-6	26

$V = [1, 3, 5, 2, 4, 6, 1]$ .  
 $Z = [V_4 \rightleftharpoons V_5], [V_3 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2]$ .  
 $P = 30, 99, 78, 107$ .

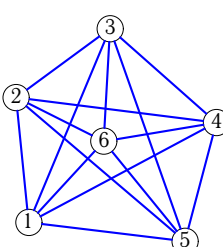
**Задача 13.4.** 3



Ребро	$L_{i,j}$
1-2	25
1-3	41
1-4	34
1-5	26
1-6	20
2-3	19
2-4	29
2-5	37
2-6	14
3-4	25
3-5	43
3-6	22
4-5	21
4-6	18
5-6	23

$V = [1, 3, 5, 4, 6, 2, 1]$ .  
 $Z = [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4], [V_6 \rightleftharpoons V_2]$ .  
 $P = 39, 94, 92, 86$ .

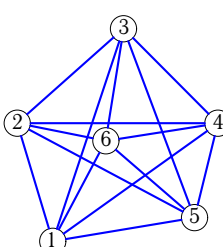
**Задача 13.5.** 3



Ребро	$L_{i,j}$
1-2	23
1-3	39
1-4	40
1-5	29
1-6	21
2-3	22
2-4	38
2-5	41
2-6	18
3-4	26
3-5	42
3-6	21
4-5	23
4-6	21
5-6	24

$V = [1, 4, 5, 3, 2, 6, 1]$ .  
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2]$ .  
 $P = 79, 75, 38, 79$ .

**Задача 13.6.** 3

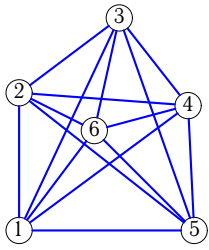


Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	38
1-5	27
1-6	21
2-3	27
2-4	38
2-5	38
2-6	17
3-4	25
3-5	38
3-6	21
4-5	18
4-6	21
5-6	22

$V = [1, 2, 3, 4, 5, 6, 1]$ .  
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2]$ .  
 $P = 35, 64, 97, 54$ .

### Задача 13.7.

3

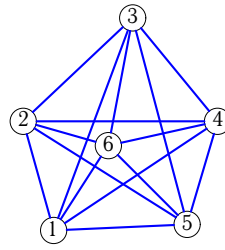


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_2 \rightleftharpoons V_3], [V_3 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_4 \rightleftharpoons V_5].$   
 $P = 25, 89, 83, 91.$

Ребро	$L_{i,j}$
1-2	26
1-3	44
1-4	39
1-5	33
1-6	23
2-3	23
2-4	32
2-5	42
2-6	16
3-4	21
3-5	42
3-6	21
4-5	23
4-6	18
5-6	26

### Задача 13.8.

3

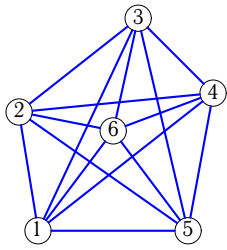


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_4], [V_6 \rightleftharpoons V_2].$   
 $P = 95, 48, 30, 52.$

Ребро	$L_{i,j}$
1-2	21
1-3	42
1-4	37
1-5	25
1-6	19
2-3	28
2-4	36
2-5	36
2-6	16
3-4	25
3-5	40
3-6	24
4-5	20
4-6	21
5-6	21

### Задача 13.9.

3

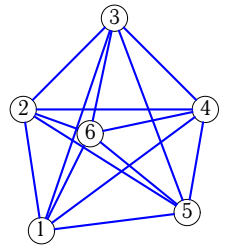


$V = [1, 3, 2, 4, 5, 6, 1].$   
 $Z = [V_2 \rightleftharpoons V_4], [V_3 \rightleftharpoons V_4],$   
 $[V_4 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2].$   
 $P = 39, 53, 25, 47.$

Ребро	$L_{i,j}$
1-2	22
1-3	44
1-4	42
1-5	28
1-6	23
2-3	28
2-4	36
2-5	39
2-6	18
3-4	20
3-5	41
3-6	21
4-5	26
4-6	20
5-6	23

### Задача 13.10.

3

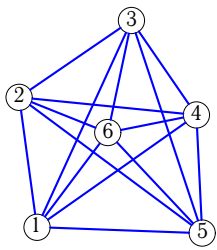


$V = [1, 4, 5, 6, 2, 3, 1].$   
 $Z = [V_2 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_5],$   
 $[V_3 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_6].$   
 $P = 55, 45, 95, 58.$

Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	38
1-5	27
1-6	20
2-3	24
2-4	34
2-5	36
2-6	13
3-4	24
3-5	39
3-6	22
4-5	19
4-6	22
5-6	23

### Задача 13.11.

3

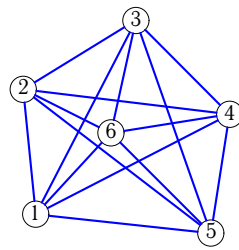


$V = [1, 3, 4, 5, 2, 6, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_5].$   
 $P = 42, 85, 98, 87.$

Ребро	$L_{i,j}$
1-2	24
1-3	43
1-4	36
1-5	31
1-6	22
2-3	25
2-4	33
2-5	43
2-6	18
3-4	21
3-5	42
3-6	21
4-5	22
4-6	17
5-6	26

### Задача 13.12.

3

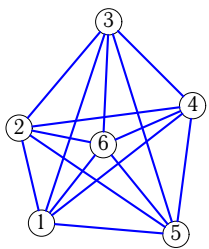


$V = [1, 4, 5, 3, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4].$   
 $P = 39, 75, 24, 87.$

Ребро	$L_{i,j}$
1-2	23
1-3	41
1-4	41
1-5	33
1-6	21
2-3	25
2-4	39
2-5	44
2-6	18
3-4	25
3-5	42
3-6	21
4-5	22
4-6	22
5-6	26

### Задача 13.13.

3

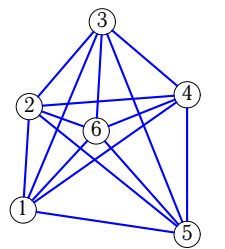


$V = [1, 4, 2, 5, 6, 3, 1].$   
 $Z = [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 21, 43, 32, 54.$

Ребро	$L_{i,j}$
1-2	18
1-3	40
1-4	36
1-5	25
1-6	18
2-3	26
2-4	33
2-5	35
2-6	16
3-4	22
3-5	42
3-6	23
4-5	24
4-6	18
5-6	21

### Задача 13.14.

3

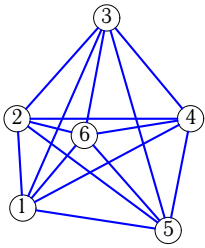


$V = [1, 4, 5, 3, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4].$   
 $P = 25, 58, 98, 46.$

Ребро	$L_{i,j}$
1-2	19
1-3	38
1-4	37
1-5	31
1-6	20
2-3	21
2-4	30
2-5	38
2-6	13
3-4	21
3-5	43
3-6	20
4-5	26
4-6	18
5-6	26

**Задача 13.15.**

3

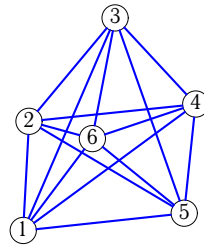


Ребро	$L_{i,j}$
1-2	17
1-3	39
1-4	36
1-5	27
1-6	18
2-3	25
2-4	32
2-5	35
2-6	13
3-4	24
3-5	41
3-6	22
4-5	21
4-6	20
5-6	24

$V = [1, 5, 2, 4, 3, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_5],$   
 $[V_2 \rightleftharpoons V_3], [V_5 \rightleftharpoons V_2].$   
 $P = 37, 40, 87, 35.$

**Задача 13.16.**

3

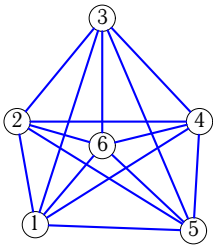


Ребро	$L_{i,j}$
1-2	20
1-3	43
1-4	40
1-5	30
1-6	21
2-3	25
2-4	31
2-5	34
2-6	12
3-4	22
3-5	39
3-6	23
4-5	20
4-6	20
5-6	22

$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_5],$   
 $[V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 66, 32, 70, 36.$

**Задача 13.17.**

3

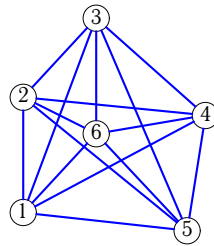


Ребро	$L_{i,j}$
1-2	19
1-3	41
1-4	36
1-5	29
1-6	19
2-3	25
2-4	34
2-5	39
2-6	16
3-4	26
3-5	43
3-6	24
4-5	20
4-6	19
5-6	23

$V = [1, 5, 4, 3, 6, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4],$   
 $[V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 46, 86, 28, 79.$

**Задача 13.18.**

3

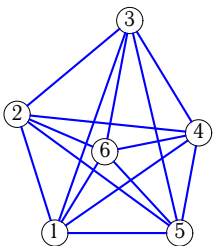


Ребро	$L_{i,j}$
1-2	21
1-3	39
1-4	39
1-5	31
1-6	20
2-3	20
2-4	34
2-5	40
2-6	15
3-4	27
3-5	43
3-6	21
4-5	22
4-6	21
5-6	25

$V = [1, 4, 3, 5, 2, 6, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_2 \rightleftharpoons V_4].$   
 $P = 43, 86, 38, 68.$

**Задача 13.19.**

3

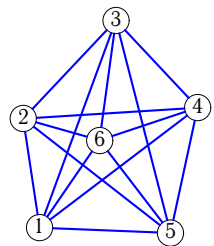


Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	33
1-5	23
1-6	18
2-3	27
2-4	34
2-5	38
2-6	18
3-4	25
3-5	41
3-6	25
4-5	19
4-6	18
5-6	21

$V = [1, 5, 4, 6, 2, 3, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 39, 65, 72, 54.$

**Задача 13.20.**

3

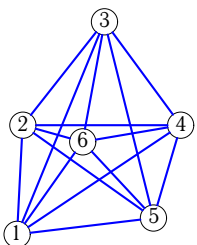


Ребро	$L_{i,j}$
1-2	20
1-3	41
1-4	37
1-5	24
1-6	20
2-3	25
2-4	33
2-5	35
2-6	15
3-4	22
3-5	41
3-6	23
4-5	24
4-6	19
5-6	22

$V = [1, 4, 5, 6, 3, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_5],$   
 $[V_4 \rightleftharpoons V_5], [V_6 \rightleftharpoons V_2].$   
 $P = 92, 30, 50, 31.$

**Задача 13.21.**

3

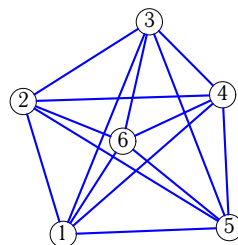


Ребро	$L_{i,j}$
1-2	20
1-3	43
1-4	37
1-5	26
1-6	21
2-3	25
2-4	29
2-5	30
2-6	11
3-4	24
3-5	38
3-6	23
4-5	18
4-6	18
5-6	19

$V = [1, 2, 3, 5, 4, 6, 1].$   
 $Z = [V_2 \rightleftharpoons V_3], [V_3 \rightleftharpoons V_5],$   
 $[V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6].$   
 $P = 33, 77, 43, 81.$

**Задача 13.22.**

3

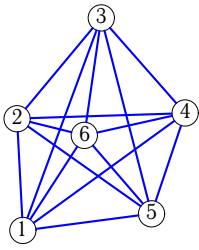


Ребро	$L_{i,j}$
1-2	26
1-3	43
1-4	40
1-5	31
1-6	21
2-3	28
2-4	37
2-5	45
2-6	20
3-4	19
3-5	41
3-6	23
4-5	25
4-6	20
5-6	26

$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_4], [V_2 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_6], [V_4 \rightleftharpoons V_6].$   
 $P = 73, 41, 98, 43.$

### Задача 13.23.

3

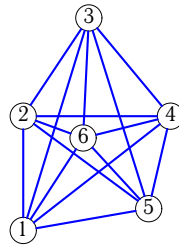


$V = [1, 3, 2, 4, 5, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_5],$   
 $[V_2 \rightleftharpoons V_3], [V_5 \rightleftharpoons V_6].$   
 $P = 87, 53, 80, 36.$

Ребро	$L_{i,j}$
1-2	21
1-3	42
1-4	37
1-5	24
1-6	21
2-3	24
2-4	31
2-5	31
2-6	13
3-4	24
3-5	38
3-6	22
4-5	20
4-6	19
5-6	19

### Задача 13.24.

3

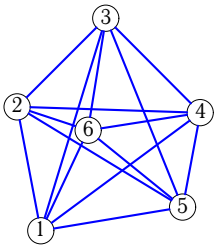


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4],$   
 $[V_2 \rightleftharpoons V_3], [V_5 \rightleftharpoons V_2].$   
 $P = 72, 21, 78, 18.$

Ребро	$L_{i,j}$
1-2	21
1-3	42
1-4	35
1-5	24
1-6	21
2-3	22
2-4	27
2-5	29
2-6	12
3-4	24
3-5	37
3-6	22
4-5	18
4-6	17
5-6	18

### Задача 13.25.

3

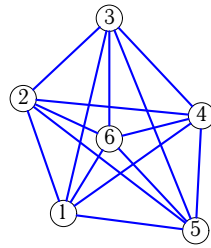


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 44, 37, 82, 44.$

Ребро	$L_{i,j}$
1-2	24
1-3	42
1-4	37
1-5	27
1-6	21
2-3	23
2-4	34
2-5	36
2-6	14
3-4	25
3-5	38
3-6	21
4-5	18
4-6	21
5-6	23

### Задача 13.26.

3

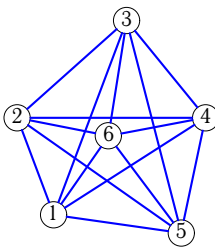


$V = [1, 5, 4, 3, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_3 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 89, 80, 70, 71.$

Ребро	$L_{i,j}$
1-2	23
1-3	38
1-4	32
1-5	25
1-6	16
2-3	22
2-4	33
2-5	41
2-6	18
3-4	25
3-5	43
3-6	22
4-5	21
4-6	18
5-6	23

### Задача 13.27.

3

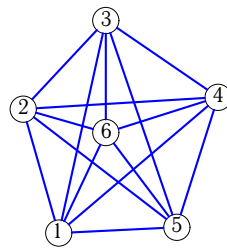


$V = [1, 4, 2, 3, 5, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2],$   
 $[V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 35, 63, 68, 53.$

Ребро	$L_{i,j}$
1-2	19
1-3	39
1-4	34
1-5	24
1-6	18
2-3	27
2-4	35
2-5	37
2-6	17
3-4	23
3-5	41
3-6	22
4-5	22
4-6	18
5-6	23

### Задача 13.28.

3

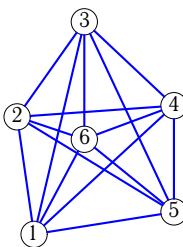


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_5].$   
 $P = 49, 74, 58, 67.$

Ребро	$L_{i,j}$
1-2	24
1-3	41
1-4	39
1-5	22
1-6	21
2-3	23
2-4	36
2-5	36
2-6	16
3-4	25
3-5	41
3-6	21
4-5	25
4-6	22
5-6	22

### Задача 13.29.

3

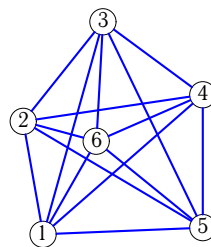


$V = [1, 2, 3, 4, 5, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_3], [V_4 \rightleftharpoons V_5].$   
 $P = 23, 56, 95, 62.$

Ребро	$L_{i,j}$
1-2	22
1-3	41
1-4	36
1-5	26
1-6	20
2-3	22
2-4	29
2-5	34
2-6	13
3-4	23
3-5	39
3-6	22
4-5	20
4-6	18
5-6	21

### Задача 13.30.

3



$V = [1, 4, 3, 5, 6, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_5].$   
 $P = 82, 26, 21, 39.$

Ребро	$L_{i,j}$
1-2	21
1-3	41
1-4	40
1-5	30
1-6	20
2-3	24
2-4	34
2-5	39
2-6	14
3-4	23
3-5	43
3-6	22
4-5	25
4-6	22
5-6	26

**Алгоритм отжига**

№	0	1	2	3	4	5
1	162	174	161	178	164	164
2	162	144	131	153	123	123
3	194	173	163	163	150	150
4	162	187	188	156	158	156
5	166	187	203	160	139	139
6	136	146	167	195	149	149
7	156	170	174	192	188	174
8	145	165	158	133	154	133
9	180	193	175	183	160	160
10	159	162	179	154	170	154
11	169	188	168	156	137	137
12	167	193	186	181	163	163
13	188	174	163	148	155	155
14	158	149	133	161	147	133
15	158	145	128	154	156	128
16	139	152	163	150	161	161
17	134	135	167	150	170	150
18	184	173	183	173	151	151
19	147	164	180	163	159	159
20	151	176	159	157	164	164
21	140	155	147	152	154	154
22	159	175	175	175	182	182
23	157	165	182	157	155	155
24	135	147	150	126	147	147
25	146	165	156	168	165	165
26	134	131	164	142	164	131
27	178	159	156	159	175	159
28	153	170	169	133	150	133
29	128	141	157	170	159	159
30	167	171	150	153	146	146