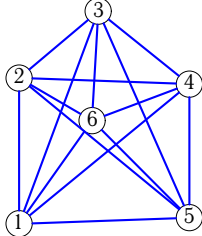


# Алгоритм отжига

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  $T_1 = 100$ .

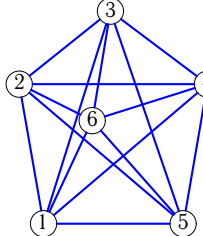
**Задача 13.1.** 2



Ребро	$L_{i,j}$
1-2	27
1-3	42
1-4	41
1-5	32
1-6	24
2-3	19
2-4	32
2-5	41
2-6	16
3-4	22
3-5	42
3-6	20
4-5	25
4-6	19
5-6	26

$V = [1, 2, 4, 3, 5, 6, 1]$ .  
 $Z = [V_2 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_4]$ .  
 $P = 67, 41, 87, 51$ .

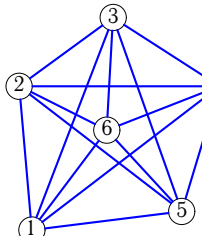
**Задача 13.2.** 2



Ребро	$L_{i,j}$
1-2	26
1-3	42
1-4	40
1-5	26
1-6	21
2-3	22
2-4	35
2-5	40
2-6	15
3-4	23
3-5	42
3-6	21
4-5	26
4-6	23
5-6	26

$V = [1, 3, 4, 2, 5, 6, 1]$ .  
 $Z = [V_2 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_6]$ .  
 $P = 71, 35, 31, 26$ .

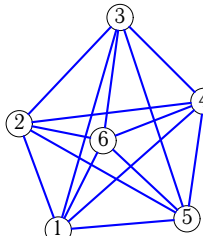
**Задача 13.3.** 2



Ребро	$L_{i,j}$
1-2	27
1-3	43
1-4	44
1-5	28
1-6	23
2-3	22
2-4	37
2-5	38
2-6	18
3-4	24
3-5	38
3-6	21
4-5	24
4-6	22
5-6	21

$V = [1, 3, 5, 4, 6, 2, 1]$ .  
 $Z = [V_4 \rightleftharpoons V_5], [V_3 \rightleftharpoons V_4], [V_2 \rightleftharpoons V_3], [V_5 \rightleftharpoons V_2]$ .  
 $P = 38, 22, 95, 10$ .

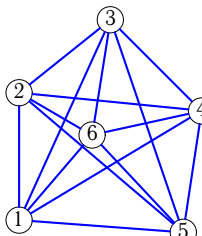
**Задача 13.4.** 2



Ребро	$L_{i,j}$
1-2	21
1-3	41
1-4	36
1-5	24
1-6	19
2-3	27
2-4	35
2-5	36
2-6	16
3-4	22
3-5	40
3-6	23
4-5	22
4-6	20
5-6	21

$V = [1, 4, 2, 5, 6, 3, 1]$ .  
 $Z = [V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2]$ .  
 $P = 80, 82, 94, 65$ .

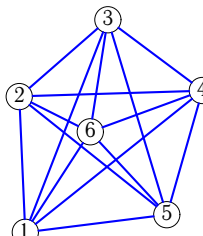
**Задача 13.5.** 2



Ребро	$L_{i,j}$
1-2	24
1-3	41
1-4	40
1-5	31
1-6	21
2-3	22
2-4	34
2-5	40
2-6	16
3-4	24
3-5	42
3-6	22
4-5	23
4-6	21
5-6	25

$V = [1, 3, 4, 5, 6, 2, 1]$ .  
 $Z = [V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_5]$ .  
 $P = 74, 25, 26, 7$ .

**Задача 13.6.** 2

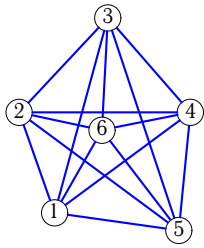


Ребро	$L_{i,j}$
1-2	25
1-3	43
1-4	42
1-5	27
1-6	22
2-3	22
2-4	34
2-5	35
2-6	15
3-4	22
3-5	38
3-6	21
4-5	24
4-6	22
5-6	21

$V = [1, 3, 4, 5, 6, 2, 1]$ .  
 $Z = [V_4 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_6], [V_2 \rightleftharpoons V_3]$ .  
 $P = 88, 73, 74, 80$ .

**Задача 13.7.**

2

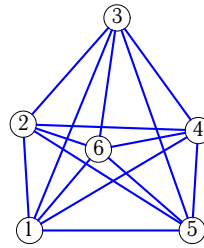


$V = [1, 4, 3, 5, 2, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_5],$   
 $[V_2 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_2].$   
 $P = 45, 31, 70, 36.$

Ребро	$L_{i,j}$
1-2	20
1-3	38
1-4	32
1-5	23
1-6	18
2-3	24
2-4	32
2-5	37
2-6	16
3-4	23
3-5	42
3-6	21
4-5	22
4-6	17
5-6	24

**Задача 13.8.**

2

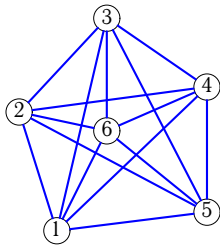


$V = [1, 5, 3, 4, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2],$   
 $[V_4 \rightleftharpoons V_5], [V_2 \rightleftharpoons V_3].$   
 $P = 91, 24, 87, 15.$

Ребро	$L_{i,j}$
1-2	20
1-3	43
1-4	37
1-5	30
1-6	20
2-3	26
2-4	33
2-5	37
2-6	15
3-4	26
3-5	42
3-6	25
4-5	19
4-6	19
5-6	23

**Задача 13.9.**

2

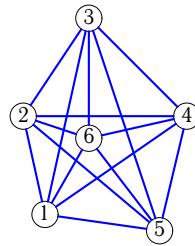


$V = [1, 4, 3, 2, 5, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2],$   
 $[V_6 \rightleftharpoons V_2], [V_4 \rightleftharpoons V_6].$   
 $P = 83, 51, 44, 60.$

Ребро	$L_{i,j}$
1-2	23
1-3	41
1-4	39
1-5	28
1-6	21
2-3	24
2-4	35
2-5	40
2-6	17
3-4	23
3-5	41
3-6	21
4-5	23
4-6	20
5-6	24

**Задача 13.10.**

2

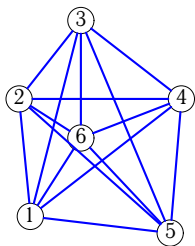


$V = [1, 4, 3, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_3], [V_4 \rightleftharpoons V_5].$   
 $P = 24, 55, 71, 54.$

Ребро	$L_{i,j}$
1-2	19
1-3	38
1-4	32
1-5	22
1-6	16
2-3	22
2-4	31
2-5	33
2-6	13
3-4	26
3-5	42
3-6	22
4-5	22
4-6	19
5-6	22

**Задача 13.11.**

2

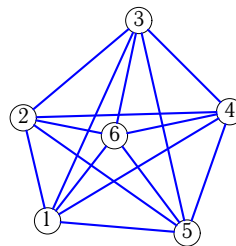


$V = [1, 3, 5, 4, 6, 2, 1].$   
 $Z = [V_2 \rightleftharpoons V_3], [V_3 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2].$   
 $P = 97, 83, 49, 83.$

Ребро	$L_{i,j}$
1-2	22
1-3	38
1-4	36
1-5	26
1-6	17
2-3	18
2-4	30
2-5	38
2-6	13
3-4	24
3-5	43
3-6	22
4-5	25
4-6	20
5-6	24

**Задача 13.12.**

2

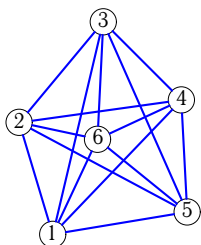


$V = [1, 4, 2, 5, 6, 3, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6],$   
 $[V_3 \rightleftharpoons V_5], [V_6 \rightleftharpoons V_2].$   
 $P = 48, 39, 76, 34.$

Ребро	$L_{i,j}$
1-2	20
1-3	41
1-4	40
1-5	26
1-6	20
2-3	28
2-4	39
2-5	37
2-6	17
3-4	24
3-5	41
3-6	22
4-5	24
4-6	22
5-6	23

**Задача 13.13.**

2

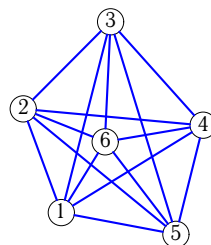


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_4 \rightleftharpoons V_6],$   
 $[V_6 \rightleftharpoons V_2], [V_2 \rightleftharpoons V_4].$   
 $P = 82, 84, 40, 89.$

Ребро	$L_{i,j}$
1-2	22
1-3	41
1-4	35
1-5	25
1-6	20
2-3	24
2-4	31
2-5	36
2-6	15
3-4	21
3-5	39
3-6	22
4-5	21
4-6	17
5-6	21

**Задача 13.14.**

2

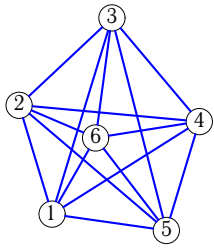


$V = [1, 5, 3, 6, 2, 4, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_2],$   
 $[V_6 \rightleftharpoons V_2], [V_4 \rightleftharpoons V_5].$   
 $P = 27, 75, 84, 78.$

Ребро	$L_{i,j}$
1-2	21
1-3	37
1-4	31
1-5	22
1-6	15
2-3	23
2-4	34
2-5	37
2-6	16
3-4	26
3-5	42
3-6	22
4-5	21
4-6	18
5-6	22

**Задача 13.15.**

2

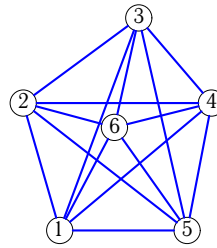


$V = [1, 4, 5, 6, 3, 2, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_3 \rightleftharpoons V_4],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 22, 52, 33, 61.$

Ребро	$L_{i,j}$
1-2	21
1-3	38
1-4	32
1-5	22
1-6	16
2-3	24
2-4	34
2-5	36
2-6	15
3-4	25
3-5	41
3-6	23
4-5	21
4-6	19
5-6	22

**Задача 13.16.**

2

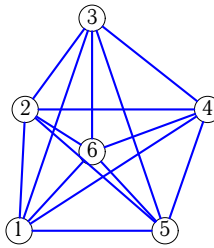


$V = [1, 2, 3, 4, 5, 6, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_4], [V_6 \rightleftharpoons V_2].$   
 $P = 48, 79, 79, 73.$

Ребро	$L_{i,j}$
1-2	25
1-3	42
1-4	37
1-5	24
1-6	22
2-3	27
2-4	35
2-5	39
2-6	17
3-4	21
3-5	41
3-6	21
4-5	24
4-6	19
5-6	24

**Задача 13.17.**

2

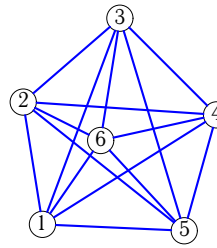


$V = [1, 4, 5, 6, 2, 3, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_4], [V_6 \rightleftharpoons V_2].$   
 $P = 95, 31, 64, 23.$

Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	42
1-5	27
1-6	20
2-3	21
2-4	34
2-5	35
2-6	15
3-4	27
3-5	42
3-6	25
4-5	24
4-6	23
5-6	20

**Задача 13.18.**

2

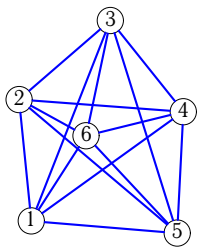


$V = [1, 4, 3, 5, 6, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_2 \rightleftharpoons V_3],$   
 $[V_4 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4].$   
 $P = 62, 90, 42, 88.$

Ребро	$L_{i,j}$
1-2	23
1-3	41
1-4	38
1-5	26
1-6	19
2-3	24
2-4	36
2-5	39
2-6	16
3-4	25
3-5	42
3-6	23
4-5	22
4-6	22
5-6	23

**Задача 13.19.**

2

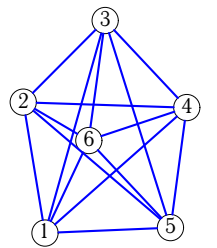


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_4], [V_4 \rightleftharpoons V_5],$   
 $[V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2].$   
 $P = 29, 89, 72, 85.$

Ребро	$L_{i,j}$
1-2	23
1-3	40
1-4	35
1-5	27
1-6	19
2-3	22
2-4	31
2-5	39
2-6	14
3-4	22
3-5	42
3-6	22
4-5	23
4-6	19
5-6	25

**Задача 13.20.**

2

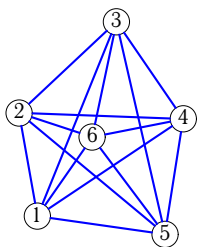


$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_5],$   
 $[V_2 \rightleftharpoons V_4], [V_5 \rightleftharpoons V_2].$   
 $P = 79, 45, 32, 28.$

Ребро	$L_{i,j}$
1-2	25
1-3	41
1-4	35
1-5	23
1-6	19
2-3	22
2-4	31
2-5	36
2-6	14
3-4	22
3-5	41
3-6	23
4-5	23
4-6	19
5-6	22

**Задача 13.21.**

2

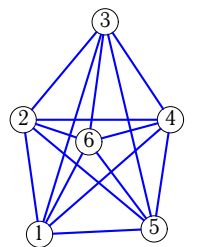


$V = [1, 4, 3, 5, 2, 6, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_4 \rightleftharpoons V_6],$   
 $[V_6 \rightleftharpoons V_2], [V_2 \rightleftharpoons V_3].$   
 $P = 26, 68, 36, 54.$

Ребро	$L_{i,j}$
1-2	19
1-3	39
1-4	33
1-5	24
1-6	18
2-3	25
2-4	31
2-5	35
2-6	14
3-4	22
3-5	41
3-6	22
4-5	22
4-6	17
5-6	23

**Задача 13.22.**

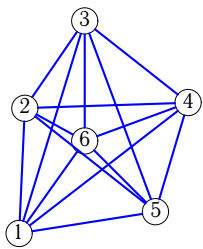
2



$V = [1, 2, 3, 4, 5, 6, 1].$   
 $Z = [V_4 \rightleftharpoons V_6], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_3], [V_6 \rightleftharpoons V_2].$   
 $P = 39, 96, 46, 78.$

Ребро	$L_{i,j}$
1-2	22
1-3	42
1-4	32
1-5	21
1-6	19
2-3	24
2-4	27
2-5	32
2-6	13
3-4	22
3-5	40
3-6	23
4-5	20
4-6	16
5-6	20

**Задача 13.23.**

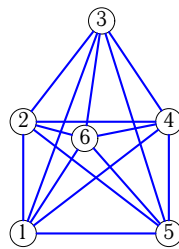


$V = [1, 2, 4, 5, 6, 3, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_6],$   
 $[V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2].$   
 $P = 35, 61, 96, 69.$

Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	40
1-5	26
1-6	21
2-3	20
2-4	31
2-5	31
2-6	13
3-4	25
3-5	38
3-6	22
4-5	21
4-6	21
5-6	19

2

**Задача 13.24.**

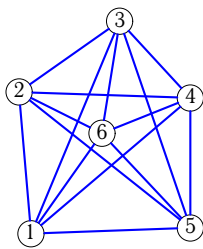


$V = [1, 3, 4, 5, 2, 6, 1].$   
 $Z = [V_5 \rightleftharpoons V_2], [V_3 \rightleftharpoons V_4],$   
 $[V_2 \rightleftharpoons V_3], [V_4 \rightleftharpoons V_6].$   
 $P = 72, 22, 22, 7.$

Ребро	$L_{i,j}$
1-2	21
1-3	42
1-4	34
1-5	27
1-6	21
2-3	24
2-4	27
2-5	34
2-6	12
3-4	23
3-5	42
3-6	22
4-5	21
4-6	16
5-6	24

2

**Задача 13.25.**

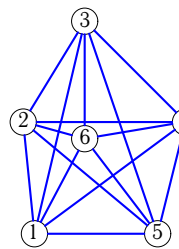


$V = [1, 2, 5, 3, 4, 6, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4],$   
 $[V_4 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 30, 36, 86, 20.$

Ребро	$L_{i,j}$
1-2	27
1-3	43
1-4	39
1-5	30
1-6	23
2-3	23
2-4	32
2-5	41
2-6	17
3-4	19
3-5	41
3-6	21
4-5	24
4-6	18
5-6	24

2

**Задача 13.26.**

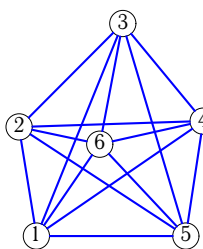


$V = [1, 2, 3, 4, 5, 6, 1].$   
 $Z = [V_4 \rightleftharpoons V_5], [V_5 \rightleftharpoons V_6],$   
 $[V_2 \rightleftharpoons V_4], [V_6 \rightleftharpoons V_2].$   
 $P = 45, 56, 32, 56.$

Ребро	$L_{i,j}$
1-2	21
1-3	41
1-4	35
1-5	23
1-6	20
2-3	22
2-4	30
2-5	33
2-6	12
3-4	27
3-5	42
3-6	22
4-5	21
4-6	19
5-6	22

2

**Задача 13.27.**

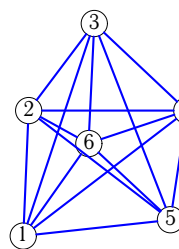


$V = [1, 4, 3, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_6],$   
 $[V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2].$   
 $P = 36, 41, 29, 30.$

Ребро	$L_{i,j}$
1-2	21
1-3	43
1-4	38
1-5	28
1-6	21
2-3	27
2-4	34
2-5	37
2-6	15
3-4	24
3-5	41
3-6	23
4-5	22
4-6	20
5-6	23

2

**Задача 13.28.**

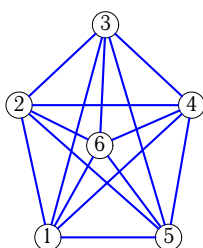


$V = [1, 2, 4, 5, 3, 6, 1].$   
 $Z = [V_5 \rightleftharpoons V_6], [V_3 \rightleftharpoons V_4],$   
 $[V_4 \rightleftharpoons V_5], [V_6 \rightleftharpoons V_2].$   
 $P = 86, 78, 76, 66.$

Ребро	$L_{i,j}$
1-2	23
1-3	42
1-4	39
1-5	28
1-6	21
2-3	20
2-4	29
2-5	33
2-6	13
3-4	24
3-5	39
3-6	22
4-5	20
4-6	19
5-6	21

2

**Задача 13.29.**

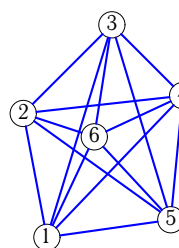


$V = [1, 3, 5, 4, 6, 2, 1].$   
 $Z = [V_5 \rightleftharpoons V_2], [V_6 \rightleftharpoons V_2],$   
 $[V_2 \rightleftharpoons V_3], [V_4 \rightleftharpoons V_5].$   
 $P = 24, 64, 32, 60.$

Ребро	$L_{i,j}$
1-2	25
1-3	41
1-4	36
1-5	22
1-6	20
2-3	22
2-4	32
2-5	37
2-6	17
3-4	22
3-5	41
3-6	22
4-5	25
4-6	19
5-6	21

2

**Задача 13.30.**



$V = [1, 3, 4, 5, 6, 2, 1].$   
 $Z = [V_3 \rightleftharpoons V_5], [V_4 \rightleftharpoons V_6],$   
 $[V_5 \rightleftharpoons V_6], [V_6 \rightleftharpoons V_2].$   
 $P = 43, 65, 50, 64.$

Ребро	$L_{i,j}$
1-2	24
1-3	42
1-4	37
1-5	23
1-6	21
2-3	23
2-4	30
2-5	34
2-6	14
3-4	19
3-5	38
3-6	21
4-5	23
4-6	18
5-6	21

2

**Алгоритм отжига**

№	0	1	2	3	4	5
1	173	187	177	142	145	145
2	187	173	157	146	179	146
3	172	188	173	170	172	172
4	192	156	174	130	148	130
5	153	175	172	159	137	137
6	150	162	169	166	136	136
7	168	154	154	141	168	141
8	152	144	163	163	159	159
9	171	168	198	184	167	167
10	154	156	166	150	179	150
11	161	148	134	165	148	134
12	202	178	191	170	191	170
13	141	154	155	143	159	143
14	167	154	150	182	168	150
15	143	153	156	165	182	165
16	143	152	170	170	143	143
17	164	195	155	135	154	135
18	167	179	162	169	187	169
19	147	161	180	134	148	134
20	147	165	167	179	146	146
21	163	152	141	154	179	154
22	127	141	126	136	146	136
23	158	143	130	160	146	130
24	153	154	142	154	152	152
25	169	187	172	141	152	152
26	133	145	161	153	141	141
27	162	170	169	165	167	167
28	154	157	159	162	173	162
29	168	135	151	155	142	142
30	143	161	153	171	149	149