## **Contents**

2-level optimisation by Quine-McCluskey method



## **Section outline**

- 2-level optimisation by Quine-McCluskey method
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- QM ex-1
- QM ex-2
- QM ex-3
- QM ex-4



## QM method

- Partition cubes into groups \( \lambda m : 1, n : D \) of m on-set and n DC-set minterms
- Combine adjacent terms between groups (matching in the position of 1's and don't cares) to get prime implicants
- Cover on-set minterms using prime implicants
  - reduce table by row dominance
     C<sub>1</sub> dominates C<sub>2</sub> if C<sub>1</sub> covers every on-set minterm covered by C<sub>2</sub>
  - reduce table by column dominance
     m<sub>2</sub> is dominated m<sub>1</sub> if any P covering m<sub>1</sub> also covers m<sub>2</sub>
     however, if C<sub>2</sub> is a bigger cube (due to DCs) it may still be retained
  - reduce table by dropping essential PMs
  - finally apply branch and bound (recursive application of covering needed)
     arbitrarily decide to keep or not to keep a cube bound exploration if the cost matches or exceeds the cost of an explored solution
  - Petrick's method may be used to generate all possible covers (especially for the cyclic core)



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨0 : 1, 0 : D⟩					
m	а	b	С	d	
0	0	0	0	0	
⟨1 : 1, 0 : D⟩					
(1:1)	, 0 : L	<b>)</b> >			
(1 : 1) m		<b>b</b>	С	d	





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨0 : 1, 0 : D⟩					
m	а	b	С	d	
0	0	0	0	0	
⟨1 : 1	, <b>0</b> : <b>I</b>	$\overline{O}$			
m	a	b	С	d	



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨0 : 1, 0 : D⟩				
m	а	b	С	d
0	0	0	0	0
⟨1 : 1,	0 : [	$\rangle$		
⟨1 : 1, <b>m</b>		<u>b</u>	С	d

⟨0 : 1, 1 : D⟩					
cube	а	b	С	d	
0, 8	-	0	0	0	





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

$\langle 1:1,0:D \rangle$					
m	а	b	С	d	
8	1	0	0	0	
⟨2 : 1, 0 : D⟩					
m	а	<del>_</del>	С	d	
<b>m</b> 5		<del>_</del>	<b>c</b>	<b>d</b>	
	а	b		<b>d</b> 1	





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨1 : 1,0 : D⟩					
m	а	b	С	d	
8	1	0	0	0	
⟨2 : 1, 0 : D⟩					
		/			
m	а	•	С	d	
<b>m</b> 5		•	<b>c</b>	<b>d</b>	
m	а	b		<b>d</b> 1	





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

$\langle 1:1,0:D\rangle$					
m	а	b	С	d	
8	1	0	0	0	
⟨2 : 1, 0 : D⟩					
m	а		С	d	
<b>m</b> 5			<b>c</b>	<b>d</b>	
m	а	b		<b>d</b> 1 1	

⟨1 : 1,1 : D⟩					
cube	а	b	С	d	
8, 9	1	0	0	-	





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

$\langle 1:1,0:D\rangle$					
m	а	b	С	d	
8	1	0	0	0	
⟨2 : 1, 0 : D⟩					
,		/			
m	а	•	С	d	
		•	<b>c</b>	<b>d</b>	
m	а	b		<b>d</b> 1	

$\langle 1:1,1:D\rangle$					
cube	а	b	С	d	
8, 9	1	0	0	-	
8. 10	1	0	_	0	





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩					
m	а	b	С	d	
5	0	1	0	1	
9	1	0	0	1	
10	1	0	1	0	
⟨3:1,	0 : [	O			
m	а	b	С	d	
11	1	0	1	1	
14	1	1	1	0	



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩					
m	а	b	С	d	
5	0	1	0	1	
9	1	0	0	1	
10	1	0	1	0	
⟨3:1,	0 : [	O			
m	а	b	С	d	
11	1	0	1	1	
14	1	1	1	0	



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
5	0	1	0	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	O				
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		

⟨2 : 1, 1 : D⟩						
cube	í	3	b	С	d	
9, 11		1	0	-	1	



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
5	0	1	0	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\rangle$				
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		

⟨2:1,1:D⟩					
cube	а	b	С	d	
9, 11	1	0	-	1	
10, 11	1	0	1	-	





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨2:1,0:D⟩						
m	а	b	С	d		
5	0	1	0	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	O				
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		

⟨2 : 1,1 : D⟩					
cube	а	b	С	d	
9, 11	1	0	-	1	
10, 11	1	0	1	-	
10, 14	1	-	1	0	





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨3 : 1, 0 : D⟩						
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		
<b>⟨4:1</b> ,						
m	а	b	С	d		
15	1	1	1	1		



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨3:1,0:D⟩						
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		
<b>⟨4:1</b> ,	0 : [	O				
m	а	b	С	d		
15	1	1	1	1		



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨3 : 1, 0 : D⟩							
m	m abcd						
11	1	0	1	1			
14	1	1	1	0			
⟨4:1,	0 : [	$\overline{O}$					
m	а	b	С	d			
15	1	1	1	1			

⟨3 : 1,1 : D⟩						
cube	а	b	С	d		
11, 15	1	-	1	1		



$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

⟨3 : 1, 0 : D⟩						
m	а	b	С	d		
11	1	0	1	1		
14	1	1	1	0		
⟨4:1,						
m	а	b	С	d		
15	1	1	1	1		

⟨3 : 1, 1 : D⟩						
cube	а	b	С	d		
11, 15	1	-	1	1		
14. 15	1	1	1	_		



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 1 : 1, 1 : D \rangle$					
cube		b	С	d	
8, 9	1	0	0	-	
8, 10	1	0	-	0	
⟨2 : 1, 1 : D⟩					
⟨2:1,	1 : D	$\rangle$			
(2 : 1, cube	1 : D	<del>_</del>	С	d	
•		b	<b>C</b>	<b>d</b>	
cube	а	b	<b>c</b> -	<b>d</b> 1	



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 1:1,1:D \rangle$						
cube	а	b	С	d		
8, 9	1	_	0	-		
8, 10	1	0	-	0		
⟨2:1,1:D⟩						
⟨∠ . Ⅰ,	1 : L	<i>)</i>				
cube	a		С	d		
•		b	<b>C</b>	<b>d</b>		
cube	а	b	<b>c</b> -	<b>d</b> 1		



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 1 : 1, 1 : D \rangle$						
cube	а		С	d		
8, 9	1		0	-		
8, 10	1	0	-	0		
⟨2:1,	1 : C	$\rangle$				
cube	а		С	d		
9, 11	1	0	-	1		
10, 11	1	0	1	_		

⟨1 : 1,2 : D⟩				
cube	a b c d			
8, 9, 10, 11	10			





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 1:1,1:D \rangle$						
cube	а	b	С	d		
8, 9	1	0	0	-		
8, 10	1	0	-	0		
⟨2:1,	1 : C	$\rangle$				
cube	а	b	С	d		
9, 11	1	0	_	1		
9, 11		U		•		
10, 11	1	0	1	-		

⟨1 : 1,2 : D⟩				
cube	a b c d			
8, 9, 10, 11	10			
8. 10. 9. 11	1 0			





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 2:1,1:D \rangle$						
cube		a	b	С	d	
9, 11		1	0	-	1	
10, 11		1	0	1	-	
10, 14		1	-	1	0	
⟨3:1,	1	: C	$\rangle$			
cube		a	b	С	d	
11, 15		1	-	1	1	
14, 15		1	1	1	-	



$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 2:1,1:D \rangle$						
cube		b	С	d		
9, 11		1 0	-	1		
10, 11		1 0	1	-		
10, 14		1 -	1	0		
⟨3:1,	1:	$D \rangle$				
cube	а	b	С	d		
11, 15		1 -	1	1		
14, 15		1 1	1	-		





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

$\langle 2:1,1:D \rangle$						
cube	а	b	С	d		
9, 11	1	0	-	1		
10, 11	1	0	1	-		
10, 14	1	-	1	0		
⟨3:1,	1 : [	$\rangle$				
cube	а	b	С	d		
11, 15	1	-	1	1		
14, 15	1	1	1	-		

⟨2 : 1,2 : D⟩					
cube	а	b	С	d	
10,11,14,15	1	-	1	-	





$$f(a,b,c,d) = \sum_{m} (0,5,8,9,10,11,14,15)$$

⟨2 : 1, 1 : D⟩						
cube		b	С	d		
9, 11	1	0	-	1		
10, 11	1	0	1	-		
10, 14	1	-	1	0		
⟨3:1,	1 : [	$\rangle$				
cube	а	b	С	d		
11, 15	1	-	1	1		
14, 15	1	1	1	-		

⟨2 : 1,2 : D⟩						
cube	а	b	С	d		
10,11,14,15	1	-	1	-		
10,14,11,15	1	-	1	-		





$$f(a, b, c, d) = \sum_{m} (0, 5, 8, 9, 10, 11, 14, 15)$$

Pls	0	5	8	9	10	11	14	15
8, 9, 10, 11			Х	$ \mathbf{X} $	X	X		
10, 11, 14, 15					Х	X	X	X
0, 8	X		Х					
5		$\mathbf{x}$						

$$f = a\bar{b} + ac + \bar{b}\bar{c}\bar{d} + \bar{a}b\bar{c}d$$

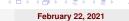




$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

$\langle 1:1,0:D \rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : C	$\rangle$					
⟨2:1, <b>m</b>	0 : [ <b>a</b>	) <b>b</b>	С	d			
			<b>C</b>	<b>d</b>			
m	а	b		<b>d</b> 1			





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D \rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,0:D⟩							
⟨2:1,	0 : <b>C</b>	$\overline{O}$					
⟨2:1, <b>m</b>	0 : C <b>a</b>	) <b>b</b>	С	d			
•			<b>C</b>	<b>d</b>			
m	а	b		<b>d</b> 1			



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D\rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : C	$\rangle$					
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

$\langle 1:1,1:D \rangle$							
cube	а	b	С	d			
1, 3	0	0	-	1			



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D\rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : C	$\rangle$					
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

⟨1 : 1, 1 : D⟩						
cube	а	b	С	d		
1, 3	0	0	-	1		
1, 9	-	0	0	1		



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D\rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : [	$\rangle$					
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

$\langle 1:1,1:D \rangle$						
cube	а	b	С	d		
1, 3	0	0	-	1		
1, 9	-	0	0	1		
2, 3	0	0	1	-		



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D\rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : C	$\rangle$					
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

⟨1 : 1, 1 : D⟩						
cube	а	b	С	d		
1, 3	0	0	-	1		
1, 9	-	0	0	1		
2, 3	0	0	1	-		
2, 10	-	0	1	0		





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨1 : 1, 0 : D⟩							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2:1,	0 : C	$\rangle$					
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

$\langle 1:1,1:D\rangle$						
cube	а	b	С	d		
1, 3	0	0	-	1		
1, 9	-	0	0	1		
2, 3	0	0	1	-		
2, 10	-	0	1	0		
8, 9	1	0	0	-		





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 1:1,0:D\rangle$							
m	а	b	С	d			
1	0	0	0	1			
2	0	0	1	0			
8	1	0	0	0			
⟨2 : 1, 0 : D⟩							
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			

/4 4	4 6	. \					
⟨1 : 1,1 : D⟩							
cube	а	b	С	d			
1, 3	0	0	-	1			
1, 9	-	0	0	1			
2, 3	0	0	1	-			
2, 10	-	0	1	0			
8, 9	1	0	0	-			
8, 10	1	0	-	0			





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩							
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			
⟨3:1,0:D⟩							
⟨3:1,	0 : <b>C</b>	$\rangle$					
⟨3 : 1, <b>m</b>	0 : C	) <b>b</b>	С	d			
-			<b>C</b>	<b>d</b>			
m	а	b		<b>d</b> 1 1			



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩							
m	а	b	С	d			
3	0	0	1	1			
9	1	0	0	1			
10	1	0	1	0			
⟨3:1,0:D⟩							
⟨3:1,	0 : C	$\rangle$					
⟨3:1, <b>m</b>	0 : C	) <b>b</b>	С	d			
•			<b>c</b>	<b>d</b>			
m	а	b		<b>d</b> 1			



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
3	0	0	1	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\rangle$				
m	а	b	С	d		
7	0	1	1	1		
11	1	0	1	1		
14	1	1	1	0		

⟨2 : 1,1 : D⟩ <b>cube</b>   <b>a b c d</b>						
а	b	С	d			
0	-	1	1			
			1 : D> <b>a b c</b> 0 - 1			



$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
3	0	0	1	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\rangle$				
m	а	b	С	d		
7	0	1	1	1		
11	1	0	1	1		
14	1	1	1	0		

⟨2 : 1, 1 : D⟩						
cube	а	b	С	d		
3, 7	0	-	1	1		
3, 11	-	0	1	1		



$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
3	0	0	1	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\rangle$				
m	а	b	С	d		
7	0	1	1	1		
11	1	0	1	1		
14	1	1	1	0		

⟨2 : 1,1 : D⟩						
cube	а	b	С	d		
3, 7	0	-	1	1		
3, 11	-	0	1	1		
9, 11	1	0	-	1		



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 2:1,0:D \rangle$						
m	а	b	С	d		
3	0	0	1	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\overline{O}$				
m	а	b	С	d		
7	0	1	1	1		
11	1	0	1	1		
14	1	1	1	0		

⟨2:1,1:D⟩					
cube	а	b	С	d	
3, 7	0	-	1	1	
3, 11	-	0	1	1	
9, 11	1	0	-	1	
10, 11	1	0	1	-	



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2 : 1, 0 : D⟩						
m	а	b	С	d		
3	0	0	1	1		
9	1	0	0	1		
10	1	0	1	0		
⟨3:1,	0 : [	$\rangle$				
m	а	b	С	d		
7	0	1	1	1		
11	1	0	1	1		
14	1	1	1	0		

⟨2:1,1:D⟩					
cube	а	b	С	d	
3, 7	0	-	1	1	
3, 11	-	0	1	1	
9, 11	1	0	-	1	
10, 11	1	0	1	-	
10, 14	1	-	1	0	



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 3:1,0:D \rangle$					
m	а	b	С	d	
7	0	1	1	1	
11	1	0	1	1	
14	1	1	1	0	
<b>⟨4:1</b> ,	0 : [	$\overline{O}$			
	_	h	_	d	
III	а	b	С	u	





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 3:1,0:D \rangle$					
m	а	b	С	d	
7	0	1	1	1	
11	1	0	1	1	
14	1	1	1	0	
<b>⟨4:1</b> ,	0 : [	$\overline{O}$			
m	а	b	С	d	
15	1	1	1	1	





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨3:1,	0 : C	$\rangle$		
m	а	b	С	d
7	0	1	1	1
11	1	0	1	1
14	1	1	1	0
⟨4:1,	0 : C	$\rangle$		
m	а	b	С	d
15	1	1	1	1

⟨3:1,	1 : [	O		
cube	а	b	С	d
7, 15	-	1	1	1



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle \mathtt{3} : \mathtt{1}, \mathtt{0} : D \rangle$					
m	а	b	С	d	
7	0	1	1	1	
11	1	0	1	1	
14	1	1	1	0	
⟨4:1,	0 : [	$\rangle$			
m	а	b	С	d	
15	1	1	1	1	

⟨3:1,	1 : [	O		
cube	а	b	С	d
7, 15	-	1	1	1
11, 15	1	-	1	1



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

$\langle 3:1,0:D \rangle$				
m	а	b	С	d
7	0	1	1	1
11	1	0	1	1
14	1	1	1	0
⟨ <b>4</b> : <b>1</b> ,	0 : E			
m	а	b	С	d
15	1	1	1	1

⟨3:1,	1 : [	$\rangle$		
cube	а	b	С	d
7, 15	-	1	1	1
11, 15	1	-	1	1
14, 15	1	1	1	-





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨1 : 1,	1 : C	$\rangle$		
cube	а	b	С	d
1, 3	0	0	-	1
1, 9	-	0	0	1
2, 3	0	0	1	-
2, 10	-	0	1	0
8, 9	1	0	0	-
8, 10	1	0		$\overline{}$
0, 10	I	U		0
⟨2 : 1,				
			C	d
⟨2:1,	1 : C	$\rangle$	<b>c</b>	
⟨2 : 1, cube	1 : C	$\rangle$		d
⟨2 : 1, <b>cube</b> 3, 7	1 : C	b -	1	<b>d</b>
(2:1, <b>cube</b> 3,7 3,11	1 : C a 0	<b>b</b> - 0	1	<b>d</b> 1

$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨ <b>1</b> : <b>1</b> ,	1 : C	$\rangle$		
cube	а	b	С	d
1, 3	0	0	-	1
1, 9	-	0	0	1
2, 3	0	0	1	-
2, 10	-	0	1	0
8, 9	1	0	0	-
8, 10	1	0	-	0
⟨2 : 1,	<u>1 · Г</u>	<u>)</u>		
\ <u>-</u> · · ·,	–	/		
cube	а	b	С	d
			<b>c</b>	<b>d</b>
cube	а			
<b>cube</b> 3, 7	а	b -	1	1
3, 7 3, 11	<b>a</b> 0	<b>b</b> - 0	1	1

$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨1 : 1,	1 : C	$\rangle$		
cube	а	b	С	d
1, 3	0	0	-	1
1, 9	-	0	0	1
2, 3	0	0	1	-
2, 10	-	0	1	0
8, 9	1	0	0	-
8, 10	1	0		0
0, 10	1	U		U
(2:1,				
			C	d
⟨2:1,	1 : C	$\rangle$	<b>c</b>	
⟨2 : 1, cube	1 : C	$\rangle$		d
(2:1, <b>cube</b> 3,7	1 : C	) b -	1	<b>d</b>
(2:1, <b>cube</b> 3,7 3,11	1 : C <b>a</b> 0	<b>b</b> - 0	1	<b>d</b> 1

⟨1 : 1,2 : D⟩				
cube	a b	c d		
1, 3, 9 ,11	- 0	- 1		

$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

(1 : 1,	1 : C	$\rangle$		
cube	а	b	С	d
1, 3	0	0	-	1
1, 9	-	0	0	1
2, 3	0	0	1	-
2, 10	-	0	1	0
8, 9	1	0	0	-
8, 10	1	0	-	0
⟨2:1,	1 : C	$\rangle$		
cube	а	b	С	d
3, 7	0	-	1	1
3, 11	-	0	1	1
9, 11	1	0	-	1
10, 11	1	0	1	-

⟨1 : 1,2 : D⟩						
cube	а	b	С	d		
1, 3, 9 ,11	-	0	-	1		
2, 3, 10 ,11	-	0	1	-		

$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

\left(1:1,	1 : [	$\rangle$		
cube	а	b	С	d
1, 3	0	0	-	1
1, 9	-	0	0	1
2, 3	0	0	1	-
2, 10	-	0	1	0
8, 9	1	0	0	-
8, 10	1	0	-	0
⟨2 : 1,	1:[	$\rangle$		
⟨2 : 1, cube	1 : E a	) <u>}</u> b	С	d
•			<b>c</b>	<b>d</b>
cube	а			
<b>cube</b> 3, 7	а	b -	1	1
3, 7 3, 11	<b>a</b> 0	<b>b</b> - 0	1	1

\left(1:1,	2 : D	$\rangle$		
cube	а	b	С	d
1, 3, 9 ,11	-	0	-	1
2, 3, 10 ,11	-	0	1	-
8, 9, 10 ,11	1	0	-	-

$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

⟨2 : 1,	1 : C	$\rangle$		
cube	а	b	С	d
3, 7	0	-	1	1
3, 11	-	0	1	1
9, 11	1	0	-	1
10, 11	1	0	1	-
10, 14	1	-	1	0
10, 14 (3 : 1,			1	0
· ·			1 C	0 <b>d</b>
⟨3 : 1,	1 : C	)>		
⟨3 : 1, cube	1 : C	)>		





$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2 : 1,	1 : C	$\rangle$		
cube	а	b	С	d
3, 7	0	-	1	1
3, 11	-	0	1	1
9, 11	1	0	-	1
10, 11	1	0	1	-
10, 14	1	-	1	0
10, 14 \(\langle 3 : 1,			1	0
· ·			•	0 <b>d</b>
⟨3 : 1,	1 : C	)	•	
⟨3 : 1, cube	1 : C	)	•	d



$$f(a,b,c,d) = \sum_{m} (1,2,3,7,8,9,10,11,14,15)$$

⟨2:1,	1 : C	$\rangle$		
cube	а	b	С	d
3, 7	0	-	1	1
3, 11	-	0	1	1
9, 11	1	0	-	1
10, 11	1	0	1	-
10, 14	1	-	1	0
⟨3:1,	1 : C	$\rangle$		
		,		
cube	а	b		d
7, 15	a -		<b>c</b>	<b>d</b>
	- 1	b		

⟨2:1,	2 : [	$\rangle$		
cube	а	b	С	d
3, 7, 11, 15	-	-	1	1





$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

⟨2:1,	1 : C	$\rangle$		
cube	а	b	С	d
3, 7	0	-	1	1
3, 11	-	0	1	1
9, 11	1	0	-	1
10, 11	1	0	1	-
10, 14	1	-	1	0
⟨3:1,	1 : C	$\rangle$		
cube	а	b		d
7, 15	-	1	1	1
11, 15	1	-	1	1
14, 15	1	1	1	_

⟨2 : 1,	2 : [	)		
cube	а	b	С	d
3, 7, 11, 15	-	-	1	1
10, 11, 14,	1	-	1	-
15				





$$f(a, b, c, d) = \sum_{m} (1, 2, 3, 7, 8, 9, 10, 11, 14, 15)$$

Pls	1	2	3	7	8	9	10	11	14	15
1, 3, 9, 11	$\mathbf{X}$		X			X		X		
2, 3, 10, 11		$\mathbf{x}$	X				X	X		
8, 9, 10, 11					$\mathbf{x}$	X	X	X		
3, 7, 11, 15			X	$\mathbf{x}$				Х		Х
10, 11, 14, 15							X	X	$\mathbf{x}$	X

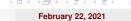
$$f = \bar{B}D + \bar{B}R + A\bar{B} + RD + AR$$



$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

<b>⟨1:1</b> ,	0 : E	$\rangle$		
m	а	b	С	d
2	0	0	1	0
4	0	1	0	0
⟨2:1,	0 : C	$\rangle$		
m	а	b	С	d
<b>m</b> 6	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>
6	0	1	1	0

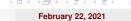




$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

$\langle 1:1,0:D\rangle$						
m	а	b	С	d		
2	0	0	1	0		
4	0	1	0	0		
⟨2 : 1, 0 : D⟩						
		,				
m	а	b	С	d		
<b>m</b> 6			<b>c</b>	<b>d</b>		
	а	b				
6	<b>a</b> 0	<b>b</b>	1	0		





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨1 : 1, 0 : D⟩								
m	а	b	С	d				
2	0	0	1	0				
4	0	1	0	0				
⟨2:1,	0 : C	⟨2:1,0:D⟩						
m	а	b	С	d				
<b>m</b> 6	<b>a</b> 0	<b>b</b>	<b>c</b>	<b>d</b>				
6	0	1	1	0				

$\langle 1:1,1:D\rangle$					
cube	а	b	С	d	
2, 6	0	-	1	0	



$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

$\langle 1:1,0:D \rangle$							
m	а	b	С	d			
2	0	0	1	0			
4	0	1	0	0			
⟨2:1,	⟨2 : 1, 0 : D⟩						
m	а	b	С	d			
<b>m</b> 6	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>			
6	0	1	1	0			

$\langle 1:1,1:D\rangle$					
cube	а	b	С	d	
2, 6	0	-	1	0	
2, 10	-	0	1	0	





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨1 : 1, 0 : D⟩							
m	а	b	С	d			
2	0	0	1	0			
4	0	1	0	0			
⟨2 : 1,	⟨2:1,0:D⟩						
m	а	b	С	d			
<b>m</b> 6	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>			
6	0	1	1	0			

⟨1 : 1, 1 : D⟩						
cube		а	b	С	d	
2, 6		0	-	1	0	
2, 10		-	0	1	0	
4, 6		0	1	-	0	





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

$\langle 1:1,0:D\rangle$						
m	а	b	С	d		
2	0	0	1	0		
4	0	1	0	0		
⟨2:1,	0 : C	$\rangle$				
m	а	b	С	d		
6	0	1	1	0		
9	1	0	0	1		
10	1	0	1	0		
12	1	1	0	0		

⟨1 : 1, 1 : D⟩						
cube	а	b	С	d		
2, 6	0	-	1	0		
2, 10	-	0	1	0		
4, 6	0	1	-	0		
4, 12	-	1	0	0		

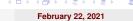




$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2 : 1,0 : D⟩						
m	а	b	С	d		
6	0	1	1	0		
9	1	0	0	1		
10	1	0	1	0		
12	1	1	0	0		
⟨3:1,	0 : C	$\rangle$				
m	а	b	С	d		
11	1	0	1	1		
13	4	4	0	4		





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2 : 1,0 : D⟩						
m	а	b	С	d		
6	0	1	1	0		
9	1	0	0	1		
10	1	0	1	0		
12	1	1	0	0		
⟨3:1,	0 : D	$\overline{O}$				
m	а	b	С	d		
11	1	0	1	1		
13	1	1	0	1		



$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

$\langle 2:1,0:D \rangle$						
m	а	b	С	d		
6	0	1	1	0		
9	1	0	0	1		
10	1	0	1	0		
12	1	1	0	0		
⟨3:1,	0 : [	O				
m	а	b	С	d		
11	1	0	1	1		
13	1	1	0	1		

⟨2:1,1:D⟩						
cube		а	b	С	d	
9, 11		1	0	-	1	



$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

$\langle 2:1,0:D \rangle$							
m	а	b	С	d			
6	0	1	1	0			
9	1	0	0	1			
10	1	0	1	0			
12	1	1	0	0			
⟨3:1,	0 : [	$\overline{O}$					
m	а	b	С	d			
11	1	0	1	1			
13	1	1	0	1			

⟨2:1,1:D⟩						
cube		а	b	С	d	
9, 11		1	0	-	1	
9, 13		1	-	0	1	





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2 : 1, 0 : D⟩							
m	а	b	С	d			
6	0	1	1	0			
9	1	0	0	1			
10	1	0	1	0			
12	1	1	0	0			
⟨3:1,	0 : [	$\overline{O}$					
m	а	b	С	d			
11	1	0	1	1			
13	1	1	0	1			

⟨2:1,1:D⟩						
cube	а	b	С	d		
9, 11	1	0	-	1		
9, 13	1	-	0	1		
10, 11	1	0	1	-		





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2 : 1, 0 : D⟩							
m	а	b	С	d			
6	0	1	1	0			
9	1	0	0	1			
10	1	0	1	0			
12	1	1	0	0			
⟨3:1,	0 : [	O					
m	а	b	С	d			
11	1	0	1	1			
13	1	1	0	1			

⟨2 : 1, 1 : D⟩						
cube	а	b	С	d		
9, 11	-	1 C	) -	1		
9, 13	•	1 -	0	1		
10, 11	•	1 0	) 1	-		
12. 13	-	1 1	0	_		





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨3 : 1, 0 : D⟩							
m	а	b	С	d			
11	1	0	1	1			
13	1	1	0	1			
⟨4 : 1, 1 : D⟩							
m	а	b	С	d			
15	1	1	1	1			



$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨3 : 1, 0 : D⟩							
m	а	b	С	d			
11	1	0	1	1			
13	1	1	0	1			
⟨4:1,1:D⟩							
m	а	b	С	d			
15	1	1	1	1			



$$f(a, b, c, d) = \sum_{m} (4, 6, 9, 10, 11, 13) + \sum_{d} (2, 12, 15)$$

⟨3 : 1, 0 : D⟩						
m	а	b	С	d		
11	1	0	1	1		
13	1	1	0	1		
⟨4:1,	1 : [	$\overline{O}$				
m	а	b	С	d		
15	1	1	1	1		

⟨3:1,	1 : C	$\rangle$		
cube	а	b	С	d
11, 15	1	-	1	1





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨3 : 1,0 : D⟩						
m	а	b	С	d		
11	1	0	1	1		
13	1	1	0	1		
<b>⟨4:1</b> ,						
m	а	b	С	d		
15	1	1	1	1		

⟨3:1,	1 : [	$\rangle$		
cube	а	b	С	d
11, 15	1	-	1	1
13, 15	1	1	-	1





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2:1,	1 : C	$\rangle$		
cube	а		С	d
9, 11	1	0	-	1
9, 13	1	-	0	1
10, 11	1	0	1	-
12, 13	1	1	0	-
⟨3:1,	1 : C	$\rangle$		
cube	а	b	С	d
<b>cube</b> 11, 15	<b>a</b>	b -	<b>c</b>	<b>d</b>





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2:1,	1 : [	$\rangle$		
cube	а		С	d
9, 11	1	0	-	1
9, 13	1	-	0	1
10, 11	1		1	-
12, 13	1	1	0	-
⟨3:1,	1 : [	$\rangle$		
cube	а		С	d
11, 15	1	-	1	1
13, 15	1	1	-	1





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2:1,	1 : [	$\rangle$		
cube	а	b	С	d
9, 11	1	0	-	1
9, 13	1	-	0	1
10, 11	1	0	1	-
12, 13	1	1	0	-
⟨3:1,	1 : [	$\rangle$		
cube	а	b	С	d
11, 15	1	-	1	1
13, 15	1	1	-	1

⟨2:1,	2 : D		
cube	a k	С	d
9,11,13,15	1		1





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

⟨2:1,	1 : [	O		
cube	а	b	С	d
9, 11	1	0	-	1
9, 13	1	-	0	1
10, 11	1	0	1	-
12, 13	1	1	0	-
⟨3:1,	1 : [	O		
cube	а	b	С	d
11, 15	1	-	1	1
13, 15	1	1	-	1

⟨2:1,	2 : D>
cube	a b c d
9,11,13,15	1 1
9,13,11,15	1 1





$$f(a,b,c,d) = \sum_{m} (4,6,9,10,11,13) + \sum_{d} (2,12,15)$$

Pls	4	6	9	10	11	13
2, 6		X				
2, 10				X		
4, 6	X	X				
4, 12	X					
9, 11, 13, 15			$\mathbf{x}$		Х	X
10, 11				X	Х	
12, 13						X

- $\langle 9, 11, 13, 15 \rangle$  dominates  $\langle 12, 13 \rangle$
- $\langle 10, 11 \rangle$  dominates  $\langle 2, 10 \rangle$
- $\langle 4,6 \rangle$  dominates  $\langle 4,12 \rangle$  and  $\langle 2,6 \rangle$

$$f = ad + \bar{a}b\bar{d}$$





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

(0	: 1, C	) : [	$\rangle$		
m	а	b	С	d	е
0	0	0	0	0	0
⟨1	: 1, C	) : C	$\rangle$		
m	а	b	С	d	е
<b>m</b>	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>
1 2					<b>e</b> 1 0



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : 1, 0 : D⟩									
m	а	b	С	d	е				
0	0	0	0	0	0				
⟨1 :	: 1, C	) : C	$\rangle$						
m	а	b	С	d	е				
<b>m</b>	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>				
1 2					<b>e</b> 1				



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : 1, 0 : D⟩									
m	а	b	С	d	е				
0	0	0	0	0	0				
⟨1 :	: 1, C	) : C	$\rangle$						
m	а	b	С	d	е				
<b>m</b>	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>				
1 2									

⟨0 : 1, 1 : D⟩								
cube	а	b	С	d	е			
0, 1	0	0	0	0	-			



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : 1, 0 : D⟩								
m	а	b	С	d	е			
0	0	0	0	0	0			
⟨1 :	: 1, C	) : C	$\rangle$					
m	а	b	С	d	е			
<b>m</b>	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>			
1 2								

⟨0 : 1, 1 : D⟩							
cube	а	b	С	d	е		
0, 1	0	0	0	0	-		
0, 2	0	0	0	-	0		





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : 1, 0 : D⟩								
m	а	b	С	d	е			
0	0	0	0	0	0			
⟨1 : 1,0 : D⟩								
m	а	b	С	d	е			
m 1	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	<b>e</b>			
1 2								

$\langle 0:1,1:D \rangle$							
cube	а	b	С	d	е		
0, 1	0	0	0	0	-		
0, 2	0	0	0	-	0		
0, 8	0	-	0	0	0		





$\langle 1:1,0:D\rangle$									
m	а	b	С	d	е				
1	0	0	0	0	1				
2	0	0	0	1	0				
8	0	1	0	0	0				
⟨2	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
2	_	_	_		-				
3	0	0	0	1	1				
6	0	0	1	1	0				
6	0	0	1	1	0				
6	0	0	1	1	0				

⟨1 : 1, 0 : D⟩								
m	а	b	С	d	е			
1	0	0	0	0	1			
2	0	0	0	1	0			
8	0	1	0	0	0			
⟨2	: 1,0	) : [	$\rangle$					
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	0	1	0			
6	0	0	1	1	0			
6	0	0	1	1	0			

⟨1 : 1, 1 : D⟩								
cube	а	b	C	d	е			
1, 3	0	0	0	-	1			

⟨1 : 1, 0 : D⟩								
m	а	b	С	d	е			
1	0	0	0	0	1			
2	0	0	0	1	0			
8	0	1	0	0	0			
⟨2	: 1,0	) : [	$\rangle$					
m	2	b	_	d	_			
111	а	D	С	u	е			
3	0	0	0	1	1			
3	0	0	0	1	1			
3	0	0	0	1	1			
3 6 9	0 0	0 0 1	0 1 0	1 1 0	1 0 1			

$\langle 1:1,1:D \rangle$								
cube	а		С	d	е			
1, 3	0	0	0	-	1			
1, 9	0	-	0	0	1			

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨1 :										
m	а	b	С	d	е					
1	0	0	0	0	1					
2	0	0	0	1	0					
8	0	1	0	0	0					
⟨2	: 1,0	) : C	$\rangle$							
m	а	b	С	d	е					
3	0	0	0	1	1					
6	0	0	1	1	0					
9	0	1	0	0	1					
10	0	1	0	1	0					
17	1	0	0	0	1					
20	1	0	1	0	0					

$\langle 1:1,1:D\rangle$								
cube	а		•	d	е			
1, 3	0	0	0	-	1			
1, 9	0	-	0	0	1			
1, 17	-	0	0	0	1			

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨1 : 1, 0 : D⟩									
m	а	b	С	d	е				
1	0	0	0	0	1				
2	0	0	0	1	0				
8	0	1	0	0	0				
⟨2	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
3	0	0	0	1	1				
5	0	U	U		1				
6	0	0	1	1	0				
6	0	0	1	1	0				
6 9	0	0	1	1	0				

$\langle 1:1,1:D \rangle$							
cube	а	b	С	d	е		
1, 3	0	0	0	-	1		
1, 9	0	-	0	0	1		
1, 17	-	0	0	0	1		
2, 3	0	0	0	1	-		

⟨1 : 1, 0 : D⟩									
m	а	b	С	d	е				
1	0	0	0	0	1				
2	0	0	0	1	0				
8	0	1	0	0	0				
⟨2	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
2	$\overline{}$	0	$\sim$	- 4	-				
3	0	U	0	1	1				
6	0	0	1	1	0				
6	0	0	1	1	0				
6	0	0	1	1	0				

⟨1	$\langle 1 : 1, 1 : D \rangle$					
cube	а	b	С	d	е	
1, 3	0	0	0	-	1	
1, 9	0	-	0	0	1	
1, 17	-	0	0	0	1	
2, 3	0	0	0	1	-	
2, 6	0	0	-	1	0	

⟨1 : 1,0 : D⟩									
m	а	b	С	d	е				
1	0	0	0	0	1				
2	0	0	0	1	0				
8	0	1	0	0	0				
⟨2	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
•	_	_	-						
3	0	0	0	1	1				
6	0	0	1	1 1	0				
6	0	0	1	1	0				
6 9	0	0	1	1	0				

(1 :	$\langle 1 : 1, 1 : D \rangle$							
cube	а	b	С	d	е			
1, 3	0	0	0	-	1			
1, 9	0	-	0	0	1			
1, 17	-	0	0	0	1			
2, 3	0	0	0	1	-			
2, 6	0	0	-	1	0			
2, 10	0	-	0	1	0			

⟨1 : 1,0 : D⟩									
m	а	b	С	d	е				
1	0	0	0	0	1				
2	0	0	0	1	0				
8	0	1	0	0	0				
⟨2	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
3	0	0	0	1	1				
6	0	0	1	1	0				
6 9	0	0	1	1	0				
9	0	1	0	0	1				

<b>(1</b> :	$\langle 1 : 1, 1 : D \rangle$								
cube	а	b	С	d	е				
1, 3	0	0	0	-	1				
1, 9	0	-	0	0	1				
1, 17	-	0	0	0	1				
2, 3	0	0	0	1	-				
2, 6	0	0	-	1	0				
2, 10	0	-	0	1	0				
8, 9	0	1	0	0	-				

⟨1 :										
m	а	b	С	d	е					
1	0	0	0	0	1					
2	0	0	0	1	0					
8	0	1	0	0	0					
⟨2	: 1,0	) : C	$\rangle$							
m	а	b	С	d	е					
3	0	0	0	1	1					
6	0	0	1	1	0					
9	0	1	0	0	1					
10	0	1	0	1	0					
17	1	0	0	0	1					
20	1	0	1	0	0					

/1	: 1, 1	· [	)\		
cube	. ', ' a	b	C	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
2, 3	0	0	0	1	-
2, 6	0	0	-	1	0
2, 10	0	-	0	1	0
8, 9	0	1	0	0	-
8, 10	0	1	0	-	0

 $f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$ 

⟨2 : 1, 0 : D⟩									
m	а	b	С	d	е				
3	0	0	0	1	1				
6	0	0	1	1	0				
9	0	1	0	0	1				
10	0	1	0	1	0				
17	1	0	0	0	1				
20	1	0	1	0	0				
⟨3	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
11	0	1	0	1	1				
21	1	0	1	0	1				
25 28	1	1	0	0	1				
	1	1	1	0	0				

 $f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$ 

⟨2 : 1,0 : D⟩									
m	а	b	С	d	е				
3	0	0	0	1	1				
6	0	0	1	1	0				
9	0	1	0	0	1				
10	0	1	0	1	0				
17	1	0	0	0	1				
20	1	0	1	0	0				
⟨3 ∣	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
<b>m</b> 11	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	e 1				
11	0	1	0	1	1				

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$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2 : 1, 0 : D⟩									
m	а	b	С	d	е				
3	0	0	0	1	1				
6	0	0	1	1	0				
9	0	1	0	0	1				
10	0	1	0	1	0				
17	1	0	0	0	1				
20	1	0	1	0	0				
⟨3 :	: 1,0	) : C	$\rangle$						
m	а	b	С	d	е				
11	0	1	0	1	1				
21	1	0	1	0	1				
25	1	1	0	0	1				
28	1	1	1	0	0				

⟨2 : 1, 1 : D⟩									
cube				d	е				
3, 11	0	-	0	1	1				

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2	: 1,0	⟨2 : 1,0 : D⟩									
m	а	b	С	d	е						
3	0	0	0	1	1						
6	0	0	1	1	0						
9	0	1	0	0	1						
10	0	1	0	1	0						
17	1	0	0	0	1						
20	1	0	1	0	0						
⟨3 ∣	: 1,0	) : C	$\rangle$								
m	а	b	С	d	е						
11	0	1	0	1	1						
21	1	0	1	0	1						
25	1	1	0	0	1						
28	1	1	1	0	0						

⟨2 : 1, 1 : D⟩									
cube	а	b	С	d	е				
3, 11	0	-	0	1	1				
9, 11	0	1	0	-	1				

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2 : 1,0 : D⟩								
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	1	1	0			
9	0	1	0	0	1			
10	0	1	0	1	0			
17	1	0	0	0	1			
20	1	0	1	0	0			
⟨3 ∣	: 1,0	) : [	$\rangle$					
m	а	b	С	d	е			
11	0	1	0	1	1			
21	1	0	1	0	1			
25	1	1	0	0	1			
28	1	1	1	0	0			

⟨2:1,1:D⟩								
cube	а	b	С	d	е			
3, 11	0	-	0	1	1			
9, 11	0	1	0	-	1			
9, 25	-	1	0	0	1			

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2 : 1,0 : D⟩								
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	1	1	0			
9	0	1	0	0	1			
10	0	1	0	1	0			
17	1	0	0	0	1			
20	1	0	1	0	0			
⟨3 ∣	: 1,0	) : <b>C</b>	$\rangle$					
m	а	b	С	d	е			
11	0	1	0	1	1			
21	1	0	1	0	1			
25	1	1	0	0	1			
28	1	1	1	0	0			

⟨2 : 1, 1 : D⟩								
cube	а	b	С	d	е			
3, 11	0	-	0	1	1			
9, 11	0	1	0	-	1			
9, 25	-	1	0	0	1			
10, 11	0	1	0	1	-			

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2:1,0:D⟩								
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	1	1	0			
9	0	1	0	0	1			
10	0	1	0	1	0			
17	1	0	0	0	1			
20	1	0	1	0	0			
⟨3	: 1,0	) : [	O					
m	а	b	С	d	е			
11	0	1	0	1	1			
21	1	0	1	0	1			
25	1	1	0	0	1			
28	1	1	1	0	0			

⟨2 : 1, 1 : D⟩							
cube	а	b	С	d	е		
3, 11	0	-	_	1	1		
9, 11	0	1	0	-	1		
9, 25	-	1	0	0	1		
10, 11	0	1	0	1	-		
17, 21	1	0	-	0	1		

$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

⟨2	: 1, 0	) : [	$\rangle$		
m	а	b	С	d	е
3	0	0	0	1	1
6	0	0	1	1	0
9	0	1	0	0	1
10	0	1	0	1	0
17	1	0	0	0	1
20	1	0	1	0	0
⟨3 ∣	: 1,0	) : [	$\rangle$		
m	а	b	С	d	е
11	0	1	0	1	1
21	1	0	1	0	1
25	1	1	0	0	1
28	1	1	1	0	0

⟨2:1,1:D⟩							
cube	а	b	С	d	е		
3, 11	0	-	0	1	1		
9, 11	0	1	0	-	1		
9, 25	-	1	0	0	1		
10, 11	0	1	0	1	-		
17, 21	1	0	-	0	1		
17, 25	1	-	0	0	1		

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2	⟨2 : 1,0 : D⟩							
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	1	1	0			
9	0	1	0	0	1			
10	0	1	0	1	0			
17	1	0	0	0	1			
20	1	0	1	0	0			
⟨3	: 1,0	) : [	$\rangle$					
m	а	b	С	d	е			
11	0	1	0	1	1			
21	1	0	1	0	1			
25	1	1	0	0	1			
28	1	1	1	0	0			

⟨2 : 1, 1 : D⟩							
cube	а	b	С	d	е		
3, 11	0	-	0	1	1		
9, 11	0	1	0	-	1		
9, 25	-	1	0	0	1		
10, 11	0	1	0	1	-		
17, 21	1	0	-	0	1		
17, 25	1	-	0	0	1		
20, 21	1	0	1	0	-		

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨2	⟨2 : 1, 0 : D⟩							
m	а	b	С	d	е			
3	0	0	0	1	1			
6	0	0	1	1	0			
9	0	1	0	0	1			
10	0	1	0	1	0			
17	1	0	0	0	1			
20	1	0	1	0	0			
⟨3	: 1,0	) : [	$\rangle$					
m	а	b	С	d	е			
11	0	1	0	1	1			
21	1	0	1	0	1			
25	1	1	0	0	1			
28	1	1	1	0	0			

⟨2 : 1, 1 : D⟩							
cube	a	b	C	d	е		
3, 11	0	-	0	1	1		
9, 11	0	1	0	-	1		
9, 25	-	1	0	0	1		
10, 11	0	1	0	1	-		
17, 21	1	0	-	0	1		
17, 25	1	-	0	0	1		
20, 21	1	0	1	0	-		
20, 28	1	-	1	0	0		

 $f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$ 

⟨3 : 1, 0 : D⟩							
m	а	b	С	d	е		
11	0	1	0	1	1		
21	1	0	1	0	1		
25	1	1	0	0	1		
28	1	1	1	0	0		
⟨4	: 1,0	) : <b>C</b>	$\rangle$				
m	а	b	С	d	е		
23	1	0	1	1	1		
30	1	1	1	1	0		



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

$\langle 3:1,0:D \rangle$							
m	а	b	С	d	е		
11	0	1	0	1	1		
21	1	0	1	0	1		
25	1	1	0	0	1		
28	1	1	1	0	0		
⟨4	: 1,0	) : [	$\rangle$				
m	а	b	С	d	е		
23	1	0	1	1	1		
30	1	1	1	1	0		





$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

⟨3 : 1, 0 : D⟩							
m	а	b	С	d	е		
11	0	1	0	1	1		
21	1	0	1	0	1		
25	1	1	0	0	1		
28	1	1	1	0	0		
⟨4 ∣	: 1,0	) : C	$\rangle$				
m	а	b	С	d	е		
23	1	0	1	1	1		
30	1	1	1	1	0		

⟨3 : 1,1 : D⟩							
cube	а	b	С	d	е		
21, 23	1	0	1	-	1		





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨3 : 1, 0 : D⟩							
m	а	b	С	d	е		
11	0	1	0	1	1		
21	1	0	1	0	1		
25	1	1	0	0	1		
28	1	1	1	0	0		
⟨4 ∣	: 1, C	) : <b>C</b>	$\rangle$				
m	а	b	С	d	е		
23	1	0	1	1	1		
30	1	1	1	1	0		

⟨3 : 1, 1 : D⟩							
cube	а	b	С	d	е		
21, 23	1	0	1	-	1		
28, 30	1	1	1	-	0		





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

$\langle 4:1,0:D\rangle$					
m	а	b	С	d	е
23	1	0	1	1	1
30	1	1	1	1	0
⟨5 : 1, 0 : D⟩					
m	а	b	С	d	е
31	1	1	1	1	1



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨ <b>4</b> : <b>1</b> , <b>0</b> : <b>D</b> ⟩								
m	а	b	С	d	е			
23	1	0	1	1	1			
30	1	1	1	1	0			
⟨5 :	: 1,0							
m	а	b	С	d	е			
31	1	1	1	1	1			



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨4 : 1,0 : D⟩							
m	а	b	С	d	е		
23	1	0	1	1	1		
30	1	1	1	1	0		
⟨5	: 1,0	) : [	$\rangle$				
m	а	b	С	d	е		
31	1	1	1	1	1		

$\langle 4:1,1:D \rangle$							
cube	а	b	С	d	е		
23, 31	1	-	1	1	1		



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨4:1,0:D⟩								
m	а	b	С	d	е			
23	1	0	1	1	1			
30	1	1	1	1	0			
⟨5 ∣	: 1,0	) : <b>C</b>	$\rangle$					
m	а	b	С	d	е			
31	1	1	1	1	1			

⟨4∶	: 1, 1	: C	$\rangle$		
cube	а	b	С	d	е
23, 31	1	-	1	1	1
30. 31	1	1	1	1	-





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0:	1, 1 : C	$\rangle$			
cube	а	b	С	d	е
0, 1	0	0	0	0	-
0, 2	0	0	0	-	0
0, 8	0	-	0	0	0
⟨1 : ¹	1,1: C	$\rangle$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
2, 6	0	0	-	1	0
2, 6 2, 10	0	0	-	1	0
		0 - 1	- 0 0	1 0	
2, 10	0	0 - 1 0		1 1 0	

 $f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$ 

/O · ·	1,1:	D)			
cube	a	b	С	d	е
0, 1	0	0	0	0	-
0, 2	0	0	0	-	0
0, 8	0	-	0	0	0
<b>√1</b> : <sup>-1</sup>	1,1:	$ D\rangle$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
1, 17 2, 6	- 0	0	0	0	0
	- 0 0		0 - 0		
2, 6			-	1	0
2, 6 2, 10	0	0	- 0	1	0

 $f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$ 

<b>(0</b> : 1	1,1:	$D \rangle$			
cube	а	b	С	d	е
0, 1	0	0	0	0	-
0, 2	0	0	0	-	0
0, 8	0	-	0	0	0
<b>(1</b> : ·	1,1:	D  angle			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	_	0	0	1
., 0	0		•	-	-
1, 17	-	0	0	0	1
,	- 0	0			
1, 17	-			0	1
1, 17 2, 6	- 0		0	0	1
1, 17 2, 6 2, 10	0	0	0 -	0 1 1	1

$\langle 0:1,2:D \rangle$							
cube	a b c d e						
0, 1, 8, 9	0 - 0 0 -						

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : ¹	1,1:	$D\rangle$			
cube	а	b	С	d	е
0, 1	0	0	0	0	-
0, 2	0	0	0	-	0
0, 8	0	-	0	0	0
<b>(1</b> : ·	1,1:	$ D\rangle$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 9 1, 17	-	0	0	0	1 1
	0 - 0	0			
1, 17	-			0	1
1, 17 2, 6	- 0		0	0	1
1, 17 2, 6 2, 10	- 0 0	0 -	0 - 0	0 1 1	1

$\langle 0:1,2:D \rangle$							
cube	а	b	С	d	е		
0, 1, 8, 9	0	-	0	0	-		
0, 1, 2, 3	0	0	0	-	-		

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : ⁻	1,1:	D  angle			
cube	а	b	С	d	е
0, 1	0	0	0	0	-
0, 2	0	0	0	-	0
0, 8	0	-	0	0	0
<b>(1</b> : ·	1,1:	$ D\rangle$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
, -	•				
1, 17	-	0	0	0	1
	- 0	0	0	0	1
1, 17	-		0 - 0		
1, 17 2, 6	- 0		-	1	0
1, 17 2, 6 2, 10	- 0 0	0	0	1	0

⟨0 : 1, 2 : D⟩						
cube	а	b	С	d	е	
0, 1, 8, 9	0	-	0	0	-	
0, 1, 2, 3	0	0	0	-	-	
0, 2, 8, 10	0	-	0	-	0	

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨1 : 1, 1 : D⟩							
cube	- 1	a	b	С	d	е	
1, 3		0	0	0	-	1	
1, 9		0	-	0	0	1	
1, 17		-	0	0	0	1	
2, 6		0	0	-	1	0	
2, 10		0	-	0	1	0	
8, 9		0	1	0	0	-	
2, 3		0	0	0	1	-	
8, 10		0	1	0	-	0	

⟨2 : 1, 1 : D⟩							
cube		а	b	С	d	е	
3, 11		0	-	0	1	1	
9, 11		0	1	0	-	1	
9, 25		-	1	0	0	1	
10, 11		0	1	0	1	-	
17, 21		1	0	-	0	1	
17, 25		1	-	0	0	1	
20, 21		1	0	1	0	-	
20, 28		1	-	1	0	0	





$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

⟨1 : 1, 1 : D⟩							
cube	а	b	С	d	е		
1, 3	0	0	0	-	1		
1, 9	0	-	0	0	1		
1, 17	-	0	0	0	1		
2, 6	0	0	-	1	0		
2, 10	0	-	0	1	0		
8, 9	0	1	0	0	-		
2, 3	0	0	0	1	-		
8, 10	0	1	0	-	0		

$\langle 2:1,1:D\rangle$							
cube		а	b	С	d	е	
3, 11		0	-	0	1	1	
9, 11		0	1	0	-	1	
9, 25		-	1	0	0	1	
10, 11		0	1	0	1	-	
17, 21		1	0	-	0	1	
17, 25		1	-	0	0	1	
20, 21		1	0	1	0	-	
20, 28		1	-	1	0	0	

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨1:	1,1:[	$\overline{O}$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
2, 6	0	0	-	1	0
2, 10	0	-	0	1	0
8, 9	0	1	0	0	-
2, 3	0	0	0	1	-
8, 10	0	1	0	-	0
⟨1 :	1,2:[	$\overline{O}$			
cube	а	b	С	d	е
1, 3, 9, 11	0	-	0	-	1

⟨2 : ¹	⟨2 : 1, 1 : D⟩							
cube		а	b	С	d	е		
3, 11		0	-	0	1	1		
9, 11		0	1	0	-	1		
9, 25		-	1	0	0	1		
10, 11		0	1	0	1	-		
17, 21		1	0	-	0	1		
17, 25		1	-	0	0	1		
20, 21		1	0	1	0	-		
20, 28		1	-	1	0	0		

$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

⟨1:	1,1:[	$\overline{O}$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
2, 6	0	0	-	1	0
2, 10	0	-	0	1	0
8, 9	0	1	0	0	-
2, 3	0	0	0	1	-
8, 10	0	1	0	-	0
⟨1:	1,2:[	$\overline{O}$			
cube	а	b	С	d	е
1, 3, 9, 11	0	-	0	-	1
1, 9, 17, 25	-	-	0	0	1

·-								
⟨2∶	$\langle 2:1,1:D \rangle$							
cube	а	b	С	d	е			
3, 11	0	-	0	1	1			
9, 11	0	1	0	-	1			
9, 25	-	1	0	0	1			
10, 11	0	1	0	1	-			
17, 21	1	0	-	0	1			
17, 25	1	-	0	0	1			
20, 21	1	0	1	0	-			
20, 28	1	-	1	0	0			

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨1:	1, 1	: [	$\rangle$			
cube		а	b	С	d	е
1, 3		0	0	0	-	1
1, 9		0	-	0	0	1
1, 17		-	0	0	0	1
2, 6		0	0	-	1	0
2, 10		0	-	0	1	0
8, 9		0	1	0	0	-
2, 3		0	0	0	1	-
8, 10		0	1	0	-	0
⟨1:	1,2	: E	$\rangle$			
cube		а	b	С	d	е
1, 3, 9, 11		0	-	0	-	1
1, 9, 17, 25		-	-	0	0	1
2, 10, 3, 11		0	-	0	1	-

/0	4 4	_	<b>)</b> \					
	⟨2 : 1, 1 : D⟩							
cube		а	b	С	a	е		
3, 11		0	-	0	1	1		
9, 11		0	1	0	-	1		
9, 25		-	1	0	0	1		
10, 11		0	1	0	1	-		
17, 21		1	0	-	0	1		
17, 25		1	-	0	0	1		
20, 21		1	0	1	0	-		
20, 28		1	-	1	0	0		

$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

⟨1:	1, 1 : C	$\rangle$			
cube	а	b	С	d	е
1, 3	0	0	0	-	1
1, 9	0	-	0	0	1
1, 17	-	0	0	0	1
2, 6	0	0	-	1	0
2, 10	0	-	0	1	0
8, 9	0	1	0	0	-
2, 3	0	0	0	1	-
8, 10	0	1	0	-	0
⟨1:	1,2 : C	$\rangle$			
cube	а	b	С	d	е
1, 3, 9, 11	0	-	0	-	1
1, 9, 17, 25	-	-	0	0	1
2, 10, 3, 11	0	-	0	1	-
8, 9, 10, 11	0	1	0	-	-

⟨2 : 1, 1 : D⟩												
cube		а		С	d	е						
3, 11		0	-	0	1	1						
9, 11		0	1	0	-	1						
9, 25		-	1	0	0	1						
10, 11		0	1	0	1	-						
17, 21		1	0	-	0	1						
17, 25		1	-	0	0	1						
20, 21		1	0	1	0	-						
20, 28		1	-	1	0	0						

$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : ¹	1,2 : D>
cube	a b c d e
0, 1, 8, 9	0 - 0 0 -
0, 1, 2, 3	0 0 0
0, 2, 8, 10	0 - 0 - 0
<b>(1</b> : '	1,2 : D>
cube	a b c d e
1, 3, 9, 11	0 - 0 - 1
1, 9, 17, 25	0 0 1
2, 10, 3, 11	0 - 0 1 -
, -, -,	



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

⟨0 : '	1,2:	$D\rangle$			
cube	а	b	С	d	е
0, 1, 8, 9	0	-	0	0	-
0, 1, 2, 3	0	0	0	-	-
0, 2, 8, 10	0	-	0	-	0
⟨1 : '	1,2:	$D\rangle$			
cube	а	b	С	d	е
<b>cube</b> 1, 3, 9, 11	<b>a</b>			d -	<b>e</b> 1
0 0 0 0 0					e 1 1
1, 3, 9, 11			0	-	<b>e</b> 1 1 -

⟨0:	1,3:D>
cube	a b c d e
0, 1, 8, 9,	0 - 0
2, 10, 3, 11	



 $f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$ 

2, 6	P <sub>1</sub>
17, 21	P <sub>2</sub>
20, 21	P <sub>3</sub>
20, 28	P <sub>4</sub>
21, 23	$P_5$
28, 30	P <sub>6</sub>
23, 31	P <sub>7</sub>
30, 31	P <sub>8</sub>
1, 9, 17, 25	P <sub>9</sub>
0, 1, 8, 9, 2, 10, 3, 11	P <sub>10</sub>



 $f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$ 

Pls	0	1	2	3	6	8	9	10	11	17	20	21	23	25	28	30	31
P <sub>1</sub>			х		х												
P <sub>2</sub>										х		х					
P <sub>3</sub>											Х	х					
P <sub>4</sub>											Х				х		
P <sub>5</sub>												х	х				
P <sub>6</sub>															х	х	
P <sub>7</sub>													х				х
P <sub>8</sub>																х	х
P <sub>9</sub>		х					х			х				Х			
P <sub>10</sub>	х	х	х	х		х	х	Х	х								



 $f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$ 

Pls	0	1	2	3	6	8	9	10	11	17	20	21	23	25	28	30	31
P <sub>1</sub>			х		х												
P <sub>2</sub>										х		Х					
P <sub>3</sub>											Х	X					
P <sub>4</sub>											Х				х		
P <sub>5</sub>												Х	х				
P <sub>6</sub>															х	х	
P <sub>7</sub>													х				х
P <sub>8</sub>																х	х
P <sub>9</sub>		х					х			х				Х			
P <sub>10</sub>	X	х	х	х		х	х	Х	х								



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	0	1	2	3	6	8	9	10	11	17	20	21	23	25	28	30	31
P <sub>1</sub>			х		х												
P <sub>2</sub>										х		Х					
P <sub>3</sub>											х	х					
P <sub>4</sub>											Х				Х		
P <sub>5</sub>												х	Х				
P <sub>6</sub>															х	х	
P <sub>7</sub>													Х				х
P <sub>8</sub>																х	х
P <sub>9</sub>		х					х			х				х			
P <sub>10</sub>	X	х	х	х		х	х	X	х								

## P<sub>10</sub> is an essential cube

$$f = \bar{a}\bar{c} +$$

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$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	6	17	20	21	23	25	28	30	31
P <sub>1</sub>	X								
P <sub>2</sub>		х		Х					
P <sub>3</sub>			х	Х					
P <sub>4</sub>			х				Х		
P <sub>5</sub>				Х	х				
P <sub>6</sub>							х	х	
P <sub>7</sub>					х				х
P <sub>8</sub>								х	х
P <sub>9</sub>		х				х			

$$f = \bar{a}\bar{c} +$$



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$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	6	17	20	21	23	25	28	30	31
P <sub>1</sub>	X								
P <sub>2</sub>		х		х					
P <sub>3</sub>			х	Х					
P <sub>4</sub>			х				Х		
P <sub>5</sub>				х	х				
P <sub>6</sub>							Х	х	
P <sub>7</sub>					х				х
P <sub>8</sub>								Х	х
P <sub>9</sub>		Х				Х			

$$f = \bar{a}\bar{c} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	6	17	20	21	23	25	28	30	31
P <sub>1</sub>	X								
P <sub>2</sub>		х		х					
P <sub>3</sub>			х	Х					
P <sub>4</sub>			х				Х		
P <sub>5</sub>				Х	х				
P <sub>6</sub>							Х	х	
P <sub>7</sub>					х				х
P <sub>8</sub>								х	х
P <sub>9</sub>		х				х			

 $\mathbf{P}_{\mathbf{1}}$  is an essential cube

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	17	20	21	23	25	28	30	31
P <sub>2</sub>	X		х					
P <sub>3</sub>		х	х					
P <sub>4</sub>		х				х		
P <sub>5</sub>			х	х				
P <sub>6</sub>						х	Х	
P <sub>7</sub>				х				х
P <sub>8</sub>							х	х
P <sub>9</sub>	Х				х			

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	17	20	21	23	25	28	30	31
P <sub>2</sub>	X		х					
P <sub>3</sub>		х	х					
P <sub>4</sub>		х				х		
P <sub>5</sub>			х	х				
P <sub>6</sub>						х	Х	
P <sub>7</sub>				Х				х
P <sub>8</sub>							Х	х
P <sub>9</sub>	Х				X			

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	17	20	21	23	25	28	30	31
P <sub>2</sub>	х		х					
P <sub>3</sub>		х	х					
P <sub>4</sub>		х				х		
P <sub>5</sub>			х	х				
P <sub>6</sub>						х	х	
P <sub>7</sub>				х				х
P <sub>8</sub>							Х	х
P <sub>9</sub>	Х				X			

 $P_9$  is an essential cube  $f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$ 





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	20	21	23	28	30	31
P <sub>2</sub>		х				
P <sub>3</sub>	х	х				
P <sub>4</sub>	х			х		
P <sub>5</sub>		х	х			
P <sub>6</sub>				х	х	
P <sub>7</sub>			х			Х
P <sub>8</sub>					х	х

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	20	21	23	28	30	31
P <sub>2</sub>		х				
P <sub>3</sub>	х	х				
P <sub>4</sub>	х			Х		
P <sub>5</sub>		х	х			
P <sub>6</sub>				Х	Х	
P <sub>7</sub>			х			х
P <sub>8</sub>					х	х

P<sub>3</sub> dominates P<sub>2</sub>

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	20	21	23	28	30	31
P <sub>3</sub>	Х	X				
P <sub>4</sub>	х			х		
P <sub>5</sub>		Х	х			
P <sub>6</sub>				х	х	
P <sub>7</sub>			х			х
P <sub>8</sub>					х	х

$$f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$$



$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	20	21	23	28	30	31
P <sub>3</sub>	х	х				
P <sub>4</sub>	х			х		
P <sub>5</sub>		х	х			
P <sub>6</sub>				Х	Х	
P <sub>7</sub>			х			х
P <sub>8</sub>					Х	х

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	23	28	30	31
P <sub>4</sub>		х		
P <sub>5</sub>	X			
P <sub>6</sub>		х	х	
P <sub>7</sub>	Х			Х
P <sub>8</sub>			х	х

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30	31
P <sub>4</sub>		х		
P <sub>5</sub>	х			
P <sub>6</sub>		х	х	
P <sub>7</sub>	х			х
P <sub>8</sub>			х	х

P<sub>6</sub> dominates P<sub>4</sub>

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30	31
P <sub>5</sub>	Х			
P <sub>6</sub>		х	х	
P <sub>7</sub>	х			X
P <sub>8</sub>			х	Х

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30	31
P <sub>5</sub>	х			
P <sub>6</sub>		х	х	
P <sub>7</sub>	х			х
P <sub>8</sub>			х	х

## P<sub>7</sub> dominates P<sub>5</sub>

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$





$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	23	28	30	31
P <sub>6</sub>		х	х	
P <sub>7</sub>	Х			Х
P <sub>8</sub>			х	Х

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30	31
P <sub>6</sub>		х	х	
P <sub>7</sub>	Х			Х
P <sub>8</sub>			х	X

## 23 dominates 31

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$





$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	23	28	30
P <sub>6</sub>		х	х
P <sub>7</sub>	Х		
P <sub>8</sub>			х

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30
P <sub>6</sub>		х	X
P <sub>7</sub>	Х		
P <sub>8</sub>			х

P<sub>6</sub> dominates P<sub>8</sub>

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	23	28	30
P <sub>6</sub>		Х	х
P <sub>7</sub>	Х		

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} +$$



$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	23	28	30
P <sub>6</sub>		X	X
P <sub>7</sub>	X		

P<sub>6</sub> and P<sub>7</sub> are essential cubes

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} + abc\bar{e} + acde$$





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	20	21	23	28	30	31
P <sub>4</sub>	Х			X		
P <sub>5</sub>		х	х			
P <sub>6</sub>				Х	Х	
P <sub>7</sub>			х			Х
P <sub>8</sub>					Х	х

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$$



$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	20	21	23	28	30	31
P <sub>4</sub>	X			Х		
P <sub>5</sub>		х	Х			
P <sub>6</sub>				X	х	
P <sub>7</sub>			х			х
P <sub>8</sub>					х	х

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e +$$



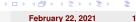
$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	20	21	23	28	30	31
P <sub>4</sub>	X			Х		
P <sub>5</sub>		х	х			
P <sub>6</sub>				Х	х	
P <sub>7</sub>			х			х
P <sub>8</sub>					х	х

## P4 is an essential cube

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} +$$





$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	21	23	30	31
P <sub>5</sub>	Х	X		
P <sub>6</sub>			х	
P <sub>7</sub>		Х		х
P <sub>8</sub>			х	Х

$$\bar{\mathbf{P}}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	21	23	30	31
P <sub>5</sub>	X	х		
P <sub>6</sub>			Х	
P <sub>7</sub>		х		X
P <sub>8</sub>			х	Х

$$ar{\mathbf{P}_3}: f = ar{a}ar{c} + ar{a}ar{b}dar{e} + ar{c}ar{d}e + acar{d}ar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	21	23	30	31
P <sub>5</sub>	X	х		
P <sub>6</sub>			х	
P <sub>7</sub>		х		Х
P <sub>8</sub>			х	Х

## P<sub>5</sub> is an essential cube

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} + a\bar{b}ce +$$





$$f(a,b,c,d,e) = \sum_{m} (0,1,2,3,6,8,9,10,11,17,20,21,23,25,28,30,31)$$

Pls	30	31
P <sub>6</sub>	X	
P <sub>7</sub>		х
P <sub>8</sub>	Х	х

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} + a\bar{b}ce +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	30	31
P <sub>6</sub>	х	
P <sub>7</sub>		х
P <sub>8</sub>	Х	х

P<sub>8</sub> dominates P<sub>6</sub> and P<sub>7</sub>

$$\bar{\mathbf{P}}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} +$$



$$f(a, b, c, d, e) = \sum_{m} (0, 1, 2, 3, 6, 8, 9, 10, 11, 17, 20, 21, 23, 25, 28, 30, 31)$$

Pls	30	31
P <sub>8</sub>	( <b>x</b> )	X

P<sub>8</sub> is an essential cube

$$\mathbf{P}_{3}: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + ac\bar{d}\bar{e} + a\bar{b}ce + abcd$$

$$\mathbf{P}_3: f = \bar{a}\bar{c} + \bar{a}\bar{b}d\bar{e} + \bar{c}\bar{d}e + a\bar{b}c\bar{d} + abc\bar{e} + acde$$

Both decisions lead to (distinct) solutions of the same cost



