

Improved asymptotically optimal error correcting codes for avoidance crosstalk type-IV on-chip data buses

Muhammad Ajmal, Masood Ur Rehman, and B G Rodrigues

Supplementary results

(1) An $(n, 4, 3)$ -IV code with size $B(n)$ over line $X = [0, 1, \dots, n - 1]$ for each $n \in \{14, 16, 22, 50\}$. All codewords are listed below.

$n = 14$

$\{0, 1, 2\},$	$\{0, 5, 13\},$	$\{1, 4, 11\},$	$\{1, 7, 12\},$	$\{2, 5, 8\},$	$\{2, 11, 12\},$	$\{3, 8, 9\},$	$\{4, 8, 12\},$	$\{6, 7, 8\},$
$\{0, 3, 10\},$	$\{0, 6, 12\},$	$\{1, 5, 10\},$	$\{1, 8, 13\},$	$\{2, 7, 10\},$	$\{3, 4, 5\},$	$\{3, 12, 13\},$	$\{5, 6, 11\},$	$\{6, 10, 13\},$
$\{0, 4, 9\},$	$\{0, 8, 11\},$	$\{1, 6, 9\},$	$\{2, 3, 6\},$	$\{2, 9, 13\},$	$\{3, 7, 11\},$	$\{4, 7, 13\},$	$\{5, 9, 12\},$	$\{9, 10, 11\}.$

$n = 16$

$\{0, 1, 5\},$	$\{0, 7, 14\},$	$\{1, 4, 13\},$	$\{1, 9, 14\},$	$\{2, 9, 13\},$	$\{3, 7, 11\},$	$\{4, 7, 10\},$	$\{5, 9, 10\},$	$\{7, 8, 9\},$
$\{0, 3, 9\},$	$\{0, 10, 13\},$	$\{1, 6, 10\},$	$\{2, 5, 11\},$	$\{2, 10, 15\},$	$\{3, 8, 13\},$	$\{4, 9, 12\},$	$\{5, 12, 13\},$	$\{8, 11, 15\},$
$\{0, 4, 8\},$	$\{0, 12, 15\},$	$\{1, 7, 15\},$	$\{2, 6, 14\},$	$\{3, 4, 15\},$	$\{3, 10, 14\},$	$\{4, 11, 14\},$	$\{6, 7, 13\},$	$\{10, 11, 12\},$
$\{0, 6, 11\},$	$\{1, 2, 3\},$	$\{1, 8, 12\},$	$\{2, 7, 12\},$	$\{3, 6, 12\},$	$\{4, 5, 6\},$	$\{5, 8, 14\},$	$\{6, 9, 15\},$	$\{13, 14, 15\}.$

$n = 22$

$\{0, 1, 2\},$	$\{0, 16, 17\},$	$\{1, 11, 18\},$	$\{2, 10, 17\},$	$\{3, 12, 16\},$	$\{4, 14, 20\},$	$\{5, 18, 21\},$	$\{7, 13, 17\},$	$\{10, 14, 21\},$
$\{0, 3, 14\},$	$\{0, 19, 20\},$	$\{1, 13, 20\},$	$\{2, 11, 14\},$	$\{3, 13, 18\},$	$\{4, 17, 21\},$	$\{6, 9, 15\},$	$\{7, 15, 21\},$	$\{10, 15, 20\},$
$\{0, 4, 7\},$	$\{1, 4, 5\},$	$\{1, 16, 21\},$	$\{2, 15, 18\},$	$\{3, 15, 19\},$	$\{5, 6, 7\},$	$\{6, 10, 16\},$	$\{8, 9, 10\},$	$\{11, 12, 13\},$
$\{0, 5, 10\},$	$\{1, 6, 17\},$	$\{2, 3, 4\},$	$\{2, 16, 19\},$	$\{4, 8, 16\},$	$\{5, 8, 20\},$	$\{6, 12, 21\},$	$\{8, 11, 17\},$	$\{11, 20, 21\},$
$\{0, 6, 11\},$	$\{1, 7, 14\},$	$\{2, 5, 9\},$	$\{3, 6, 20\},$	$\{4, 9, 19\},$	$\{5, 11, 19\},$	$\{6, 14, 19\},$	$\{8, 13, 19\},$	$\{12, 17, 20\},$
$\{0, 8, 12\},$	$\{1, 8, 15\},$	$\{2, 6, 13\},$	$\{3, 7, 8\},$	$\{4, 10, 13\},$	$\{5, 12, 15\},$	$\{7, 10, 18\},$	$\{8, 14, 18\},$	$\{14, 15, 16\},$
$\{0, 9, 18\},$	$\{1, 9, 12\},$	$\{2, 7, 20\},$	$\{3, 9, 17\},$	$\{4, 11, 15\},$	$\{5, 13, 16\},$	$\{7, 11, 16\},$	$\{9, 13, 14\},$	$\{17, 18, 19\}.$
$\{0, 13, 21\},$	$\{1, 10, 19\},$	$\{2, 8, 21\},$	$\{3, 10, 11\},$	$\{4, 12, 18\},$	$\{5, 14, 17\},$	$\{7, 12, 19\},$	$\{9, 16, 20\},$	

$n = 50$

$\{0, 1, 2\},$	$\{0, 35, 42\},$	$\{1, 28, 41\},$	$\{2, 21, 37\},$	$\{3, 30, 49\},$	$\{4, 28, 37\},$	$\{5, 27, 43\},$	$\{6, 34, 41\},$	$\{8, 9, 49\},$
$\{0, 3, 12\},$	$\{0, 37, 46\},$	$\{1, 29, 38\},$	$\{2, 22, 30\},$	$\{3, 31, 45\},$	$\{4, 29, 46\},$	$\{5, 34, 37\},$	$\{6, 37, 49\},$	$\{8, 12, 23\},$
$\{0, 4, 34\},$	$\{0, 39, 45\},$	$\{1, 31, 36\},$	$\{2, 27, 45\},$	$\{3, 33, 42\},$	$\{4, 31, 49\},$	$\{5, 35, 39\},$	$\{6, 42, 48\},$	$\{8, 13, 25\},$
$\{0, 5, 17\},$	$\{1, 4, 7\},$	$\{1, 32, 37\},$	$\{2, 28, 44\},$	$\{3, 34, 48\},$	$\{4, 33, 41\},$	$\{5, 36, 46\},$	$\{7, 11, 16\},$	$\{8, 14, 19\},$
$\{0, 6, 13\},$	$\{1, 5, 18\},$	$\{1, 33, 48\},$	$\{2, 32, 36\},$	$\{3, 35, 38\},$	$\{4, 36, 43\},$	$\{5, 48, 49\},$	$\{7, 12, 21\},$	$\{8, 15, 18\},$
$\{0, 7, 28\},$	$\{1, 6, 39\},$	$\{2, 3, 4\},$	$\{2, 35, 49\},$	$\{3, 36, 37\},$	$\{4, 39, 47\},$	$\{6, 7, 8\},$	$\{7, 13, 24\},$	$\{8, 17, 45\},$
$\{0, 8, 16\},$	$\{1, 8, 11\},$	$\{2, 5, 29\},$	$\{2, 43, 48\},$	$\{3, 39, 46\},$	$\{4, 42, 45\},$	$\{6, 9, 40\},$	$\{7, 14, 30\},$	$\{8, 20, 21\},$
$\{0, 9, 23\},$	$\{1, 9, 14\},$	$\{2, 6, 23\},$	$\{3, 6, 20\},$	$\{4, 5, 6\},$	$\{5, 8, 30\},$	$\{6, 10, 44\},$	$\{7, 15, 23\},$	$\{8, 22, 36\},$
$\{0, 11, 36\},$	$\{1, 10, 13\},$	$\{2, 7, 38\},$	$\{3, 7, 10\},$	$\{4, 8, 32\},$	$\{5, 9, 42\},$	$\{6, 11, 35\},$	$\{7, 17, 47\},$	$\{8, 24, 39\},$
$\{0, 14, 47\},$	$\{1, 12, 49\},$	$\{2, 8, 34\},$	$\{3, 8, 29\},$	$\{4, 9, 16\},$	$\{5, 10, 21\},$	$\{6, 12, 22\},$	$\{7, 18, 35\},$	$\{8, 26, 40\},$
$\{0, 15, 22\},$	$\{1, 15, 34\},$	$\{2, 9, 13\},$	$\{3, 9, 32\},$	$\{4, 10, 19\},$	$\{5, 11, 32\},$	$\{6, 14, 15\},$	$\{7, 19, 25\},$	$\{8, 27, 37\},$
$\{0, 18, 43\},$	$\{1, 16, 30\},$	$\{2, 10, 47\},$	$\{3, 11, 28\},$	$\{4, 11, 12\},$	$\{5, 12, 28\},$	$\{6, 16, 24\},$	$\{7, 20, 29\},$	$\{8, 28, 43\},$
$\{0, 19, 40\},$	$\{1, 17, 27\},$	$\{2, 11, 25\},$	$\{3, 13, 17\},$	$\{4, 13, 21\},$	$\{5, 13, 23\},$	$\{6, 17, 36\},$	$\{7, 22, 49\},$	$\{8, 31, 44\},$
$\{0, 20, 24\},$	$\{1, 19, 46\},$	$\{2, 12, 31\},$	$\{3, 14, 22\},$	$\{4, 14, 44\},$	$\{5, 14, 33\},$	$\{6, 18, 31\},$	$\{7, 26, 45\},$	$\{8, 33, 47\},$
$\{0, 21, 38\},$	$\{1, 20, 47\},$	$\{2, 14, 46\},$	$\{3, 16, 43\},$	$\{4, 15, 44\},$	$\{5, 16, 40\},$	$\{6, 19, 30\},$	$\{7, 27, 41\},$	$\{8, 35, 48\},$
$\{0, 25, 33\},$	$\{1, 21, 40\},$	$\{2, 15, 33\},$	$\{3, 18, 19\},$	$\{4, 17, 26\},$	$\{5, 19, 47\},$	$\{6, 21, 27\},$	$\{7, 31, 42\},$	$\{8, 38, 41\},$
$\{0, 26, 49\},$	$\{1, 22, 45\},$	$\{2, 16, 26\},$	$\{3, 21, 26\},$	$\{4, 18, 22\},$	$\{5, 20, 41\},$	$\{6, 25, 28\},$	$\{7, 32, 46\},$	$\{8, 42, 46\},$
$\{0, 27, 31\},$	$\{1, 23, 44\},$	$\{2, 17, 24\},$	$\{3, 23, 41\},$	$\{4, 20, 35\},$	$\{5, 22, 44\},$	$\{6, 26, 38\},$	$\{7, 33, 37\},$	$\{9, 10, 11\},$
$\{0, 29, 48\},$	$\{1, 24, 43\},$	$\{2, 18, 40\},$	$\{3, 24, 44\},$	$\{4, 23, 38\},$	$\{5, 24, 38\},$	$\{6, 29, 43\},$	$\{7, 34, 43\},$	$\{9, 12, 30\},$
$\{0, 30, 44\},$	$\{1, 25, 35\},$	$\{2, 19, 39\},$	$\{3, 25, 47\},$	$\{4, 24, 27\},$	$\{5, 25, 45\},$	$\{6, 32, 47\},$	$\{7, 36, 48\},$	$\{9, 15, 46\},$
$\{0, 32, 41\},$	$\{1, 26, 42\},$	$\{2, 20, 42\},$	$\{3, 27, 40\},$	$\{4, 25, 40\},$	$\{5, 26, 31\},$	$\{6, 33, 45\},$	$\{7, 39, 40\},$	$\{9, 17, 48\},$

{9, 18, 37},	{10, 30, 34},	{12, 17, 35},	{13, 38, 45},	{15, 31, 35},	{17, 32, 44},	{20, 37, 48},	{23, 34, 46},	{28, 42, 49},
{9, 19, 34},	{10, 31, 40},	{12, 18, 47},	{13, 39, 49},	{15, 32, 42},	{17, 46, 49},	{20, 44, 49},	{23, 37, 40},	{29, 30, 35},
{9, 20, 38},	{10, 32, 49},	{12, 19, 33},	{13, 43, 46},	{15, 36, 49},	{18, 21, 34},	{21, 22, 23},	{24, 25, 26},	{29, 40, 47},
{9, 21, 44},	{10, 33, 38},	{12, 24, 46},	{14, 17, 37},	{15, 40, 43},	{18, 23, 42},	{21, 24, 42},	{24, 28, 48},	{29, 45, 49},
{9, 22, 25},	{10, 36, 39},	{12, 25, 29},	{14, 18, 28},	{16, 19, 20},	{18, 27, 46},	{21, 25, 49},	{24, 29, 34},	{30, 37, 45},
{9, 24, 45},	{11, 14, 21},	{12, 26, 37},	{14, 20, 32},	{16, 21, 31},	{18, 29, 33},	{21, 28, 33},	{24, 30, 41},	{31, 32, 33},
{9, 26, 29},	{11, 15, 45},	{12, 27, 38},	{14, 23, 49},	{16, 22, 28},	{18, 30, 39},	{21, 30, 46},	{24, 31, 37},	{31, 38, 48},
{9, 27, 36},	{11, 17, 33},	{12, 34, 45},	{14, 25, 39},	{16, 23, 29},	{18, 32, 45},	{21, 32, 48},	{24, 32, 35},	{33, 40, 46},
{9, 28, 35},	{11, 18, 24},	{12, 36, 40},	{14, 26, 41},	{16, 25, 38},	{18, 36, 44},	{21, 35, 47},	{24, 33, 36},	{33, 43, 49},
{9, 31, 43},	{11, 19, 37},	{12, 39, 48},	{14, 27, 48},	{16, 27, 33},	{18, 41, 49},	{21, 36, 45},	{24, 40, 49},	{34, 35, 36},
{9, 33, 39},	{11, 20, 26},	{12, 41, 44},	{14, 29, 36},	{16, 34, 49},	{19, 22, 42},	{21, 39, 43},	{25, 30, 48},	{34, 39, 42},
{9, 41, 47},	{11, 22, 43},	{12, 42, 43},	{14, 31, 34},	{16, 35, 41},	{19, 23, 24},	{22, 26, 47},	{25, 32, 43},	{35, 40, 44},
{10, 14, 24},	{11, 23, 47},	{13, 16, 36},	{14, 35, 43},	{16, 37, 42},	{19, 27, 49},	{22, 27, 39},	{25, 34, 44},	{36, 42, 47},
{10, 15, 41},	{11, 27, 42},	{13, 18, 26},	{14, 38, 42},	{16, 39, 44},	{19, 28, 32},	{22, 29, 32},	{25, 36, 41},	{37, 38, 39},
{10, 16, 46},	{11, 29, 39},	{13, 19, 48},	{14, 40, 45},	{16, 47, 48},	{19, 29, 44},	{22, 31, 46},	{26, 27, 34},	{37, 43, 47},
{10, 17, 22},	{11, 30, 31},	{13, 20, 31},	{15, 16, 17},	{17, 18, 38},	{19, 31, 41},	{22, 34, 38},	{26, 30, 36},	{38, 44, 47},
{10, 18, 48},	{11, 34, 40},	{13, 22, 33},	{15, 19, 26},	{17, 20, 39},	{19, 35, 45},	{22, 37, 41},	{26, 32, 39},	{40, 41, 42},
{10, 20, 27},	{11, 38, 49},	{13, 27, 35},	{15, 21, 29},	{17, 21, 41},	{19, 38, 43},	{22, 40, 48},	{26, 33, 44},	{41, 45, 48},
{10, 23, 35},	{11, 41, 46},	{13, 29, 41},	{15, 24, 47},	{17, 23, 43},	{20, 23, 45},	{23, 26, 48},	{26, 35, 46},	{43, 44, 45},
{10, 25, 42},	{11, 44, 48},	{13, 30, 42},	{15, 25, 37},	{17, 25, 31},	{20, 25, 46},	{23, 27, 32},	{27, 28, 29},	{45, 46, 47},
{10, 26, 43},	{12, 13, 14},	{13, 32, 40},	{15, 27, 44},	{17, 28, 34},	{20, 28, 40},	{23, 28, 36},	{27, 30, 47},	
{10, 28, 45},	{12, 15, 20},	{13, 34, 47},	{15, 28, 39},	{17, 29, 42},	{20, 30, 43},	{23, 30, 33},	{28, 31, 47},	
{10, 29, 37},	{12, 16, 32},	{13, 37, 44},	{15, 30, 38},	{17, 30, 40},	{20, 33, 34},	{23, 31, 39},	{28, 38, 46},	

(2) An $(n, 4, 3)$ -IV code with size $B(n)$ over line $X = [0, 1, \dots, n-1]$ for each $n \in \{18, 20, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48\}$. While three pairs $\{n/2-2, n/2\}$, $\{n/2-1, n/2\}$, $\{n/2-1, n/2+1\}$ of line X must be contained in its leave graph. All codewords are listed below.

$n = 18$

{0, 1, 2},	{0, 9, 13},	{1, 7, 14},	{2, 5, 13},	{2, 12, 17},	{3, 11, 14},	{4, 10, 13},	{6, 9, 15},	{8, 12, 13},
{0, 3, 10},	{0, 11, 17},	{1, 9, 10},	{2, 7, 15},	{3, 4, 5},	{3, 12, 15},	{5, 6, 7},	{6, 10, 14},	{8, 14, 17},
{0, 4, 12},	{1, 4, 17},	{1, 11, 15},	{2, 8, 11},	{3, 7, 13},	{4, 7, 11},	{5, 9, 12},	{6, 13, 17},	{10, 11, 12},
{0, 5, 14},	{1, 5, 8},	{1, 13, 16},	{2, 9, 14},	{3, 8, 16},	{4, 8, 15},	{5, 10, 15},	{7, 10, 17},	{13, 14, 15},
{0, 6, 16},	{1, 6, 12},	{2, 3, 6},	{2, 10, 16},	{3, 9, 17},	{4, 9, 16},	{5, 11, 16},	{7, 12, 16},	{15, 16, 17},
{0, 7, 8},								

$n = 20$

{0, 1, 2},	{0, 12, 18},	{1, 10, 17},	{2, 8, 18},	{3, 8, 12},	{4, 10, 19},	{5, 15, 18},	{8, 9, 19},	{14, 15, 16},
{0, 3, 14},	{0, 16, 19},	{1, 12, 15},	{2, 9, 15},	{3, 9, 18},	{4, 11, 18},	{6, 7, 8},	{8, 11, 14},	{17, 18, 19},
{0, 5, 13},	{1, 4, 16},	{1, 14, 18},	{2, 11, 16},	{3, 10, 11},	{4, 13, 17},	{6, 12, 16},	{9, 13, 14},	
{0, 6, 9},	{1, 5, 9},	{2, 3, 17},	{2, 14, 19},	{3, 13, 19},	{5, 6, 19},	{6, 13, 18},	{9, 16, 17},	
{0, 7, 11},	{1, 6, 11},	{2, 5, 12},	{3, 4, 5},	{4, 7, 14},	{5, 8, 16},	{6, 14, 17},	{10, 13, 16},	
{0, 8, 17},	{1, 7, 19},	{2, 6, 10},	{3, 6, 15},	{4, 8, 15},	{5, 10, 14},	{7, 10, 18},	{11, 12, 13},	
{0, 10, 15},	{1, 8, 13},	{2, 7, 13},	{3, 7, 16},	{4, 9, 12},	{5, 11, 17},	{7, 12, 17},	{11, 15, 19},	

$n = 24$

{0, 1, 2},	{0, 16, 21},	{1, 13, 18},	{2, 18, 22},	{4, 7, 8},	{5, 11, 17},	{7, 10, 15},	{8, 18, 23},	{13, 22, 23},
{0, 3, 13},	{1, 4, 19},	{2, 3, 4},	{3, 6, 12},	{4, 9, 12},	{5, 12, 16},	{7, 12, 20},	{9, 17, 22},	{14, 15, 19},
{0, 4, 22},	{1, 5, 22},	{2, 5, 8},	{3, 7, 14},	{4, 10, 13},	{5, 13, 19},	{7, 13, 17},	{9, 20, 23},	{14, 17, 21},
{0, 5, 20},	{1, 6, 16},	{2, 6, 17},	{3, 8, 19},	{4, 11, 15},	{5, 15, 23},	{7, 18, 21},	{10, 11, 23},	{15, 16, 17},
{0, 7, 11},	{1, 7, 23},	{2, 7, 16},	{3, 9, 15},	{4, 14, 18},	{6, 9, 13},	{7, 19, 22},	{10, 16, 19},	{18, 19, 20},
{0, 8, 12},	{1, 8, 17},	{2, 9, 14},	{3, 10, 22},	{4, 16, 20},	{6, 10, 18},	{8, 9, 10},	{11, 16, 22},	
{0, 9, 19},	{1, 9, 21},	{2, 10, 21},	{3, 11, 18},	{4, 17, 23},	{6, 11, 21},	{8, 11, 20},	{12, 13, 14},	
{0, 10, 17},	{1, 10, 20},	{2, 11, 19},	{3, 16, 23},	{5, 6, 7},	{6, 14, 20},	{8, 13, 16},	{12, 17, 18},	
{0, 14, 23},	{1, 11, 14},	{2, 12, 23},	{3, 17, 20},	{5, 9, 18},	{6, 15, 22},	{8, 14, 22},	{12, 21, 22},	
{0, 15, 18},	{1, 12, 15},	{2, 15, 20},	{4, 5, 21},	{5, 10, 14},	{6, 19, 23},	{8, 15, 21},	{13, 20, 21},	

$n = 26$

{0, 1, 2},	{0, 16, 24},	{1, 16, 19},	{2, 12, 16},	{3, 13, 24},	{4, 18, 24},	{6, 7, 8},	{7, 16, 23},	{9, 10, 11},
{0, 3, 7},	{0, 18, 23},	{1, 17, 25},	{2, 14, 17},	{3, 14, 18},	{4, 19, 25},	{6, 11, 22},	{7, 17, 20},	{9, 12, 23},
{0, 4, 20},	{1, 4, 8},	{1, 20, 23},	{2, 15, 20},	{3, 15, 25},	{5, 6, 10},	{6, 12, 17},	{7, 21, 25},	{9, 14, 24},
{0, 5, 8},	{1, 5, 22},	{2, 3, 21},	{2, 22, 25},	{3, 16, 22},	{5, 9, 25},	{6, 15, 23},	{8, 9, 21},	{9, 15, 19},
{0, 6, 13},	{1, 6, 14},	{2, 5, 13},	{3, 4, 5},	{4, 7, 11},	{5, 11, 16},	{6, 16, 21},	{8, 11, 20},	{9, 18, 22},
{0, 9, 17},	{1, 7, 10},	{2, 6, 9},	{3, 6, 19},	{4, 9, 16},	{5, 12, 20},	{6, 18, 25},	{8, 12, 18},	{10, 13, 23},
{0, 10, 19},	{1, 9, 13},	{2, 7, 24},	{3, 8, 23},	{4, 12, 15},	{5, 14, 19},	{6, 20, 24},	{8, 13, 25},	{10, 14, 20},
{0, 11, 15},	{1, 11, 18},	{2, 8, 19},	{3, 9, 20},	{4, 13, 21},	{5, 15, 24},	{7, 12, 19},	{8, 14, 22},	{10, 15, 22},
{0, 12, 25},	{1, 12, 24},	{2, 10, 18},	{3, 10, 17},	{4, 14, 23},	{5, 17, 23},	{7, 13, 22},	{8, 15, 16},	{10, 16, 25},
{0, 14, 21},	{1, 15, 21},	{2, 11, 23},	{3, 11, 12},	{4, 17, 22},	{5, 18, 21},	{7, 15, 18},	{8, 17, 24},	

{10, 21, 24}, {11, 17, 21}, {12, 21, 22}, {13, 16, 20}, {16, 17, 18}, {19, 22, 23},
 {11, 14, 25}, {11, 19, 24}, {13, 14, 15}, {13, 18, 19}, {19, 20, 21}, {23, 24, 25}.

$n = 28$

{0, 1, 2}, {1, 5, 10}, {2, 7, 14}, {3, 12, 13}, {4, 20, 26}, {6, 15, 21}, {8, 14, 25}, {11, 14, 17}, {17, 18, 19},
 {0, 3, 25}, {1, 6, 7}, {2, 8, 27}, {3, 14, 26}, {5, 8, 19}, {6, 19, 25}, {8, 15, 20}, {11, 15, 19}, {17, 21, 26},
 {0, 4, 21}, {1, 8, 17}, {2, 9, 16}, {3, 16, 27}, {5, 9, 20}, {6, 23, 27}, {8, 22, 26}, {11, 20, 27}, {17, 22, 27},
 {0, 5, 17}, {1, 9, 13}, {2, 10, 15}, {3, 18, 22}, {5, 11, 26}, {7, 8, 9}, {9, 10, 23}, {12, 15, 18}, {18, 21, 25},
 {0, 6, 10}, {1, 11, 25}, {2, 11, 18}, {3, 20, 23}, {5, 12, 22}, {7, 10, 25}, {9, 12, 27}, {12, 16, 19}, {20, 21, 22},
 {0, 7, 12}, {1, 12, 21}, {2, 12, 26}, {4, 5, 6}, {5, 13, 21}, {7, 11, 24}, {9, 14, 21}, {12, 20, 25}, {23, 24, 25},
 {0, 9, 18}, {1, 15, 22}, {2, 13, 19}, {4, 7, 22}, {5, 15, 27}, {7, 13, 16}, {9, 17, 25}, {13, 17, 24},
 {0, 11, 22}, {1, 16, 26}, {2, 17, 23}, {4, 8, 16}, {5, 16, 25}, {7, 15, 23}, {9, 19, 22}, {13, 23, 26},
 {0, 13, 27}, {1, 18, 27}, {2, 22, 25}, {4, 9, 24}, {5, 18, 23}, {7, 17, 20}, {10, 11, 12}, {14, 15, 16},
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