

Different Types of Magic Rectangles

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Abstract

*This work brings the idea of different types of magic rectangles. These includes **bordered magic rectangles**, **double digits magic rectangles** and **cornered magic rectangles**. These kinds are frequently used in construction of different types of magic squares. Main idea is in construction magic squares based on four of equal order and equal sums of magic rectangles. For details, see author's work [86, 87, 88, 89].*

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1 Different Type Magic Rectangles

Magic rectangles are well known in the literature. Below are two magic rectangles of orders 12×20 and 14×18 .

196	109	50	80	79	39	203	61	93	98	18	95	223	85	158	137	108	129	225	224	2410
142	240	154	74	150	73	30	11	120	37	121	46	66	236	218	180	174	166	110	62	2410
115	35	59	232	163	107	133	16	228	49	112	19	209	197	13	113	235	204	149	22	2410
54	24	135	185	117	220	141	145	6	201	202	186	156	51	194	81	119	53	106	34	2410
184	92	168	9	237	29	153	226	207	94	229	1	56	26	7	175	123	84	199	111	2410
12	43	128	136	5	173	138	216	105	78	214	160	144	99	44	114	89	116	231	165	2410
205	212	47	41	146	210	227	86	14	151	71	155	36	181	195	20	126	72	76	139	2410
100	187	217	208	147	177	67	127	27	183	104	77	60	233	191	45	125	42	2	91	2410
215	55	40	58	159	122	161	211	70	176	221	192	148	25	57	96	172	82	48	102	2410
200	206	189	3	198	131	4	33	239	101	21	222	32	178	38	152	65	193	75	130	2410
8	140	171	238	17	31	179	124	170	188	69	63	97	83	213	164	23	143	157	132	2410
15	103	88	182	28	134	10	190	167	90	64	230	219	52	118	169	87	162	68	234	2410
1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	

146	36	193	244	132	91	39	249	15	226	106	208	85	12	168	94	192	41	2277
53	189	40	137	170	234	147	131	100	5	173	145	140	198	182	6	190	37	2277
188	200	1	26	128	177	102	218	149	97	31	171	236	65	30	235	169	54	2277
23	101	81	233	114	158	72	199	112	66	135	184	134	79	52	213	99	222	2277
50	201	118	86	7	47	212	247	136	163	248	156	108	109	232	75	68	14	2277
243	157	42	129	214	107	45	8	88	197	240	183	29	144	180	117	83	71	2277
143	205	82	43	46	206	90	4	34	210	19	16	165	195	202	238	231	148	2277
116	80	179	224	187	38	130	11	175	13	215	139	20	239	103	181	18	209	2277
78	119	124	44	59	35	228	98	252	2	105	27	250	211	120	162	142	221	2277
154	121	223	58	219	160	152	60	74	207	63	77	229	3	55	10	251	161	2277
57	115	246	237	151	32	110	217	93	230	69	203	28	25	133	33	104	194	2277
196	24	216	48	96	123	141	87	242	56	51	111	155	191	73	76	166	225	2277
138	64	22	245	95	178	62	92	125	172	227	67	122	174	220	164	49	61	2277
186	159	204	17	153	185	241	150	176	127	89	84	70	126	21	167	9	113	2277
1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	1771	

Above two are just simple magic rectangles. Below we have given three different types of magic rectangles classifying as:

1. Bordered Magic Rectangles;

2. Double Digits Magic Rectangles;
3. Cornered Magic Rectangles.

Later these types of magic rectangles are used to construct magic squares. The construction is based on four equal order and equal sums magic rectangles of each type. For details refer author’s work [86, 87, 88, 89]. These are given in following subsections. The examples considered in this work are calculated using softwares by H. White [1].

1.1 Bordered Magic Rectangles

Bordered magic rectangles are very much similar to **bordered magic squares**. The difference is that in case **bordered magic rectangles**, the width and height are different, while in case of **bordered magic squares** the width and height are the same. Below are few examples of **bordered magic rectangles**.

1.1.1 Example 1

Let’s consider a **bordered magic rectangle** of order 12×18 formed by 216 sequential entries, i.e., from 1 to 216:

8	210	198	5	202	207	21	26	204	194	197	28	1	25	200	9	206	12	1953
201	44	184	35	50	185	30	180	51	172	175	41	177	39	170	165	38	16	1953
215	49	56	66	148	158	57	149	147	157	163	65	55	67	159	72	168	2	1953
22	169	61	88	81	73	141	132	83	131	82	143	78	133	137	156	48	195	1953
14	34	155	140	90	97	95	128	118	96	94	126	124	117	77	62	183	203	1953
4	181	63	130	119	109	105	116	106	103	115	104	110	98	87	154	36	213	1953
24	43	153	75	125	108	112	101	111	114	102	113	107	92	142	64	174	193	1953
190	186	164	138	100	120	122	89	99	121	123	91	93	127	79	53	31	27	1953
6	29	71	80	136	144	76	85	134	86	135	74	139	84	129	146	188	211	1953
199	171	145	151	69	59	160	68	70	60	54	152	162	150	58	161	46	18	1953
214	179	33	182	167	32	187	37	166	45	42	176	40	178	47	52	173	3	1953
205	7	19	212	15	10	196	191	13	23	20	189	216	192	17	208	11	209	1953
1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	

By **bordered magic rectangle**, we understand that if we remove, external borders still we are left with **bordered magic rectangle**. See below the examples of lower orders:

44	184	35	50	185	30	180	51	172	175	41	177	39	170	165	38	1736
49	56	66	148	158	57	149	147	157	163	65	55	67	159	72	168	1736
169	61	88	81	73	141	132	83	131	82	143	78	133	137	156	48	1736
34	155	140	90	97	95	128	118	96	94	126	124	117	77	62	183	1736
181	63	130	119	109	105	116	106	103	115	104	110	98	87	154	36	1736
43	153	75	125	108	112	101	111	114	102	113	107	92	142	64	174	1736
186	164	138	100	120	122	89	99	121	123	91	93	127	79	53	31	1736
29	71	80	136	144	76	85	134	86	135	74	139	84	129	146	188	1736
171	145	151	69	59	160	68	70	60	54	152	162	150	58	161	46	1736
179	33	182	167	32	187	37	166	45	42	176	40	178	47	52	173	1736
1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	1085	

56	66	148	158	57	149	147	157	163	65	55	67	159	72	1519
61	88	81	73	141	132	83	131	82	143	78	133	137	156	1519
155	140	90	97	95	128	118	96	94	126	124	117	77	62	1519
63	130	119	109	105	116	106	103	115	104	110	98	87	154	1519
153	75	125	108	112	101	111	114	102	113	107	92	142	64	1519
164	138	100	120	122	89	99	121	123	91	93	127	79	53	1519
71	80	136	144	76	85	134	86	135	74	139	84	129	146	1519
145	151	69	59	160	68	70	60	54	152	162	150	58	161	1519
868	868	868	868	868	868	868	868	868	868	868	868	868	868	868

88	81	73	141	132	83	131	82	143	78	133	137	1302
140	90	97	95	128	118	96	94	126	124	117	77	1302
130	119	109	105	116	106	103	115	104	110	98	87	1302
75	125	108	112	101	111	114	102	113	107	92	142	1302
138	100	120	122	89	99	121	123	91	93	127	79	1302
80	136	144	76	85	134	86	135	74	139	84	129	1302
651	651	651	651	651	651	651	651	651	651	651	651	

90	97	95	128	118	96	94	126	124	117	1085
119	109	105	116	106	103	115	104	110	98	1085
125	108	112	101	111	114	102	113	107	92	1085
100	120	122	89	99	121	123	91	93	127	1085
434	434	434	434	434	434	434	434	434	434	

According to colors the entries are as follows:

The distribution entries of above magic rectangles are as follows:

1.1.2 Example 2

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By **bordered magic rectangle**, we understand that if we remove, external borders still we are left with **bordered magic rectangle**. See below the examples of lower orders:

According to colors the entries are as follows:

The distribution entries of above magic rectangles are as follows:

There are many magic squares are constructed based on this idea. See the author's work [55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66]

1.2 Double Digits Magic Rectangles

Below we shall give two examples of **double digits magic rectangles**.

1.2.1 Example 1

Let’s consider a **double digits magic rectangle** of order 14×20 formed by 280 sequential entries, i.e., from 1 to 280:

20	273	224	277	28	245	271	58	50	15	59	19	34	13	232	23	221	256	259	233	2810
8	261	57	4	253	36	10	223	231	266	222	262	247	268	49	258	60	25	48	22	2810
226	55	70	189	69	102	193	79	63	94	204	215	214	81	191	93	178	213	249	32	2810
237	44	92	211	212	179	88	202	218	187	77	66	67	200	90	188	68	103	251	30	2810
228	53	192	89	169	110	173	168	158	154	107	119	159	106	149	114	185	96	6	275	2810
252	29	201	80	171	112	108	113	123	127	174	162	122	175	167	132	84	197	243	38	2810
227	54	196	85	150	131	146	137	143	136	147	133	142	140	109	172	91	190	257	24	2810
26	255	186	95	117	164	135	144	138	145	134	148	139	141	156	125	194	87	2	279	2810
244	37	74	207	116	161	176	128	166	124	121	126	129	118	151	170	180	101	7	274	2810
229	52	209	72	120	165	105	153	115	157	160	155	152	163	111	130	64	217	27	254	2810
250	31	99	195	198	78	210	76	75	100	199	61	208	183	62	216	184	104	39	242	2810
16	265	86	182	83	203	71	205	206	181	82	220	73	98	219	65	177	97	269	12	2810
1	278	9	264	235	14	51	43	56	241	248	42	236	41	246	276	21	11	263	234	2810
3	280	272	17	46	267	230	238	225	40	33	239	45	240	35	5	260	270	47	18	2810
1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	1967	

By double digits we understand that, except corners, all others rows or columns taken in pairs are of equal sums. Actually, these are **double digits bordered magic rectangles**, but for simplicity, we shall call it **double digits magic rectangles**. See below sums according to colors:

● Horizontal Sums in Pairs

224	277	28	245	271	58	50	15	59	19	34	13	232	23	221	256
57	4	253	36	10	223	231	266	222	262	247	268	49	258	60	25
281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281

9	264	235	14	51	43	56	241	248	42	236	41	246	276	21	11
272	17	46	267	230	238	225	40	33	239	45	240	35	5	260	270
281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281

69	102	193	79	63	94	204	215	214	81	191	93
212	179	88	202	218	187	77	66	67	200	90	188
281	281	281	281	281	281	281	281	281	281	281	281

198	78	210	76	75	100	199	61	208	183	62	216
83	203	71	205	206	181	82	220	73	98	219	65
281	281	281	281	281	281	281	281	281	281	281	281

173	168	158	154	107	119	159	106
108	113	123	127	174	162	122	175
281	281	281	281	281	281	281	281

176	128	166	124	121	126	129	118
105	153	115	157	160	155	152	163
281	281	281	281	281	281	281	281

146	137	143	136	147	133	142	140
135	144	138	145	134	148	139	141
281	281	281	281	281	281	281	281

● Vertical Sums in Pairs

226	55	281	249	32	281	192	89	281	185	96	281
237	44	281	251	30	281	201	80	281	84	197	281
228	53	281	6	275	281	196	85	281	91	190	281
252	29	281	243	38	281	186	95	281	194	87	281
227	54	281	257	24	281	74	207	281	180	101	281
26	255	281	2	279	281	209	72	281	64	217	281
244	37	281	7	274	281						
229	52	281	27	254	281	150	131	281	109	172	281
250	31	281	39	242	281	117	164	281	156	125	281
16	265	281	269	12	281						

Removing the external borders, still we get **double digit magic rectangle** of sequential numbers entries. See below:

70	189	69	102	193	79	63	94	204	215	214	81	191	93	178	213	2248
92	211	212	179	88	202	218	187	77	66	67	200	90	188	68	103	2248
192	89	169	110	173	168	158	154	107	119	159	106	149	114	185	96	2248
201	80	171	112	108	113	123	127	174	162	122	175	167	132	84	197	2248
196	85	150	131	146	137	143	136	147	133	142	140	109	172	91	190	2248
186	95	117	164	135	144	138	145	134	148	139	141	156	125	194	87	2248
74	207	116	161	176	128	166	124	121	126	129	118	151	170	180	101	2248
209	72	120	165	105	153	115	157	160	155	152	163	111	130	64	217	2248
99	195	198	78	210	76	75	100	199	61	208	183	62	216	184	104	2248
86	182	83	203	71	205	206	181	82	220	73	98	219	65	177	97	2248
1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	

169	110	173	168	158	154	107	119	159	106	149	114	1686
171	112	108	113	123	127	174	162	122	175	167	132	1686
150	131	146	137	143	136	147	133	142	140	109	172	1686
117	164	135	144	138	145	134	148	139	141	156	125	1686
116	161	176	128	166	124	121	126	129	118	151	170	1686
120	165	105	153	115	157	160	155	152	163	111	130	1686
843	843	843	843	843	843	843	843	843	843	843	843	

146	137	143	136	147	133	142	140	1124
135	144	138	145	134	148	139	141	1124
281	281	281	281	281	281	281	281	

The entries are respectively

$$D_{14 \times 20} := \{1, 2, \dots, 280\}.$$

$$D_{10 \times 16} := \{61, 62, \dots, 220\} \quad \text{and} \quad D_{14 \times 20} := \{1, 2, \dots, 60, D_{10 \times 16}, 221, 222, \dots, 280\}.$$

$$D_{6 \times 12} := \{105, 106, \dots, 176\} \quad \text{and} \quad D_{10 \times 16} := \{61, 62, \dots, 104, D_{6 \times 10}, 177, 178, \dots, 220\}.$$

$$D_{2 \times 8} := \{133, 134, \dots, 148\} \quad \text{and} \quad D_{6 \times 12} := \{105, 106, \dots, 132, D_{2 \times 8}, 149, 150, \dots, 176\}.$$

1.2.2 Example 2

Let's consider a **double digits magic rectangle** of order 12×22 formed by 264 sequential entries, i.e., from 1 to 264:

229	253	32	18	49	245	11	16	41	214	50	232	241	218	23	45	239	244	212	38	240	25	2915
36	12	233	247	216	20	254	249	224	51	215	33	24	47	242	220	26	21	53	227	258	7	2915
248	17	83	190	192	101	78	191	180	178	95	198	90	94	200	102	82	66	88	177	3	262	2915
2	263	182	75	73	164	187	74	85	87	170	67	175	171	65	163	183	199	201	64	46	219	2915
256	9	174	91	137	121	134	141	127	152	108	150	151	114	131	149	116	124	81	184	213	52	2915
260	5	79	186	144	120	110	159	136	113	128	130	118	139	147	158	138	115	188	77	230	35	2915
13	252	100	165	132	160	153	123	125	109	140	105	135	155	106	112	157	143	76	189	31	234	2915
261	4	194	71	117	129	133	107	142	156	154	145	126	122	146	111	119	148	161	104	15	250	2915
228	37	168	97	86	96	98	84	195	172	89	204	103	62	196	202	193	68	99	173	34	231	2915
29	236	80	185	179	169	167	181	70	93	176	61	162	203	69	63	72	197	166	92	255	10	2915
6	259	209	27	54	246	235	58	264	225	42	210	60	43	8	57	226	206	28	217	14	221	2915
22	243	56	238	211	19	30	207	1	40	223	55	205	222	257	208	39	59	237	48	251	44	2915
1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	

See below sums according to colors:

● Horizontal Sums in Pairs

32	18	49	245	11	16	41	214	50	232	241	218	23	45	239	244	212	38
233	247	216	20	254	249	224	51	215	33	24	47	242	220	26	21	53	227
265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265
209	27	54	246	235	58	264	225	42	210	60	43	8	57	226	206	28	217
56	238	211	19	30	207	1	40	223	55	205	222	257	208	39	59	237	48
265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265
															</		

• Vertical Sums in Pairs

248	17	265		3	262	265										
2	263	265		46	219	265										
256	9	265		213	52	265		174	91	265		81	184	265		
260	5	265		230	35	265		79	186	265		188	77	265		
13	252	265		31	234	265		100	165	265		76	189	265		
261	4	265		15	250	265		194	71	265		161	104	265		
228	37	265		34	231	265										
29	236	265		255	10	265										

Removing the external borders, still we get **double digit magic rectangle** of sequential numbers entries. See below:

83	190	192	101	78	191	180	178	95	198	90	94	200	102	82	66	88	177	2385
182	75	73	164	187	74	85	87	170	67	175	171	65	163	183	199	201	64	2385
174	91	137	121	134	141	127	152	108	150	151	114	131	149	116	124	81	184	2385
79	186	144	120	110	159	136	113	128	130	118	139	147	158	138	115	188	77	2385
100	165	132	160	153	123	125	109	140	105	135	155	106	112	157	143	76	189	2385
194	71	117	129	133	107	142	156	154	145	126	122	146	111	119	148	161	104	2385
168	97	86	96	98	84	195	172	89	204	103	62	196	202	193	68	99	173	2385
80	185	179	169	167	181	70	93	176	61	162	203	69	63	72	197	166	92	2385
1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060

137	121	134	141	127	152	108	150	151	114	131	149	116	124	1855
144	120	110	159	136	113	128	130	118	139	147	158	138	115	1855
132	160	153	123	125	109	140	105	135	155	106	112	157	143	1855
117	129	133	107	142	156	154	145	126	122	146	111	119	148	1855
530	530	530	530	530	530	530	530	530	530	530	530	530	530	

The above figure is just magic rectangle with 4 lines. In this case we can't write it as two digits magic rectangles. Let's write it as **bordered magic rectangle**:

157	107	151	152	146	117	116	159	155	145	115	118	105	112	1855
109	140	128	131	132	126	141	127	143	142	129	130	121	156	1855
111	125	137	134	133	139	124	138	122	123	136	135	144	154	1855
153	158	114	113	119	148	149	106	110	120	150	147	160	108	1855
530	530	530	530	530	530	530	530	530	530	530	530	530	530	

Combing it with original **double digits magic rectangle**, we get it as

229	253	32	18	49	245	11	16	41	214	50	232	241	218	23	45	239	244	212	38	240	25	2915
36	12	233	247	216	20	254	249	224	51	215	33	24	47	242	220	26	21	53	227	258	7	2915
248	17	83	190	192	101	78	191	180	178	95	198	90	94	200	102	82	66	88	177	3	262	2915
2	263	182	75	73	164	187	74	85	87	170	67	175	171	65	163	183	199	201	64	46	219	2915
256	9	174	91	157	107	151	152	146	117	116	159	155	145	115	118	105	112	81	184	213	52	2915
260	5	79	186	109	140	128	131	132	126	141	127	143	142	129	130	121	156	188	77	230	35	2915
13	252	100	165	111	125	137	134	133	139	124	138	122	123	136	135	144	154	76	189	31	234	2915
261	4	194	71	153	158	114	113	119	148	149	106	110	120	150	147	160	108	161	104	15	250	2915
228	37	168	97	86	96	98	84	195	172	89	204	103	62	196	202	193	68	99	173	34	231	2915
29	236	80	185	179	169	167	181	70	93	176	61	162	203	69	63	72	197	166	92	255	10	2915
6	259	209	27	54	246	235	58	264	225	42	210	60	43	8	57	226	206	28	217	14	221	2915
22	243	56	238	211	19	30	207	1	40	223	55	205	222	257	208	39	59	237	48	251	44	2915
1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590	

The entries are respectively

$$D_{12 \times 22} := \{1, 2, \dots, 264\}.$$

$$D_{8 \times 18} := \{61, 62, \dots, 204\} \quad \text{and} \quad D_{12 \times 22} := \{1, 2, \dots, 60, D_{8 \times 18}, 205, 206, \dots, 264\}.$$

$$D_{4 \times 14} := \{105, 106, \dots, 160\} \quad \text{and} \quad D_{8 \times 18} := \{61, 62, \dots, 104, D_{4 \times 14}, 161, 162, \dots, 204\}.$$

$$D_{2 \times 12} := \{121, 122, \dots, 144\} \quad \text{and} \quad D_{4 \times 14} := \{105, 106, \dots, 120, D_{2 \times 12}, 145, 146, \dots, 160\}.$$

There are many magic squares are constructed based on this idea. See the author's work [67, 68, 69, 70, 71, 72]. Magic squares of orders 7 to 108 can be seen in [81].

1.3 Cornered Magic Rectangle

Below are two examples of **cornered magic rectangles**.

1.3.1 Example 1

Let's consider a **cornered magic rectangle** of order 8×12 formed by 96 sequential entries, i.e., from 1 to 96:

49	53	50	43	45	51	56	41	30	67	12	85	582
48	44	47	54	52	46	40	57	22	75	15	82	582
33	39	63	38	37	55	62	61	76	21	91	6	582
64	58	34	59	60	42	36	35	71	26	11	86	582
68	73	27	72	19	77	32	66	23	28	84	13	582
29	24	70	25	78	20	65	31	69	74	93	4	582
1	90	81	88	14	92	89	87	3	18	2	17	582
96	7	16	9	83	5	8	10	94	79	80	95	582
388	388	388	388	388	388	388	388	388	388	388	388	

In this case the distribution is $D_{8 \times 12} := \{1, 2, \dots, 96\}$. Except the corners the numbers are of equal sums in pairs. Distributions in colors as follows:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
19	20	21	22	23	24	25	26	27	28	29	30	31	32	65	66	67	68	69	70	71	72	73	74	75	76	77	78								
33	34	35	36	37	38	39	40	41	42	55	56	57	58	59	60	61	62	63	64																
43	44	45	46	47	48	49	50	51	52	53	54																								

Except the last entries, the others are known by half-sequential entries.

Let’s remove external border, still we left with **cornered magic rectangle** of lower order, i.e., 6×10 , see below

49	53	50	43	45	51	56	41	30	67	485
48	44	47	54	52	46	40	57	22	75	485
33	39	63	38	37	55	62	61	76	21	485
64	58	34	59	60	42	36	35	71	26	485
68	73	27	72	19	77	32	66	23	28	485
29	24	70	25	78	20	65	31	69	74	485
291	291	291	291	291	291	291	291	291	291	

In this case the distributions are $D_{6 \times 10} := \{19, 20, \dots, 78\}$ and $D_{8 \times 12} := \{1, 2, \dots, 18, D_{6 \times 10}, 79, 80, \dots, 96\}$. Again, removing the external border, we still left with magic rectangle of order 4×8 . See below:

49	53	50	43	45	51	56	41	388
48	44	47	54	52	46	40	57	388
33	39	63	38	37	55	62	61	388
64	58	34	59	60	42	36	35	388
194	194	194	194	194	194	194	194	

In this case the distributions are $D_{4 \times 8} := \{33, 34, \dots, 64\}$ and $D_{6 \times 10} := \{19, 20, \dots, 32, D_{4 \times 8}, 65, 66, \dots, 78\}$. Again, removing the external border, we still left with magic rectangle of order 2×6 . See below:

49	53	50	43	45	51	291
48	44	47	54	52	46	291
97	97	97	97	97	97	

In this case the distributions are $D_{2 \times 6} := \{43, 44, \dots, 54\}$ and $D_{4 \times 8} := \{33, 34, \dots, 43, D_{2 \times 6}, 55, 56, \dots, 64\}$.

1.3.2 Example 2

Let’s consider a **cornered magic rectangle** of order 10×24 formed by 240 sequential entries, i.e., from 1 to 240:

115	113	135	124	136	116	110	111	109	133	129	119	123	107	127	121	98	143	167	74	206	35	8	233	2892
126	128	106	117	105	125	131	130	132	108	112	122	118	134	114	120	90	151	77	164	36	205	229	12	2892
141	96	92	139	154	101	144	99	91	103	88	137	156	86	152	147	148	95	76	165	57	184	213	28	2892
100	145	149	102	87	140	97	142	150	138	153	104	85	155	89	94	146	93	174	67	198	43	27	214	2892
173	177	175	73	83	180	62	63	71	84	171	163	166	161	72	162	159	65	69	81	202	39	209	32	2892
68	64	66	168	158	61	179	178	170	157	70	78	75	80	169	79	82	176	160	172	34	207	240	1	2892
48	197	182	188	55	190	196	54	40	58	46	56	200	191	181	33	38	52	49	199	194	204	224	17	2892
193	44	59	53	186	51	45	187	201	183	195	185	41	50	60	208	203	189	192	42	37	47	25	216	2892
13	5	239	231	6	237	20	220	26	30	227	11	15	219	16	238	31	217	223	9	212	222	7	218	2892
228	236	2	10	235	4	221	21	215	211	14	230	226	22	225	3	210	24	18	232	29	19	23	234	2892
1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	1205	

In this case the distribution is $D_{10 \times 24} := \{1, 2, \dots, 240\}$. Except the corners, the numbers are of equal sums in pairs. Distributions in colors as follows:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60				
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208				
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84								
157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180								
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104												
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156												
115	105	106	107	108	109	110	111	112	113	114	116	117	118	119	120																
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136																

Except the last entries, the others are known by **half-sequential** entries.

Let's remove external border, still we left with **cornered magic rectangle** of lower order, i.e., 8×22 , see below

115	113	135	124	136	116	110	111	109	133	129	119	123	107	127	121	98	143	167	74	206	35	2651
126	128	106	117	105	125	131	130	132	108	112	122	118	134	114	120	90	151	77	164	36	205	2651
141	96	92	139	154	101	144	99	91	103	88	137	156	86	152	147	148	95	76	165	57	184	2651
100	145	149	102	87	140	97	142	150	138	153	104	85	155	89	94	146	93	174	67	198	43	2651
173	177	175	73	83	180	62	63	71	84	171	163	166	161	72	162	159	65	69	81	202	39	2651
68	64	66	168	158	61	179	178	170	157	70	78	75	80	169	79	82	176	160	172	34	207	2651
48	197	182	188	55	190	196	54	40	58	46	56	200	191	181	33	38	52	49	199	194	204	2651
193	44	59	53	186	51	45	187	201	183	195	185	41	50	60	208	203	189	192	42	37	47	2651
964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	964	

In this case the distributions are $D_{8 \times 22} := \{33, 34, \dots, 208\}$ and $D_{10 \times 24} := \{1, 2, \dots, 32, D_{8 \times 22}, 209, 210, \dots, 240\}$. Again, removing the external border, we still left with magic rectangle of order 6×20 . See below:

115	113	135	124	136	116	110	111	109	133	129	119	123	107	127	121	98	143	167	74	2410
126	128	106	117	105	125	131	130	132	108	112	122	118	134	114	120	90	151	77	164	2410
141	96	92	139	154	101	144	99	91	103	88	137	156	86	152	147	148	95	76	165	2410
100	145	149	102	87	140	97	142	150	138	153	104	85	155	89	94	146	93	174	67	2410
173	177	175	73	83	180	62	63	71	84	171	163	166	161	72	162	159	65	69	81	2410
68	64	66	168	158	61	179	178	170	157	70	78	75	80	169	79	82	176	160	172	2410
723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	723	

In this case the distributions are $D_{6 \times 20} := \{61, 62, \dots, 180\}$ and $D_{8 \times 22} := \{19, 20, \dots, 32, D_{6 \times 20}, 65, 66, \dots, 78\}$. Again, removing the external border, we still left with magic rectangle of order 4×18 . See below:

115	113	135	124	136	116	110	111	109	133	129	119	123	107	127	121	98	143	2169
126	128	106	117	105	125	131	130	132	108	112	122	118	134	114	120	90	151	2169
141	96	92	139	154	101	144	99	91	103	88	137	156	86	152	147	148	95	2169
100	145	149	102	87	140	97	142	150	138	153	104	85	155	89	94	146	93	2169
482	482	482	482	482	482	482	482	482	482	482	482	482	482	482	482	482	482	

In this case the distributions are $D_{4 \times 18} := \{85, 86, \dots, 156\}$ and $D_{6 \times 20} := \{61, 62, \dots, 84, D_{4 \times 18}, 157, 158, \dots, 180\}$. Again, removing the external border, we still left with magic rectangle of order 2×16 . See below:

115	113	135	124	136	116	110	111	109	133	129	119	123	107	127	121	1928
126	128	106	117	105	125	131	130	132	108	112	122	118	134	114	120	1928
241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	241	

In this case the distributions are $D_{2 \times 16} := \{115, 116, \dots, 136\}$ and $D_{4 \times 18} := \{85, 86, \dots, 114, D_{2 \times 16}, 137, 138, \dots, 156\}$.

Few work on magic squares connected with **cornered magic rectangles** can be seen in [82, 83, 84, 85].

Acknowledgement

The examples considered in the work are considered using different softwares by H. White [1]. The author is thankful to H. White for providing these softwares.

2 Author’s Contribution to Magic Squares and Recreation Numbers

For author’s contribution to **magic squares** and **recreation numbers** please see the links below:

- **Inder J. Taneja**, Magic Squares, <https://inderjtaneja.com/2019/06/27/publications-magic-squares/>
- **Inder J. Taneja**, Recreation of Numbers, <https://inderjtaneja.com/2019/06/27/publications-recreation-of-numbers/>

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