

choice_sim

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1 Simulation of reasonable choices

1.0.1 NOTE: We create a random matrix with zero diagonal.

1.0.2 Furthermore, let $r \in [0, 1]$ be A's reasons to be chosen over B. Then $r(A, B) = -r(B, A)$

```
In [13]: import numpy as np
import string
import pandas as pd
from itertools import combinations, permutations, product, chain
import warnings
warnings.filterwarnings('ignore')
```

```
In [3]: # the following function creates a matrix with random entries in the upper diagonal,
# the negative of the upper diagonal on the lower diagonal and zeros on the diagonal
def init_reasons_matrix(size, num_reasons):
    init_array = np.random.uniform(-1*num_reasons, num_reasons, (size, size))
    X = np.triu(-init_array).T + np.triu(init_array)
    return pd.DataFrame(X, columns=[string.ascii_lowercase[i] for i in range(X[:,0].size)],
                        index=[string.ascii_lowercase[i] for i in range(X[:,0].size)])
```

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In [10]: # Example: a 4*4 matrix, i.e. choice set X=a,b,c,d
example = init_reasons_matrix(4, 1)
print(example)
```

	a	b	c	d
a	0.000000	-0.484926	-0.849135	0.737676
b	0.484926	0.000000	0.971414	0.179173
c	0.849135	-0.971414	0.000000	0.659471
d	-0.737676	-0.179173	-0.659471	0.000000

```
In [11]: # the following function picks the alternative (i.e. letter) with the maximum
# column sum
def get_choice(reason_matrix):
    choice = np.argmax(np.sum(reason_matrix, axis=1))
    return choice
```

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In [14]: # For example, with the reasons matrix above:
         the_choice = get_choice(example)
         print(the_choice)
```

b

```
In [16]: # Intermediary function to get all possible subsets of a choice problem
         def powerset(iterable):
             s = list(iterable)
             return chain.from_iterable(combinations(s, r) for r in range(len(s)+1))
```

```
In [23]: # Now, we generate a random 9*9 matrix as above and get the choices
         # for that and all possible "submatrices" (i.e. the choice from
         # the grand set and all possible subsets):
         ll = []
         ul = []
         X = init_reasons_matrix(9, 1)
         print(X.to_string())
         for sub in [list(i) for i in list(powerset(list(X))) if len(i)>1]:
             ll.append(sub)
             ul.append(get_choice(X.loc[sub][sub]))
         the_pd = pd.DataFrame({'set': ll, 'choice':ul})
         print(the_pd.to_string())
```

	a	b	c	d	e	f	g	h	i
a	0.000000	-0.705007	0.593389	0.018518	-0.085860	0.954000	0.911992	0.806396	-0.784077
b	0.705007	0.000000	0.645960	-0.816071	0.945257	0.671399	-0.470474	-0.556619	-0.154075
c	-0.593389	-0.645960	0.000000	0.604809	-0.874216	-0.337586	0.924796	-0.638917	0.570491
d	-0.018518	0.816071	-0.604809	0.000000	-0.558400	0.651432	0.368800	-0.466420	0.878271
e	0.085860	-0.945257	0.874216	0.558400	0.000000	-0.732254	0.020656	0.007452	-0.082491
f	-0.954000	-0.671399	0.337586	-0.651432	0.732254	0.000000	0.316948	-0.536624	0.513572
g	-0.911992	0.470474	-0.924796	-0.368800	-0.020656	-0.316948	0.000000	-0.626545	0.140465
h	-0.806396	0.556619	0.638917	0.466420	-0.007452	0.536624	0.626545	0.000000	-0.426278
i	0.784077	0.154075	-0.570491	-0.878271	0.082491	-0.513572	-0.140465	0.426278	0.000000

	set	choice
0	[a, b]	b
1	[a, c]	a
2	[a, d]	a
3	[a, e]	e
4	[a, f]	a
5	[a, g]	a
6	[a, h]	a
7	[a, i]	i
8	[b, c]	b
9	[b, d]	d
10	[b, e]	b
11	[b, f]	b
12	[b, g]	g

13	[b, h]	h
14	[b, i]	i
15	[c, d]	c
16	[c, e]	e
17	[c, f]	f
18	[c, g]	c
19	[c, h]	h
20	[c, i]	c
21	[d, e]	e
22	[d, f]	d
23	[d, g]	d
24	[d, h]	h
25	[d, i]	d
26	[e, f]	f
27	[e, g]	e
28	[e, h]	e
29	[e, i]	i
30	[f, g]	f
31	[f, h]	h
32	[f, i]	f
33	[g, h]	h
34	[g, i]	g
35	[h, i]	i
36	[a, b, c]	b
37	[a, b, d]	d
38	[a, b, e]	b
39	[a, b, f]	b
40	[a, b, g]	b
41	[a, b, h]	b
42	[a, b, i]	i
43	[a, c, d]	a
44	[a, c, e]	e
45	[a, c, f]	a
46	[a, c, g]	a
47	[a, c, h]	a
48	[a, c, i]	i
49	[a, d, e]	e
50	[a, d, f]	a
51	[a, d, g]	a
52	[a, d, h]	a
53	[a, d, i]	d
54	[a, e, f]	a
55	[a, e, g]	a
56	[a, e, h]	a
57	[a, e, i]	i
58	[a, f, g]	a
59	[a, f, h]	a
60	[a, f, i]	i

61	[a, g, h]	a
62	[a, g, i]	i
63	[a, h, i]	i
64	[b, c, d]	d
65	[b, c, e]	b
66	[b, c, f]	b
67	[b, c, g]	c
68	[b, c, h]	h
69	[b, c, i]	b
70	[b, d, e]	d
71	[b, d, f]	d
72	[b, d, g]	d
73	[b, d, h]	h
74	[b, d, i]	d
75	[b, e, f]	b
76	[b, e, g]	b
77	[b, e, h]	h
78	[b, e, i]	b
79	[b, f, g]	b
80	[b, f, h]	h
81	[b, f, i]	b
82	[b, g, h]	h
83	[b, g, i]	g
84	[b, h, i]	i
85	[c, d, e]	e
86	[c, d, f]	c
87	[c, d, g]	c
88	[c, d, h]	h
89	[c, d, i]	c
90	[c, e, f]	f
91	[c, e, g]	e
92	[c, e, h]	e
93	[c, e, i]	e
94	[c, f, g]	f
95	[c, f, h]	h
96	[c, f, i]	f
97	[c, g, h]	h
98	[c, g, i]	c
99	[c, h, i]	h
100	[d, e, f]	d
101	[d, e, g]	e
102	[d, e, h]	e
103	[d, e, i]	e
104	[d, f, g]	d
105	[d, f, h]	h
106	[d, f, i]	d
107	[d, g, h]	h
108	[d, g, i]	d

109	[d, h, i]	d
110	[e, f, g]	f
111	[e, f, h]	h
112	[e, f, i]	f
113	[e, g, h]	h
114	[e, g, i]	g
115	[e, h, i]	i
116	[f, g, h]	h
117	[f, g, i]	f
118	[f, h, i]	h
119	[g, h, i]	i
120	[a, b, c, d]	b
121	[a, b, c, e]	b
122	[a, b, c, f]	b
123	[a, b, c, g]	b
124	[a, b, c, h]	b
125	[a, b, c, i]	b
126	[a, b, d, e]	b
127	[a, b, d, f]	d
128	[a, b, d, g]	d
129	[a, b, d, h]	d
130	[a, b, d, i]	d
131	[a, b, e, f]	b
132	[a, b, e, g]	b
133	[a, b, e, h]	b
134	[a, b, e, i]	b
135	[a, b, f, g]	a
136	[a, b, f, h]	a
137	[a, b, f, i]	b
138	[a, b, g, h]	a
139	[a, b, g, i]	i
140	[a, b, h, i]	i
141	[a, c, d, e]	e
142	[a, c, d, f]	a
143	[a, c, d, g]	a
144	[a, c, d, h]	a
145	[a, c, d, i]	c
146	[a, c, e, f]	a
147	[a, c, e, g]	a
148	[a, c, e, h]	a
149	[a, c, e, i]	e
150	[a, c, f, g]	a
151	[a, c, f, h]	a
152	[a, c, f, i]	a
153	[a, c, g, h]	a
154	[a, c, g, i]	c
155	[a, c, h, i]	i
156	[a, d, e, f]	a

157	[a, d, e, g]	a
158	[a, d, e, h]	a
159	[a, d, e, i]	e
160	[a, d, f, g]	a
161	[a, d, f, h]	a
162	[a, d, f, i]	d
163	[a, d, g, h]	a
164	[a, d, g, i]	d
165	[a, d, h, i]	d
166	[a, e, f, g]	a
167	[a, e, f, h]	a
168	[a, e, f, i]	i
169	[a, e, g, h]	a
170	[a, e, g, i]	i
171	[a, e, h, i]	i
172	[a, f, g, h]	a
173	[a, f, g, i]	a
174	[a, f, h, i]	a
175	[a, g, h, i]	i
176	[b, c, d, e]	b
177	[b, c, d, f]	d
178	[b, c, d, g]	c
179	[b, c, d, h]	h
180	[b, c, d, i]	d
181	[b, c, e, f]	b
182	[b, c, e, g]	b
183	[b, c, e, h]	h
184	[b, c, e, i]	b
185	[b, c, f, g]	b
186	[b, c, f, h]	h
187	[b, c, f, i]	b
188	[b, c, g, h]	h
189	[b, c, g, i]	c
190	[b, c, h, i]	h
191	[b, d, e, f]	d
192	[b, d, e, g]	d
193	[b, d, e, h]	h
194	[b, d, e, i]	d
195	[b, d, f, g]	d
196	[b, d, f, h]	h
197	[b, d, f, i]	d
198	[b, d, g, h]	h
199	[b, d, g, i]	d
200	[b, d, h, i]	d
201	[b, e, f, g]	b
202	[b, e, f, h]	h
203	[b, e, f, i]	b
204	[b, e, g, h]	h

205	[b, e, g, i]	g
206	[b, e, h, i]	i
207	[b, f, g, h]	h
208	[b, f, g, i]	g
209	[b, f, h, i]	h
210	[b, g, h, i]	h
211	[c, d, e, f]	e
212	[c, d, e, g]	e
213	[c, d, e, h]	e
214	[c, d, e, i]	e
215	[c, d, f, g]	c
216	[c, d, f, h]	h
217	[c, d, f, i]	d
218	[c, d, g, h]	h
219	[c, d, g, i]	c
220	[c, d, h, i]	h
221	[c, e, f, g]	f
222	[c, e, f, h]	h
223	[c, e, f, i]	f
224	[c, e, g, h]	h
225	[c, e, g, i]	e
226	[c, e, h, i]	e
227	[c, f, g, h]	h
228	[c, f, g, i]	f
229	[c, f, h, i]	h
230	[c, g, h, i]	c
231	[d, e, f, g]	d
232	[d, e, f, h]	h
233	[d, e, f, i]	d
234	[d, e, g, h]	h
235	[d, e, g, i]	d
236	[d, e, h, i]	e
237	[d, f, g, h]	h
238	[d, f, g, i]	d
239	[d, f, h, i]	d
240	[d, g, h, i]	d
241	[e, f, g, h]	h
242	[e, f, g, i]	f
243	[e, f, h, i]	f
244	[e, g, h, i]	i
245	[f, g, h, i]	h
246	[a, b, c, d, e]	b
247	[a, b, c, d, f]	b
248	[a, b, c, d, g]	a
249	[a, b, c, d, h]	h
250	[a, b, c, d, i]	d
251	[a, b, c, e, f]	b
252	[a, b, c, e, g]	b

253	[a, b, c, e, h]	b
254	[a, b, c, e, i]	b
255	[a, b, c, f, g]	a
256	[a, b, c, f, h]	a
257	[a, b, c, f, i]	b
258	[a, b, c, g, h]	a
259	[a, b, c, g, i]	b
260	[a, b, c, h, i]	i
261	[a, b, d, e, f]	b
262	[a, b, d, e, g]	d
263	[a, b, d, e, h]	b
264	[a, b, d, e, i]	d
265	[a, b, d, f, g]	d
266	[a, b, d, f, h]	a
267	[a, b, d, f, i]	d
268	[a, b, d, g, h]	a
269	[a, b, d, g, i]	d
270	[a, b, d, h, i]	d
271	[a, b, e, f, g]	b
272	[a, b, e, f, h]	b
273	[a, b, e, f, i]	b
274	[a, b, e, g, h]	a
275	[a, b, e, g, i]	b
276	[a, b, e, h, i]	i
277	[a, b, f, g, h]	a
278	[a, b, f, g, i]	b
279	[a, b, f, h, i]	i
280	[a, b, g, h, i]	i
281	[a, c, d, e, f]	a
282	[a, c, d, e, g]	e
283	[a, c, d, e, h]	e
284	[a, c, d, e, i]	e
285	[a, c, d, f, g]	a
286	[a, c, d, f, h]	a
287	[a, c, d, f, i]	d
288	[a, c, d, g, h]	a
289	[a, c, d, g, i]	c
290	[a, c, d, h, i]	a
291	[a, c, e, f, g]	a
292	[a, c, e, f, h]	a
293	[a, c, e, f, i]	a
294	[a, c, e, g, h]	a
295	[a, c, e, g, i]	e
296	[a, c, e, h, i]	e
297	[a, c, f, g, h]	a
298	[a, c, f, g, i]	a
299	[a, c, f, h, i]	a
300	[a, c, g, h, i]	a

301	[a, d, e, f, g]	a
302	[a, d, e, f, h]	a
303	[a, d, e, f, i]	d
304	[a, d, e, g, h]	a
305	[a, d, e, g, i]	d
306	[a, d, e, h, i]	e
307	[a, d, f, g, h]	a
308	[a, d, f, g, i]	d
309	[a, d, f, h, i]	d
310	[a, d, g, h, i]	a
311	[a, e, f, g, h]	a
312	[a, e, f, g, i]	a
313	[a, e, f, h, i]	a
314	[a, e, g, h, i]	i
315	[a, f, g, h, i]	a
316	[b, c, d, e, f]	b
317	[b, c, d, e, g]	e
318	[b, c, d, e, h]	h
319	[b, c, d, e, i]	b
320	[b, c, d, f, g]	d
321	[b, c, d, f, h]	h
322	[b, c, d, f, i]	d
323	[b, c, d, g, h]	h
324	[b, c, d, g, i]	d
325	[b, c, d, h, i]	h
326	[b, c, e, f, g]	b
327	[b, c, e, f, h]	h
328	[b, c, e, f, i]	b
329	[b, c, e, g, h]	h
330	[b, c, e, g, i]	b
331	[b, c, e, h, i]	b
332	[b, c, f, g, h]	h
333	[b, c, f, g, i]	b
334	[b, c, f, h, i]	h
335	[b, c, g, h, i]	h
336	[b, d, e, f, g]	d
337	[b, d, e, f, h]	h
338	[b, d, e, f, i]	d
339	[b, d, e, g, h]	h
340	[b, d, e, g, i]	d
341	[b, d, e, h, i]	d
342	[b, d, f, g, h]	h
343	[b, d, f, g, i]	d
344	[b, d, f, h, i]	d
345	[b, d, g, h, i]	d
346	[b, e, f, g, h]	h
347	[b, e, f, g, i]	b
348	[b, e, f, h, i]	b

349	[b, e, g, h, i]	h
350	[b, f, g, h, i]	h
351	[c, d, e, f, g]	f
352	[c, d, e, f, h]	h
353	[c, d, e, f, i]	f
354	[c, d, e, g, h]	h
355	[c, d, e, g, i]	e
356	[c, d, e, h, i]	e
357	[c, d, f, g, h]	h
358	[c, d, f, g, i]	c
359	[c, d, f, h, i]	h
360	[c, d, g, h, i]	c
361	[c, e, f, g, h]	h
362	[c, e, f, g, i]	f
363	[c, e, f, h, i]	f
364	[c, e, g, h, i]	h
365	[c, f, g, h, i]	h
366	[d, e, f, g, h]	h
367	[d, e, f, g, i]	d
368	[d, e, f, h, i]	h
369	[d, e, g, h, i]	h
370	[d, f, g, h, i]	d
371	[e, f, g, h, i]	f
372	[a, b, c, d, e, f]	b
373	[a, b, c, d, e, g]	b
374	[a, b, c, d, e, h]	b
375	[a, b, c, d, e, i]	b
376	[a, b, c, d, f, g]	a
377	[a, b, c, d, f, h]	a
378	[a, b, c, d, f, i]	d
379	[a, b, c, d, g, h]	a
380	[a, b, c, d, g, i]	d
381	[a, b, c, d, h, i]	d
382	[a, b, c, e, f, g]	b
383	[a, b, c, e, f, h]	b
384	[a, b, c, e, f, i]	b
385	[a, b, c, e, g, h]	a
386	[a, b, c, e, g, i]	b
387	[a, b, c, e, h, i]	b
388	[a, b, c, f, g, h]	a
389	[a, b, c, f, g, i]	b
390	[a, b, c, f, h, i]	b
391	[a, b, c, g, h, i]	a
392	[a, b, d, e, f, g]	d
393	[a, b, d, e, f, h]	a
394	[a, b, d, e, f, i]	d
395	[a, b, d, e, g, h]	a
396	[a, b, d, e, g, i]	d

397	[a, b, d, e, h, i]	d
398	[a, b, d, f, g, h]	a
399	[a, b, d, f, g, i]	d
400	[a, b, d, f, h, i]	d
401	[a, b, d, g, h, i]	d
402	[a, b, e, f, g, h]	a
403	[a, b, e, f, g, i]	b
404	[a, b, e, f, h, i]	b
405	[a, b, e, g, h, i]	i
406	[a, b, f, g, h, i]	a
407	[a, c, d, e, f, g]	a
408	[a, c, d, e, f, h]	a
409	[a, c, d, e, f, i]	e
410	[a, c, d, e, g, h]	a
411	[a, c, d, e, g, i]	e
412	[a, c, d, e, h, i]	e
413	[a, c, d, f, g, h]	a
414	[a, c, d, f, g, i]	a
415	[a, c, d, f, h, i]	a
416	[a, c, d, g, h, i]	a
417	[a, c, e, f, g, h]	a
418	[a, c, e, f, g, i]	a
419	[a, c, e, f, h, i]	a
420	[a, c, e, g, h, i]	a
421	[a, c, f, g, h, i]	a
422	[a, d, e, f, g, h]	a
423	[a, d, e, f, g, i]	d
424	[a, d, e, f, h, i]	a
425	[a, d, e, g, h, i]	a
426	[a, d, f, g, h, i]	a
427	[a, e, f, g, h, i]	a
428	[b, c, d, e, f, g]	b
429	[b, c, d, e, f, h]	h
430	[b, c, d, e, f, i]	b
431	[b, c, d, e, g, h]	h
432	[b, c, d, e, g, i]	d
433	[b, c, d, e, h, i]	h
434	[b, c, d, f, g, h]	h
435	[b, c, d, f, g, i]	d
436	[b, c, d, f, h, i]	h
437	[b, c, d, g, h, i]	h
438	[b, c, e, f, g, h]	h
439	[b, c, e, f, g, i]	b
440	[b, c, e, f, h, i]	b
441	[b, c, e, g, h, i]	h
442	[b, c, f, g, h, i]	h
443	[b, d, e, f, g, h]	h
444	[b, d, e, f, g, i]	d

445	[b, d, e, f, h, i]	d
446	[b, d, e, g, h, i]	h
447	[b, d, f, g, h, i]	d
448	[b, e, f, g, h, i]	h
449	[c, d, e, f, g, h]	h
450	[c, d, e, f, g, i]	f
451	[c, d, e, f, h, i]	h
452	[c, d, e, g, h, i]	e
453	[c, d, f, g, h, i]	h
454	[c, e, f, g, h, i]	h
455	[d, e, f, g, h, i]	h
456	[a, b, c, d, e, f, g]	a
457	[a, b, c, d, e, f, h]	b
458	[a, b, c, d, e, f, i]	b
459	[a, b, c, d, e, g, h]	a
460	[a, b, c, d, e, g, i]	d
461	[a, b, c, d, e, h, i]	b
462	[a, b, c, d, f, g, h]	a
463	[a, b, c, d, f, g, i]	d
464	[a, b, c, d, f, h, i]	d
465	[a, b, c, d, g, h, i]	h
466	[a, b, c, e, f, g, h]	a
467	[a, b, c, e, f, g, i]	b
468	[a, b, c, e, f, h, i]	b
469	[a, b, c, e, g, h, i]	b
470	[a, b, c, f, g, h, i]	a
471	[a, b, d, e, f, g, h]	a
472	[a, b, d, e, f, g, i]	d
473	[a, b, d, e, f, h, i]	d
474	[a, b, d, e, g, h, i]	d
475	[a, b, d, f, g, h, i]	d
476	[a, b, e, f, g, h, i]	b
477	[a, c, d, e, f, g, h]	a
478	[a, c, d, e, f, g, i]	a
479	[a, c, d, e, f, h, i]	a
480	[a, c, d, e, g, h, i]	e
481	[a, c, d, f, g, h, i]	a
482	[a, c, e, f, g, h, i]	a
483	[a, d, e, f, g, h, i]	a
484	[b, c, d, e, f, g, h]	h
485	[b, c, d, e, f, g, i]	d
486	[b, c, d, e, f, h, i]	h
487	[b, c, d, e, g, h, i]	h
488	[b, c, d, f, g, h, i]	h
489	[b, c, e, f, g, h, i]	h
490	[b, d, e, f, g, h, i]	h
491	[c, d, e, f, g, h, i]	h
492	[a, b, c, d, e, f, g, h]	a

493	[a, b, c, d, e, f, g, i]	d
494	[a, b, c, d, e, f, h, i]	b
495	[a, b, c, d, e, g, h, i]	h
496	[a, b, c, d, f, g, h, i]	a
497	[a, b, c, e, f, g, h, i]	b
498	[a, b, d, e, f, g, h, i]	d
499	[a, c, d, e, f, g, h, i]	a
500	[b, c, d, e, f, g, h, i]	h
501	[a, b, c, d, e, f, g, h, i]	a