Solução do Problema stair - Solver HiGHS

Análise Computacional

17 de setembro de 2025

1 Informações do Problema

Informações do Problema:

- Nome: stair

- Número de Variáveis: 467

- Número de Restrições: 356

- Inviabilidade Primal: 0.000e+00

- Inviabilidade Dual: 0.000e+00

- Valor Primal: -2.513e+02

- Valor Dual: -9.077e+01

- Gap: -7.413e-18

- Número de Iterações: 16

2 Variáveis Primais e Custos Reduzidos

Tabela 1: Variáveis primais e custos reduzidos do problema stair

Coordenada x	Valor x	Coordenada z	Valor z
1	3.039609	1	0.000000
2	55.000000	2	-0.165090
3	208.799990	3	-0.721506
4	2.601997	4	0.000000
5	0.213963	5	0.000000
6	1.122785	6	0.000000
7	3.468623	7	0.000000
8	1.523205	8	0.000000
9	0.680166	9	0.000000
10	1.690391	10	0.000000
11	0.552432	11	0.000000
12	1.249039	12	0.000000
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Coordenada x	Valor x	Coordenada z	Valor z
13	3.843900	13	0.000000
14	2.696308	14	0.000000
15	0.665271	15	0.000000
16	6.504971	16	0.000000
17	0.701413	17	0.000000
18	5.448831	18	0.000000
19	3.039609	19	0.000000
20	251.266951	20	0.000000
21	42.466961	21	0.000000
22	0.001097	22	0.000000
23	0.007371	23	0.000000
24	0.054722	24	0.000000
25	0.614560	25	0.000000
26	0.000000	26	4.626103
27	0.000000	27	1.682219
28	0.000000	28	1.682219
29	0.000000	29	0.384193
30	9.505511	30	0.000000
31	0.095446	31	0.000000
32	0.773771	32	0.000000
33	1.633098	33	0.000000
34	6.280011	34	0.000000
35	6.774440	35	0.000000
36	4.341970	36	0.003676
37	2.654680	37	-0.042807
38	0.470550	38	-0.044249
39	3.430120	39	-0.042059
40	0.661870	40	-0.032549
41	0.369210	41	-0.012733
42	0.878460	42	-0.031348
43	0.149080	43	-0.028420
44	0.306130	44	-0.026781
45	0.786760	45	-0.015671
46	1.367480	46	0.000000
47	17.805856	47	0.000000
48	5.465000	48	0.010007
49	2.500000	49	0.000000
50	4.300000	50	-0.126778
51	5.000000	51	-0.026513
52	4.900000	52	0.126778
53	71.574714	53	0.000000
54	52.099990	54	0.000000
55	260.899900	55	0.000000
56	52.580980	56	0.000000
57	5.715890	57	0.000000
58	20.369346	58	0.000000
59	59.094870	59	0.000000
60	27.240605	60	0.000000
61	11.867498	61	0.000000

Coordenada x	Valor x	Coordenada z	Valor z
62	22.984164	62	0.000000
63	7.008295	63	0.000000
64	14.515116	64	0.000000
65	38.762689	65	0.000000
66	34.862914	66	0.000000
67	7.664813	67	0.000000
68	109.352914	68	0.000000
69	14.702238	69	0.000000
70	88.588484	70	0.000000
71	1.390654	71	0.000000
72	0.244188	72	0.000000
73	1.510372	73	0.000000
74	4.525687	74	0.000000
75	2.313464	75	0.000000
76	0.862683	76	0.000000
77	2.442693	77	0.000000
78	0.537945	78	0.000000
79	1.633526	79	0.000000
80	4.609229	80	0.000000
81	1.345569	81	0.000000
82	0.922598	82	0.000000
83	7.581211	83	0.000000
84	0.862635	84	0.000000
85	7.112787	85	0.000000
86	-0.000000	86	0.000000
87	0.138128	87	0.000000
88	0.015590	88	0.000000
89	12.545120	89	0.000000
90	5.000000	90	0.000000
91	69.074714	91	0.000000
92	303.290677	92	0.000000
93	52.023726	93	0.000000
94	320.341665	94	0.000000
95	0.006592	95	0.000000
96	0.066830	96	0.000000
97	0.220295	97	0.000000
98	1.836779	98	0.000000
99	0.000000	99	2.745574
100	0.000000	100	0.998390
101	0.000000	101	0.998390
102	0.000000	102	0.237488
103	0.000000	103	0.003745
104	0.116334	104	0.000000
105	0.927198	105	0.000000
106	1.916227	106	0.000000
107	7.134384	107	0.000000
108	6.004221	108	0.000000
109	4.884120	109	0.007800
110	2.986150	110	-0.028496

Coordenada x	Valor x	Coordenada z	Valor z
111	0.492050	111	-0.027987
112	4.085310	112	-0.026246
113	0.755310	113	-0.021035
114	0.439740	114	-0.008396
115	1.169220	115	-0.019022
116	0.185200	116	-0.018117
117	0.407460	117	-0.014494
118	1.105340	118	-0.010217
119	3.122366	119	0.000000
120	22.675290	120	0.000000
121	7.077320	121	0.006132
122	-0.005000	122	0.000000
123	4.700000	123	-0.073963
124	5.500000	124	-0.012233
125	4.900000	125	0.073963
126	81.630026	126	0.000000
127	56.752942	127	0.000000
128	6.448453	128	0.000000
129	24.900463	129	0.000000
130	72.671932	130	0.000000
131	34.180996	131	0.000000
132	14.455547	132	0.000000
133	30.312243	133	0.000000
134	8.622130	134	0.000000
135	19.415695	135	0.000000
136	52.590377	136	0.000000
137	38.899622	137	0.000000
138	10.432608	138	0.000000
139	132.096546	139	0.000000
140	17.290142	140	0.000000
141	109.926847	141	0.000000
142	3.235075	142	0.000000
143	0.338310	143	0.000000
144	2.096090	144	0.000000
145	5.933374	145	0.000000
146	3.038687	146	0.000000
147	1.224085	147	0.000000
148	3.493370	148	0.000000
149	0.969531	149	0.000000
150	2.539950	150	0.000000
151	6.822443	151	0.000000
152	3.431706	152	0.000000
153	1.322104	153	0.000000
154	9.811009	154	0.000000
155	1.055717	155	0.000000
156	7.492240	156	0.000000
157	0.015590	157	0.000000
158	0.085029	158	0.000000
159	0.324677	159	0.000000

Coordenada x	Valor x	Coordenada z	Valor z
160	0.000000	160	1.330047
161	0.138128	161	0.000000
162	0.019851	162	0.000000
163	12.545120	163	0.000000
164	10.500000	164	0.000000
165	81.635026	165	0.000000
166	367.021823	166	0.000000
167	63.731145	167	0.000000
168	384.925703	168	0.000000
169	1.618113	169	0.000000
170	0.000000	170	2.141451
171	0.000000	171	1.327279
172	0.000000	172	0.602668
173	0.000000	173	0.129401
174	4.801350	174	0.000000
175	0.145298	175	0.000000
176	1.100644	176	0.000000
177	2.264134	177	0.000000
178	8.267677	178	0.000000
179	6.702887	179	0.000000
180	5.493960	180	0.002640
181	3.359000	181	-0.013171
182	0.514520	182	-0.014384
183	4.865660	183	-0.014328
184	0.861930	184	-0.011064
185	0.523730	185	-0.004305
186	1.556230	186	-0.009111
187	0.230070	187	-0.008963
188	0.542320	188	-0.006607
189	1.552920	189	-0.003189
190	6.482480	190	0.000000
191	30.010187	191	0.000000
192	9.165300	192	0.005085
193	-3.970500	193	0.000000
194	4.300000	194	-0.044163
195	5.500000	195	-0.005442
196	4.900000	196	0.044163
197	104.977874	197	0.000000
198	66.458167	198	0.000000
199	7.463384	199	0.000000
200	31.188732	200	0.000000
201	90.472055	201	0.000000
202	43.297058	202	0.000000
203	18.127801	203	0.000000
204	40.792352	204	0.000000
205	11.530723	205	0.000000
206	27.035544	206	0.000000
207	73.057706	207	0.000000
208	49.194738	208	0.000000

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Coordenada x	Valor x	Coordenada z	Valor z
209	14.398919	209	0.000000
210	161.529575	210	0.000000
211	20.457294	211	0.000000
212	132.403567	212	0.000000
213	3.170735	213	0.000000
214	0.367314	214	0.000000
215	2.560310	215	0.000000
216	7.006345	216	0.000000
217	3.783374	217	0.000000
218	1.422246	218	0.000000
219	4.443194	219	0.000000
220	1.117904	220	0.000000
221	3.206736	221	0.000000
222	8.782492	222	0.000000
223	3.404782	223	0.000000
224	1.782114	224	0.000000
225	11.592612	225	0.000000
226	1.233437	226	0.000000
227	9.620133	227	0.000000
228	0.019851	228	0.000000
229	0.061995	229	0.000000
230	0.357315	230	0.000000
231	0.015590	231	0.000000
232	0.085029	232	0.000000
233	0.462805	233	0.000000
234	0.019251	234	0.000000
235	17.346470	235	0.000000
236	108.948374	236	0.000000
237	16.000000	237	0.000000
238	445.095025	238	0.000000
239	78.073202	239	0.000000
240	475.970197	240	0.000000
241	1.999332	241	0.000000
242	0.000000	242	1.073225
243	0.000000	243	0.991413
244	0.000000	244	0.205729
245	0.000000	245	0.087632
246	5.158147	246	0.000000
247	0.182321	247	0.000000
248	1.310786	248	0.000000
249	2.671592	249	0.000000
250	9.505237	250	0.000000
251	6.830668	251	0.000000
252	6.179950	252	0.003652
253	3.778420	253	-0.008792
254	0.538020	254	-0.009673
255	5.795070	255	-0.009581
256	0.983600	256	-0.007132
257	0.623770	257	-0.003021

Coordenada x	Valor x	Coordenada z	Valor z
258	2.071340	258	-0.006789
259	0.285810	259	-0.005517
260	0.721830	260	-0.004493
261	2.181730	261	-0.002512
262	9.471745	262	0.000000
263	37.689172	263	0.000000
264	11.869290	264	0.003237
265	-8.636000	265	0.000000
266	3.100000	266	-0.027132
267	5.500000	267	-0.002547
268	4.900000	268	0.027132
269	128.645180	269	0.000000
270	75.970372	270	0.000000
271	8.565324	271	0.000000
272	38.869661	272	0.000000
273	111.491091	273	0.000000
274	54.647181	274	0.000000
275	22.394539	275	0.000000
276	54.121933	276	0.000000
277	14.884436	277	0.000000
278	36.655751	278	0.000000
279	99.405183	279	0.000000
280	59.409084	280	0.000000
281	19.745261	281	0.000000
282	196.307410	282	0.000000
283	24.157606	283	0.000000
284	161.263967	284	0.000000
285	3.903773	285	0.000000
286	0.400462	286	0.000000
287	3.149073	287	0.000000
288	8.512284	288	0.000000
289	4.767437	289	0.000000
290	1.667690	290	0.000000
291	5.746803	291	0.000000
292	1.290654	292	0.000000
293	4.011375	293	0.000000
294	11.134450	294	0.000000
295	3.234967	295	0.000000
296	2.349782	296	0.000000
297	13.631614	297	0.000000
298	1.435312	298	0.000000
299	11.672741	299	0.000000
300	0.019251	300	0.000000
301	0.104718	301	0.000000
302	0.319987	302	0.000000
303	0.035441	303	0.000000
304	0.147023	304	0.000000
305	0.820120	305	0.000000
306	0.031359	306	0.000000

Coordenada x	Valor x	Coordenada z	Valor z
307	22.504617	307	0.000000
308	21.500000	308	0.000000
309	137.281180	309	0.000000
310	540.737821	310	0.000000
311	95.642796	311	0.000000
312	582.376205	312	0.000000
313	2.483131	313	0.000000
314	0.000000	314	1.150413
315	0.000000	315	0.131950
316	0.000000	316	0.314171
317	0.000000	317	0.050780
318	11.330378	318	0.000000
319	0.222572	319	0.000000
320	1.557586	320	0.000000
321	3.138565	321	0.000000
322	10.836876	322	0.000000
323	6.886869	323	0.000000
324	6.951600	324	0.001730
325	4.250200	325	-0.005183
326	0.562600	326	-0.005775
327	6.902000	327	-0.005913
328	1.122450	328	-0.004386
329	0.742920	329	-0.002150
330	2.756950	330	-0.003892
331	0.355060	331	-0.003011
332	0.960750	332	-0.002521
333	3.065170	333	-0.001175
334	12.839483	334	0.000000
335	46.788153	335	0.000000
336	15.371020	336	0.001636
337	-15.501500	337	0.000000
338	1.500000	338	-0.016164
339	3.500000	339	0.000000
340	4.900000	340	0.016164
341	152.489955	341	0.000000
342	87.681690	342	0.000000
343	9.766710	343	0.000000
344	48.316879	344	0.000000
345	137.027943	345	0.000000
346	68.949493	346	0.000000
347	27.397610	347	0.000000
348	71.362344	348	0.000000
349	18.756397	349	0.000000
350	48.689877	350	0.000000
351	132.808534	351	0.000000
352	69.113985	352	0.000000
353	26.794606	353	0.000000
354	237.202252	354	0.000000
355	28.463541	355	0.000000

Coordenada x	Valor x	Coordenada z	Valor z
356	196.282190	356	0.000000
357	3.085984	357	0.000000
358	0.430032	358	0.000000
359	3.693457	359	0.000000
360	8.649824	360	0.000000
361	5.629330	361	0.000000
362	1.784575	362	0.000000
363	6.541171	363	0.000000
364	1.544103	364	0.000000
365	4.683339	365	0.000000
366	13.671679	366	0.000000
367	4.076411	367	0.000000
368	2.828405	368	0.000000
369	15.383229	369	0.000000
370	1.660719	370	0.000000
371	13.437732	371	0.000000
372	0.031359	372	0.000000
373	0.090238	373	0.000000
374	0.398574	374	0.000000
375	0.054692	375	0.000000
376	0.251741	376	0.000000
377	1.140108	377	0.000000
378	0.017203	378	0.000000
379	33.834995	379	0.000000
380	25.000000	380	0.000000
381	167.991455	381	0.000000
382	657.904072	382	0.000000
383	117.166251	383	0.000000
384	708.729276	384	0.000000
385	2.477369	385	0.000000
386	0.006185	386	0.000000
387	0.000000	387	0.557714
388	0.000000	388	0.047088
389	0.000000	389	0.086065
390	0.000000	390	0.011513
391	0.271985	391	0.000000
392	1.831039	392	0.000000
393	3.644737	393	0.000000
394	12.226031	394	0.000000
395	6.604230	395	0.000000
396	7.819590	396	0.001559
397	4.780890	397	-0.007530
398	0.588290	398	-0.008765
399	8.220380	399	-0.009624
400	1.280890	400	-0.006868
401	0.884830	401	-0.003263
402	3.669480	402	-0.006298
403	0.441090	403	-0.003861
404	1.278760	404	-0.003434

Coordenada x	Valor x	Coordenada z	Valor z
405	4.306340	405	-0.001430
406	9.025918	406	0.000000
407	48.852458	407	0.000000
408	19.905850	408	0.003794
409	-17.625000	409	0.000000
410	-0.500000	410	-0.025538
411	5.000000	411	-0.022680
412	4.900000	412	0.025538
413	175.127685	413	0.000000
414	192.752685	414	0.000000
415	143.533344	415	0.000000
416	850.656757	416	0.000000
417	96.939643	417	0.000000
418	11.056807	418	0.000000
419	59.397251	419	0.000000
420	162.977416	420	0.000000
421	85.837483	421	0.000000
422	32.751334	422	0.000000
423	90.985857	423	0.000000
424	23.388705	424	0.000000
425	62.739892	425	0.000000
426	173.823572	426	0.000000
427	81.343217	427	0.000000
428	35.279822	428	0.000000
429	283.351938	429	0.000000
430	33.445699	430	0.000000
431	236.595386	431	0.000000
432	7.103155	432	0.000000
433	0.644329	433	0.000000
434	4.255799	434	0.000000
435	11.341899	435	0.000000
436	6.127160	436	0.000000
437	2.323634	437	0.000000
438	6.588618	438	0.000000
439	1.706671	439	0.000000
440	4.619505	440	0.000000
441	12.872813	441	0.000000
442	6.083149	442	0.000000
443	2.549668	443	0.000000
444	20.567558	444	0.000000
445	2.429984	445	0.000000
446	16.698688	446	0.000000
447	0.017203	447	0.000000
448	0.123601	448	0.000000
449	0.229328	449	0.000000
450	0.086050	450	0.000000
451	0.341979	451	0.000000
452	1.538681	452	0.000000
453	33.834995	453	0.000000

Coordenada x	Valor x	Coordenada z	Valor z
454	801.437416	454	0.000000
455	0.103253	455	0.000000
456	0.465581	456	0.000000
457	1.768010	457	0.000000
458	2.123643	458	0.000000
459	0.000000	459	0.972511
460	0.000000	460	0.391163
461	0.000000	461	0.287994
462	0.000000	462	0.000000
463	0.320253	463	0.000000
464	2.157556	464	0.000000
465	4.237200	465	0.000000
466	13.771634	466	0.000000
467	8.428357	467	0.000000

3   Variáveis Duais (Multiplicadores de Lagrange)

Tabela 2: Variáveis duais do problema stair

Coordenada y	Valor y
1	-0.165090
2	0.165090
3	-0.721506
4	-0.139188
5	-0.092705
6	-0.091263
7	-0.093453
8	-0.102963
9	-0.122779
10	-0.104164
11	-0.107092
12	-0.108731
13	-0.119841
14	-0.096724
15	-0.152508
16	-0.053137
17	-0.279099
18	-0.160080
19	-0.123377
20	-0.056130
21	-0.095257
22	-0.050627
23	-0.044299
24	-0.075556
25	-0.070768
26	-0.073410

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Coordenada y	Valor y
27	-0.095532
28	-0.053929
29	-0.011666
30	-0.249505
31	-0.027185
32	-0.515079
33	-0.165640
34	-8.831652
35	-4.205549
36	-2.523329
37	-0.841110
38	-0.456917
39	-8.831652
40	-4.205549
41	-2.523329
42	-0.841110
43	-0.456917
44	-0.135512
45	-0.126778
46	-0.126778
47	-0.000000
48	-0.000000
49	-0.000000
50	0.588965
51	-0.000000
52	0.091595
53	-0.100264
54	0.166963
55	-0.092053
56	-0.055758
57	-0.056266
58	-0.058008
59	-0.063219
60	-0.075858
61	-0.065231
62	-0.066137
63	-0.069760
64	-0.074036
65	-0.059503
66	-0.102054
67	-0.031975
68	-0.183815
69	-0.098953
70	-0.084296
71	-0.032929
72	-0.056779
73	-0.030133
74	-0.026665
75	-0.046419

Coordenada y	Valor y
76	-0.042750
77	-0.044179
78	-0.058799
79	-0.032255
80	-0.007039
81	-0.158545
82	-0.016257
83	-0.317885
84	-0.100275
85	-5.241550
86	-2.495976
87	-1.497586
88	-0.499195
89	-0.261708
90	-5.241550
91	-2.495976
92	-1.497586
93	-0.499195
94	-0.261708
95	-0.084254
96	-0.078691
97	-0.073963
98	0.004728
99	0.004728
100	-0.002026
101	0.344481
102	-0.000000
103	0.051928
104	5.727957
105	2.456040
106	6.926539
107	-0.061730
108	0.095388
109	-0.044788
110	-0.028978
111	-0.027764
112	-0.027821
113	-0.031085
114	-0.037844
115	-0.033037
116	-0.033186
117	-0.035542
118	-0.038960
119	-0.031440
120	-0.052944
121	-0.015755
122	-0.088690
123	-0.053917
124	-0.048723

Coordenada y	Valor y
125	-0.018792
126	-0.032384
127	-0.017172
128	-0.015019
129	-0.026446
130	-0.024050
131	-0.025438
132	-0.033704
133	-0.018067
134	-0.004103
135	-0.094217
136	-0.009584
137	-0.182591
138	-0.057158
139	-4.308708
140	-2.167258
141	-0.839979
142	-0.237311
143	-0.107909
144	-4.308708
145	-2.167258
146	-0.839979
147	-0.237311
148	-0.107909
149	-0.042149
150	-0.039435
151	-0.044163
152	-0.004728
153	-0.004728
154	0.002026
155	0.203334
156	-0.006755
157	0.036515
158	9.756975
159	3.399519
160	1.457650
161	4.110872
162	-0.038721
163	0.062047
164	-0.032670
165	-0.020226
166	-0.019345
167	-0.019437
168	-0.021885
169	-0.025997
170	-0.022229
171	-0.023501
172	-0.024525
173	-0.026506

Coordenada y	Valor y
174	-0.022102
175	-0.036715
176	-0.010810
177	-0.062490
178	-0.036513
179	-0.028763
180	-0.012405
181	-0.021128
182	-0.011147
183	-0.009524
184	-0.016927
185	-0.015170
186	-0.016717
187	-0.021366
188	-0.011433
189	-0.002730
190	-0.062170
191	-0.006535
192	-0.118864
193	-0.037588
194	-2.474677
195	-1.401451
196	-0.410038
197	-0.204309
198	-0.116678
199	-2.474677
200	-1.401451
201	-0.410038
202	-0.204309
203	-0.116678
204	-0.029018
205	-0.027132
206	-0.027132
207	-0.000000
208	-0.000000
209	-0.000000
210	0.115333
211	-0.000000
212	0.020811
213	5.890062
214	2.072241
215	0.854982
216	2.607492
217	-0.024585
218	0.037660
219	-0.018997
220	-0.012084
221	-0.011492
222	-0.011354

Coordenada y	Valor y
223	-0.012881
224	-0.015117
225	-0.013374
226	-0.014256
227	-0.014746
228	-0.016092
229	-0.013542
230	-0.023152
231	-0.006709
232	-0.038478
233	-0.021158
234	-0.017610
235	-0.007578
236	-0.012856
237	-0.006771
238	-0.005715
239	-0.010258
240	-0.009047
241	-0.010276
242	-0.012915
243	-0.006823
244	-0.001687
245	-0.039114
246	-0.004091
247	-0.072921
248	-0.022998
249	-1.710687
250	-0.560274
251	-0.428323
252	-0.114153
253	-0.063373
254	-1.710687
255	-0.560274
256	-0.428323
257	-0.114153
258	-0.063373
259	-0.017267
260	-0.016164
261	-0.016164
262	-0.000000
263	-0.000000
264	-0.000000
265	0.063404
266	-0.000000
267	0.012774
268	3.528000
269	1.080828
270	0.649253
271	1.366902

Coordenada y	Valor y
272	-0.016164
273	0.023237
274	-0.002858
275	-0.028782
276	-0.019692
277	-0.018457
278	-0.017599
279	-0.020354
280	-0.023960
281	-0.020925
282	-0.023362
283	-0.023788
284	-0.025793
285	-0.022305
286	-0.039069
287	-0.010583
288	-0.061309
289	-0.035860
290	-0.010259
291	-0.004719
292	-0.007968
293	-0.004181
294	-0.003482
295	-0.006289
296	-0.005494
297	-0.006419
298	-0.007891
299	-0.004143
300	-0.001070
301	-0.024929
302	-0.002619
303	-0.045088
304	-0.014105
305	-0.690867
306	-0.690867
307	-0.133153
308	-0.086065
309	-0.000000
310	-0.690867
311	-0.690867
312	-0.133153
313	-0.086065
314	-0.000000
315	-0.027223
316	-0.025538
317	-0.025538
318	-0.000000
319	-0.000000
320	-0.000000

Coordenada y	Valor y
321	0.032788
322	-0.000000
323	0.012774
324	2.206051
325	0.948877
326	0.335082
327	1.197888
328	0.032788
329	-0.040060
330	-0.027183
331	-0.029757
332	-0.026697
333	-0.026626
334	-0.032378
335	-0.027868
336	-0.035050
337	-0.037602
338	-0.031236
339	-0.026362
340	-0.072541
341	-0.015555
342	-0.110072
343	-0.047908
344	-1.765090
345	-0.792579
346	-0.401416
347	-0.113422
348	-0.113422
349	-1.765090
350	-0.792579
351	-0.401416
352	-0.113422
353	-0.113422
354	1.481023
355	0.391163
356	0.287994

4 Observações

- O solver HiGHS foi configurado com o método IPM (Interior Point Method).

- Este arquivo contém a solução detalhada para o problema stair.

- As variáveis duais representam os multiplicadores de Lagrange das restrições.

- Os custos reduzidos (z) indicam o impacto de forçar variáveis não-básicas na base.