Báo cáo BT3 - Solving Knapsack Problems Using Google OR Tools

Môn: CS106 - Trí tuệ nhân tạo

Phan Hoàng Phước

MSSV: 22521156

Lớp: KHTN2022

Mã môn học: CS106.O21.KHTN

Mục lục

1 Giới thiệu bài toán

Bài toán Knapsack là một trong những bài toán tối ưu cổ điển trong lĩnh vực khoa học máy tính. Đã có rất nhiều ứng dụng trong việc sử dụng lời giải cái túi sang những bài toán khác trong cuộc sống.

Mô tả vấn đề: Cho một cái túi có giới hạn C, ta cần lựa ra trong n món sao cho tổng trọng lượng không vượt quá C và có giá trị lớn nhất.

Đã có nhiều cách để giải bài toán này. Ngày nay, để tiện sử dụng hơn thì google đã tạo ra công cụ hỗ trợ. Google OR Tools là một bộ công cụ mã nguồn mở cung cấp bởi Google để giải quyết các bài toán tối ưu hóa rời rạc. Trong lần thực nghiệm này, ta sẽ thống kê các kết quả thực nghiệm khi sử dụng OR tools trên bộ test kplib.

2 Thực nghiệm

2.1 Mô tả

- Môi trường chạy: Kaggle với 30 GB RAM.

- Thời gian chạy một test: 3 phút.

- Bộ test: Chạy 13 nhóm test, với mỗi nhóm test, chạy 8 loại từ n00050 đến n10000, mỗi loại chạy với một testcase ngẫu nhiên trong cả 2 giá trị ứng với folder R01000 và R10000.

- Xét lời giải có tối ưu: Kiểm tra thời gian chạy test có vượt quá thời gian tối đa hay không. Nếu có thì lời giải chưa chắc đã tối ưu

2.2 Kết quả thực nghiệm

Group	Name	Value	Weight	Optimal
00 Uncorrelated	n00050/R01000/s050.kp	22274	10358	TRUE
	n00050/R10000/s021.kp	197193	133505	TRUE
	n00100/R01000/s019.kp	37539	23003	TRUE
	n00100/R10000/s002.kp	455227	215945	TRUE
	n00200/R01000/s022.kp	82819	46488	TRUE
	n00200/R10000/s027.kp	829514	522743	TRUE
	n00500/R01000/s054.kp	204315	125246	TRUE
	n00500/R10000/s064.kp	2004851	1242750	TRUE
	n01000/R01000/s008.kp	406621	239138	TRUE
	n01000/R10000/s089.kp	4092529	2447884	TRUE
	n02000/R01000/s067.kp	807030	487617	TRUE
	n02000/R10000/s073.kp	7806077	4925757	TRUE
	n05000/R01000/s002.kp	2024515	1224942	TRUE
	n05000/R10000/s042.kp	20197559	12380939	TRUE
	n10000/R01000/s002.kp	4033221	2485169	TRUE
	n10000/R10000/s063.kp	40303613	24591218	TRUE
01 Weakly Correlated	n00050/R01000/s009.kp	11991	10836	TRUE
	n00050/R10000/s009.kp	119733	108238	TRUE
	n00100/R01000/s060.kp	26421	24423	TRUE
	n00100/R10000/s084.kp	285544	254766	TRUE
	n00200/R01000/s000.kp	56976	51563	TRUE
	n00200/R10000/s080.kp	547093	502024	TRUE
	n00500/R01000/s072.kp	142330	128123	TRUE
	n00500/R10000/s080.kp	1333278	1189499	TRUE
	n01000/R01000/s015.kp	281317	255523	TRUE
	n01000/R10000/s034.kp	2811895	2564847	TRUE
	n02000/R01000/s069.kp	545606	494005	TRUE
	n02000/R10000/s080.kp	5444951	4910990	TRUE
	n05000/R01000/s033.kp	1370446	1241497	TRUE
	n05000/R10000/s095.kp	13623483	12305049	TRUE
	n10000/R01000/s058.kp	2769272	2503066	TRUE
	n10000/R10000/s022.kp	27555728	24998413	TRUE

Group	Name	Value	Weight	Optimal
02 Strongly Correlated	n00050/R01000/s028.kp	14277	10577	TRUE
	n00050/R10000/s022.kp	173947	139947	TRUE
	n00100/R01000/s023.kp	32029	25029	TRUE
	n00100/R10000/s007.kp	303840	232840	TRUE
	n00200/R01000/s055.kp	64087	50287	TRUE
	n00200/R10000/s037.kp	626834	486834	TRUE
	n00500/R01000/s027.kp	163206	128606	FALSE
	n00500/R10000/s010.kp	1586838	1236838	TRUE
	n01000/R01000/s057.kp	317272	246872	FALSE
	n01000/R10000/s086.kp	3181331	2478331	FALSE
	n02000/R01000/s061.kp	629677	488077	FALSE
	n02000/R10000/s082.kp	6370178	4962178	FALSE
	n05000/R01000/s004.kp	1595808	1244508	FALSE
	n05000/R10000/s070.kp	15929097	12416097	FALSE
	n10000/R01000/s097.kp	3181743	2479643	FALSE
	n10000/R10000/s053.kp	31820541	24794541	FALSE
03 Inverse Strongly Correlated	n00050/R01000/s037.kp	13480	15180	TRUE
	n00050/R10000/s016.kp	127931	143931	TRUE
	n00100/R01000/s063.kp	26644	29844	TRUE
	n00100/R10000/s098.kp	270164	302164	TRUE
	n00200/R01000/s020.kp	49976	56076	FALSE
	n00200/R10000/s037.kp	520890	583890	FALSE
	n00500/R01000/s068.kp	133217	148917	FALSE
	n00500/R10000/s055.kp	1343986	1503986	FALSE
	n01000/R01000/s060.kp	264372	296272	FALSE
	n01000/R10000/s064.kp	2657150	2971150	TRUE
	n02000/R01000/s093.kp	538676	601676	FALSE
	n02000/R10000/s026.kp	5252705	5878705	FALSE
	n05000/R01000/s072.kp	1343846	1502346	FALSE
	n05000/R10000/s017.kp	13304171	14892171	FALSE
	n10000/R01000/s036.kp	2641651	2955551	FALSE
	n10000/R10000/s063.kp	26499852	29645852	FALSE

Group	Name	Value	Weight	Optimal
04 Almost Strongly Correlated	n00050/R01000/s039.kp	15519	12031	TRUE
	n00050/R10000/s065.kp	161708	127579	TRUE
	n00100/R01000/s045.kp	30822	23788	FALSE
	n00100/R10000/s091.kp	338405	270310	TRUE
	n00200/R01000/s003.kp	64765	50855	FALSE
	n00200/R10000/s022.kp	645334	505407	FALSE
	n00500/R01000/s024.kp	162443	127434	TRUE
	n00500/R10000/s026.kp	1549302	1192354	FALSE
	n01000/R01000/s094.kp	322932	252982	FALSE
	n01000/R10000/s021.kp	3190029	2492035	FALSE
	n02000/R01000/s026.kp	630754	489572	FALSE
	n02000/R10000/s031.kp	6440635	5039955	FALSE
	n05000/R01000/s031.kp	1603204	1252522	FALSE
	n05000/R10000/s087.kp	15936930	12427947	FALSE
	n10000/R01000/s077.kp	3168657	2464229	FALSE
	n10000/R10000/s084.kp	31985728	24959783	TRUE
05 Subset Sum	n00050/R01000/s062.kp	12341	12341	TRUE
	n00050/R10000/s010.kp	124893	124893	TRUE
	n00100/R01000/s042.kp	23764	23764	TRUE
	n00100/R10000/s079.kp	234975	234975	TRUE
	n00200/R01000/s089.kp	49527	49527	TRUE
	n00200/R10000/s058.kp	485422	485422	TRUE
	n00500/R01000/s038.kp	123993	123993	TRUE
	n00500/R10000/s006.kp	1248025	1248025	TRUE
	n01000/R01000/s050.kp	250529	250529	TRUE
	n01000/R10000/s099.kp	2434405	2434405	TRUE
	n02000/R01000/s021.kp	497414	497414	TRUE
	n02000/R10000/s039.kp	4770600	4770600	TRUE
	n05000/R01000/s004.kp	1244508	1244508	TRUE
	n05000/R10000/s009.kp	12307796	12307796	TRUE
	n10000/R01000/s026.kp	2475727	2475727	TRUE
	n10000/R10000/s056.kp	24871975	24871975	TRUE

Group	Name	Value	Weight	Optimal
06 Uncorrelated With Similar Weights	n00050/R01000/s043.kp	18303	2401377	TRUE
	n00050/R10000/s011.kp	18378	2401152	TRUE
	n00100/R01000/s095.kp	36030	4902143	TRUE
	n00100/R10000/s045.kp	36371	4902439	TRUE
	n00200/R01000/s086.kp	73614	9905057	TRUE
	n00200/R10000/s097.kp	76612	9904902	TRUE
	n00500/R01000/s026.kp	184531	24712629	TRUE
	n00500/R10000/s087.kp	179211	24712545	FALSE
	n01000/R01000/s053.kp	370698	49525707	TRUE
	n01000/R10000/s068.kp	376197	49524583	TRUE
	n02000/R01000/s072.kp	754615	99051899	FALSE
	n02000/R10000/s001.kp	746520	99050111	FALSE
	n05000/R01000/s064.kp	1874423	247624255	FALSE
	n05000/R10000/s026.kp	1871494	247624298	FALSE
	n10000/R01000/s052.kp	3711198	495248213	FALSE
	n10000/R10000/s099.kp	3719942	495248122	FALSE
07 Spanner Uncorrelated	n00050/R01000/s053.kp	8961	6603	TRUE
	n00050/R10000/s077.kp	97860	62949	TRUE
	n00100/R01000/s032.kp	3537	14283	FALSE
	n00100/R10000/s000.kp	243893	88483	FALSE
	n00200/R01000/s087.kp	9908	33991	FALSE
	n00200/R10000/s091.kp	113196	208216	FALSE
	n00500/R01000/s092.kp	66657	69271	FALSE
	n00500/R10000/s001.kp	1193638	636829	FALSE
	n01000/R01000/s015.kp	146686	111332	FALSE
	n01000/R10000/s060.kp	1266108	1371083	FALSE
	n02000/R01000/s063.kp	191932	341920	FALSE
	n02000/R10000/s029.kp	2611502	2805718	FALSE
	n05000/R01000/s053.kp	965479	718248	FALSE
	n05000/R10000/s076.kp	9942623	3110670	FALSE
	n10000/R01000/s017.kp	2414869	1545128	FALSE
	n10000/R10000/s050.kp	10296164	10682016	FALSE

Group	Name	Value	Weight	Optimal
08 Spanner Weakly Correlated	n00050/R01000/s012.kp	9357	5506	TRUE
	n00050/R10000/s076.kp	60860	84050	TRUE
	n00100/R01000/s054.kp	26114	13716	FALSE
	n00100/R10000/s047.kp	172809	99125	FALSE
	n00200/R01000/s005.kp	77262	32763	FALSE
	n00200/R10000/s030.kp	435090	193832	FALSE
	n00500/R01000/s087.kp	137944	19709	FALSE
	n00500/R10000/s026.kp	1130177	604095	FALSE
	n01000/R01000/s048.kp	210556	86066	FALSE
	n01000/R10000/s008.kp	2174519	1438810	FALSE
	n02000/R01000/s094.kp	355782	164024	FALSE
	n02000/R10000/s087.kp	5612622	822484	FALSE
	n05000/R01000/s076.kp	611207	820571	FALSE
	n05000/R10000/s006.kp	11507032	9953237	FALSE
	n10000/R01000/s083.kp	1454168	1671208	FALSE
	n10000/R10000/s087.kp	28112368	4141248	FALSE
09 Spanner Strongly Correlated	n00050/R01000/s022.kp	29138	6738	TRUE
	n00050/R10000/s012.kp	177301	56301	TRUE
	n00100/R01000/s058.kp	41664	9064	TRUE
	n00100/R10000/s033.kp	410868	140868	FALSE
	n00200/R01000/s072.kp	102844	16644	FALSE
	n00200/R10000/s053.kp	1014095	375095	FALSE
	n00500/R01000/s022.kp	263290	68790	FALSE
	n00500/R10000/s023.kp	2622132	1197132	FALSE
	n01000/R01000/s064.kp	428221	132721	FALSE
	n01000/R10000/s099.kp	4049771	724771	FALSE
	n02000/R01000/s031.kp	823809	30309	FALSE
	n02000/R10000/s020.kp	9893674	3855674	FALSE
	n05000/R01000/s051.kp	2197891	461891	FALSE
	n05000/R10000/s043.kp	24772817	4563817	FALSE
	n10000/R01000/s021.kp	4784453	1053353	FALSE
	n10000/R10000/s042.kp	48974053	8255053	FALSE

Group	Name	Value	Weight	Optimal
10 Multiple Strongly Correlated	n00050/R01000/s057.kp	20188	12888	TRUE
	n00050/R10000/s093.kp	201390	124390	TRUE
	n00100/R01000/s078.kp	39291	23391	TRUE
	n00100/R10000/s047.kp	402493	250493	TRUE
	n00200/R01000/s090.kp	80946	50046	TRUE
	n00200/R10000/s022.kp	818416	505416	TRUE
	n00500/R01000/s019.kp	200544	122544	FALSE
	n00500/R10000/s080.kp	1969506	1189506	FALSE
	n01000/R01000/s066.kp	402446	248346	FALSE
	n01000/R10000/s023.kp	4032306	2484306	FALSE
	n02000/R01000/s007.kp	799406	486906	FALSE
	n02000/R10000/s085.kp	8084490	4988490	FALSE
	n05000/R01000/s013.kp	2006092	1231392	FALSE
	n05000/R10000/s021.kp	20000570	12240570	FALSE
	n10000/R01000/s063.kp	4024730	2471730	FALSE
	n10000/R10000/s007.kp	40166360	24676360	FALSE
11 Profit Ceiling	n00050/R01000/s024.kp	13770	13778	TRUE
	n00050/R10000/s086.kp	125550	125559	TRUE
	n00100/R01000/s044.kp	22701	22713	TRUE
	n00100/R10000/s019.kp	225780	225782	TRUE
	n00200/R01000/s046.kp	46347	46369	TRUE
	n00200/R10000/s042.kp	479460	479483	TRUE
	n00500/R01000/s027.kp	128565	128604	FALSE
	n00500/R10000/s042.kp	1241277	1241320	FALSE
	n01000/R01000/s009.kp	239361	239451	FALSE
	n01000/R10000/s098.kp	2438937	2439020	FALSE
	n02000/R01000/s067.kp	494397	494551	FALSE
	n02000/R10000/s072.kp	5035341	5035541	FALSE
	n05000/R01000/s033.kp	1241019	1241495	FALSE
	n05000/R10000/s040.kp	12279726	12280192	FALSE
	n10000/R01000/s043.kp	2479953	2480848	FALSE
	n10000/R10000/s009.kp	24527571	24528448	FALSE

Group	Name	Value	Weight	Optimal
12 Circle	n00050/R01000/s016.kp	251354	11929	TRUE
	n00050/R10000/s084.kp	7795205	116934	TRUE
	n00100/R01000/s021.kp	536677	25470	FALSE
	n00100/R10000/s048.kp	15606943	234116	TRUE
	n00200/R01000/s086.kp	1029969	48881	FALSE
	n00200/R10000/s044.kp	31353480	470326	TRUE
	n00500/R01000/s005.kp	2595920	123199	TRUE
	n00500/R10000/s040.kp	77924325	1168924	FALSE
	n01000/R01000/s083.kp	5318914	252429	FALSE
	n01000/R10000/s099.kp	162285467	2434405	FALSE
	n02000/R01000/s005.kp	10263335	487085	FALSE
	n02000/R10000/s055.kp	333627662	5004668	FALSE
	n05000/R01000/s092.kp	25840848	1226373	FALSE
	n05000/R10000/s096.kp	828856551	12433477	FALSE
	n10000/R01000/s092.kp	51593730	2448573	FALSE
	n10000/R10000/s024.kp	1635309895	24530889	FALSE

2.3 Nhận xét

Nhìn vào kết quả xuất ra, nếu số kết quả tối ưu nhiều hơn thì ta xếp vào nhóm test khó, ngược lại là nhóm test dễ.

- Những nhóm test dễ bao gồm: 00-Uncorrelated, 01-Weakly-Correlated, 05-Subset-Sum, 06-Uncorrelated-With-Similar-Weights.

- Những nhóm test khó bao gồm: 02-Strongly-Correlated, 03-Inverse-Strongly-Correlated, 04-Almost-Strongly-Correlated, 08-Spanner-Weakly-Correlated, 09-Spanner-Strongly-Correlated, 10-Multiple-Strongly-Correlated, 11-Profit-Ceiling, 12-Circle.