

**ĐẠI HỌC QUỐC GIA THÀNH PHỐ HỒ CHÍ MINH**

**TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN**

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**TRÍ TUỆ NHÂN TẠO**

**LỚP: CS106.O21**

**Solving Knapsack Problems Using  
 Google OR Tools**

**Họ và tên: Trần Đình Khánh Đăng**

**MSSV: 22520195**



**Heuristics & A\* Search**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s098.kp | 50 | 126583 | 126438 | 206338 | ✓ |
| \n00100\R10000\s093.kp | 100 | 251553 | 251350 | 402619 | ✓ |
| \n00200\R10000\s029.kp | 200 | 485019 | 484950 | 818812 | ✓ |
| \n00500\R10000\s099.kp | 500 | 1224440 | 1224357 | 1966501 | ✓ |
| \n01000\R10000\s087.kp | 1000 | 2485410 | 2485363 | 3882548 | ✓ |
| \n02000\R10000\s079.kp | 2000 | 4954470 | 4954461 | 8039939 | ✓ |
| \n05000\R10000\s017.kp | 5000 | 12255824 | 12255824 | 20192624 | ✓ |
| \n10000\R10000\s079.kp | 10000 | 24786486 | 24786485 | 40443988 | ✓ |

Bảng 1: 00Uncorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s063.kp | 50 | 127712 | 127684 | 138679 | ✓ |
| \n00100\R10000\s008.kp | 100 | 227845 | 227816 | 255382v | ✓ |
| \n00200\R10000\s060.kp | 200 | 470952 | 470873 | 526825 | ✓ |
| \n00500\R10000\s073.kp | 500 | 1210869 | 1210865 | 1329152 | ✓ |
| \n01000\R10000\s048.kp | 1000 | 2527171 | 2527160 | 2799626 | ✓ |
| \n02000\R10000\s084.kp | 2000 | 4946057 | 4946054 | 5489956 | ✓ |
| \n05000\R10000\s082.kp | 5000 | 12426748 | 12426745 | 13693417 | ✓ |
| \n10000\R10000\s038.kp | 10000 | 24724763 | 24724763 | 27306195 | ✓ |

Bảng 2: 01WeaklyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s099.kp | 50 | 127788 | 127778 | 162778 | ✓ |
| \n00100\R10000\s082.kp | 100 | 250353 | 250353 | 320353 | ✓ |
| \n00200\R10000\s096.kp | 200 | 477359 | 477359 | 618359 | ✓ |
| \n00500\R10000\s076.kp | 500 | 1251696 | 1251696 | 1600696 | ✓ |
| \n01000\R10000\s019.kp | 1000 | 2387246 | 2383982 | 3091982 |  |
| \n02000\R10000\s066.kp | 2000 | 4953825 | 4950668 | 6351668 |  |
| \n05000\R10000\s049.kp | 5000 | 12276679 | 12271206 | 15794206 |  |
| \n10000\R10000\s050.kp | 10000 | 24870234 | 24867989 | 31901989 |  |

Bảng 3: 02StronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s090.kp | 50 | 148037 | 148037 | 132037 | ✓ |
| \n00100\R10000\s005.kp | 100 | 295717 | 295717 | 265717 | ✓ |
| \n00200\R10000\s075.kp | 200 | 595634 | 594199 | 531199 |  |
| \n00500\R10000\s026.kp | 500 | 1442019 | 1438600 | 1286600 |  |
| \n01000\R10000\s097.kp | 1000 | 2979604 | 2977505 | 2663505 |  |
| \n02000\R10000\s043.kp | 2000 | 5896631 | 5895014 | 5262014 |  |
| \n05000\R10000\s044.kp | 5000 | 14760288 | 14760288 | 13191288 |  |
| \n10000\R10000\s058.kp | 10000 | 29958961 | 29954775 | 26795775 |  |

Bảng 4: 03InverseStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s023.kp | 50 | 112283 | 112272 | 147363 | ✓ |
| \n00100\R10000\s091.kp | 100 | 270311 | 270310 | 338405 | ✓ |
| \n00200\R10000\s072.kp | 200 | 498025 | 498018 | 637480 | ✓ |
| \n00500\R10000\s069.kp | 500 | 1223941 | 1223940 | 1576059 |  |
| \n01000\R10000\s092.kp | 1000 | 2491375 | 2489299 | 3189482 |  |
| \n02000\R10000\s009.kp | 2000 | 4947362 | 4942912 | 6349710 |  |
| \n05000\R10000\s022.kp | 5000 | 12403220 | 12401146 | 15922031 |  |
| \n10000\R10000\s051.kp | 10000 | 24937050 | 24932396 | 31942894 |  |

Bảng 5: 04AlmostStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s033.kp | 50 | 120976 | 120976 | 120976 | ✓ |
| \n00100\R10000\s027.kp | 100 | 247710 | 247710 | 247710 | ✓ |
| \n00200\R10000\s042.kp | 200 | 479483 | 479483 | 479483 | ✓ |
| \n00500\R10000\s085.kp | 500 | 1209405 | 1209405 | 1209405 | ✓ |
| \n01000\R10000\s074.kp | 1000 | 2562918 | 2562918 | 2562918 | ✓ |
| \n02000\R10000\s064.kp | 2000 | 4938043 | 4938043 | 4938043 | ✓ |
| \n05000\R10000\s075.kp | 5000 | 12239988 | 12239988 | 12239988 | ✓ |
| \n10000\R10000\s027.kp | 10000 | 25002713 | 25002713 | 25002713 | ✓ |

Bảng 6: 05SubsetSum

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s035.kp | 50 | 2476435 | 2401158 | 19003 | ✓ |
| \n00100\R10000\s097.kp | 100 | 4953150 | 4902553 | 37094 | ✓ |
| \n00200\R10000\s011.kp | 200 | 9906056 | 9904977 | 76162 | ✓ |
| \n00500\R10000\s050.kp | 500 | 24765068 | 24712081 | 184670 |  |
| \n01000\R10000\s075.kp | 1000 | 49529343 | 49524098 | 376014 | ✓ |
| \n02000\R10000\s044.kp | 2000 | 99058739 | 99048604 | 743152 |  |
| \n05000\R10000\s040.kp | 5000 | 247647355 | 247623107 | 1847387 |  |
| \n10000\R10000\s017.kp | 10000 | 495296144 | 495246480 | 3708624 |  |

Bảng 7: 06UncorrelatedWithSimilarWeights

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s079.kp | 50 | 24744 | 24676 | 34764 | ✓ |
| \n00100\R10000\s029.kp | 100 | 133611 | 133192 | 124988 |  |
| \n00200\R10000\s030.kp | 200 | 160182 | 159624 | 319970 |  |
| \n00500\R10000\s098.kp | 500 | 218828 | 218673 | 1218007 |  |
| \n01000\R10000\s086.kp | 1000 | 1346994 | 1346970 | 1272630 |  |
| \n02000\R10000\s033.kp | 2000 | 2716700 | 2716364 | 4103260 |  |
| \n05000\R10000\s092.kp | 5000 | 7009228 | 7009035 | 6720813 |  |
| \n10000\R10000\s066.kp | 10000 | 8542855 | 8542665 | 8331735 |  |

Bảng 8: 07SpannerUncorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s073.kp | 50 | 42261 | 42048 | 110016 | ✓ |
| \n00100\R10000\s021.kp | 100 | 103256 | 103242 | 284677 |  |
| \n00200\R10000\s002.kp | 200 | 479623 | 479593 | 87902 | ✓ |
| \n00500\R10000\s075.kp | 500 | 550401 | 550242 | 1487178 |  |
| \n01000\R10000\s086.kp | 1000 | 941056 | 940986 | 2628389 |  |
| \n02000\R10000\s015.kp | 2000 | 2404684 | 2404493 | 4582538 |  |
| \n05000\R10000\s071.kp | 5000 | 5856738 | 5856620 | 15987885 |  |
| \n10000\R10000\s024.kp | 10000 | 18992682 | 18992596 | 43809920 |  |

Bảng 9: 08SpannerWeaklyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s031.kp | 50 | 8324 | 8248 | 187248 | ✓ |
| \n00100\R10000\s093.kp | 100 | 185528 | 184926 | 518926 |  |
| \n00200\R10000\s064.kp | 200 | 262115 | 261882 | 830882 |  |
| \n00500\R10000\s024.kp | 500 | 942617 | 941945 | 2368945 |  |
| \n01000\R10000\s013.kp | 1000 | 1141962 | 1141754 | 4715754 |  |
| \n02000\R10000\s049.kp | 2000 | 1177782 | 1177620 | 8834620 |  |
| \n05000\R10000\s078.kp | 5000 | 5672787 | 5672230 | 25753230 |  |
| \n10000\R10000\s050.kp | 10000 | 9308095 | 9308092 | 42844092 |  |

Bảng 10: 09SpannerStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s017.kp | 50 | 140598 | 140595 | 215595 | ✓ |
| \n00100\R10000\s033.kp | 100 | 229290 | 229290 | 388290 | ✓ |
| \n00200\R10000\s003.kp | 200 | 508116 | 508074 | 814074 | ✓ |
| \n00500\R10000\s029.kp | 500 | 1244010 | 1244007 | 2024007 | ✓ |
| \n01000\R10000\s047.kp | 1000 | 2510976 | 2510976 | 4051976 | ✓ |
| \n02000\R10000\s036.kp | 2000 | 4973274 | 4973274 | 8049274 |  |
| \n05000\R10000\s046.kp | 5000 | 12302172 | 12300627 | 20104627 |  |
| \n10000\R10000\s039.kp | 10000 | 24659922 | 24659922 | 40153922 |  |

Bảng 11: 10MultipleStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s065.kp | 50 | 127589 | 127589 | 127581 | ✓ |
| \n00100\R10000\s046.kp | 100 | 223437 | 223437 | 223431 | ✓ |
| \n00200\R10000\s008.kp | 200 | 485134 | 485133 | 485106 |  |
| \n00500\R10000\s076.kp | 500 | 1251696 | 1251696 | 1251642 | ✓ |
| \n01000\R10000\s058.kp | 1000 | 2563956 | 2563956 | 2563851 |  |
| \n02000\R10000\s030.kp | 2000 | 4929046 | 4929046 | 4928850 |  |
| \n05000\R10000\s010.kp | 5000 | 12429655 | 12429655 | 12429168 |  |
| \n10000\R10000\s058.kp | 10000 | 25008466 | 25008465 | 25007493 |  |

Bảng 12: 11ProfitCeiling

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Capacities | Total Weight | Total Value | Optimized |
| \n00050\R10000\s072.kp | 50 | 120969 | 120969 | 8064191 | ✓ |
| \n00100\R10000\s000.kp | 100 | 289961 | 289961 | 19329757 | ✓ |
| \n00200\R10000\s055.kp | 200 | 502415 | 502415 | 33492638 |  |
| \n00500\R10000\s035.kp | 500 | 1188432 | 1188432 | 79224793 |  |
| \n01000\R10000\s053.kp | 1000 | 2484840 | 2484840 | 165647615 |  |
| \n02000\R10000\s007.kp | 2000 | 4864617 | 4864617 | 324291400 |  |
| \n05000\R10000\s031.kp | 5000 | 12514519 | 12514519 | 834259070 |  |
| \n10000\R10000\s096.kp | 10000 | 24752022 | 24752022 | 1650051367 |  |

Bảng 13: 12Circle

Nhận xét:

* Các nhóm **00Uncorrelated, 01WeaklyCorrelated, 05SubsetSum** dễ vì có thể tìm ra lời giải tối ưu trong toàn bộ các testcase.
* Các nhóm **07SpannerUncorrelated, 08SpannerWeaklyCorrelated, 09SpannerStronglyCorrelated** khó vì chỉ có thể tìm lời giải với số lượng đồ vật nhỏ (thường là 50 đồ vật).