**ĐẠI HỌC QUỐC GIA TP. HỒ CHÍ MINH**

**TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN**

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**BÁO CÁO THỰC HÀNH**

**MÔN CS106 – TRÍ TUỆ NHÂN TẠO**

**BT3 - Solving Knapsack Problems Using Google OR Tools**

**Giảng viên hướng dẫn: Thầy Lương Ngọc Hoàng**

**Sinh viên thực hiện: Trần Ngọc Thiện**

**MSSV: 21521465**

**TP. HỒ CHÍ MINH, Tháng 3 Năm 2024**

# NHẬN XÉT CỦA GIẢNG VIÊN

TPHCM, Ngày … Tháng … Năm …

Người nhận xét

(Ký tên)

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# Quá trình thực hiện

* Đặt mốc chi phí là tối đa 120 giây cho mỗi lần chạy.
* Trong mỗi nhóm testcase, chọn ngẫu nhiên 1 testcase ứng với mỗi kích thước.

# Kết quả

## Uncorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\00Uncorrelated\n00050\R01000\s081.kp | 50 | 13335 | 19473 | 13322 | 0 |
| testcase\kplib-master\00Uncorrelated\n00100\R01000\s014.kp | 100 | 26464 | 37248 | 26450 | 0 |
| testcase\kplib-master\00Uncorrelated\n00200\R01000\s003.kp | 200 | 49551 | 81680 | 49545 | 0 |
| testcase\kplib-master\00Uncorrelated\n00500\R01000\s094.kp | 500 | 123596 | 209767 | 123594 | 0 |
| testcase\kplib-master\00Uncorrelated\n01000\R01000\s035.kp | 1000 | 246819 | 398394 | 246812 | 0.01718 |
| testcase\kplib-master\00Uncorrelated\n02000\R01000\s031.kp | 2000 | 496783 | 822269 | 496780 | 0.015942 |
| testcase\kplib-master\00Uncorrelated\n05000\R01000\s028.kp | 5000 | 1233887 | 2034212 | 1233885 | 0.067444 |
| testcase\kplib-master\00Uncorrelated\n10000\R01000\s017.kp | 10000 | 2469230 | 4032422 | 2469230 | 0.31084 |

* Tìm ra lời giải chắc chắn tối ưu cho tất cả testcase

## WeaklyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\01WeaklyCorrelated\n00050\R01000\s094.kp | 50 | 11888 | 13175 | 11885 | 0 |
| testcase\kplib-master\01WeaklyCorrelated\n00100\R01000\s013.kp | 100 | 24322 | 26297 | 24319 | 0 |
| testcase\kplib-master\01WeaklyCorrelated\n00200\R01000\s086.kp | 200 | 48881 | 54298 | 48881 | 0 |
| testcase\kplib-master\01WeaklyCorrelated\n00500\R01000\s094.kp | 500 | 129518 | 142384 | 129516 | 0.015621 |
| testcase\kplib-master\01WeaklyCorrelated\n01000\R01000\s069.kp | 1000 | 245164 | 271373 | 245163 | 0.004618 |
| testcase\kplib-master\01WeaklyCorrelated\n02000\R01000\s011.kp | 2000 | 493039 | 545286 | 493039 | 0.009233 |
| testcase\kplib-master\01WeaklyCorrelated\n05000\R01000\s075.kp | 5000 | 1225116 | 1354119 | 1225116 | 0.092209 |
| testcase\kplib-master\01WeaklyCorrelated\n10000\R01000\s054.kp | 10000 | 2485622 | 2747406 | 2485622 | 0.299428 |

* Tìm ra lời giải chắc chắn tối ưu cho tất cả testcase

## StronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\02StronglyCorrelated\n00050\R01000\s004.kp | 50 | 12263 | 15763 | 12263 | 0 |
| testcase\kplib-master\02StronglyCorrelated\n00100\R01000\s003.kp | 100 | 26811 | 33711 | 26811 | 0.149914 |
| testcase\kplib-master\02StronglyCorrelated\n00200\R01000\s011.kp | 200 | 49817 | 63917 | 49817 | 120.0431 |
| testcase\kplib-master\02StronglyCorrelated\n00500\R01000\s027.kp | 500 | 128606 | 163206 | 128606 | 120.0339 |
| testcase\kplib-master\02StronglyCorrelated\n01000\R01000\s029.kp | 1000 | 242756 | 313119 | 242519 | 120.0459 |
| testcase\kplib-master\02StronglyCorrelated\n02000\R01000\s064.kp | 2000 | 494251 | 635151 | 494251 | 120.0243 |
| testcase\kplib-master\02StronglyCorrelated\n05000\R01000\s077.kp | 5000 | 1220893 | 1572869 | 1220469 | 120.0731 |
| testcase\kplib-master\02StronglyCorrelated\n10000\R01000\s003.kp | 10000 | 2480159 | 3184177 | 2479877 | 120.3268 |

* Chỉ tìm được lời giải chắc chắn tối ưu cho 2 testcase có kích thước 50 và 100

## InverseStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\03InverseStronglyCorrelated\n00050\R01000\s071.kp | 50 | 12930 | 11430 | 12930 | 0.018454 |
| testcase\kplib-master\03InverseStronglyCorrelated\n00100\R01000\s025.kp | 100 | 28170 | 24970 | 28170 | 12.21254 |
| testcase\kplib-master\03InverseStronglyCorrelated\n00200\R01000\s091.kp | 200 | 63271 | 56671 | 63271 | 120.0443 |
| testcase\kplib-master\03InverseStronglyCorrelated\n00500\R01000\s083.kp | 500 | 155169 | 138642 | 155042 | 121.9788 |
| testcase\kplib-master\03InverseStronglyCorrelated\n01000\R01000\s089.kp | 1000 | 297453 | 265691 | 296991 | 120.5593 |
| testcase\kplib-master\03InverseStronglyCorrelated\n02000\R01000\s069.kp | 2000 | 593015 | 529919 | 592719 | 120.0464 |
| testcase\kplib-master\03InverseStronglyCorrelated\n05000\R01000\s053.kp | 5000 | 1492281 | 1333928 | 1492128 | 120.0723 |
| testcase\kplib-master\03InverseStronglyCorrelated\n10000\R01000\s028.kp | 10000 | 2966188 | 2652217 | 2966117 | 120.1523 |

* Chỉ tìm được lời giải chắc chắn tối ưu cho 2 testcase có kích thước 50 và 100

## AlmostStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\04AlmostStronglyCorrelated\n00050\R01000\s057.kp | 50 | 12889 | 16292 | 12889 | 0 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n00100\R01000\s075.kp | 100 | 25741 | 32654 | 25741 | 0.244647 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n00200\R01000\s035.kp | 200 | 47486 | 61694 | 47484 | 0 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n00500\R01000\s000.kp | 500 | 127278 | 162154 | 127278 | 120.0145 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n01000\R01000\s097.kp | 1000 | 248678 | 319110 | 248678 | 120.028 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n02000\R01000\s020.kp | 2000 | 490184 | 631421 | 489843 | 120.0349 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n05000\R01000\s089.kp | 5000 | 1237047 | 1589318 | 1237047 | 6.847284 |
| testcase\kplib-master\04AlmostStronglyCorrelated\n10000\R01000\s054.kp | 10000 | 2485622 | 3188670 | 2485622 | 120.3157 |

* Tìm được lời giải chắc chắn tối ưu cho 4 testcase có kích thước 50; 100; 200; 5000

## SubsetSum

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\05SubsetSum\n00050\R01000\s043.kp | 50 | 12828 | 12828 | 12828 | 0.00368 |
| testcase\kplib-master\05SubsetSum\n00100\R01000\s035.kp | 100 | 24868 | 24868 | 24868 | 0 |
| testcase\kplib-master\05SubsetSum\n00200\R01000\s019.kp | 200 | 45641 | 45641 | 45641 | 0.000999 |
| testcase\kplib-master\05SubsetSum\n00500\R01000\s027.kp | 500 | 128606 | 128606 | 128606 | 0.001684 |
| testcase\kplib-master\05SubsetSum\n01000\R01000\s097.kp | 1000 | 248678 | 248678 | 248678 | 0.002572 |
| testcase\kplib-master\05SubsetSum\n02000\R01000\s043.kp | 2000 | 491101 | 491101 | 491101 | 0.012677 |
| testcase\kplib-master\05SubsetSum\n05000\R01000\s013.kp | 5000 | 1231397 | 1231397 | 1231397 | 0.045912 |
| testcase\kplib-master\05SubsetSum\n10000\R01000\s011.kp | 10000 | 2462668 | 2462668 | 2462668 | 0.145541 |

* Tìm ra lời giải chắc chắn tối ưu cho tất cả testcase

## UncorrelatedWithSimilarWeight

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n00050\R01000\s048.kp | 50 | 2476542 | 15837 | 2401289 | 0.004587 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n00100\R01000\s012.kp | 100 | 4953076 | 35206 | 4902525 | 0.047831 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n00200\R01000\s045.kp | 200 | 9906322 | 75694 | 9905148 | 0 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n00500\R01000\s044.kp | 500 | 24764970 | 181758 | 24712733 | 120.0344 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n01000\R01000\s077.kp | 1000 | 49529080 | 372222 | 49523572 | 0.341479 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n02000\R01000\s033.kp | 2000 | 99059596 | 747261 | 99049394 | 120.0298 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n05000\R01000\s005.kp | 5000 | 2.48E+08 | 1861906 | 2.48E+08 | 120.0914 |
| testcase\kplib-master\06UncorrelatedWithSimilarWeights\n10000\R01000\s093.kp | 10000 | 4.95E+08 | 3733539 | 4.95E+08 | 120.2399 |

* Tìm được lời giải chắc chắn tối ưu cho 4 testcase có kích thước 50; 100; 200; 1000

## SpannerUncorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\07SpannerUncorrelated\n00050\R01000\s081.kp | 50 | 6076 | 6777 | 6075 | 0.009973 |
| testcase\kplib-master\07SpannerUncorrelated\n00100\R01000\s014.kp | 100 | 19750 | 14616 | 19720 | 120.0302 |
| testcase\kplib-master\07SpannerUncorrelated\n00200\R01000\s003.kp | 200 | 24625 | 22344 | 24624 | 120.0288 |
| testcase\kplib-master\07SpannerUncorrelated\n00500\R01000\s094.kp | 500 | 43763 | 72200 | 43748 | 126.8287 |
| testcase\kplib-master\07SpannerUncorrelated\n01000\R01000\s035.kp | 1000 | 199191 | 173615 | 199182 | 120.0665 |
| testcase\kplib-master\07SpannerUncorrelated\n02000\R01000\s031.kp | 2000 | 265680 | 42850 | 265670 | 122.0943 |
| testcase\kplib-master\07SpannerUncorrelated\n05000\R01000\s028.kp | 5000 | 482811 | 198036 | 482800 | 120.1127 |
| testcase\kplib-master\07SpannerUncorrelated\n10000\R01000\s017.kp | 10000 | 1545201 | 2414869 | 1545128 | 120.2763 |

* Chỉ tìm được lời giải chắc chắn tối ưu cho testcase có kích thước 50

## SpannerWeaklyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n00050\R01000\s081.kp | 50 | 6178 | 10988 | 6164 | 0.011968 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n00100\R01000\s014.kp | 100 | 9824 | 37952 | 9819 | 120.0503 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n00200\R01000\s003.kp | 200 | 19807 | 40005 | 19775 | 119.7033 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n00500\R01000\s094.kp | 500 | 41977 | 88122 | 41969 | 120.021 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n01000\R01000\s035.kp | 1000 | 158826 | 360726 | 158820 | 120.023 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n02000\R01000\s031.kp | 2000 | 30321 | 406972 | 30319 | 120.0367 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n05000\R01000\s028.kp | 5000 | 143186 | 932456 | 143178 | 120.0619 |
| testcase\kplib-master\08SpannerWeaklyCorrelated\n10000\R01000\s017.kp | 10000 | 1617013 | 4171773 | 1617006 | 120.2716 |

* Tìm được lời giải chắc chắn tối ưu cho 2 testcase có kích thước 50 và 200

## SpannerStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\09SpannerStronglyCorrelated\n00050\R01000\s094.kp | 50 | 4230 | 22222 | 4222 | 93.53636 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n00100\R01000\s013.kp | 100 | 10370 | 40746 | 10346 | 116.3455 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n00200\R01000\s086.kp | 200 | 18971 | 98654 | 18954 | 120.0616 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n00500\R01000\s094.kp | 500 | 41953 | 232320 | 41920 | 120.0254 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n01000\R01000\s069.kp | 1000 | 94391 | 483084 | 94384 | 120.0346 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n02000\R01000\s011.kp | 2000 | 245896 | 833361 | 245861 | 120.0296 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n05000\R01000\s075.kp | 5000 | 541956 | 1929455 | 541955 | 120.0514 |
| testcase\kplib-master\09SpannerStronglyCorrelated\n10000\R01000\s054.kp | 10000 | 1273941 | 5212314 | 1273914 | 120.2806 |

* Tìm được lời giải chắc chắn tối ưu cho 2 testcase có kích thước 50; 100

## MultipleStronglyCorrelated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\10MultipleStronglyCorrelated\n00050\R01000\s004.kp | 50 | 12258 | 20450 | 12250 | 0 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n00100\R01000\s003.kp | 100 | 26808 | 41805 | 26805 | 0 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n00200\R01000\s011.kp | 200 | 49812 | 80908 | 49808 | 0.001248 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n00500\R01000\s027.kp | 500 | 128604 | 205104 | 128604 | 120.3484 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n01000\R01000\s029.kp | 1000 | 242754 | 398754 | 242754 | 120.0261 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n02000\R01000\s064.kp | 2000 | 494250 | 802850 | 494250 | 120.0435 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n05000\R01000\s077.kp | 5000 | 1220892 | 1994892 | 1220892 | 120.1189 |
| testcase\kplib-master\10MultipleStronglyCorrelated\n10000\R01000\s003.kp | 10000 | 2480154 | 4030439 | 2480139 | 120.4751 |

* Tìm được lời giải chắc chắn tối ưu cho 3 testcase có kích thước 50; 100; 200

## ProfitCeiling

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\11ProfitCeiling\n00050\R01000\s071.kp | 50 | 10454 | 10446 | 10453 | 0.004988 |
| testcase\kplib-master\11ProfitCeiling\n00100\R01000\s025.kp | 100 | 23220 | 23205 | 23220 | 0.018113 |
| testcase\kplib-master\11ProfitCeiling\n00200\R01000\s091.kp | 200 | 53370 | 53340 | 53370 | 3.943108 |
| testcase\kplib-master\11ProfitCeiling\n00500\R01000\s083.kp | 500 | 130417 | 130371 | 130415 | 120.1193 |
| testcase\kplib-master\11ProfitCeiling\n01000\R01000\s089.kp | 1000 | 247948 | 247854 | 247946 | 120.041 |
| testcase\kplib-master\11ProfitCeiling\n02000\R01000\s069.kp | 2000 | 494005 | 493821 | 494004 | 120.0301 |
| testcase\kplib-master\11ProfitCeiling\n05000\R01000\s053.kp | 5000 | 1244756 | 1244301 | 1244755 | 120.0555 |
| testcase\kplib-master\11ProfitCeiling\n10000\R01000\s028.kp | 10000 | 2471138 | 2470188 | 2471137 | 120.2981 |

* Tìm được lời giải chắc chắn tối ưu cho 3 testcase có kích thước 50; 100; 200

## Circle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **File path** | **Problem size** | **Max weight** | **Total value** | **Total weight** | **Runtime** |
| testcase\kplib-master\12Circle\n00050\R01000\s057.kp | 50 | 12889 | 271584 | 12889 | 0.001996 |
| testcase\kplib-master\12Circle\n00100\R01000\s075.kp | 100 | 25741 | 542386 | 25741 | 120.242 |
| testcase\kplib-master\12Circle\n00200\R01000\s035.kp | 200 | 47486 | 1000572 | 47486 | 0.008444 |
| testcase\kplib-master\12Circle\n00500\R01000\s000.kp | 500 | 127278 | 2681868 | 127278 | 120.2467 |
| testcase\kplib-master\12Circle\n01000\R01000\s097.kp | 1000 | 248678 | 5239876 | 248678 | 120.0385 |
| testcase\kplib-master\12Circle\n02000\R01000\s020.kp | 2000 | 490184 | 10328628 | 490184 | 120.0165 |
| testcase\kplib-master\12Circle\n05000\R01000\s089.kp | 5000 | 1237047 | 26065737 | 1237047 | 120.0419 |
| testcase\kplib-master\12Circle\n10000\R01000\s054.kp | 10000 | 2485622 | 52374379 | 2485622 | 120.173 |

* Tìm được lời giải chắc chắn tối ưu cho 2 testcase có kích thước 50; 200

# Kết luận

* Các nhóm testcase 00Uncorrelated, 01WeaklyCorrelated, 05SubsetSum là dễ nhất (tìm được lời giải chắc chắn chắc chắn tối ưu cho tất cả testcase).
* Nhóm 07SpannerUncorrelated là khó nhất (chỉ tìm được lời giải tối ưu cho 1 testcase).