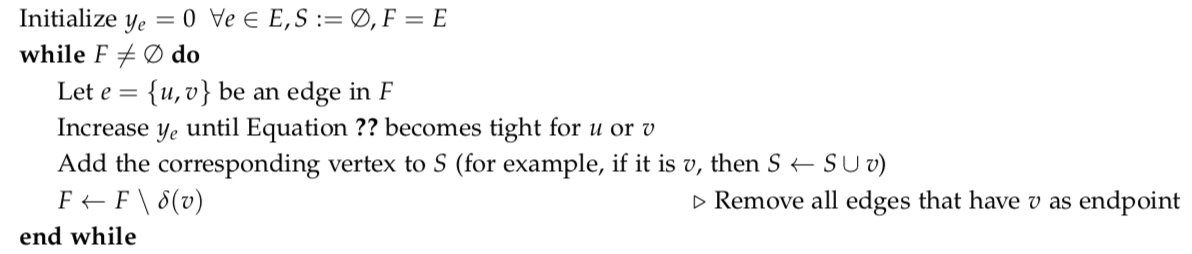
Advanced Algorithms - Vertex Cover

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In this report, I will study the vertex cover problem. 2-approximation via Maximum Matching and Greedy algorithm and PrimalDual are implemented in order to compare their behavior. After studying the three approximation algorithms, I given the results of solution quality and runtimes.

Designing the primal-dual approximation algorithm for MVC requires both the primal and dual formulation of the problem. The primal of the LP-relaxation for Minimum Vertex Cover is given by:



Firstly, I test the dataset of frb30-15-mis, frb35-17-mis, frb40-19-mis. For each algorithm is tested ten times for each of the tested datasets. The runtimes are recorded for each execution.

The table of the results:

（The X-axis is the algorithm, and the Y-axis is time.）

The detailed test results are as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MVC | Vertices | EC | algorithm | coverSize | Time |
| 720 | 760 | 41619 | Greedy | 731 | 0.756 |
| 720 | 760 | 41619 | Greedy | 731 | 0.752 |
| 720 | 760 | 41619 | Greedy | 731 | 0.75 |
| 720 | 760 | 41619 | Greedy | 731 | 0.75 |
| 720 | 760 | 41619 | Greedy | 731 | 0.748 |
| 720 | 760 | 41619 | Greedy | 731 | 0.751 |
| 720 | 760 | 41619 | Greedy | 731 | 0.75 |
| 720 | 760 | 41619 | Greedy | 731 | 0.746 |
| 720 | 760 | 41619 | Greedy | 731 | 0.749 |
| 720 | 760 | 41619 | Greedy | 731 | 0.751 |
| 720 | 760 | 41619 | Matching | 754 | 0.118 |
| 720 | 760 | 41619 | Matching | 754 | 0.121 |
| 720 | 760 | 41619 | Matching | 752 | 0.119 |
| 720 | 760 | 41619 | Matching | 752 | 0.12 |
| 720 | 760 | 41619 | Matching | 756 | 0.122 |
| 720 | 760 | 41619 | Matching | 754 | 0.12 |
| 720 | 760 | 41619 | Matching | 750 | 0.122 |
| 720 | 760 | 41619 | Matching | 752 | 0.119 |
| 720 | 760 | 41619 | Matching | 752 | 0.118 |
| 720 | 760 | 41619 | Matching | 752 | 0.121 |
| 720 | 760 | 41619 | PrimalDual | 756 | 0.121 |
| 720 | 760 | 41619 | PrimalDual | 754 | 0.123 |
| 720 | 760 | 41619 | PrimalDual | 754 | 0.121 |
| 720 | 760 | 41619 | PrimalDual | 754 | 0.118 |
| 720 | 760 | 41619 | PrimalDual | 754 | 0.117 |
| 720 | 760 | 41619 | PrimalDual | 756 | 0.122 |
| 720 | 760 | 41619 | PrimalDual | 756 | 0.122 |
| 720 | 760 | 41619 | PrimalDual | 756 | 0.122 |
| 720 | 760 | 41619 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41619 | PrimalDual | 752 | 0.121 |
| 720 | 760 | 41263 | Greedy | 731 | 0.748 |
| 720 | 760 | 41263 | Greedy | 731 | 0.751 |
| 720 | 760 | 41263 | Greedy | 731 | 0.749 |
| 720 | 760 | 41263 | Greedy | 731 | 0.748 |
| 720 | 760 | 41263 | Greedy | 731 | 0.745 |
| 720 | 760 | 41263 | Greedy | 731 | 0.748 |
| 720 | 760 | 41263 | Greedy | 731 | 0.755 |
| 720 | 760 | 41263 | Greedy | 731 | 0.745 |
| 720 | 760 | 41263 | Greedy | 731 | 0.748 |
| 720 | 760 | 41263 | Greedy | 731 | 0.748 |
| 720 | 760 | 41263 | Matching | 754 | 0.118 |
| 720 | 760 | 41263 | Matching | 750 | 0.118 |
| 720 | 760 | 41263 | Matching | 756 | 0.125 |
| 720 | 760 | 41263 | Matching | 752 | 0.117 |
| 720 | 760 | 41263 | Matching | 752 | 0.12 |
| 720 | 760 | 41263 | Matching | 756 | 0.124 |
| 720 | 760 | 41263 | Matching | 752 | 0.122 |
| 720 | 760 | 41263 | Matching | 754 | 0.123 |
| 720 | 760 | 41263 | Matching | 756 | 0.121 |
| 720 | 760 | 41263 | Matching | 754 | 0.123 |
| 720 | 760 | 41263 | PrimalDual | 754 | 0.121 |
| 720 | 760 | 41263 | PrimalDual | 754 | 0.122 |
| 720 | 760 | 41263 | PrimalDual | 756 | 0.122 |
| 720 | 760 | 41263 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41263 | PrimalDual | 752 | 0.121 |
| 720 | 760 | 41263 | PrimalDual | 754 | 0.122 |
| 720 | 760 | 41263 | PrimalDual | 754 | 0.119 |
| 720 | 760 | 41263 | PrimalDual | 750 | 0.119 |
| 720 | 760 | 41263 | PrimalDual | 752 | 0.123 |
| 720 | 760 | 41263 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41314 | Greedy | 738 | 0.745 |
| 720 | 760 | 41314 | Greedy | 738 | 0.743 |
| 720 | 760 | 41314 | Greedy | 738 | 0.746 |
| 720 | 760 | 41314 | Greedy | 738 | 0.746 |
| 720 | 760 | 41314 | Greedy | 738 | 0.748 |
| 720 | 760 | 41314 | Greedy | 738 | 0.745 |
| 720 | 760 | 41314 | Greedy | 738 | 0.745 |
| 720 | 760 | 41314 | Greedy | 738 | 0.741 |
| 720 | 760 | 41314 | Greedy | 738 | 0.742 |
| 720 | 760 | 41314 | Greedy | 738 | 0.747 |
| 720 | 760 | 41314 | Matching | 756 | 0.12 |
| 720 | 760 | 41314 | Matching | 756 | 0.125 |
| 720 | 760 | 41314 | Matching | 754 | 0.122 |
| 720 | 760 | 41314 | Matching | 752 | 0.123 |
| 720 | 760 | 41314 | Matching | 756 | 0.121 |
| 720 | 760 | 41314 | Matching | 758 | 0.119 |
| 720 | 760 | 41314 | Matching | 752 | 0.12 |
| 720 | 760 | 41314 | Matching | 754 | 0.121 |
| 720 | 760 | 41314 | Matching | 754 | 0.118 |
| 720 | 760 | 41314 | Matching | 752 | 0.123 |
| 720 | 760 | 41314 | PrimalDual | 754 | 0.121 |
| 720 | 760 | 41314 | PrimalDual | 750 | 0.119 |
| 720 | 760 | 41314 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41314 | PrimalDual | 752 | 0.12 |
| 720 | 760 | 41314 | PrimalDual | 756 | 0.126 |
| 720 | 760 | 41314 | PrimalDual | 756 | 0.121 |
| 720 | 760 | 41314 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41314 | PrimalDual | 756 | 0.124 |
| 720 | 760 | 41314 | PrimalDual | 750 | 0.12 |
| 720 | 760 | 41314 | PrimalDual | 754 | 0.122 |
| 720 | 760 | 41605 | Greedy | 733 | 0.751 |
| 720 | 760 | 41605 | Greedy | 733 | 0.758 |
| 720 | 760 | 41605 | Greedy | 733 | 0.755 |
| 720 | 760 | 41605 | Greedy | 733 | 0.754 |
| 720 | 760 | 41605 | Greedy | 733 | 0.752 |
| 720 | 760 | 41605 | Greedy | 733 | 0.753 |
| 720 | 760 | 41605 | Greedy | 733 | 0.751 |
| 720 | 760 | 41605 | Greedy | 733 | 0.753 |
| 720 | 760 | 41605 | Greedy | 733 | 0.752 |
| 720 | 760 | 41605 | Greedy | 733 | 0.753 |
| 720 | 760 | 41605 | Matching | 756 | 0.12 |
| 720 | 760 | 41605 | Matching | 750 | 0.117 |
| 720 | 760 | 41605 | Matching | 752 | 0.119 |
| 720 | 760 | 41605 | Matching | 756 | 0.121 |
| 720 | 760 | 41605 | Matching | 756 | 0.122 |
| 720 | 760 | 41605 | Matching | 754 | 0.119 |
| 720 | 760 | 41605 | Matching | 754 | 0.122 |
| 720 | 760 | 41605 | Matching | 750 | 0.119 |
| 720 | 760 | 41605 | Matching | 756 | 0.117 |
| 720 | 760 | 41605 | Matching | 754 | 0.122 |
| 720 | 760 | 41605 | PrimalDual | 754 | 0.123 |
| 720 | 760 | 41605 | PrimalDual | 752 | 0.121 |
| 720 | 760 | 41605 | PrimalDual | 756 | 0.119 |
| 720 | 760 | 41605 | PrimalDual | 750 | 0.12 |
| 720 | 760 | 41605 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41605 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41605 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41605 | PrimalDual | 750 | 0.125 |
| 720 | 760 | 41605 | PrimalDual | 756 | 0.122 |
| 720 | 760 | 41605 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41095 | Greedy | 729 | 0.764 |
| 720 | 760 | 41095 | Greedy | 729 | 0.756 |
| 720 | 760 | 41095 | Greedy | 729 | 0.759 |
| 720 | 760 | 41095 | Greedy | 729 | 0.761 |
| 720 | 760 | 41095 | Greedy | 729 | 0.766 |
| 720 | 760 | 41095 | Greedy | 729 | 0.761 |
| 720 | 760 | 41095 | Greedy | 729 | 0.764 |
| 720 | 760 | 41095 | Greedy | 729 | 0.767 |
| 720 | 760 | 41095 | Greedy | 729 | 0.778 |
| 720 | 760 | 41095 | Greedy | 729 | 0.77 |
| 720 | 760 | 41095 | Matching | 754 | 0.12 |
| 720 | 760 | 41095 | Matching | 754 | 0.119 |
| 720 | 760 | 41095 | Matching | 756 | 0.124 |
| 720 | 760 | 41095 | Matching | 754 | 0.12 |
| 720 | 760 | 41095 | Matching | 750 | 0.122 |
| 720 | 760 | 41095 | Matching | 752 | 0.122 |
| 720 | 760 | 41095 | Matching | 754 | 0.124 |
| 720 | 760 | 41095 | Matching | 752 | 0.126 |
| 720 | 760 | 41095 | Matching | 756 | 0.123 |
| 720 | 760 | 41095 | Matching | 752 | 0.12 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.119 |
| 720 | 760 | 41095 | PrimalDual | 754 | 0.122 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.12 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.122 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.123 |
| 720 | 760 | 41095 | PrimalDual | 754 | 0.121 |
| 720 | 760 | 41095 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41095 | PrimalDual | 754 | 0.12 |
| 720 | 760 | 41095 | PrimalDual | 752 | 0.12 |
| 420 | 450 | 17794 | Greedy | 428 | 0.169 |
| 420 | 450 | 17794 | Greedy | 428 | 0.171 |
| 420 | 450 | 17794 | Greedy | 428 | 0.175 |
| 420 | 450 | 17794 | Greedy | 428 | 0.17 |
| 420 | 450 | 17794 | Greedy | 428 | 0.172 |
| 420 | 450 | 17794 | Greedy | 428 | 0.171 |
| 420 | 450 | 17794 | Greedy | 428 | 0.173 |
| 420 | 450 | 17794 | Greedy | 428 | 0.171 |
| 420 | 450 | 17794 | Greedy | 428 | 0.172 |
| 420 | 450 | 17794 | Greedy | 428 | 0.169 |
| 420 | 450 | 17794 | Matching | 442 | 0.029 |
| 420 | 450 | 17794 | Matching | 446 | 0.026 |
| 420 | 450 | 17794 | Matching | 446 | 0.027 |
| 420 | 450 | 17794 | Matching | 444 | 0.027 |
| 420 | 450 | 17794 | Matching | 448 | 0.027 |
| 420 | 450 | 17794 | Matching | 446 | 0.028 |
| 420 | 450 | 17794 | Matching | 444 | 0.027 |
| 420 | 450 | 17794 | Matching | 442 | 0.027 |
| 420 | 450 | 17794 | Matching | 444 | 0.028 |
| 420 | 450 | 17794 | Matching | 446 | 0.027 |
| 420 | 450 | 17794 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17794 | PrimalDual | 442 | 0.026 |
| 420 | 450 | 17794 | PrimalDual | 442 | 0.027 |
| 420 | 450 | 17794 | PrimalDual | 446 | 0.025 |
| 420 | 450 | 17794 | PrimalDual | 444 | 0.027 |
| 420 | 450 | 17794 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17794 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17794 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17794 | PrimalDual | 448 | 0.026 |
| 420 | 450 | 17794 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17809 | Greedy | 428 | 0.172 |
| 420 | 450 | 17809 | Greedy | 428 | 0.173 |
| 420 | 450 | 17809 | Greedy | 428 | 0.168 |
| 420 | 450 | 17809 | Greedy | 428 | 0.168 |
| 420 | 450 | 17809 | Greedy | 428 | 0.168 |
| 420 | 450 | 17809 | Greedy | 428 | 0.166 |
| 420 | 450 | 17809 | Greedy | 428 | 0.165 |
| 420 | 450 | 17809 | Greedy | 428 | 0.164 |
| 420 | 450 | 17809 | Greedy | 428 | 0.168 |
| 420 | 450 | 17809 | Greedy | 428 | 0.167 |
| 420 | 450 | 17809 | Matching | 444 | 0.027 |
| 420 | 450 | 17809 | Matching | 442 | 0.025 |
| 420 | 450 | 17809 | Matching | 446 | 0.027 |
| 420 | 450 | 17809 | Matching | 444 | 0.027 |
| 420 | 450 | 17809 | Matching | 442 | 0.027 |
| 420 | 450 | 17809 | Matching | 440 | 0.026 |
| 420 | 450 | 17809 | Matching | 444 | 0.025 |
| 420 | 450 | 17809 | Matching | 446 | 0.027 |
| 420 | 450 | 17809 | Matching | 448 | 0.027 |
| 420 | 450 | 17809 | Matching | 446 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 442 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 440 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 448 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 440 | 0.027 |
| 420 | 450 | 17809 | PrimalDual | 442 | 0.027 |
| 420 | 450 | 17809 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 448 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 448 | 0.027 |
| 420 | 450 | 17809 | PrimalDual | 446 | 0.026 |
| 420 | 450 | 17809 | PrimalDual | 442 | 0.025 |
| 420 | 450 | 17827 | Greedy | 428 | 0.165 |
| 420 | 450 | 17827 | Greedy | 428 | 0.164 |
| 420 | 450 | 17827 | Greedy | 428 | 0.166 |
| 420 | 450 | 17827 | Greedy | 428 | 0.174 |
| 420 | 450 | 17827 | Greedy | 428 | 0.168 |
| 420 | 450 | 17827 | Greedy | 428 | 0.165 |
| 420 | 450 | 17827 | Greedy | 428 | 0.165 |
| 420 | 450 | 17827 | Greedy | 428 | 0.166 |
| 420 | 450 | 17827 | Greedy | 428 | 0.164 |
| 420 | 450 | 17827 | Greedy | 428 | 0.165 |
| 420 | 450 | 17827 | Matching | 446 | 0.026 |
| 420 | 450 | 17827 | Matching | 446 | 0.026 |
| 420 | 450 | 17827 | Matching | 446 | 0.025 |
| 420 | 450 | 17827 | Matching | 446 | 0.026 |
| 420 | 450 | 17827 | Matching | 442 | 0.026 |
| 420 | 450 | 17827 | Matching | 446 | 0.025 |
| 420 | 450 | 17827 | Matching | 448 | 0.026 |
| 420 | 450 | 17827 | Matching | 442 | 0.026 |
| 420 | 450 | 17827 | Matching | 444 | 0.026 |
| 420 | 450 | 17827 | Matching | 444 | 0.025 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.026 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.026 |
| 420 | 450 | 17827 | PrimalDual | 448 | 0.025 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17827 | PrimalDual | 444 | 0.027 |
| 420 | 450 | 17827 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17827 | PrimalDual | 444 | 0.025 |
| 420 | 450 | 17827 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17874 | Greedy | 431 | 0.172 |
| 420 | 450 | 17874 | Greedy | 431 | 0.17 |
| 420 | 450 | 17874 | Greedy | 431 | 0.169 |
| 420 | 450 | 17874 | Greedy | 431 | 0.167 |
| 420 | 450 | 17874 | Greedy | 431 | 0.166 |
| 420 | 450 | 17874 | Greedy | 431 | 0.174 |
| 420 | 450 | 17874 | Greedy | 431 | 0.173 |
| 420 | 450 | 17874 | Greedy | 431 | 0.174 |
| 420 | 450 | 17874 | Greedy | 431 | 0.173 |
| 420 | 450 | 17874 | Greedy | 431 | 0.173 |
| 420 | 450 | 17874 | Matching | 444 | 0.027 |
| 420 | 450 | 17874 | Matching | 444 | 0.026 |
| 420 | 450 | 17874 | Matching | 446 | 0.027 |
| 420 | 450 | 17874 | Matching | 444 | 0.028 |
| 420 | 450 | 17874 | Matching | 446 | 0.027 |
| 420 | 450 | 17874 | Matching | 446 | 0.027 |
| 420 | 450 | 17874 | Matching | 446 | 0.027 |
| 420 | 450 | 17874 | Matching | 448 | 0.028 |
| 420 | 450 | 17874 | Matching | 446 | 0.028 |
| 420 | 450 | 17874 | Matching | 442 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17874 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17874 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 444 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 444 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 442 | 0.026 |
| 420 | 450 | 17874 | PrimalDual | 440 | 0.026 |
| 420 | 450 | 17874 | PrimalDual | 442 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 446 | 0.027 |
| 420 | 450 | 17874 | PrimalDual | 444 | 0.028 |
| 420 | 450 | 17831 | Greedy | 429 | 0.169 |
| 420 | 450 | 17831 | Greedy | 429 | 0.166 |
| 420 | 450 | 17831 | Greedy | 429 | 0.165 |
| 420 | 450 | 17831 | Greedy | 429 | 0.166 |
| 420 | 450 | 17831 | Greedy | 429 | 0.165 |
| 420 | 450 | 17831 | Greedy | 429 | 0.175 |
| 420 | 450 | 17831 | Greedy | 429 | 0.164 |
| 420 | 450 | 17831 | Greedy | 429 | 0.165 |
| 420 | 450 | 17831 | Greedy | 429 | 0.166 |
| 420 | 450 | 17831 | Greedy | 429 | 0.165 |
| 420 | 450 | 17831 | Matching | 446 | 0.026 |
| 420 | 450 | 17831 | Matching | 444 | 0.025 |
| 420 | 450 | 17831 | Matching | 442 | 0.025 |
| 420 | 450 | 17831 | Matching | 446 | 0.025 |
| 420 | 450 | 17831 | Matching | 446 | 0.026 |
| 420 | 450 | 17831 | Matching | 446 | 0.026 |
| 420 | 450 | 17831 | Matching | 446 | 0.026 |
| 420 | 450 | 17831 | Matching | 448 | 0.025 |
| 420 | 450 | 17831 | Matching | 444 | 0.027 |
| 420 | 450 | 17831 | Matching | 442 | 0.025 |
| 420 | 450 | 17831 | PrimalDual | 446 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 446 | 0.025 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 448 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.025 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.026 |
| 420 | 450 | 17831 | PrimalDual | 444 | 0.027 |
| 420 | 450 | 17831 | PrimalDual | 442 | 0.025 |
| 560 | 595 | 27856 | Greedy | 571 | 0.367 |
| 560 | 595 | 27856 | Greedy | 571 | 0.377 |
| 560 | 595 | 27856 | Greedy | 571 | 0.367 |
| 560 | 595 | 27856 | Greedy | 571 | 0.367 |
| 560 | 595 | 27856 | Greedy | 571 | 0.379 |
| 560 | 595 | 27856 | Greedy | 571 | 0.369 |
| 560 | 595 | 27856 | Greedy | 571 | 0.372 |
| 560 | 595 | 27856 | Greedy | 571 | 0.368 |
| 560 | 595 | 27856 | Greedy | 571 | 0.367 |
| 560 | 595 | 27856 | Greedy | 571 | 0.367 |
| 560 | 595 | 27856 | Matching | 586 | 0.06 |
| 560 | 595 | 27856 | Matching | 588 | 0.059 |
| 560 | 595 | 27856 | Matching | 586 | 0.06 |
| 560 | 595 | 27856 | Matching | 592 | 0.059 |
| 560 | 595 | 27856 | Matching | 588 | 0.06 |
| 560 | 595 | 27856 | Matching | 588 | 0.059 |
| 560 | 595 | 27856 | Matching | 594 | 0.06 |
| 560 | 595 | 27856 | Matching | 590 | 0.059 |
| 560 | 595 | 27856 | Matching | 592 | 0.059 |
| 560 | 595 | 27856 | Matching | 590 | 0.06 |
| 560 | 595 | 27856 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27856 | PrimalDual | 588 | 0.06 |
| 560 | 595 | 27856 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27856 | PrimalDual | 586 | 0.059 |
| 560 | 595 | 27856 | PrimalDual | 590 | 0.061 |
| 560 | 595 | 27856 | PrimalDual | 588 | 0.059 |
| 560 | 595 | 27856 | PrimalDual | 586 | 0.059 |
| 560 | 595 | 27856 | PrimalDual | 590 | 0.059 |
| 560 | 595 | 27856 | PrimalDual | 590 | 0.061 |
| 560 | 595 | 27856 | PrimalDual | 590 | 0.059 |
| 560 | 595 | 28143 | Greedy | 571 | 0.368 |
| 560 | 595 | 28143 | Greedy | 571 | 0.368 |
| 560 | 595 | 28143 | Greedy | 571 | 0.368 |
| 560 | 595 | 28143 | Greedy | 571 | 0.369 |
| 560 | 595 | 28143 | Greedy | 571 | 0.374 |
| 560 | 595 | 28143 | Greedy | 571 | 0.37 |
| 560 | 595 | 28143 | Greedy | 571 | 0.367 |
| 560 | 595 | 28143 | Greedy | 571 | 0.368 |
| 560 | 595 | 28143 | Greedy | 571 | 0.369 |
| 560 | 595 | 28143 | Greedy | 571 | 0.37 |
| 560 | 595 | 28143 | Matching | 588 | 0.06 |
| 560 | 595 | 28143 | Matching | 592 | 0.059 |
| 560 | 595 | 28143 | Matching | 592 | 0.06 |
| 560 | 595 | 28143 | Matching | 586 | 0.058 |
| 560 | 595 | 28143 | Matching | 592 | 0.06 |
| 560 | 595 | 28143 | Matching | 590 | 0.059 |
| 560 | 595 | 28143 | Matching | 590 | 0.059 |
| 560 | 595 | 28143 | Matching | 590 | 0.058 |
| 560 | 595 | 28143 | Matching | 590 | 0.057 |
| 560 | 595 | 28143 | Matching | 592 | 0.06 |
| 560 | 595 | 28143 | PrimalDual | 588 | 0.057 |
| 560 | 595 | 28143 | PrimalDual | 590 | 0.06 |
| 560 | 595 | 28143 | PrimalDual | 592 | 0.059 |
| 560 | 595 | 28143 | PrimalDual | 594 | 0.059 |
| 560 | 595 | 28143 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 28143 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 28143 | PrimalDual | 590 | 0.06 |
| 560 | 595 | 28143 | PrimalDual | 592 | 0.059 |
| 560 | 595 | 28143 | PrimalDual | 588 | 0.06 |
| 560 | 595 | 28143 | PrimalDual | 586 | 0.058 |
| 560 | 595 | 27842 | Greedy | 571 | 0.375 |
| 560 | 595 | 27842 | Greedy | 571 | 0.369 |
| 560 | 595 | 27842 | Greedy | 571 | 0.368 |
| 560 | 595 | 27842 | Greedy | 571 | 0.378 |
| 560 | 595 | 27842 | Greedy | 571 | 0.367 |
| 560 | 595 | 27842 | Greedy | 571 | 0.368 |
| 560 | 595 | 27842 | Greedy | 571 | 0.367 |
| 560 | 595 | 27842 | Greedy | 571 | 0.368 |
| 560 | 595 | 27842 | Greedy | 571 | 0.37 |
| 560 | 595 | 27842 | Greedy | 571 | 0.368 |
| 560 | 595 | 27842 | Matching | 592 | 0.059 |
| 560 | 595 | 27842 | Matching | 588 | 0.057 |
| 560 | 595 | 27842 | Matching | 592 | 0.059 |
| 560 | 595 | 27842 | Matching | 586 | 0.057 |
| 560 | 595 | 27842 | Matching | 588 | 0.059 |
| 560 | 595 | 27842 | Matching | 588 | 0.059 |
| 560 | 595 | 27842 | Matching | 590 | 0.059 |
| 560 | 595 | 27842 | Matching | 590 | 0.06 |
| 560 | 595 | 27842 | Matching | 586 | 0.06 |
| 560 | 595 | 27842 | Matching | 584 | 0.06 |
| 560 | 595 | 27842 | PrimalDual | 590 | 0.057 |
| 560 | 595 | 27842 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27842 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27842 | PrimalDual | 584 | 0.059 |
| 560 | 595 | 27842 | PrimalDual | 588 | 0.06 |
| 560 | 595 | 27842 | PrimalDual | 588 | 0.061 |
| 560 | 595 | 27842 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27842 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27842 | PrimalDual | 592 | 0.059 |
| 560 | 595 | 27842 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27931 | Greedy | 572 | 0.367 |
| 560 | 595 | 27931 | Greedy | 572 | 0.365 |
| 560 | 595 | 27931 | Greedy | 572 | 0.373 |
| 560 | 595 | 27931 | Greedy | 572 | 0.366 |
| 560 | 595 | 27931 | Greedy | 572 | 0.366 |
| 560 | 595 | 27931 | Greedy | 572 | 0.366 |
| 560 | 595 | 27931 | Greedy | 572 | 0.366 |
| 560 | 595 | 27931 | Greedy | 572 | 0.37 |
| 560 | 595 | 27931 | Greedy | 572 | 0.366 |
| 560 | 595 | 27931 | Greedy | 572 | 0.365 |
| 560 | 595 | 27931 | Matching | 590 | 0.058 |
| 560 | 595 | 27931 | Matching | 588 | 0.057 |
| 560 | 595 | 27931 | Matching | 586 | 0.056 |
| 560 | 595 | 27931 | Matching | 588 | 0.058 |
| 560 | 595 | 27931 | Matching | 590 | 0.058 |
| 560 | 595 | 27931 | Matching | 590 | 0.057 |
| 560 | 595 | 27931 | Matching | 590 | 0.059 |
| 560 | 595 | 27931 | Matching | 588 | 0.058 |
| 560 | 595 | 27931 | Matching | 590 | 0.06 |
| 560 | 595 | 27931 | Matching | 586 | 0.057 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.059 |
| 560 | 595 | 27931 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.057 |
| 560 | 595 | 27931 | PrimalDual | 586 | 0.056 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.06 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.06 |
| 560 | 595 | 27931 | PrimalDual | 590 | 0.057 |
| 560 | 595 | 27931 | PrimalDual | 588 | 0.058 |
| 560 | 595 | 27931 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27847 | Greedy | 572 | 0.373 |
| 560 | 595 | 27847 | Greedy | 572 | 0.37 |
| 560 | 595 | 27847 | Greedy | 572 | 0.369 |
| 560 | 595 | 27847 | Greedy | 572 | 0.373 |
| 560 | 595 | 27847 | Greedy | 572 | 0.371 |
| 560 | 595 | 27847 | Greedy | 572 | 0.372 |
| 560 | 595 | 27847 | Greedy | 572 | 0.373 |
| 560 | 595 | 27847 | Greedy | 572 | 0.373 |
| 560 | 595 | 27847 | Greedy | 572 | 0.371 |
| 560 | 595 | 27847 | Greedy | 572 | 0.372 |
| 560 | 595 | 27847 | Matching | 590 | 0.058 |
| 560 | 595 | 27847 | Matching | 588 | 0.059 |
| 560 | 595 | 27847 | Matching | 586 | 0.057 |
| 560 | 595 | 27847 | Matching | 590 | 0.059 |
| 560 | 595 | 27847 | Matching | 590 | 0.06 |
| 560 | 595 | 27847 | Matching | 588 | 0.058 |
| 560 | 595 | 27847 | Matching | 590 | 0.06 |
| 560 | 595 | 27847 | Matching | 592 | 0.06 |
| 560 | 595 | 27847 | Matching | 590 | 0.059 |
| 560 | 595 | 27847 | Matching | 588 | 0.059 |
| 560 | 595 | 27847 | PrimalDual | 592 | 0.059 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27847 | PrimalDual | 592 | 0.059 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.06 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.061 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.059 |
| 560 | 595 | 27847 | PrimalDual | 590 | 0.058 |
| 560 | 595 | 27847 | PrimalDual | 588 | 0.057 |
| 560 | 595 | 27847 | PrimalDual | 588 | 0.058 |

To consider the runtime, the 2-approximation via Maximum Matching and PrimalDual are the best. Then is the Greedy algorithm. However, considering performance, the greedy algorithm is better than others algorithms. Because the performance ratio of the 2-approximation via Maximum Matching and PrimalDual are almost similar. But the number of performance ratio of them are higher than the performance ratio of Greedy algorithm.

The conclusion is that the greedy algorithm performs better than other algorithms at the cost of some extra running time.