Report on Assignment-3

Solving the Max-cut problem by GRASP

Sumaiya Saeha
Student ID: 1905033
Subsection: A2
Date: 18-Aug-2023

1 Overview

1.1 GRASP

GRASP is a randomized multistart iterative method. Generally speaking, GRASP is a randomized heuristic having two phases: a construction phase and a local search phase.

Main Characteristics and Steps:

Construction Phase: The construction phase adds one element at a time to a set that ends up with a representation of a feasible solution. At each iteration, an element is randomly selected from a restricted candidate list, whose elements are among the best ordered, according to some greedy function. We used a semi-greedy variant of the greedy algorithm for our assignment.

Local Search Phase: After constructing an initial solution, the algorithm enters a local search phase. Here, the solution is further improved by applying local search techniques, which involve making small modifications to the current solution while maintaining feasibility. Local search helps in fine-tuning the solution and exploring the local search space around the current solution.

Adaptation and Iteration: GRASP operates in an iterative manner. After each iteration, the algorithm adapts its construction and search parameters based on the quality of the solutions obtained so far. This adaptation helps in focusing on promising areas of the search space and adjusting the balance between exploration and exploitation.

Stopping Criteria: GRASP terminates when a predefined stopping criterion is met, such as a maximum number of iterations, convergence to a satisfactory solution, or the exhaustion of computational resources.

1.2 Simple Greedy Algorithm

A simple greedy heuristic like below is used in this assignment: The algorithm starts by placing one vertex to each partition X and Y (initially both are empty) such that each contains an endpoint of a largest-weight edge. The remaining $|V| - 2$ vertices are examined one by one to find out the placement of which vertex to either one of the two partitions maximizes the weight of the partial cut constructed so far. At each iteration, one vertex is placed to either set X or set Y.

1.3 Simple Randomized Algorithm

For comparison with the simple greedy algorithm described earlier, we used a simple randomized algorithm like below: Initially, both partitions X and Y are empty. For each vertex vV, place v in partition X or partition Y with uniform randomness, i.e., with probability 1/2. The procedure terminates when all vertices are placed either in X or Y.

2 Tables

See the statistics in tabel 1 and 2

Problem			Constructive algorithm			Local search		GRASP		Known best solution or upper bound
Name	$\|V\|$ or n	$\|E\|$ or m	Simple Randomized or Randomized 1	Simple Greedy or Greedy-1	Semi greedy-1	Simple local or local-1		GRASP-1		
						No. of iterations	Best value	No. of iterations	Best value	
g1	800	19176	9598	11346	11142	7	11375	100	11463	12078
g2	800	19176	9597	11204	11144	7	11379	100	11466	12084
g3	800	19176	9611	11254	11140	6	11374	100	11521	12077
g4	800	19176	9557	11229	11147	7	11392	100	11495	
g5	800	19176	9574	11277	11155	6	11380	100	11528	
g6	800	19176	111	1742	1629	7	1912	100	1997	
g7	800	19176	-20	1573	1668	7	1737	100	1815	
g8	800	19176	-53	1586	1473	7	1748	100	1841	
g9	800	19176	-71	1701	1512	7	1778	100	1893	
g10	800	19176	-114	1556	1463	7	1740	100	1855	
g11	800	1600	14	484	442	2	462	100	508	627
g12	800	1600	-5	480	429	2	451	100	498	621
g13	800	1600	26	498	450	2	474	100	522	645
g14	800	4694	2355	2917	2931	2	2965	100	2994	3187
g15	800	4661	2324	2883	2913	2	2947	100	2977	3169
g16	800	4672	2330	2895	2918	2	2952	100	2975	3172
g17	800	4667	2331	2925	2916	2	2950	100	2975	
g18	800	4694	37	846	752	3	848	100	905	
g19	800	4661	-50	756	672	3	765	100	830	
g20	800	4672	-31	813	708	3	799	100	870	
g21	800	4667	-37	764	687	3	787	100	842	
g22	2000	19990	9997	12773	12676	6	12916	10	13034	14123
g23	2000	19990	10019	12827	12676	5	12904	10	13003	14129
g24	2000	19990	9999	12780	12703	5	12918	10	12989	14131
g25	2000	19990	9975	12752	12692	5	12915	10	12988	
g26	2000	19990	9953	12852	12699	6	12931	10	12977	
g27	2000	19990	-17	2694	2445	6	2839	10	2892	

Table 1: Statistics

Problem			Constructive algorithm			Local search		GRASP		Known best solution or upper bound
Name	$\|V\|$ or n	$\|E\|$ or m	Simple Randomized or Randomized 1	Simple Greedy or Greedy-1	Semi greedy-1	Simple local or local-1		GRASP-1		
						No. of iterations	Best value	No. of iterations	Best value	
g28	2000	19990	-57	2682	2526	6	2831	10	2942	
g29	2000	19990	61	2735	2521	6	2892	10	2989	
g30	2000	19990	63	2778	2617	5	2927	10	3003	
g31	2000	19990	-38	2699	2412	6	2799	10	2924	
g32	2000	4000	13	1226	1105	2	1153	10	1228	1560
g33	2000	4000	-22	1196	1031	3	1101	10	1196	1537
g34	2000	4000	-15	1210	1129	2	1171	10	1210	
g35	2000	11778	5884	7264	7353	2	7436	10	7454	
g36	2000	11766	5885	7294	7343	3	7422	10	7443	
g37	2000	11785	5871	7296	7340	3	7432	10	7467	
g38	2000	11779	5885	7298	7340	3	7432	10	7480	
g39	2000	11778	18	2026	1788	4	2032	10	2132	
g40	2000	11766	-36	2009	1734	4	2008	10	2138	
g41	2000	11766	-8	2058	1783	4	2036	50	2162	
g42	2000	11779	65	2115	1894	4	2128	50	2244	
g43	1000	9990	5009	6390	6314	5	6440	50	6503	7027
g44	1000	9990	5025	6428	6279	5	6427	50	6511	7022
g45	1000	9990	4979	6366	6292	5	6432	50	6505	7020
g46	1000	9990	5038	6362	6301	4	6427	50	6471	
g47	1000	9990	4993	6437	6315	4	6447	50	6538	
g48	3000	6000	3002	6000	6000	1	6000	10	6000	6000
g49	3000	6000	2999	6000	6000	1	6000	10	6000	6000
g50	3000	6000	2994	5880	5871	1	5871	10	5880	5988
g51	1000	5909	2957	3661	3688	2	3728	50	3763	
g52	1000	5916	2952	3653	3682	3	3729	50	3752	
g53	1000	5914	2929	3660	3684	2	3723	50	3749	
g54	1000	5916	2964	3656	3679	2	3722	50	3747	

Table 2: Statistics

3 Observation

Compared to the known best solutions in the benchmark data set, we got comparatively lower values from GRASP or greedy approaches. Simple randomized approach gives the worst value.

4 Used Website

1. RANDOMIZED HEURISTICS FOR THE MAX-CUT PROBLEM