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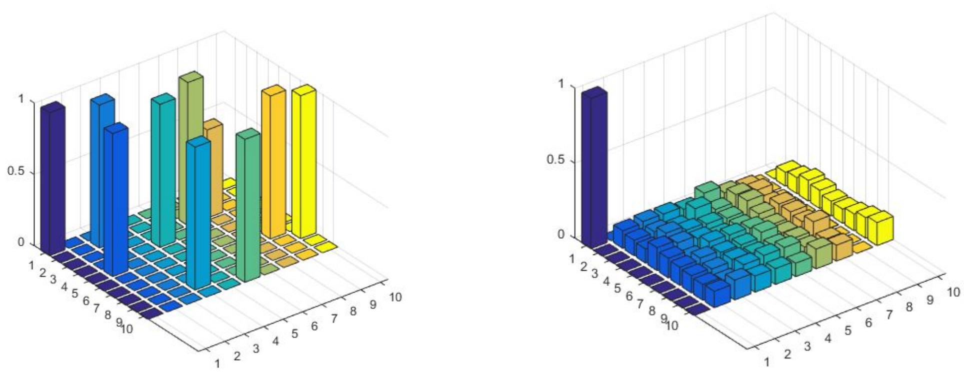
Problem Set 6

Unless otherwise noted, all experiments were performed with A=500, B=500, C=1500, D=1000 and the integral error term enabled.

Integral Error Term

As will be demonstrated in the Choice of Parameters section below, the network can be tuned to converge to legal solutions with better values of the A, B, C and D parameters without using the integral error term. However, with the integral error learn the network is forced to converge to a legal solution much faster, even in as little as 300 iterations.



The state of the network at 300 iterations with the integral error term (left) enabled and (right) disabled.

Aggregate Statistics

Running a batch of 100 of these networks for 300 iterations each yielded the following trip costs:

5.4977	6.1360,	5.5273,	6.1951,	6.2962,
6.5198	6.9531,	5.7866,	7.0093,	5.5152,
5.7389	6.3468,	6.2489,	6.4147,	6.2789,
5.6665	6.7722,	5.6421,	6.1970,	6.0406,
6.5561	6.7488,	5.4349,	6.8811,	7.0012,
5.9386	5.8416,	6.9144,	5.6127,	6.2822,
6.9569	6.1607,	5.3502,	7.1720,	5.8047,
5.9633,	5.1570,	6.2859,	5.4546,	8.0220,
5.5678,	6.4698,	6.8505,	6.4263,	5.8892,
6.2966,	6.1463,	5.5065,	6.1890,	5.8300,

6.2132,	5.7263,	7.4430,	5.3077,	6.6623,
6.5783,	6.4919,	6.5563,	5.2773,	5.8058,
5.7022,	6.7408,	5.1351,	6.6896,	5.1758,
6.2904,	5.0781,	5.8697,	6.2180,	6.8744,
6.5257,	6.2899,	6.5697,	5.5823,	5.9749,
6.1752,	6.2882,	5.5066,	5.5704,	5.5980,
5.9301,	5.4230,	6.4192,	6.1147,	6.4194,
6.5066,	6.5225,	6.8912,	6.2428,	7.4140,
5.2060,	7.1034,	5.7082,	5.5847,	6.4753,
4.6095,	7.2510,	6.3274,	6.0705,	6.8235,

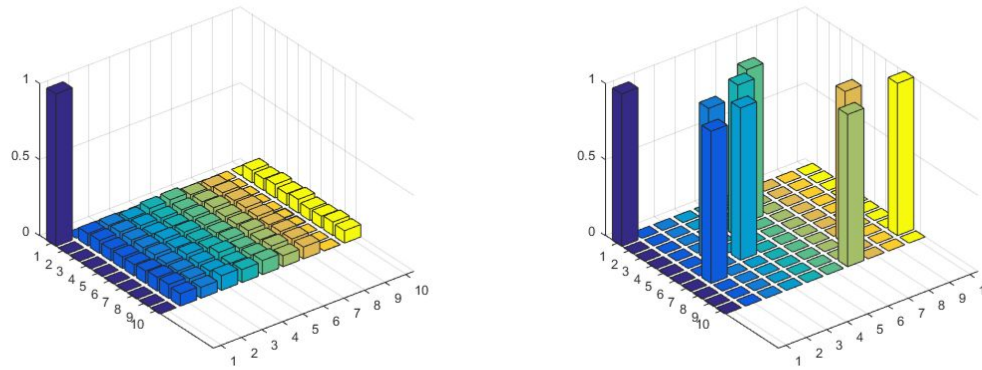
And from these are derived the following statistics, compared side-by-side with those of the exhaustive solution set:

	sampled	exhaustive
mean	6.1646	6.1484
std	.6056	0.6230
min	4.6095	3.7309
max	8.022	8.0657

As we can see, for all statistics the value obtained from the batch of 100 solutions is very close to that of the exhaustive solution set, to within one decimal place for the mean, standard deviation and max. It is of course to be expected that the min and max might differ more widely as these values are probabilistically sampled from the solution space without any smoothing, as opposed to the mean and standard deviation which are computed from the aggregate of the given solution set and thus less likely to vary between samples or as in this case between a sample and the entire solution set.

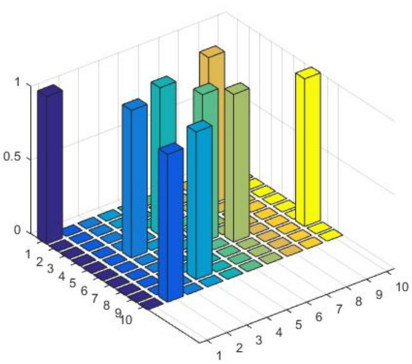
Choice of Parameters

With the default values of A,B,C and D and without the integral error term, the state of the network quickly converged to visiting no cities (except the first one which we manually force) and then took a very long time (approx. 2000 iterations) to come out of this state and reach something more akin to a legal solution, and even then cities were often missing:



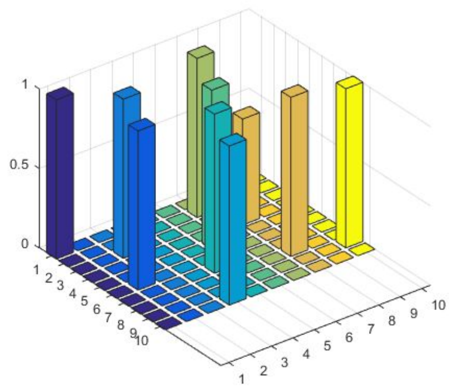
The state of the network for C=200 at (left) 300 iterations and (right) 2000 iterations. Notice that even at 2000 iterations, one city is missing.

This would be because the other constraints and cost minimization terms end up dominating the C term, which enforces that the total number of cities visited is equal to all 10 cities. Originally this coefficient was set at 200, but turning it up to 400 yielded faster near-convergence, albeit still not fully satisfying the problem constraint that each city must be visited.



The state of the network for C=400 at 1000 iterations. Notice one city is still missing.

Increasing C further seems to have no noticeable effect on this problem until around C=1500, at which the network is finally forced to converge to a legal solution after only 1000 iterations.



The state of the network for C=15000 at 1000 iterations. Notice all cities are finally accounted for and the network has converged to a legal solution.

It is important to note that although the above demonstrates that the network can converge without the integral error term to legal solutions with better tuned values for A,B,C, and D, this convergence is still slower than with the integral error term and more prone to illegal solutions. Thus, enabling the integral error term is likely the best strategy for guaranteeing legal convergence.