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Problem 2

1. The position of at least 1 leg must be changed, both new legs will move in the same direction (if both move)
2. All the muscles between two activated legs are default to be 0

Problem 3

1. The number of time segments that will change is determined by the temperature
2. Amount of legs that change will depend on temperature
3. Each muscle that is not between legs can change, the possibility is directly proportional to temperature

Problem 7

The program uses simulated annealing first, during which some solutions will be marked as “waitlist”. After the simulated annealing, each “waitlist” solution will go through steepest ascent.

**Base case**:

iterations: 100

temperature decreasing rate: 0.99

permute: probability of changes on muscle: temperature/100

waitlist: when 4 denied moves in a row, or when accepting a big failure (drop by more than 200),

or the best answer of simulated annealing, AND no less than 0.6 of the best score

best score: 445.6 (simulated annealing), 1106.6 (after steepest ascent).

This base case gave very solid results, as we were extremely happy with 1106, and showed that we at least had a good jumping off point. The addition of steepest ascent hill climbing after the simulated annealing also evidently played a huge role, but the success of this shows how effective the simulated annealing was in this case at giving “waitlist” points to then use steepest ascent from.

**Variation 1**:

iterations: 500

temperature decreasing rate: 0.99

permute: probability of changes on muscle: temperature/100

waitlist: when 4 denied moves in a row, or when accepting a big failure (drop by more than 200),

or the best score of simulated annealing, AND no less than 0.6 of the best score

best score: 705.4 (simulated annealing), 1070 (after steepest ascent)

This variation is applied because the score we get from the simulated annealing is typically not very good, so we try to increase the amount of iteration so that it spends more time on the final “hill”. Allowing for more iterations at a lower temperature should theoretically do something similar to the steepest ascent climb, but with there still being the slight chance of a bad move being accepted. As shown this was effective at providing a higher score than the base case for the simulated annealing, but ended up not giving significantly improved results after the steepest ascent.

**Variation 2:**

iterations: 500

temperature decreasing rate: 0.99

permute: probability of changes on muscle: (temperature+200)/600

waitlist: when 4 denies in a row, or when accepting a big failure (drop by more than 200),

or the best score of simulated annealing, AND no less than 0.6 of the best score

best score: 761.2 (simulated annealing), 1076 (after steepest ascent)

This variation is applied because, as the temperature cools down, the probability of changes on muscle approaches 0; therefore, the formula of permute is modifies and thus the probability of muscle change will range between 50% to 30%. This was done to give more variation to the actual simulated annealing answers, and though we expected this to result in a better steepest ascent score, and there would be much more variety in the “waitlisted” answers, it really didn’t allow for any improvement in the end.

**Variation 3:**

iterations: 500

temperature decreasing rate: 0.99

permute: probability of changes on muscle: (temperature+200)/600

waitlist: when 4 denies in a row, or when accepting a big failure (drop by more than 200),

or the best score of simulated annealing

best score: 703.2 (simulated annealing), 1202.3 (after steepest ascent)

Although I found a positive correlation between simulated annealing score and the final score, that correlation does not mean certainty; therefore, I removed one restriction from the waitlist, which prevent lower scores to be promoted through the steepest ascent. However, this is achieved by the cost of longer running time. This change allowed for significantly more “waitlisted” answers to be tested with steepest ascent, and therefore gave better results than all other variations in the end.

In conclusion, although the variation 3 produce the best outcome, other scores yielded by variation 3 are not significantly higher than other 2 variations. The increase on the number of iterations significantly increase the score from simulated annealing, while the final score, which has been promoted by steepest ascent, does not significantly change.

Best Answer:

1202.3

0 0 0 1 1

1 1 0 0 0

0 0 0 1 1

1 1 0 0 0

0 0 0 1 1

1 1 0 0 0

0 0 0 1 1

1 1 0 0 0

0 0 0 1 1

1 1 0 0 0

0 100 100 0

0 0 0 100

100 100 100 0

100 0 0 100

100 100 100 0

100 0 0 0

0 100 100 100

0 0 0 100

100 100 100 0

0 0 0 0