ME617 - Homework 2

Rothanak Chan, Cong Huang

1. The way the candidates are represented change between the search methods depending on extra data that they need. What they will always include though is a name/mfg. plan that lists in a string the solution and a input rotational velocity. The name can be read through as it is a string and it will tell you which gear to use and how to mate it with the previous gear (parallel or mate). Within the class, there is also the computed rotational velocity. In UCS and A\*, the number of teeth in the gearbox is also tracked.
2. We use the rotational velocity of the parent, the gear teeth from the parent, and compute a new rotational velocity based on the new gear and joining operation chosen. The new rotational velocity is then used to compute the error based on the given input and output rotational velocity. If the error is less or equal to 2.5%, then the goal is met.

gears = [11,23,31,47,59,71,83,97,109,127]

1. Consider the string as an order of operations, the number representing which gear rom the list it is. M is mate the gears; P is place them in parallel.
   1. The solution for problem 1 is 9M9P8M9P8M9P8M9P4M2 (BF = 5.85)
   2. The solution for problem 2 is 9M9P8M9P8M9M9M7P3M4 (BF = 8.1)
   3. The solution for problem 3 is 9M9P8M9P8M9M7M5P2M0 (BF = 8.46)
   4. The solution for problem 4 is 9M9P8M9P8M9P8M9P0M2 (BF = 5.61)
   5. Does not reach in a timely manner (out of mem)
   6. Does not reach in a timely manner (out of mem)
   7. Discussion: The large and small values will require a lot of pairing of gears that output a ratio that increments towards them. Since DPS looks at very similar gears at first due to the way the tree is structures, this will take a long time to discover anything with high or low output rotational velocities. (High meaning far away from 0 in either direction, low meaning closer to 0)
2. 1. Found the smallest set of gears in group A: 5M5M3M4
   2. Found the smallest set of gears in group B: 2M3P6M5
   3. Found the smallest set of gears in group C: 1M1M0P9M7M5
   4. Found the smallest set of gears in group D: 0M0M2M4
   5. Found the smallest set of gears in group E: 3M3M1M0P4M2M0
   6. Found the smallest set of gears in group F: 0M1M3P0M2M4
   7. Discussion: This method was able to find much smaller/shorter solutions than DFS because it searches by “levels” the levels here are number of gears, so it lends itself well to finding a short solution more quickly.

The amount of sets of gears in layer 1: 10, average branching factor is 10.

The amount of sets of gears in layer 2: 27, average branching factor is 5.20.

The amount of sets of gears in layer 3: 338, average branching factor is 6.97.

The amount of sets of gears in layer 4: 2168, average branching factor is 6.82.

The amount of sets of gears in layer 5: 19876, average branching factor is 7.24.

The amount of sets of gears in layer 6: 148403, average branching factor is 7.28.

The amount of sets of gears in layer 7: 1241446, average branching factor is 7.42.

The amount of sets of gears in layer 8: 9738814, average branching factor is 7.47.

2. The A\* search heuristic estimates a “perfect gear” to add to get to the goal. This ignores the 30 tooth minimum. If the perfect gear has negative teeth, a minimum 11 tooth gear is added as an idler gear before the “perfect gear is added. This estimate is admissible.
   1. Found the smallest set of gears in group A: 1M2P1M0P1M2
   2. Found the smallest set of gears in group B: 0M1P5M4P2M0M1
   3. Found the smallest set of gears in group C: 0M0P2M1P2M0M0
   4. Found the smallest set of gears in group D: 0M1P0M0M1P0
   5. Found the smallest set of gears in group E: 3M3M1M0P4M2M0
   6. Found the smallest set of gears in group F: 0M2M4P0M1M3P0
3. Relaxed to 100, the solution found the same solutions.
   1. Found the smallest set of gears in group A: 1M2P1M0P1M2
   2. Found the smallest set of gears in group B: 0M1P5M4P2M0M1
   3. Found the smallest set of gears in group C: 0M0P2M1P2M0M0
   4. Found the smallest set of gears in group D: 0M1P0M0M1P0
   5. Found the smallest set of gears in group E: 3M3M1M0P4M2M0
   6. Found the smallest set of gears in group F: 0M2M4P0M1M3P0