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CS 461 Intro to A.I

Program 2 report

For my genetic algorithm I started by putting all the parameters into a data file of list objects. This includes the class list, list of instructors, times for class and the locations for the classes. These are all created into schedule “objects” of class, class size, time, instructor, location and location size. To create a full schedule the class list is used to iterate and create a schedule. Within each class assignment a random time, instructor and location is chosen.

Once the schedule has been generated it is passed into the fitness function. This will evaluate the randomly created schedule based on a wide amount of criteria. Most of these evaluations can and are evaluated on a class by class basis so utilizing some for loops the schedule is evaluated for its overall fitness score. This gives a best estimate on how well the schedule conforms to the constraints posed by the overall problem.

This schedule creation and evaluation is further expanded upon in the main program by generating a random generation of 1000 full schedules first. Once these have been created and evaluated they are passed into the crossover and mutation functions which takes the generation and list of scores and creates a probability distribution using L2 normalization and random selection to create a generation of child schedules by selecting from the probability distribution, picking 2 parents from the distribution ,then given a random split from parents, ideally picking the best schedules but also giving the opportunity to pick less well performing schedules. Once these child schedules have been created they are then evaluated for mutation by a 1% chance of each attribute given the possibility of taking a random value from the original data. The best performing schedule of the generation is displayed along with the average of the entire generation for tracking purposes.

This process is repeated for multiple generations until a convergence is reached based on the schedules not improving by greater the .2% for 3 subsequent generations. Once this convergence is reached, the highest performing schedule from all generations is reported with it’s score, a text representation of the schedule and its list of constraint violations which is evaluated through a separate function in the fitness evaluation.

The main limitation in expanding and generalizing this current program is that certain parts of the fitness evaluation is dependent on specific indexes of classes for quick lookup of constraint violations. These evaluations could be potentially rewritten, making the program easier to expand for further class requirements. The primary limitation into generalizing this program comes with the creation of the schedule object. This could easily be resolved by adding more attributes to the schedule object when additional parameters are required. As long as the data provided for the schedule is a list or can be interpreted or converted into a list the program is robust enough to accept this additional input. With further parameters however, further evaluations would be needed in the fitness function based on requirements for accurate score reporting. The fitness function is relatively easy to expand upon since each evaluation criteria is mostly independent so can be removed or left untouched without causing any issue if further evaluations were created.

Overall the program is efficient in its run time by taking a maximum of 5 minutes to run and this is primarily dependent on the amount of schedule objects that are created per generation or the requirements for convergence which are quite easy to change without creating any additional repercussions in the overall program.

Sample Output (some generations omitted for means of space):

Best Child of generation: 274.2488412031251

CS101A : 40 : 10A : Bingham : Flarsheim260 : 25

CS101B : 25 : 12P : Mitchell : Haag206 : 30

CS201A : 30 : 4P : Hare : Haag301 : 70

CS201B : 30 : 10A : Mitchell : Haag301 : 70

CS191A : 60 : 11A : Kuhail : Flarsheim310 : 80

CS191B : 20 : 3P : Kuhail : Flarsheim260 : 25

CS291B : 40 : 3P : Hare : Royall204 : 70

CS291A : 20 : 11A : Hare : Haag301 : 70

CS303 : 50 : 4P : Kuhail : Flarsheim310 : 80

CS341 : 40 : 1P : Bingham : Flarsheim310 : 80

CS449 : 55 : 10A : Hare : Royall204 : 70

CS461 : 40 : 3P : Hare : Haag206 : 30

Average Child of Generation: 162.6901206231926

Best Child of generation: 291.0884497500001

CS101A : 40 : 10A : Bingham : Haag301 : 70

CS101B : 25 : 10A : Hare : Flarsheim260 : 25

CS201A : 30 : 4P : Rao : Flarsheim310 : 80

CS201B : 30 : 3P : Bingham : Royall204 : 70

CS191A : 60 : 11A : Hare : Haag301 : 70

CS191B : 20 : 1P : Mitchell : Haag206 : 30

CS291B : 40 : 2P : Hare : Royall204 : 70

CS291A : 20 : 2P : Bingham : Flarsheim310 : 80

CS303 : 50 : 2P : Kuhail : Flarsheim310 : 80

CS341 : 40 : 10A : Mitchell : Katz209 : 50

CS449 : 55 : 11A : Kuhail : Bloch0009 : 30

CS461 : 40 : 1P : Rao : Royall204 : 70

Average Child of Generation: 166.91321153809434

Best Child of generation: 260.8912625773438

CS101A : 40 : 3P : Rao : Royall204 : 70

CS101B : 25 : 1P : Mitchell : Flarsheim310 : 80

CS201A : 30 : 3P : Bingham : Haag206 : 30

CS201B : 30 : 1P : Bingham : Royall204 : 70

CS191A : 60 : 2P : Mitchell : Haag301 : 70

CS191B : 20 : 4P : Kuhail : Flarsheim260 : 25

CS291B : 40 : 2P : Kuhail : Royall204 : 70

CS291A : 20 : 4P : Bingham : Haag301 : 70

CS303 : 50 : 10A : Kuhail : Bloch0009 : 30

CS341 : 40 : 12P : Kuhail : Flarsheim310 : 80

CS449 : 55 : 1P : Kuhail : Katz209 : 50

CS461 : 40 : 11A : Mitchell : Katz209 : 50

Average Child of Generation: 166.86256401116665

Best Child of generation: 305.00576780625016

CS101A : 40 : 3P : Rao : Haag301 : 70

CS101B : 25 : 10A : Kuhail : Flarsheim260 : 25

CS201A : 30 : 12P : Kuhail : Haag206 : 30

CS201B : 30 : 10A : Rao : Haag301 : 70

CS191A : 60 : 4P : Bingham : Haag301 : 70

CS191B : 20 : 2P : Hare : Haag206 : 30

CS291B : 40 : 4P : Mitchell : Royall204 : 70

CS291A : 20 : 11A : Rao : Flarsheim260 : 25

CS303 : 50 : 4P : Hare : Flarsheim310 : 80

CS341 : 40 : 12P : Hare : Bloch0009 : 30

CS449 : 55 : 3P : Kuhail : Royall204 : 70

CS461 : 40 : 10A : Bingham : Katz209 : 50

Average Child of Generation: 168.76934512841282

Best Child of generation: 267.8056066875

CS101A : 40 : 1P : Mitchell : Flarsheim310 : 80

CS101B : 25 : 10A : Hare : Flarsheim260 : 25

CS201A : 30 : 10A : Kuhail : Royall204 : 70

CS201B : 30 : 3P : Rao : Haag206 : 30

CS191A : 60 : 3P : Hare : Flarsheim310 : 80

CS191B : 20 : 4P : Kuhail : Haag206 : 30

CS291B : 40 : 4P : Mitchell : Haag301 : 70

CS291A : 20 : 11A : Bingham : Royall204 : 70

CS303 : 50 : 3P : Mitchell : Royall204 : 70

CS341 : 40 : 10A : Rao : Katz209 : 50

CS449 : 55 : 12P : Bingham : Royall204 : 70

CS461 : 40 : 12P : Mitchell : Haag301 : 70

Average Child of Generation: 167.1471781839352

Best Child of generation: 315.53839125193

CS101A : 40 : 1P : Kuhail : Katz209 : 50

CS101B : 25 : 10A : Bingham : Haag206 : 30

CS201A : 30 : 12P : Mitchell : Haag301 : 70

CS201B : 30 : 10A : Hare : Royall204 : 70

CS191A : 60 : 4P : Kuhail : Flarsheim310 : 80

CS191B : 20 : 11A : Bingham : Haag206 : 30

CS291B : 40 : 11A : Kuhail : Royall204 : 70

CS291A : 20 : 11A : Hare : Royall204 : 70

CS303 : 50 : 3P : Kuhail : Katz209 : 50

CS341 : 40 : 1P : Bingham : Flarsheim310 : 80

CS449 : 55 : 11A : Hare : Flarsheim310 : 80

CS461 : 40 : 3P : Hare : Katz209 : 50

Average Child of Generation: 165.9921124758457

Best Child of generation: 265.35645974110736

CS101A : 40 : 12P : Hare : Royall204 : 70

CS101B : 25 : 10A : Mitchell : Haag206 : 30

CS201A : 30 : 4P : Rao : Katz209 : 50

CS201B : 30 : 12P : Kuhail : Katz209 : 50

CS191A : 60 : 11A : Bingham : Royall204 : 70

CS191B : 20 : 11A : Bingham : Haag206 : 30

CS291B : 40 : 2P : Hare : Flarsheim260 : 25

CS291A : 20 : 1P : Bingham : Flarsheim310 : 80

CS303 : 50 : 10A : Hare : Flarsheim260 : 25

CS341 : 40 : 4P : Mitchell : Royall204 : 70

CS449 : 55 : 3P : Hare : Bloch0009 : 30

CS461 : 40 : 3P : Kuhail : Flarsheim260 : 25

Average Child of Generation: 167.0928869788185

Best Child of generation: 264.6755895016407

CS101A : 40 : 1P : Rao : Flarsheim260 : 25

CS101B : 25 : 11A : Mitchell : Flarsheim260 : 25

CS201A : 30 : 10A : Kuhail : Haag206 : 30

CS201B : 30 : 3P : Kuhail : Haag301 : 70

CS191A : 60 : 2P : Bingham : Royall204 : 70

CS191B : 20 : 12P : Kuhail : Royall204 : 70

CS291B : 40 : 11A : Hare : Flarsheim310 : 80

CS291A : 20 : 4P : Rao : Royall204 : 70

CS303 : 50 : 10A : Mitchell : Katz209 : 50

CS341 : 40 : 12P : Kuhail : Flarsheim310 : 80

CS449 : 55 : 4P : Hare : Haag301 : 70

CS461 : 40 : 4P : Mitchell : Flarsheim310 : 80

Average Child of Generation: 168.8569878496502

Best Child of generation: 298.64567389584386

CS101A : 40 : 1P : Kuhail : Haag206 : 30

CS101B : 25 : 3P : Hare : Flarsheim260 : 25

CS201A : 30 : 10A : Mitchell : Haag301 : 70

CS201B : 30 : 12P : Mitchell : Flarsheim260 : 25

CS191A : 60 : 2P : Bingham : Haag301 : 70

CS191B : 20 : 2P : Rao : Haag206 : 30

CS291B : 40 : 4P : Hare : Royall204 : 70

CS291A : 20 : 11A : Kuhail : Haag206 : 30

CS303 : 50 : 4P : Bingham : Flarsheim310 : 80

CS341 : 40 : 2P : Kuhail : Flarsheim260 : 25

CS449 : 55 : 12P : Rao : Flarsheim310 : 80

CS461 : 40 : 1P : Rao : Royall204 : 70

Average Child of Generation: 165.9332664528749

Over all best Child with score: 315.53839125193

CS101A : 40 : 1P : Kuhail : Katz209 : 50

CS101B : 25 : 10A : Bingham : Haag206 : 30

CS201A : 30 : 12P : Mitchell : Haag301 : 70

CS201B : 30 : 10A : Hare : Royall204 : 70

CS191A : 60 : 4P : Kuhail : Flarsheim310 : 80

CS191B : 20 : 11A : Bingham : Haag206 : 30

CS291B : 40 : 11A : Kuhail : Royall204 : 70

CS291A : 20 : 11A : Hare : Royall204 : 70

CS303 : 50 : 3P : Kuhail : Katz209 : 50

CS341 : 40 : 1P : Bingham : Flarsheim310 : 80

CS449 : 55 : 11A : Hare : Flarsheim310 : 80

CS461 : 40 : 3P : Hare : Katz209 : 50

Violation List :

Kuhail not qualified to teach: CS101A

Mitchell not qualified to teach: CS201A

Kuhail not qualified to teach: CS191A

Kuhail not qualified to teach: CS291B

2 Classes scheduled in Royall204 at the same time

Katz209 is too small for CS303

2 Classes scheduled in Katz209 at the same time

Bingham not qualified to teach: CS341