Final Report Submission

Solving Bin Packing Problem Using Ant Colony Organization

December 09, 2020

Functions Defined

1. ACAO: It finds the best fitness for the bin packing problem algorithm, where fitness is the difference between largest and smallest bin. It returns the best path's fitness found on the final evaluation.

Arguments Used In the function

bins (int) : Number of bins to be used

items (list(int)) : List of items to be sorted into the bins

paths (int): Number of ant paths to be taken each fitness evaluation

evap_rate (float) : Rate at which all nodes evaporate

fitness_evals (int) : Number of fitness evaluations

- **In this function, we create the random pheromones on each of the nodes that the ant can take. Then we use global_best variable for printing out the current best when running.**
- **Then we determined the amount of times to do the evaluations based on the number of paths and appended the path to the path list for this iteration.**
- **Then we get the weights of the bins and find the fitness of the individual path.**
- **Then update the pheromones for the paths calculated and calculate the overall fitness of the path.**
- **Go through each node in the path and update the pheromone in pheromone_paths with the pheromone update.**
- **Final step is to evaporate all nodes in pheromone_paths by the evaporation rate and check if the fitness for this iteration is better than the global best (not used for actual result)**

2. **navigate_path:** It is a method for the ant choosing a path based on pheromones. It returns the path taken by the ant as it navigates its way through the bins.

Arguments Used In the function:

items (list(int)): The items to be placed into the bins

pheromones (list(list(int))) : The current pheromones for the path nodes.

bins (int) : The number of bins

- **In this function, we iterate through the items, choosing which bin to put the item in.**
- **Then we retrieving the probabilities for the bins next in the ant's path and choose a bin based on its probability**

3. **evaporate:** It evaporates all of the nodes in the pheromone lists. It returns the pheromones updated by the evaporation rate.

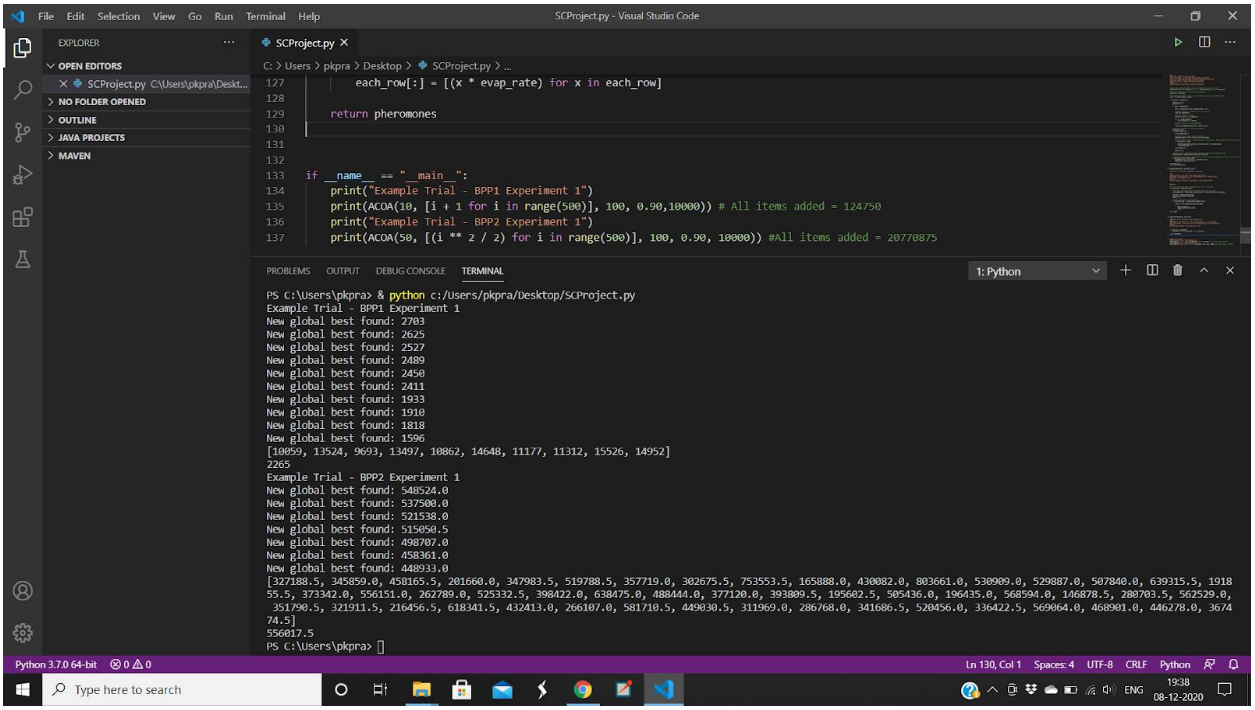
Arguments Used In the function:

pheromones (list(list(int))) : The current pheromone list to be updated

evap_rate (float) : The value which each pheromone needs to be multiplied by.

- **In this function, we iterate with the help of a for loop to evaporates all of the nodes in the pheromones list.**

Screenshot of the Output:



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SCProject.py - Visual Studio Code
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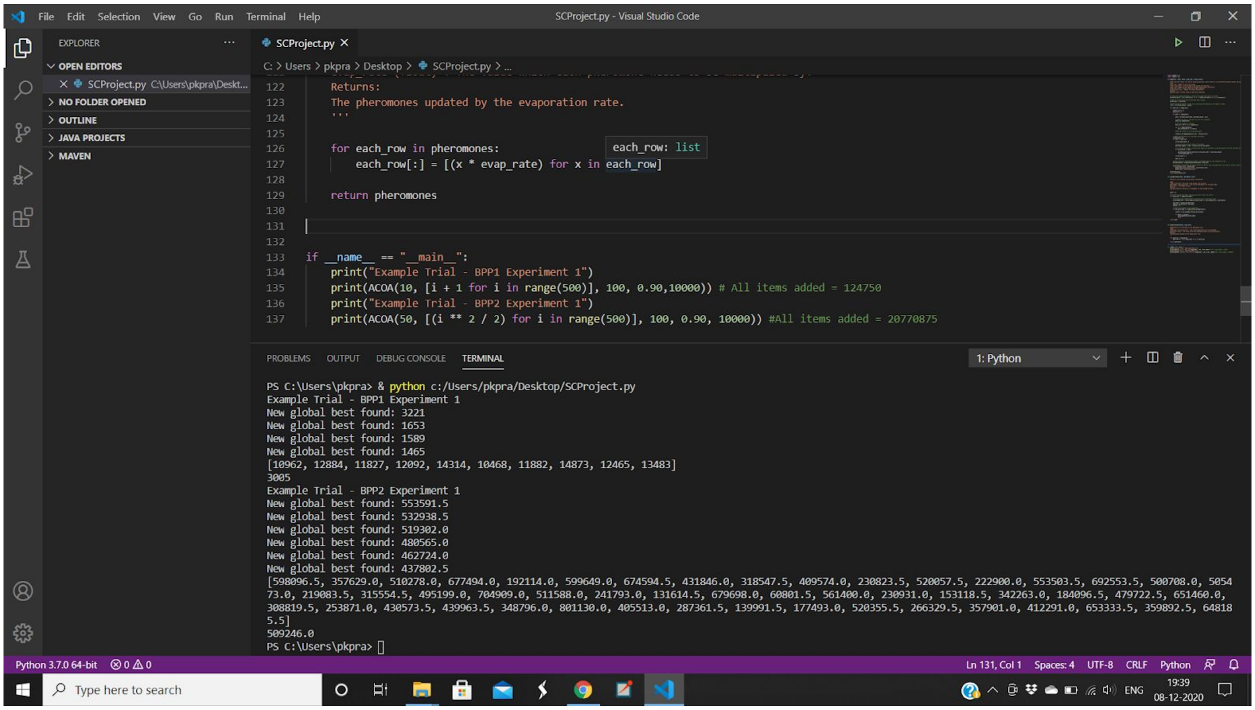
```python
        each_row[:] = [(x * evap_rate) for x in each_row]

    return pheromones



if __name__ == "__main__":
    print("Example Trial - BPP1 Experiment 1")
    print(ACOA(10, [i + 1 for i in range(500)], 100, 0.90,10000)) # All items added = 124750
    print("Example Trial - BPP2 Experiment 1")
    print(ACOA(50, [(i ** 2 / 2) for i in range(500)], 100, 0.90, 10000)) #All items added = 20770875
```

```
PS C:\Users\pkpra> & python c:/Users/pkpra/Desktop/SCProject.py
Example Trial - BPP1 Experiment 1
New global best found: 2703
New global best found: 2625
New global best found: 2527
New global best found: 2489
New global best found: 2450
New global best found: 2411
New global best found: 1933
New global best found: 1910
New global best found: 1818
New global best found: 1596
[10059, 13524, 9693, 13497, 10862, 14648, 11177, 11312, 15526, 14952]
2265
Example Trial - BPP2 Experiment 1
New global best found: 548524.0
New global best found: 537500.0
New global best found: 521538.0
New global best found: 515050.5
New global best found: 498707.0
New global best found: 458361.0
New global best found: 448933.0
[327188.5, 345859.0, 458165.5, 201660.0, 347983.5, 519788.5, 357719.0, 302675.5, 753553.5, 165888.0, 430082.0, 803661.0, 530909.0, 529887.0, 507840.0, 639315.5, 1918
55.5, 373342.0, 556151.0, 262789.0, 525332.5, 398422.0, 638475.0, 488444.0, 377120.0, 393809.5, 195602.5, 505436.0, 196435.0, 568594.0, 146878.5, 280703.5, 562529.0,
 351790.5, 321911.5, 216456.5, 618341.5, 432413.0, 266107.0, 581710.5, 449030.5, 311969.0, 286768.0, 341686.5, 520456.0, 336422.5, 569064.0, 468901.0, 446278.0, 3674
74.5]
556017.5
PS C:\Users\pkpra> []
```



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each_row: list
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```python
    Returns:
    The pheromones updated by the evaporation rate.
    '''

    for each_row in pheromones:
        each_row[:] = [(x * evap_rate) for x in each_row]

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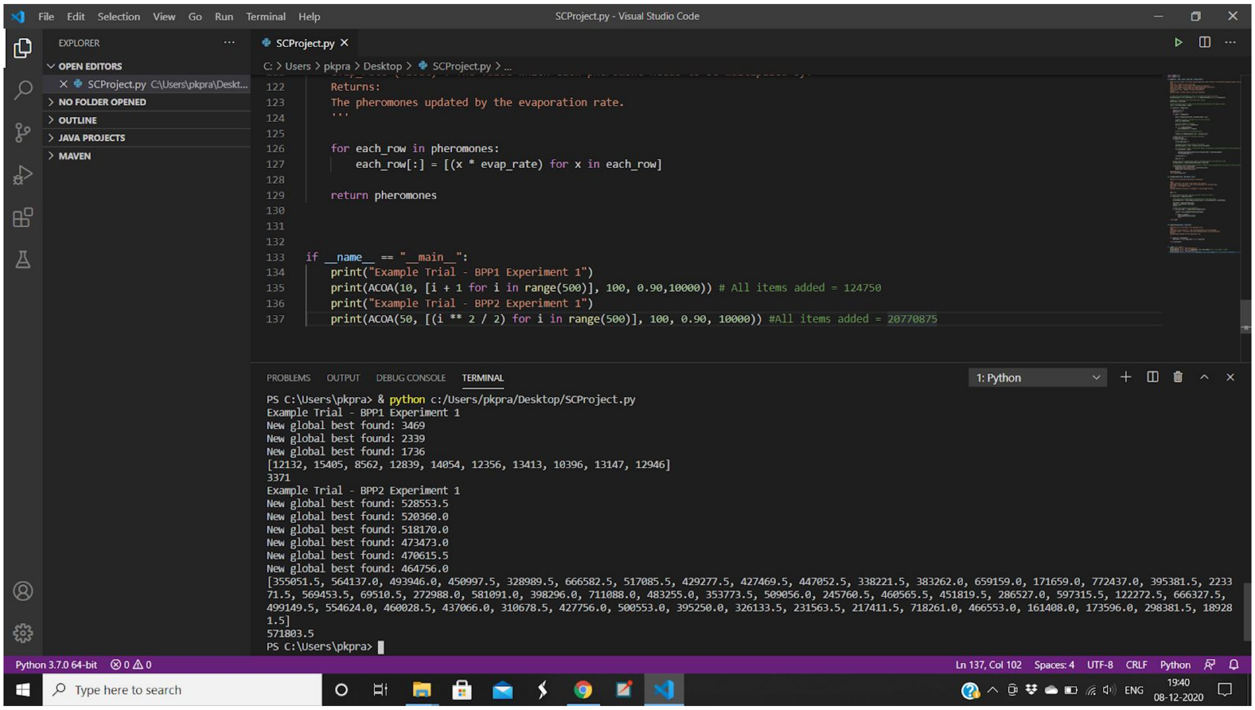
    print(ACOA(50, [(i ** 2 / 2) for i in range(500)], 100, 0.90, 10000)) #All items added = 20770875
```

```
PS C:\Users\pkpra> & python c:/Users/pkpra/Desktop/SCProject.py
Example Trial - BPP1 Experiment 1
New global best found: 3221
New global best found: 1653
New global best found: 1589
New global best found: 1465
[10962, 12884, 11827, 12092, 14314, 10468, 11882, 14873, 12465, 13483]
3005
Example Trial - BPP2 Experiment 1
New global best found: 553591.5
New global best found: 532938.5
New global best found: 519302.0
New global best found: 480565.0
New global best found: 462724.0
New global best found: 437802.5
[598096.5, 357629.0, 510278.0, 677494.0, 192114.0, 599649.0, 674594.5, 431846.0, 318547.5, 409574.0, 230823.5, 520057.5, 222900.0, 553503.5, 692553.5, 500708.0, 5054
73.0, 219083.5, 315554.5, 495199.0, 704909.0, 511588.0, 241793.0, 131614.5, 679698.0, 60801.5, 561400.0, 230931.0, 153118.5, 342263.0, 184096.5, 479722.5, 651460.0,
308819.5, 253871.0, 430573.5, 439963.5, 348796.0, 801130.0, 405513.0, 287361.5, 139991.5, 177493.0, 520355.5, 266329.5, 357901.0, 412291.0, 653333.5, 359892.5, 64818
5.5]
509246.0
PS C:\Users\pkpra> []
```



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```

```
PS C:\Users\pkpra> & python c:/Users/pkpra/Desktop/SCProject.py
Example Trial - BPP1 Experiment 1
New global best found: 3469
New global best found: 2339
New global best found: 1736
[12132, 15405, 8562, 12839, 14054, 12356, 13413, 10396, 13147, 12946]
3371
Example Trial - BPP2 Experiment 1
New global best found: 528553.5
New global best found: 520360.0
New global best found: 518170.0
New global best found: 473473.0
New global best found: 470615.5
New global best found: 464756.0
[355051.5, 564137.0, 493946.0, 450997.5, 328989.5, 666582.5, 517085.5, 429277.5, 427469.5, 447052.5, 338221.5, 383262.0, 659159.0, 171659.0, 772437.0, 395381.5, 2233
71.5, 569453.5, 69510.5, 272988.0, 581091.0, 398296.0, 711088.0, 483255.0, 353773.5, 509056.0, 245760.5, 460565.5, 451819.5, 286527.0, 597315.5, 122272.5, 666327.5,
499149.5, 554624.0, 460028.5, 437066.0, 310678.5, 427756.0, 500553.0, 395250.0, 326133.5, 231563.5, 217411.5, 718261.0, 466553.0, 161408.0, 173596.0, 298381.5, 18928
1.5]
571803.5
PS C:\Users\pkpra>
```