

```
1 /System/Volumes/Data/Users/liangwenlong/envs/ml_env
  /bin/python3.12 /Users/liangwenlong/study/bme/3/
  ml_usage/project/solutionv6.py
2     Loading data ...
3     Cleaning numeric-like columns ...
4     Feature engineering ...
5     Target & frequency encoding ...
6     Will do target encoding for: ['driver_name_and_id
  ', 'vehicle_type', 'vehicle_motortype', '
  deviceuniquecode']
7     Total features: 76
8     Categorical features: ['deviceuniquecode', '
  driver_name_and_id', 'vehicle_type', '
  vehicle_motortype', 'env_relative_humidity', '
  vehicle_type_1', 'vehicle_type_2', 'vehicle_type_3
  ', 'vehicle_type_4', 'vehicle_type_5', '
  vehicle_type_6', 'driver_name_and_id_freq', '
  vehicle_type_freq', 'vehicle_motortype_freq', '
  deviceuniquecode_freq']
9     Start multi-seed LightGBM training ...
10
11 ===== Seed 42 =====
12     -> Seed 42 | Fold 1/5
13 Training until validation scores don't improve for
  300 rounds
14 [500]    valid_0's l1: 19.8894
15 [1000]   valid_0's l1: 19.6067
16 [1500]   valid_0's l1: 19.4642
17 [2000]   valid_0's l1: 19.3796
18 [2500]   valid_0's l1: 19.3176
19 [3000]   valid_0's l1: 19.2768
20 [3500]   valid_0's l1: 19.244
21 [4000]   valid_0's l1: 19.2228
22 [4500]   valid_0's l1: 19.2008
23 [5000]   valid_0's l1: 19.1832
24 [5500]   valid_0's l1: 19.1681
25 [6000]   valid_0's l1: 19.1565
26 [6500]   valid_0's l1: 19.1454
27 [7000]   valid_0's l1: 19.1378
28 [7500]   valid_0's l1: 19.1293
29 [8000]   valid_0's l1: 19.1192
```

```
30 [8500] valid_0's l1: 19.1151
31 [9000] valid_0's l1: 19.109
32 [9500] valid_0's l1: 19.1009
33 [10000] valid_0's l1: 19.0977
34 Did not meet early stopping. Best iteration is:
35 [10000] valid_0's l1: 19.0977
36     Fold 1 MAE: 19.0977
37     -> Seed 42 | Fold 2/5
38 Training until validation scores don't improve for
   300 rounds
39 [500] valid_0's l1: 20.0581
40 [1000] valid_0's l1: 19.7639
41 [1500] valid_0's l1: 19.6321
42 [2000] valid_0's l1: 19.5639
43 [2500] valid_0's l1: 19.5097
44 [3000] valid_0's l1: 19.4762
45 [3500] valid_0's l1: 19.447
46 [4000] valid_0's l1: 19.4254
47 [4500] valid_0's l1: 19.4041
48 [5000] valid_0's l1: 19.3886
49 [5500] valid_0's l1: 19.3765
50 [6000] valid_0's l1: 19.3621
51 [6500] valid_0's l1: 19.3526
52 [7000] valid_0's l1: 19.3428
53 [7500] valid_0's l1: 19.3353
54 [8000] valid_0's l1: 19.3288
55 [8500] valid_0's l1: 19.3195
56 [9000] valid_0's l1: 19.3133
57 [9500] valid_0's l1: 19.3069
58 [10000] valid_0's l1: 19.3023
59 Did not meet early stopping. Best iteration is:
60 [9978] valid_0's l1: 19.3021
61     Fold 2 MAE: 19.3021
62     -> Seed 42 | Fold 3/5
63 Training until validation scores don't improve for
   300 rounds
64 [500] valid_0's l1: 20.1878
65 [1000] valid_0's l1: 19.8709
66 [1500] valid_0's l1: 19.737
67 [2000] valid_0's l1: 19.6598
68 [2500] valid_0's l1: 19.6094
```

```
69 [3000] valid_0's l1: 19.5592
70 [3500] valid_0's l1: 19.528
71 [4000] valid_0's l1: 19.5072
72 [4500] valid_0's l1: 19.4889
73 [5000] valid_0's l1: 19.474
74 [5500] valid_0's l1: 19.4593
75 [6000] valid_0's l1: 19.4473
76 [6500] valid_0's l1: 19.4351
77 [7000] valid_0's l1: 19.4265
78 [7500] valid_0's l1: 19.4173
79 [8000] valid_0's l1: 19.413
80 [8500] valid_0's l1: 19.4085
81 [9000] valid_0's l1: 19.4005
82 [9500] valid_0's l1: 19.3945
83 [10000] valid_0's l1: 19.3904
84 Did not meet early stopping. Best iteration is:
85 [10000] valid_0's l1: 19.3904
86     Fold 3 MAE: 19.3904
87     -> Seed 42 | Fold 4/5
88 Training until validation scores don't improve for
    300 rounds
89 [500] valid_0's l1: 20.1123
90 [1000] valid_0's l1: 19.8107
91 [1500] valid_0's l1: 19.6806
92 [2000] valid_0's l1: 19.6148
93 [2500] valid_0's l1: 19.5666
94 [3000] valid_0's l1: 19.5299
95 [3500] valid_0's l1: 19.4942
96 [4000] valid_0's l1: 19.4716
97 [4500] valid_0's l1: 19.4559
98 [5000] valid_0's l1: 19.4387
99 [5500] valid_0's l1: 19.423
100 [6000] valid_0's l1: 19.4104
101 [6500] valid_0's l1: 19.3985
102 [7000] valid_0's l1: 19.3884
103 [7500] valid_0's l1: 19.3795
104 [8000] valid_0's l1: 19.3715
105 [8500] valid_0's l1: 19.3653
106 [9000] valid_0's l1: 19.3586
107 [9500] valid_0's l1: 19.3534
108 [10000] valid_0's l1: 19.3476
```

```
109 Did not meet early stopping. Best iteration is:
110 [10000] valid_0's l1: 19.3476
111     Fold 4 MAE: 19.3476
112     -> Seed 42 | Fold 5/5
113 Training until validation scores don't improve for
    300 rounds
114 [500]    valid_0's l1: 20.0505
115 [1000]   valid_0's l1: 19.7946
116 [1500]   valid_0's l1: 19.6556
117 [2000]   valid_0's l1: 19.5782
118 [2500]   valid_0's l1: 19.5283
119 [3000]   valid_0's l1: 19.4854
120 [3500]   valid_0's l1: 19.4622
121 [4000]   valid_0's l1: 19.4394
122 [4500]   valid_0's l1: 19.4222
123 [5000]   valid_0's l1: 19.4064
124 [5500]   valid_0's l1: 19.3945
125 [6000]   valid_0's l1: 19.3809
126 [6500]   valid_0's l1: 19.3714
127 [7000]   valid_0's l1: 19.3645
128 [7500]   valid_0's l1: 19.3576
129 [8000]   valid_0's l1: 19.3508
130 [8500]   valid_0's l1: 19.3415
131 [9000]   valid_0's l1: 19.3327
132 [9500]   valid_0's l1: 19.3296
133 [10000]  valid_0's l1: 19.3261
134 Did not meet early stopping. Best iteration is:
135 [9883]   valid_0's l1: 19.326
136     Fold 5 MAE: 19.3260
137 ===== Seed 42 mean MAE: 19.2928 =====
138
139 ===== Seed 2025 =====
140     -> Seed 2025 | Fold 1/5
141 Training until validation scores don't improve for
    300 rounds
142 [500]    valid_0's l1: 20.0491
143 [1000]   valid_0's l1: 19.7558
144 [1500]   valid_0's l1: 19.6136
145 [2000]   valid_0's l1: 19.5492
146 [2500]   valid_0's l1: 19.4987
147 [3000]   valid_0's l1: 19.4618
```

```
148 [3500] valid_0's l1: 19.4359
149 [4000] valid_0's l1: 19.409
150 [4500] valid_0's l1: 19.3917
151 [5000] valid_0's l1: 19.3748
152 [5500] valid_0's l1: 19.3579
153 [6000] valid_0's l1: 19.3475
154 [6500] valid_0's l1: 19.3324
155 [7000] valid_0's l1: 19.3226
156 [7500] valid_0's l1: 19.3146
157 [8000] valid_0's l1: 19.3083
158 [8500] valid_0's l1: 19.2993
159 [9000] valid_0's l1: 19.291
160 [9500] valid_0's l1: 19.285
161 [10000] valid_0's l1: 19.282
162 Did not meet early stopping. Best iteration is:
163 [9966] valid_0's l1: 19.2819
164     Fold 1 MAE: 19.2819
165     -> Seed 2025 | Fold 2/5
166 Training until validation scores don't improve for
    300 rounds
167 [500] valid_0's l1: 20.0735
168 [1000] valid_0's l1: 19.8052
169 [1500] valid_0's l1: 19.6922
170 [2000] valid_0's l1: 19.6173
171 [2500] valid_0's l1: 19.568
172 [3000] valid_0's l1: 19.5293
173 [3500] valid_0's l1: 19.504
174 [4000] valid_0's l1: 19.4831
175 [4500] valid_0's l1: 19.4591
176 [5000] valid_0's l1: 19.446
177 [5500] valid_0's l1: 19.4334
178 [6000] valid_0's l1: 19.4245
179 [6500] valid_0's l1: 19.4147
180 [7000] valid_0's l1: 19.4042
181 [7500] valid_0's l1: 19.3955
182 [8000] valid_0's l1: 19.3863
183 [8500] valid_0's l1: 19.3801
184 [9000] valid_0's l1: 19.3734
185 [9500] valid_0's l1: 19.3675
186 [10000] valid_0's l1: 19.362
187 Did not meet early stopping. Best iteration is:
```

```
188 [10000] valid_0's l1: 19.362
189         Fold 2 MAE: 19.3620
190     -> Seed 2025 | Fold 3/5
191 Training until validation scores don't improve for
    300 rounds
192 [500]    valid_0's l1: 19.7784
193 [1000]   valid_0's l1: 19.5033
194 [1500]   valid_0's l1: 19.3685
195 [2000]   valid_0's l1: 19.2995
196 [2500]   valid_0's l1: 19.2538
197 [3000]   valid_0's l1: 19.2161
198 [3500]   valid_0's l1: 19.1943
199 [4000]   valid_0's l1: 19.1698
200 [4500]   valid_0's l1: 19.1521
201 [5000]   valid_0's l1: 19.1362
202 [5500]   valid_0's l1: 19.1258
203 [6000]   valid_0's l1: 19.1165
204 [6500]   valid_0's l1: 19.107
205 [7000]   valid_0's l1: 19.0986
206 [7500]   valid_0's l1: 19.0901
207 [8000]   valid_0's l1: 19.0844
208 [8500]   valid_0's l1: 19.0816
209 [9000]   valid_0's l1: 19.0765
210 [9500]   valid_0's l1: 19.074
211 [10000]  valid_0's l1: 19.0685
212 Did not meet early stopping. Best iteration is:
213 [10000]  valid_0's l1: 19.0685
214         Fold 3 MAE: 19.0685
215     -> Seed 2025 | Fold 4/5
216 Training until validation scores don't improve for
    300 rounds
217 [500]    valid_0's l1: 20.0705
218 [1000]   valid_0's l1: 19.7857
219 [1500]   valid_0's l1: 19.6426
220 [2000]   valid_0's l1: 19.5715
221 [2500]   valid_0's l1: 19.5228
222 [3000]   valid_0's l1: 19.4875
223 [3500]   valid_0's l1: 19.4643
224 [4000]   valid_0's l1: 19.4412
225 [4500]   valid_0's l1: 19.4239
226 [5000]   valid_0's l1: 19.4091
```

```
227 [5500] valid_0's l1: 19.3953
228 [6000] valid_0's l1: 19.3831
229 [6500] valid_0's l1: 19.3728
230 [7000] valid_0's l1: 19.3638
231 [7500] valid_0's l1: 19.3576
232 [8000] valid_0's l1: 19.3486
233 [8500] valid_0's l1: 19.3415
234 [9000] valid_0's l1: 19.3364
235 [9500] valid_0's l1: 19.3287
236 [10000] valid_0's l1: 19.3238
237 Did not meet early stopping. Best iteration is:
238 [10000] valid_0's l1: 19.3238
239     Fold 4 MAE: 19.3238
240     -> Seed 2025 | Fold 5/5
241 Training until validation scores don't improve for
    300 rounds
242 [500] valid_0's l1: 20.1182
243 [1000] valid_0's l1: 19.8027
244 [1500] valid_0's l1: 19.6629
245 [2000] valid_0's l1: 19.5884
246 [2500] valid_0's l1: 19.5373
247 [3000] valid_0's l1: 19.5021
248 [3500] valid_0's l1: 19.4747
249 [4000] valid_0's l1: 19.4491
250 [4500] valid_0's l1: 19.4303
251 [5000] valid_0's l1: 19.415
252 [5500] valid_0's l1: 19.3997
253 [6000] valid_0's l1: 19.3894
254 [6500] valid_0's l1: 19.3786
255 [7000] valid_0's l1: 19.3692
256 [7500] valid_0's l1: 19.362
257 [8000] valid_0's l1: 19.3544
258 [8500] valid_0's l1: 19.3488
259 [9000] valid_0's l1: 19.3417
260 [9500] valid_0's l1: 19.336
261 [10000] valid_0's l1: 19.3314
262 Did not meet early stopping. Best iteration is:
263 [9912] valid_0's l1: 19.3313
264     Fold 5 MAE: 19.3313
265 ===== Seed 2025 mean MAE: 19.2735 =====
266
```

```
267 ===== Seed 3407 =====
268     -> Seed 3407 | Fold 1/5
269 Training until validation scores don't improve for
    300 rounds
270 [500]    valid_0's l1: 20.0307
271 [1000]   valid_0's l1: 19.7218
272 [1500]   valid_0's l1: 19.5788
273 [2000]   valid_0's l1: 19.5005
274 [2500]   valid_0's l1: 19.4475
275 [3000]   valid_0's l1: 19.4073
276 [3500]   valid_0's l1: 19.381
277 [4000]   valid_0's l1: 19.3523
278 [4500]   valid_0's l1: 19.3327
279 [5000]   valid_0's l1: 19.3188
280 [5500]   valid_0's l1: 19.3071
281 [6000]   valid_0's l1: 19.2969
282 [6500]   valid_0's l1: 19.2845
283 [7000]   valid_0's l1: 19.275
284 [7500]   valid_0's l1: 19.2688
285 [8000]   valid_0's l1: 19.2619
286 [8500]   valid_0's l1: 19.2543
287 [9000]   valid_0's l1: 19.2468
288 [9500]   valid_0's l1: 19.2407
289 [10000]  valid_0's l1: 19.2356
290 Did not meet early stopping. Best iteration is:
291 [9997]   valid_0's l1: 19.2355
292         Fold 1 MAE: 19.2355
293     -> Seed 3407 | Fold 2/5
294 Training until validation scores don't improve for
    300 rounds
295 [500]    valid_0's l1: 20.025
296 [1000]   valid_0's l1: 19.7014
297 [1500]   valid_0's l1: 19.5564
298 [2000]   valid_0's l1: 19.4762
299 [2500]   valid_0's l1: 19.4204
300 [3000]   valid_0's l1: 19.3815
301 [3500]   valid_0's l1: 19.3505
302 [4000]   valid_0's l1: 19.3259
303 [4500]   valid_0's l1: 19.3023
304 [5000]   valid_0's l1: 19.29
305 [5500]   valid_0's l1: 19.279
```



```
306 [6000] valid_0's l1: 19.2682
307 [6500] valid_0's l1: 19.2597
308 [7000] valid_0's l1: 19.2498
309 [7500] valid_0's l1: 19.2395
310 [8000] valid_0's l1: 19.2319
311 [8500] valid_0's l1: 19.2244
312 [9000] valid_0's l1: 19.2174
313 [9500] valid_0's l1: 19.2147
314 [10000] valid_0's l1: 19.2092
315 Did not meet early stopping. Best iteration is:
316 [9982] valid_0's l1: 19.209
317     Fold 2 MAE: 19.2090
318     -> Seed 3407 | Fold 3/5
319 Training until validation scores don't improve for
    300 rounds
320 [500] valid_0's l1: 19.866
321 [1000] valid_0's l1: 19.5494
322 [1500] valid_0's l1: 19.4207
323 [2000] valid_0's l1: 19.3527
324 [2500] valid_0's l1: 19.2877
325 [3000] valid_0's l1: 19.2473
326 [3500] valid_0's l1: 19.2158
327 [4000] valid_0's l1: 19.1929
328 [4500] valid_0's l1: 19.1701
329 [5000] valid_0's l1: 19.1561
330 [5500] valid_0's l1: 19.1465
331 [6000] valid_0's l1: 19.1369
332 [6500] valid_0's l1: 19.127
333 [7000] valid_0's l1: 19.117
334 [7500] valid_0's l1: 19.109
335 [8000] valid_0's l1: 19.1049
336 [8500] valid_0's l1: 19.098
337 [9000] valid_0's l1: 19.0948
338 [9500] valid_0's l1: 19.0913
339 [10000] valid_0's l1: 19.0855
340 Did not meet early stopping. Best iteration is:
341 [10000] valid_0's l1: 19.0855
342     Fold 3 MAE: 19.0855
343     -> Seed 3407 | Fold 4/5
344 Training until validation scores don't improve for
    300 rounds
```

```
345 [500]    valid_0's l1: 20.1315
346 [1000]   valid_0's l1: 19.7823
347 [1500]   valid_0's l1: 19.6549
348 [2000]   valid_0's l1: 19.5818
349 [2500]   valid_0's l1: 19.5335
350 [3000]   valid_0's l1: 19.4916
351 [3500]   valid_0's l1: 19.463
352 [4000]   valid_0's l1: 19.4306
353 [4500]   valid_0's l1: 19.4077
354 [5000]   valid_0's l1: 19.3909
355 [5500]   valid_0's l1: 19.3753
356 [6000]   valid_0's l1: 19.3661
357 [6500]   valid_0's l1: 19.3541
358 [7000]   valid_0's l1: 19.3433
359 [7500]   valid_0's l1: 19.3367
360 [8000]   valid_0's l1: 19.3313
361 [8500]   valid_0's l1: 19.3251
362 [9000]   valid_0's l1: 19.3177
363 [9500]   valid_0's l1: 19.3128
364 [10000]  valid_0's l1: 19.3103
365 Did not meet early stopping. Best iteration is:
366 [9979]   valid_0's l1: 19.3101
367         Fold 4 MAE: 19.3101
368     -> Seed 3407 | Fold 5/5
369 Training until validation scores don't improve for
    300 rounds
370 [500]    valid_0's l1: 20.1471
371 [1000]   valid_0's l1: 19.8399
372 [1500]   valid_0's l1: 19.7087
373 [2000]   valid_0's l1: 19.6297
374 [2500]   valid_0's l1: 19.5722
375 [3000]   valid_0's l1: 19.5295
376 [3500]   valid_0's l1: 19.4976
377 [4000]   valid_0's l1: 19.4755
378 [4500]   valid_0's l1: 19.4551
379 [5000]   valid_0's l1: 19.4391
380 [5500]   valid_0's l1: 19.4289
381 [6000]   valid_0's l1: 19.4161
382 [6500]   valid_0's l1: 19.4056
383 [7000]   valid_0's l1: 19.3925
384 [7500]   valid_0's l1: 19.3838
```

```
385 [8000] valid_0's l1: 19.377
386 [8500] valid_0's l1: 19.3708
387 [9000] valid_0's l1: 19.3654
388 [9500] valid_0's l1: 19.3608
389 [10000] valid_0's l1: 19.3541
390 Did not meet early stopping. Best iteration is:
391 [9999] valid_0's l1: 19.3541
392     Fold 5 MAE: 19.3541
393 ===== Seed 3407 mean MAE: 19.2389 =====
394
395 =====
396     Multi-seed CV MAE mean: 19.2684 (std: 0.0223)
397 =====
398     Submission saved as:
399     submission_v6_ensemble_mae_19.2684.csv
400     Feature importance plot saved as
401     feature_importance_v6.png
402
```