2024 Fall

CS386-02

Assignment #5: Working with Uncertainty

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Question #1-1.

I used wine dataset by using 'load_wine()' function. The result of training is shown below. You can check this result by running 'submission.py'

```
[ question #1-1 ]
[0.9166666666666666, 0.8055555555555556, 0.8333333333333334, 0.7428571428571429, 0.9428571428571428]
```

Question #1-2.

You can check this result by running 'submission.py'

```
[ question #1-2 ]
n_estimator =  10 , criterion =  entropy
- scores:  [0.9722222222222222, 0.8611111111111112, 0.9166666666666666, 0.8857142857142857, 0.7142857142857143]
- average:  0.8699999999999999
n_estimator =  25 , criterion =  entropy
- scores:  [0.8611111111111112, 0.8888888888888888, 0.9166666666666666, 1.0, 1.0]
- average:  0.9333333333333332
n_estimator =  50 , criterion =  entropy
- scores:  [0.8888888888888888, 0.9722222222222222, 0.9166666666666666, 0.9714285714285714, 0.8857142857142857]
- average:  0.9269841269841269
n_estimator =  10 , criterion =  gini
- scores:  [0.9444444444444444, 0.9722222222222222, 0.9444444444444444, 1.0, 0.8571428571428571]
- average:  0.9436507936507935
n_estimator =  25 , criterion =  gini
- scores:  [0.8888888888888888, 0.9444444444444444, 0.9444444444444444, 1.0, 0.9714285714285714]
- average:  0.9498412698412698
n_estimator =  50 , criterion =  gini
- scores:  [0.9166666666666666, 0.9166666666666666, 0.8888888888888888, 1.0, 0.9714285714285714]
- average:  0.9387301587301587
```

The result is organized in the table below.

Average accuracy based on the estimator and criterion			
		Criterion	
		entropy	gini
n_estimator	10	0.870	0.944
	25	0.933	0.950
	50	0.927	0.939

Question #1-3.

You can check this result by running ‘submission.py’

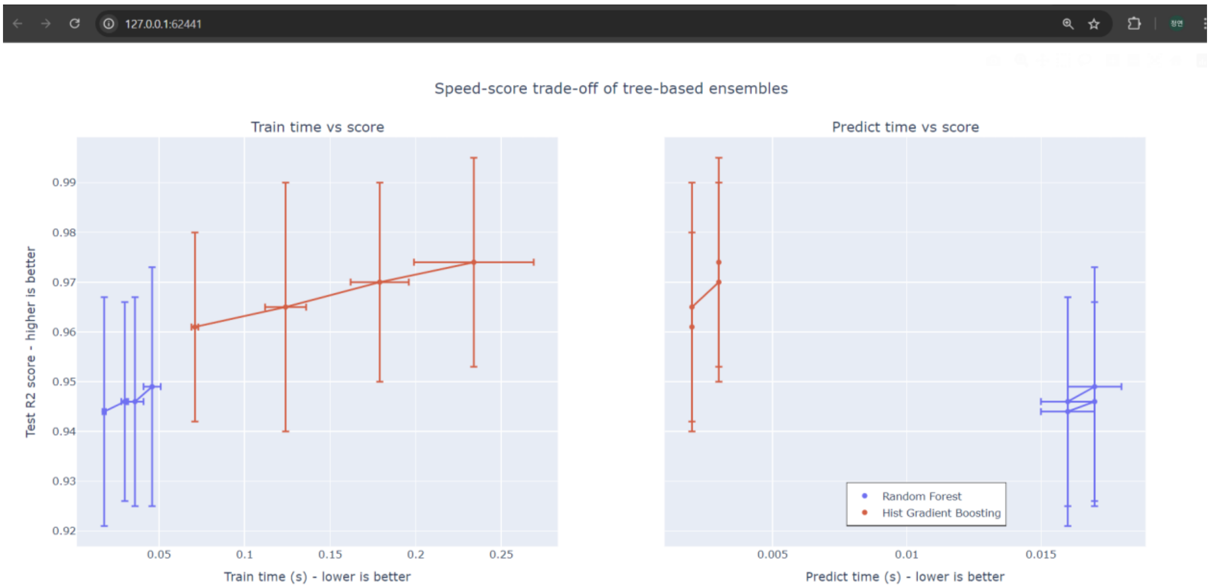
```
[ question #1-3 ]
Number of physical cores: 4
[{'model': 'Random Forest', 'cv_results':    mean_fit_time  std_fit_time  mean_score_time  std_score_time param_n_estimators  ... split2_train_score  split3_train_score  split4_train_score  mean_tra
in_score  std_train_score
0       0.017404      0.001777         0.015838        0.000424                  5  ...           0.975824            0.971429            0.969298           0.970563         0.005660
1       0.028018      0.001273         0.015996        0.000990                 10  ...           0.982418            0.971429            0.986842           0.980226         0.005208
2       0.029312      0.000326         0.015047        0.000553                 15  ...           0.980220            0.980220            0.982456           0.981986         0.001647
3       0.038137      0.004869         0.015384        0.000572                 20  ...           0.982418            0.982418            0.980263           0.982866         0.002143

[4 rows x 21 columns]}, {'model': 'Hist Gradient Boosting', 'cv_results':    mean_fit_time  std_fit_time  mean_score_time  std_score_time param_max_iter  ... split2_train_score  split3_train_score
split4_train_score  mean_train_score  std_train_score
0       0.061822      0.002611         0.001399        0.000490             25  ...           0.993407            0.989011            0.986842           0.989456         0.002557
1       0.119367      0.011760         0.002239        0.000388             50  ...           1.000000            1.000000            1.000000           1.000000         0.000000
2       0.231981      0.016579         0.004022        0.000630             75  ...           1.000000            1.000000            1.000000           1.000000         0.000000
3       0.502710      0.156014         0.007200        0.002992            100  ...           1.000000            1.000000            1.000000           1.000000         0.000000

[4 rows x 21 columns]}]
```

Question #1-4.

You can check the result below by running ‘submission.py’



Question #2-1.

You can check the result below by running ‘alarm.py’

```
the probability of Mary Calling given that John called:
+---------------+-----------------+
¦ MaryCalls     ¦   phi(MaryCalls) ¦
+===============+=================+
¦ MaryCalls(yes) ¦          0.1002 ¦
+---------------+-----------------+
¦ MaryCalls(no)  ¦          0.8998 ¦
+---------------+-----------------+
The probability of both John and Mary calling given Alarm:
+---------------+---------------+--------------------------+
¦ MaryCalls     ¦ JohnCalls     ¦   phi(MaryCalls,JohnCalls) ¦
+===============+===============+==========================+
¦ MaryCalls(yes) ¦ JohnCalls(yes) ¦                   0.0950 ¦
+---------------+---------------+--------------------------+
¦ MaryCalls(yes) ¦ JohnCalls(no)  ¦                   0.0050 ¦
+---------------+---------------+--------------------------+
¦ MaryCalls(no)  ¦ JohnCalls(yes) ¦                   0.8550 ¦
+---------------+---------------+--------------------------+
¦ MaryCalls(no)  ¦ JohnCalls(no)  ¦                   0.0450 ¦
+---------------+---------------+--------------------------+
the probability of Alarm, given that Mary called:
+------------+-------------+
¦ Alarm      ¦   phi(Alarm) ¦
+============+=============+
¦ Alarm(yes) ¦      0.9826 ¦
+------------+-------------+
¦ Alarm(no)  ¦      0.0174 ¦
+------------+-------------+
```

Question #2-2.

You can check the result below by running 'carnet.py'

Given that the car will not move, what is the probability that the battery is not working?

```
+----------------------+----------------+
¦ Battery              ¦   phi(Battery) ¦
+======================+================+
¦ Battery(Works)       ¦         0.6410 ¦
+----------------------+----------------+
¦ Battery(Doesn't work) ¦         0.3590 ¦
+----------------------+----------------+
```

Answer: 0.3590

Given that the radio is not working, what is the probability that the car will not start?

```
+-------------+---------------+
¦ Starts      ¦   phi(Starts) ¦
+=============+===============+
¦ Starts(yes) ¦        0.1313 ¦
+-------------+---------------+
¦ Starts(no)  ¦        0.8687 ¦
+-------------+---------------+
```

Answer: 0.8687

Given that the battery is working, does the probability of the radio working change if we discover that the car has gas in it?

```
Given that the battery is working, does the probability of the radio working change if we discover that the car has gas in it?
(not discovered about gas)
+----------------------+-------------+
| Radio                |  phi(Radio) |
+======================+=============+
| Radio(turns on)      |      0.7500 |
+----------------------+-------------+
| Radio(Doesn't turn on) |    0.2500 |
+----------------------+-------------+
(discovered that gas is full)
+----------------------+-------------+
| Radio                |  phi(Radio) |
+======================+=============+
| Radio(turns on)      |      0.7500 |
+----------------------+-------------+
| Radio(Doesn't turn on) |    0.2500 |
+----------------------+-------------+
```

Answer: It does not change.

Given that the car doesn't move, how does the probability of the ignition failing change if we observe that the car dies not have gas in it?

```
Given that the car doesn't move, how does the probability of the ignition failing change if we observe that the car dies not have gas in it?
(not observed about gas)
+-----------------------+-----------------+
| Ignition              |   phi(Ignition) |
+=======================+=================+
| Ignition(Works)       |          0.4334 |
+-----------------------+-----------------+
| Ignition(Doesn't work) |         0.5666 |
+-----------------------+-----------------+
(observed that gas is empty)
+-----------------------+-----------------+
| Ignition              |   phi(Ignition) |
+=======================+=================+
| Ignition(Works)       |          0.5178 |
+-----------------------+-----------------+
| Ignition(Doesn't work) |         0.4822 |
+-----------------------+-----------------+
```

Answer: It declines by 0.0844.

What is the probability that the car starts if the radio works and it has gas in it?

```
What is the probability that the car starts if the radio works and it has gas in it?
+-------------+---------------+
| Starts      |   phi(Starts) |
+=============+===============+
| Starts(yes) |        0.7212 |
+-------------+---------------+
| Starts(no)  |        0.2788 |
+-------------+---------------+
```

Answer: 0.7212

Question #2-3.

You can check the result below by running ‘carnet.py’

The probability that the key is not present given that the car does not move?

```
[ question #2-3 ]

The probability that the key is not present given that the car does not move:
+-----------------+-------------------+
¦ KeyPresent      ¦   phi(KeyPresent) ¦
+=================+===================+
¦ KeyPresent(yes) ¦            0.6604 ¦
+-----------------+-------------------+
¦ KeyPresent(no)  ¦            0.3396 ¦
+-----------------+-------------------+
```

Answer: 0.3396

Question #3-1.

I implemented the code for this question in the files ‘HMM.py’ and ‘test_HMM.py’. You can check the results by running the command ‘python -m unittest test_HMM.py’

```
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python -m unittest test_HMM.py
.
----------------------------------------------------------------------
Ran 1 test in 0.010s

OK
```

Question #3-2.

I implemented the code for this question in the files ‘HMM.py’. You can check the results by running the command ‘python HMM.py [basename] --generate [length]’.

```
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py cat --generate 20
grumpy grumpy happy grumpy happy happy grumpy happy happy hungry grumpy grumpy hungry hungry grumpy happy hungry grumpy happy hungry
purr silent meow silent purr meow silent purr meow meow silent meow purr silent meow purr meow silent purr meow
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py partofspeech --generate 20
PRT DET ADJ PRT DET NOUN ADP DET NOUN CONJ DET NOUN VERB VERB DET NOUN . . ADP NOUN
to ther gargantuan to the charles as the audience or the state be maintained another players . , in feed
```

Question #3-3.

I modified the file ‘lander.trans’ and ‘lander.emit’ for question 3-3. You can check the results by running the command ‘python HMM.py lander --generate [length]’.

```
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py lander --generate 20
1,1 2,2 3,3 4,4 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5
1,1 2,2 3,3 3,4 5,5 5,4 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5 5,5
```

Question #3-4.

I implemented the code for this question in the files ‘HMM.py’. You can check the results by running the command ‘python HMM.py [basename] --forward [basename]_sequence.obs’.

```
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py partofspeech --forward partofspeech_sequence.obs
Most likely hidden states:  NOUN
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py cat --forward cat_sequence.obs
Most likely hidden states:  happy
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py lander --forward lander_sequence.obs
Most likely hidden states:  5,5
Safe:  Yes
```

Question #3-5.

I implemented the code for this question in the files ‘HMM.py’. You can check the results by running the command ‘python HMM.py [basename] --viterbi [basename]_sequence.obs’.

```
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py cat --viterbi cat_sequence.obs
Most likely hidden states:  ['grumpy', 'happy', 'happy', 'hungry', 'grumpy', 'happy', 'happy', 'happy', 'happy', 'hungry', 'grumpy', 'happy', 'happy', 'hungry', 'grumpy', 'happy', 'happy', 'happy',
'happy', 'happy']
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py lander --viterbi lander_sequence.obs
Most likely hidden states:  ['1,1', '2,2', '3,3', '4,4', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5', '5,5']
ppy04@DESKTOP-UF37E4B:/c/workspace/cs386-02/assignment-5-working-with-uncertainty-13155a1$ python HMM.py partofspeech --viterbi partofspeech_sequence.obs
Most likely hidden states:  ['NOUN', 'NOUN', '.', 'VERB', 'DET', 'ADJ', 'NOUN', 'VERB', 'ADV', 'ADJ', 'NOUN', 'VERB', 'PRON', 'ADP', 'DET', 'ADJ', 'NOUN', 'NOUN', 'ADP', 'NOUN']
```

Question #4.

I attached the ‘Assignment#5_Part4.pdf’ file for this question.