

Computer vision – HW10

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Question 1

A、Source code

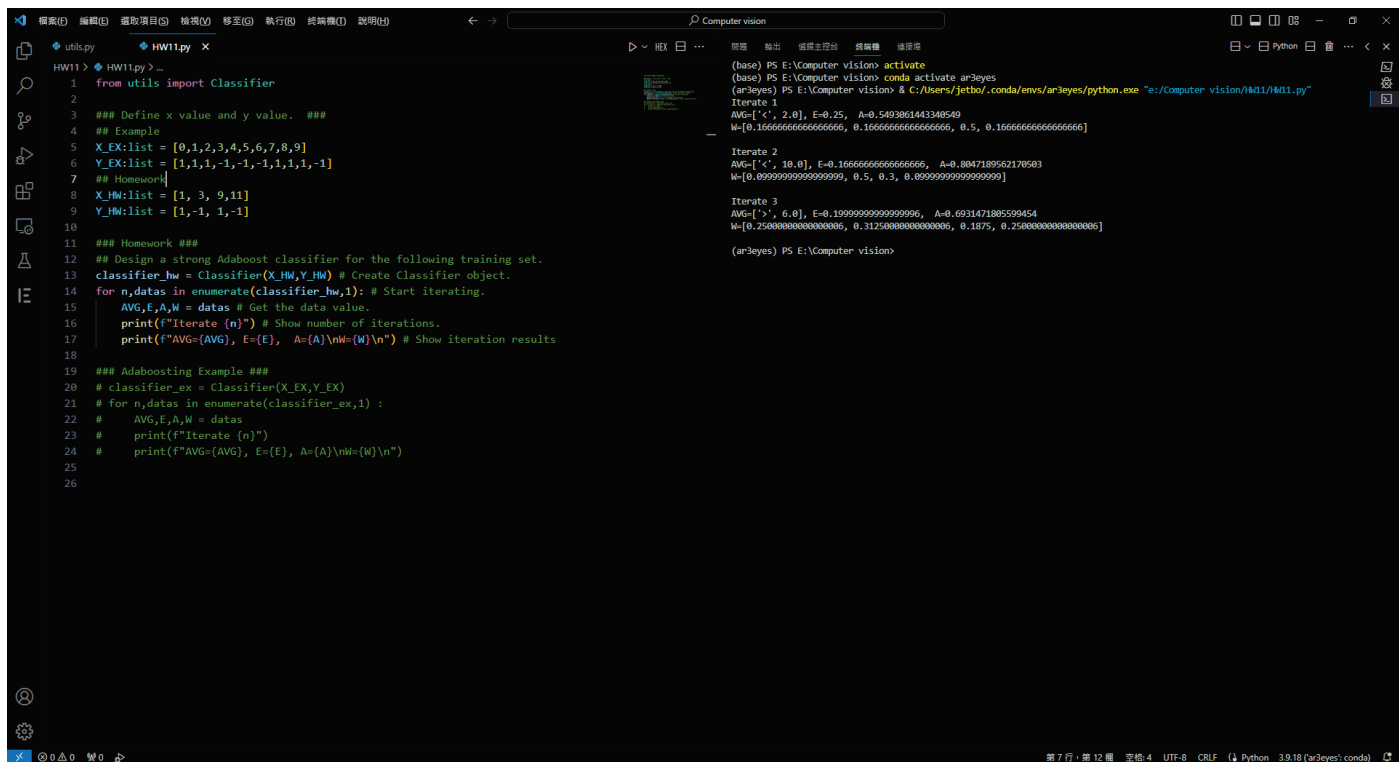
```
from utils import Classifier

### Define x value and y value. ###
## Example
X_EX:list = [0,1,2,3,4,5,6,7,8,9]
Y_EX:list = [1,1,1,-1,-1,-1,1,1,1,-1]
## Homework
X_HW:list = [1, 3, 9,11]
Y_HW:list = [1,-1, 1,-1]

### Homework ###
## Design a strong Adaboost classifier for the following training set.
classifier_hw = Classifier(X_HW,Y_HW) # Create Classifier object.
for n,datas in enumerate(classifier_hw,1): # Start iterating.
    AVG,E,A,W = datas # Get the data value.
    print(f"Iterate {n}") # Show number of iterations.
    print(f"AVG={AVG}, E={E}, A={A}\nW={W}\n") # Show iteration results

### Adaboosting Example ###
# classifier_ex = Classifier(X_EX,Y_EX)
# for n,datas in enumerate(classifier_ex,1) :
#     AVG,E,A,W = datas
#     print(f"Iterate {n}")
#     print(f"AVG={AVG}, E={E}, A={A}\nW={W}\n")
```

B、Result map



```
utils.py HW11.py x
HW11.py
1 from utils import Classifier
2
3 ### Define x value and y value. ###
4 ## Example
5 X_EX:list = [0,1,2,3,4,5,6,7,8,9]
6 Y_EX:list = [1,1,1,-1,-1,-1,1,1,-1]
7 ## Homework
8 X_HW:list = [1, 3, 9,11]
9 Y_HW:list = [1,-1, 1,-1]
10
11 ### Homework ###
12 ## Design a strong Adaboost classifier for the following training set.
13 classifier_hw = Classifier(X_HW,Y_HW) # Create Classifier object.
14 for n,datas in enumerate(classifier_hw,1): # Start iterating.
15     AVG,E,A,W = datas # Get the data value.
16     print(f"Iterate {n}") # Show number of iterations.
17     print(f"AVG={AVG}, E={E}, A={A}\nW={W}\n") # Show iteration results
18
19 ### Adaboosting Example ###
20 # classifier_ex = Classifier(X_EX,Y_EX)
21 # for n,datas in enumerate(classifier_ex,1):
22 #     AVG,E,A,W = datas
23 #     print(f"Iterate {n}")
24 #     print(f"AVG={AVG}, E={E}, A={A}\nW={W}\n")
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Appendix(utils.py)

```
# utils.py WeiWen Wu
from typing import Union,Optional
from numpy import log,exp,sign,float64

class Classifier:
    """
    Adaboost (Adaptive Boosting algorithm)

    # Example (for loop)
    ...

    classifier = Classifier(X,Y)
    for n,datas in enumerate(classifier,1):
        AVG,E,A,W = datas
        print(f"Iterate {n}")
        print(f"AVG={AVG}, E={E}, A={A}, W={W}")
    ...

    # Example (while loop)
    ...

    ### Parameter default value. ###
    classifier = Classifier(X_EX,Y_EX)
    verify = False

    ### Start iterating. ###
    while verify == False:
        AVG,E = classifier.error()
        A = classifier.alpha(E)
        W = classifier.update_weight(alpha=A,avg=AVG)
        verify = classifier.verify()
        print(f"AVG={AVG}, E={E}, A={A}, W={W}")
    ...

    """
    _verify:bool = False
    ### Record ###
    weight_record:list = []
    alpha_record:list = []
    avg_record:list = []
    error_record:list = []
    def __init__(self,x:list,y:list) -> None:
        _x_len = len(x)
```

```

    assert _x_len == len(y)
    self.X = x
    self.Y = y
    self.data_count = _x_len
    self.update_weight()

def error(self,p:Optional[list] = None) -> tuple[list[Union[str,int]],float]:
    """Train a weak classifier h(x) weighted training data minimizing the
    error."""
    x,y = self.X,self.Y
    value:list = []
    ave:list[float] = [] # average
    data_count:int = self.data_count
    p = self.weight_record[-1] if p == None else p
    for i in range(1,data_count):
        ave.append(['<',(x[i]+x[i-1])/2])
        ave.append(['>',(x[i]+x[i-1])/2])
        _error:int = 0
        for j in range(data_count):
            if (lambda a : -1 if a == 0 else 1)(x[j] < ave[-1][1]) !=
y[j]:_error+=p[j]
        _error_scale = _error
        value.append(_error_scale)
        value.append(1-_error_scale)
    index = value.index(min(value))
    # print(value)
    # print(ave)
    self.avg_record.append(ave[index])
    self.error_record.append(min(value))

    return ave[index], min(value)

def alpha(self,e:Optional[float]=None) -> float:
    """Compute voting weight of h(x)."""
    e = self.error_record[-1] if e == None else e
    assert e!=0, "<e> must not be 0"
    _result = float(0.5*log((1-e)/e))
    self.alpha_record.append(_result)
    return _result # a=0.5*log((1-e)/e)

```

```

def
update_weight(self, _w:Optional[list]=None,alpha:Optional[float]=None,avg:Optional[fl
at]=None) -> list:
    """Recompute weights (Weighting update)."""
    x,y = self.X,self.Y
    data_count = self.data_count
    weight_record = self.weight_record
    if len(weight_record)==0: # Initialize weights.
        _result = [1/data_count for _ in range(data_count)]
    else:
        _w = weight_record[-1] if _w == None else _w
        alpha = self.alpha_record[-1] if alpha == None else alpha
        avg = self.avg_record[-1] if avg == None else avg

        I = self.I
        _temp:list = []
        for n in range(data_count):
            # print(f"{sign(X,avg)[n]}, {Y[n]}")
            _exp:float64 = exp(-alpha*y[n]*I(x,avg[1],avg[0])[n])
            _temp.append(_w[n]*_exp)
        zt:int = sum(_temp)
        _result = [_/zt for _ in _temp] # Normalization.
    self.weight_record.append(_result)
    return _result #  $w(i) = wt(i) * \exp\{-\alpha * y_i * ht(x_i)\} / Z_t$ 

def I(self, _value:list,threshold:float,symbol:str='<'):
    _result:list = []
    for value in _value:
        _ = 1 if value < threshold else -1
        _result.append(_)
    if symbol == '<':return _result
    elif symbol == '>':return [-_ for _ in _result]
    else: raise ValueError("<symbol> must be '<' or '>'"")

def
sign_of_h(self,alpha_lists:Optional[list]=None,avg_lists:Optional[list]=None):
    """sign(H(x))"""
    x = self.X
    alpha_lists = self.alpha_record if alpha_lists == None else alpha_lists
    avg_lists = self.avg_record if avg_lists == None else avg_lists
    _result:list = []

```

```

assert len(alpha_lists)==len(avg_lists)

for n in range(self.data_count):
    _total = 0
    for count in range(len(alpha_lists)):
        a=self.I(x,avg_lists[count][1],avg_lists[count][0])
        _total += alpha_lists[count]*a[n]
    _result.append(sign(_total))

return _result


def verify(self,alpha_lists:Optional[list]=None,avg_lists:Optional[list]=None) ->
bool:
    """Verify the answer is correct."""
    y = self.Y
    for n,value in enumerate(self.sign_of_h(alpha_lists,avg_lists)):
        if float(value) != y[n]:return False # If verification error, exit the for
loop.
    return True


def __next__(self) -> tuple[list[str,int], float, float, list]:
    AVG,E = self.error() # Train a weak classifier weighted training data
minimizing the error.
    A = self.alpha() # Compute voting weight.
    W = self.update_weight() # Recompute weights.
    if self._verify==True: # If the verification is correct, the iteration will
end.
        raise StopIteration("The answer has been verified correct") # Verified
correct.
    self._verify = self.verify() # Verify the answer is correct.
    return AVG,E,A,W


def __iter__(self): return self

```