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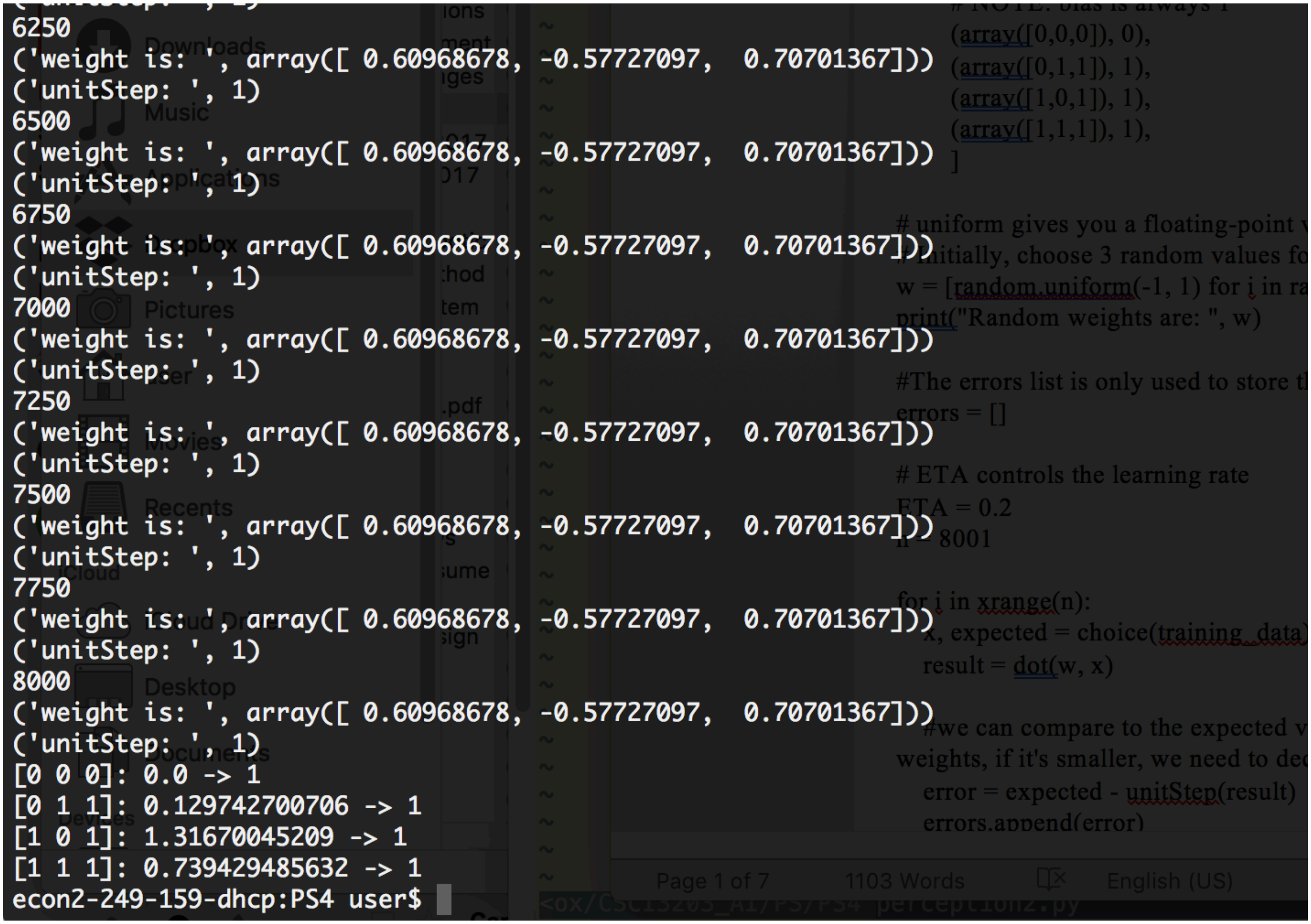
1) Perceptron

```
#!/bash/python

#The perceptron equation is S = sum(wi x xi) from i = 0 to i = n

#The function of the separated line is f(s) = 1 if S >= 0, 0 otherwise. I call it
#a step funciton

from random import choice
from numpy import array, dot, random

unitStep = lambda x: 0 if x < 0 else 1

training_data = [
        # array([A, B, C, bias]), expected output)]
        # NOTE: bias is always 1
        (array([0,0,0]), 0),
        (array([0,1,1]), 1),
        (array([1,0,1]), 1),
        (array([1,1,1]), 1),
        ]

# uniform gives you a floating-point value from -1 to 1
# Initially, choose 3 random values for weight
w = [random.uniform(-1, 1) for i in range(3)]
print("Random weights are: ", w)

#The errors list is only used to store the error values so that they can be plotted later on
errors = []

# ETA controls the learning rate
ETA = 0.2
n = 8001

for i in xrange(n):
    x, expected = choice(training_data)
    result = dot(w, x)

    #we can compare to the expected value. If the expected value is bigger, we need to increase the
weights, if it's smaller, we need to decrease them
    error = expected - unitStep(result)
    errors.append(error)
    w += ETA * error * x
```

```
    #print("w: ", w)
    if i % 250 == 0:
        print(i)
        print("weight is: ", w)
        print("unitStep: ", unitStep(result))
        #print("error array: ", errors)

for x, _ in training_data:
    #print("x: ", x)
    #print("_: ", _)
    #print("w: ", w)
    result = dot(x, w)
    print("{}: {} -> {}".format(x[:3], result, unitStep(result)))
```

```
('Random weights are: ', [0.6096867849252561, -0.577270966455786, 0.7070136671621734])
0
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
1000
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
1250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
1500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
1750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
2000
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
2250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
2500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
2750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
3000
```

```
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
3250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
3500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
3750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
4000
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
4250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
4500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
4750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
5000
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
5250
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
5500
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
5750
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
6000
('weight is: ', array([ 0.60968678, -0.57727097,  0.70701367]))
('unitStep: ', 1)
6250
```



There is no error before looping 250 times already, and the weight doesn't change anymore. I spoke to professor about this, he mentioned this depends on how we train our data. Also, we aren't supposed to train the input D because it's a bias.

2) Schelling neighborhood model

```
#!/bash/python3

#each element of neighbotModel is a house, we begin with all random int from 0 to 2 without
# beyond 6 for 0. 27 for 1, 27 for 2.
#I generat a value(num), which is an index of list, neighborModel and compare its neighbots
#, if it has two same kind of types, it will print "The number is satisfied", not otherwise.
# If the random number in the list is satisfied, the list doesn't swap. If it's not, then swap.

# Choose a random index for the list and output 6 more indexes from the chosen index

from random import randint
from collections import Counter
neighborModel = []

def generateRanArr():
    keepGenerating = False
    numCounter = 3
    zeroCounter = 1 # < 6
    oneCounter = 1 # < 27
    twoCounter = 1 # < 27

    while(not keepGenerating):
        m = randint(0, 2)

        # Make the first 3 elements different
        if m not in neighborModel:
            neighborModel.append(m)
        else:
            if m == 0 and zeroCounter < 6:
                neighborModel.append(m)
                zeroCounter = zeroCounter + 1

            elif m == 1 and oneCounter < 27:
                neighborModel.append(m)
                oneCounter = oneCounter + 1

            elif m == 2 and twoCounter < 27:
                neighborModel.append(m)
                twoCounter = twoCounter + 1

        if(zeroCounter + oneCounter + twoCounter == 60):
            keepGenerating = True

#Check a random dissatisfied occupant
def checkSatisfied(num, indexZero, numZero):
```

```
    #print("num is: ", num)
    #print("numZero: ", numZero)
    #print("Old indexZero: ", indexZero)

    if(num == 58):
        if (neighborModel[num + 1] == neighborModel[num] and neighborModel[0] ==
neighborModel[num]):
            print("The number is satisfied")
    elif(num == 59):
        if (neighborModel[0] == neighborModel[num] and neighborModel[1] ==
neighborModel[num]):
            print("The number is satisfied")
    # Check if the random occupant is happy
    elif (neighborModel[num + 1] == neighborModel[num] and neighborModel[num + 2] ==
neighborModel[num]):
        print("The number is satisfied")
    elif (neighborModel[num - 1] == neighborModel[num] and neighborModel[num -2] ==
neighborModel[num]):
        print("The number is satisfied")
    else:
        print("The number is NOT satisfied")
        #print("trackIndexZeroList: ", indexZero[numZero])
        swap = neighborModel[num]
        neighborModel[num] = neighborModel[indexZero[numZero]]
        neighborModel[indexZero[numZero]] = swap

    indexZero = [i for i, index in enumerate(neighborModel) if index == 0]
    #print("new indexZero: ", indexZero)
    #print ("new neighborModel: ", neighborModel)

generateRanArr()
counter = 1
i = 1

for i in range(60):
    first = []
    last = []
    #print(Counter(neighborModel))
    #print("Old neighborModel: ", neighborModel)

    # find indexes of 0 (empty occupant) in list
    indexZero = [i for i, index in enumerate(neighborModel) if index == 0]

    # Pick a value from 1 to 60
    num = randint(0, 59)
```

```
# Pick a random value for indexZero
numZero = randint(0, 5)

checkSatisfied(num, indexZero, numZero)
counter = counter + 1
# Output from a random index of list to 5 values more
if(counter % 20 == 0):
    ranSixDigitIndex = randint(0, 59)
    print("ranSixDigit: ", ranSixDigitIndex)

    # Handle some certain cases, and extend the output array
    if(ranSixDigitIndex == 55):
        first = neighborModel[:1]
        last = neighborModel[-5 : ]
        last.extend(first)
        print(last)
        #print(neighborModel[-5: 0])
    elif(ranSixDigitIndex == 56):
        first = neighborModel[:2]
        last = neighborModel[-4 : ]
        last.extend(first)
        print(last)

        #print(neighborModel[-4: 1])
    elif(ranSixDigitIndex == 57):
        first = neighborModel[:3]
        last = neighborModel[-3 : ]
        last.extend(first)
        print(last)

        #print(neighborModel[-3 : 2])
    elif(ranSixDigitIndex == 58):
        first = neighborModel[:4]
        last = neighborModel[-2 : ]
        last.extend(first)
        print(last)

        #print(neighborModel[-2 : 3])
    elif(ranSixDigitIndex == 59):
        first = neighborModel[ : 5]
        last = neighborModel[-1: ]
        last.extend(first)
        print(last)
        #print(neighborModel[-1 : 4])
    else:
        print("six digits neighborModel", neighborModel[ranSixDigitIndex: ranSixDigitIndex + 6])
```

```python
    print(counter)
```

Output:

```
six digits neighborModel [1, 1, 1, 1, 1, 1]
20
six digits neighborModel [0, 1, 2, 0, 2, 2]
40
six digits neighborModel [1, 2, 1, 1, 1, 2]
60
six digits neighborModel [1, 0, 1, 2, 1, 2]
80
six digits neighborModel [2, 2, 2, 2, 1, 2]
100
six digits neighborModel [1, 1, 1, 1, 1, 1]
120
six digits neighborModel [2, 1, 2, 2, 2, 2]
140
six digits neighborModel [1, 1, 1, 1, 1, 1]
160
six digits neighborModel [1, 1, 1, 1, 2, 2]
180
six digits neighborModel [1, 1, 1, 1, 1, 1]
200
six digits neighborModel [2, 2, 2, 2, 1, 1]
220
six digits neighborModel [1, 1, 1, 1, 1, 1]
240
six digits neighborModel [2, 2, 2, 2, 2, 1]
260
six digits neighborModel [2, 2, 2, 2, 1, 1]
280
six digits neighborModel [1, 1, 1, 1, 1, 1]
300
[1, 1, 1, 1, 1, 2]
320
six digits neighborModel [2, 2, 2, 2, 2, 2]
340
six digits neighborModel [1, 1, 1, 1, 1, 1]
360
six digits neighborModel [2, 2, 2, 1, 1, 1]
380
[1, 1, 1, 0, 0, 0]
400
new neighborModel:  [1, 1, 0, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 2, 2, 2, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
```

The “ring city’ does move toward a “totally satisfied” state every time I run it. Although sometimes it is just close to the state of “totally satisfied”, it is a really beautiful idea of swap. In some way, this looks like a sorting algorithm like the selection sort.

This time (the picture above), it is completely satisfied! I am really surprised this happens because when I got this assignment and read it, I told the professor that this will never be the totally satisfied state.