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CS453x – Jacob Whitehill
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HOMEWORK 1

1. PYTHON AND NUMPY

Jonathan Metzger
Homework1
CS453x Machine Learning

VALUES:

```
# arrays
A = np.array([[3,5],[6,2]])
B = np.array([[2,3],[7,5]])
C = np.array([[5,3],[13,5]])

x = np.array([[5],[6]])
y = np.array([[4],[8]])

# scalars
alpha = 2
c = 0
d = 4

k = 5

## row
i = 0
## column
j = 1
```

Problem 1
[[5 8] [13 7]]

Problem 2
[[36 31] [13 23]]

Problem 3
[[11 28] [45 15]]

Problem 4
[[68]]

Problem 5
[[0 0] [0 0]]

Problem 6
[1. 1.]

Problem 7
[[-0.08333 0.20833] [0.25   -0.125   ]]

Problem 8
[[5. 5.] [6. 4.]]

Problem 9
5

Problem 10
8

Problem 11
2.5

Problem 12
[40. -15.]

Problem 13
[[45.] [42.]]

Problem 14
[[0.83333333] [0.5   ]]

2. SMILE

A. Step-wise classifier: Timed at 3.5 hours

m	Pixel	Best Accuracy per Test
1	(20, 7, 17, 7)	71.1%
2	(12, 5, 10, 13)	71.6%
3	(12, 19, 17, 7)	71.8%
4	(12, 5, 9, 6)	72.2%
5	--	----

B. Output

```
$ python
homework1_smile_jrmetzger.py
```

Found best: (0, 0, 0, 1) with 0.515

Found best: (0, 0, 0, 2) with 0.531

Found best: (0, 0, 0, 3) with 0.535

Found best: (0, 0, 0, 4) with 0.550

Found best: (0, 0, 0, 18) with 0.555

Found best: (0, 0, 0, 19) with 0.556

Found best: (0, 1, 0, 4) with 0.558

Found best: (0, 8, 0, 19) with 0.560

Found best: (0, 8, 11, 11) with 0.562

Found best: (0, 8, 16, 8) with 0.567

Found best: (0, 8, 17, 8) with 0.568

Found best: (1, 7, 10, 12) with 0.569

Found best: (1, 7, 12, 12) with 0.569

Found best: (1, 8, 2, 6) with 0.573

Found best: (1, 8, 3, 5) with 0.578

Found best: (1, 8, 11, 11) with 0.588

Found best: (1, 8, 16, 7) with 0.592

Found best: (2, 8, 16, 7) with 0.593

Found best: (3, 7, 16, 7) with 0.595

Found best: (3, 8, 16, 7) with 0.608

Found best: (4, 8, 16, 7) with 0.610

Found best: (6, 11, 15, 8) with 0.621

Found best: (6, 12, 15, 16) with 0.625

Found best: (6, 12, 16, 17) with 0.628

Found best: (7, 11, 16, 7) with 0.630

Found best: (7, 12, 16, 7) with 0.631

Found best: (7, 12, 16, 8) with 0.639

Found best: (14, 3, 16, 7) with 0.644

Found best: (17, 4, 16, 17) with 0.646

Found best: (18, 4, 16, 7) with 0.648

Found best: (18, 4, 16, 16) with 0.660

Found best: (18, 5, 16, 6) with 0.663

Found best: (18, 5, 16, 7) with 0.667

Found best: (18, 5, 16, 17) with 0.670

Found best: (19, 5, 16, 7) with 0.678

Found best: (19, 6, 16, 7) with 0.683

Found best: (19, 6, 17, 7) with 0.685

Found best: (20, 6, 17, 7) with 0.690

Found best: (20, 7, 17, 7) with 0.711

Found Most Accurate Set
[(20, 7, 17, 7)] with 71.1 %

Found best: (0, 0, 0, 1) with 0.609

Found best: (0, 0, 0, 2) with 0.626

Found best: (0, 0, 0, 3) with 0.639

Found best: (0, 0, 0, 4) with 0.651

Found best: (0, 0, 0, 19) with 0.652

Found best: (0, 0, 8, 7) with 0.664

Found best: (0, 9, 0, 6) with 0.665

Found best: (0, 9, 0, 18) with 0.668

Found best: (0, 9, 0, 19) with 0.672

Found best: (1, 7, 0, 18) with 0.672

Found best: (1, 8, 0, 4) with 0.674

Found best: (1, 8, 0, 5) with 0.680

Found best: (1, 8, 0, 18) with 0.681

Found best: (1, 8, 0, 19) with 0.683

Found best: (1, 9, 0, 19) with 0.689

Found best: (2, 8, 0, 5) with 0.690

Found best: (2, 8, 0, 19) with 0.691

Found best: (2, 14, 9, 6) with 0.691

Found best: (3, 7, 0, 18) with 0.693

Found best: (3, 7, 0, 19) with 0.696

Found best: (3, 9, 0, 19) with 0.699

Found best: (3, 15, 0, 19) with 0.701

Found best: (4, 10, 0, 19) with 0.704

Found best: (4, 11, 0, 19) with 0.705

Found best: (5, 12, 0, 19) with 0.706

Found best: (11, 3, 0, 19) with 0.707

Found best: (11, 4, 9, 6) with 0.709

Found best: (11, 19, 17, 7) with 0.711

Found best: (12, 4, 9, 6) with 0.713

Found best: (12, 5, 10, 13) with 0.716

Found Most Accurate Set
[(20, 7, 17, 7), (12, 5, 10, 13)] with 71.6%

Found best: (0, 0, 0, 1) with 0.606

Found best: (0, 0, 0, 2) with 0.625

Found best: (0, 0, 0, 3) with 0.640

Found best: (0, 0, 0, 4) with 0.654

Found best: (0, 0, 8, 7) with 0.668

Found best: (0, 9, 0, 18) with 0.671

Found best: (1, 7, 0, 5) with 0.674

Found best: (1, 7, 0, 18) with 0.676

Found best: (1, 8, 0, 5) with 0.681

Found best: (1, 8, 0, 7) with 0.683

Found best: (1, 8, 0, 18) with 0.685

Found best: (1, 8, 0, 19) with 0.686

Found best: (1, 9, 0, 19) with 0.692

Found best: (2, 8, 0, 5) with 0.693

Found best: (2, 9, 8, 6) with 0.694

Found best: (2, 9, 8, 7) with 0.695

Found best: (3, 7, 0, 18) with 0.697

Found best: (3, 7, 0, 19) with 0.698

Found best: (3, 9, 0, 19) with 0.701

Found best: (3, 9, 8, 7) with 0.702

Found best: (3, 15, 0, 19) with 0.703

Found best: (4, 9, 0, 19) with 0.703

Found best: (4, 9, 8, 6) with 0.704

Found best: (4, 9, 8, 7) with 0.705

Found best: (4, 9, 17, 7) with 0.706

Found best: (4, 10, 0, 19) with 0.707

Found best: (11, 3, 0, 19) with 0.709

Found best: (11, 4, 9, 6) with 0.712

Found best: (11, 19, 17, 7) with 0.713

Found best: (12, 4, 9, 6) with 0.714

Found best: (12, 5, 9, 6) with 0.717

Found best: (12, 19, 17, 7) with 0.718

Found Most Accurate Set
[(20, 7, 17, 7), (12, 5, 10, 13), (12, 19, 17, 7)]
71.8%

Found best: (0, 0, 0, 1) with 0.608

Found best: (0, 0, 0, 2) with 0.627

Found best: (0, 0, 0, 3) with 0.642

Found best: (0, 0, 0, 4) with 0.655

Found best: (0, 0, 8, 7) with 0.670

Found best: (1, 7, 0, 5) with 0.675

Found best: (1, 7, 0, 18) with 0.676

Found best: (1, 8, 0, 4) with 0.677

Found best: (1, 8, 0, 5) with 0.682

Found best: (1, 8, 0, 7) with 0.685

Found best: (1, 8, 0, 19) with 0.686

Found best: (1, 9, 0, 11) with 0.688

Found best: (1, 9, 0, 19) with 0.692

Found best: (2, 8, 0, 5) with 0.694

Found best: (2, 8, 0, 19) with 0.695

Found best: (2, 9, 8, 6) with 0.698

Found best: (2, 9, 8, 7) with 0.699

Found best: (3, 7, 0, 19) with 0.701

Found best: (3, 9, 0, 19) with 0.703

Found best: (3, 9, 8, 7) with 0.706

Found best: (4, 9, 0, 19) with 0.706

Found best: (4, 9, 8, 6) with 0.707

Found best: (4, 9, 8, 7) with 0.708

Found best: (4, 10, 0, 19) with 0.709

Found best: (5, 10, 8, 7) with 0.710

Found best: (11, 4, 9, 6) with 0.714

Found best: (12, 4, 9, 6) with 0.716

Found best: (12, 4, 9, 7) with 0.716

Found best: (12, 5, 9, 6) with 0.720

Found Most Accurate Set
[(20, 7, 17, 7), (12, 5, 10, 13), (12, 19, 17, 7), (12, 5, 9, 6)] 72.0%

Found best: (0, 0, 0, 1) with 0.608

Found best: (0, 0, 0, 2) with 0.627

Found best: (0, 0, 0, 3) with 0.642

Found best: (0, 0, 0, 4) with 0.655

Found best: (0, 0, 8, 7) with 0.670

Found best: (1, 7, 0, 5) with 0.675

Found best: (1, 7, 0, 18) with 0.677

Found best: (1, 8, 0, 4) with 0.678

Found best: (1, 8, 0, 5) with 0.683

Found best: (1, 8, 0, 7) with 0.685

Found best: (1, 8, 0, 19) with 0.687

Found best: (1, 9, 0, 11) with 0.690

Found best: (1, 9, 0, 19) with 0.692

Found best: (2, 8, 0, 5) with 0.696

Found best: (2, 9, 8, 6) with 0.697

Found best: (2, 9, 8, 7) with 0.700

Found best: (3, 7, 0, 19) with 0.701

Found best: (3, 9, 0, 19) with 0.704

Found best: (3, 9, 8, 7) with 0.706

Found best: (4, 9, 0, 19) with 0.707

Found best: (4, 9, 8, 7) with 0.709

Found best: (4, 10, 0, 19) with 0.710

Found best: (4, 11, 0, 19) with 0.710

Found best: (5, 10, 8, 7) with 0.711

Found best: (11, 4, 9, 6) with 0.713

Found best: (11, 19, 17, 7) with 0.715

Found best: (12, 4, 9, 6) with 0.716

Found best: (12, 4, 9, 7) with 0.718

Found best: (12, 5, 9, 6) with 0.720

Found best: (12, 6, 9, 6) with 0.720

Found Most Accurate Set
[(20, 7, 17, 7), (12, 5, 10, 13), (12, 19, 17, 7), (12, 5, 9, 6), (12, 6, 9, 6)]

Accuracy on training set: 0.720

Accuracy on testing set: 0.693

Found Most Accurate Set

AT 6.5 HOURS

WE ASSUME THIS IS THE MOST ACCURATE:

m	Accuracy	Pixel Point
5	**72%**	**at (12,6,9,6)**
4	**72%**	**at (12, 5, 9, 6)**
3	**71.8%**	**at (20, 7, 17,7)**
2	**71.6%**	**at (12, 5, 910 13)**
1	**71.1%**	**at (20, 7, 17, 7)**

(further implemented Accuracy % and Test % Done)