CS101 Practice Final Exam
NO SOLUTIONS WILL BE PROVIDED

- Be sure to enter your NetID and the code below on your Scantron.
- Do not turn this page until instructed to.
- There are a total of 200 possible points on this exam.
- There are 30 multiple choice questions worth 5 points each.
- There are 2 coding questions worth 25 points each.
- Each question has only one correct answer.
- You must not communicate with other students during this test.
- No books, notes, or electronic devices allowed.
- This is a 120 minute exam.
- There are several different versions of this exam.

1. Fill in your information:
   
   **Full Name:** ________________________________
   
   **UIN (Student Number):** ________________________________
   
   **NetID:** ________________________________

2. Fill in the following answers on the Scantron form:

   93. A
   94. A
   95. D
   96. C
The following 20 questions are about Python.

10 questions in this section will be based on questions from the previous midterms and study guides, so use them as a study guide for those questions. The remaining 10 Python questions will look like the ones below.

1. (1 point) Consider the following simulation program.

```python
v=500000
x=0.0
t=0.0
dt=.001
while x<1000:
    t+=dt
    x+=v*dt
```

The program simulates an object (the Millennium Falcon, of course) moving at a constant velocity (she’s fast enough for you). Which of the following is a state variable in this simulation?

(A) v
(B) dt
(C) x
2. (1 point) Consider the following incomplete program:

```python
import itertools
x="R2D2"
???
    print(x)
```

Replacing the three question marks with which of the following will result in 'R2D2' being printed exactly once?

- (A) for a in itertools.combinations(x,1):
- (B) for a in itertools.combinations(x,2):
- (C) for a in itertools.combinations(x,4):
- (D) for a in itertools.combinations(x,3):

3. (1 point) Which of the following lines would best simulate a roll of one dice?

- (A) x=np.random.rand(np.arange(1,7))
- (B) x=np.random.randn(np.arange(1,7))
- (C) x=np.random.shuffle(np.arange(1,7))
- (D) x=np.random.choice(np.arange(1,7))
4. (1 point) Your friend is very proud of his new laptop password. In fact, he’s so confident you can’t
guess it, he tells you he’ll give you $100 dollars if you can guess it correctly, and he says you can guess
as many times as you like. You know that the password contains only letters (upper and lower case,) and
that the password is less than 10 characters long. Your friend also accidentally revealed that the
password contains no repeating characters. Let f be a function that tells you how much money a given
password is worth. The function should return 100 if the password is correct or 0 if the password is
wrong.

```python
letters="abcdefghijklmnopqrstuvwxyz"
letters+=letters.upper()
???
print("The password is: %s" % ''.join(answer))
```

What should replace the three question marks to complete the program to find the input that maximizes
the function f?

(A) for i in range(10):
    for p in itertools.combinations(letters,i):
        if f(p)>0:
            answer=p

(B) for i in range(10):
    for p in itertools.product(letters,i):
        if f(p)>0:
            answer=p

(C) for i in range(10):
    for p in itertools.permutations(letters,i):
        if f(p)>0:
            answer=p

(D) None of the other answers are correct.
5. (1 point) Consider the following incomplete program.

```python
v=0.0
y=1.0
g=-9.8
t=0.0
dt=???
while y>0.0:
    t+=dt
    v+=g*dt
    y+=v*dt
```

The program is intended to simulate an object (a lightsaber, of course) falling from a height of 1 meter. If we replace the question marks with one of the following values, which choice would produce the most accurate simulation?

(A) 0.0001
(B) 0.1
(C) 0.001
(D) 0.01

6. (1 point) What do we call the optimization technique that involves computing the entire domain of a function?

(A) Brute-force search
(B) Hill climbing
(C) Random search
(D) Greedy search
7. (1 point) Consider the following incomplete program.

```python
import matplotlib.pyplot as plt
import numpy as np

???
plt.hist(x,bins=100)
plot.show()
```

Which line should replace the three question marks to produce the following plot?

(A) `x=np.random.rand(1000000)`

(B) `x=np.random.randn(1000000)`

(C) `x=np.random.choice(np.arange(1000000))`

(D) `x=np.random.shuffle(np.arange(1000000))`
8. (1 point) When a greedy or hill-climbing algorithm gets stuck on a suboptimal solution, what do we call this?

(A) A local optimum
(B) Steepest ascent
(C) An exception
(D) Random search

9. (1 point) What do we call the optimization heuristic that involves iteratively checking to see if neighboring solutions improve upon the current solution?

(A) Random search
(B) Local optimum
(C) Brute-force search
(D) Hill climbing
10. (1 point) Consider the following program.

```python
import numpy as np
x=np.arange(1,4)
np.random.shuffle(x)
print(x)
```

Which of the following is not a possible output for this program?

(A) [3,1,2]
(B) All of the other answers are possible outputs.
(C) [3,2,1]
(D) [1,2,3]
(E) [2,3,1]
The following 10 questions are about Matlab.

Since we haven’t seen a lot of Matlab, there are 15 practice questions below. There will only be 10 on the actual final exam.

11. (5 points) Consider the following Matlab program.

\[
A = \text{eye}(3,3) + \text{ones}(3,3);
\]
\[
A = 2 \times A;
\]
\[
A = A(:,1:2)
\]

After it is run, what is the final \textbf{value} of \( A \)?

(A) \[
\begin{bmatrix}
4 & 2 \\
2 & 4 \\
2 & 2
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
4 & 2 & 2 \\
2 & 4 & 2
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
2 & 4 & 2 \\
2 & 2 & 4
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
2 & 2 \\
4 & 2 \\
2 & 4
\end{bmatrix}
\]
12. (5 points) Consider the following Matlab program.

\[ x = (3 < 5) \lor ((2 > 3) \land (1"=1)) \]

After it is run, what is the final value of \( x \)?

(A) False

(B) True

(C) 1

(D) 0

13. (5 points) Consider the following 2-dimensional Matlab array:

\[
\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{bmatrix}
\]

Assuming it is stored in a variable named \( A \), how can we index and retrieve the value 3?

(A) \( A(3,1) \)

(B) \( A(2,0) \)

(C) \( A(1,3) \)

(D) \( A(0,2) \)
14. (5 points) Consider the following Matlab program.

```matlab
x=1:3;
y=2:4;
z=[x ; y];
```

After it is run, what is the final value of z?

(A) \[
\begin{bmatrix}
1 & 2 \\
3 & 4
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
1 & 2 & 3 \\
2 & 3 & 4
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
1 & 3 \\
2 & 4
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
1 & 2 \\
2 & 3 \\
3 & 4
\end{bmatrix}
\]

(E) \[
\begin{bmatrix}
1 & 2 \\
3 & 4
\end{bmatrix}
\]
15. (5 points) Consider the following Matlab program.

\[ A = \text{ones}(3,3) \times \text{ones}(3,3); \]

After it is run, what is the final value of A?

(A) \[
\begin{bmatrix}
3 & 0 & 0 \\
0 & 3 & 0 \\
0 & 0 & 3
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
2 & 0 & 0 \\
0 & 2 & 0 \\
0 & 0 & 2
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
3 & 3 & 3 \\
3 & 3 & 3 \\
3 & 3 & 3
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
1 & 1 & 1 \\
1 & 1 & 1 \\
1 & 1 & 1
\end{bmatrix}
\]
16. (5 points) Consider the following Matlab program.

\[ A = \text{ones}(3,3) - \text{eye}(3,3); \]
\[ A = 2 * A; \]
\[ A = A(1:2,:); \]

After it is run, what is the final value of \( A \)?

(A) \[
\begin{bmatrix}
2 & 0 & 2 \\
2 & 2 & 0
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
2 & 2 \\
0 & 2 \\
2 & 0
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
0 & 2 & 2 \\
2 & 0 & 2
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
0 & 2 \\
2 & 0 \\
2 & 2
\end{bmatrix}
\]

17. (5 points) Consider the following Matlab program.

\[ A = [1,1,1;0,1,1;0,0,1] \]
\[ B = A([1,2,1],[2,3,2]) \]
\[ x = B(1,1) + B(2,2) + B(3,3) \]

After it is run, what is the final value of \( x \)?

(A) None of the other answers are correct.

(B) 12

(C) 11

(D) 0

(E) 7
18. (5 points) Consider the following 2-dimensional Matlab array:

\[
\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
10 & 11 & 12 \\
\end{bmatrix}
\]

Assuming it is stored in a variable named `a`, how can we index and retrieve the value 8?

(A) A(1,2)

(B) A(3,2)

(C) A(2,1)

(D) A(2,3)
19. (5 points) Consider the following Matlab program.

\[
x = 2 \times \text{eye}(2,2);
y = [1,2;3,4];
z = [y', x'; x, y]
\]

After it is run, what is the final value of \( z \)?

(A) \[
\begin{pmatrix}
1 & 3 & 2 & 0 \\
2 & 4 & 0 & 2 \\
0 & 2 & 2 & 4
\end{pmatrix}
\]

(B) \[
\begin{pmatrix}
1 & 3 & 2 & 0 \\
2 & 4 & 0 & 2 \\
2 & 0 & 1 & 2 \\
0 & 2 & 3 & 4
\end{pmatrix}
\]

(C) \[
\begin{pmatrix}
1 & 2 & 2 & 0 \\
3 & 4 & 0 & 2 \\
2 & 0 & 1 & 3 \\
0 & 2 & 2 & 4
\end{pmatrix}
\]

(D) None of the other answers are correct

(E) \[
\begin{pmatrix}
2 & 0 & 1 & 3 \\
0 & 2 & 2 & 4 \\
1 & 3 & 2 & 0 \\
2 & 4 & 0 & 2
\end{pmatrix}
\]
20. (5 points) Consider the following Matlab program.

```matlab
x=0:4;
y=5:9;
z=x+y;
```

After it is run, what is the final value of z?

(A) \[
\begin{bmatrix}
7 & 9 & 11 & 13 & 15 \\
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
1 & 6 \\
5 & 10 \\
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
1 & 5 \\
6 & 10 \\
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
7 \\
15 \\
\end{bmatrix}
\]

(E) \[
\begin{bmatrix}
5 & 7 & 9 & 11 & 13 \\
\end{bmatrix}
\]
21. (5 points) Consider the following Matlab program.

\[
A=\text{eye}(3,3)+\text{ones}(3,3);
\]

\[
\text{for } x=1:3
\]

\[
\text{\quad for } y=1:3
\]

\[
\text{\quad \quad if } A(x,y)\neq 2
\]

\[
\text{\quad \quad \quad } A(x,y)=x+y;
\]

\[
\text{\quad \quad end}
\]

\[
\text{\quad end}
\]

After it is run, what is the final value of A?

(A) \[
\begin{bmatrix}
2 & 4 & 6 \\
2 & 2 & 6 \\
2 & 4 & 2 \\
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
2 & 2 & 2 \\
4 & 2 & 4 \\
6 & 6 & 2 \\
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
2 & 1 & 1 \\
1 & 4 & 1 \\
1 & 1 & 6 \\
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
2 & 3 & 4 \\
3 & 2 & 5 \\
4 & 5 & 2 \\
\end{bmatrix}
\]
22. (5 points) Consider the following Matlab program.

\[ A = [2*\text{ones}(2,2) ; 3*\text{eye}(3,2)] \]
\[ x = A([5:-2:1], [3, 3, 1]) \]

After it is run, what is the final value of \( x \)?

(A) \[
\begin{bmatrix}
2 & 2 & 2 \\
0 & 0 & 0
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
3 & 3 & 0 \\
0 & 0 & 3 \\
2 & 2 & 2
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
3 & 0 & 0 \\
0 & 0 & 3 \\
2 & 2 & 2
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
0 & 0 & 0 \\
2 & 2 & 2
\end{bmatrix}
\]
23. (5 points) Consider the following Matlab program.

```matlab
x=0
for y=1:3
    for z=1:3
        if (y+z)==3
            x = x + (y | z)
        end
    end
end
```

After it is run, what is the final value of \( x \)?

(A) 7  
(B) 2  
(C) 1  
(D) 3

24. (5 points) Consider the following Matlab program.

```matlab
A=[1,1,1;0,1,1;0,0,1];  
B=A';  
x=B(1,2)+B(2,2)+B(3,2);  
```

After it is run, what is the final value of \( x \)?

(A) 3  
(B) 2  
(C) None of the other answers are correct.  
(D) 1  
(E) 0
25. (5 points) Consider the following Matlab program.

```matlab
A=eye(3,3);
for x=1:2:3
    for y=1:3
        A(x,y)=A(y,x)+1;
    end
end
```

After it is run, what is the final value of A?

(A) \[
\begin{bmatrix}
2 & 0 & 1 \\
0 & 2 & 0 \\
1 & 0 & 2 \\
\end{bmatrix}
\]

(B) \[
\begin{bmatrix}
1 & 2 & 1 \\
2 & 0 & 2 \\
2 & 1 & 2 \\
\end{bmatrix}
\]

(C) \[
\begin{bmatrix}
1 & 1 & 1 \\
1 & 1 & 1 \\
1 & 1 & 1 \\
\end{bmatrix}
\]

(D) \[
\begin{bmatrix}
1 & 2 & 0 \\
0 & 2 & 0 \\
0 & 2 & 1 \\
\end{bmatrix}
\]

(E) \[
\begin{bmatrix}
2 & 1 & 1 \\
0 & 1 & 0 \\
2 & 1 & 2 \\
\end{bmatrix}
\]
The following 2 coding questions are about Python.

There are many practice questions below. On the real exam, there will be 2. We wanted to give you some extra practice.

26. (25 points) Congratulations! You’ve just been hired by the FBI, and your boss needs your help unlocking a criminal’s iPhone. The default iPhone passcode is exactly 4 digits long, each between 0 and 9. Assume someone else has already written a function `test_password` that takes a single string argument representing a possible passcode (with a length of exactly 4 characters.) `test_password` returns `True` if the input passcode unlocks the phone and `False` otherwise. Write a Python function `crack_iphone` that takes no arguments and returns a string representing the passcode that unlocks the phone. **CAUTION:** The string "0" is not a possible passcode, but "0000" is.

```python
def crack_iphone():
```

27. (25 points) Write a Python function named `sum_elements` which takes three arguments, `A`, `m`, and `n`. `A` is a 2-dimensional numpy array of floating point values. `m` is the number of rows in the matrix and `n` is the number of columns. Your function should return the sum of all of the elements of the input array. **NOTE:** You may not import any modules. Your answer should be pure Python.

```python
def sum_elements(A,m,n):
```
28. (25 points) Without using import, write a function called \texttt{print\_pass} that takes two dictionary arguments \texttt{dictA} and \texttt{dictB}. \texttt{dictA} is a dictionary containing a mapping between a student's netId and his or her full name. For example,
\begin{verbatim}
dictA = {"bwilson":"Brian Wilson","mlove2":"Mike Love","jlennon":"John Lennon"}
\end{verbatim}
\texttt{dictB} is a dictionary that contains a mapping between a student's netId and his or her letter grade in CS101. For example:
\begin{verbatim}
dictB = {"bwilson":85,"mlove2":90,"jlennon":55}
\end{verbatim}
Write a Python function that prints the names and grades of students who got an 70 or better. For example, your output might look like:

Brian Wilson 85
Mike Love 90

If a student’s netid is missing from either dictionary, their name should not be printed.

29. (25 points) Write a Python function named \texttt{sum\_elements} which takes three arguments, \texttt{A}, \texttt{m}, and \texttt{n}. \texttt{A} is a 2-dimensional numpy array of floating point values. \texttt{m} is the number of rows in the matrix and \texttt{n} is the number of columns. Your function should return the sum of all of the elements whose value is greater than 10 of the input array. \textbf{NOTE:} You may not import any modules. Your answer should be pure Python.

30. (25 points) Without using import, write a function called \texttt{best\_pair} that takes a single argument \texttt{input\_list}, which is a list of floating point numbers. Your function should return a tuple containing the pair of indexes whose values in \texttt{input\_list} have the highest sum. For example, if \texttt{input\_list}=[3.2,1.9,3.7,4.4,1.3], then your function should return the tuple (2,3)
31. (25 points) Without using import, write a function called `sorting_hat` that takes a single argument `wizards`, which is a list of tuples. Each tuple contains a wizard’s courage, cunning and ambition. For example, `(3, 5, 9)` is a wizard with 3 courage, 5 cunning, and 9 ambition. Wizards are assigned to a house according to the following criteria:

- Wizards with courage of 9 or more are assigned to house “Griffindor”.
- Wizards not in “Griffindor” with cunning of 9 or more are assigned to house “Ravenclaw”.
- Wizards not in “Griffindor” or “Ravenclaw” with ambition of 9 or more are assigned to house “Slitheryn”.
- All other wizards are assigned to house “Hufflepuff”.

Your function should return a dictionary that counts the number of wizards assigned to each house.