

Name _____

Python for Math and Stat Fall 2022 Final Exam

This exam is worth 75 points. Assume that all necessary packages have been imported. When done with the exam, please **scan and upload to Gradescope**, then hand in the paper version.

1. (12 pts) Let

```
arr = np.array([[ 7, 13,  3,  2],  
               [12,  6,  9,  5]])
```

For the following 4 problems, write down what each code block would display if executed in a Jupyter cell.

(a) `arr[1, ::-1]`

(b) `arr[:, 3] ** 2`

(c) `arr[arr // 10 > 0]`

(d) `(lambda x: x+10)(arr[1, 2:])`

3. (8 pts) Write a function `translate(words, lang_dict)` that takes a string of words, separated by spaces, and returns a new string, replacing each word found in `lang_dict` with its equivalent. If a word is not found in the dictionary, it appears unchanged in the new string.

Example: To convert Spanish words into English, create a Spanish-English dictionary like the one below. Suppose the word `'python'` (which means python) is not included.

```
span_dict = { 'casa': 'house', 'azul': 'blue', ... }
```

Then `translate('casa azul python', span_dict)` returns `'house blue python'`.

4. (8 pts)

```
def func(n):  
    return ...
```

Suppose `func` is an increasing function and you wish to find a value of `n` such that `func(n)` is greater than a threshold value. Write a function `exceed(thresh)` that checks the integers $n=1, 2, 4, 8, \dots$, one at a time, and stops when `func(n)` is greater than `thresh`, returning the successful value of `n`. Each iteration doubles the previous value of `n`. (Assume that the domain and range of `func` include all positive real numbers.)

Example:

Suppose `func(n)` returns $n + 2^{*n}$. Then `exceed(25)` returns 8 because $4 + 2^4 < 25$ and $8 + 2^8 > 25$.

5. (8 pts) Consider the nested square root expression

$$\sqrt{a_1 + \sqrt{a_2 + \cdots + \sqrt{a_n}}}$$

Write a **recursive** function `roots(nums)` that takes a non-empty list of positive numbers a_i and returns the value of the corresponding nested square root expression.

Example: `roots([7, 2, 4])` returns 3.0 because $\sqrt{7 + \sqrt{2 + \sqrt{4}}} = 3$.

7. (19 pts)

(a) Create a class called `Point`. Each object in the class represents a point in the xy -plane. It has two attributes:

- `x`: the x -coordinate of the point
- `y`: the y -coordinate of the point

and the following methods:

- `dist(pt)`

