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:])`

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2. (8 pts) Write a function `digit_in_num(digit, num)` that returns `True` if the integer `num` contains `digit` and returns `False` otherwise. Assume that `num` is a positive `int` and that `digit` is an `int` between 0 and 9 inclusive. **Use arithmetic operations.** DO NOT use string operations.

   Examples:
   `digit_in_num(8, 56180)` returns `True`.
   `digit_in_num(4, 5618073)` returns `False`.

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 `'piton'` (which means python) is not included.

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

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

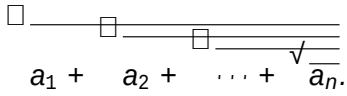
4. (8 pts)

```
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, ...`, 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)`

(b) Add this `Point` method:

- `connect(pt_list)`: given a list of `Points`, draws line segments connecting the given point to the other points, in order.

Example:

```
pt1 = Point(-2, 6)
pt2 = Point(3, 3)
Point(1, 2).connect([pt1, pt2])
```

draws line segments from (1, 2) to (−2, 6) to (3, 3).