

ChatGPT or CheatGPT? Mathematical Programming with Python

MATH 2604: Advanced Scientific Computing 4

Spring 2025

Monday/Wednesday/Friday, 1:00-1:50pm

Room A202 Langley Hall

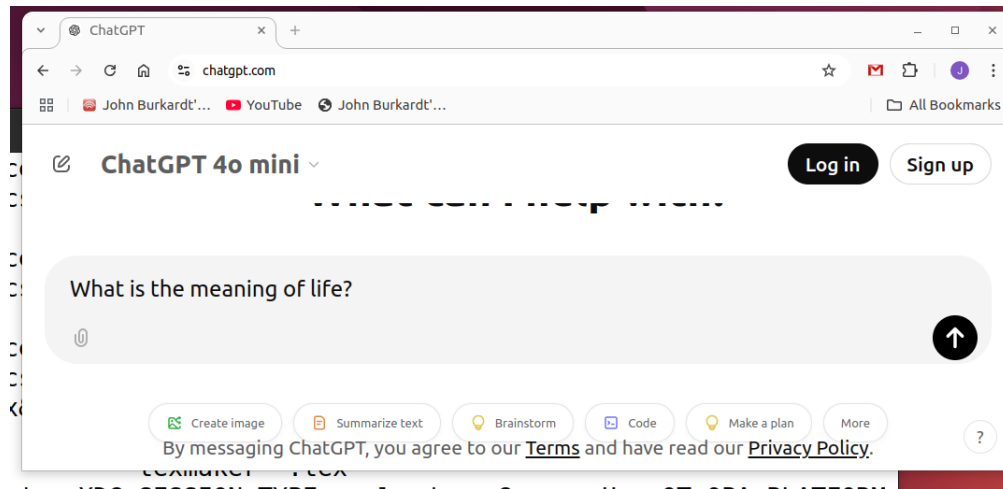
https://people.sc.fsu.edu/~jburkardt/classes/python_2025/chatgpt/chatgpt.pdf



The educator's nightmare is the student who seems brilliant but is just really good at secretly looking things up!

1 Talking to the Oracle

Want to know the meaning of life? Just go to the website <https://www.chatgpt.com/> where you will see a box into which you can put your question, and expect an answer!



You really will get an answer, but it's more like philosophy, and in this class we don't care about life, wisdom, or philosophy, we just care about Python programs!

Luckily, ChatGPT also seems to think it can answer Python questions. So given any assignment in this class, a student can simply type "Write a Python program that does...what the instructor has just asked." and in at least some cases, you will get a program, along with documentation and test code, that you can pretend is your own work. I will even show you how to do this today. From the way people panic about ChatGPT, you might think it threatens to destroy the academic system, but I think we can actually find it to be a very useful tool.

2 The reality of online resources

Some educators feel that ChatGPT and other online systems mean that the world is going to end. But for a long time, the simple model of testing student learning has been threatened by a buildup of easily accessible sources of information.

ChatGPT is only one example; you can write on your hand; you can take a bathroom break and leave notes for a friend there; fraternities keep files of old tests and homework; there are essay-writing services; Chegg offers to help with a homework assignment, which might actually be a take home test or even an in-class exam; phones and watches can store information or contact remote helpers. A responsible instructor is aware some students bend or break the rules. There are ways to try to catch the worst offenders.

Nonetheless, most students are honest, and teaching must go on. More importantly, learning must go on. And for my class, I feel that ChatGPT can assist students to learn how to write Python programs.

I will show you a few examples of exercises for this class which I turned over to ChatGPT, what it did with them, and what I got out of looking at these responses. In several cases, ChatGPT seemed like a somewhat smarter programmer with some different skills, some of which were worth trying out. I would not replace any program I wrote with the ChatGPT version, but I would definitely use it to improve or clean up the work that I did.

In this class, I suggest that you always try to completely solve each assignment on your own. Only after you have succeeded, or tried really hard and failed, you might take a look at what ChatGPT suggests, and see where you might do better.

And if you get some ideas from ChatGPT, I would suggest that you include a credit line like this in the code you turn in:

```
# Author:
#
# Original coding by me.
# Some program modifications were based on references to ChatGPT.
```

So now let's take a look at what a ChatGPT session can do for us!

3 Experiment 1: Average length of increasing random sequence

The Python random number generator `random()` returns a random number between 0 and 1. Consider the case where we use this feature to compute the random value r_1 , and plan to compute a sequence r_i in this way, stopping as soon as the latest value is smaller than the previous one. Hence our sequence could be as short as 2 values, and we could have sequences that are arbitrarily long, although that is very unlikely.

What is the average length of such a sequence, including the final decreasing value? (I happen to know that the average length is about 2.7.)

It actually took me several tries before I was able to ask the question in a way that ChatGPT understood. The first time I asked the question, I didn't mention the words "Python program", and ChatGPT came back with an answer in the form of an integral - much more mathematical, but not what I wanted at all! This brings up the point that the question you want to ask has to include all your interests, and be formed in language that ChatGPT can understand. This is not always easy!

After several failed questions, here is what I ended up asking:

Write a Python program which computes a random number in $[0,1]$, and repeats this process until a smaller value is computed. What is the average length of such a sequence?

Here is the program created:

```
import random

def generate_sequence():
    count = 1
    current_value = random.random() # First random number in [0, 1]

    while True:
        next_value = random.random() # Generate the next random number
        if next_value < current_value:
            break # Stop if the next number is smaller than the current one
        current_value = next_value
        count += 1

    return count

def average_length(num_trials):
    total_length = 0
    for _ in range(num_trials):
        total_length += generate_sequence()
    return total_length / num_trials

# Run the simulation with 100,000 trials
num_trials = 100000
avg_len = average_length(num_trials)
print(f"Average length of the sequence: {avg_len}")
```

If you run this program, you get an answer of about 1.7, but that's because I didn't make it clear that we should include the final decreasing value as part of the sequence length, which is why my result was about 2.7.

I have to say that there is nothing very exciting about this coding, and it does things in a somewhat roundabout way. Nonetheless, it did what I asked, included a test program, and some further documentation which I don't show here.

4 Experiment 2: Heron's triangle area formula

The Greek mathematician Heron had a formula for computing the area of a triangle, whose sides were of length a , b and c . First, define s , the half perimeter:

$$s = \frac{1}{2}(a + b + c)$$

and then compute

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

I decided to see if ChatGPT knew about Heron's formula, and could program it:

Write a Python program which computes the area of a triangle using Heron's formula.

Here is the program that I got in response:

```
import math

def compute_area(a, b, c):
    # Calculate the semi-perimeter
    s = (a + b + c) / 2

    # Calculate the area using Heron's formula
    area = math.sqrt(s * (s - a) * (s - b) * (s - c))
    return area

# Input the lengths of the sides of the triangle
a = float(input("Enter the length of side a: "))
b = float(input("Enter the length of side b: "))
c = float(input("Enter the length of side c: "))

# Check if the input values form a valid triangle
if a + b > c and a + c > b and b + c > a:
    # Calculate and display the area
    area = compute_area(a, b, c)
    print(f"The area of the triangle is: {area:.2f}")
else:
    print("The given sides do not form a valid triangle.")
```

As we can see, not only did ChatGPT know about Heron's formula. It also knew that it should check that the values a , b and c formed a valid triangle before trying to apply Heron's formula. I should note that the output include a prologue presenting a typeset version of Heron's formula and a definition of the parameters, and the program was followed by an explanation, a sample set of input and the result of the computation.

These extras are things you give a student an A for (assuming of course that the actual program is correct, first of all!)

5 Experiment 3: Reduced Row Echelon Form of a Matrix

So far, our tasks have been relatively simple. Now we look at a more involved problem, involving the computation of the reduced row echelon form of a matrix. You may recall that, for an $m \times n$ matrix A , the row reduced echelon form is derived using a combination of 3 elementary row operations:

- row interchanges
- row scaling
- addition of a multiple of one row to another.

Using these operations, A can be transformed into RREF such that

- rows that are completely zero occur below all other rows;
- the leading nonzero entry in a row occurs to the right of the leading nonzero entry in the previous row.
- the leading entry in each nonzero row is a 1;
- any column with a leading 1 has zeros in all entries above (and below) that leading 1.

While it is not hard to compute the RREF of a matrix by hand (except for the arithmetic!), it is hard to correctly organize a procedure for doing this computationally. Here is a code called `rref.py` that I wrote for this purpose:

```

m, n = A.shape

c = 0
r = 0

while ( True ):
#
# Find row index P of maximum element in subvector A(R:M,C).
#
    pval = np.max ( np.abs ( A[r:m,c] ) )
    p = np.argmax ( np.abs ( A[r:m,c] ) ) + r
#
# If A(r:m,c) was all zero, there is no pivot for this column.
# Here, we use a tolerance TOL instead of checking for an exact zero.
#
    if ( pval == 0.0 ):
        c = c + 1
        if ( n <= c ):
            break
        else:
            continue

    temp      = A[r,c:n].copy ( )
    A[r,c:n] = A[p,c:n].copy ( )
    A[p,c:n] = temp.copy ( )

    A[r,c:n] = A[r,c:n] / A[r,c]

    for i in range ( 0, m ):
        if ( i != r ):
            A[i,c:n] = A[i,c:n] - A[i,c] * A[r,c:n]

    if ( c + 1 < n ):
        c = c + 1
    else:
        break

    if ( r + 1 < m ):
        r = r + 1
    else:
        break

```

Then I asked ChatGPT:

Write a Python program to compute the reduced row echelon form of a matrix.

```

import numpy as np

```

```

def rref(A):
    # Get the number of rows and columns
    rows, cols = A.shape
    lead = 0 # The column to pivot

    for r in range(rows):
        if lead >= cols:
            return A
        i = r
        while A[i, lead] == 0:
            i += 1
            if i == rows:
                i = r
                lead += 1
                if lead == cols:
                    return A
        # Swap the rows
        A[i], A[r] = A[r], A[i]

        # Normalize the pivot row
        A[r] = A[r] / A[r, lead]

        # Eliminate the current column for all rows except the pivot row
        for i in range(rows):
            if i != r:
                A[i] -= A[i, lead] * A[r]

        lead += 1
    return A

```

Even though I removed comments from my program, the ChatGPT program, including its comments, uses fewer lines, and has fewer complicated steps. It uses a clever feature of array indexing which allows it to swap two rows easily. My version was buggy, and had to use the horrible `.copy()` feature to work properly. I had forgotten that you could do that. My program also had more trouble keeping track of the row and column indices. So I learned a few things from this exercise.

6 Conclusion

ChatGPT is not just for cheaters. Honest students can use it as a helper; it has a lot of general knowledge, and can find clever and efficient ways to solve problems. As long as we can describe what we are looking for in a few clear, simple statements, we can get an answer. This is best used as a check on our own efforts, although sometimes we might ask it just to help us get started.

In school work, it's important to be know that your instructor does not have an issue with ChatGPT usage, and that you are careful to state where you have gotten any outside help.