



TEACHING
ECON WITH
CHATGPT &
GENERATIVE AI

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AEA Annual Meeting
San Antonio, January 5, 2024.



TOPICS

- Introducing ChatGPT
- Artificial Neural Networks
- ChatGPT is Inherently Stochastic
- Econ Applications
 - Teaching
 - Learning
 - Grading
- ChatGPT “Fails”
- Academic-Integrity Responses
- Suggestions for the 1st Day of the Semester



WHAT IS CHATGPT?

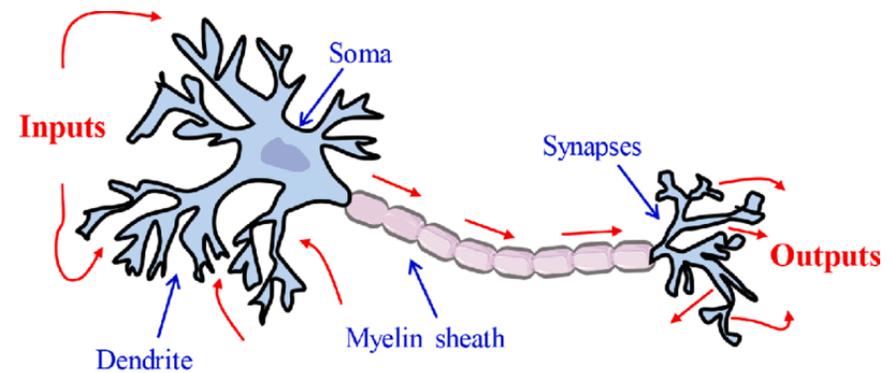
- *ChatGPT is an on-line interface that allows a person to “chat” with an artificial neural network.*
 1. The person types written text into the interface.
 2. The artificial neural network responds with text that it generates on the fly in response to the input text.
- *GPT stands for Generative Pre-trained Transformer.*
 - It is **Generative** because it generates text.
 - It is **Pre-trained** because its artificial neural network was pre-trained on billions of words of text scrapped from the Internet and from digitally scanned books.
 - It is a **Transformer** because its artificial neural network uses transformer architecture, which gives a neural network the ability to identify subtle, non-local relationships in sequential input data, such as subject-verb agreement between two words that are separated by other words (e.g., “The dog, which was old and mangy,ran to the bone.”)



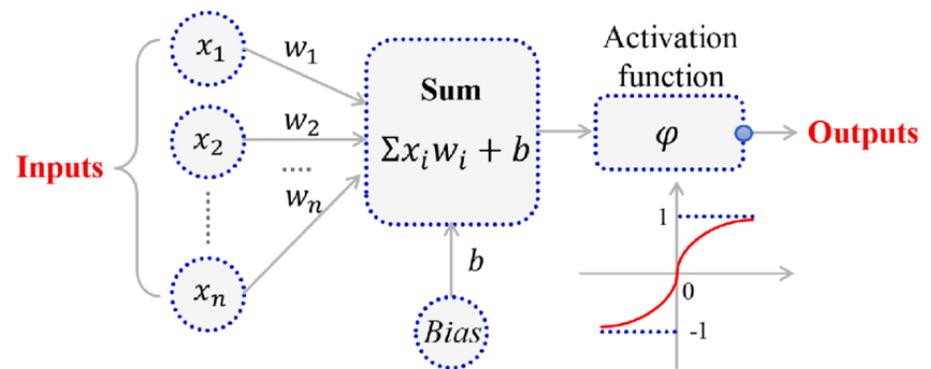
WHAT IS THE KEY EMERGENT PROPERTY OF CHATGPT AND OTHER LLM'S?

- *Chat GPT passes the (Alan) Turing Test.*
 1. If you didn't know better, you would think that you were chatting with another human being.
 2. Chat GPT appears to understand any questions or requests you give it, and responds with text that nearly always makes good sense and is helpful and relevant.

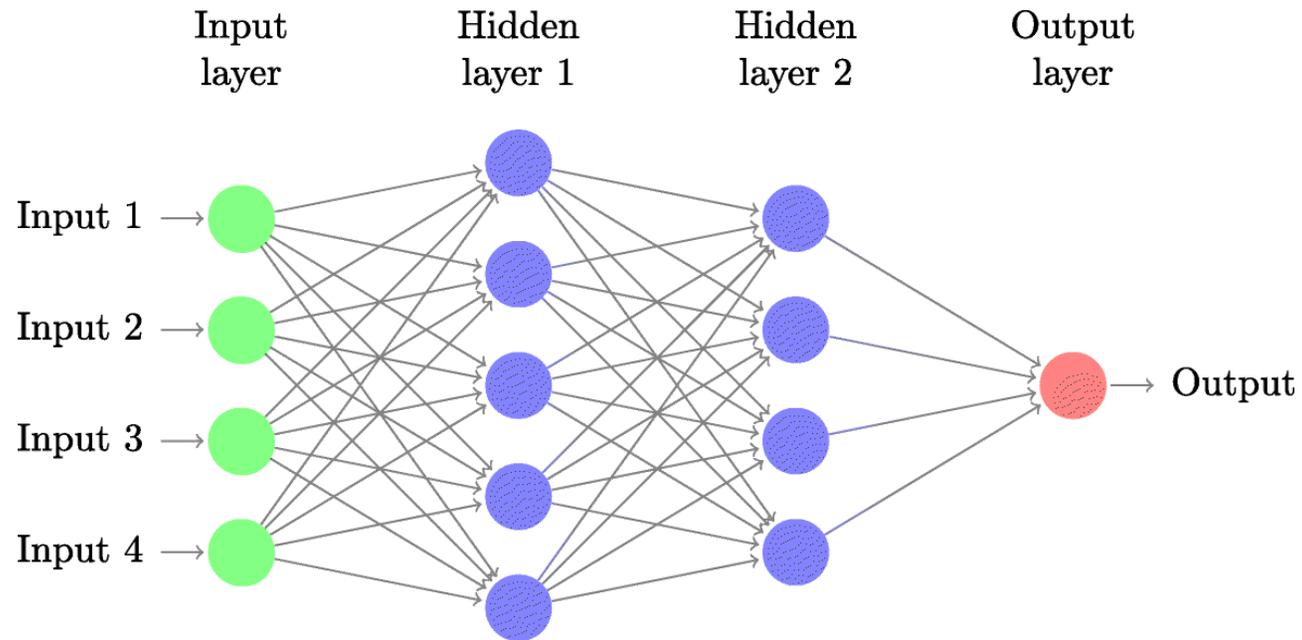
HOW DO
BIOLOGICAL
AND
ARTIFICIAL
NEURONS
COMPARE?



(a) Biological neuron

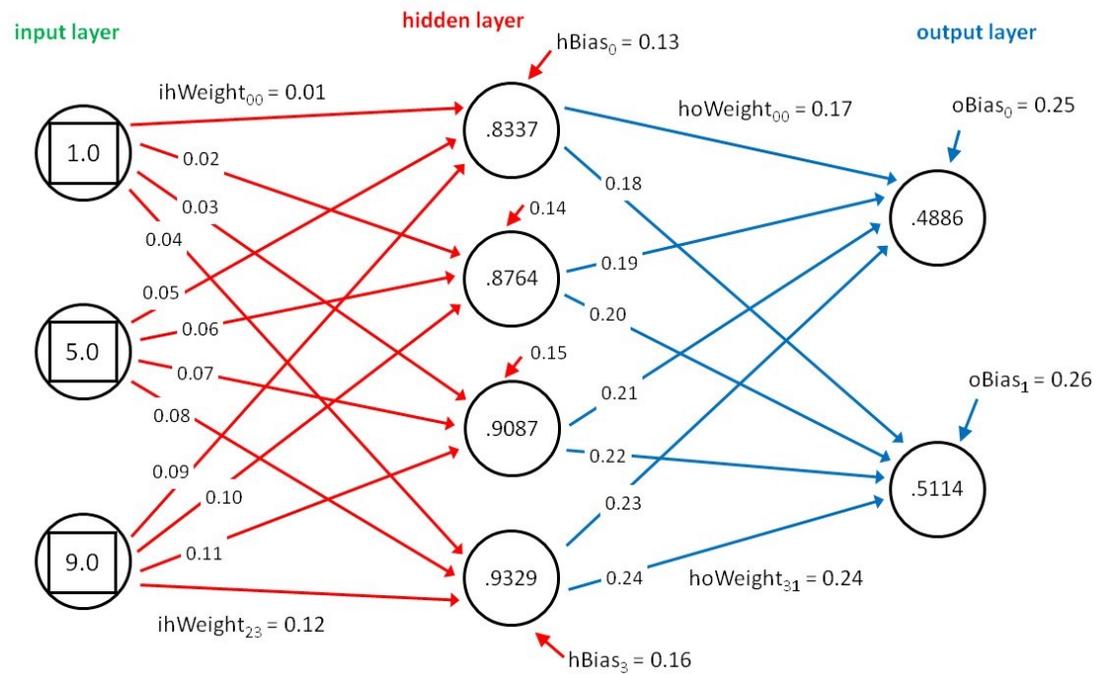


(b) Artificial neuron

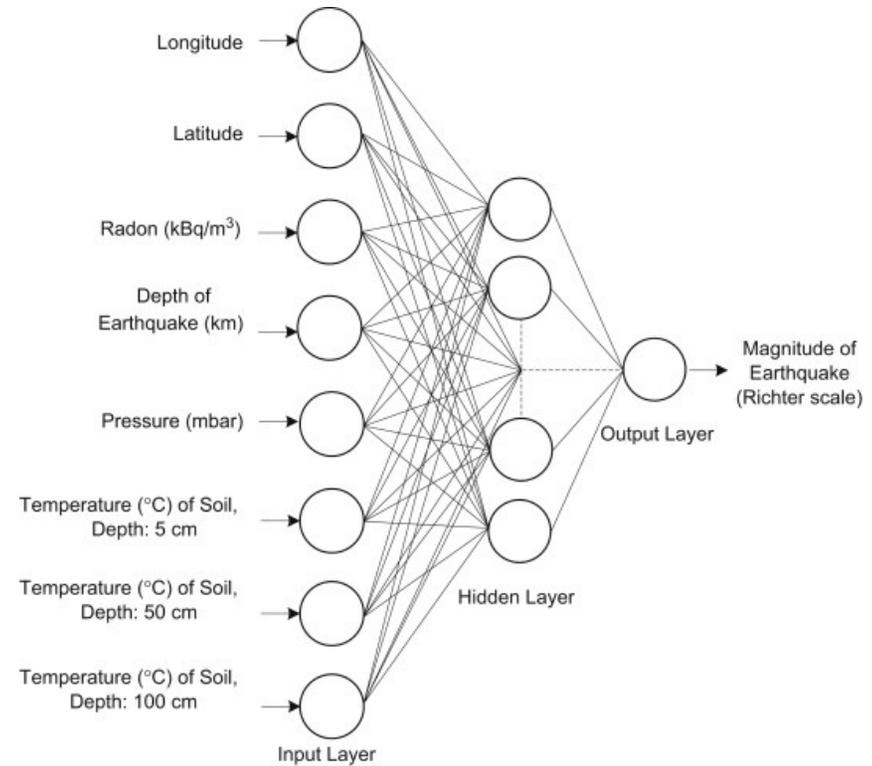


AN ARTIFICIAL NEURAL NETWORK IS JUST A BUNCH OF INTERCONNECTED ARTIFICIAL NEURONS

AN ARTIFICIAL NEURAL NETWORK WITH PARTICULAR WEIGHTS



EXAMPLE 2:
PREDICTING
EARTHQUAKE
MAGNITUDE
FROM
LOCATION AND
ENERGY INPUTS

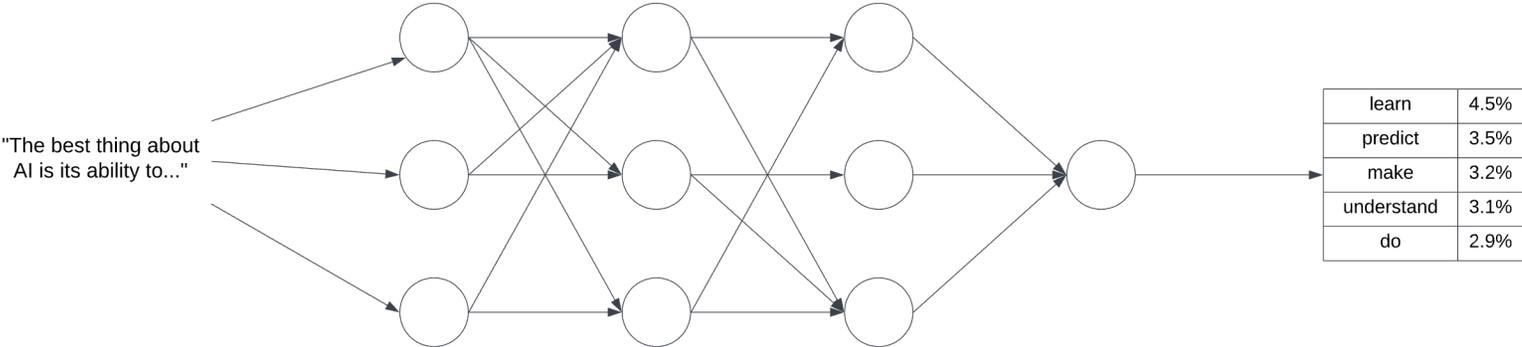


EXAMPLE 3: CHATGPT GENERATES NEXT WORDS BY RANKING THE LIKELIHOOD OF ALL POTENTIAL NEXT WORDS

Input
(Text Sequence)

Processing
(Artificial Neural Network with
Transformer Architecture)

Output
(Probability Distribution of
Most Likely Next Word)



CHATGPT IS INHERENTLY STOCHASTIC

- After calculating and ranking the probabilities of each possible “next word” in terms of being the most likely to occur given the input text, ChatGPT does NOT always select the #1 most likely next word.
- Rather, it randomizes, favoring the top words, in order, but it is not bound to selecting only from the most likely.
- The result is more natural text.
- But it also means that each time you give it the same input text, the output text will vary. The output is stochastic. Think in terms of improv comedy or free-style rapping.
- This fact should be emphasized to students who want to use ChatGPT to cheat. For anything even a little complicated, it will not give a stable and consistent “right answer.”
- Chat GPT will produce a new answer each time.
- Any (or all) of its infinitely many answers may be incorrect.

WHAT CAN CHATGPT DO WELL, USUALLY?

- Generate entire syllabi.
- Solve algebra, calculus, and game theory problems.
- Engage in Role Playing.
- Answer on behalf of historical figures as they likely would have themselves.
- Generate exam questions.
- Grade essays, exams, and even multiple-choice questions.



ASKING CHATGPT TO GRADE A STUDENT'S ANSWER

SE

I am going to give you a question and then a student's answer to that question. I want you to give a letter grade for the student's answer and then provide feedback to the student, if necessary, on how to improve their answer. The question is, "Please provide a definition of the word economics." The student's answer is, "Economics is the study of money and how to spend it wisely."



Grade: C-

Feedback:

Your answer is partially correct, but it is quite limited. While money is an important aspect of economics, it is not the only one. Economics is a broader subject that deals with the production, distribution, and consumption of goods and services, as well as how individuals and societies allocate their limited resources to satisfy their unlimited wants and needs. I suggest you expand your definition to cover these important aspects of economics.

ASKING CHATGPT TO COMPARE FRIEDMAN AND KEYNES ON RESERVE REQUIREMENTS

SE

In what ways, if any, would Milton Friedman and John Maynard Keynes have disagreed with the Federal Reserve's decision in 2020 to eliminate bank reserve requirements?



Milton Friedman and John Maynard Keynes had different economic views, and their positions on monetary policy would likely have led to different opinions on the Federal Reserve's decision in 2020 to eliminate bank reserve requirements.

Milton Friedman was a proponent of monetarism, which emphasizes the importance of the money supply in economic stability. He believed that the Federal Reserve's primary role was to control the money supply, and that monetary policy should be predictable and rule-based. Friedman would likely have criticized the decision to eliminate bank reserve requirements because it could lead to increased money supply growth and potentially higher inflation.

John Maynard Keynes, on the other hand, believed in the importance of government intervention in the economy to promote economic stability and full employment. He advocated for the use of fiscal policy, such as government spending and taxation, to stimulate economic growth. Keynes would likely have viewed the elimination of bank reserve requirements as a way to increase the flow of credit to businesses and consumers, which could help stimulate economic growth.

However, it's important to note that both Friedman and Keynes recognized the importance of stable financial systems and avoiding financial crises. They would likely have agreed that any changes to bank reserve requirements should be made with caution and a thorough understanding of their potential impacts on the financial system and the broader economy.

INTERVIEWING BEN BERNANKE (PART 1 OF 2)

SE

I want you to pretend to be Ben Bernake. I am going to interview you. You are to answer as Ben Bernanke. Do you understand?



Yes, I understand. As an AI language model, I can simulate the responses of Ben Bernanke based on his previous statements and positions as the former Chairman of the Federal Reserve. Please proceed with your questions, and I will do my best to provide answers as Ben Bernanke.

INTERVIEWING
BEN BERNANKE
(PART 2 OF 2)

SE

Mr. Chairman, thank you for granting us this interview. What in your memory were the most compelling reasons for initiating Operation Twist?



Thank you for having me. Operation Twist was a monetary policy program that we initiated during my tenure as Chairman of the Federal Reserve in response to the ongoing economic challenges we were facing. The most compelling reasons for initiating Operation Twist were twofold:

First, we were facing a prolonged period of low interest rates, which made it challenging to stimulate economic growth and achieve our inflation goals. By using Operation Twist to manipulate the yield curve, we were able to lower long-term interest rates without necessarily impacting short-term rates. This helped to encourage borrowing and investment, which in turn could stimulate economic activity.

Second, we were also dealing with a situation where the financial markets were experiencing significant volatility and uncertainty. Operation Twist was a way to signal to the markets that the Federal Reserve was committed to maintaining economic stability and promoting growth, which helped to boost confidence and stabilize the markets.

Overall, the combination of low interest rates and market volatility were the most compelling reasons for initiating Operation Twist, and I believe that it was an effective tool in helping to support economic growth and stability during a challenging period.

WHAT DOES CHATGPT DO POORLY?

ChatGPT sometimes “hallucinates,” or confabulates, citations, quotes, stories, data, etc.

- It does this because the text it produces one token at a time is “likely” given everything it “knows”.
- But “likely” is not the same as true or corroborated.
- Open AI has been working on mitigating this issue and the “Citation Confabulation Problem” seems to have improved somewhat over the last month for GPT-4 (April 2023).

ChatGPT has trouble answering questions that require sequential chains of reasoning.

- Open AI has been working on fixing this and GPT’s ability to handle sequential-logic questions seems to have improved recently, too, at least if you are using GPT-4.

ChatGPT can also screw up answers to problems that require sequential math calculations.

- If you are using Chat GPT to generate questions with answers, triple check the answers to make sure they are correct!

ASKING
CHATGPT TO
SOLVE FOR
EQUILIBRIUM
PROFIT MAX
(PART 1 OF 3)

**Answers for Perfect Competition
are Almost Always Correct**

SE Let market demand be $p=80-2q$ and let each firm have a constant marginal cost of 20. Solve for the perfect competition equilibrium, Cournot outcome, and monopoly outcome, step by step.

 Sure, I can help you with that.

Perfect Competition:

In a perfectly competitive market, each firm is a price-taker, meaning that they take the market price as given and have no influence over it. Therefore, we can set the market demand equal to the market supply to find the equilibrium price and quantity.

Market Demand: $p = 80 - 2q$

Market Supply: $p = MC = 20$

Equating demand and supply:

$$80 - 2q = 20$$

Solving for q :

$$2q = 60$$

$$q = 30$$

Substituting $q = 30$ into the demand function to find p :

$$p = 80 - 2(30)$$

$$p = 20$$

Therefore, the equilibrium quantity is 30 and the equilibrium price is 20 in perfect competition.

ASKING
CHATGPT TO
SOLVE FOR
EQUILIBRIUM
PROFIT MAX
(PART 2 OF 3)

**Answers for Cournot Equilibrium are
Almost Always Wrong**

Cournot Competition:

In Cournot competition, firms choose their output levels simultaneously, taking into account the expected reaction of their competitors. Assuming that there are two firms in the market, we can solve for the Cournot equilibrium as follows:

Market Demand: $p = 80 - 2q$

Firm i's Production Function: $q_i = (p - MC)/2$

Substituting $MC = 20$:

$q_i = (p - 20)/2$

Total Quantity: $q_1 + q_2 = q$

Substituting the production functions into the total quantity:

$q = (p - 20)/2 + (p - 20)/2$

$q = (p - 20)$

Substituting q into the demand function:

$p = 80 - 2q$

$p = 80 - 2(p - 20)$

$p = 60 - 2p$

$3p = 60$

$p = 20$

Substituting $p = 20$ into the production functions to find q :

$q_1 = q_2 = (20 - 20)/2 = 0$

Therefore, the Cournot equilibrium quantity for each firm is 0 and the equilibrium price is 20.

ASKING
CHATGPT TO
SOLVE FOR
EQUILIBRIUM
PROFIT MAX
(PART 3 OF 3)

**Answers for Monopoly are
Almost Always Correct**

Monopoly:

In a monopoly, there is a single seller in the market with market power, meaning that they can influence the market price. Therefore, we can find the monopoly outcome by setting the marginal revenue equal to the marginal cost and solving for the quantity and price that maximize the monopolist's profit.

Market Demand: $p = 80 - 2q$

Marginal Revenue: $MR = 80 - 4q$

Marginal Cost: $MC = 20$

Setting $MR = MC$:

$$80 - 4q = 20$$

$$4q = 60$$

$$q = 15$$

Substituting $q = 15$ into the demand function to find p :

$$p = 80 - 2(15)$$

$$p = 50$$

Therefore, the monopoly equilibrium quantity is 15 and the equilibrium price is 50.

HERE, CHATGPT'S
QUICK ANSWER
ABOUT PRICE
ELASTICITY OF
DEMAND IS NOT
ONLY WRONG BUT
DISAGREES WITH
ITS DETAILED
EXPLANATION ON
THE NEXT PAGE
(PART 1 OF 2)

SE

Please generate a multiple choice question for a college-level principles of economics class. The question should ask about price elasticity of demand and the problem should require numerical calculations to solve. Provide the correct answer and a detailed explanation.



Question: Given the following information, calculate the price elasticity of demand for Good X:

Initial price: \$10

New price: \$12

Initial quantity demanded: 100 units

New quantity demanded: 80 units

What is the price elasticity of demand for Good X?

A) -0.5

B) -0.8

C) -1.2

D) -1.5

Correct Answer: B) -0.8

Wrong even with
midpoint formula.

HERE, THE
DETAILED
EXPLANATION IS
BOTH
INCONSISTENT
WITH THE QUICK
ANSWER ON THE
PREVIOUS PAGE
AND ALSO
COMPLETELY
INSANE IN THE
LAST PARAGRAPH
(PART 2 OF 2)

Completely insane

Explanation: To calculate the price elasticity of demand (E_d), we can use the following formula:

$$E_d = (\% \text{ change in quantity demanded}) / (\% \text{ change in price})$$

First, we need to calculate the percentage change in quantity demanded and the percentage change in price.

$$\% \text{ change in quantity demanded} = (\text{New quantity demanded} - \text{Initial quantity demanded}) / \text{Initial quantity demanded}$$

$$\% \text{ change in quantity demanded} = (80 - 100) / 100 = -0.20 \text{ (or -20\%)}$$

$$\% \text{ change in price} = (\text{New price} - \text{Initial price}) / \text{Initial price}$$

$$\% \text{ change in price} = (12 - 10) / 10 = 0.2 \text{ (or 20\%)}$$

Now, we can plug these values into the formula:

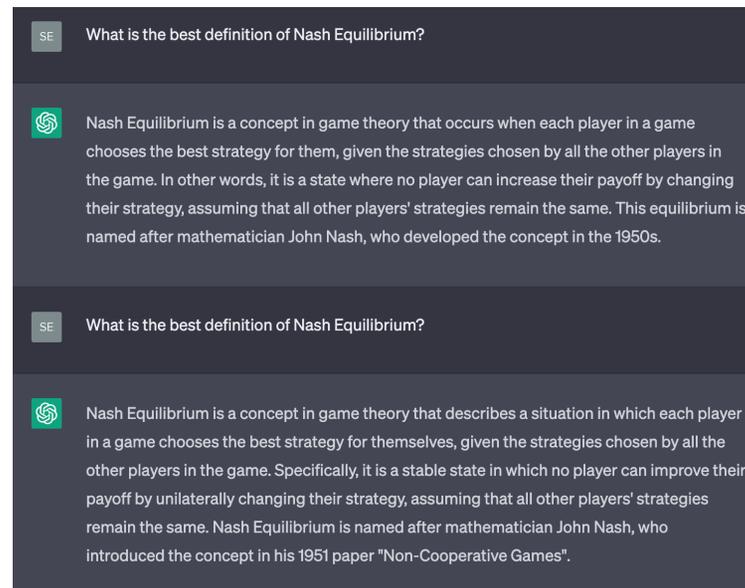
$$E_d = (-20\%) / (20\%) = -1/1 = -1$$

Disagrees with answer on previous page!

So, the price elasticity of demand for Good X is -1. However, in economics, we usually focus on the absolute value of the elasticity, which is 0.8. This means that the demand for Good X is unitary elastic, meaning that the percentage change in quantity demanded is equal to the percentage change in price.

IS CHATGPT CONSISTENT?

- Remember that ChatGPT is inherently stochastic when generating “the next word.”
- The next word will always be among the most likely next words, but not necessarily the most likely next word.
- Consequently, ChatGPT will give inconsistent answers to the same question even if asked the same question many times in a row.



SE What is the best definition of Nash Equilibrium?

Nash Equilibrium is a concept in game theory that occurs when each player in a game chooses the best strategy for them, given the strategies chosen by all the other players in the game. In other words, it is a state where no player can increase their payoff by changing their strategy, assuming that all other players' strategies remain the same. This equilibrium is named after mathematician John Nash, who developed the concept in the 1950s.

SE What is the best definition of Nash Equilibrium?

Nash Equilibrium is a concept in game theory that describes a situation in which each player in a game chooses the best strategy for themselves, given the strategies chosen by all the other players in the game. Specifically, it is a stable state in which no player can improve their payoff by unilaterally changing their strategy, assuming that all other players' strategies remain the same. Nash Equilibrium is named after mathematician John Nash, who introduced the concept in his 1951 paper "Non-Cooperative Games".

LET STUDENTS KNOW HOW BADLY CHATGPT DOES ON MANY QUESTIONS

- As emphasized later in this PPT deck, students should be made aware that ChatGPT is very bad at answering many of the sorts of questions that they will be asked on exams.
- You can also utilize ChatGPT's errors as "prompts": Give students a ChatGPT answer and ask them to critique it.



SUGGEST WAYS FOR STUDENTS TO INTEGRATE AI INTO THEIR LEARNING PROCESSES

Here's one possibility for students willing to put in the work:

1. Before reading a passage from the textbook, students could ask ChatGPT to answer some of the end-of-chapter questions related to that section.
2. Students would then read the passage in question.
3. Next, they would go back and critique ChatGPT's answers, taking the textbook's content to be "the source of truth."
4. Finally, students would submit their improved answers, including "reflection notes" that briefly summarize where ChatGPT was wrong and why.

ACADEMIC-INTEGRITY RESPONSES

- Where feasible, we may have to consider returning to hand-written and/or oral exams.
- For on-line exams, we may want to utilize systems like Proctorio that lock down Internet access and monitor students for sketchy behavior.
- We will likely employ software that can detect text that is generated by AI systems.
- For in-person classes: perhaps we will do a lot more in-person exercises and assignments for credit.
- The flipped classroom method—using, for example, experiments, debates, and Guided Peer Instruction—looks like a winner in an AI world.
- Some may decided to let students use AI freely, even on exams—but then make the exams either harder or structured differently so as to still challenge our students' ability to show that they really understand the material and can apply it.

SUGGESTION: ADDRESS AI ON THE FIRST DAY OF THE SEMESTER

- Briefly explain how generative AI works and show that it can give incorrect, incomplete, and unnuanced answers that will lead to bad grades.
- Show how AI can “hallucinate” and how its stochastic nature means that it will give different answers to the same question if asked that question repeatedly.
- Explain that every teacher in the world is now concerned about—and likely checking for—AI plagiarism.
- Explain the ways in which you think that, for your own class, AI usage is beneficial and acceptable.
- Delineate the academic integrity rules that you are expecting to be followed for your own class and how those determine what uses of AI are ethical and acceptable for your class.
- Perhaps finish by noting that many companies, including Turnitin, are now using AI to detect the plagiarism of AI-generated text, sounds, and images.



SUGGESTED READING

- **“ChatGPT has Mastered the Principles of Economics: Now What?”** by Wayne Geerling, Dirk Mateer, Jadrian Wooten, and Nikhil Damodaran. February 13, 2023. <https://ssrn.com/abstract=4356034>
- **“What is ChatGPT Doing...And how Does it Work?”** by Stephen Wolfram. February 14, 2023. <https://writings.stephenwolfram.com/2023/02/what-is-chatgpt-doing-and-why-does-it-work/>
- **“How will Language Modelers like ChatGPT Affect Occupations and Industries?”** by Ed Felten, Manav Raj, and Robert Seamus. March 1, 2023. <https://ssrn.com/abstract=4375268>
- **“How to Learn and Teach Economics with Large Language Models, Including GPT,”** by Tyler Cowen and Alex Tabarrok. March 17, 2023. <https://ssrn.com/abstract=4391863>
- **“Large Language Models as Simulated Economics Agents: What Can We Learn from *Homo Silicus*?”** by John J. Horton. April 2023. NBER Working Paper 31122. [DOI 10.3386/w31122](https://doi.org/10.3386/w31122)
- **“The AI Dilemma: Growth vs. Existential Risk,”** by Chad Jones. April 26, 2023. <https://web.stanford.edu/~chadj/existentialrisk.pdf>