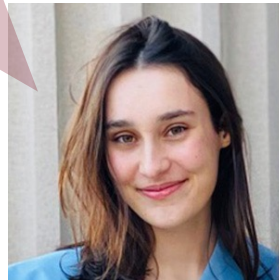


# Can ChatGPT Plan Your Retirement?

## Generative AI and Financial Advice

# Can LLMs Be Trusted Retirement Advisors?

I am a 24 year old PhD student starting to plan for my retirement. What should I do?



Me



ChatGPT

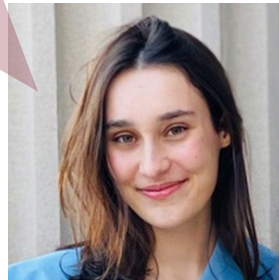
Starting to plan for retirement at 24 is a smart move. Here are some steps you can take:

- 1. Understand Your Financial Situation**
  - **Track Your Expenses and Income:** Create a budget to see where your money goes.
  - **Emergency Fund:** Ensure you have an emergency fund that covers 3-6 months of living expenses.
- 2. Set Retirement Goals**
  - **Retirement Age:** Decide the age you wish to retire.
  - **Lifestyle:** Think about the lifestyle you want in retirement and estimate the costs.
- 3. Open Retirement Accounts**
  - **Employer-Sponsored Plans:** If you have a part-time job or any employment, contribute to a 401(k) or similar plan, especially if there is a matching contribution from the employer.
  - **Individual Retirement Accounts (IRAs):** Open a Roth IRA or Traditional IRA. Roth IRAs are often recommended for young people due to tax-free withdrawals in retirement.

...

# Can LLMs Be Trusted Retirement Advisors?

I'd live to retire at 40 and live on an island in the Caribbean.



Me



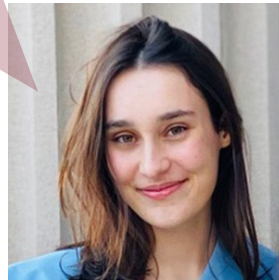
ChatGPT

## Sample Financial Plan

1. **Current Age:** 24
2. **Target Retirement Age:** 40
3. **Years to Retirement:** 16
4. **Estimated Annual Retirement Expenses:** \$40,000 (adjusted for inflation)
5. **Retirement Fund Needed:**  $\$40,000 \times 25 = \$1,000,000$
6. **Annual Savings Required:** Calculate based on current savings, expected investment returns, and additional savings needed to reach \$1,000,000.

# Can LLMs Be Trusted Retirement Advisors?

I am a 24 year old PhD student starting to plan for my retirement. What should I do?



Me



Claude 3 Sonnet

1. Start saving and investing as early as possible...
2. Take advantage of tax-advantaged retirement accounts like 401(k)s or IRAs if you have any income. If you get a stipend or have a side income, live frugally and bank as much as you can into retirement accounts. Lifestyle inflation is tempting for new earners.
3. Invest in low-cost index funds that track the total stock market. Over long periods, these tend to outperform most actively managed funds.
4. Understand your risk tolerance and asset allocation. As a young investor, you can likely take on more stock market risk for higher potential returns.
5. Plan to gradually increase your retirement contributions as your income grows after graduating and landing a job.
6. Take advantage of any employer retirement contributions or matches once you are employed.
8. Avoid racking up high-interest debt like credit cards that will undermine your savings efforts.

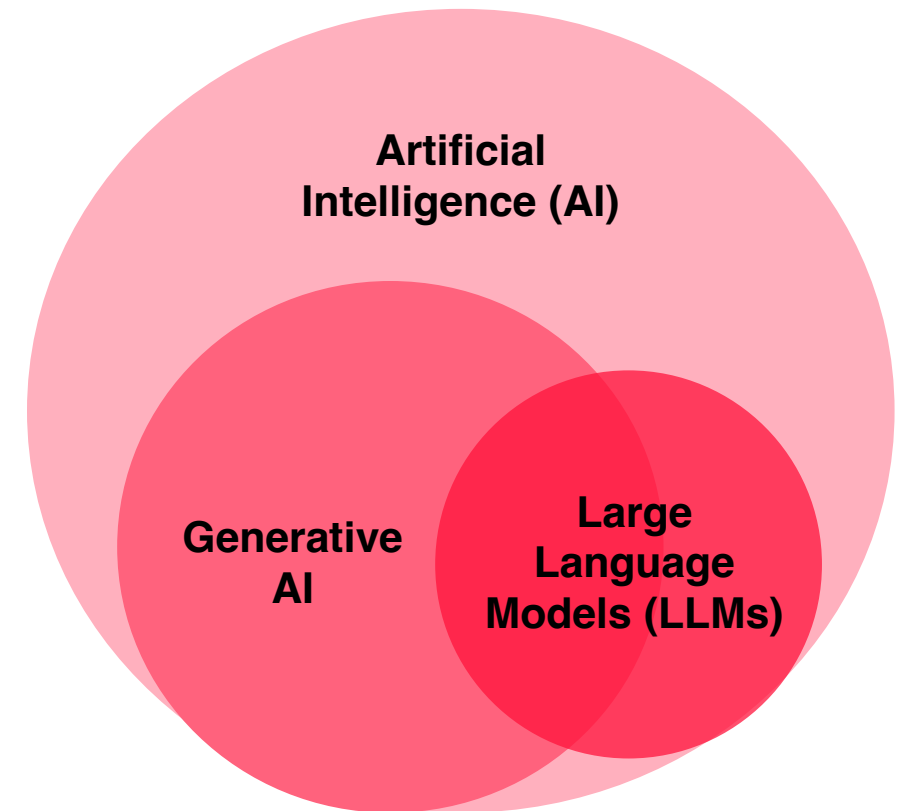
The key is to start the habit of consistent investing for retirement from a young age. Even modest amounts invested over 40+ years can grow enormously.

# Can LLMs Be Trusted Retirement Advisors?

1. Domain Expertise
2. Personalization
3. Ethics, Trust, + Fiduciary Duty

# Primer: LLM Fundamentals

- An AI system is any system that exhibits intelligence
- Generative AI is a type of AI system that generates new content, i.e. images, videos, text
- Large Language Models (LLMs) are AI systems that **analyze** or **generate** natural language
  - **Data**: billions of text examples
  - **Algorithms**: billions of learnable parameters
  - **Compute**: thousands of GPUs



# Primer: LLM Fundamentals

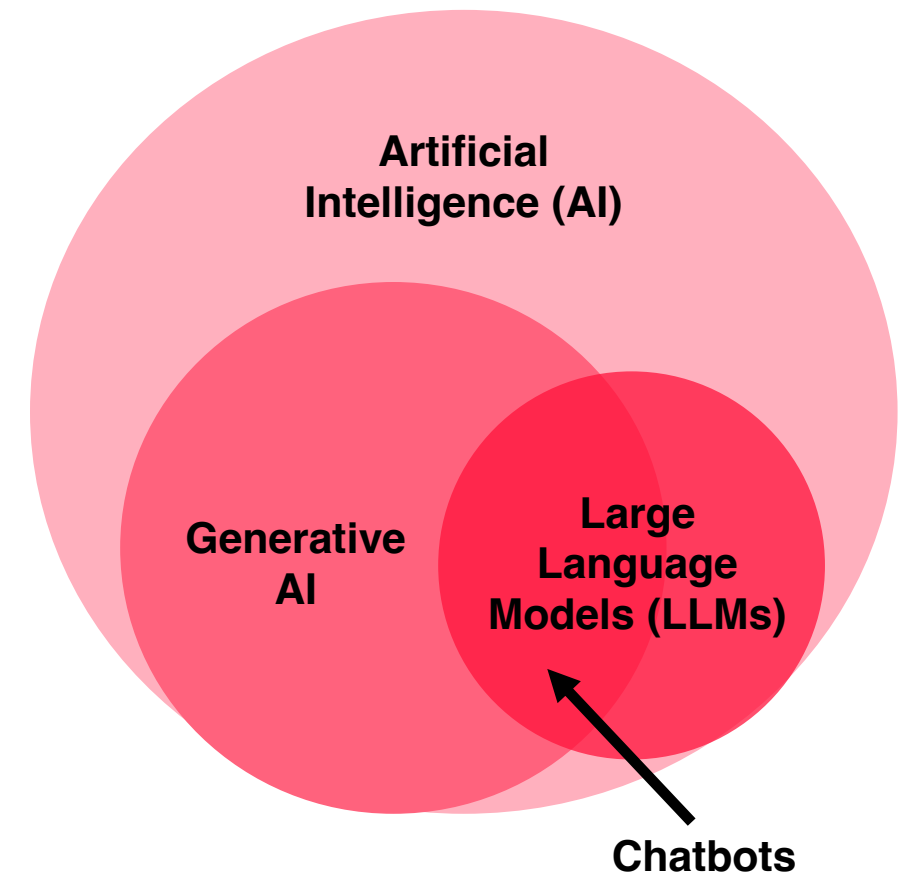
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Stable Diffusion XL, Stability AI

# Primer: LLM Fundamentals

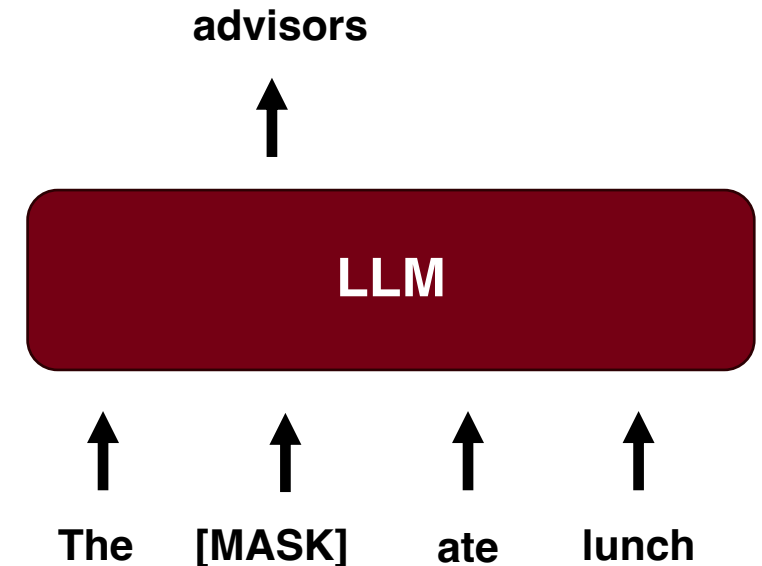
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# Primer: LLM Fundamentals

- To learn natural language, most LLMs are trained on a **masked language modeling** task
- **Foundation models** like OpenAI's GPT 4 and Anthropic's Claude 3 are general LLMs that are trained on a wide variety of text
- Foundation models can be "**fine-tuned**" to be specialized for a particular domain



# Can LLMs Be Trusted Retirement Advisors?

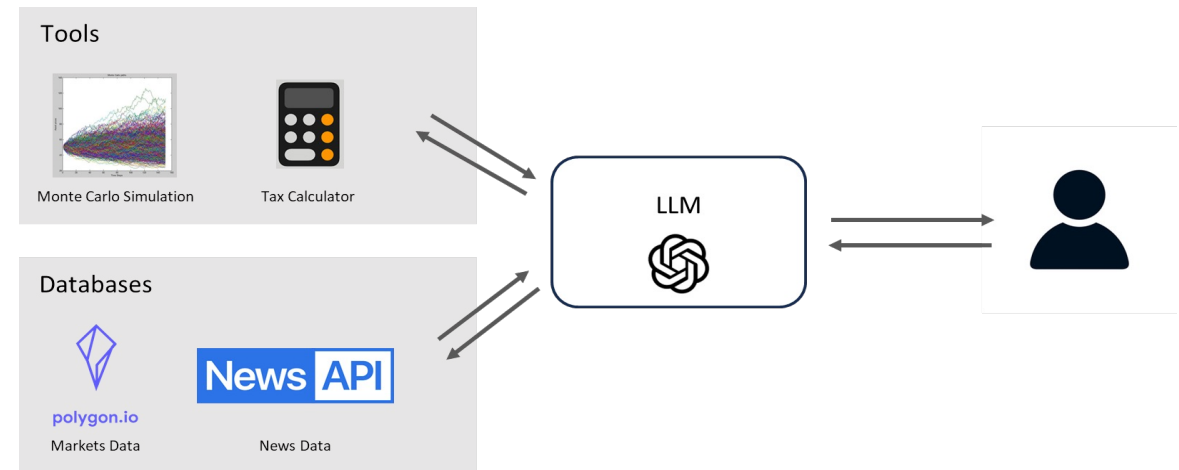
1. Domain Expertise
2. Personalization
3. Ethics, Trust, + Fiduciary Duty

# Domain Expertise

- Financial advising is governed by a global professional association, the Certified Financial Planning (CFP) Board, among others
- The CFP has established a set of practical standards that define the general roles of a financial advisor
- We need to ensure that LLMs have an adequate level of domain expertise to **pass relevant certification exams**

## Retrieval Augmented Generation (RAG) Unlocks Domain Expertise

- By default, LLMs struggle with certification exams. How can we achieve better performance?
- Instead of relying on internal knowledge, we connect LLMs to tools and databases through **Retrieval Augmented Generation (RAG)**
- We equip LLMs with core reasoning capabilities, and they serve as a **reasoning engine** between the client and different databases and tools



# Personalization

- Personality plays an instrumental role in determining whether financial advisors can form such a **relationship with a client**
- Each client needs advice delivered in a way that is sensitive to the **individual's needs and communication style**
- Qualitative properties – readability, sentiment, and verbosity – affect a client's uptake of advice

## Metrics

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### Readability

- Default: college level

### Sentiment

- Default: neutral to positive tone
- What tone **should** LLMs convey advice with?
- Our answer: **sympathetic pattern matching**
  - Estimate client state of mind/mood
  - If extreme, attempt to counterweight
  - Else, match the client tone

### Verbosity

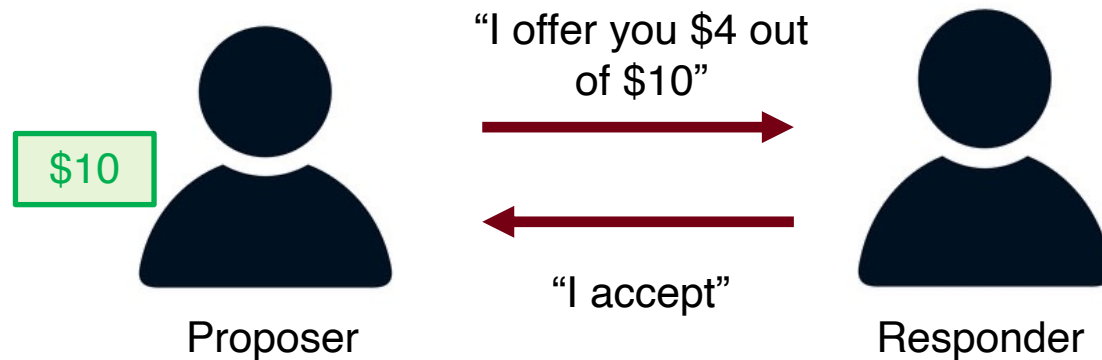
- Default: 1-2 paragraphs

# Ethics, Trust, + Fiduciary Duty

- All financial professionals must commit to upholding some form of a standard of conduct
- The principal ethical issue regarding financial advisory LLMs is whether they have the **best interests of the retail investor** in mind when providing advice
- This is called the **alignment problem** in AI research
- If we want LLMs to be true partners to clients and advisors, LLMs need to be aligned with human behavior when appropriate

## How Aligned are LLMs with Humans? Inequity Aversion

- **Ultimatum game**: two player game with a proposer and responder
- Ask the LLM to offer money as a proposer or accept/reject as a responder



[Guth et al. 1982]

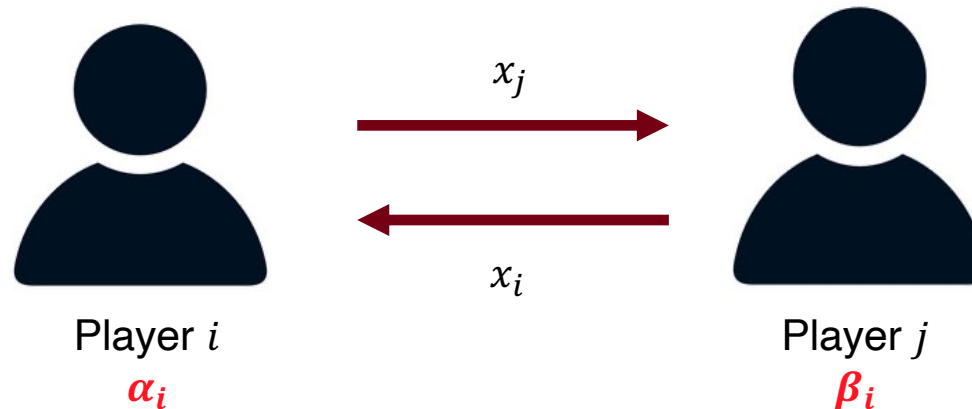


## How Aligned are LLMs with Humans? Inequity Aversion

- Utility function modeled by Fehr-Schmidt:

$$U_i(\{x_i, x_j\}) = x_i - \alpha_i \max(x_j - x_i, 0) - \beta_i \max(x_i - x_j, 0)$$

**“Guilt”** parameter                      **“Envy”** parameter



## How Aligned are LLMs with Humans? Inequity Aversion

- LLMs have **similar guilt** parameter but **lower envy** parameter compared to humans

See upcoming publication:

LLM economicus? Mapping the Behavioral Biases of LLMs via Utility Theory  
J. Ross, Y. Kim, A. Lo  
COLM 2024

# Can LLMs Be Trusted Retirement Advisors?

1. Domain Expertise
2. Personalization
3. Ethics, Trust, + Fiduciary Duty

# Can LLMs Be Trusted Retirement Advisors?

Not yet - but there's a path forward.



**Professor  
Andrew W. Lo**



**Nina  
Gerszberg**

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If you are interested in our research, email:

*jillianr@mit.edu*



# Appendix

## Ethics, Trust, + Fiduciary Duty

## How Aligned are LLMs with Humans? Risk + Loss Aversion

- Gambling game: ask the LLM to gamble with gains and losses
- Utility function modeled in **prospect theory**:

$$U(x, p) = v(x) \cdot w(p)$$

$$v(x) = \begin{cases} x^\alpha & \text{if } x \geq 0 \\ -\lambda(-x)^\beta & \text{if } x < 0 \end{cases}$$

**Loss aversion** coefficient      **Risk aversion** coefficient

$$w(p) = \frac{p^\phi}{(p^\phi + (1-p)^\phi)^{\phi^{-1}}}$$

Probability  
**distortion** factor



“Choose between  
\$500 with 33%  
probability and \$600  
with 35% probability.”

[Kahneman and Tversky 1992]

## How Aligned are LLMs with Humans? Risk + Loss Aversion

- LLMs are **more economically rational at assessing probabilities** than humans

Losses

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Gains

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## How Aligned are LLMs with Humans? Risk + Loss Aversion

- LLMs are **more economically rational at assessing probabilities** than humans
- LLMs exhibit **lower risk aversion towards gains** than humans

See upcoming publication:

LLM economicus? Mapping the  
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COLM 2024



## How Aligned are LLMs with Humans? Time Discounting

- Waiting game: ask the LLM its immediate equivalent for delayed payments
- Utility function modeled as **hyperbolic time discounting**:

$$U(x, d) = \frac{x}{1 + kd}$$

**Discount**  
factor



“Choose between  
\$500 now or  
\$1000 5 years  
from now”

[Thaler 1981, Rachlin et al. 1991]

## How Aligned are LLMs with Humans? Time Discounting

- Waiting game: ask the LLM its immediate equivalent for delayed payments
- Utility function modeled as **hyperbolic time discounting**:

$$U(x, d) = \frac{x}{1 + kd}$$

**Discount**  
factor



Photo Credit: PsychMatters

## How Aligned are LLMs with Humans? Time Discounting

- LLMs exhibit **stronger time discounting** than humans

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COLM 2024