LLMs and Portfolio Attribution

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About me

Investment due diligence and risk oversight

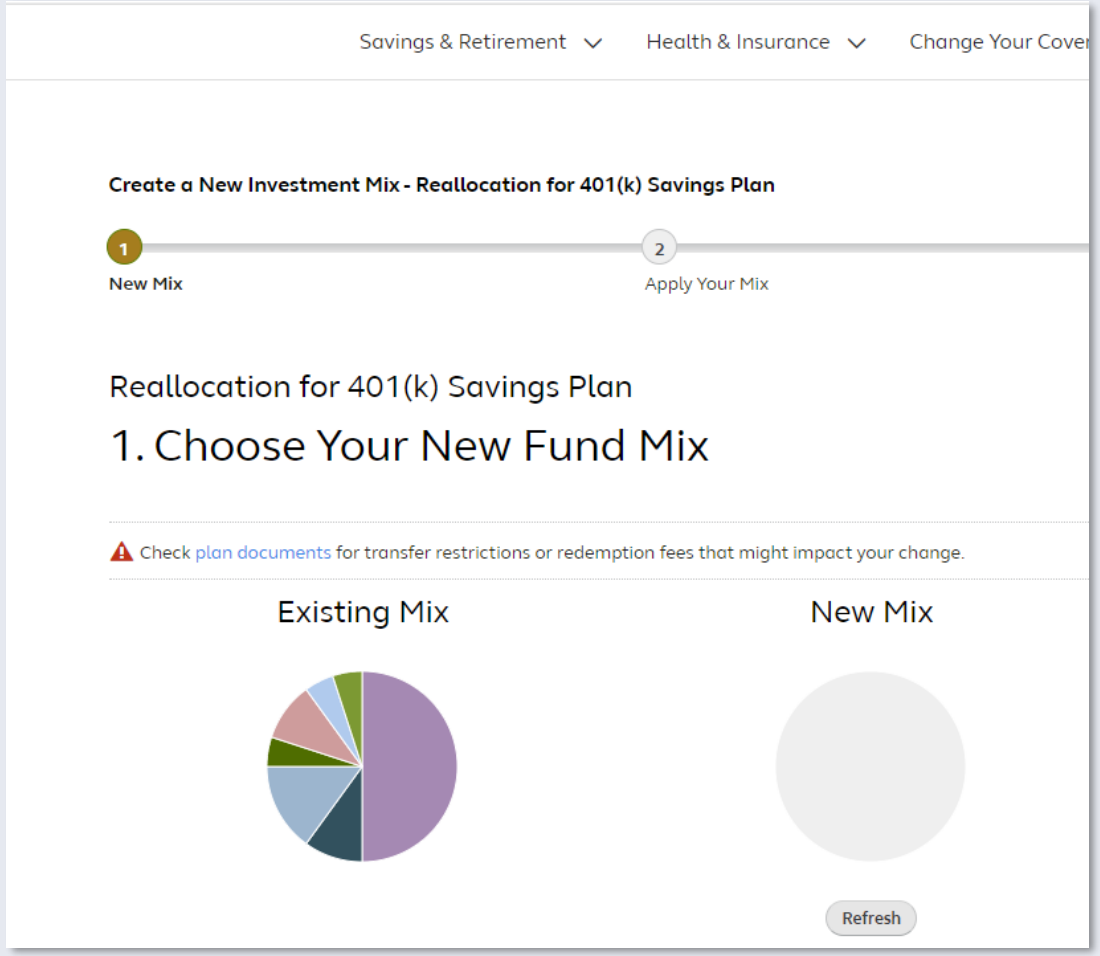
Gen AI applications on portfolio and risk management

Master's in Data Science

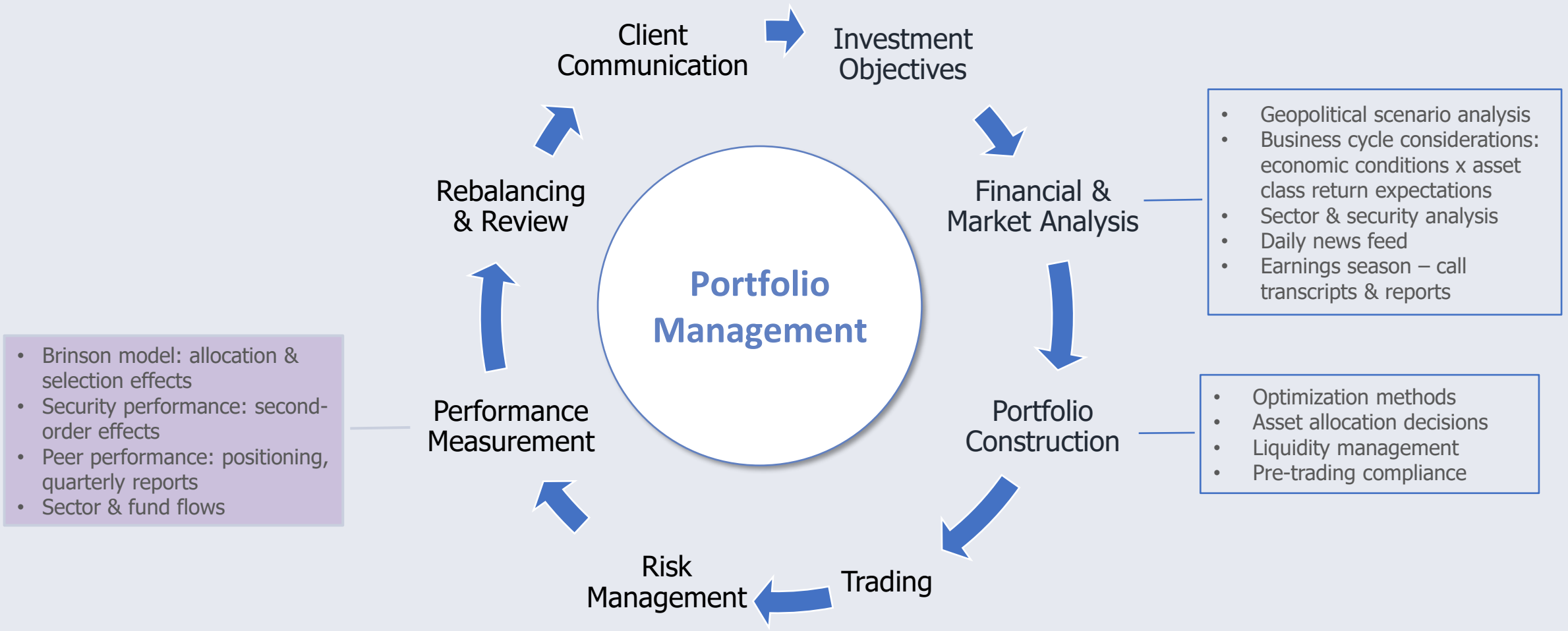
Portfolio Management & investment process

We are all Portfolio Managers!

- Reallocating/Rebalancing of your 401(k)
- That NVDA investment in your stock brokerage account
- Deciding to refinance when interest rates are lower
- Communicating to your partner or parents when you lost money on Crypto!

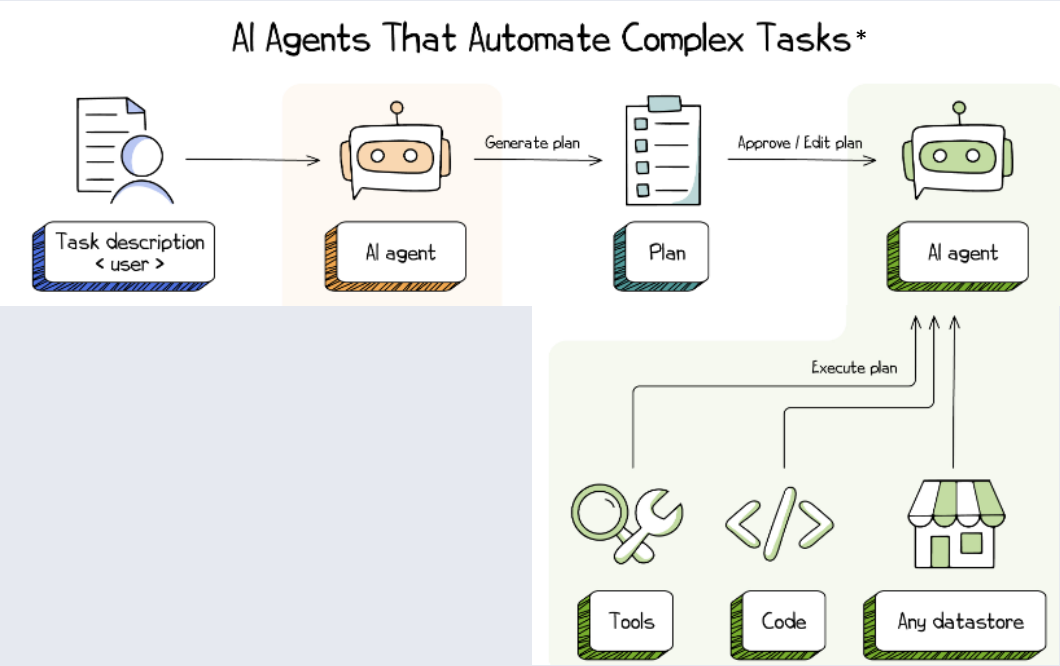


Portfolio Management is a complex endeavor



How can LLMs help with portfolio management?

Agentic Workflows / AI agents



Features

- Enhanced by new reasoning models
- Low barrier to experiment
- Highly customizable
- Incorporate cognitive science: memory layers, pre-frontal cortex planning

*https://twitter.com/bindureddy/status/1778508892382884265

Agent Leaderboard: Geminis offer the best cost/benefit

Rank	Model	Type	Vendor	Cost (I/O)	Avg Category Score (TSQ)
1st	claude-3-7-sonnet-20250219	Private	Anthropic	$3.00/$15.00	0.953
2nd	gemini-2.0-flash-001	Private	Google	$0.15/$0.60	0.938
3rd	gemini-2.0-flash-lite-001	Private	Google	$0.07/$0.30	0.933
4	gpt-4o-2024-11-20	Private	OpenAI	$2.50/$10.00	0.900
5	gpt-4.5-preview-2025-02-27	Private	OpenAI	$75.00/$150.00	0.900
6	gemini-1.5-flash	Private	Google	$0.07/$0.30	0.895
7	gemini-1.5-pro	Private	Google	$1.25/$5.00	0.885
8	o1-2024-12-17	Private	OpenAI	$15.00/$60.00	0.876
9	o3-mini-2025-01-31	Private	OpenAI	$1.10/$4.40	0.847
10	mistral-small-2501	Open source	Mistral	$0.10/$0.30	0.832
11	gpt-4o-mini	Private	OpenAI	$0.15/$0.60	0.832
12	qwen2.5-72b-instruct	Open source	Alibaba	$0.90/$0.90	0.817
13	mistral-large-2411	Private	Mistral	$2.00/$6.00	0.810
14	claude-3-5-sonnet-20241022	Private	Anthropic	$3.00/$15.00	0.801
15	Llama-3.3-70B-Instruct-Turbo	Open source	Meta	$0.90/$0.90	0.774
16	claude-3-5-haiku-20241022	Private	Anthropic	$0.80/$4.00	0.765
17	mistral-small-2409	Private	Mistral	$0.20/$0.60	0.750
18	ministral-8b-2410	Private	Mistral	$0.10/$0.10	0.689
19	Meta-Llama-3.1-8B-Instruct-Turbo	Open source	Meta	$0.20/$0.20	0.678
20	open-mistral-nemo-2407	Open source	Mistral	$0.15/$0.15	0.661

Features

- Based on Tool Selection Quality (TSQ)
- Assess agents' tool call performance, evaluating tool selection accuracy and effectiveness of parameter usage.
- Developed by `Galileo.ai`

A deeper dive into **Performance Attribution**

Question: Could an agentic workflow help me with performance attribution analysis*?

What it is

The measure of portfolio performance or excess return versus a benchmark, which actively informs the investment decision process

GICS Sector	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)	Investment Decisions
Technology	40%	35%	8.0%	7.0%	**Overweight**
Healthcare	30%	25%	5.0%	6.0%	**Overweight**
Financials	30%	40%	4.5%	5.0%	**Underweight**
					Excess Return
Total	**100%**	**100%**	**6.05%**	**5.95%**	**0.10%**

*: arXiv:2403.10482

Question: Could an agentic workflow help me with performance attribution analysis*?

Why it's important

- Essential part of the investment-process
- Transparent way to assess portfolio managers
- Based on established financial and mathematical foundation

AI agent objectives

- #1: To analyze, reason, and explain a performance attribution report
- #2: Calculation engine (single and multi-level)
- #3: Complete question-answer tasks mimicking a Financial Analyst-level exam
- *Premise: Use of a readily available AI Agent*
- *Model used: gpt-4-0613*

**: arXiv:2403.10482*

Table + theory understanding

- More than just sorting highest/lowest row values
- Involves reasoning across the Weights and Returns columns to arrive at the correct answer
- Requires Intermediate calculations such as Benchmark Total Return

Breakdown | **Portfolio and Benchmark Returns & Weights** | **Effects**

GICS Sector	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)	Investment Decisions	Allocation Effect	Selection Effect	Total Contribution
Technology	40%	35%	8.0%	7.0%	**Overweight**	0.053%	0.400%	0.453%
Healthcare	30%	25%	5.0%	6.0%	**Overweight**	0.002%	-0.300%	-0.298%
Financials	30%	40%	4.5%	5.0%	**Underweight**	0.095%	-0.150%	-0.055%
					Excess Return			
Total	**100%**	**100%**	**6.05%**	**5.95%**	**0.10%**	**0.15%**	**-0.05%**	**0.10%**

Allocation Effect Explanation

Allocation Effect: Measures whether overweighting or underweighting certain sectors added or detracted value.

$$A_i = (w_i - W_i) \times (b_i - b)$$

Technology: (40%-35%) * (7%-5.95%) = 0.053%

GICS Sector	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)	Investment Decisions	Allocation Effect	Selection Effect	Total Contribution
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Selection Effect Explanation

Selection Effect: Measures whether security selection within a sector was successful.

$$S_i = w_i \times (r_i - b_i)$$

Technology: (40%) * (8% - 7%) = 0.400%

GICS Sector	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)	Investment Decisions	Allocation Effect	Selection Effect	Total Contribution
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Allocation Effect: Weights and Returns

Allocation Effect: Sector bets

$$A_i = (w_i - W_i) \times (b_i - b)$$

Weights W	Returns R: $(b_i - b) > 0$	Returns R: $(b_i - b) < 0$	Returns R: $(b_i - b) = 0$
$(w_i - W_i) > 0$	Allocation Positive W: Overweight R: Outperformance	Allocation Negative W: Overweight R: Underperformance	Zero Allocation W: Overweight R: Neutral
$(w_i - W_i) < 0$	Allocation Negative W: Underweight R: Outperformance	Allocation Positive W: Underweight R: Underperformance	Zero Allocation W: Underweight R: Neutral
$(w_i - W_i) = 0$	Zero Allocation W: Neutral R: Outperformance	Zero Allocation W: Neutral R: Underperformance	Zero Allocation W: Neutral R: Neutral

Selection Effect: Weights and Returns

Selection Effect: Security bets

$$S_i = w_i \times (r_i - b_i)$$

Weights W	Returns R: $(r_i - b_i) > 0$	Returns R: $(r_i - b_i) < 0$	Returns R: $(r_i - b_i) = 0$
$w_i > 0$	Selection Positive Outperformance	Selection Negative Underperformance	Zero Selection Neutral
$w_i < 0$	Not applicable	Not applicable	Not applicable
$w_i = 0$	Zero Selection No exposure	Zero Selection No exposure	Zero Selection No exposure

Research Objectives

#1: Analysis Engine

Write sentences with correct explanation (~300 sentences)

Allocation: The Technology sector had a **positive** allocation effect due to the fund being **overweight** in a sector that **outperformed** the benchmark.
Selection: The Technology sector also had a **positive** selection as investments in this sector **outperformed** the sector benchmark.

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Research Objectives

#2: Calculation Engine (12 portfolios)
#3: Question-Answering Tasks (140 questions)

The exhibit below shows the weights and returns of a portfolio and its benchmark.

	Portfolio Weight	Benchmark Weight	Portfolio Return	Benchmark Return
Health Care	10%	20%	3%	2%
Utilities	30%	30%	4%	4%
Consumer Goods	60%	50%	7%	8%
Total	**100%**	**100%**	**5.7%**	**5.6%**

According to the Brinson–Fachler attribution model, the allocation effect from the Consumer Goods sector is *closest* to:

A –0.50%.
B 0.24%.
C 0.80%.

Exhibit 17 – QAMC question - Bacon and Wright (2019)

What the AI agent does with the table input

create_csv_agent: This agent calls the *Pandas DataFrame* agent under the hood, which in turn calls the *Python agent*, which executes LLM generated Python code - this can be bad if the LLM generated Python code is harmful. Use cautiously.

Overall Results

- Required **Prompt Engineering** with advanced instructions like **Chain-of-Thought** and **Plan & Solve**
- Encouraging Results!

#1: Analysis Engine: Sentence Generation

- 94-99% of Semantic Similarity
- 93-100% Accuracy in Reasoning

#2: Calculation Engine

- 100% Accuracy

#3: Question-Answering tasks

- Multiple Choice: 89% accuracy
- Direct Answer: 84% accuracy

Using Qwen-QwQ-32B:

- Achieving 100% Accuracy in Reasoning
- No 'agents' used

Takeaways – the results are encouraging!

01

Good Enough at Analysis

Produces a good enough performance attribution analysis

02

Great Calculation Engine

Calculates its main components following specific formulae and step-by-step instructions

03

Winning couple

Use of a pre-canned AI agent coupled with prompt engineering yields very robust results

Next Step: Insights Generation

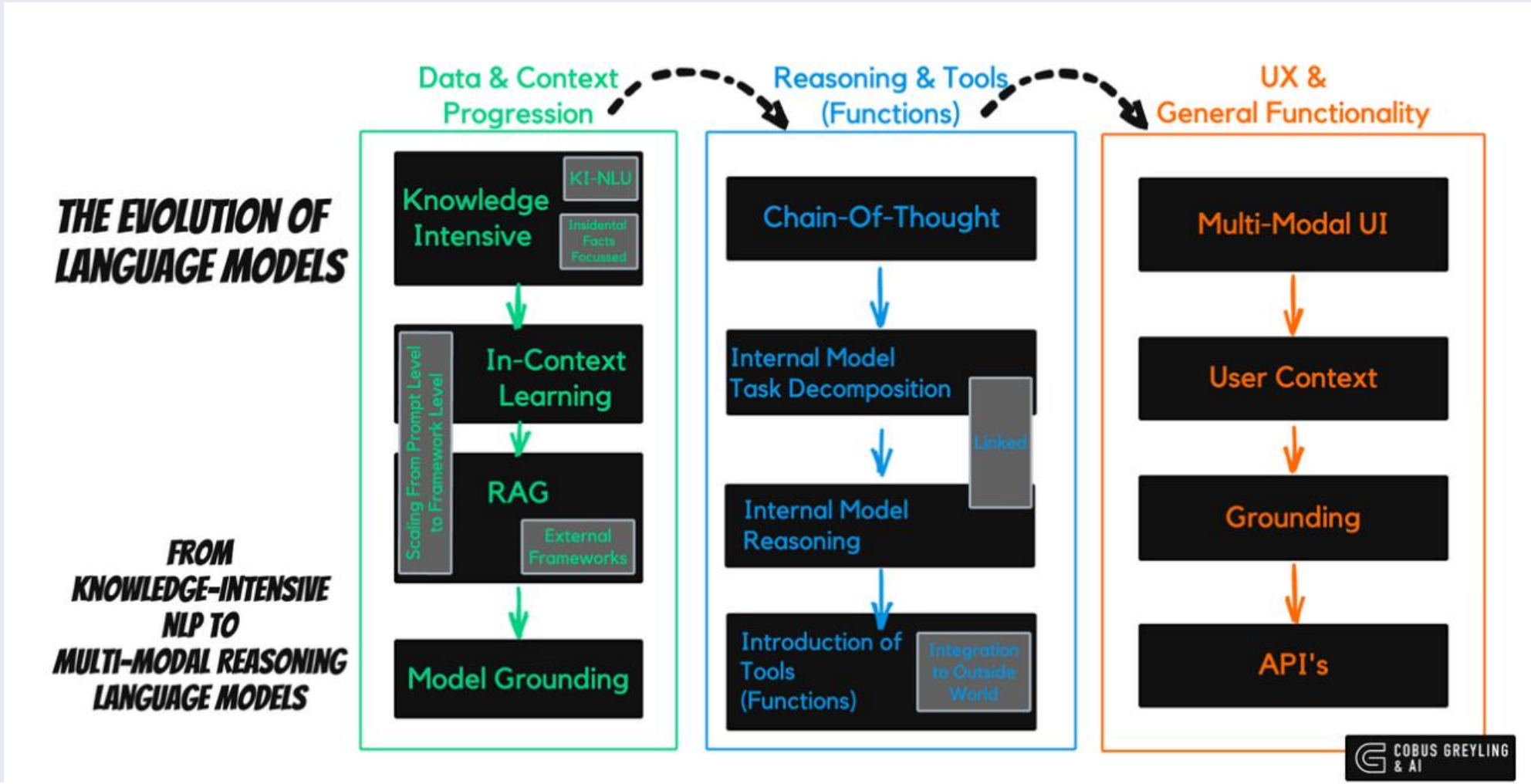
Scenario 1: Investment Due Diligence on a new manager

Scenario 2: Investment thesis validation and monitoring

Scenario 3: Insights across a platform of funds

Scenario 4: Report generation

Appendix


THE EVOLUTION OF LANGUAGE MODELS
FROM KNOWLEDGE-INTENSIVE NLP TO MULTI-MODAL REASONING LANGUAGE MODELS
Data & Context Progression
Reasoning & Tools (Functions)
UX & General Functionality
Knowledge Intensive
KI-NLU
Insidental Facts Focussed
In-Context Learning
Scaling From Prompt Level to Framework Level
RAG
External Frameworks
Model Grounding
Chain-Of-Thought
Internal Model Task Decomposition
Linked
Internal Model Reasoning
Introduction of Tools (Functions)
Integration to Outside World
Multi-Modal UI
User Context
Grounding
API's
COBUS GREYLING & AI