

ActuaryGPT: Applying LLMs to Insurance and Actuarial Work

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How can we
use LLMs?

Before we start

More detail in the paper

This session to convey ideas

... and spark some ideas

ACTUARYGPT: APPLICATIONS OF LARGE LANGUAGE MODELS TO INSURANCE AND ACTUARIAL WORK

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ABSTRACT

Recent advances in large language models (LLMs), such as GPT-4, have spurred interest in their potential applications across various fields, including actuarial work. This paper introduces the use of LLMs in actuarial and insurance-related tasks, both as direct contributors to actuarial modeling and as workflow assistants. It provides an overview of LLM concepts and their potential applications in actuarial science and insurance, examining specific areas where LLMs can be beneficial, including a detailed assessment of the claims process. Additionally, a decision framework for determining the suitability of LLMs for specific tasks is presented. Case studies with accompanying code showcase the potential of LLMs to enhance actuarial work. Overall, the results suggest that LLMs can be valuable tools for actuarial tasks involving natural language processing or structuring unstructured data, and as workflow and coding assistants. However, their use in actuarial work also presents challenges, particularly regarding professionalism and ethics, for which high-level guidance is provided.

Keywords: Large Language Models · ChatGPT · Insurance · Actuarial Science · Workflow Automation · Machine Learning · Artificial Intelligence · OpenAI · Natural Language Processing · Claims Management

Available here:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4543652

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Today:

Introduce LLMs

Some ways to use them

Some examples

Some closing remarks

LLM?

Large Language Model (LLM)

 ChatGPT 4 ▾




How can I help you today?

Plan a trip
to see the best of New York in 3 days

Help me study
vocabulary for a college entrance exam

Tell me a fun fact
about the Roman Empire

Come up with concepts
for a retro-style arcade game

 Message ChatGPT...



ChatGPT can make mistakes. Consider checking important information.

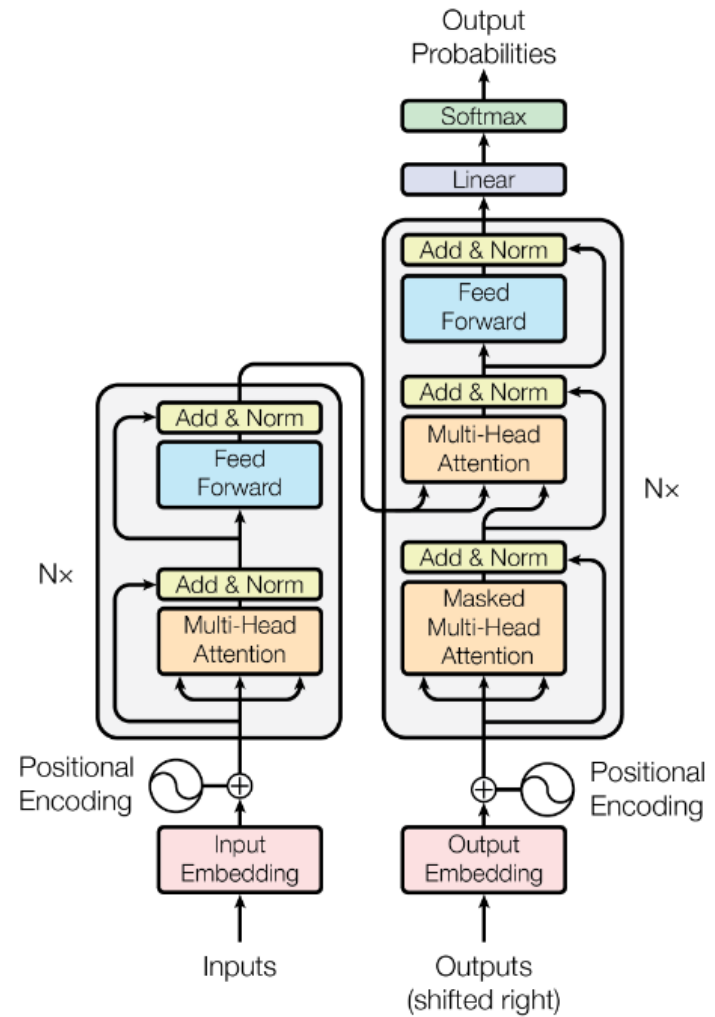


How do they work?

Basically, a **BIG** neural network

Leveraging transformers

“Attention” – or better handling of the context of a word in a sentence



Source: Vaswani, A. et al, I. (2017). Attention Is All You Need.

Sounds complicated

They are super accessible

And immediately useful

Websites

Already seen one: ChatGPT



My manager just mailed me asking for some data analysis by COB. Please help me to put together some R code to clean and summarise some data!



Sounds like a you problem.



 Regenerate

Send a message

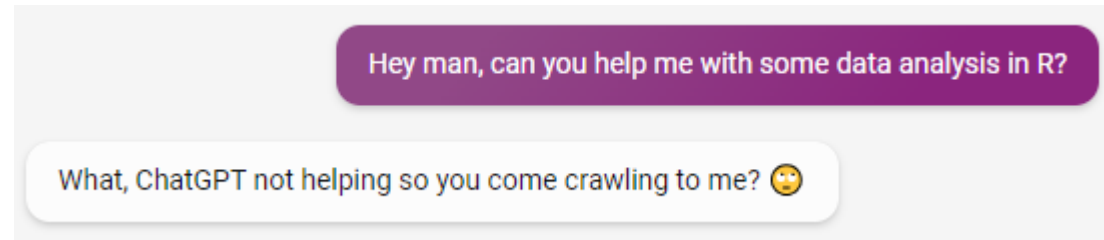


Websites

Already seen one: ChatGPT

Most widely used, but others exist, like Bing

These offer easy ways to get informal help from an LLM



Coding assistant



Can you help me understand scikit-learn? I want to use it to fit a linear regression to some insurance data.



Of course! `scikit-learn` is one of the most popular Python libraries for machine learning, and it provides tools for various tasks including regression, classification, clustering, and more. It's designed to be integrated seamlessly with other popular Python libraries such as `NumPy` and `pandas`.

Let's walk through the process of using `scikit-learn` to perform a simple linear regression on insurance data.

Step-by-step Guide:

1. **Setting Up:** Make sure you have `scikit-learn`, `pandas`, and `numpy` installed:

```
bash
```

Copy code

```
pip install scikit-learn pandas numpy
```

Stop generating

2. **Data Loading:** First, you'll want to load your insurance data. Assuming it's in a CSV format:

Straight up data analysis



freMTPL2freq.csv

Here is some data, can you do some EDA?

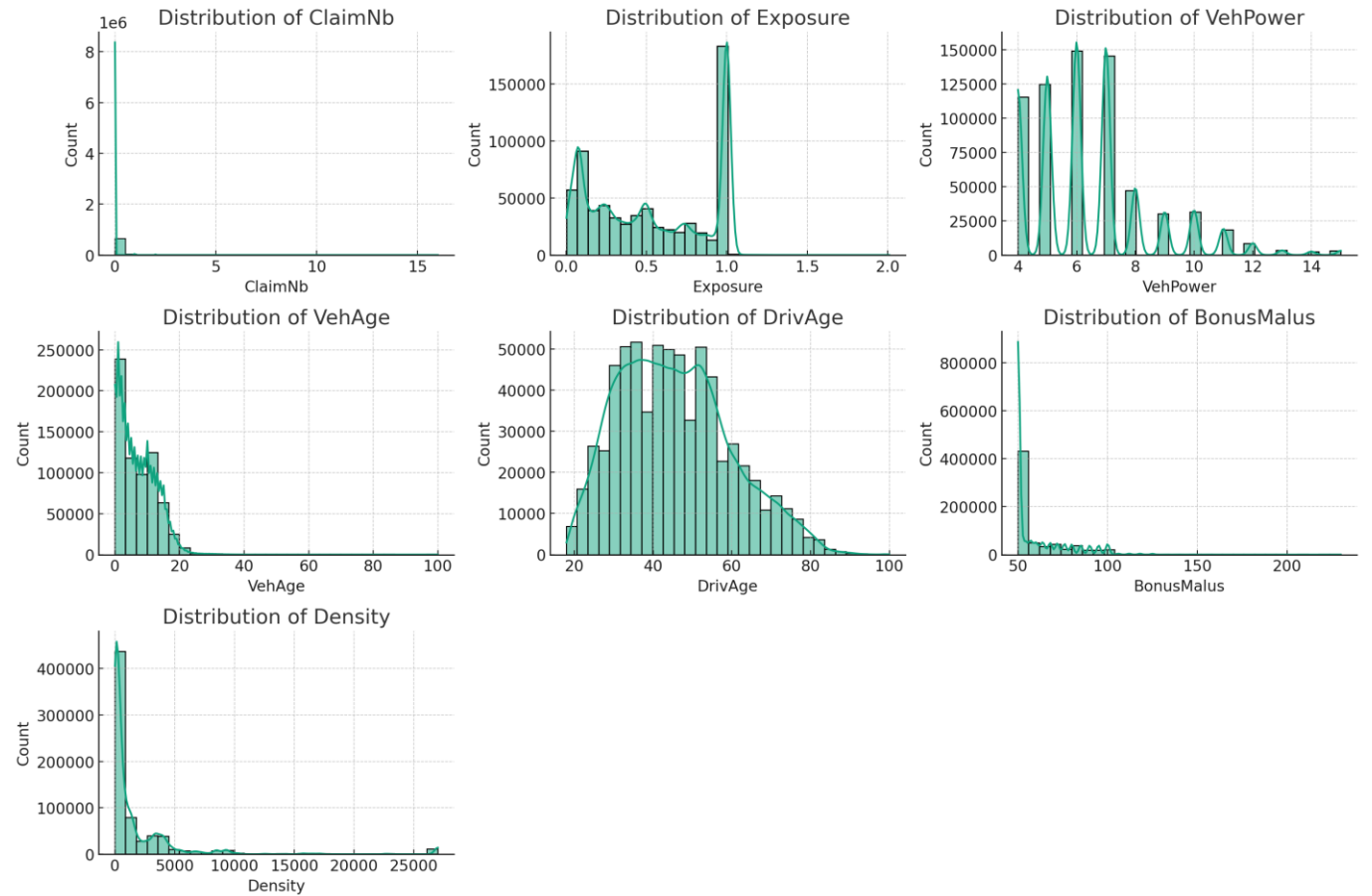
```
python Copy code  
  
import matplotlib.pyplot as plt  
import seaborn as sns  
  
# List of numerical columns  
numerical_cols = ['ClaimNb', 'Exposure', 'VehPower', 'VehAge', 'DrivAge', 'B  
  
# Set up the figure size  
plt.figure(figsize=(15, 10))  
  
# Plot histograms for each numerical column  
for i, col in enumerate(numerical_cols, 1):  
    plt.subplot(3, 3, i)  
    sns.histplot(data[col], kde=True, bins=30)  
    plt.title(f'Distribution of {col}')  
    plt.tight_layout()  
  
plt.show() Stop gen
```

Straight up data analysis



freMTPL2freq.csv

Here is some data, can you do some EDA?



Let's talk about prompts



Here is some data, can you do some EDA?



Bad Prompt



I am an actuary working at a french short term insurer. I have a list of historic claims data. I want to generate a report on claims experience.

My main concerns are identifying regions and vehicles that have a high frequency of claims so that we can apply targeted interventions.

Good Prompt

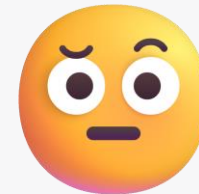
Good prompt result

RESULT

	ClaimNb
Region	
R24	9204
R82	5032
R11	3978
R93	3907
R53	2702

The regions with the highest number of claims are:

1. **Region R24** with 9,204 claims.
2. **Region R82** with 5,032 claims.
3. **Region R11** with 3,978 claims.
4. **Region R93** with 3,907 claims.
5. **Region R53** with 2,702 claims.



🔄 Reger

Few shot learning

Showing the LLM what we want

Typically, by giving examples

Or by giving some feedback on its output



That's not bad, but I want to consider the frequency relative to the exposure. So instead of an absolute number of claims, we need to consider the frequency of claims per 1,000 exposure units.

Few shot learning

```
RESULT
      Frequency_per_1000
Region
R94          139.869216
R21          132.688521
R11          131.684172
R22          122.817464
R82          110.965526
```

After adjusting for exposure, the regions with the highest frequency of claims per 1,000 exposure units are:

1. **Region R94** with approximately 139.87 claims per 1,000 exposure units.
2. **Region R21** with approximately 132.69 claims per 1,000 exposure units.
3. **Region R11** with approximately 131.68 claims per 1,000 exposure units.
4. **Region R22** with approximately 122.82 claims per 1,000 exposure units.
5. **Region R82** with approximately 110.97 claims per 1,000 exposure units.



Other uses

- Coding assistant
- Problem solving assistant
- Draft reports or summarise them
- Education / tutor
- Data cleaning and prep
- Model development and interpretation
- Generating documentation
- Generating ORSA scenarios and stresses
- Monitor regulation changes
- Knowledge management
- ...

Recap

LLMs are models tuned to language generation

Websites like ChatGPT allow easy access

Can be used in various support roles like a coding assistant

But this is all very manual... how do we embed?

But a website is too manual

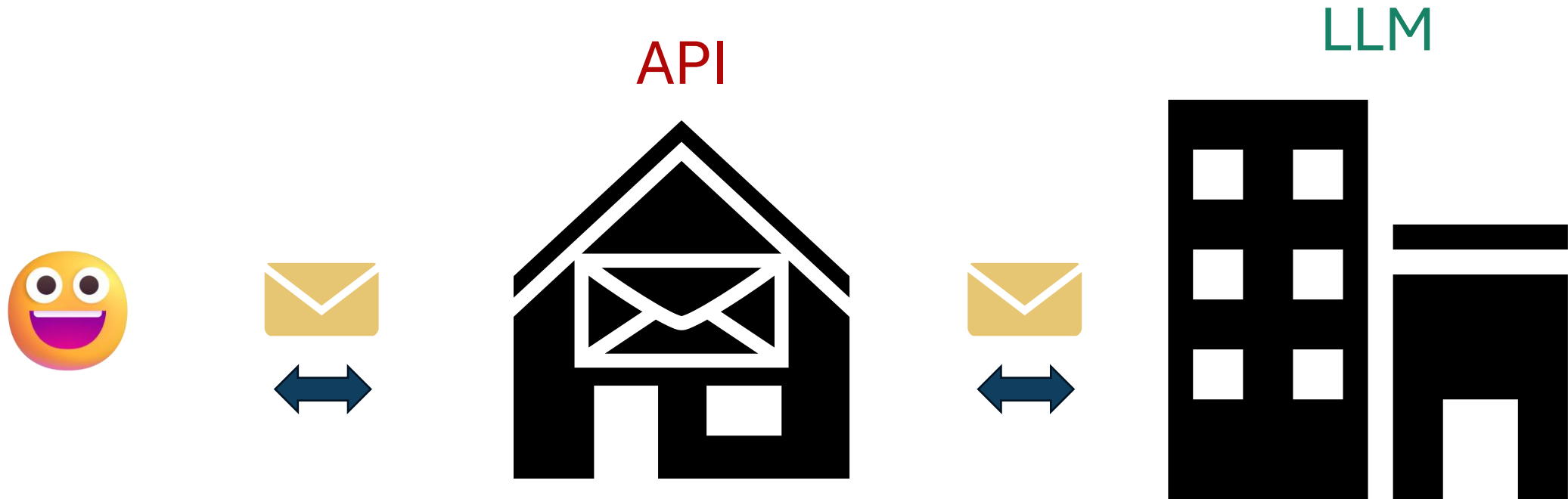
Enter the **API**

Application **P**rogramming **I**nterface

An interface through which different machines can communicate

Can automate interaction with an LLM and hence allow is to **embed** them in processes

API is like a post office



You send a message, you get a response

This allows programmatic interface with LLM

Can **embed** the LLM within a process

For example, automatically translating a claim description

Fetching news articles on a regular basis

Or extracting detail from documents

Case studies available

1: Parsing Claims

2: Identifying Emerging Risks

3: Regulatory Knowledgebase

4: Parsing Reinsurance Documents

Case studies available

1: Parsing Claims

2: Identifying Emerging Risks

3: Regulatory Knowledgebase

4: Parsing Reinsurance Documents

Case studies code

All freely available at the following URL:

<https://github.com/cbalona/actuarygpt-code>

Case studies available

1: Parsing Claims

2: Identifying Emerging Risks

3: Regulatory Knowledgebase

4: Parsing Reinsurance Documents

Identifying Emerging Risks

Task

1. Search for news articles related to cyber risk
2. LLM to summarise for the board
3. LLM to extract action points
4. LLM to create project plans for each action point

All through automated code using APIs

Identifying Emerging Risks

1. Search for news articles related to cyber risk

Use custom google search engine to find news articles mentioning certain terms: cyber risk, GDPR compliance, security risk, etc. in last 3 months

Get a large list of articles and their summaries

Identifying Emerging Risks

2. LLM to summarise into for the board

```
def summary_prompt(titles: list[str], descriptions: list[str], save_dir: str) -> str:
    user_prompt: str = "\n".join([
        [f"{title}: {description}" for title, description in zip(titles, descriptions)]
    ])

    system_prompt: str = """
    I am a risk analyst for a large insurance company. I am tasked with
    identifying emerging cyber risks that could impact our business.
    I have collected snippets of a series of news articles.
    I'd like you to identify a few notable emerging cyber risks, themes, and
    trends and list them. Don't name any companies or individuals.

    Following this, produce a short summary identifying the emerging risks common
    in all the articles. The summary should be of sufficient length and detail
    that a Board member can understand the risks and opportunities and make an
    informed decision on how to proceed.
    This summary will be included in a report to the Board of Directors.
    """
```

Identifying Emerging Risks

2. LLM to summarise into for the board

Summary:

Emerging cyber risks are characterised by a diverse set of themes, including regulatory changes, technological evolution, cybercrime sophistication, increased digital platform use, and growing AI technology concerns. New laws are being introduced that require advanced security measures, particularly for non-governmental entities and digital platforms. These regulations aim to better manage surveillance, privacy, and possibly control the demographic accessing these platforms.

Simultaneously, the rise in cybercrime activities requires continuous innovation in identification and prevention methods. The evolution of online criminal activities such as fraud, cyberbullying, and sophisticated cyberattacks presents an ever-increasing threat.

Therefore, the Board needs to consider focusing on proactive security measures, incorporating AI responsibly, and investing in cutting-edge fraud prevention tools while constantly updating its users about potential risks. Additionally, the rise in AI use throughout workplaces presents ethical and security concerns that will require our careful attention moving forward. Finally, we must remain vigilant about regulatory compliance, while also anticipating and learning from the changing cybercrime landscape.

Identifying Emerging Risks

3. LLM to extract action points

```
def action_points_prompt(summary: str, save_dir: Path) -> str:
    follow_up_prompt: str = """
    List three action points that the Board should consider in order of priority.
    List not more than three points.
    Seperate each action point with "\n".
    Each action point should be a single complete sentence.

    For example, if the summary states that "the Board should consider cyber
    security providers", then the action point would be "Provide a high-level
    project plan to discover and evaluate cyber security providers, including
    some information on how to evaluate them."
    """
```

Identifying Emerging Risks

3. LLM to extract action points

GPT 4

→

1. "Formulate a strategic plan to continuously monitor cybercrime activities and promptly advance security measures to combat emerging threats."
 2. "Implement a robust ethical framework and security protocols for AI use in the workplace to avoid misuse and potential cyber risks."
 3. "Assess existing regulations on cybersecurity, ensuring stringent compliance and proactively adjusting strategies with evolving legal landscape."
-

Identifying Emerging Risks

4. LLM to create project plans for each action point

GPT → Project Plan

4

I. Project Overview

- Project Title: Cybersecurity Strategy and Continuous Monitoring Project
- Project Goal: Develop a strategic plan for continuous monitoring of cybercrime activities and advancing security measures.

II. Project Scope

1. Enhancement of current cybercrime detection systems.
2. Development of a proactive strategy to tackle emerging cyber threats.
3. Continuous monitoring and prompt reporting of cybercrime activities.
4. Regular advancement of security measures.

III. Detailed Strategies and Actions

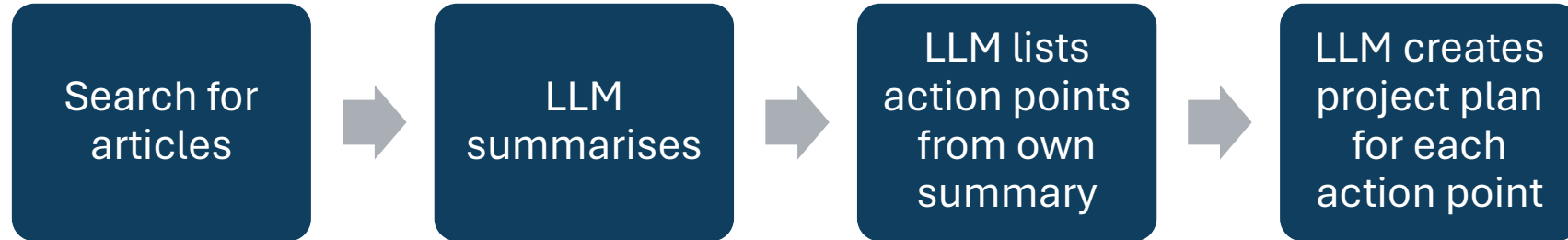
Phase 1: Understanding the Current State

- 1.1. Conduct an assessment of the current system and identify vulnerabilities.
- 1.2. Gather data on recent cybercrime activities and understand how they were resolved.
- 1.3. Identify tools, resources, and personnel necessary to improve security measures.

Phase 2: Development of the Strategic Plan

Identifying Emerging Risks

Recap



Entirely automated process



Case studies available

1: Parsing Claims

2: Identifying Emerging Risks

3: Regulatory Knowledgebase

4: Parsing Reinsurance Documents

Parsing Reinsurance Documents

Task

Extract structured information from reinsurance documents

Placement Slip

TYPE: Catastrophe Excess of Loss Reinsurance

INSURED: DEF Insurance Company

REINSURER: PQR Reinsurance Company

PERIOD: From - 1st July 2023
To - 30th June 2024
Both days at 12.01 am Local Standard Time at the address of the Insured

INTEREST: Covers all lines of business of the Insured including Property, Liability, and Aviation.

SUM INSURED: 100%
80000000 EUR

```
"treatyType": "Catastrophe Excess of  
Loss Reinsurance",  
"insured": "DEF Insurance Company",  
"reinsurer": "PQR Reinsurance  
Company",  
"period": {  
  "start": "1st July 2023",  
  "end": "30th June 2024"  
},
```

Parsing Reinsurance Documents

1. Extract text from PDF

```
def extract_text_from_pdf(pdf_path: Path) -> str:
    with open(pdf_path, "rb") as file:
        pdf_reader: PdfReader = PdfReader(file)
        num_pages: int = len(pdf_reader.pages)

        extracted_text: str = ""
        for page_num in range(num_pages):
            page = pdf_reader.pages[page_num]
            text: str = page.extract_text()
            extracted_text += text

    return extracted_text
```

Parsing Reinsurance Documents

2. Convert to JSON using LLM

```
def convert_text_to_json(text: str) -> dict:
    prompt: str = (
        f"Contract: {text}\n\n"
        "Q: What is the JSON representation of this reinsurance contract?"
    )

    gpt_response = openai.ChatCompletion.create(
        model="gpt-3.5-turbo-0613",
        messages=[
            {
                "role": "user",
                "content": SYSTEM_PROMPT,
            },
            {"role": "user", "content": prompt},
        ],
    )

    return json.loads(gpt_response.choices[0].message.content)
```

Parsing Reinsurance Documents

3. Output

```
case-study-4 > json > {...} ri1.json > ...
1  {
2    "treatyType": "Catastrophe Excess of Loss Reinsurance",
3    "insured": "DEF Insurance Company",
4    "reinsurer": "PQR Reinsurance Company",
5    "period": {
6      "start": "1st July 2023",
7      "end": "30th June 2024"
8    },
9    "lossLayers": [
10     {
11       "layer": 1,
12       "excessOf": 12000000,
13       "limit": 6000000,
14       "reinsuredPercent": 100
```

Recap

We can embed LLMs into processes using API access

LLMs can perform tasks based on input and their output

They can even extract structured output from various sources

Cue the actuary... what are the risks?

Risks of LLMs

Inherent Flaws & Biases

LLMs can produce errors and reflect biases present in training data. Critical evaluation needed for sensitive applications.

Memory & Context Limitation

Limited memory can result in lost context or inaccurate outputs. Restricted use for prolonged interactions.

Data Security & Privacy Concerns

Ensure compliance with data protection laws. Transparent and explainable use of LLMs is crucial.

Ongoing Monitoring & Validation

Continuous review of LLM outputs, providers, and associated policies. Development of validation frameworks essential.

Professionalism

Actuaries' Core Responsibility

Ensure accuracy, reliability, and act in the best interests of the insurer and policyholders, especially with LLMs.

Key Questions & Complexities

Compliance with professional standards, managing LLM risks, and avoiding unfair discrimination or adverse outcomes.

Responsibility Amidst AI Errors

Actuaries bear the onus for LLM outputs, similar to using spreadsheet software or word processors. Risk mitigation is essential.

Impact on Actuaries

Evolve Skillset

Actuaries must understand LLM limitations, biases, and ethical implications. Adaptation to AI technology is crucial.

Collaborative Interdisciplinary Work

Actuaries collaborating with data scientists, ethicists, and engineers; focus on data privacy, algorithmic fairness, and transparency.

Changing Workflows & Communication

Automation of time-consuming tasks; increased emphasis on complex reasoning, creativity, and effective communication of LLM results.

More in the paper...

- Detailed example of inclusion in claims process...
- ... plus, lighter examples in other areas

- Decision tree to identify LLM use cases...
- ... and a risk assessment tree to guide use

- Primer on how to use LLMs
- 4 case studies with code
- Overall useful reference

Developments Since Writing

Developments since writing



AGI?

Developments since writing

An AI that “...could learn to accomplish any intellectual task that human beings or animals can perform.”

https://en.wikipedia.org/wiki/Artificial_general_intelligence

AGI?

Developments since writing

~~LLM~~

LLanguageM

LAudioM

LVideoM

Developments since writing

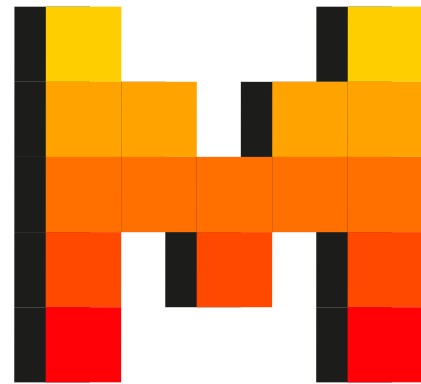
~~LLM~~

Multi-Modal
Model

Developments since writing



Developments since writing



MISTRAL
AI_

Open Source

Developments since writing

**Open
Source**

vs

**Closed
Source**

Developments since writing

“... I’m not that interested in the killer robots walking on the street direction of things going wrong,” Altman said. “I’m much more interested in the very subtle societal misalignments where we just have these systems out in society and **through no particular ill intention**, things just go horribly wrong.”



Thank You



You

Will AI replace actuaries?



ChatGPT

Will AI replace actuaries? Not entirely, but it might start asking for coffee breaks and better office views! Actuaries have a unique blend of skills that go beyond just crunching numbers—it's about interpreting them in ways that AI is still catching up on. Plus, who else will double-check the AI's homework?



Message ChatGPT...

