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Large Language Models in Financial Services

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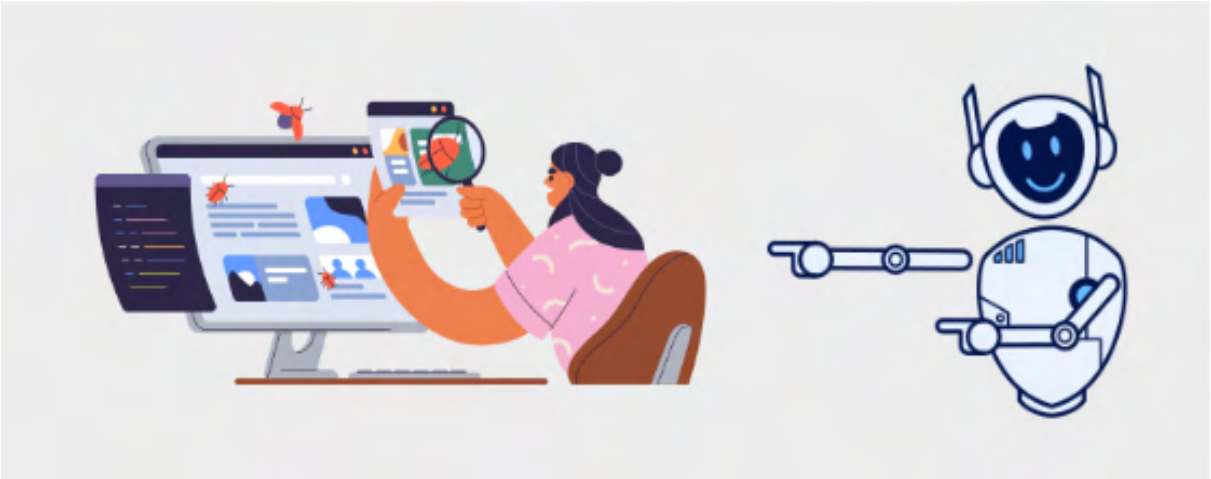
Large Language Models such as ChatGPT are without doubt the most significant development of the last year. The speed with which Chat GPT is capturing the user base and imagination of public is unrivalled in history: in just 5 days after its opening to the public, ChatGPT has gathered over 1 million of users - something Spotify managed to do in 5 months and Netflix in 5 years. ChatGPT is the talk of the day, also in financial institutions' hallways and boardrooms.

In this white paper, we outline those areas of financial services where we think Large Language Models will be applied in the near future, and discuss challenges associated with these applications.

Our goal is to start a dialog about the role of LLMs in financial industry. So, if after reading this paper, you have insights you would like to share with us - or if you disagree with our opinions - please get in touch! Let us explore this exciting topic together and think of ways LLMs can align with ambitions and goals of your organization.



Introduction

Today's data-driven world presents the financial services industry with big challenges. For example, how to gather, process and use timely and accurate information in decision-making, risk management, and customer service? The recent emergence of Large Language Models (LLMs) has the potential to fundamentally change the way businesses - and also financial institutions - operate. In this white paper we will discuss the opportunities and challenges LLMs present in the financial services.

Large Language Models, such as the ChatGPT, have captured the imagination of millions of users and researchers. These models use artificial intelligence and machine learning to process vast amounts of textual data, enabling them to generate human-like responses, write coherent essays, and engage in meaningful conversations. The potential disruption LLMs can cause in the financial services industry stems from their ability to automate and streamline a wide array of tasks previously performed by or with humans. For example, traditional roles that rely on data processing, such as data analysis, risk assessment, and compliance monitoring, may be taken over by LLMs. Moreover, the automation of routine tasks through LLMs can free up valuable time, enabling finance professionals to focus on complex problem-solving, conceptual thinking and strategic decision-making.

At the moment, it is hard to predict where LLMs will make the biggest impact in financial industry. In the next section, we will outline some applications of LLMs we think will soon emerge.

At this early stage of LLMs, it is important for financial institutions to engage in internal and external dialogues (with stakeholders, regulators as well as experts in academic and business community), to understand how LLMs can contribute to the success of your organization and how to avoid the pitfalls associated with their use.

1 LLMs in Financial Services

Here we will outline application areas where we think LLMs can make most significant and material impact. Broadly speaking, LLMs can assist in risk assessment, fraud detection, and compliance. Moreover, LLMs can enhance customer service through intelligent chat bots, personalized recommendations, and natural language interfaces, creating more engaging interactions. All these applications stem from the fact that LLMs can process vast volumes of unstructured data, such as news articles, research reports, and customer feedback.

Macroeconomic strategy and scenario generation

LLMs can process extensive macroeconomic data, including current market trends and economic indicators. This can help with evaluating investments, predicting future market trends, and determining strategic directions in the current macroeconomic circumstances. Moreover, LLMs can be asked to generate realistic economic scenarios, which can serve as input for ALM and other models that require economic scenario generation. For example, the ability of LLMs to see patterns can result in suggesting scenarios that are coherent across various indicators, such as increasing interest rates that are accompanied to the decline in growth stocks or dampening of housing market activity.

Credit Risk Management and Rating Models

Accurate credit risk assessment is crucial for financial institutions to mitigate potential losses in their credit portfolios and make informed lending decisions. LLMs can analyze vast amounts of client data, and help to identify potential risks in lending, assess creditworthiness and provide more accurate risk ratings. For example, by gathering data from various credit agencies and lenders, a bank can better assess the amount of credit a potential client already has.

Using LLMs for credit risk assessment, financial institutions can improve their lending processes, reducing the likelihood of defaults and optimizing their loan portfolios. However, banks should not blindly rely on LLMs or any other AI technology for credit decisions, and protect their customers by ensuring fair and accurate credit assessments.

> The European Union's AI legislation, known as the **AI Act**, is set to be enforced starting in 2024. The primary objective of this act is to establish trust among citizens and consumers while upholding the EU's core values, including the protection of human rights.

Fraud Detection and Risk Behavior Analysis in Insurance

Fraud detection is one area of finance where machine learning models are already widely and successfully applied. LLMs have the potential to further advance fraud detection, as well as a related area of risk behavior analysis in the insurance. By acting as virtual "private detectives", LLMs can scour vast amounts of data from multiple sources to identify patterns and detect fraudulent activities. Insurers also can benefit from the increased accuracy of LLM-driven analysis of insurance policy and claim applications, leading to improved underwriting decisions and reduced losses. Here, again, financial institutions have a task of protecting their customers from "false positives", i.e., instances of flagged transactions, which are not actually fraudulent.

Investment Analysis and Portfolio Management

By processing and interpreting large volumes of financial data (trading information, market transactions, news and social media content), LLMs can help optimize portfolio allocations, choose potentially profitable investment opportunities and identify market trends in real-time.

A practical handy tool that can result from the integration of LLM capabilities with financial data are smart dashboards that provide real-time insights, predictions, and recommendations. These interactive dashboards can be a great tool for investors, traders, and financial analysts to make better decisions. The combination of LLMs and financial data in user-friendly interfaces will allow users to visualize market trends, quickly identify current investment opportunities, and optimize portfolio strategies via what-if-like dashboard capabilities.

For example, an emerging investment theme might be "Investment in companies that are champions in leveraging Large Language Models". That same LLMs will be abe to suggest you a list of companies with high exposure to this theme, which you might consider including in your thematic portfolio - perhaps combining LLM's suggestions with some of your own fundamental analysis.

Model Validation and Documentation

LLMs can leverage their accumulated "knowledge" of mathematical and econometric models used for various applications. Since LLMs are able to write computer code, they can potentially provide challenger models to the models that need to be validated.

Furthermore, LLMs will help automate the process of model validation and especially creating model documentation. By using LLMs for creating model documentation, financial institutions can ensure transparency, regulatory compliance, and better communication with stakeholders. However, it is important to evaluate the relevance of traditional documentation versus LLMs' on-demand explanations and descriptions of a model: it is important to strike a balance between clarity, accessibility and rigor. What can be done already now, is asking an LLM to generate model validation templates for various types of validation (initial, periodic) and use that to optimize generation of your current model validation documentation.

Client Behavior Modeling and Regulatory Impact Analysis

LLMs can help financial institutions to gain deeper insights into client behavior and preferences - something AI and ML are already doing for retail and streaming services. As in those areas, LLMs can help identify patterns and predict customer needs, allowing institutions to offer more personalized products and services. For example, an LLM can be asked to predict how the customers would react if a bank decides to increase or decrease the interest on its deposits by a certain amount. Again, one should probably not rely on LLM's predictions for 100%, but such forecasts can inspire your own thought process. In the same way, LLMs can assist in regulatory impact analysis, by predicting the impact of regulatory changes on e.g., customer or market behaviour.

Enhanced Customer Experience via Virtual Financial Advisors

LLMs will power chat bots and virtual assistants, and improve customer service by providing instantaneous, accurate, and personalized responses. Virtual advisors powered by LLMs can

assist retail investors by offering personalized investment advice, portfolio management recommendations, and financial planning services. This development improves access to financial expertise for retail investors. It also enhances customer engagement and satisfaction, hence strengthening client relationships.

For those of you who already used ChatGPT, remember how amazed you were at first by human-like interaction you had with it. Soon, customers will expect this kind of interaction with any automated chat bots or virtual assistants, so it is important not to get stuck with your current technology that powers these bots.

Integrating LLMs with Blockchain and Quantum Computing

Looking further ahead, we foresee the integration of LLMs with emerging technologies such as blockchain and quantum computing. Blockchain technology can provide secure data storage, enabling LLMs to access and analyze distributed financial data. By combining LLMs with blockchain, financial institutions can enhance data privacy and design smart contracts. Quantum computing, on the other hand, can exponentially increase the computational power required for complex LLM algorithms, making their applications more scalable.

> *"ChatGPT and AI innovations will revolutionize industries by automating repetitive tasks, increasing productivity, improving quality control, and redefining job roles."*
> *Gartner, Inc. - April 2023*

The areas summarized above are all quite advanced applications of LLMs; there are, of course, more immediate areas where LLMs are already applied: such as report writing, text editing and coding. For example, this article could have been written by ChatGPT; however we have chosen to write it ourselves and personally address our readers in a more "human" language.

In the next section, we will elaborate on some risks and challenges of LLMs.

2 Navigating the challenges

While the potential of Large Language Models (LLMs) is significant, there are some critical issues that must be addressed for their successful implementation. This section explores some challenges that financial institutions must consider when implementing LLMs in their operations.

Regulatory hurdles: Explainability, Bias and Data Privacy

To use LLMs in a financial context, we need a deep understanding of applicable regulatory frameworks. Financial institutions must ensure compliance with regulations regarding data usage, transparency, and explainability, especially in highly regulated areas, such as credit or regulatory capital models.

Regulatory restrictions are currently seen as a hurdle for the deployment of AI-based models in IRB or CRR models, and the use of such models in any credit applications by banks is limited as a result. The main regulatory criticisms of AI models (and hence, also LLMs) is their lack of explainability and possible unfairness (i.e., bias) of the outcomes. Regulators require transparency of all models, making it essential to ensure LLM outputs are explainable and align

with regulatory guidelines for trustworthy AI applications in finance. Modern methods for explainable AI - such as couterfactual explanations or SHAP values - help us understand why a ML-powered model generates a particular output, and more sophisticated explainability methods are being developed. It remains to be seen how such methods can be applied to complex AI algorithms such as LLMs. For modellers and model risk management professionals, it is important to be on top of these developments and continuously monitor recent advances in this field.

LLMs learn from the vast amounts of historical data, potentially inheriting (and even exacerbating) biases present in that data. Financial institutions must ensure that their LLMs are monitored, to detect (and mitigate) biases: broadly speaking, LLMs, just as all other models used by a financial institution, must adhere to the institution's own ethical standards and the non-discrimination laws of their jurisdiction.

One way to minimize bias, is to use diverse and representative datasets to train LLMs, but, unfortunately, such "ideal" datasets do not always exist. Additionally, one should keep in mind that recommendations derived from LLMs trained on foreign data may not always be applicable in your specific cultural and regulatory contexts. Fortunately, there are many bias measurement and mitigation algorithms currently available, and the task of model builders and validators is to adapt them to LLMs.

LLMs require financial institutions to handle and process substantial amounts of sensitive customer data. Robust data privacy and security measures must be implemented to safeguard against breaches and maintain regulatory compliance.

To conclude, collaboration between experts in LLM technology, regulatory bodies, and financial institutions is essential to develop frameworks, guidelines, and best practices that enable the responsible and successful application of LLMs in the financial services industry.

Timeliness and information security

Financial markets resemble living organisms, constantly moving and changing, and any information becomes stale within days if not hours. To generate factually correct and timely responses, LLMs have to be constantly re-trained, using the latest available information. At this stage, this is not the case. At the time of writing this paper, ChatGPT was trained on the information until September 2021. This is clearly a big problem for any current successful LLM application. For example, if you ask ChatGPT now, when was the last time Max Verstapppen won the Grand Prix, the answer is in September 2021, but we all know that he had several big wins since then. In the same way, if LLMs are asked about current recommended investment opportunities, an answer which takes into account current market circumstances is not available. However, we expect that this issue will be resolved in the future, and LLMs will be coupled with diverse real-time data feeds, including those from financial markets.

If LLMs are used in combination with proprietary/internal datasets, then financial institutions must have robust mechanisms in place for collecting, aggregating, and storing such data. Data lakes, which are centralized repositories for storing structured and unstructured data, provide a scalable and flexible infrastructure to manage vast amounts of financial data. Data lakes provide significant opportunities for financial institutions, but they also present challenges related to information security and confidentiality. Apart from obvious risks, another, new one is (unintentionally) sharing these data with external LLMs, by this giving away valuable and proprietary insights.

To mitigate these risks, robust cybersecurity measures must be put in place. This includes implementing stringent access and data sharing controls, encryption protocols, and conducting regular security audits to prevent data breaches and unauthorized access. Moreover, strict protocols for data handling should be established to ensure client confidentiality and maintain the integrity of financial systems.

Risk of misinformation and human judgement

It is by now well-known that LLMs can provide incorrect responses: in fact, they are often dubbed "convincing bullshitters". This is currently very hard to detect and counteract. As LLMs gains widespread adoption in financial services, the risk of misinformation and market manipulation grows. This is especially problematic in applications of LLMs in investment and asset management. LLMs have the potential to inadvertently amplify false or misleading information, which can result in incorrect or even harmful investment decisions. So any user of LLMs (in financial sector or otherwise) must be alert and aware of this possibility, and not take LLM's answers for granted.

Over-reliance on LLM-generated recommendations can be a significant threat, particularly during periods of market stress or crises. In such events, LLMs may amplify market volatility or recommend actions that exacerbate the situation. Financial institutions must exercise caution, maintaining a balance between the insights provided by LLMs and human expertise to mitigate risks and ensure prudent decision-making in high-pressure situations.

While LLMs can offer human-like capabilities (e.g., in text generation), they cannot fully replace human expertise and judgment. Financial institutions must strike a delicate balance between using LLM-generated recommendations and incorporating human insights. Ideally, a successful LLM-human integration will provide the benefits of LLM-driven efficiency while upholding the value of human experience, intuition, and contextual understanding in complex financial decision-making.
Only time will show how these (and other) LLM-related challenges will be addressed. For now, it is important to be aware of these hurdles, have checks in place to detect and potentially mitigate them, and stay on top of technological as well as regulatory developments in this exciting field.

3 To conclude

The emergence of Large Language Models (LLMs) represents a groundbreaking technological advancement with the potential to reshape the financial services industry. These powerful language models can automate a wide range of tasks and improve efficiency, accuracy, and customer experiences. As we witness the rapid adoption of LLMs across various sectors, for example the integration of LLMs in Microsoft applications, it becomes evident that embracing this technology can lead to significant advantages. Financial institutions that proactively integrate LLMs into their operations - while still ensuring fairness, integrity and reliability - can position themselves as leaders in this rapidly evolving landscape.

Financial institutions have to take responsibility of reshaping the future of financial services, and the emergence of LLMs is an opportunity that requires active engagement. We encourage you to explore the possibilities that LLMs hold for your organization. To harness the full benefits of LLMs, you need to develop a vision and an implementation strategy that aligns with your needs, regulatory requirements and financial goals.

By engaging with thought leaders such as academics and experts, you can shape such vision, seize the opportunities and navigate the challenges LLMs present.

How can Probability & Partners help?

Probability & Partners is a risk advisory firm that specializes in risk management and quantitative modeling solutions for the financial sector. With our deep expertise in AI and Machine Learning, we are well-equipped to offer extensive support in this domain. We understand the pivotal role of AI and Machine Learning in today's business landscape. Our team of experts is dedicated to delivering tailored solutions that meet your specific needs in data analysis, model development, validation, and software development. Contact us today and let us help you unlock the full potential of AI/ML in your business.

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