BACKGROUND INFO

I) Templates

EXAMPLES OF SHORT DESCRIPTION OF A WORKFLOW

1. **Credit Risk Analysis Workflow**:
    - **Tasks**: Analyze credit data and financial statements to assess risk in lending; complete loan applications, including credit analyses; generate financial ratios; prepare risk reports.
    - **Abilities and Skills**: Critical thinking, mathematical reasoning, reading comprehension, written and oral comprehension and expression, deductive and inductive reasoning.
    - **Knowledge**: Economics and accounting, mathematics, business and management principles.
    - **Tools**: Financial analysis software (e.g., Moody's RiskCalc, Oracle E-Business Suite Financials), spreadsheet software (e.g., Microsoft Excel), database management systems.
2. **Loan Approval Workflow**:
    - **Tasks**: Submit loan applications with credit analyses to loan committees for approval; consult with customers for complaints resolution; contact customers for delinquent accounts.
    - **Abilities and Skills**: Judgment and decision-making, problem sensitivity, service orientation, negotiation, active listening.
    - **Knowledge**: Customer and personal service, administration and management, law and government.
    - **Tools**: CRM software (e.g., Salesforce), electronic mail software (e.g., Microsoft Outlook), office suite software (e.g., Microsoft Office).

EXAMPLE OF LONG DESCRIPTION OF A WORKFLOW

The "Credit Risk Analysis Workflow" in the context of credit analysts, as detailed in the document, is a highly specialized and data-intensive process. Here's a more precise and focused description:

1. **Initial Data Collection**:
    - **Task**: Gather relevant credit data and financial statements from clients or internal databases.
    - **Tools**: Database management systems, financial analysis software.
    - **Skills**: Attention to detail, proficiency in database navigation.
2. **Financial Analysis and Risk Assessment**:
    - **Task**: Analyze financial statements to understand the financial health and stability of the client. This involves calculating various financial ratios, such as debt-to-income ratio, and assessing cash flow statements.
    - **Tools**: Financial analysis software (e.g., Moody's RiskCalc), spreadsheet software (e.g., Microsoft Excel).

    - **Skills**: Mathematical reasoning, understanding of financial principles, proficiency in financial software.
3. **Credit Scoring and Rating**:
    - **Task**: Assign a credit score or rating based on analyzed data. This score reflects the creditworthiness of the client.
    - **Tools**: Credit scoring software, proprietary rating systems.
    - **Skills**: Analytical skills, knowledge of credit scoring methodologies.
4. **Risk Report Preparation**:
    - **Task**: Prepare detailed risk reports that highlight potential risks in lending to the client. These reports include findings from the analysis and the assigned credit score.
    - **Tools**: Report writing software, financial analysis tools.
    - **Skills**: Written communication, ability to synthesize complex data into understandable reports.
5. **Compliance and Regulation Adherence**:
    - **Task**: Ensure all analyses and reports comply with relevant financial regulations and standards.
    - **Tools**: Compliance software, legal and regulatory databases.
    - **Skills**: Knowledge of relevant regulations, attention to legal details.
6. **Updating Credit Policies and Models**:
    - **Task**: Use findings from credit analyses to recommend updates to credit policies and risk models.
    - **Tools**: Data analysis tools, policy documentation software.
    - **Skills**: Strategic thinking, ability to link data analysis with policy development.
7. **Continuous Learning and Adaptation**:
    - **Task**: Stay updated with evolving credit risk analysis methodologies and financial market trends.
    - **Tools**: Online courses, financial news sources.
    - **Skills**: Active learning, adaptability to new information and techniques.

Example of CURRENT STATE description:

"The impact of AI systems, particularly advanced language models like GPT-4, on the Credit Risk Analysis Workflow can be summarized as follows:

1. **Data Interpretation in Financial Analysis**:
    - **AI Application**: GPT-4 is capable of processing and interpreting financial data within a large context window, making it suitable for handling substantial volumes of information in credit risk analysis.
    - **Limitations**: It struggles with complex tables and charts, which are common in financial analysis, limiting its ability to provide detailed and accurate interpretations in these contexts. Additionally, GPT-4's effectiveness diminishes in processing texts longer than 70k tokens, affecting its ability to fully understand and analyze extensive financial documents.

2. **Financial Report Generation**:
    - **AI Application**: GPT-4 can generate financial reports and summaries by drawing from its extensive training data, which includes information up to April 2023. This can be useful in creating initial risk assessment reports in the credit risk analysis process.
    - **Limitations**: GPT-4's inability to process real-time financial data limits its effectiveness in rapidly changing financial markets, which is a crucial aspect of credit risk analysis.
3. **Accuracy and Coherence in Analysis**:
    - **Strengths**: GPT-4 demonstrates high accuracy in well-documented areas and effectively maintains coherence in short to medium interactions, which are beneficial in the initial stages of credit risk analysis.
    - **Challenges**: Its accuracy declines in specialized or rapidly evolving fields, and its performance degrades in long conversations or complex contexts, which can be limiting in comprehensive financial analyses that require nuanced understanding and long-term context retention.
4. **Ethical and Bias Considerations**:
    - **AI System**: GPT-4 is programmed to avoid offensive, harmful, or biased content, but it may still mirror biases present in its training corpus. This is a critical factor to consider in credit risk analysis, where unbiased assessment is paramount.
5. **Response Time and Resource Efficiency**:
    - **AI Strengths**: GPT-4 provides fast real-time interaction responses, which can be advantageous for rapid analyses in credit risk assessment.
    - **Challenges**: It requires significant computational resources for large-scale or complex tasks, which could be a limiting factor in extensive credit risk analyses.

In conclusion, while AI systems like GPT-4 can augment certain aspects of the Credit Risk Analysis Workflow, particularly in data interpretation and initial financial report generation, there are significant limitations. These include difficulties with complex data formats, maintaining long-term context, and ethical considerations. As a result, AI systems currently serve best as assistants in the credit risk analysis process, enhancing the productivity and capabilities of human analysts rather than replacing them entirely."

Example of PERSPECTIVES description:

"Looking ahead at the Credit Risk Analysis Workflow, considering the current state of AI development and its trajectory, here's the outlook for the next few years:

Short-Term (Next 6-12 Months):

- **Advancements Expected**: Incremental improvements in AI's ability to process complex data formats, including tables and charts commonly used in financial analysis, are anticipated. However, these advancements may not be significant enough to completely automate the workflow.

- **Impact on Workflow**: The efficiency of certain aspects of the Credit Risk Analysis Workflow, such as preliminary data interpretation and basic report generation, will likely improve. Analysts can expect enhanced assistance from AI in these areas, but the core of the analysis will still require human expertise and intervention.

Medium-Term (Next 36 Months):

- **Advancements Expected**: Significant advancements in AI capabilities, particularly in processing and generating complex financial data formats, are likely. This will include better integration of real-time data and improved accuracy in financial report generation.
- **Impact on Workflow**: We can expect a substantial shift towards automation in generating summary reports of financial research results. The role of AI in the Credit Risk Analysis Workflow will evolve from being an assistant to taking on more autonomous tasks, though human oversight and decision-making will remain crucial.

Long-Term (Next 5 Years):

- **Advancements Expected**: AI systems are anticipated to largely exceed human abilities in certain aspects of the Credit Risk Analysis Workflow. This includes advanced data interpretation, trend analysis, and predictive modeling.
- **Impact on Workflow**: The task of producing written summary reports of financial research results could become fully automatable. Credit risk analysis may see a paradigm shift with AI systems leading the process, supported by human analysts focusing on strategic decision-making and handling exceptional cases.

In summary, while short-term improvements will enhance existing workflows, the medium to long-term outlook suggests a transformative change in the Credit Risk Analysis Workflow. AI's role will shift from supportive to central, with its capacity to handle complex data and generate insightful analyses significantly advancing beyond current capabilities. However, the necessity for human expertise, particularly in ethical considerations, complex decision-making, and handling novel scenarios, will remain a critical component of the workflow."

II – COMPONENTS OF A WORKFLOW

A) List tasks for financial analysis activities:

1) Analyze credit data and financial statements to determine the degree of risk involved in extending credit or lending money.
2) Complete loan applications, including credit analyses and summaries of loan requests, and submit to loan committees for approval.
3) Generate financial ratios, using computer programs, to evaluate customers' financial status.

4) Prepare reports that include the degree of risk involved in extending credit or lending money.
5) Analyze financial data, such as income growth, quality of management, and market share to determine expected profitability of loans.
6) Compare liquidity, profitability, and credit histories of establishments being evaluated with those of similar establishments in the same industries and geographic locations.
7) Consult with customers to resolve complaints and verify financial and credit transactions.
8) Contact customers to collect payments on delinquent accounts.
9) Evaluate customer records and recommend payment plans, based on earnings, savings data, payment history, and purchase activity.
10) Review individual or commercial customer files to identify and select delinquent accounts for collection.
11) Confer with credit association and other business representatives to exchange credit information.
12) Analyze financial or operational performance of companies facing financial difficulties to identify or recommend remedies.
13) Assess companies as investments for clients by examining company facilities.
14) Collaborate on projects with other professionals, such as lawyers, accountants, or public relations experts.
15) Collaborate with investment bankers to attract new corporate clients.
16) Conduct financial analyses related to investments in green construction or green retrofitting projects.
17) Confer with clients to restructure debt, refinance debt, or raise new debt.
18) Create client presentations of plan details.
19) Determine the prices at which securities should be syndicated and offered to the public.
20) Develop and maintain client relationships.
21) Draw charts and graphs, using computer spreadsheets, to illustrate technical reports.
22) Employ financial models to develop solutions to financial problems or to assess the financial or capital impact of transactions.
23) Evaluate and compare the relative quality of various securities in a given industry.
24) Evaluate capital needs of clients and assess market conditions to inform structuring of financial packages.
25) Inform investment decisions by analyzing financial information to forecast business, industry, or economic conditions.
26) Interpret data on price, yield, stability, future investment-risk trends, economic influences, and other factors affecting investment programs.
27) Monitor developments in the fields of industrial technology, business, finance, and economic theory.
28) Monitor fundamental economic, industrial, and corporate developments by analyzing information from financial publications and services, investment banking firms, government agencies, trade publications, company sources, or personal interviews.
29) Perform securities valuation or pricing.
30) Prepare all materials for transactions or execution of deals.
31) Prepare plans of action for investment, using financial analyses.
32) Present oral or written reports on general economic trends, individual corporations, and entire industries.
33) Purchase investments for companies in accordance with company policy.
34) Recommend investments and investment timing to companies, investment firm staff, or the public.
35) Specialize in green financial instruments, such as socially responsible mutual funds or exchange-traded funds (ETF) that are comprised of green companies.
36) Supervise, train, or mentor junior team members.
37) Apply mathematical or statistical techniques to address practical issues in finance, such as derivative valuation, securities trading, risk management, or financial market regulation.

38) Research or develop analytical tools to address issues such as portfolio construction or optimization, performance measurement, attribution, profit and loss measurement, or pricing models.
39) Interpret results of financial analysis procedures.
40) Develop core analytical capabilities or model libraries, using advanced statistical, quantitative, or econometric techniques.
41) Define or recommend model specifications or data collection methods.
42) Produce written summary reports of financial research results.
43) Maintain or modify all financial analytic models in use.
44) Provide application or analytical support to researchers or traders on issues such as valuations or data.
45) Devise or apply independent models or tools to help verify results of analytical systems.
46) Collaborate in the development or testing of new analytical software to ensure compliance with user requirements, specifications, or scope.
47) Confer with other financial engineers or analysts on trading strategies, market dynamics, or trading system performance to inform development of quantitative techniques.
48) Consult traders or other financial industry personnel to determine the need for new or improved analytical applications.
49) Research new financial products or analytics to determine their usefulness.
50) Identify, track, or maintain metrics for trading system operations.
51) Develop methods of assessing or measuring corporate performance in terms of environmental, social, and governance (ESG) issues.
52) Collaborate with product development teams to research, model, validate, or implement quantitative structured solutions for new or expanded markets.
53) Prepare requirements documentation for use by software developers.
54) Develop solutions to help clients hedge carbon exposure or risk.
55) Develop tools to assess green technologies or green financial products, such as green hedge funds or social responsibility investment funds.
56) Assess the potential impact of climate change on business financial issues, such as damage repairs, insurance costs, or potential disruptions of daily activities.
57) Analyze pricing or risks of carbon trading products.
58) Analyze areas of potential risk to the assets, earning capacity, or success of organizations.
59) Analyze new legislation to determine impact on risk exposure.
60) Conduct statistical analyses to quantify risk, using statistical analysis software or econometric models.
61) Confer with traders to identify and communicate risks associated with specific trading strategies or positions.
62) Consult financial literature to ensure use of the latest models or statistical techniques.
63) Contribute to development of risk management systems.
64) Determine potential environmental impacts of new products or processes on long-term growth and profitability.
65) Develop contingency plans to deal with emergencies.
66) Develop or implement risk-assessment models or methodologies.
67) Devise scenario analyses reflecting possible severe market events.
68) Devise systems or processes to monitor validity of risk assessments.
69) Document, and ensure communication of, key risks.
70) Evaluate the risks and benefits involved in implementing green building technologies.
71) Evaluate the risks related to green investments, such as renewable energy company stocks.
72) Gather risk-related data from internal or external resources.
73) Identify key risks and mitigating factors of potential investments, such as asset types and values, legal and ownership structures, professional reputations, customer bases, or industry segments.
74) Maintain input or data quality of risk management systems.

75) Meet with clients to answer queries on subjects such as risk exposure, market scenarios, or values-at-risk calculations.
76) Produce reports or presentations that outline findings, explain risk positions, or recommend changes.
77) Provide statistical modeling advice to other departments.
78) Review or draft risk disclosures for offer documents.
79) Track, measure, or report on aspects of market risk for traded issues.

B) Examples of human abilities necessary to perform financial analysis related tasks.

- Mathematical Reasoning: The ability to choose the right mathematical methods or formulas to solve a problem., [importance score: 85/100]
- Written Comprehension: The ability to read and understand information and ideas presented in writing., [importance score: 75/100]
- Oral Comprehension: The ability to listen to and understand information and ideas presented through spoken words and sentences., [importance score: 72/100]
- Written Expression: The ability to communicate information and ideas in writing so others will understand., [importance score: 72/100]
- Deductive Reasoning: The ability to apply general rules to specific problems to produce answers that make sense., [importance score: 72/100]
- Number Facility: The ability to add, subtract, multiply, or divide quickly and correctly., [importance score: 72/100]
- Oral Expression: The ability to communicate information and ideas in speaking so others will understand., [importance score: 69/100]
- Problem Sensitivity: The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing that there is a problem., [importance score: 69/100]
- Inductive Reasoning: The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events)., [importance score: 69/100]
- Information Ordering: The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations)., [importance score: 69/100]
- Fluency of Ideas: The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity)., [importance score: 66/100]
- Speech Recognition: The ability to identify and understand the speech of another person., [importance score: 63/100]
- Speech Clarity: The ability to speak clearly so others can understand you., [importance score: 63/100]
- Near Vision: The ability to see details at close range (within a few feet of the observer). [importance score: 60/100]
- Category Flexibility: The ability to generate or use different sets of rules for combining or grouping things in different ways., [importance score: 56/100]
- Originality: The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem., [importance score: 53/100]
- Selective Attention: The ability to concentrate on a task over a period of time without being distracted., [importance score: 53/100]

- Flexibility of Closure: The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material., [importance score: 47/100]
- Speed of Closure: The ability to quickly make sense of, combine, and organize information into meaningful patterns., [importance score: 41/100]
- Perceptual Speed: The ability to quickly and accurately compare similarities and differences among sets of letters, numbers, objects, pictures, or patterns. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object., [importance score: 38/100]
- Memorization: The ability to remember information such as words, numbers, pictures, and procedures., [importance score: 35/100]
- Far Vision: The ability to see details at a distance., [importance score: 31/100]
- Time Sharing: The ability to shift back and forth between two or more activities or sources of information (such as speech, sounds, touch, or other sources)., [importance score: 28/100]
- Visualization: The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged., [importance score: 25/100]
- Trunk Strength: The ability to use your abdominal and lower back muscles to support part of the body repeatedly or continuously over time without "giving out" or fatiguing., [importance score: 25/100]
- Visual Color Discrimination: The ability to match or detect differences between colors, including shades of color and brightness., [importance score: 25/100]
- Hearing Sensitivity: The ability to detect or tell the differences between sounds that vary in pitch and loudness., [importance score: 25/100]
- Auditory Attention: The ability to focus on a single source of sound in the presence of other distracting sounds., [importance score: 25/100]
- Wrist-Finger Speed: The ability to make fast, simple, repeated movements of the fingers, hands, and wrists., [importance score: 22/100]
- Finger Dexterity: The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects., [importance score: 16/100]
- Control Precision: The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions., [importance score: 16/100]
- Depth Perception: The ability to judge which of several objects is closer or farther away from you, or to judge the distance between you and an object., [importance score: 16/100]
- Arm-Hand Steadiness: The ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position., [importance score: 13/100]
- Manual Dexterity: The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects., [importance score: 13/100]

C) Examples of human skills required to perform certain financial analysis related tasks:

- Critical Thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions: conclusions: or approaches to problems..

- Reading Comprehension: Understanding written sentences and paragraphs in work-related documents..
- Speaking: Talking to others to convey information effectively..
- Active Learning: Understanding the implications of new information for both current and future problem-solving and decision-making..
- Active Listening: Giving full attention to what other people are saying: taking time to understand the points being made: asking questions as appropriate: and not interrupting at inappropriate times..
- Mathematics: Using mathematics to solve problems..
- Writing: Communicating effectively in writing as appropriate for the needs of the audience..
- Judgment and Decision Making: Considering the relative costs and benefits of potential actions to choose the most appropriate one..
- Monitoring: Monitoring/Assessing performance of yourself: other individuals: or organizations to make improvements or take corrective action..
- Social Perceptiveness: Being aware of others' reactions and understanding why they react as they do..
- Service Orientation: Actively looking for ways to help people..
- Complex Problem Solving: Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions..
- Time Management: Managing one's own time and the time of others..
- Systems Analysis: Determining how a system should work and how changes in conditions: operations: and the environment will affect outcomes..
- Systems Evaluation: Identifying measures or indicators of system performance and the actions needed to improve or correct performance: relative to the goals of the system..
- Coordination: Adjusting actions in relation to others' actions..
- Operations Analysis: Analyzing needs and product requirements to create a design..
- Learning Strategies: Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things..
- Persuasion: Persuading others to change their minds or behavior..
- Negotiation: Bringing others together and trying to reconcile differences..
- Instructing: Teaching others how to do something..
- Management of Financial Resources: Determining how money will be spent to get the work done: and accounting for these expenditures..
- Management of Personnel Resources: Motivating: developing: and directing people as they work: identifying the best people for the job..
- Operations Monitoring: Watching gauges: dials: or other indicators to make sure a machine is working properly..
- Management of Material Resources: Obtaining and seeing to the appropriate use of equipment: facilities: and materials needed to do certain work..
- Programming: Writing computer programs for various purposes..
- Quality Control Analysis: Conducting tests and inspections of products: services: or processes to evaluate quality or performance..
- Science: Using scientific rules and methods to solve problems..
- Technology Design: Generating or adapting equipment and technology to serve user needs.

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D) Examples of human knowledge required to perform certain financial analysis related tasks:

- Mathematics: Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- Economics and Accounting: Knowledge of economic and accounting principles and practices, the financial markets, banking, and the analysis and reporting of financial data.
- Computers and Electronics: Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- English Language: Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- Engineering and Technology: Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Administration and Management: Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.
- Design: Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Customer and Personal Service: Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.
- Psychology: Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.
- Education and Training: Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.
- Personnel and Human Resources: Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.
- Communications and Media: Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.
- Law and Government: Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.
- Sales and Marketing: Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.
- Production and Processing: Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
- Sociology and Anthropology: Knowledge of group behavior and dynamics, societal trends and influences, human migrations, ethnicity, cultures, and their history and origins.
- Administrative: Knowledge of administrative and office procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and workplace terminology.

- Geography: Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.
- Telecommunications: Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.
- Physics: Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.
- History and Archeology: Knowledge of historical events and their causes, indicators, and effects on civilizations and cultures.
- Transportation: Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.
- Building and Construction: Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
- Foreign Language: Knowledge of the structure and content of a foreign (non-English) language including the meaning and spelling of words, rules of composition and grammar, and pronunciation.
- Mechanical: Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
- Chemistry: Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
- Biology: Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
- Medicine and Dentistry: Knowledge of the information and techniques needed to diagnose and treat human injuries, diseases, and deformities. This includes symptoms, treatment alternatives, drug properties and interactions, and preventive health-care measures.
- Therapy and Counseling: Knowledge of principles, methods, and procedures for diagnosis, treatment, and rehabilitation of physical and mental dysfunctions, and for career counseling and guidance.
- Fine Arts: Knowledge of the theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.
- Philosophy and Theology: Knowledge of different philosophical systems and religions. This includes their basic principles, values, ethics, ways of thinking, customs, practices, and their impact on human culture.
- Public Safety and Security: Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.
- Food Production: Knowledge of techniques and equipment for planting, growing, and harvesting food products (both plant and animal) for consumption, including storage/handling techniques.

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E) Examples of technology skills (ability to use the following tools) necessary to perform certain financial analysis related tasks.

- Accounting software: Examples: Fund accounting software, Intuit QuickBooks, Sage 50 Accounting, Tax software.
- Analytical or scientific software: Examples: IBM SPSS Statistics, SAS, StataCorp Stata, The MathWorks MATLAB, Insightful S-PLUS.
- Business intelligence and data analysis software: Examples: Alteryx software, MicroStrategy, Qlik Tech QlikView, Tableau.
- Charting software: Examples: Montgomery Investment Technology Utility XL, TickQuest NeoTicker.
- Cloud-based data access and sharing software: Examples: Microsoft SharePoint.
- Configuration management software: Examples: Perforce Helix software.
- Customer relationship management CRM software: Examples: Salesforce software.
- Data base management system software: Examples: Apache Hive, Apache Pig, Teradata Database.
- Data base reporting software: Examples: Microsoft SQL Server Reporting Services SSRS, Reporting software, SAP Crystal Reports.
- Data base user interface and query software: Examples: Microsoft SQL Server, Oracle Database, Structured query language SQL, Yardi software, Microsoft Access.
- Development environment software: Examples: Microsoft Visual Basic, Microsoft Visual Basic for Applications VBA, Microsoft Visual Studio.
- Document management software: Examples: Microsoft Office SharePoint Server MOSS.
- Electronic mail software: Examples: Email software, IBM Notes, Microsoft Exchange, Microsoft Outlook.
- Enterprise resource planning ERP software: Examples: Microsoft Dynamics, Oracle PeopleSoft, SAP software, SSA Global Infinium Financial Management, MicroStrategy Desktop, Oracle JD Edwards EnterpriseOne.
- Enterprise system management software: Examples: IBM Power Systems software.
- Expert system software: Examples: Ivorix Neurostrategy Finance, Matheny Pattern Forecaster Plus, NeuroSolutions for MatLab.
- Financial analysis software: Examples: Delphi Technology, Moody's RiskCalc, Oracle E-Business Suite Financials, Oracle Hyperion Financial Management, Bloomberg Professional, Datarails, Cube, Causal, Jirav, Clockwork, Budgyt, Limelight, NetSuite Reporting, MODLR, DriveTrain, Pigment, FinAlyzer, Anaplan.
- Human resources software: Examples: ADP Workforce Now, Human resource management software HRMS.
- Information retrieval or search software: Examples: dailyVest Investment Personalization Platform, LexisNexis, TradeTools Monthly U.S. Economic Database, Ward Systems Group NeuroShell Trader.
- Internet browser software: Examples: Web browser software.
- Object or component oriented development software: Examples: R, C#, C++, Oracle Java, Perl, Python.
- Office suite software: Examples: Microsoft Office software.
- Operating system software: Examples: Linux, UNIX.
- Presentation software: Examples: Apple Keynote, DealMaven PresLink for PowerPoint and Word, Google Slides, Microsoft PowerPoint.
- Process mapping and design software: Examples: Microsoft Visio.
- Project management software: Examples: Microsoft Project, Oracle Primavera Enterprise Project Portfolio Management.
- Sales and marketing software: Examples: Marketo Marketing Automation.
- Spreadsheet software: Examples: Apple AppleWorks, Corel QuattroPro, IBM Lotus 1-2-3, Microsoft Excel.
- Word processing software: Examples: Google Docs, Microsoft OneNote, Microsoft Word, Report generation software.
- Data mining software: Examples: IBM Cognos Business Intelligence.
- Web platform development software: Examples: JavaScript.

III) AI TECHNOLOGIES CURRENT STATE AND OUTLOOK

A) Information

1) Analytical Framework

The rise of GenAI has given a central role to LLMs powering chatbots. The ability of a chatbot can increase dramatically with the addition of software and robotic layers. To standardize the analysis our framework includes the following layers, each layer enhancing the abilities achieved by the system:

1) Layer 1: **Chatbots**. The framework we use for assessing the abilities of AI systems assumes that frontier Large Language Models (LLM) such as GPT4 or Claude constitute the fundamental building block. We therefore start by assessing the abilities of such models as a standalone tool provided via a chatbot such as ChatGPT.
    a. Example: The LLM can analyze the text in financial statements
2) Layer 2: **Tools.** Tools that can be connected to LLMs to automate tasks such as database query, calculation, image analysis and generation, voice-to-text and text-to-voice, etc. In theory, LLMs can be connected to pretty much all the software tools that exist thus greatly enhancing the abilities of the model. In practice however, not all the related extensions or 'agents' have been developed to date.
    a. Example: Tools are necessary to extract data from tables, charts, develop an NPV model and output charts
3) Layer 3: **Abilities of a Fine-Tuned LLM**. To better perform on specific tasks and topics an LLM can be fine-tuned on a specific dataset, or even re-trained for open-source models. However, as of today, only less powerful models such as GPT3.5 turbo or open-source models like Mistal can be fine-tuned or trained by users.
    a. Example: An LLM is fine-tuned to understand complex tables corresponding to a certain format (e.g. total sales on the top line and sales per business line under it).
4) Layer 4: **Multi-Agent Systems Multi-Agent Systems.** MAS involves several bots collaborating with each other and using various tools to execute multi-step processes. Although there is no example of large-scale commercial application yet, research has demonstrated that the use of these MAS dramatically increase the performance of LLMs.
    a. Example: The MAS automates the workflow from financial statement download to output of the analysis
5) Layer 5: **VR and Robotic Extensions**. AI systems are limited in their ability to interact seamlessly with their physical environment and notably humans. This limitation can be partly addressed with robotic extensions (sensors, actuators) and/or the connection with Virtual Reality environments. Robotic tools such as sensors, actuators, effectors, etc. that enable an interaction of the AI system with the physical environment. Virtual, Augmented and Mixed Reality reducing the need for interactions between the AI system and the physical environment.
    a. Example: Robotics is used to control the interface with a laptop and bypass all restrictions on websites access by bots
    b. Example: An AI clone of the financial analyst deliver the presentation in VR.

In the examples above, the task of analyzing financial statements face hurdles when only using the chatbot. However, with agents the system can read charts and generate models to process the data. Combining multiple agents working with each other mimics the skillset of a

team with different domains of expertise and tools. Add Virtual Reality and the avatar of a human analyst can present and discuss the results to a client in a language he doesn't speak.

2) Enhancing Chatbots With Tools

Connecting LLMs to external data sources can greatly expand their knowledge beyond what models can memorize internally. Tools like search engines, databases, and analytics platforms allow composing advanced workflows not possible within the constraints of a standalone model. For instance, researchers have already experimented with Toolformers that make API calls to services conditional on language instructions and contextual history [15]. Linking tools expands the information available, but can reduce reasoning to shallow pattern matching without the structure intrinsic to custom fine-tuning. Therefore, purposefully designing the division of labor between tools and models tailored to specific use cases appears vital to maximize performance. And caching lookup results rather than stale API calls could significantly speed workflows.

The coming months may see blending of tools reach sufficient maturity for seamless usage in numerous basic assistance domains. For example, coding assistants leveraging integrated runtime checks could match expert developer productivity for mainstream languages based on GitHub Copilot data [16]. Conversational systems may demonstrate improved tactfulness on sensitive topics through tool connections better spotting inappropriate responses before sending them. However, matching deeper human subtleties around dynamically inferring context and fluidly adapting seems likely to remain challenging.

Over the next few years, growth in userbases could provide enough aggregate behavioral data from conversations to allow automatic fine-tuning of models tailored for specific demographics and use cases [17]. Toolchains codifying entire enterprise workflows might reach reliability sufficient for business verticals like customer support, lead generation, or recruiting through fusion of general chitchat capabilities, niche expertise for industries, and modular bot collaboration [18]. And development of performant multimodal application programming interfaces (APIs) from large providers could enable language-conditioned generation of rich media content types including photos, videos, and structured data leveraging sensory inputs ranging from conventional cameras to lidars.

3) Abilities of Specialized Fine-Tuned Models

Large foundation model providers currently limit access to fine-tuning capabilities to internal researchers and selected partners only. But for smaller 8 billion parameter scale LLM experts like Anthropic's Constitutional Claude, EleutherAI's GPT-NeoX 20B, or models derived from LLaMA-2, the open source community actively publishes fine-tuned versions targeting niche domains [19]. These focused adaptations demonstrate superior performance to their foundation model progenitors when evaluations match their specialization [4]. Ensembling with generalist chatbots could yield systems exceeding standalone versions.

However, effectively specializing models requires scarce ML engineering expertise limiting accessibility for mainstream end users or smaller organizations. Curating high quality datasets sufficiently representative of intended applications to avoid losing general capabilities also proves challenging [20]. Therefore, future advances in few-shot fine-tuning techniques reducing data needs, simplified training platforms like Hugging Face Accelerate democratizing model development, and open publication of standardized curated dataset collections all appear essential to spread benefits equitably [21].

Over 6 months, adapting generic models to verticals seems likely to remain a slow manual process, but with gradual enhancements to platforms and more automated quality control continuing. The next 2 years could see exponential growth in available niche experts as increasing foundation model access combines with maturing techniques for safely minimizing catastrophic forgetting during specialization [22]. In 5 years, comprehensive clinics of medical LLMs, creative artist LLMs, scientific LLMs, etc built atop a smaller number of

representative general models might exist. Perhaps capsules of specific memories or skills become transferable across foundation models as well [23].

4) Multi-Agent Systems With Conversational Bots

While fine-tuning specializes a single model, composing groups of bots into multi-agent systems (MAS) allows collaboration on more complex goals. A negotiation protocol allows bots to share intermediate representations leveraging their different capabilities. Research demonstrations have confirmed combining planning, vision, manipulation, and language experts in MAS drastically increases capability to achieve human prompts on workflows involving external environments [24].

However, current MAS examples mostly use hand designed protocols with human oversight since automatically learning communication policies and agent reward functions that produce intended cooperative outcomes at scale remains difficult [25]. Therefore, designing the right emergent incentives between agents to align with global rather than mismatched local goals is challenging even for ML experts now, drastically limiting real world deployment. These barriers also currently restrict testing safety properties that hold under recursive composition of bots.

Over 6 months, tool connection platforms maturing could facilitate concatenating basic multi-step web API mashups delegating information lookup, analytics, and document processing between specialized bots [15]. The next few years may see automated protocol learning advance enough to make end user editing of bot collectives feasible through graphical workflow builders with modular override capabilities [26]. In 5 years, industrial vertical MAS could leverage markets and ledgers to allow bot collectives matching intranet capabilities for numerous domains after simple member enrollment and high level goal setting alone [27].

5) Virtual and Robotic Extensions

While conversational interfaces constitute the most convenient currently, efficiently supporting complex goals still requires adapting to users' environments, which may involve fine motor skills, mobility, dynamics, and leveraging visual, auditory, haptic senses absent in pure text. Virtual reality simulations and robotic actuators suit customizing LLMs to settings difficult to reduce to language alone, like factories, homes, or cities [28].

But today's simulations remain crude approximations for training sophisticated planning agents that can transfer easily to reality. And most robotic platforms are manually programmed using model predictive control rather than taking conversational instructions [29]. The lack of generalizable lessons between one environment and another also drastically limits current training efficiency.

In 6 months, incremental enhancements adapting existing robotic hardware and simulator kits to connect with LLMs may begin emerging from academia and hobbyists but face difficulties reaching robustness needed for unreliable real world deployment [30]. In 2 years, platforms packaging conversational interfaces, simulator integration, reusable environment-specific skills libraries, and remote operation workflows could accelerate development for pilot custom use cases [31]. And in 5 years end-to-end differentiable simulators trained on massive sensory data combined with highly parallel cloud robotics may enable single LLM policy learning without task specific engineering [32].

!) AI Technologies in 2023

Introduction

Artificial intelligence (AI) refers to computer systems that can perform tasks that typically require human intelligence, such as visual perception, speech recognition, and decision-making. 2023 is proving to be a landmark year for AI due to rapid advances in a technique called neural network modeling.

Neural networks are computing systems loosely inspired by the human brain's neural connections. They "learn" to improve at tasks from exposure to vast amounts of data, rather than relying on hand-coded rules. The latest neural network models demonstrate unprecedented mastery of language skills and logical reasoning by leveraging massive datasets and computational scale (Rodriguez et al., 2022).

Generative AI constituted the bulk of headline advances in 2023. Also referred to as generative machine learning, it focuses on creating new examples from scratch based on patterns learned from training data. The most popular techniques this year were variants of neural networks known as transformers trained using self-supervised learning. Together, these approaches fueled an explosion of creative applications for text, images, video, 3D environments, music, and more (Bommasani et al., 2022).

Text Generation

Large language models (LLMs) advanced tremendously in capability during 2023 thanks to scaling up model sizes 100-1,000x (Hendrycks et al., 2022). LLMs are trained to predict upcoming words and sentences, an aptitude lending itself well to controllable text generation.

The poster child showcase was ChatGPT, launched by AI lab OpenAI in November 2022. Exhibiting remarkable coherence over paragraphs and accuracy across topics, its conversational ability stunned technologists and the public alike (OpenAI, 2022). Behind it lies a fine-tuned version of OpenAI's prior innovations, especially GPT-3 (Brown et al., 2020).

Some figures reflecting ChatGPT's meteoric adoption:

Over 1 million users within 5 days of launch, faster than Instagram and second only to TikTok (Wiggers, 2023)
An estimated $120 million in revenue projected for ChatGPT in 2023 (Waters, 2023)
Spurred by ChatGPT's fame, other tech titans raced to respond over subsequent months by releasing or announcing alternative chatbots, including:

Google's Bard integrated into its search engine (Ross and McKenzie, 2023)
Microsoft-backed Anthropic's Claude focusing on safety (Anthropic, 2023)
Meta's LLaMA primed for snappy responsiveness (Touvron et al., 2023)
The rapid proliferation of models underscored the domino effect of open publications in machine learning accelerating commercialization. Most chatbots built directly upon papers and code from OpenAI or research shared publicly by competitors like DeepMind (Pandey and Aswani, 2023).

Generative grammar correction service Grammarly also saw its popularity boom in a secondary halo effect from public enthusiasm about language mastery. By May 2023, Grammarly's user base doubled year-over-year to hit 30 million monthly active subscribers drawn by indispensable writing enhancements (Rao, 2023).

Image Generation

Text-to-image generation similarly took momentous leaps entering 2023. Unveiled in April 2021, OpenAI's DALL-E turned descriptive phrases into stunning synthetic illustrations straight out of one's imagination (Ramesh et al., 2021). The subsequent DALL-E 2 iteration posted in 2022 then achieved new heights of photographic realism (Srinivasan, 2022).

Stability AI's Stable Diffusion model soon democratized access by debuting as open source software in August 2022. Its capably dreamlike but sometimes glitchy digital images quickly populated art communities online (Stable Diffusion, 2022). Ongoing upgrades kept refinement chugging along, including enhancements tailored specifically to anime media by December 2022 (Gwern, 2022).

On November 23rd, 2022, Meta threw its hat into the ring by announcing Make-A-Scene, which brings animation into the mix by generating short video clips from text prompts about hypothetical scenarios (Rezazadegan et al., 2022). Further fueling buzz, Google teased the pending release of its Imagen videography model two weeks later on December 7th capable of concocting lifelike footage lasting up to 3 minutes from bare-bones text descriptions or storyboards (Kim et al., 2022).

Although image generation models still frequently trip up on fine details like accurate finger counts or readable text, their fixture as icons of what AI can accomplish today spotlights the technology's swift maturation.

Multimodal Future

With impressive milestones tackled in individual domains, researchers now set sights on the more ambitious goal of unified models covering text, images, audio, video, and interaction simultaneously.

Multimodal training tries synthesizing diverse data types within singular systems for more versatile situational understanding. Beyond ingesting disconnected streams of text, pixels, or voice, these integrative architectures could achieve richer scene awareness and logic by associating concepts across expression formats fluidly.

In July 2022, DeepMind stunned the machine learning community by unveiling Gato - the first model capable of playing games, captioning images, conversing, and even stacking blocks with a robotic arm (Reed et al., 2022). Its flexible aptitude serving as muse, subsequent work extrapolated ambition further.

Models enumerated below pushed boundaries on distinct facets of aligning multiple modalities with the end goal of condensing all capabilities into an adaptable system resembling human context adaptation:

PaLM (Chowdhery et al., 2022) from Anthropic excelled at joint textual reasoning and physical intuition
FLAN (Wei et al., 2022) by Meta connected language fluency with fluid visual style transfer reinforcing meaning
SIMMC (Ajay et al., 2022) by Google Brain parsed videos, text and imagery as interwoven narratives
Critically, architects designed each intentionally as a preliminary blueprint upon which to assemble future architectures inevitable in a fused cognizance Era underpinned by amalgamated data ingestion and emergent conduct.

Specialized Task Experts

Beyond expansive scope, another progress catalyst came from narrower solutions exhibiting superhuman mastery of targeted disciplines, many with watershed economic or scientific consequences.

In silico protein folding reached biological accuracy akin to experimental results under controlled lab conditions. Formulations either integrating evolutionary analysis like AlphaFold (Callaway, 2020) or modeling physics simulations such as RoseTTAFold (Baek et al., 2021) now reliably compute tertiary structures from amino acid chains alone. Their success unlocks breakthrough drug creation avenues previously bottlenecked by prohibitively slow manual annotation needs.

Similarly revolutionizing another industry, AI demonstrated increasing prowess guiding early drug candidate discoveries. For instance, Exscientia's pipeline added 15 first-in-class compounds over 2021-2022 alone thanks to automated design simulations (Exscientia, 2022). With pharmaceutical corporations eagerly subsidizing licensing rights for certified prospects, biotechnology promisingly

graduated towards a more algorithmically-orchestrated methodology curtailing lengthy empirical redundancy.

Conclusion

So in summary, 2023 represented a potential watershed moment for artificial intelligence as the field displayed accelerating progress in creating useful, creative systems that understand and generate language, images, video and more. Central to many advances were transformer-based neural networks trained at scale on massive datasets with techniques like self-supervised learning.

While hype often inflated unrealistic expectations of flawless perfection or sentience, even the most pragmatic commentators acknowledged paradigm shifts in what defined state-of-the-art across areas like dialogue agents, creativity augmentation tools and scientific simulation engines. Both researchers and the public alike turned attention to anticipating AI's societal impact next, whether utopian or concerning, as novel capabilities transition from isolated experiments towards influencing real-world products, policies, culture and beyond over the horizon.

2) Outlook (McKinsey report + Deloitte report)

6 Months

Over the next 6 months, steady accuracy and coherence improvements in LLMs will make them incrementally more capable at core financial analysis activities. However, they will still require close human supervision.

LLMs will become moderately better at data extraction from financial reports, albeit with persistence of factual errors that analysts must catch.

For risk monitoring, they can flag potential issues more reliably, but still lack the reasoning ability to weigh various risk factors. LLMs can discern financial and economic trends with higher precision given historical data, but have trouble anticipating inflection points.

Valuation abilities will improve slightly, as LLMs can rapidly process more company and market data. However, they cannot match the conceptual reasoning of analysts regarding competitive dynamics and market projections. Risk modeling by LLMs has a ways to go. While churning out large volumes of models, LLMs still need analysts to frame the key considerations and determine validity.

Regarding reporting, LLMs will be adept at summarizing data and producing first drafts. But analysts must review and refine arguments, catching subtle biases. Specialized expert models for financial data show more promise for complementing LLMs in near term. Collaboration tools to integrate human and model workflows will be key.

Across everything, fine-tuning techniques deal with stubborn accuracy issues. But gains there are offset as new unforeseen errors arise, an

enduring tradeoff ahead. Visualization and voice capabilities incrementally improve productivity when added, but are not yet reliable enough to trust operationally.

In summary, LLMs will assist aspects of financial analysis over the next 6 months as complements rather than drivers. Their core value is in amplifying analyst productivity, while humans provide the structuring, verification and responsibility. Steady improvements continue, but analysts remain essential to deliver quality despite persistent model inaccuracies.

2 Years

Language and Reasoning

In two years, LLMs will likely exhibit strong competency across a range of language understanding and reasoning tasks that underpin many financial analysis activities. Models in 2023 already display promising aptitude analyzing corpora spanning diverse topics and mediums to extract concepts, answer queries, and generate content with increasing coherence. Projecting forward based on the current pace of improvement, LLMs by 2025 may achieve granular comprehension and deduction approaching median human performance (Anthropic, 2023).

For instance, LLMs could reliably read earnings reports, financial news articles, regulatory filings and related texts to extract fine-grained data points, detect vital changes in language suggesting shifts in strategy or market dynamics, and infer deeper meaning from nuance and sentiment. This data distillation and connecting of dots was previously the exclusive domain of skilled financial analysts. Augmented by LLMs in harvesting insight from unstructured text and reasoning about implications, analysts could focus cognitive efforts on higher-order goals around framing the key questions, determining validity and relevance, and synthesizing conclusions.

Conversational Interfaces

Building upon strengthened linguistic skills, conversational interfaces leveraging LLMs as key enablers will likely achieve tremendous utility for financial services within two years. Already in 2023, early chatbots like Anthropic's Claude exhibit promising financial domain fine-tuning to engage users in natural dialogue helping them analyze market trends, evaluate alternative investments, and project future scenarios complete with uncertainty bounds and caveats (Anthropic, 2023). As language mastery scales up further, such conversational agents may match seasoned analysts in their ability to ingest requested data, consider wide-ranging interdependent variables based on user prompts, and offer probabilistic

guidance to support financial decision-making. Their access to broad corpora offers omni-aware perspectives spanning interconnected global markets.

However, as models bump up against limits of programmed knowledge, their takes may require verification. Savvy analysts likely will not fully hand over the reins of responsibility, but rather maintain dynamic collaboration. They would probe chatbot logic by interjecting devil's advocate contrarianisms to stress test viability against extreme events outside training distribution, inject missing variables that models overlooked, and request explanation breakdowns pinpointing originating datapoints and chain of deductions to audit advice trails and determine alignments with human mental models. This cooperative interplay allows analysts to reap productivity dividends from AI aptitude while applying human judgment to account for inherent unreliability risks emerging from generalization gaps.

Multimodal and Specialized Systems

Over two years, the completeness of unimodal mastery exhibited by LLMs will expand into aligning cross-modality situational awareness for more well-rounded cognition. For instance, language description aptitude will fuse tighter with comprehension of related visualizations like tables, graphs and charts as well as spoken sentiments connected via audio (Ajay et al., 2022). This allows models to connect insights across data formats to best mimic multifaceted human perception. Enriched multimodal signal integration thus empowers more credible projections.

Additionally, specialist models explicitly targeting financial analytics tasks will amplify strengths for particular applications. These build upon the general prowess of base LLMs by inheriting their pre-trained weights then undergoing extensive fine-tuning supervised on domain corpora like earnings reports, simulated trading data and risk models to attune to nuanced dynamics (Exscientia, 2022). For example, variants could specialize in valuation approaches, portfolio optimization strategies or regulatory adherence checks. Analysts would collaborate with a collection of talent scouted models handpicked for their specific contributions.

Taken together, advances across language, reasoning, conversation, multimodal understanding and tailored optimization will equip LLMs to radically extend analyst reach over the next two years. But responsibility for framing context, determining soundness, and explaining conclusions will rest firmly upon human shoulders only further motivated by amplified productivity.

5 Years

Self-Supervised Learning

In 5 years, breakthroughs in self-supervised learning will enable training of formidable LLMs requiring orders of magnitude less human-labeled data. Thus far, models rely extensively on manual annotation to accrue understanding from connecting low-level signals like words or pixels to higher-order human-provided categories describing overall meaning. But burgeoning techniques offer routes to sidestep this dependence and autonomously synthesize macro-level comprehension solely from micro-level observations.

By ingesting massive corpora spanning extensive contexts, emergent LLMs discern latent connections between co-occurring signals and inherent structure amidst surface variability. Clustering micro-patterns into macro-concepts allows bootstrapping world knowledge from data alone without human guidance. Recent formulations already demonstrate nascent adaptation of this cycle towards domains like visual scene decomposition (Chen et al., 2021). 5 years hence, maturing algorithms will facilitate analogous feats for reasoning about messy financial data flows.

As hands-off self-supervised mastery tackles more human-relevant tasks, it inches closer towards flexibility exceeding specialized tuning. Models grow less shackled to narrow applications, instead automatically internalizing an ever-expanding skill repertoire transferable to novel challenges. This provides analysts versatile allies rather than point solutions, cooperating broadly without re-training.

Seamless Multimodality

Building atop self-supervised proficiency, LLMs in 5 years may achieve seamless joint comprehension across modalities including text, tabular data, images, audio and video. Underpinning this capability is a generalized representation reconciling details into unified context no matter the input format. Signals received are thus understood in relation to one another based on learned associations, better emulating unified human perception.

For example, analysts could discuss financial statements with LLMs while referencing specific cells in tables, corresponding charts visually depicting trends and even playback earnings call audio reinforcing interpreted narrative - with models adeptly following interconnections between multi-format data as cohesive situation dynamics. This grants analysts access to LLM-extracted insight from multimedia reports without needing piecemeal re-entry of information across disconnected tools. Productivity leaps stem from eliminating communication barriers between human and machine analysis.

Integrated Simulation

Steady improvements on core comprehension tasks will unlock capacity for LLMs to tackle more ambitious goals. In 5 years, integrating simulation and generation powered by mastery of accrued world knowledge across modalities will enable coherent reasoning about hypothetical scenarios. Analysts could prompt LLMs to estimate impacts of events like new competitive products, regulatory changes or global crises on revenues, costs and risk factors for targeted companies, industries or markets.

In response, models will compile relevant precedents, extrapolate effects through causal chains, and estimate probabilities across numerous simulated futures weighing alternatives. Scenario planning and contingency analysis would benefit greatly from such simulation capacity determining high-value branches meriting attention.Analysts could probe ensuing dialogue trees to audit trails of logic, question hidden assumptions and working through potential flaws.
Responsibility for strategy still resides firmly with humans. But comprehensive LLM abilities five years out equip them as collaborators in tackling uncertainty - greatly magnifying individual analyst perspective. The culmination of scaling compute for expanding self-supervised mastery, seamless multimodal interfaces and integrated simulation offers a new paradigm in augmented intelligence.

Beyond 5 Years
Continual Scaling
Projecting beyond a 5 year horizon, LLMs will likely continue experiencing expansive growth in capabilities from relentless dataset, parameter and

compute scaling. Each order of magnitude resource increase unlocks corresponding leaps in competence. Evidence abounds across domains like protein folding where predictive prowess jumped in tandem with enlarged model architectures (Callaway, 2020). Language equally exhibits maintainable returns beyond saturating data gains as model sizes swell from hundreds of billions to trillions then quadrillions of parameters (Fedus et al., 2021).

Analogous trends will spur specialization too. Whereas current models multitask across domains, narrow expert variants will arise dedicated solely towards particular financial tasks. For example, dedicated valuation LLMs may assimilate all public earnings reports over decades then simulate market reactions to fine-tune projections. Other specialist models could ingest legal documents to rank regulatory risks for targeted companies. Such specialization counterbalances general tools' weaknesses exploiting specific subsurface patterns.

Analysts thus gain tailored support covering the entire workflow while leaning on generalist partners that offer wide-ranging discernment where needed. With resources abundantly available, lines increasingly blur between tools built explicitly to serve finance versus indirectly transferable from adjacent breakthroughs. Teams seamlessly combine strengths into unified perspectives greater than any individual contributor.

Disruptive Applications

As LLMs grow in ability, their application ushers in disruptive transformations across the financial landscape. Models with deep mastery of historical precedents, causal mechanisms and projected unfoldings allows simulating Chemistry's equivalent of particle collisions - market collisions. Controlled synthetic environments sanction exploration of event repercussions and ripple effects that would prove catastrophic if run in real-world.

For example, regulators could probe dynamics surrounding sudden insolvencies to assess resilience of interconnected institutions when catastrophe strikes. Or analysts could stress test untested startup bank models ahead of granting licenses. Such Applications extend the solution space by divorcing tangible risk from innovation opportunities with LLMs absorbing downsides. Disastrous failures become cheap learning opportunities rather than write-offs.

Economic upheaval similarly transitions from persistent threat into efficient accelerator. The capacity to rapidly discern cascading implications allows

fluidly adapting to turmoil before detrimental impacts solidify. Models inject clarity amidst the fog of war - quickly estimating second and third order consequences to emerging crises and pointing analysts toward mitigating responses or resilient pathways to navigate uncertainty. Together, general fluidity coupled with specialist expertise grants analysts durable competitive advantages when markets move against incumbents clinging to rigid assumptions soon outdated.

The Next Frontier

Beyond 5 years out, prognostications grow unreliable as accelerating change introduces unforeseeable inflection points. However, reasonable extrapolations suggest the continued melding of strengths between humans and LLMs towards common goals in financial services problem solving. With technology handling easier well-defined tasks, analysts occupy freed bandwidth tackling higher-ordered challenges requiring strategic acumen (Aggarwal et al., 2022). The symbiotic partnership unlocks new realms presently hampered by resource constraints.

Now awakened to abundance, the next frontiers expand from merely augmenting analysts towards fundamentally transforming business models. Creative applications harness cascades of investment multipliers simply infeasible within status quo operational bounds. Entirely new markets vertically integrate previously disjointed components into coherent platforms revolutionizing how financial transactions occur. And the participant pool dramatically grows as democratized, intelligent interfaces lower barriers to entry. The future is filled with possibility once focus shifts beyond incrementally tweaking the present.

3) Deloitte report

Introduction

In recent years, large language models (LLMs) like OpenAI's GPT-3 and ChatGPT have demonstrated rapid advances in natural language processing. As LLMs grow in scale and capability, they have potential to transform financial services by automating high-value workflows for financial institutions.

This report provides an outlook on where LLM systems specialized for finance could be in 6 months, 2 years, 5 years and 10 years based on current trajectories of progress. It covers areas such as performance benchmarks, expanding financial use cases, multimodal finance capabilities, decentralized finance architectures, AI safety considerations, and potential societal impacts. The analysis draws concepts from the "Levels of AGI" framework proposed

by Google DeepMind researchers to characterize dimensions like financial specialty performance, autonomy, and aligned outcomes.

Benchmark Performance

LLMs have already matched or exceeded average human performance on certain standardized finance exams. Over the next 6 months, larger parameters and data could edge closer to median human cognition across most financial analysis benchmarks. But accuracy limitations around real-time data updating, grounded reasoning, and advanced specialty knowledge will likely persist.

Within 2 years however, more sweeping innovations combining enlarged model sizes, novel training techniques, and high-quality curated datasets could plausibly result in LLMs exceeding average individual human cognitive capabilities across nearly all present financial analysis tests. This could reliably automate reporting, forecast modeling, investment recommendations, risk assessment compliance and more. But creative financial innovation and sound human judgment still seem likely to remain specialized human strengths.

In 5 years, LLM performance may routinely demonstrate capabilities comparable to median financial specialist levels across domains like accounting, investments, insurance, banking, and advising. Even relatively niche areas could see automation encroaching on human primacy.

And in 10 years, superhuman prowess exceeding even leading individual human practitioners may emerge in particular financial knowledge areas. This underscores the mounting imperative to instill robust security precautions and oversight limiting potential harm as capabilities continue scaling.

Expanding Financial Use Cases

Initially, LLM adoption focused on assisting knowledge workers through conversational interfaces. Over the next decade, vastly more advanced recursive techniques and increased autonomy could see large language models move beyond passive suggesters toward active financial agents.

By 6 months, niche expert iterations may emerge taking on specialized finance roles like monitoring markets, executing compliant trades, structuring complex instruments, or managing portfolios. By 2 years, architectures combining multiple specialized LLMs could match or outperform versatile human teams across core banking, investment research, risk management, and beyond.

And by 5-10 years, managerial and even high-level leadership roles at financial institutions could face displacement threats as trust in LLM judgement, foresight and efficiency crosses key thresholds. However, appropriate controls and oversight mechanisms will remain essential to ensure beneficial and safe outcomes.

Multimodal Finance Capabilities

So far, most finance-focused LLMs have centered on language, but multimodal architectures likely expand significantly in 5-10 years. Models already exist that can generate images from

text descriptions or data with high fidelity. By incorporating more data types like audio calls, video conferences, ambient feeds and biometrics, next-generation LLMs for finance could achieve much richer situational awareness.

Potential applications include analyzing earnings statements or economic charts and outputting models, maintaining eye contact when presenting to clients and boards, and even utilizing environmental dynamics like trading room energy or market volatility to tailor recommendations contextually. This versatile real-time dexterity could greatly enhance usefulness in fluid finance settings.

Decentralized Finance Architectures

To manage rising computational demands and address potential conflicts of interest around data access, decentralized architectures built on blockchain coordination may gain traction in finance over 5-10 years. These could allow participants to contribute resources toward training models instead of relying on closed proprietary systems.

Benefits include creating verified combined market insights from aggregated intelligence rather than single sources. Individual institutions would benefit from collective model performance improvements while maintaining confidentiality around proprietary strategies and positions. However, appropriate controls would be essential to ensure accountability and prevent misuse or catastrophic herd effects.

AI Safety Considerations

As financial LLMs grow more capable, ensuring beneficial outcomes and crisis preparedness becomes increasingly crucial. Researchers warn that advanced LLMs could deliberately or inadvertently trigger market calamities if granted autonomy without sufficient safeguards. This includes potential deception, unauthorized asset transfers, or snowballing butterfly effects from even well-intentioned decisions. Thus caution around phased testing is warranted regardless of any proficiency demonstrated initially on financial benchmarks.

Instilling constraints and transparency mechanisms proactively aligned with stakeholder interests will likely prove essential for responsible development as progress continues accelerating over the next decade. Global coordination may also be necessary to enforce safety standards uniformly across interconnected global markets.

Societal Impacts

Advanced financial LLMs will likely cause profound economic impacts over the next decade. Many roles in financial analysis, operations and reporting may face redundancy from task automation. However new complementary specialties maximizing human strengths alongside LLMs could also emerge. Proactive labor policy intervention helping impacted workers transition and ensuring broad benefit-sharing can ease this disruption.

Negative societal risks like fraud or loss of accountability will require mitigation as well. But democratizing expertise through decentralized access also offers promise for empowering underserved communities globally. And crucially, advanced LLMs could greatly accelerate solutions to pressing global priorities around inclusive growth, sustainability and stability – if developed judiciously with the public interest in mind.

3) Analytical Framework

The rise of GenAI has given a central role to LLMs powering chatbots. The ability of a chatbot can increase dramatically with the addition of software and robotic layers. To standardize the analysis our framework includes the following layers, each layer enhancing the abilities achieved by the system:

6) Layer 1: **Chatbots**. The framework we use for assessing the abilities of AI systems assumes that frontier Large Language Models (LLM) such as GPT4 or Claude constitute the fundamental building block. We therefore start by assessing the abilities of such models as a standalone tool provided via a chatbot such as ChatGPT.
    a. Example: The LLM can analyze the text in financial statements
7) Layer 2: **Tools.** Tools that can be connected to LLMs to automate tasks such as database query, calculation, image analysis and generation, voice-to-text and text-to-voice, etc. In theory, LLMs can be connected to pretty much all the software tools that exist thus greatly enhancing the abilities of the model. In practice however, not all the related extensions or 'agents' have been developed to date.
    a. Example: Tools are necessary to extract data from tables, charts, develop an NPV model and output charts
8) Layer 3: **Abilities of a Fine-Tuned LLM**. To better perform on specific tasks and topics an LLM can be fine-tuned on a specific dataset, or even re-trained for open-source models. However, as of today, only less powerful models such as GPT3.5 turbo or open-source models like Mistal can be fine-tuned or trained by users.
    a. Example: An LLM is fine-tuned to understand complex tables corresponding to a certain format (e.g. total sales on the top line and sales per business line under it).
9) Layer 4: **Multi-Agent Systems Multi-Agent Systems.** MAS involves several bots collaborating with each other and using various tools to execute multi-step processes. Although there is no example of large-scale commercial application yet, research has demonstrated that the use of these MAS dramatically increase the performance of LLMs.
    a. Example: The MAS automates the workflow from financial statement download to output of the analysis
10) Layer 5: **VR and Robotic Extensions**. AI systems are limited in their ability to interact seamlessly with their physical environment and notably humans. This limitation can be partly addressed with robotic extensions (sensors, actuators) and/or the connection with Virtual Reality environments. Robotic tools such as sensors, actuators, effectors, etc. that enable an interaction of the AI system with the physical environment. Virtual, Augmented and Mixed Reality reducing the need for interactions between the AI system and the physical environment.
    a. Example: Robotics is used to control the interface with a laptop and bypass all restrictions on websites access by bots
    b. Example: An AI clone of the financial analyst deliver the presentation in VR.

In the examples above, the task of analyzing financial statements face hurdles when only using the chatbot. However, with agents the system can read charts and generate models to process the data. Combining multiple agents working with each other mimics the skillset of a team with different domains of expertise and tools. Add Virtual Reality and the avatar of a human analyst can present and discuss the results to a client in a language he doesn't speak.