

foundation models vs large language models

Foundation Models vs Large Language Models: Understanding the Differences and Overlaps

foundation models vs large language models — these terms have become buzzwords in the world of artificial intelligence and machine learning. While they are often used interchangeably, they represent subtly different concepts with unique implications for how AI systems are built and deployed. If you've ever wondered what sets foundation models apart from large language models, or how these technologies intersect and diverge, you're in the right place. Let's dive into the world of cutting-edge AI and explore these fascinating models in detail.

What Are Foundation Models?

Foundation models represent a class of AI models trained on broad datasets at scale, which serve as a versatile base for a wide variety of downstream tasks. The term "foundation" is used because these models form the groundwork upon which more specialized applications can be built. Think of them as a jack-of-all-trades, highly adaptable AI that can be fine-tuned or prompted to solve diverse problems.

These models are typically trained on massive and diverse datasets — such as text, images, audio, or combinations thereof — enabling them to learn rich, generalized representations of information. This ability to generalize is what makes foundation models particularly powerful. They can be adapted for tasks ranging from language translation and summarization to image recognition and even complex reasoning.

Key Characteristics of Foundation Models

- **Scale and Diversity:** Trained on enormous datasets that cover various domains and modalities.
- **Generalization:** Able to handle multiple downstream tasks without needing to be retrained from scratch.
- **Transfer Learning:** Serve as a base for fine-tuning on specific tasks, which reduces the need for large labeled datasets.
- **Multimodality:** Some foundation models integrate multiple data types, like text and images, enabling richer understanding.

Popular examples of foundation models include OpenAI's GPT series, Google's BERT and T5, and multimodal models like CLIP, which connects visual and textual concepts.

Understanding Large Language Models (LLMs)

Large language models are a subset of foundation models focused specifically on natural language processing (NLP). These models use deep learning architectures, most notably transformers, to understand, generate, and manipulate human language at scale. LLMs are trained on extensive

corpora of text data to predict the next word, sentence, or paragraph, effectively learning the statistical patterns of language.

Unlike smaller NLP models, LLMs have billions or even trillions of parameters, which allow them to capture nuanced semantics, context, and even some elements of reasoning. Because of their sheer size and training data breadth, they can perform a wide array of language-related tasks with impressive accuracy, often without task-specific fine-tuning.

Distinctive Features of Large Language Models

- **Massive Parameter Counts:** Scaling up model size has been shown to improve performance across many language tasks.
- **Contextual Understanding:** Ability to process long-range dependencies in text, enabling coherent and context-aware responses.
- **Few-Shot and Zero-Shot Learning:** Can perform tasks with minimal or no task-specific training by leveraging prompts.
- **Generative Capabilities:** Can produce human-like text, summaries, translations, and even code.

Examples of LLMs include OpenAI's GPT-3, GPT-4, Google's PaLM, and Meta's LLaMA models.

Foundation Models vs Large Language Models: What Sets Them Apart?

At first glance, foundation models and large language models might seem like two sides of the same coin, but understanding their distinctions is crucial for appreciating their roles in AI development.

Scope and Modality

Foundation models encompass a broader scope. They are not limited to language but can be trained on various data modalities — vision, speech, or combinations thereof. Large language models, as the name suggests, focus solely on language data. This means that while all LLMs are foundation models, not all foundation models are LLMs.

Flexibility and Application

Foundation models are designed to be a backbone for multiple AI tasks across different domains. For instance, a multimodal foundation model might enable an AI to understand an image and generate a relevant caption, answer questions about the image, or even create art. LLMs specialize in language tasks and excel at generating and understanding text but don't inherently handle other data types unless integrated with additional modules.

Training Data and Objectives

The training regime for foundation models often involves multi-task learning and self-supervised learning on diverse datasets. Large language models are primarily trained using language modeling objectives — predicting the next word or filling in blanks — focusing on mastering the structure and patterns of natural language.

Parameter Size and Complexity

While both foundation models and LLMs can be massive, LLMs are generally characterized by their huge parameter counts tailored specifically for language tasks. Foundation models may vary more widely in size depending on the problem domain and the modalities involved.

Why Does This Distinction Matter?

Understanding the difference between foundation models and large language models is not just academic—it has practical implications for businesses, developers, and researchers.

Choosing the Right Model for Your AI Project

If your project centers around text-based tasks like chatbots, content generation, or language translation, large language models are likely the most relevant choice. However, if you need a model that integrates multiple data types or handles a variety of tasks—such as combining image recognition with language understanding—foundation models offer a more comprehensive solution.

Fine-tuning and Customization

Foundation models provide a flexible base that can be fine-tuned or adapted to very specific domains, including specialized medical, legal, or technical language. LLMs also support fine-tuning, but their scope is limited to language-processing tasks, making them less versatile for non-language domains.

Ethical and Operational Considerations

Both foundation models and large language models raise important ethical questions such as bias, fairness, and transparency. However, foundation models' broader scope means these concerns can be more complex, especially when models process sensitive multimodal data. Understanding the nature of the model you are working with can guide better responsible AI practices.

The Future of Foundation Models and Large Language Models

As AI research progresses, the line between foundation models and large language models continues to blur. Increasingly, large language models are being integrated into multimodal foundation models, creating hybrid systems that can analyze images, text, and even video seamlessly.

Emerging trends include:

- **Multimodal Foundation Models:** Models that combine language, vision, and audio to provide richer interactions.
- **Efficient Training Techniques:** Innovations like parameter-efficient fine-tuning make foundation models and LLMs more accessible to smaller organizations.
- **Domain-Specific Foundation Models:** Customized foundation models tailored to industries such as healthcare, finance, or law.
- **Improved Interpretability:** Tools to better understand how these models make decisions, enhancing trust and safety.

This convergence suggests a future where AI systems are not just large or versatile but also deeply integrated, adaptive, and responsive to complex real-world tasks.

Final Thoughts on Foundation Models vs Large Language Models

Navigating the AI landscape requires clarity about what different models represent and how they fit into your goals. Foundation models offer a broad, flexible framework capable of addressing a variety of challenges across modalities, while large language models focus deeply on mastering the nuances of human language.

Whether you're a developer, business leader, or AI enthusiast, understanding these distinctions helps unlock the full potential of modern AI technology. As research advances, the synergy between foundation models and large language models will continue to shape the future of intelligent systems in exciting and unexpected ways.

Frequently Asked Questions

What are foundation models?

Foundation models are large-scale machine learning models trained on broad data at scale that can be adapted to a wide range of downstream tasks. They serve as a base for various applications by providing a general understanding of language, vision, or other modalities.

How do large language models (LLMs) relate to foundation models?

Large language models are a subset of foundation models specifically focused on natural language processing. They are trained on massive text corpora and can perform tasks like text generation, translation, summarization, and question answering.

What distinguishes foundation models from large language models?

Foundation models encompass a broader category that includes models trained on multiple modalities (text, images, audio) and tasks, while large language models are specifically designed for language understanding and generation.

Are all large language models considered foundation models?

Generally, yes. Large language models like GPT-4 and BERT are considered foundation models because they provide a base for transfer learning and adaptation to various language-related tasks.

Can foundation models handle multimodal data unlike large language models?

Yes, foundation models can be trained on and handle multiple data modalities such as text, images, and audio, while large language models primarily focus on text data.

What are some examples of foundation models besides large language models?

Examples include vision foundation models like CLIP and DALL-E which combine text and images, as well as multimodal models like Flamingo and PaLI.

How does the training process differ between foundation models and large language models?

While both are trained on massive datasets, foundation models may incorporate diverse data types and objectives to build versatile representations, whereas large language models focus primarily on language modeling objectives using text data.

Why are foundation models important for AI development?

Foundation models provide a reusable and adaptable base that can be fine-tuned for multiple downstream applications, reducing the need for task-specific training and enabling faster and more efficient AI deployment.

What challenges are associated with foundation models compared to large language models?

Foundation models face challenges such as managing multimodal data complexity, higher computational costs, ethical considerations, and ensuring robustness across diverse tasks and domains.

Additional Resources

Foundation Models vs Large Language Models: Understanding the Distinctions and Overlaps

foundation models vs large language models is a topic gaining significant attention in the artificial intelligence (AI) community, reflecting the evolving landscape of machine learning architectures. As AI technologies advance rapidly, these terms often emerge interchangeably in discussions, yet they represent distinct concepts with overlapping capabilities. This article aims to dissect the nuances between foundation models and large language models (LLMs), exploring their definitions, applications, and implications for future AI developments.

Defining Foundation Models and Large Language Models

The term "foundation models" was popularized following a seminal paper by researchers at Stanford's Center for Research on Foundation Models (CRFM). Foundation models refer to large-scale AI systems trained on vast and diverse datasets that form a versatile base for multiple downstream tasks. These models are designed to be adaptable, capable of being fine-tuned or prompted to perform a wide range of functions beyond their original training objectives.

In contrast, large language models are a subset of foundation models primarily focused on natural language processing (NLP). LLMs such as GPT-4, BERT, and PaLM are trained on extensive corpora of text data to understand and generate human language. While all large language models can be considered foundation models due to their foundational role in various NLP tasks, not all foundation models are restricted to language-based applications.

Core Characteristics and Training Methodologies

Foundation models typically employ self-supervised learning techniques, enabling them to learn latent representations from unlabeled data. Their training involves massive datasets encompassing multiple modalities—text, images, audio, and sometimes video—which contributes to their general-

purpose nature. This multimodal capability distinguishes foundation models from traditional narrow AI systems.

Large language models, by design, focus almost exclusively on textual data. Their architectures are usually based on transformer networks, which excel at capturing contextual relationships within sequences of words. Training LLMs involves predicting the next word in a sentence or filling in missing tokens, thereby enabling them to generate coherent and contextually relevant text.

Comparative Analysis of Capabilities

When examining foundation models vs large language models, it's critical to consider the scope and adaptability of each. Foundation models serve as versatile platforms that can be fine-tuned for various domains—including computer vision, speech recognition, and reinforcement learning—beyond language tasks. For instance, models like CLIP (Contrastive Language-Image Pre-training) integrate visual and textual inputs, showcasing foundation models' ability to bridge multiple data types.

Large language models showcase remarkable proficiency in linguistic tasks such as translation, summarization, sentiment analysis, and conversational AI. Their extensive parameter counts—ranging from hundreds of millions to hundreds of billions—enable them to capture complex linguistic patterns. However, their capabilities are largely confined to the textual domain, which can limit their performance in multimodal or highly specialized non-linguistic tasks.

Strengths and Limitations

- **Foundation Models:** Their multimodal nature offers broad applicability, making them suitable for industries requiring integration of various data types. However, their large size demands substantial computational resources, and their general-purpose design can sometimes lead to performance trade-offs in highly specialized tasks.
- **Large Language Models:** LLMs excel in generating human-like language and understanding context, proving invaluable for chatbots, content creation, and language translation. Despite this, they can struggle with factual accuracy, hallucinations, and require fine-tuning to mitigate biases inherent in training data.

Applications in Industry and Research

The deployment of foundation models has transformed sectors such as healthcare, finance, and autonomous systems by enabling more generalized AI solutions. For example, foundation models can integrate medical images and patient records to assist in diagnostics, demonstrating their cross-modal flexibility. Their ability to serve as a base for transfer learning accelerates the development cycle for novel applications.

Large language models have revolutionized how businesses approach customer interaction and content automation. Enterprises leverage LLMs for automated support, document summarization, and sentiment analysis, benefiting from the models' linguistic versatility. Nevertheless, ethical considerations around misinformation and data privacy remain paramount when deploying LLMs at scale.

Future Trends and Research Directions

Ongoing research explores bridging the gap between foundation models and large language models, aiming to create systems that combine the expansive language understanding of LLMs with the multimodal and adaptable nature of foundation models. Innovations in model efficiency, such as sparsity and parameter sharing, seek to reduce computational costs without sacrificing performance.

Moreover, efforts to improve explainability and fairness in both foundation models and LLMs are crucial for broader acceptance and regulatory compliance. As these AI systems become foundational to digital infrastructure, transparent mechanisms to audit and control their outputs will be essential.

The distinction between foundation models and large language models is becoming increasingly nuanced as AI architectures evolve. While LLMs represent a critical subset focused on language, foundation models embody a broader paradigm encompassing diverse data modalities and applications. Understanding these differences is vital for practitioners and organizations aiming to harness AI's full potential responsibly and effectively.

Foundation Models Vs Large Language Models

foundation models vs large language models: A Beginner's Guide to Large Language Models StoryBuddiesPlay, 2024-09-08 A Beginner's Guide to Large Language Models is an essential resource for anyone looking to understand and work with cutting-edge AI language technology. This comprehensive guide covers everything from the basics of natural language processing to advanced topics like model architecture, training techniques, and ethical considerations. Whether you're a student, researcher, or industry professional, this book provides the knowledge and practical insights needed to navigate the exciting world of Large Language Models. Discover how these powerful AI systems are reshaping the landscape of language understanding and generation, and learn how to apply them in real-world scenarios. Large Language Models, AI, Natural Language Processing, Machine Learning, Deep Learning, Transformers, GPT, BERT, Neural Networks, Text Generation

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for software developers, AI researchers, and technology enthusiasts with a foundational understanding of AI, this book offers both theoretical insights and practical code examples in Python. Companion files with code, figures, and datasets are available for downloading from the publisher.

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situates readers at the cutting edge of parameter-efficient fine-tuning techniques. The work stands out for its rigorous treatment of the mathematical and engineering foundations underpinning LoRA. Through detailed explorations of low-rank matrix decomposition, formal parameter mappings, and empirical strategies for rank selection, readers gain a robust understanding of both the theoretical expressivity and practical impact of LoRA compared to other adaptation techniques. The text moves beyond the abstract, offering actionable guidance for integrating LoRA into modern transformer architectures, optimizing training for scalability and resource constraints, and leveraging composable and hybrid approaches to meet diverse adaptation goals. Bridging theory and application, the book culminates in advanced chapters on operationalizing LoRA in real-world settings, evaluating adaptation effectiveness, and innovating for next-generation language models. It presents a rich collection of strategies for serving LoRA-augmented models in production, maintaining long-term adaptability, and meeting the needs of privacy-conscious environments. Through tutorials, case studies, and a survey of open-source tools, LoRA Techniques for Large Language Model Adaptation provides a definitive resource for machine learning practitioners, researchers, and engineers seeking to master the art and science of efficient large model adaptation.

foundation models vs large language models: *Mastering Large Language Models with Python: Unleash the Power of Advanced Natural Language Processing for Enterprise Innovation and Efficiency Using Large Language Models (LLMs) with Python* Raj Arun, 2024-04-12 A

Comprehensive Guide to Leverage Generative AI in the Modern Enterprise Key Features ● Gain a comprehensive understanding of LLMs within the framework of Generative AI, from foundational concepts to advanced applications. ● Dive into practical exercises and real-world applications, accompanied by detailed code walkthroughs in Python. ● Explore LLMOps with a dedicated focus on ensuring trustworthy AI and best practices for deploying, managing, and maintaining LLMs in enterprise settings. Book Description “Mastering Large Language Models with Python” is an indispensable resource that offers a comprehensive exploration of Large Language Models (LLMs), providing the essential knowledge to leverage these transformative AI models effectively. From unraveling the intricacies of LLM architecture to practical applications like code generation and AI-driven recommendation systems, readers will gain valuable insights into implementing LLMs in diverse projects. Covering both open-source and proprietary LLMs, the book delves into foundational concepts and advanced techniques, empowering professionals to harness the full potential of these models. Detailed discussions on quantization techniques for efficient deployment, operational strategies with LLMOps, and ethical considerations ensure a well-rounded understanding of LLM implementation. Through real-world case studies, code snippets, and practical examples, readers will navigate the complexities of LLMs with confidence, paving the way for innovative solutions and organizational growth. Whether you seek to deepen your understanding, drive impactful applications, or lead AI-driven initiatives, this book equips you with the tools and insights needed to excel in the dynamic landscape of artificial intelligence. What you will learn ● In-depth study of LLM architecture and its versatile applications across industries. ● Harness open-source and proprietary LLMs to craft innovative solutions. ● Implement LLM APIs for a wide range of tasks spanning natural language processing, audio analysis, and visual recognition. ● Optimize LLM deployment through techniques such as quantization and operational strategies like LLMOps, ensuring efficient and scalable model usage. Table of Contents 1. The Basics of Large Language Models and Their Applications 2. Demystifying Open-Source Large Language Models 3. Closed-Source Large Language Models 4. LLM APIs for Various Large Language Model Tasks 5. Integrating Cohere API in Google Sheets 6. Dynamic Movie Recommendation Engine Using LLMs 7. Document-and Web-based QA Bots with Large Language Models 8. LLM Quantization Techniques and Implementation 9. Fine-tuning and Evaluation of LLMs 10. Recipes for Fine-Tuning and Evaluating LLMs 11. LLMOps - Operationalizing LLMs at Scale 12. Implementing LLMOps in Practice Using MLflow on Databricks 13. Mastering the Art of Prompt Engineering 14. Prompt Engineering Essentials and Design Patterns 15. Ethical Considerations and Regulatory Frameworks for LLMs 16. Towards Trustworthy Generative AI (A Novel Framework Inspired by Symbolic Reasoning) Index

foundation models vs large language models: Large Language Models John

Atkinson-Abutridy, 2024-10-17 This book serves as an introduction to the science and applications of Large Language Models (LLMs). You'll discover the common thread that drives some of the most revolutionary recent applications of artificial intelligence (AI): from conversational systems like ChatGPT or BARD, to machine translation, summary generation, question answering, and much more. At the heart of these innovative applications is a powerful and rapidly evolving discipline, natural language processing (NLP). For more than 60 years, research in this science has been focused on enabling machines to efficiently understand and generate human language. The secrets behind these technological advances lie in LLMs, whose power lies in their ability to capture complex patterns and learn contextual representations of language. How do these LLMs work? What are the available models and how are they evaluated? This book will help you answer these and many other questions. With a technical but accessible introduction:

- You will explore the fascinating world of LLMs, from its foundations to its most powerful applications
- You will learn how to build your own simple applications with some of the LLMs

Designed to guide you step by step, with six chapters combining theory and practice, along with exercises in Python on the Colab platform, you will master the secrets of LLMs and their application in NLP. From deep neural networks and attention mechanisms, to the most relevant LLMs such as BERT, GPT-4, LLaMA, Palm-2 and Falcon, this book guides you through the most important achievements in NLP. Not only will you learn the benchmarks used to evaluate the capabilities of these models, but you will also gain the skill to create your own NLP applications. It will be of great value to professionals, researchers and students within AI, data science and beyond.

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- The Evolution of LLMs: From early statistical models to transformer architectures and foundation models.
- How LLMs Understand Language: Demystifying key components like self-attention, embeddings, and deep linguistic modeling.
- The Art of Inference: Exploring inference parameters for controlling and optimizing LLM outputs.
- Appropriate Use Cases: A nuanced look at LLM strengths and limitations across applications like creative writing, conversational agents, search, and coding assistance.
- Productivity Gains: Synthesizing the latest research on generative AI's impact on worker efficiency and satisfaction.
- The Perils of Automation: Examining risks like automation blindness, deskilling, disrupted teamwork and more if LLMs are deployed without deliberate precautions.
- The LLM Value Chain: Analyzing key components, players, trends and strategic considerations.
- Computational Power: A deep dive into the staggering compute requirements behind state-of-the-art generative AI.
- Open Source vs Big Tech: Exploring the high-stakes battle between open and proprietary approaches to AI development.
- The Generative AI Project Lifecycle: A blueprint spanning use case definition, model selection, adaptation, integration and deployment.
- Ethical Data Sourcing: Why the training data supply chain proves as crucial as model architecture for responsible development.
- Evaluating LLMs: Surveying common benchmarks, their limitations, and holistic alternatives.
- Efficient Fine-Tuning: Examining techniques like LoRA and PEFT that adapt LLMs for applications with minimal compute.
- Human Feedback: How reinforcement learning incorporating human ratings and demonstrations steers models towards helpfulness.
- Ensemble Models and Mixture-of-Experts: Parallels between collaborative intelligence in human teams and AI systems.
- Areas of Research and Innovation: Retrieval augmentation, program-aided language models, action-based reasoning and more.
- Ethical Deployment: Pragmatic steps for testing, monitoring,

seeking feedback, auditing incentives and mitigating risks responsibly. The book offers an impartial narrative aimed at informing readers for thoughtful adoption, maximizing real-world benefits while proactively addressing risks. With this guide, leaders gain integrated perspectives essential to setting sound strategies amidst generative AI's rapid evolution. More Than a Book By purchasing this book, you will also be granted free access to the AI Academy platform. There you can view free course modules, test your knowledge through quizzes, attend webinars, and engage in discussion with other readers. No credit card required. AI Academy by Now Next Later AI We are the most trusted and effective learning platform dedicated to empowering leaders with the knowledge and skills needed to harness the power of AI safely and ethically.

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foundation models vs large language models: *Internet of Vehicles and Computer Vision*

Solutions for Smart City Transformations Anuj Abraham, Shitala Prasad, Ahmed Alhammadi, Thierry Lestable, Ferdaous Chaabane, 2025-02-19 This book compiles recent research endeavors at the intersection of computer vision (CV) and deep learning for Internet of Vehicles (IoV) applications, which are pivotal in shaping the landscape of smart cities. These technologies play instrumental roles in enhancing various facets of urban life, encompassing safety, transportation, infrastructure management, and sustainability. The amalgamation of CV and deep learning within smart cities creates a powerful synergy that fosters safer, more efficient, and sustainable urban environments. By harnessing these cutting-edge technologies to drive data-driven decision-making, cities can elevate the quality of life for their inhabitants, mitigate environmental impact, and optimize overall urban functionality. Additionally, this compilation provides in-depth technical and scientific insights into various facets of artificial intelligence (AI) technologies, including forthcoming trends and innovations that are poised to transform smart cities. The book also extends its focus to other areas of smart city development. It explores the application of these technologies in the creation of smart parking solutions, discusses the role of surveillance for public safety, and examines how CV and IoV can be utilized for environmental monitoring. The book also delves into urban planning and infrastructure development, emphasizing the importance of a data-driven approach. It sheds light on the social impact of smart cities and the importance of citizen engagement and discusses issues of security and privacy in the context of smart cities. The book concludes with a look at future trends and challenges in the field of smart cities. Targeted at researchers, practitioners, engineers, and scientists, this book is geared toward those engaged in the development of advanced algorithms for future-forward smart city applications in computer vision, vehicular networking, communication technology, sensor devices, IoT communication, vehicular and on-road safety, data security, and services for IoV-related devices.

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engineers, data scientists, machine learning practitioners, software developers, and technical leaders looking to advance their expertise in LLMs and generative AI or explore latest industry trends. Familiarity with Python and basic machine learning concepts will help you fully understand the use cases and code examples. However, hands-on examples involving LLM user interfaces, prompt engineering, and no-code model building ensure this book remains accessible to anyone curious about the AI revolution.

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How Large Language Models Work is authored by top machine learning researchers at Booz Allen Hamilton, including researcher Stella Biderman, Director of AI/ML Research Drew Farris, and Director of Emerging AI Edward Raff. They lay out how LLM and GPT technology works in plain language that's accessible and engaging for all. About the Technology Large Language Models put the "I" in "AI." By connecting words, concepts, and patterns from billions of documents, LLMs are able to generate the human-like responses we've come to expect from tools like ChatGPT, Claude, and Deep-Seek. In this informative and entertaining book, the world's best machine learning researchers from Booz Allen Hamilton explore foundational concepts of LLMs, their opportunities and limitations, and the best practices for incorporating AI into your organizations and applications. About the Book How Large Language Models Work takes you inside an LLM, showing step-by-step how a natural language prompt becomes a clear, readable text completion. Written in plain language, you'll learn how LLMs are created, why they make errors, and how you can design reliable AI solutions. Along the way, you'll learn how LLMs "think," how to design LLM-powered applications like agents and Q&A systems, and how to navigate the ethical, legal, and security issues. What's Inside

- Customize LLMs for specific applications
- Reduce the risk of bad outputs and bias
- Dispel myths about LLMs
- Go beyond language processing

About the Readers No knowledge of ML or AI systems is required.

About the Author Edward Raff, Drew Farris and Stella Biderman are the Director of Emerging AI, Director of AI/ML Research, and machine learning researcher at Booz Allen Hamilton.

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