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Analysis of search engine optimization tactics in the context of digital marketing for enhancing websites ranking and visibility in Generative AI and large language models

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Abstract

Rise of generative Artificial Intelligence (AI) and Large Language Models (LLMs) has significantly transformed Search Engine Optimization (SEO) strategies and tactics. This study presents a quantitative analysis among digital professionals, assessing the effectiveness of on-page SEO, technical SEO, user engagement metrics and off-page SEO in optimizing a website for better ranking and visibility in AI and LLM-generated search results. Using statistical analysis, we evaluate the impact of traditional SEO tactics in new AI environment applications visibility. The results demonstrate that semantic keyword usage, content quality and structured data, remain critical for AI-driven search rankings. Findings also reveal a significant shift toward user engagement metrics, which AI models prioritize to assess content relevance and quality. Results offer actionable insights for digital marketers and webmasters seeking to optimize their websites for Generative AI and LLMs.

Keywords: SEO, AI Generators, large language models, digital marketing

Introduction

Generative AI and LLM, such as OpenAI's GPT (Generative Pre-trained Transformer) series (Chat GPT-3, GPT-4), Google's Bard, DeepSeek, Meta's LLaMA and other advanced large language models, has significantly transformed the landscape of search engine optimization. Unlike traditional search engines such as Google and Bing, which primarily rely on keyword matching and backlink profiles, AI-driven search models emphasize semantic relevance, structured data, and user engagement metrics (Raut, *et al.* 2025) ^[14]. This shift has presented both opportunities and challenges for digital marketers, web developers, and SEO professionals who aim to optimize websites for AI-generated search results (Chodak, *et al.* 2023) ^[5].

Traditional SEO strategies have largely been centered around keyword density, meta tags and backlink building to improve ranking positions in search engine results pages (SERPs). However, AI-driven «search engines» rely on more sophisticated methods of content interpretation, focusing on context, intent and user experience. In response to these evolving ranking algorithms, digital marketers must reconsider traditional SEO techniques and adopt new strategies tailored for AI search (Amer, *et al.* 2024) ^[1]. The growing emphasis on structured data, natural language processing (NLP), and user interaction signals necessitates a more dynamic approach to SEO (Cutler, 2023) ^[6].

This study aims to quantitatively analyze the key SEO factors that contribute to improved website ranking and visibility in AI-generated search results. We categorize SEO into four fundamental dimensions:

- **On-Page SEO:** Encompassing elements such as semantic keyword usage, content quality, meta descriptions, heading tags, webpage titles, image alt text usage, domain names and meta tags utilization (Roumeliotis, Tselikas, 2022) ^[17].
- **Technical SEO:** Including schema markup, XML sitemaps, canonical tags, URL structure, mobile responsiveness, UX/UI design quality and direct visit rates (Bengtson, 2024) ^[12].

- **User Engagement Metrics:** Focusing on bounce rate, session duration, and pages per session as indicators of user satisfaction and content relevance.
- **Off-Page SEO:** Evaluating the significance of high-quality backlinks and domain authority in AI search engine rankings.

By examining these four key dimensions, this research provides actionable insights into the factors influencing website visibility in AI-powered search ecosystems. The study uses statistical methods to assess the impact of traditional SEO techniques in the context of AI generators and evaluates how digital professionals can optimize their strategies for emerging AI search environments.

2. Literature Review

2.1 On-page SEO for AI search optimization

The role of on-page SEO in traditional search engines has been well-documented, focusing on the optimization of website content, keyword placement and metadata structuring. In the context of AI-driven generators or search engines, the emphasis has shifted towards semantic relevance and entity-based content structuring (Ziakis, Vlachopoulou, 2023) ^[19]. Research indicates that AI search algorithms prioritize content that effectively integrates semantic keyword optimization, entity relationships and structured formatting. This evolution necessitates a shift from mere keyword stuffing to contextually rich content that aligns with AI-based interpretation (Macumber, *et al.* 2024) ^[10]. Additionally, well-optimized meta descriptions, webpage titles and heading tags contribute to a website's recognition by LLMs (Reisenbichler, *et al.* 2022) ^[15]. AI-driven search engines rely on advanced NLP techniques to assess the relevance and coherence of content, making high-quality, informative and user-centric content a priority for optimization. The use of structured data and schema markup further enhances visibility by enabling AI models to categorize and interpret content more effectively (Ngo, 2024) ^[13].

In AI-driven search ecosystems, keyword optimization extends beyond simple keyword placement and density. AI models prioritize content that integrates semantic keyword usage, entity-based content structuring, and contextual relevance. Unlike traditional keyword stuffing methods, which focus on exact match phrases, AI search engines leverage advanced NLP techniques to assess content coherence and its alignment with user intent (Manisha, 2024) ^[11].

Entities, relationships, and topic modeling are crucial components of AI search optimization. Instead of merely focusing on specific keywords, content creators must strategically incorporate semantically related terms, synonyms, and contextually relevant phrases to improve AI comprehension. LLMs analyze content holistically, identifying key concepts and understanding how they relate to broader topics. This means that well-written, informative, and comprehensive content is more likely to rank favorably in AI search results (Reisenbichler, *et al.* 2021) ^[16].

Content quality is a major determinant in AI-driven SEO rankings. AI models prioritize informative, well-structured, and engaging content that provides real value to users (Bouزيد, *et al.* 2024) ^[3]. The effectiveness of content is assessed based on readability, coherence, factual accuracy, and depth of information. High-quality, long-form content

that thoroughly addresses a topic with supporting evidence, examples, and authoritative references is more likely to be ranked prominently by AI searches.

Additionally, LLM and AI search assess the credibility and trustworthiness of content. Factually accurate, well-cited, and unbiased content gains higher visibility in AI-driven search ecosystems.

Optimizing meta descriptions, webpage titles, and heading tags remains a critical component of on-page SEO, even in AI search environments. AI-driven search engines assess metadata to understand the primary focus of a page and determine its relevance to user queries. Titles and meta descriptions should be concise, informative, and keyword-optimized without being overly stuffed with unnatural phrasing.

Heading tags (H₁, H₂, H₃, etc.) used as structural elements that guide both users and AI models through the content. Proper use of heading tags improves content readability and enables AI search engines to identify key sections and subtopics within an article. Implementing a logical heading hierarchy enhances the organization of content, making it easier for AI algorithms to interpret and categorize information.

2.2 Technical SEO and AI search comprehension

Technical SEO has always played a crucial role in optimizing website performance and search ability. With the emergence of AI-driven search engines and AI generators, the importance of technical SEO has only intensified. AI models utilize structured data and site architecture to determine content hierarchy and contextual relevance. Essential components such as schema markup, XML sitemaps, and canonical tags ensure that AI search accurately comprehend and categorize website content. Moreover, the efficiency of AI-based indexing and ranking is influenced by proper URL structuring and mobile responsiveness (Lively, *et al.* 2023). Given that AI search models prioritize user experience, websites with well-designed UX/UI and mobile-friendly interfaces receive higher rankings. Ensuring smooth navigation, optimizing page load speeds, and structuring URLs for easy accessibility enhances a site's AI search visibility.

AI generators utilize structured data, schema markup and XML sitemaps to categorize and interpret website content. Implementing schema markup helps search engines better understand the relationships between different elements on a webpage, leading to richer search results and higher visibility. Similarly, XML sitemaps facilitate efficient content discovery, ensuring that AI algorithms can seamlessly access and analyze all relevant pages.

Canonical tags play a crucial role in preventing duplicate content issues by indicating the preferred version of a page. This is particularly important in AI-driven search environments, where duplicate or ambiguous content can negatively impact rankings. Proper implementation of canonical tags ensures that AI models correctly attribute rankings to the intended URLs, improving search visibility.

The structure of URLs and overall site architecture significantly impacts how AI search engines index and rank web pages. AI models prioritize logically structured websites that provide clear navigation paths and intuitive site hierarchies. Well-optimized URLs should be concise, descriptive, and free of unnecessary parameters. A well-organized website structure not only aids AI comprehension

but also enhances the user experience by making information easily accessible.

Also AI models prioritize websites with superior User Experience (UX) and mobile responsiveness. Websites that are mobile-friendly, load quickly, and offer seamless navigation tend to rank higher in AI search results. Google's mobile-first indexing and AI search prioritization underscore the importance of optimizing for smaller screens. Implementing responsive design, optimizing images, and ensuring fast page load speeds contribute to improved AI search visibility.

2.3 User engagement metrics and AI rankings

User engagement metrics are fundamental indicators of content relevance and quality in AI-driven search environments. Unlike traditional search engines that rely heavily on keyword density and backlink profiles, AI generators analyze user interaction metrics to determine ranking positions (Vajroboi, *et al.* 2024) ^[18]. These metrics include bounce rate, average session duration, direct visits, and pages per session. Higher user engagement signals indicate valuable content, leading to improved AI search visibility.

AI models track session duration and bounce rates to assess user satisfaction. Lower bounce rates and longer session durations suggest that users find the content relevant and engaging, factors that AI generators prioritize. Additionally, AI-driven search algorithms analyze user return rates, evaluating the frequency of repeat visits as an indicator of website credibility and authority (Chodak, 2024) ^[4].

Creating interactive, well-structured, and visually appealing content enhances user retention. Features such as engaging multimedia, well-formatted text, and easy navigation improve user experience and reduce bounce rates. Personalized content recommendations, interactive elements, and AI-powered chatbots can further encourage user interaction and extended session durations (Krol *et al.* 2024) ^[8].

Optimizing for AI search engines requires a focus on user engagement metrics. High-quality, relevant, and interactive content, coupled with seamless user experience, contributes to increased AI search visibility (Cutler, 2023) ^[6]. Digital marketers must prioritize content strategies that align with AI models' evaluation of user interactions to maintain competitive rankings in AI powered search ecosystems.

2.4 Off-page SEO

Off-page SEO remains a critical factor in determining website rankings within AI-driven search engines. Unlike traditional search engines that heavily rely on keyword relevance and backlink volume, AI search models focus on content authority, trustworthiness, and contextual link-building strategies (Guelailia, *et al.* 2024) ^[7]. High-quality backlinks, domain authority, and brand mentions significantly impact AI search rankings. Websites earning links from authoritative sources enjoy greater credibility in AI ecosystems.

AI search models prioritize quality over quantity when evaluating backlinks. Low-quality links from spammy or irrelevant sources can negatively impact search visibility. Thus, digital marketers must adopt strategic link-building efforts, emphasizing natural, high-authority connections. Contextual linking, topic-related citations, and brand mentions enhance off-page SEO effectiveness for AI search

optimization. Additionally, social media engagement and digital PR campaigns contribute to improved visibility in AI-generated search results, reinforcing a website's domain authority and trustworthiness.

3. Methodology

3.1 Research design

This study based on a quantitative research design to analyze the impact of various SEO factors on AI generators rankings. A structured survey was conducted at 2nd semester of 2024, among 287 digital marketing professionals, web developers and website administrators, capturing their insights and experiences in optimizing websites for AI generators and LLM search engines. The research methodology incorporates both descriptive and inferential statistical techniques to assess the significance of different SEO elements. The survey focused on the four primary SEO dimensions outlined in the introduction: on-page SEO, technical SEO, user engagement metrics, and off-page SEO. Participants were asked to evaluate the effectiveness of these SEO tactics in improving website visibility and ranking in AI-generated application search results.

3.2 Variables and statistical analysis

To quantitatively measure the impact of SEO factors on AI rankings, this study analyzes various independent variables related to each SEO dimension:

- **On-Page SEO:** Semantic keyword usage, content quality, heading tags, webpage titles, and image alt text utilization.
- **Technical SEO:** Schema markup, XML sitemaps, canonical tags, URL structure, mobile responsiveness, and UX/UI design quality.
- **User Engagement Metrics:** Bounce rate, session duration, and pages per session as indicators of content engagement.
- **Off-Page SEO:** The number and quality of backlinks as measures of domain authority and external credibility.

Data was analyzed using statistical techniques such as descriptive statistics, correlation analysis and multiple regression modeling. The analysis aimed to determine the correlation between various SEO factors and AI-driven ranking outcomes, identifying the most influential variables in AI search optimization. By applying SPSS for data processing, the study ensured the accuracy and reliability of statistical interpretations. The findings provide a comprehensive understanding of the evolving role of SEO in AI-powered search environments and offer practical recommendations for digital marketers seeking to enhance website rankings in AI-driven search results.

4. Results

The descriptive statistics (Table 1) reveals a generally high degree of optimization across the sampled SEO factors. The mean values for the majority of the SEO factors hover around 4.0 to 5.0, indicating that digital marketing professionals, web developers, and website administrators are, on average, utilizing effective SEO strategies.

Semantic Keyword Usage (Mean=4.12) and Content Quality (Mean=4.38) had slightly higher average scores, suggesting that these factors are prioritized in the current SEO landscape, which aligns with AI's focus on semantic relevance and content quality.

Bounce Rate (Mean=3.76) and Mobile Responsiveness (Mean=4.30) suggest moderate engagement strategies with a focus on mobile-first indexing, essential for AI-based search engines.

Backlink Quantity and Domain Name Features were also rated highly, underscoring the enduring importance of off-page SEO for AI ranking models.

Second table shows correlation between each SEO factor and AI rankings, indicating how strongly each variable is related to AI-driven rankings.

Table 1: Descriptive statistics of SEO factors

Variable	Mean	Std. Dev.	Min	Max
Semantic Keyword Usage	4.12	0.080	1.0	5.0
Content Quality	4.38	0.081	2.0	5.0
Webpage Titles	4.20	0.084	1.0	5.0
Meta Description Tag Utilization	4.15	0.087	1.0	5.0
Meta Tags Utilization	4.10	0.088	1.0	5.0
Backlink Quantity	4.10	0.084	1.0	5.0
Bounce Rate	3.76	0.092	2.0	5.0
Average Session Duration	4.25	0.080	1.0	5.0
Pages per Session	4.30	0.078	1.0	5.0
Mobile Responsiveness	4.20	0.076	1.0	5.0
UX/UI Design Quality	4.20	0.074	2.0	5.0
URL Structure	4.20	0.080	1.0	5.0
Heading Tags Usage	4.29	0.080	1.0	5.0
Submenu Tags Usage	4.20	0.080	1.0	5.0
Canonical Tags Usage	4.06	0.080	1.0	5.0
Image Alt Text Usage	4.30	0.080	1.0	5.0
XML Sitemap Presence	4.10	0.081	1.0	5.0
Domain Name Features	4.20	0.081	1.0	5.0
Direct Visits Ratio	4.10	0.084	1.0	5.0

The correlation analysis (Table 2) presents significant relationships between several SEO factors and AI rankings: Semantic Keyword Usage and Content Quality exhibited the highest correlation (0.72 and 0.75, respectively), confirming that AI models prioritize content relevance and well-structured semantic information.

Backlink Quantity ($r=0.62$) and Schema Tags Usage ($r=0.65$) also showed strong correlations, underlining the importance of off-page SEO and structured data for AI search engines.

Bounce Rate is inversely correlated with AI rankings ($r=-0.49$), which aligns with the assumption that higher user engagement leads to better AI visibility.

User engagement metrics such as Average Session Duration ($r=0.65$) and Pages per Session ($r=0.58$) were significantly correlated with AI rankings, highlighting the impact of UX on SEO.

Multiple regression analysis expands on the previous multiple regression analysis, now incorporating all the variables included in the descriptive statistics (Table 1) and the correlation analysis (Table 2). In this analysis, we assess the contribution of each variable to the prediction of AI rankings. The table includes all the key SEO dimensions from on-page, technical, and off-page SEO, as well as user engagement and design factors.

Semantic Keyword Usage and Content Quality have the highest predictive power for AI rankings ($\beta=0.32$, 0.28), confirming that the quality of content and its semantic relevance are essential for high visibility in AI-driven search results (Table 3).

Backlinks Quantity and Direct Visits Rate (a proxy for traffic quality and engagement) also remain significant

($\beta=0.20$, 0.22), although their influence is somewhat lower than content-related factors.

Table 2: Correlation between SEO factors and AI ranking

Variable	Correlation with AI Ranking (r)	P-Value
Semantic Keyword Usage	0.72	0.0001
Content Quality	0.74	0.0001
Webpage Titles	0.73	0.0002
Meta Description Tag Utilization	0.70	0.0003
Meta Tags Utilization	0.64	0.0004
Backlink Quantity	0.72	0.0003
Bounce Rate	0.68	0.0006
Average Session Duration	0.63	0.0006
Pages per Session	0.71	0.0004
Mobile Responsiveness	0.63	0.0007
UX/UI Design Quality	0.64	0.0007
URL Structure	0.68	0.0006
Heading Tags Usage	0.70	0.0005
Submenu Tags Usage	0.66	0.0006
Canonical Tags Usage	0.58	0.0009
Image Alt Text Usage	0.61	0.0008
XML Sitemap Presence	0.60	0.0008
Domain Name Features	0.61	0.0009
Direct Visits Ratio	0.62	0.0007

User engagement metrics like Bounce Rate (negatively correlated, $\beta=-0.18$) and Average Session Duration (positively correlated, $\beta=0.18$) provide moderate contributions to the regression model.

Mobile Responsiveness, UX/UI Design Quality, and Schema Tags Usage are other important factors contributing to AI rankings, with statistically significant coefficients.

Table 3: Multiple regression analysis-predicting AI rankings

Variable	Beta Coefficient (β)	P-Value
Semantic Keyword Usage	0.32	0.001
Content Quality	0.28	0.002
Webpage Titles	0.25	0.005
Meta Description Tag Utilization	0.22	0.010
Meta Tags Utilization	0.21	0.015
Backlinks Quantity	0.20	0.025
Bounce Rate	-0.18	0.035
Average Session Duration	0.18	0.040
Pages per Session	0.16	0.050
Mobile Responsiveness	0.15	0.060
UX/UI Design Quality	0.18	0.050
URL Structure	0.12	0.080
Heading Tags Usage	0.13	0.070
Schema Tags Usage	0.15	0.045
Canonical Tags Usage	0.10	0.090
Image Alt Text Usage	0.12	0.075
XML Sitemaps Presence	0.14	0.060
Domain Name Features	0.08	0.125
Direct Visits Rate	0.22	0.015

ANOVA (Table 4) evaluates how industry type influences the usage of various SEO strategies across different sectors (e.g., ecommerce, SaaS, blogs, news sites). All the variables identified in Table 1 and Table 2 are included in this analysis.

Content Quality and Backlinks Quantity show significant industry differences ($F=4.45$, 3.92), indicating that content-centric industries (e.g., SaaS, ecommerce) are more focused on producing quality content and acquiring backlinks.

Mobile Responsiveness and UX/UI Design Quality are especially important for industries like ecommerce and SaaS, with higher F-values, suggesting these factors have a more substantial impact on these sectors due to their focus

on user experience. Meta tags utilization and direct visits rate appear to have more moderate but still relevant impacts across various industries ($p < 0.1$).

Table 4: ANOVA-Comparison of SEO factor impact by industry type

SEO Variable	F-Value	P-Value
Semantic Keyword Usage	3.12	0.045
Content Quality	4.45	0.002
Webpage Titles	3.20	0.038
Meta Description Tag Utilization	2.85	0.065
Meta Tags Utilization	2.75	0.070
Backlinks Quantity	3.92	0.004
Bounce Rate	2.50	0.080
Average Session Duration	2.95	0.060
Pages per Session	3.20	0.045
Mobile Responsiveness	4.20	0.003
UX/UI Design Quality	3.50	0.005
URL Structure	2.85	0.075
Heading Tags Usage	3.15	0.050
Schema Tags Usage	3.30	0.040
Canonical Tags Usage	2.95	0.065
Image Alt Text Usage	2.80	0.075
XML Sitemaps Presence	3.10	0.045
Domain Name Features	2.60	0.090
Direct Visits Rate	3.45	0.015

Factor analysis (Table 5) was conducted to identify the underlying dimensions or components that explain the variance in AI-driven search ranking. The analysis reveals how different SEO factors cluster into broader categories, helping to understand their impact on search visibility.

- **Factor 1:** On-Page SEO (32.0%)-Highlights the importance of content optimization and keyword relevance for AI rankings.
- **Factor 2:** Technical SEO (27.0%)-Groups essential

technical elements that contribute to site structure, mobile usability, and search engine crawl ability.

- **Factor 3:** User Engagement Metrics (22.5%)-Emphasizes key engagement indicators such as bounce rate, session duration, and pages per session that AI-driven search algorithms consider.
- **Factor 4:** Off-Page SEO (18.5%)-Focuses solely on backlink quantity, reaffirming the value of external credibility in search ranking algorithms.

Table 5: Factor Analysis-Identifying SEO Components for AI Ranking

Factor	Variables Included	Eigenvalue	% Variance Explained
Factor 1: On-Page SEO	Semantic keyword usage, content quality, meta descriptions, heading tags, webpage titles, image alt text usage, domain name, meta tags utilization	5.40	32.0%
Factor 2: Technical SEO	Schema Markup, XML Sitemaps, Canonical Tags, URL Structure, Mobile Responsiveness, UX/UI Design Quality, Direct Visits Rate	4.50	27.0%
Factor 3: User Engagement Metrics	Bounce Rate, Session Duration, Pages per Session	3.80	22.5%
Factor 4: Off-Page SEO	Backlink Quantity	3.20	18.5%

Discussion

Results from the study highlight the evolving nature of search engine optimization in the era of generative artificial intelligence and large language models. Statistical analysis reinforces that traditional SEO elements, such as semantic keyword usage, content quality, and structured data, remain critical for AI search rankings. However, the findings also reveal a significant shift toward user engagement metrics, which AI models prioritize to assess content relevance and quality.

The strong correlation between Semantic Keyword Usage ($r=0.72$) and Content Quality ($r=0.75$) with AI ranking underscores the importance of semantic relevance in optimizing content for AI-driven search results. The negative correlation of Bounce Rate (-0.49) suggests that AI-powered search engines prefer content that retains user engagement. The moderate correlation between Backlink Quantity ($r=0.62$) and AI ranking confirms that off-page

SEO remains influential but has a relatively lower impact compared to content-focused factors.

The multiple regression analysis further validates these observations, with Semantic Keyword Usage ($\beta=0.32$) and Content Quality ($\beta=0.28$) emerging as the most significant predictors of AI rankings. Meanwhile, factors such as UX/UI Design Quality ($\beta=0.18$) and Schema Tags Usage ($\beta=0.15$) reinforce the need for a well-structured and user-friendly website for AI visibility. The ANOVA findings also demonstrate industry-specific differences, with content-heavy industries placing more emphasis on Content Quality and Backlink Quantity.

These findings indicate that AI-driven search engines, such as ChatGPT and Deep Seek, prioritize contextually rich, structured, and engagement-oriented content over traditional keyword-matching techniques. The shift toward engagement-driven metrics suggests that AI-generated

results rely on implicit user feedback to determine content credibility and relevance.

The significance of structured data elements like Schema Tags and XML Sitemaps implies that AI algorithms prefer websites with clear, machine-readable organization. Additionally, the high correlation of Mobile Responsiveness with AI rankings indicates that AI-powered search engines favor websites optimized for mobile-first experiences, aligning with broader web usability trends.

While Backlink Quantity remains an essential ranking factor, its lower impact compared to On-Page SEO factors suggests that AI search weigh content and user engagement more heavily than external authority signals. This is in contrast to traditional search engines, where backlink profiles play a dominant role in determining rankings. The study's results reinforce the need for digital marketers to prioritize high-quality, structured content and user engagement strategies over conventional link-building approaches.

Limitations

Despite the insightful findings, this study has several limitations. First, the sample size of 287 professionals, while representative, may not fully capture the diversity of SEO practices across different industries and regions. Second, the study relies on self-reported data from digital marketers, which may introduce response bias. Third, the study does not account for potential differences in AI search algorithms across various platforms, such as ChatGPT, Deep Seek, and Perplexity AI, which may weigh SEO factors differently. Future research should expand the sample size, incorporate real-world testing of SEO tactics, and analyze AI search ranking patterns across multiple platforms.

Conclusion

The study provides empirical evidence on how SEO tactics influence website ranking and visibility in AI Generators and LLM results. Key findings indicate that AI models prioritize on-page SEO factors such as semantic keyword usage and content quality while also incorporating Technical SEO elements like schema markup and mobile responsiveness. User engagement metrics, including bounce rate and session duration, further influence AI rankings, signaling a shift toward a user-centric approach to search visibility. These insights suggest that digital marketers and webmasters should optimize their strategies by focusing on high-quality, structured content, improving user engagement, and leveraging technical SEO enhancements to maximize their website's AI-driven ranking potential. As AI generators and LLM's continue to evolve, ongoing research is necessary to refine SEO best practices and adapt to the changing digital landscape.

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