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Evolution of Google Algorithms: From Search Heuristics to AI-Generated Content Ranking

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ABSTRACT

The article analyzes how the rapid development of artificial intelligence has gradually changed Google search and, accordingly, the logic of SEO. The evolution of approaches to ranking was described. Starting from early mechanisms, where links and page authority (PageRank) played a key role, to modern models that try to "understand" the content of the query, context and user intent. The article explained that SEO is gradually changing and instead of "technical tricks" under algorithm signals, high-quality content, clear structure, real benefit for the reader and trust in the source are becoming the main ones. Generative changes in the issue were also considered - SGE and AI Overviews - when Google does not just show links, but increasingly forms a ready-made short answer right on the results page (SERP). In addition, the available data and observations on the impact of AI Overviews on the clickability of organic results, the growth of the share of "zero-click" interactions and changing user behavioral scenarios are summarized. It is also described how in such conditions, the need for approaches such as Generative Engine Optimization is formed, where it is important not only to "be in the top", but also to get to the sources on which the generated answer is based. In addition, the article highlights the risks associated with generative content in search: possible errors and "hallucinations", the difficulty of quick fact-checking, as well as the blurring of responsibility between the platform, content authors and the audience. It was also substantiated the need to adapt the digital competencies of specialists to the conditions when classic search is increasingly transformed into a dialogue with large language models, and the competitiveness of content is determined by its structure, transparency of sources and compliance with EEAT principles. As a result, the work describes the transition of search to a model where the answer becomes a product, and quality, transparency and trust are key factors for both users and site owners. The study is based on a review of scientific publications and technical materials of Google, as well as on the analysis of data already collected from SEO platforms. The results obtained outline the cause-and-effect relationships between the stages of algorithm development and optimization practices and form the requirements for business content strategies in the reality of generative search.

KEYWORDS

Google algorithms, search engine optimization (SEO), artificial intelligence, Generative Engine Optimization (GEO), AI Overviews, digital competencies, PageRank, BERT, large language models.

Introduction

Information search has long been one of the basic "infrastructures" of the digital society. Since the emergence of the first search engines in the late 1990s, ranking mechanisms have undergone a rapid evolution: from a fairly simple calculation of keywords to complex artificial intelligence systems that work with context and even combine different types of data (text, images, etc.). Against this background, Google's dominant position in the global search market, with a share of more than 89%, means that changes to its algorithms significantly influence the development of the online information ecosystem and content optimization practices. (StatCounter, 2026)

Generative systems are increasingly integrated into search results and are actually reshaping the very usage scenario: the answer increasingly appears right on the results page, without the need to open external resources. In this logic, the role of the click changes, and with it the usual model, where traffic is directly converted into revenue from content. Therefore, for media and digital marketing, this means the need to rethink what monetization and audience engagement are based on in the new conditions.

The purpose of the article is to identify patterns in the evolution of Google search algorithms and assess the impact of implementing generative AI on search efficiency and content optimization strategies.

Literature Review

Research on the evolution of search engines has traditionally focused on how the criteria for "quality results" in SERPs have changed under the influence of technological, economic and behavioral factors. Early approaches to ranking were based on heuristics and signals that can be formalized through link graphs and basic indicators of relevance. In this context, the basic starting point is the work describing the transition from purely content comparison to assessing the authority of pages through link structure, where PageRank is considered as a mechanism for interpreting the "trust" and "weight" of a document on the network (Martinez-Romo & Araujo, 2013). Importantly, it is this logic that has changed the understanding of relevance: the result is not just a coincidence of words, but a compromise between the topic and the authority of the source.

The next stage in the evolution of search is associated with the transition to machine learning - it allowed to generalize hundreds of signals at once and better deal with uncertainty, especially when the query is new, rare or has several possible interpretations. In this context, RankBrain is often called a turning point: from "hard" rules, Google moved to a model that is able to recognize user intent and select formulations that are close in meaning (Perficient, 2016). Importantly, these changes are not limited to "increasing accuracy" - they change the approach to SEO itself: pages begin to compete not for one specific keyword query, but for the ability to best meet the user's need in a specific context.

It was only with the advent of transformative models that learned to understand text in context that semantic search began to develop rapidly. BERT can be cited as a simple example of how Google moved from word matching to understanding content. That is, the system analyzes how words are related to each other and tries to understand what exactly the user meant in their query. (Nayak, 2019)

In a broader sense, this means that the role of artificial intelligence in SEO is noticeably growing: algorithms evaluate not only the formal correspondence of the query text, but also the real quality of the material - whether it really helps the user and meets his need. (Ziakis & Vlachopoulou, 2024)

Other studies also often mention the transition to multimodal and multitasking data processing, which has significantly expanded the capabilities of search. An example is the concept of the Multitask Unified Model. This concept orients the system to work not only with text, but also to combine different formats of information and process complex queries, where one short formulation is no longer enough (Google, 2021). Therefore, over time, search has evolved from simply displaying a list of

pages to a “ready-made answer” format: the system not only finds sources, but also briefly summarizes them and explains the main content.

The latest stage is related to generative search: the user increasingly receives a concise synthesis directly in the results, without going to individual pages. This is what has formed two parallel lines of research. The first line is technical and methodological. It introduces the concept of GEO (Generative Engine Optimization) as a set of practices that help content remain understandable and “usable” by generative systems when forming an answer (Aggarwal et al., 2024).

The second category of research is more applied in nature. It assesses how these changes affect traffic, CTR, and the overall “economic conditions of the web.” As an example, we can cite industry reports and analytics from SEO platforms that user behavior changes noticeably. In particular, people are less likely to click on organic results when generative blocks appear in the SERP (Guan, 2025; Seer Interactive, 2025; Taylor, 2024).

Problem Statement

The goal of this article is to trace how Google’s algorithms have evolved from simple heuristics to the use of generative artificial intelligence, and to understand how this has impacted the entire web ecosystem. The main focus was on how these changes affect SEO, content creation methods, and key user engagement metrics with search results.

The object of research on this topic is the development of Google's search engine algorithms and elements, and the subject matter is specific transformations in ranking signals, query interpretation methods, and response generation mechanisms. This trend directly determines how visible sites are in search and how much traffic they receive.

The research task is based on the fact that algorithm updates are not just technical improvements, but real transitions between paradigms. Initially, the emphasis was on the popularity and authority of resources, then on understanding the meaning, and now on generating answers. Because of this, the traditional idea of a search engine as a tool for navigating documents is gradually changing to the concept of receiving a ready-made answer. This can reduce the number of transitions to the original source pages and forces us to reconsider approaches to content optimization.

To achieve the goal, you need to complete the following tasks:

1) Analyze the evolution of algorithms - from PageRank to models like BERT and MUM.
2) Explore how AI Overviews work and how they affect CTR (click-through rate).
3) Identify the basic principles of optimization for generative models (GEO).
4) To systematize changes in the types of ranking signals - referential, content, behavioral, semantic, and generative - and show how they affect content quality requirements.
5) Identify the practical risks of generative search for web resources and outline areas for adapting content strategies.

Methods and Materials

The methodological basis of the study is the methods of systematic analysis of scientific literature and technical documentation of Google. To form a holistic picture, the principle of “from general to specific” was applied: first, the key stages of evolution were outlined (heuristic, ML-stage, semantic, generative), and then it was detailed how each stage changes the set of signals and requirements for content. Theoretical materials were selected based on works describing the evolution of ranking, mechanisms of query interpretation, as well as the role of artificial intelligence in modern SEO and generative search (Martinez-Romo & Araujo, 2013; Nayak, 2019; Ziakis & Vlachopoulou, 2024; Google, 2021; Aggarwal et al., 2024).

To assess the impact of the new algorithms, a secondary analysis of empirical data from leading commercial industry reports and analytics platforms for the period 2024-2025 was used. In particular, the results of observations on changes in CTR and user behavior in the presence of generative elements of the output were taken into account, which allows interpreting the consequences for web traffic in an applied dimension (Guan, 2025; Seer Interactive, 2025; Taylor, 2024). However, a caveat

must be made regarding the limitations of their methodology: these reports often lack full transparency regarding sample size, region, and targeted specialization. Since these data have different collection and coverage methods, they are considered not as "absolute values", but as indicators of the direction and scale of changes.

A comparative analysis was applied to compare the principles of traditional SEO and the new direction of GEO. The comparison is performed according to the logic:

1) what is being optimized (document position or content suitability for inclusion in a generative response);
2) which signals become dominant (keywords/links vs semantic completeness/structure/authority);
3) which practices are of primary importance (structure, sources, clarity of wording, question-answer orientation, etc.) (Aggarwal et al., 2024; Ziakis & Vlachopoulou, 2024).

In order to maintain objectivity, the reports of leading SEO platforms were compared with official Google statements, taking into account the limitations of secondary metrics. Such metrics include their dependence on the region, type of query and niche specificity. To increase the reliability of the conclusions, data triangulation was used: combining several sources to verify the results. But it is important to remember that generative functions and their prominence in the results may vary depending on the region, query intent and stage of experimental launches. Therefore, these results should be perceived as a generalization of key trends, and not as universal rules for all situations.

Results and Discussion

From references to meanings: the era of machine learning

Google's early algorithms relied heavily on PageRank. PageRank is an approach that determined the "weight" of a page based on the number and quality of incoming links (Martinez-Romo & Araujo, 2013). This solution worked well and naturally organized the web in the form of a graph. So, links actually worked as recommendations between resources. However, as competition grew, PageRank signals gradually became a convenient field for manipulation - link exchanges, satellite networks, aggressive schemes, and keyword stuffing appeared, which distorted the real idea of the value of content. That is why Google was forced to shift its focus towards models where relevance is not reduced to "popularity", but is determined by semantic relevance, context, and how much the page really meets the user's need.

The turning point was the introduction of RankBrain in 2015, the first machine learning algorithm. Industry reports and technical observations have shown that RankBrain allowed the system to interpret queries that it had not previously encountered (about 15% of daily queries), comparing them with known word vectors (Perficient, 2016; Sullivan, 2016). The practical meaning of this step is to move away from literal matching of formulations. If previously an "unknown" query often led to inaccurate results, then RankBrain made the search more resistant to language variability: synonyms, atypical constructions, colloquial forms, as well as situations where the user formulates a problem, and not the "right key". If we talk about SEO, then this indicates for them, first of all, a change in the optimization logic. Pages begin to compete not only for keywords, but for the ability to cover the topic broadly and consistently and demonstrate a clear structure. As a result, the importance of semantic clusters, thematic integrity, and internal logic of content, rather than individual formulations, increases.

The next step was the integration of the BERT (Bidirectional Encoder Representations from Transformers) model in 2019. According to Google, BERT allowed analyzing the context of words in a sentence in both directions, which dramatically improved the understanding of user intent for long and conversational queries (Nayak, 2019). This marked the transition from "string search" to "meaning search". In the applied dimension, BERT enhances the role of contextual "trifles" that were previously often ignored: prepositions, clarifications, dependencies between words, as well as user intent (informational, navigational, transactional). It is important that in such a system, it is not the text that simply contains many keys that wins, but the text that gives unambiguous answers, does

not contradict itself, and closes the query "from the standpoint of meaning". So, within this stage, the results demonstrate: ML tools and transformers have significantly shifted the focus of ranking from mechanical signals to semantic interpretation, where quality is determined by the ability of a page to be relevant not formally, but substantively (Perficient, 2016; Sullivan, 2016; Nayak, 2019).

Generative revolution: MUM and AI overviews

Google introduced the MUM (Multitask Unified Model) model in 2021. According to their statements, it is approximately 1000 times more powerful than BERT and can work with different types of content (text, images, videos) and languages (Google, 2021). If we talk about BERT, then it has noticeably improved text understanding, but it is MUM that has expanded the approach to search in general. The system has gained the ability to combine information from different sources and formats to form a more holistic answer. As a result, search behavior is changing - people are more often asking complex questions with several conditions and expect not only a list of links, but also clear explanations, comparisons and practical advice. That is why AI Overviews (formerly SGE) appeared - generated answers that are shown at the top of the search results. (Google, 2021)

Data from 2025 shows that AI Overviews are significantly changing the way people search. However, before considering any of these figures, it should be noted that this data is based on limited samples from commercial platforms, and the region and niche are not disclosed. Analysis of industry reports shows a link between the appearance of an AI Overview and a 58% drop in the CTR of the first organic result (Guan, 2025). When the answer is visible immediately in the SERP, the "zero-click" scenario is strengthened - the user gets what they need without going to the site (Taylor, 2024). Reports from analytics platforms also noted that for informational queries with AI Overviews, organic CTR can decrease by more than 60% (Seer Interactive, 2025). In general, this changes the usual traffic model. If previously search mainly sent people to primary sources, now it closes part of the need directly in the results, through a synthesized answer. This is most visible in queries where people are looking for a short explanation, help, comparison or step-by-step instructions. (Taylor, 2024; Seer Interactive, 2025)

In such a situation, simple visibility in the SERP no longer means that the user will go to the site. This, in turn, changes the priorities for the content strategy. Therefore, it is important for a web resource not only to be "in the top", but to become one of the sources on which the generated answer is based. Therefore, competition for citations, a clear structure of materials and a strong factual basis is growing. Therefore, AI Overviews can be considered to affect not only ranking, but also the entire user journey, transferring part of the value from sites to the search interface. (Guan, 2025; Taylor, 2024; Seer Interactive, 2025).

Generative engine optimization (GEO)

The concept of GEO emerged in response to these changes. Researchers describe GEO as a set of approaches that help to adjust content so that generative models are more likely to take it as a source and cite it in their responses (Aggarwal et al., 2024). While traditional SEO focuses on the position of a page in the results, GEO is more about how "suitable" the material is for use in the generated summary. In practice, this means that the content should not only be relevant to the topic, but also as understandable as possible for automatic extraction: short and clear definitions, unambiguous formulations, a logical structure, consistent terminology and a minimum of ambiguities.

Key GEO strategies include:

- Using authoritative sources and statistics.
- Structuring content in a question-and-answer format.
- Technical data markup to facilitate their extraction by RAG (Retrieval-Augmented Generation) algorithms.

Table 1. Comparison of traditional SEO and GEO approaches

Criterion	Traditional SEO	Generative Engine Optimization (GEO)
Main goal	To improve the visibility and position of a page in search results.	To increase the chances that content will be used or cited in AI-generated answers.
Main focus	Ranking, keywords, backlinks, technical optimization, and user behavior signals.	Clarity, structure, factual accuracy, source transparency, and suitability for automated summarization.
User interaction model	The user usually clicks on a search result and reads the information on the website.	The user may receive a summarized answer directly in the search interface without visiting the source page.
Content requirements	Content should be relevant, optimized for search queries, and useful for readers.	Content should be clearly structured, easy to extract, supported by evidence, and understandable for both users and AI systems.
Role of keywords	Keywords help search engines understand the topic and match the page with queries.	Keywords remain useful, but semantic completeness and clear answers to user questions become more important.
Role of sources and evidence	Sources improve credibility and can support expertise and trust.	Sources are especially important because generative systems need reliable information for forming answers.
Typical optimization practices	Keyword research, meta tags, internal linking, backlinks, technical SEO, content updates.	Question-answer structure, concise definitions, clear headings, factual support, structured data, and transparent references.
Success indicators	Higher ranking positions, organic traffic, CTR, impressions, conversions.	Inclusion in AI-generated answers, citations by generative systems, visibility in AI Overviews, and trust signals.
Risks	Losing ranking positions or traffic due to algorithm changes and competition.	Losing visibility even with good rankings if the content is not selected as a source for generated answers.
General limitation	Focuses mainly on the traditional search results model.	Still developing, because generative search systems and their selection logic remain partly opaque.

Source: Developed by the author.

At the same time, within GEO, it is important not to reduce optimization to mechanical “fitting” to a model. Excessive patterning, regeneration, and repetition can, on the contrary, reduce trust in the material. Therefore, it is indicative that Google continues to fight against low-quality automatically generated content. The Helpful Content Update aims to lower the ranking of materials created exclusively for search engines, and not for people (Google, 2022). This emphasizes the importance of the EEAT criteria (Experience, Expertise, Authority, Reliability). In the context of this study, this means: GEO should work as a superstructure on top of high-quality content, and not as a replacement for quality with “technical optimization”. That is why the most promising strategy is one where structure, evidence, and human benefit simultaneously make the content suitable for generative systems (Aggarwal et al., 2024; Google, 2022).

The problem of trust and competence

The integration of generative AI into search inevitably increases the risks of spreading false information - the so-called "hallucinations". Studies show that AI is able to generate answers that are convincing in form, but in fact incorrect. This in turn potentially undermines trust in search engines (Memon & West, 2024). In this sense, generative output increases the "cost of error": inaccuracy in synthesis can scale to a large audience, reinforcing misconceptions or provoking incorrect decisions. At the user experience level, this is felt especially strongly, because the "ready-made answer" format reduces the motivation to turn to primary sources. This is due to the fact that a person receives a generalization in an authoritative interface and therefore often perceives it as correct a priori.

That is why the problem of digital literacy is becoming more relevant. As Zhyvko & Petrukha (2023) emphasize, in the conditions of digitalization of society, the “formation and development of digital competencies” that allow users to verify information and consciously interact with new technologies are critically important.

In practice, this means that it is important not just to find another source, but to understand whether it can be trusted. This requires the ability to check claims, see weaknesses in arguments, distinguish facts from someone else's interpretations, and understand the limits of what generative models can (and cannot) do. This is why the web values more highly materials that do not just give a short answer, but explain it, support it with evidence, and clearly show the sources of their conclusions - that is, they comply with the principles of EEAT (Google, 2022).

Accordingly, search is entering a phase where the algorithm does not simply sort sites in the results, but actually "assembles" the finished answer as a separate product. For users, this is convenient and fast, but for sites it means new competition and higher requirements: more quality, more trust and a higher level of digital competence are needed in the modern information environment (Guan, 2025; Seer Interactive, 2025; Memon & West, 2024; Zhyvko & Petrukha, 2023).

Conclusion

The evolution of Google algorithms took place quite quickly: at first, search was more focused on the "popularity" of pages and external signals, then it learned to better understand the content, and today it increasingly tries to give a ready-made answer right away. If earlier, visibility in the results could be increased by relatively simple techniques, now the user's intention and the context of the query have become decisive. Therefore, the requirements for content have increased: it must not only be relevant, but also really high-quality - logical, understandable and meaningful. As a result, SEO is gradually shifting from purely "technical advancement" to work with trust and expertise: materials must be useful to people and at the same time be well read by algorithms that analyze meaning.

The emergence of generative blocks in the results (AI Overviews/SGE) changes the rules of the game even more: search becomes not just a "go to sites", but a place where you can get the answer directly in the SERP. For sites, this means a real risk of traffic reduction even when the positions have not formally sunk. Analytics also shows a shift in CTR: when there are generative elements in the results, users are more often satisfied with a short summary and do not always go to the original sources. It is crucial, however, to take these analytical data with caution, as they are derived from limited commercial platform samples whose regional and niche scope are not fully disclosed.

The scientific novelty of the work lies in the systematization of the stages of the transition to generative search and in specifying how the set of ranking signals changes at each stage - from referential to semantic and generative. Of particular value is the analytical comparison of traditional SEO with GEO approaches as a reaction to new principles of response formation. The practical significance of the results lies in proving the need to adapt marketing and content strategies. This means that the focus is shifting to creating expert, structured content with clear logic, support for facts and understandable formulations that can be correctly used by generative systems as a reliable source.

At the same time, the shift to generative search raises the bar for professionals: not only the tools are changing, but also how quality and trust are assessed. Now it is especially important to be able to think critically, check sources and understand how digital platforms work. So the evolution of Google algorithms affects how people consume information, how web traffic is distributed and what skills are becoming key for specialists in search, content and digital communications.

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