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# ecommerce SEO services

**keyword variations**

keyword variations

on-page readability checks"On-page readability checks ensure that your content is easy to read, comprehend, and navigate. By improving readability, you enhance user engagement, reduce bounce rates, and increase the pages relevance in search results."

on-page relevance"On-page relevance refers to how closely your content aligns with the keywords youre targeting. By creating high-quality, targeted content, you increase the pages relevance, improve user engagement, and boost search rankings."

on-page SEO"On-page SEO refers to the practice of optimizing individual web pages to improve search rankings and drive organic traffic. Best SEO Agency Sydney Australia. This involves using relevant keywords in content, ensuring proper heading structure, adding meta tags, and improving URL formats for better readability and indexing."

Best SEO Sydney Agency.

# Keyword-rich anchor text —

- keyword variations
- Keyword-rich anchor text
- lazy loading images
- Link bait strategies
- Link building automation
- link building campaigns
- Link building campaigns

on-page SEO"On-page SEO refers to optimizing individual web pages to rank higher in search engine results. It involves improving content quality, optimizing meta tags, using appropriate headings, and structuring the sites internal links to enhance both user experience and search engine visibility."

on-page SEO checklist"An on-page SEO checklist outlines all the key elements to optimize, including meta tags, headings, content quality, and internal links. By following a checklist, you ensure that every aspect of the page is optimized for better rankings."

on-page SEO improvements"On-page SEO improvements focus on optimizing elements like meta tags, headings, and content structure. Making these adjustments enhances the pages relevance, increases search engine visibility, and improves overall performance."

Local SEO .

# lazy loading images

optimized image alt attributes"Alt attributes provide descriptive text for images, helping search engines and screen readers understand their content.

## Ecommerce SEO services - Keyword difficulty analysis

- ○ Keyword difficulty analysis
- ○ Google search trends
- ○ Search relevance signals

Optimizing these attributes with relevant keywords improves accessibility and boosts search visibility." optimized image backup solutions"Optimized image backup solutions store compressed and resized versions of your files, ensuring you always have access to efficient, web-ready images. Best SEO Audit Sydney. Reliable backups help maintain site quality and improve recovery times if issues arise."

optimized image delivery networks"Delivery networks, such as CDNs, distribute image files to servers closer to users, improving load times and reliability. Optimized delivery ensures that images load quickly and consistently, enhancing user experience and search performance."

# HOW SEARCH ENGINE MAR

## HELPS BUSINESS GROW OF

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265 GEORGE ST, SYDNEY NSW 2000
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TAKING YOUR SMALL B[USINESS]
TO THE NEXT LEVEL
SEO SERVICES AUST[RALIA]
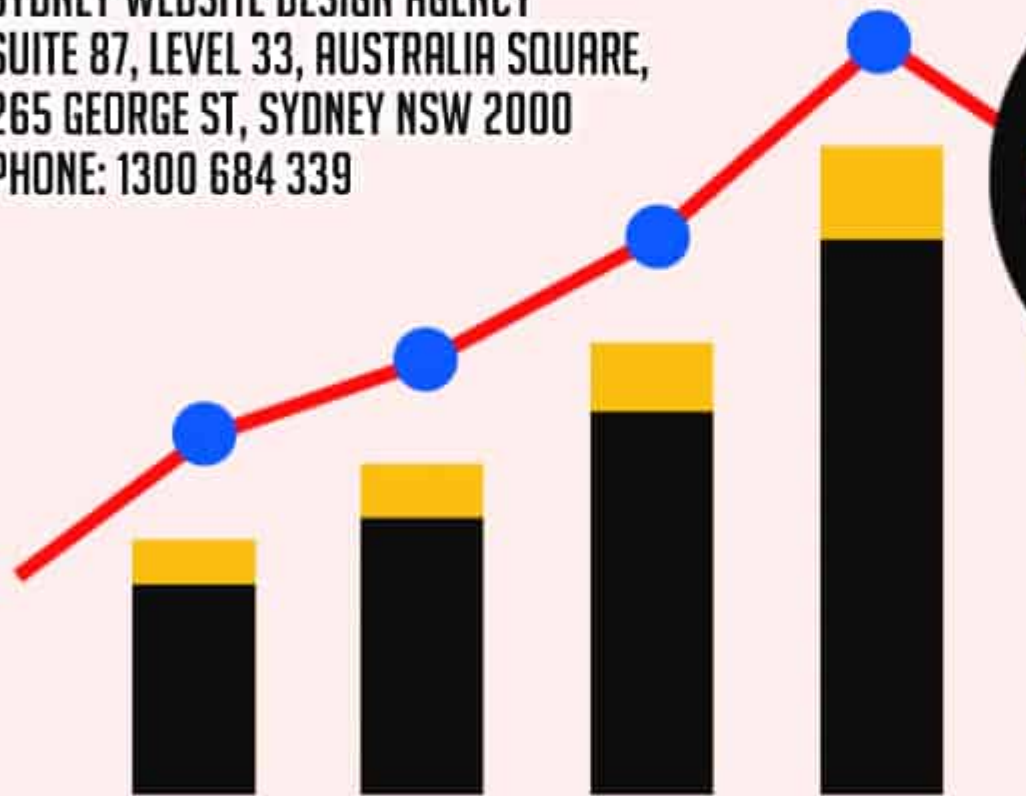
Link bait strategies

optimized image dimensions"Using the correct dimensions for images prevents slow load times and distorted displays. By setting optimized dimensions, you ensure that images look great on all devices and contribute to a faster, more user-friendly site."

optimized image file naming conventions"Consistent naming conventions improve organization, searchability, and SEO performance. By using logical, descriptive filenames, you ensure that images are easy to find and contribute to a well-structured site."

optimized image file storage"Efficient image file storage organizes images into logical directories, reduces duplication, and makes it easier to manage and update your visuals. comprehensive SEO Packages Sydney services. Proper storage solutions improve site maintenance and ensure consistent performance."

# Link building automation

optimized image formats for web"Choosing optimized image formats like WebP or JPEG improves load times and visual quality. Using the right format ensures that your site remains fast, user-friendly, and visually appealing."

optimized image hosting providers"Choosing optimized image hosting providers ensures faster load times, higher reliability, and better scalability. A quality hosting provider helps maintain smooth performance and enhances the overall user experience."

optimized image naming strategies"Using descriptive, keyword-rich filenames ensures that images are easily identifiable by search engines and users. Proper naming strategies improve image search visibility and enhance the user experience."

range of SEO Services and Australia .

KEY ADVANTAGE
LOCAL SEO S

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CONTENT MARKETING
TYPES FOR SMALL BUSINESS
AND BRAND BUILDING

link building campaigns

optimized image placement"Placing images strategically within content enhances readability and engagement. By positioning images near relevant text and using them to illustrate key points, you create a more engaging user experience and improve on-page SEO."

optimized image sourcesChoosing optimized image sourcessuch as stock photos or high-resolution originalsprovides better quality and performance.

## Ecommerce SEO services - Google search trends

1. Google PageSpeed Insights
2. Google site audits

High-quality sources ensure that your images look great and load quickly on all devices. optimized image storage formats"Choosing optimized storage formats, such as WebP or SVG, ensures that your images are both high-quality and efficient. Proper storage formats improve load times, reduce bandwidth usage, and maintain visual appeal across devices."

# Link building campaigns

optimized image thumbnails"Optimizing image thumbnails reduces file sizes while maintaining clarity, ensuring that small previews load quickly. Fast-loading thumbnails enhance user experience and help users navigate the site more efficiently."

organic search traffic"Organic search traffic refers to visitors who arrive at a website through unpaid search engine results. By optimizing content, keywords, and website structure, businesses can attract more organic traffic, leading to higher-quality leads and a greater return on investment."
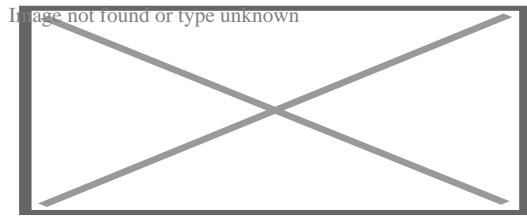
outbound links"Outbound links point to relevant, authoritative external websites. Including high-quality outbound links enhances the credibility of your content and provides additional resources for users, which can indirectly boost your pages authority and search rankings."

**About Semantic Web**

A tag cloud (a typical Web 3.0 phenomenon in itself) presenting Web 3.0 themes

- v
- t
- e

| Semantics |
| --- |
| <ul><li>Linguistic<ul><li>Logical</li></ul></li></ul> |

## Subfields

- Computational
- Lexical (lexis, lexicology)
- Statistical
- Structural

## Topics

- Analysis
- Compositionality
- Context
  - Prototype theory
  - Force dynamics
- Semantic feature
- Semantic gap
- Theory of descriptions

## Analysis

- Latent
- Computational
- Machine-learning

## Applications

- Semantic file system
- Semantic desktop
- Semantic matching
- Semantic parsing
- Semantic similarity
- Semantic query
  - Semantic Web
  - Semantic wiki

**Semantics of
programming languages**

**Types**

- Action
- Algebraic
- Axiomatic
- Categorical
- Concurrency
- Denotational
- Game
- Operational
- Predicate transformational

**Theory**

- Abstract interpretation
- Abstract semantic graph

- Language
- Linguistics

The **Semantic Web**, sometimes known as **Web 3.0** (not to be confused with Web3), is an extension of the World Wide Web through standards[1] set by the World Wide Web Consortium (W3C). The goal of the Semantic Web is to make Internet data machine-readable.

To enable the encoding of semantics with the data, technologies such as Resource Description Framework (RDF)[2] and Web Ontology Language (OWL)[3] are used. These technologies are used to formally represent metadata. For example, ontology can describe concepts, relationships between entities, and categories of things. These embedded semantics offer significant advantages such as reasoning over data and operating with heterogeneous data sources.[4] These standards promote common data formats and exchange protocols on the Web, fundamentally the RDF. According to the W3C, "The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."[5] The Semantic Web is therefore regarded as an integrator across different content and information applications and systems.

## History

[edit]

The term was coined by Tim Berners-Lee for a web of data (or **data web**)[6] that can be processed by machines[7]—that is, one in which much of the meaning is machine-readable. While its critics have questioned its feasibility, proponents argue that applications in library and information science, industry, biology and human sciences research have already proven the validity of the original concept.[8]

Berners-Lee originally expressed his vision of the Semantic Web in 1999 as follows:

> I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web – the content, links, and transactions between people and computers. A "Semantic Web", which makes this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and our daily lives will be handled by machines talking to machines. The "intelligent agents" people have touted for ages will finally materialize.[9]

The 2001 *Scientific American* article by Berners-Lee, Hendler, and Lassila described an expected evolution of the existing Web to a Semantic Web.[10] In 2006, Berners-Lee and colleagues stated that: "This simple idea…remains largely unrealized".[11] In 2013, more than four million Web domains (out of roughly 250 million total) contained Semantic Web markup.[12]
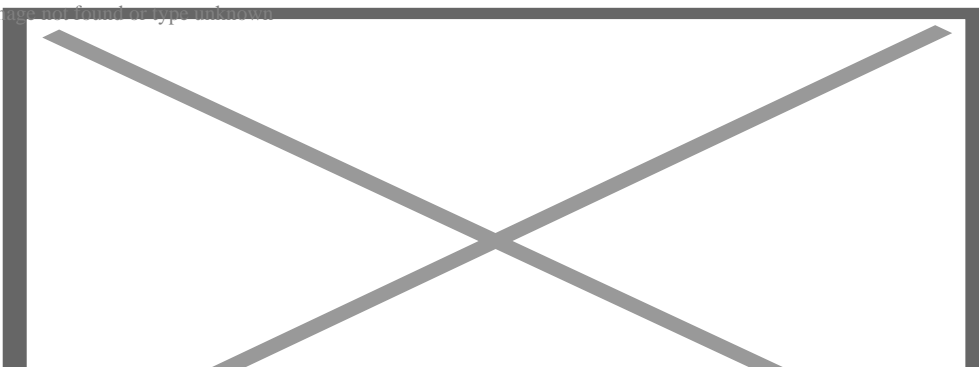
## Example

[edit]

In the following example, the text "Paul Schuster was born in Dresden" on a website will be annotated, connecting a person with their place of birth. The following HTML fragment shows how a small graph is being described, in RDFa-syntax using a schema.org vocabulary and a Wikidata ID:

```
<div vocab="https://schema.org/" typeof="Person">
  <span property="name">Paul Schuster</span> was born in
  <span property="birthPlace" typeof="Place" href="https://www.wikidata.org/entity/Q1731">
    <span property="name">Dresden</span>.
  </span>
</div>
```
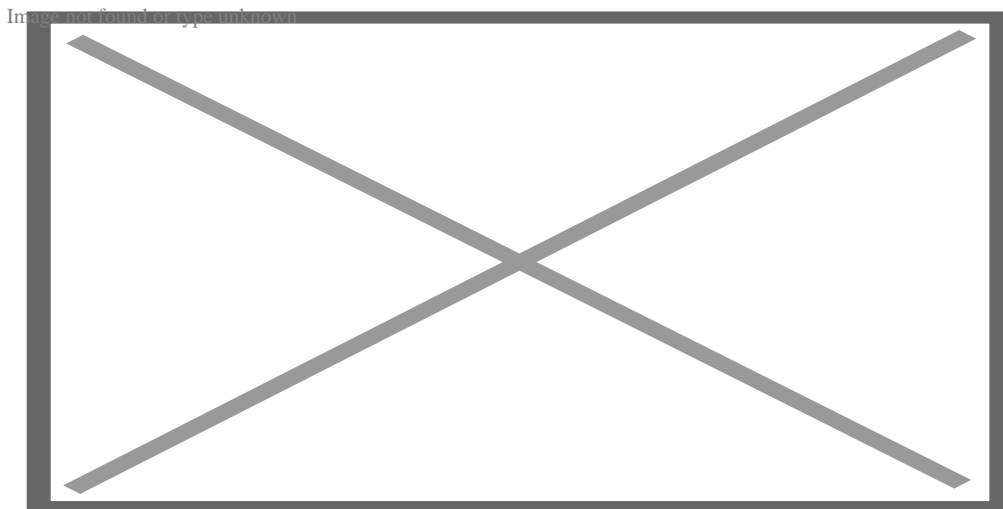
Graph resulting from the RDFa example

The example defines the following five triples (shown in Turtle syntax). Each triple represents one edge in the resulting graph: the first element of the triple (the *subject*) is the name of the node where the edge starts, the second element (the *predicate*) the type of the edge, and the last and third element (the *object*) either the name of the node where the edge ends or a literal value (e.g. a text, a number, etc.).

```
_:a <https://www.w3.org/1999/02/22-rdf-syntax-ns#type> <https://schema.org/Person> .
_:a <https://schema.org/name> "Paul Schuster" .
_:a <https://schema.org/birthPlace> <https://www.wikidata.org/entity/Q1731> .
<https://www.wikidata.org/entity/Q1731> <https://schema.org/itemtype> <https://schema.org/Place>
<https://www.wikidata.org/entity/Q1731> <https://schema.org/name> "Dresden" .
```

The triples result in the graph shown in the given figure.



Graph resulting from the RDFa example, enriched with further data from the Web

One of the advantages of using Uniform Resource Identifiers (URIs) is that they can be dereferenced using the HTTP protocol. According to the so-called Linked Open Data principles, such a dereferenced URI should result in a document that offers further data about the given URI. In this example, all URIs, both for edges and nodes (e.g. http://schema.org/Person, http://schema.org/birthPlace, http://www.wikidata.org/entity/Q1731) can be dereferenced and will result in further RDF graphs, describing the URI, e.g. that Dresden is a city in Germany, or that a person, in the sense of that URI, can be fictional.

The second graph shows the previous example, but now enriched with a few of the triples from the documents that result from dereferencing https://schema.org/Person (green edge)

and https://www.wikidata.org/entity/Q1731 (blue edges).

Additionally to the edges given in the involved documents explicitly, edges can be automatically inferred: the triple

```
_:a <https://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://schema.org/Person> .
```

from the original RDFa fragment and the triple

```
<https://schema.org/Person> <http://www.w3.org/2002/07/owl#equivalentClass> <http://xmlns.com/
```

from the document at https://schema.org/Person (green edge in the figure) allow to infer the following triple, given OWL semantics (red dashed line in the second Figure):

```
_:a <https://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://xmlns.com/foaf/0.1/Person> .
```

## Background

[edit]
Further information: Semantic network § History

The concept of the semantic network model was formed in the early 1960s by researchers such as the cognitive scientist Allan M. Collins, linguist Ross Quillian and psychologist Elizabeth F. Loftus as a form to represent semantically structured knowledge. When applied in the context of the modern internet, it extends the network of hyperlinked human-readable web pages by inserting machine-readable metadata about pages and how they are related to each other. This enables automated agents to access the Web more intelligently and perform more tasks on behalf of users. The term "Semantic Web" was coined by Tim Berners-Lee,[7] the inventor of the World Wide Web and director of the World Wide Web Consortium ("W3C"), which oversees the development of proposed Semantic Web standards. He defines the Semantic Web as "a web of data that can be processed directly and indirectly by machines".

Many of the technologies proposed by the W3C already existed before they were positioned under the W3C umbrella. These are used in various contexts, particularly those dealing with information that encompasses a limited and defined domain, and where sharing data is a common necessity, such as scientific research or data exchange among businesses. In addition, other technologies with similar goals have emerged, such as microformats.

# Limitations of HTML

[edit]

Many files on a typical computer can be loosely divided into either human-readable documents, or machine-readable data. Examples of human-readable document files are mail messages, reports, and brochures. Examples of machine-readable data files are calendars, address books, playlists, and spreadsheets, which are presented to a user using an application program that lets the files be viewed, searched, and combined.

Currently, the World Wide Web is based mainly on documents written in Hypertext Markup Language (HTML), a markup convention that is used for coding a body of text interspersed with multimedia objects such as images and interactive forms. Metadata tags provide a method by which computers can categorize the content of web pages. In the examples below, the field names "keywords", "description" and "author" are assigned values such as "computing", and "cheap widgets for sale" and "John Doe".

<meta name="keywords" content="computing, computer studies, computer" />
<meta name="description" content="Cheap widgets for sale" />
<meta name="author" content="John Doe" />

Because of this metadata tagging and categorization, other computer systems that want to access and share this data can easily identify the relevant values.

With HTML and a tool to render it (perhaps web browser software, perhaps another user agent), one can create and present a page that lists items for sale. The HTML of this catalog page can make simple, document-level assertions such as "this document's title is 'Widget Superstore'", but there is no capability within the HTML itself to assert unambiguously that, for example, item number X586172 is an Acme Gizmo with a retail price of €199, or that it is a consumer product. Rather, HTML can only say that the span of text "X586172" is something that should be positioned near "Acme Gizmo" and "€199", etc. There is no way to say "this is a catalog" or even to establish that "Acme Gizmo" is a kind of title or that "€199" is a price. There is also no way to express that these pieces of information are bound together in describing a discrete item, distinct from other items perhaps listed on the page.

Semantic HTML refers to the traditional HTML practice of markup following intention, rather than specifying layout details directly. For example, the use of <em> denoting "emphasis" rather than <i>, which specifies italics. Layout details are left up to the browser, in combination with Cascading Style Sheets. But this practice falls short of specifying the semantics of objects such as items for sale or prices.

Microformats extend HTML syntax to create machine-readable semantic markup about objects including people, organizations, events and products.[13] Similar initiatives include RDFa, Microdata and Schema.org.

# Semantic Web solutions

[edit]

The Semantic Web takes the solution further. It involves publishing in languages specifically designed for data: Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML). HTML describes documents and the links between them. RDF, OWL, and XML, by contrast, can describe arbitrary things such as people, meetings, or airplane parts.

These technologies are combined in order to provide descriptions that supplement or replace the content of Web documents. Thus, content may manifest itself as descriptive data stored in Web-accessible databases,[14] or as markup within documents (particularly, in Extensible HTML (XHTML) interspersed with XML, or, more often, purely in XML, with layout or rendering cues stored separately). The machine-readable descriptions enable content managers to add meaning to the content, i.e., to describe the structure of the knowledge we have about that content. In this way, a machine can process knowledge itself, instead of text, using processes similar to human deductive reasoning and inference, thereby obtaining more meaningful results and helping computers to perform automated information gathering and research.

An example of a tag that would be used in a non-semantic web page:

<item>blog</item>

Encoding similar information in a semantic web page might look like this:

<item rdf:about="https://example.org/semantic-web/">Semantic Web</item>

Tim Berners-Lee calls the resulting network of Linked Data the Giant Global Graph, in contrast to the HTML-based World Wide Web. Berners-Lee posits that if the past was document sharing, the future is data sharing. His answer to the question of "how" provides three points of instruction. One, a URL should point to the data. Two, anyone accessing the URL should get data back. Three, relationships in the data should point to additional URLs

**Tags and identifiers**

Tags, including hierarchical categories and tags that are collaboratively added and maintained (e.g. with folksonomies) can be considered part of, of potential use to or a step towards the semantic Web vision.[15][16][17]

Unique identifiers, including hierarchical categories and collaboratively added ones, analysis tools and metadata, including tags, can be used to create forms of semantic webs – webs that are to a certain degree semantic.[18] In particular, such has been used for structuring scientific research i.a. by research topics and scientific fields by the projects OpenAlex,[19][20][21] Wikidata and Scholia which are under development and provide APIs, Web-pages, feeds and graphs for various semantic queries.

# Web 3.0

Tim Berners-Lee has described the Semantic Web as a component of Web 3.0.[22]

> People keep asking what Web 3.0 is. I think maybe when you've got an overlay of scalable vector graphics – everything rippling and folding and looking misty – on Web 2.0 and access to a semantic Web integrated across a huge space of data, you'll have access to an unbelievable data resource …
>
> —ÃƒÂ¢Ã¢â‚¬šÂ¬Ã…Â *Tim Berners-Lee, 2006*

"Semantic Web" is sometimes used as a synonym for "Web 3.0",[23] though the definition of each term varies.

# Beyond Web 3.0

The next generation of the Web is often termed Web 4.0, but its definition is not clear. According to some sources, it is a Web that involves artificial intelligence,[24] the internet of things, pervasive computing, ubiquitous computing and the Web of Things among other concepts.[25] According to the European Union, Web 4.0 is "the expected fourth generation of the World Wide Web. Using advanced artificial and ambient intelligence, the internet of things, trusted blockchain transactions, virtual worlds and XR capabilities, digital and real objects and environments are fully integrated and communicate with each other, enabling truly intuitive, immersive experiences, seamlessly blending the physical and digital worlds".[26]

## Challenges

[edit]

Some of the challenges for the Semantic Web include vastness, vagueness, uncertainty, inconsistency, and deceit. Automated reasoning systems will have to deal with all of these issues in order to deliver on the promise of the Semantic Web.

- Vastness: The World Wide Web contains many billions of pages. The SNOMED CT medical terminology ontology alone contains 370,000 class names, and existing technology has not yet been able to eliminate all semantically duplicated terms. Any automated reasoning system will have to deal with truly huge inputs.
- Vagueness: These are imprecise concepts like "young" or "tall". This arises from the vagueness of user queries, of concepts represented by content providers, of matching query terms to provider terms and of trying to combine different knowledge bases with overlapping but subtly different concepts. Fuzzy logic is the most common technique for dealing with vagueness.
- Uncertainty: These are precise concepts with uncertain values. For example, a patient might present a set of symptoms that correspond to a number of different distinct diagnoses each with a different probability. Probabilistic reasoning techniques are generally employed to address uncertainty.
- Inconsistency: These are logical contradictions that will inevitably arise during the development of large ontologies, and when ontologies from separate sources are combined. Deductive reasoning fails catastrophically when faced with inconsistency, because "anything follows from a contradiction". Defeasible reasoning and paraconsistent reasoning are two techniques that can be employed to deal with inconsistency.
- Deceit: This is when the producer of the information is intentionally misleading the consumer of the information. Cryptography techniques are currently utilized to alleviate this threat. By providing a means to determine the information's integrity, including that which relates to the identity of the entity that produced or published the information, however credibility issues still have to be addressed in cases of potential deceit.

This list of challenges is illustrative rather than exhaustive, and it focuses on the challenges to the "unifying logic" and "proof" layers of the Semantic Web. The World Wide Web Consortium (W3C) Incubator Group for Uncertainty Reasoning for the World Wide Web[27] (URW3-XG) final report lumps these problems together under the single heading of "uncertainty".[28] Many of the techniques mentioned here will require extensions to the Web Ontology Language (OWL) for example to annotate conditional probabilities. This is an area of active research.[29]

**Standards**

[edit]

Standardization for Semantic Web in the context of Web 3.0 is under the care of W3C.[30]

# Components

[edit]

The term "Semantic Web" is often used more specifically to refer to the formats and technologies that enable it.[5] The collection, structuring and recovery of linked data are enabled by technologies that provide a formal description of concepts, terms, and relationships within a given knowledge domain. These technologies are specified as W3C standards and include:

- Resource Description Framework (RDF), a general method for describing information
- RDF Schema (RDFS)
- Simple Knowledge Organization System (SKOS)
- SPARQL, an RDF query language
- Notation3 (N3), designed with human readability in mind
- N-Triples, a format for storing and transmitting data
- Turtle (Terse RDF Triple Language)
- Web Ontology Language (OWL), a family of knowledge representation languages
- Rule Interchange Format (RIF), a framework of web rule language dialects supporting rule interchange on the Web
- JavaScript Object Notation for Linked Data (JSON-LD), a JSON-based method to describe data
- ActivityPub, a generic way for client and server to communicate with each other. This is used by the popular decentralized social network Mastodon.

The Semantic Web Stack illustrates the architecture of the Semantic Web. The functions and relationships of the components can be summarized as follows:[31]

- XML provides an elemental syntax for content structure within documents, yet associates no semantics with the meaning of the content contained within. XML is not at present a necessary component of Semantic Web technologies in most cases, as alternative syntaxes exist, such as Turtle. Turtle is a de facto standard, but has not been through a formal standardization process.
- XML Schema is a language for providing and restricting the structure and content of elements contained within XML documents.
- RDF is a simple language for expressing data models, which refer to objects ("web resources") and their relationships. An RDF-based model can be represented in a variety of syntaxes, e.g., RDF/XML, N3, Turtle, and RDFa. RDF is a fundamental standard of the Semantic Web.[32][33]
- RDF Schema extends RDF and is a vocabulary for describing properties and classes of RDF-based resources, with semantics for generalized-hierarchies of such properties and classes.
- OWL adds more vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.
- SPARQL is a protocol and query language for semantic web data sources.
- RIF is the W3C Rule Interchange Format. It is an XML language for expressing Web rules that computers can execute. RIF provides multiple versions, called dialects. It includes a RIF Basic Logic Dialect (RIF-BLD) and RIF Production Rules Dialect (RIF PRD).

# Current state of standardization

[edit]

Well-established standards:

- RDF - Resource Description Framework
- RDFS - Resource Description Framework Schema
- RIF - Rule Interchange Format
- SPARQL - 'SPARQL Protocol and RDF Query Language'
- Unicode
- URI - Uniform Resource Identifier
- OWL - Web Ontology Language
- XML - Extensible Markup Language

Not yet fully realized:

- Unifying Logic and Proof layers
- SWRL - Semantic Web Rule Language

## Applications

[edit]

The intent is to enhance the usability and usefulness of the Web and its interconnected resources by creating semantic web services, such as:

- Servers that expose existing data systems using the RDF and SPARQL standards. Many converters to RDF exist from different applications.[34] Relational databases are an important source. The semantic web server attaches to the existing system without affecting its operation.
- Documents "marked up" with semantic information (an extension of the HTML <meta> tags used in today's Web pages to supply information for Web search engines using web crawlers). This could be machine-understandable information about the human-understandable content of the document (such as the creator, title, description, etc.) or it could be purely metadata representing a set of facts (such as resources and services elsewhere on the site). Note that *anything* that can be identified with a *Uniform Resource Identifier* (URI) can be described, so the semantic web can reason about animals, people, places, ideas, etc. There are four semantic annotation formats that can be used in HTML documents; Microformat, RDFa, Microdata and JSON-LD.[35] Semantic markup is often generated automatically, rather than manually.
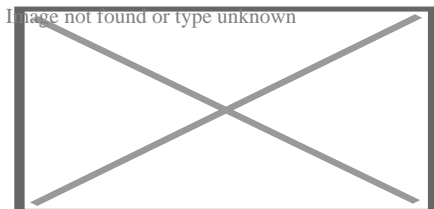
  
  Arguments as distinct semantic units with specified relations and version control on Kialo

- Common metadata vocabularies (ontologies) and maps between vocabularies that allow document creators to know how to mark up their documents so that agents can use the information in the supplied metadata (so that *Author* in the sense of 'the Author of the page' will not be confused with *Author* in the sense of a book that is the subject of a book review).
- Automated agents to perform tasks for users of the semantic web using this data.
- Semantic translation. An alternative or complementary approach are improvements to contextual and semantic understanding of texts – these could be aided via Semantic Web methods so that only increasingly small numbers of mistranslations need to be corrected in manual or semi-automated post-editing.

- Web-based services (often with agents of their own) to supply information specifically to agents, for example, a Trust service that an agent could ask if some online store has a history of poor service or spamming.
- Semantic Web ideas are implemented in collaborative structured argument mapping sites where their relations are organized semantically, arguments can be mirrored (linked) to multiple places, reused (copied), rated, and changed as semantic distinct units. Ideas for such, or a more widely adopted "World Wide Argument Web", go back to at least 2007[36] and have been implemented to some degree in Argüman[37] and Kialo . Further steps towards semantic web services may include enabling "Querying", argument search engines,[38] and "summarizing the contentious and agreed-upon points of a discussion".[39]

Such services could be useful to public search engines, or could be used for knowledge management within an organization. Business applications include:

- Facilitating the integration of information from mixed sources[40]
- Dissolving ambiguities in corporate terminology
- Improving information retrieval thereby reducing information overload and increasing the refinement and precision of the data retrieved[41][42][43][44]
- Identifying relevant information with respect to a given domain[45]
- Providing decision making support

In a corporation, there is a closed group of users and the management is able to enforce company guidelines like the adoption of specific ontologies and use of semantic annotation. Compared to the public Semantic Web there are lesser requirements on scalability and the information circulating within a company can be more trusted in general; privacy is less of an issue outside of handling of customer data.

**Skeptical reactions**

[edit]

# Practical feasibility

[edit]

Critics question the basic feasibility of a complete or even partial fulfillment of the Semantic Web, pointing out both difficulties in setting it up and a lack of general-purpose usefulness that prevents the required effort from being invested. In a 2003 paper, Marshall and Shipman point out the cognitive overhead inherent in formalizing knowledge, compared to the authoring of traditional web hypertext:[46]

While learning the basics of HTML is relatively straightforward, learning a knowledge representation language or tool requires the author to learn about the representation's methods of abstraction and their effect on reasoning. For example, understanding the class-instance relationship, or the superclass-subclass relationship, is more than understanding that one concept is a "type of" another concept. [...] These abstractions are taught to computer scientists generally and knowledge engineers specifically but do not match the similar natural language meaning of being a "type of" something. Effective use of such a formal representation requires the author to become a skilled knowledge engineer in addition to any other skills required by the domain. [...] Once one has learned a formal representation language, it is still often much more effort to express ideas in that representation than in a less formal representation [...]. Indeed, this is a form of programming based on the declaration of semantic data and requires an understanding of how reasoning algorithms will interpret the authored structures.

According to Marshall and Shipman, the tacit and changing nature of much knowledge adds to the knowledge engineering problem, and limits the Semantic Web's applicability to specific domains. A further issue that they point out are domain- or organization-specific ways to express knowledge, which must be solved through community agreement rather than only technical means.[46] As it turns out, specialized communities and organizations for intra-company projects have tended to adopt semantic web technologies greater than peripheral and less-specialized communities.[47] The practical constraints toward adoption have appeared less challenging where domain and scope is more limited than that of the general public and the World-Wide Web.[47]

Finally, Marshall and Shipman see pragmatic problems in the idea of (Knowledge Navigator-style) intelligent agents working in the largely manually curated Semantic Web:[46]

In situations in which user needs are known and distributed information resources are well described, this approach can be highly effective; in situations that are not foreseen and that bring together an unanticipated array of information resources, the Google approach is more robust. Furthermore, the Semantic Web relies on inference chains that are more brittle; a missing element of the chain results in a failure to perform the desired action, while the human can supply missing pieces in a more Google-like approach. [...] cost-benefit tradeoffs can work in favor of specially-created Semantic Web metadata directed at weaving together sensible well-structured domain-specific information resources; close attention to user/customer needs will drive these federations if they are to be successful.

Cory Doctorow's critique ("metacrap")[48] is from the perspective of human behavior and personal preferences. For example, people may include spurious metadata into Web pages in an attempt to mislead Semantic Web engines that naively assume the metadata's veracity.

This phenomenon was well known with metatags that fooled the Altavista ranking algorithm into elevating the ranking of certain Web pages: the Google indexing engine specifically looks for such attempts at manipulation. Peter Gärdenfors and Timo Honkela point out that logic-based semantic web technologies cover only a fraction of the relevant phenomena related to semantics.[49][50]

# Censorship and privacy

[edit]

Enthusiasm about the semantic web could be tempered by concerns regarding censorship and privacy. For instance, text-analyzing techniques can now be easily bypassed by using other words, metaphors for instance, or by using images in place of words. An advanced implementation of the semantic web would make it much easier for governments to control the viewing and creation of online information, as this information would be much easier for an automated content-blocking machine to understand. In addition, the issue has also been raised that, with the use of FOAF files and geolocation meta-data, there would be very little anonymity associated with the authorship of articles on things such as a personal blog. Some of these concerns were addressed in the "Policy Aware Web" project[51] and is an active research and development topic.

# Doubling output formats

[edit]

Another criticism of the semantic web is that it would be much more time-consuming to create and publish content because there would need to be two formats for one piece of data: one for human viewing and one for machines. However, many web applications in development are addressing this issue by creating a machine-readable format upon the publishing of data or the request of a machine for such data. The development of microformats has been one reaction to this kind of criticism. Another argument in defense of the feasibility of semantic web is the likely falling price of human intelligence tasks in digital labor markets, such as Amazon's Mechanical Turk.[*citation needed*]

Specifications such as eRDF and RDFa allow arbitrary RDF data to be embedded in HTML pages. The GRDDL (Gleaning Resource Descriptions from Dialects of Language) mechanism allows existing material (including microformats) to be automatically interpreted as RDF, so publishers only need to use a single format, such as HTML.

**Research activities on corporate applications**

[edit]

The first research group explicitly focusing on the Corporate Semantic Web was the ACACIA team at INRIA-Sophia-Antipolis, founded in 2002. Results of their work include the RDF(S) based Corese[52] search engine, and the application of semantic web technology in the realm of distributed artificial intelligence for knowledge management (e.g. ontologies and multi-agent systems for corporate semantic Web) [53] and E-learning.[54]

Since 2008, the Corporate Semantic Web research group, located at the Free University of Berlin, focuses on building blocks: Corporate Semantic Search, Corporate Semantic Collaboration, and Corporate Ontology Engineering.[55]

Ontology engineering research includes the question of how to involve non-expert users in creating ontologies and semantically annotated content[56] and for extracting explicit knowledge from the interaction of users within enterprises.

# Future of applications

[edit]

Tim O'Reilly, who coined the term Web 2.0, proposed a long-term vision of the Semantic Web as a web of data, where sophisticated applications are navigating and manipulating it.[57] The data web transforms the World Wide Web from a distributed file system into a distributed database.[58]

**See also**

[edit]

- AGRIS
- Business semantics management
- Computational semantics
- Calais (Reuters product)
- DBpedia
- Entity–attribute–value model
- EU Open Data Portal
- History of the World Wide Web
- Hyperdata
- Internet of things

- Linked data
- List of emerging technologies
- Nextbio
- Ontology alignment
- Ontology learning
- RDF and OWL
- Semantic computing
- Semantic Geospatial Web
- Semantic heterogeneity
- Semantic integration
- Semantic matching
- Semantic MediaWiki
- Semantic Sensor Web
- Semantic social network
- Semantic technology
- *Semantic Web*
- Semantically-Interlinked Online Communities
- Smart-M3
- Social Semantic Web
- Web engineering
- Web resource
- Web science

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## Further reading

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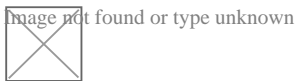
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**External links**

[edit]

**Semantic Web** at Wikipedia's sister projects

Image not found or type unknown
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- Textbooks from Wikibooks
Image not found or type unknown
- Data from Wikidata

Image not found or type unknown

Scholia has a *topic* profile for ***Semantic Web***.

- Official website

- **v**
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- **e**

Semantic Web

| | |
|---|---|
| **Background** | ○ Databases<br>○ Hypertext<br>○ Internet<br>○ Ontologies<br>○ Semantics<br>○ Semantic networks<br>○ World Wide Web |
| **Sub-topics** | ○ Dataspaces<br>○ Hyperdata<br>○ Linked data<br>○ Rule-based systems |
| **Applications** | ○ Semantic analytics<br>○ Semantic broker<br>○ Semantic computing<br>○ Semantic mapper<br>○ Semantic matching<br>○ Semantic publishing<br>○ Semantic reasoner<br>○ Semantic search<br>○ Semantic service-oriented architecture<br>○ Semantic wiki<br>○ Solid |

**Related topics**

- Collective intelligence
- Description logic
- Folksonomy
- Geotagging
- Information architecture
- iXBRL
- Knowledge extraction
- Knowledge management
- Knowledge representation and reasoning
- Library 2.0
- Digital library
- Digital humanities
- Metadata
- References
- Topic map
- Web 2.0
- Web engineering
- Web Science Trust

**Standards**

**Syntax and supporting technologies**

- HTTP
- IRI
    - URI
- RDF
    - triples
    - RDF/XML
    - JSON-LD
    - Turtle
    - TriG
    - Notation3
    - N-Triples
    - TriX (no W3C standard)
- RRID
- SPARQL
- XML
- Semantic HTML

**Schemas, ontologies and rules**

- Common Logic
- OWL
- RDFS
- Rule Interchange Format
- Semantic Web Rule Language
- ALPS
- SHACL

**Semantic annotation**

- eRDF
- GRDDL
- Microdata
- Microformats
- RDFa
- SAWSDL
- Facebook Platform

**Common vocabularies**

- DOAP
- Dublin Core
- FOAF
- Schema.org
- SIOC
- SKOS

**Microformat vocabularies**

- hAtom
- hCalendar
- hCard

- v
- t
- e

Emerging technologies

**Fields**   **Information and communications**

- Ambient intelligence
  - Internet of things
- Artificial intelligence
  - Applications of artificial intelligence
  - Machine translation
  - Machine vision
  - Mobile translation
  - Progress in artificial intelligence
  - Semantic Web
  - Speech recognition
- Atomtronics
- Carbon nanotube field-effect transistor
- Cybermethodology
- Extended reality
- Fourth-generation optical discs
  - 3D optical data storage
  - Holographic data storage
- GPGPU
- Memory
  - CBRAM
  - ECRAM
  - FRAM
  - Millipede
  - MRAM
  - NRAM
  - PRAM
  - Racetrack memory
  - RRAM
  - SONOS
  - UltraRAM
- Optical computing
- RFID
  - Chipless RFID
- Software-defined radio
- Three-dimensional integrated circuit

**Topics**

- Automation
- Collingridge dilemma
- Differential technological development
- Disruptive innovation
- Ephemeralization
- Ethics
  - Bioethics
  - Cyberethics
  - Neuroethics
  - Robot ethics
- Exploratory engineering
- Proactionary principle
- Technological change
  - Technological unemployment
- Technological convergence
- Technological evolution
- Technological paradigm
- Technology forecasting
  - Accelerating change
  - Future-oriented technology analysis
  - Horizon scanning
  - Moore's law
  - Technological singularity
  - Technology scouting
- Technology in science fiction
- Technology readiness level
- Technology roadmap
- Transhumanism

- **List**

- **v**
- **t**
- **e**

Digital humanities

- Computational archaeology
- Computational philosophy
- Computational theory of mind
- Computers and writing
- Cultural analytics
- Cybertext
- Digital classics
- Digital history
- Digital library
- Digital Medievalist
- Digital ontology
- Digital physics
- Digital religion
- Digital rhetoric
- Digital scholarship
- Digital theology
- Digitization
- E-research
- Electronic literature
- Humanistic informatics
- New media
- Philosophy of computer science
- Semantic Web
- Systems theory
- Text Encoding Initiative
- Transliteracy

 This article's "criticism" or "controversy" section **may compromise the article's neutrality**. Please help rewrite or integrate negative information to other sections through discussion on the talk page. *(June 2024)*

# Google Maps
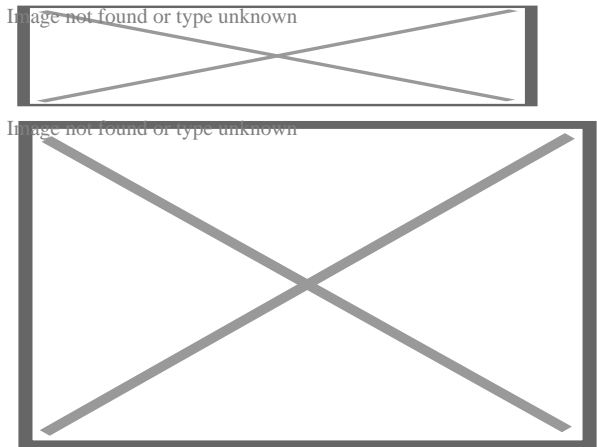




Screenshot of Google Maps in a web browser

| | |
|---|---|
| **Type of site** | Web mapping |
| **Available in** | 74 languages |

List of languages
Afrikaans, Azerbaijani, Indonesian, Malay, Bosnian, Catalan, Czech, Danish, German (Germany), Estonian, English (United States), Spanish (Spain), Spanish (Latin America), Basque, Filipino, French (France), Galician, Croatian, Zulu, Icelandic, Italian, Swahili, Latvian, Lithuanian, Hungarian, Dutch, Norwegian, Uzbek, Polish, Portuguese (Brazil), Portuguese (Portugal), Romanian, Albanian, Slovak, Slovenian, Finnish, Swedish, Vietnamese, Turkish, Greek, Bulgarian, Kyrgyz, Kazakh, Macedonian, Mongolian, Russian, Serbian, Ukrainian, Georgian, Armenian, Hebrew, Urdu, Arabic, Persian, Amharic, Nepali, Hindi, Marathi, Bengali, Punjabi, Gujarati, Tamil, Telugu, Kannada, Malayalam, Sinhala, Thai, Lao, Burmese, Khmer, Korean, Japanese, Simplified Chinese, Traditional Chinese

| | |
|---|---|
| **Owner** | Google |
| **URL** | google.com/maps  Edit this at Wikidata |
| **Commercial** | Yes |
| **Registration** | Optional, included with a Google Account |
| **Launched** | February 8, 2005; 20 years ago |

| | |
|---|---|
| **Current status** | Active |
| **Written in** | C++ (back-end), JavaScript, XML, Ajax (UI) |

**Google Maps** is a web mapping platform and consumer application offered by Google. It offers satellite imagery, aerial photography, street maps, 360° interactive panoramic views of streets (Street View), real-time traffic conditions, and route planning for traveling by foot, car, bike, air (in beta) and public transportation. As of 2020, Google Maps was being used by over one billion people every month around the world.[1]

Google Maps began as a C++ desktop program developed by brothers Lars and Jens Rasmussen in Australia at Where 2 Technologies. In October 2004, the company was acquired by Google, which converted it into a web application. After additional acquisitions of a geospatial data visualization company and a real-time traffic analyzer, Google Maps was launched in February 2005.[2] The service's front end utilizes JavaScript, XML, and Ajax. Google Maps offers an API that allows maps to be embedded on third-party websites,[3] and offers a locator for businesses and other organizations in numerous countries around the world. Google Map Maker allowed users to collaboratively expand and update the service's mapping worldwide but was discontinued from March 2017. However, crowdsourced contributions to Google Maps were not discontinued as the company announced those features would be transferred to the Google Local Guides program,[4] although users that are not Local Guides can still contribute.

Google Maps' satellite view is a "top-down" or bird's-eye view; most of the high-resolution imagery of cities is aerial photography taken from aircraft flying at 800 to 1,500 feet (240 to 460 m), while most other imagery is from satellites.[5] Much of the available satellite imagery is no more than three years old and is updated on a regular basis, according to a 2011 report. [6] Google Maps previously used a variant of the Mercator projection, and therefore could not accurately show areas around the poles.[7] In August 2018, the desktop version of Google Maps was updated to show a 3D globe. It is still possible to switch back to the 2D map in the settings.

Google Maps for mobile devices was first released in 2006; the latest versions feature GPS turn-by-turn navigation along with dedicated parking assistance features. By 2013, it was found to be the world's most popular smartphone app, with over 54% of global smartphone owners using it.[8] In 2017, the app was reported to have two billion users on Android, along with several other Google services including YouTube, Chrome, Gmail, Search, and Google Play.

**History**

[edit]

# Acquisitions

Google Maps first started as a C++ program designed by two Danish brothers, Lars and Jens Eilstrup Rasmussen, and Noel Gordon and Stephen Ma, at the Sydney-based company Where 2 Technologies, which was founded in early 2003. The program was initially designed to be separately downloaded by users, but the company later pitched the idea for a purely Web-based product to Google management, changing the method of distribution.[9] In October 2004, the company was acquired by Google Inc.[10] where it transformed into the web application Google Maps. The Rasmussen brothers, Gordon and Ma joined Google at that time.

In the same month, Google acquired Keyhole, a geospatial data visualization company (with investment from the CIA), whose marquee application suite, Earth Viewer, emerged as the Google Earth application in 2005 while other aspects of its core technology were integrated into Google Maps.[11] In September 2004, Google acquired ZipDash, a company that provided real-time traffic analysis.[12]

# 2005–2010
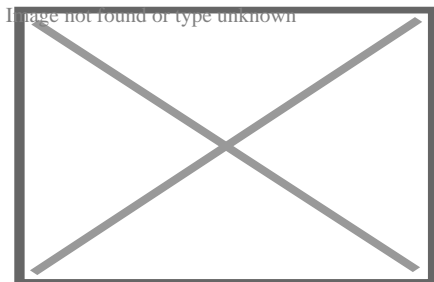
Google Maps Beta in 2005

The launch of Google Maps was first announced on the Google Blog on February 8, 2005.[13]

In September 2005, in the aftermath of Hurricane Katrina, Google Maps quickly updated its satellite imagery of New Orleans to allow users to view the extent of the flooding in various parts of that city.[14][15]

As of 2007, Google Maps was equipped with a miniature view with a draggable rectangle that denotes the area shown in the main viewport, and "Info windows" for previewing details about locations on maps.[16] As of 2024, this feature had been removed (likely several years prior).
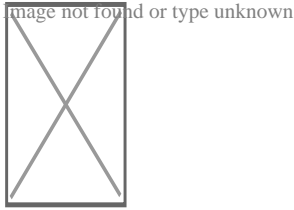

Original Google Maps icon

On November 28, 2007, Google Maps for Mobile 2.0 was released.[17][18][19] It featured a beta version of a "My Location" feature, which uses the GPS / Assisted GPS location of the mobile device, if available, supplemented by determining the nearest wireless networks and cell sites.[18][19] The software looks up the location of the cell site using a database of known wireless networks and sites.[20][21] By triangulating the different signal strengths from cell transmitters and then using their location property (retrieved from the database), My Location determines the user's current location.[22]

On September 23, 2008, coinciding with the announcement of the first commercial Android device, Google announced that a Google Maps app had been released for its Android operating system.[23][24]

In October 2009, Google replaced Tele Atlas as their primary supplier of geospatial data in the US version of Maps and used their own data.[25]

# 2011–2015

[edit]

On April 19, 2011, Map Maker was added to the American version of Google Maps, allowing any viewer to edit and add changes to Google Maps. This provides Google with local map updates almost in real-time instead of waiting for digital map data companies to release more infrequent updates.
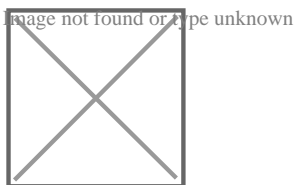

Icon used from 2015 to 2020

On January 31, 2012, Google, due to offering its Maps for free, was found guilty of abusing the dominant position of its Google Maps application and ordered by a court to pay a fine and damages to Bottin Cartographer, a French mapping company.[26] This ruling was overturned on appeal.[27]

In June 2012, Google started mapping the UK's rivers and canals in partnership with the Canal and River Trust. The company has stated that "it would update the program during the year to allow users to plan trips which include locks, bridges and towpaths along the 2,000 miles of river paths in the UK."[28]
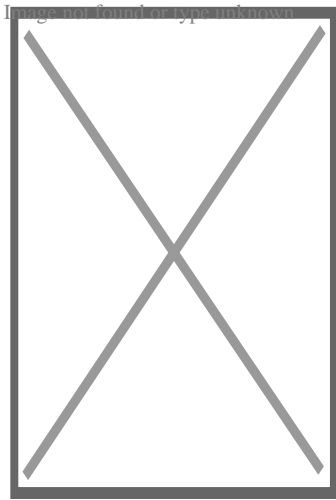


A monument in the shape of a Google Maps pin in the center of the city of Szczecin, Poland

In December 2012, the Google Maps application was separately made available in the App Store, after Apple removed it from its default installation of the mobile operating system version iOS 6 in September 2012.[29]

On January 29, 2013, Google Maps was updated to include a map of North Korea.[30] As of May 3, 2013, Google Maps recognizes Palestine as a country, instead of redirecting to the Palestinian territories.[31]

In August 2013, Google Maps removed the Wikipedia Layer, which provided links to Wikipedia content about locations shown in Google Maps using Wikipedia geocodes.[32]

On April 12, 2014, Google Maps was updated to reflect the annexation of Ukrainian Crimea by Russia. Crimea is shown as the Republic of Crimea in Russia and as the Autonomous Republic of Crimea in Ukraine. All other versions show a dotted disputed border.[33]

In April 2015, on a map near the Pakistani city of Rawalpindi, the imagery of the Android logo urinating on the Apple logo was added via Map Maker and appeared on Google Maps. The vandalism was soon removed and Google publicly apologized.[34] However, as a result, Google disabled user moderation on Map Maker, and on May 12, disabled editing worldwide

until it could devise a new policy for approving edits and avoiding vandalism.[35]

On April 29, 2015, users of the classic Google Maps were forwarded to the new Google Maps with the option to be removed from the interface.[36]

On July 14, 2015, the Chinese name for Scarborough Shoal was removed after a petition from the Philippines was posted on Change.org.[37]

# 2016–2018

[edit]

On June 27, 2016, Google rolled out new satellite imagery worldwide sourced from Landsat 8 , comprising over 700 trillion pixels of new data.[38] In September 2016, Google Maps acquired mapping analytics startup Urban Engines.[39]

In 2016, the Government of South Korea offered Google conditional access to the country's geographic database – access that already allows indigenous Korean mapping providers high-detail maps. Google declined the offer, as it was unwilling to accept restrictions on reducing the quality around locations the South Korean Government felt were sensitive (see restrictions on geographic data in South Korea).[40]

On October 16, 2017, Google Maps was updated with accessible imagery of several planets and moons such as Titan, Mercury, and Venus, as well as direct access to imagery of the Moon and Mars.[41][42]

In May 2018, Google announced major changes to the API structure starting June 11, 2018. This change consolidated the 18 different endpoints into three services and merged the basic and premium plans into one pay-as-you-go plan.[43] This meant a 1400% price raise for users on the basic plan, with only six weeks of notice. This caused a harsh reaction within the developers community.[44] In June, Google postponed the change date to July 16, 2018.

In August 2018, Google Maps designed its overall view (when zoomed out completely) into a 3D globe dropping the Mercator projection that projected the planet onto a flat surface.[45]

# 2019–present

[edit]

Google Maps icon 2020

Image not found or type unknown

2020 icon redesign

In January 2019, Google Maps added speed trap and speed camera alerts as reported by other users.[46][47]

On October 17, 2019, Google Maps was updated to include incident reporting, resembling a functionality in Waze which was acquired by Google in 2013.[48]

In December 2019, Incognito mode was added, allowing users to enter destinations without saving entries to their Google accounts.[49]

In February 2020, Maps received a 15th anniversary redesign.[50] It notably added a brand-new app icon, which now resembles the original icon in 2005.

On September 23, 2020, Google announced a COVID-19 Layer update for Google maps, which is designed to offer a seven-day average data of the total COVID-19-positive cases per 100,000 people in the area selected on the map. It also features a label indicating the rise and fall in the number of cases.[51]

In January 2021, Google announced that it would be launching a new feature displaying COVID-19 vaccination sites.[52]

In January 2021, Google announced updates to the route planner that would accommodate drivers of electric vehicles. Routing would take into account the type of vehicle, vehicle status including current charge, and the locations of charging stations.[53]

In June 2022, Google Maps added a layer displaying air quality for certain countries.[54]

In September 2022, Google removed the COVID-19 Layer from Google Maps due to lack of usage of the feature.[55]

**Functionality**

[edit]

# Directions and transit

[edit]

Google Maps provides a route planner,[56] allowing users to find available directions through driving, public transportation, walking, or biking.[57] Google has partnered globally with over 800 public transportation providers to adopt GTFS (General Transit Feed Specification), making the data available to third parties.[58][59] The app can indicate users' transit route,

thanks to an October 2019 update. The incognito mode, eyes-free walking navigation features were released earlier.[60] A July 2020 update provided bike share routes.[61]

In February 2024, Google Maps started rolling out glanceable directions for its Android and iOS apps. The feature allows users to track their journey from their device's lock screen.[62][63]

# Traffic conditions

[edit]

Screenshot of Google Maps with traffic option enabled

Image not found or type unknown
Screenshot of Google Maps with traffic option enabled

In 2007, Google began offering traffic data as a colored overlay on top of roads and motorways to represent the speed of vehicles on particular roads. Crowdsourcing is used to obtain the GPS-determined locations of a large number of cellphone users, from which live traffic maps are produced.[64][65][66]

Google has stated that the speed and location information it collects to calculate traffic conditions is anonymous.[67] Options available in each phone's settings allow users not to share information about their location with Google Maps.[68] Google stated, "Once you disable or opt out of My Location, Maps will not continue to send radio information back to Google servers to determine your handset's approximate location".[69][*failed verification*]
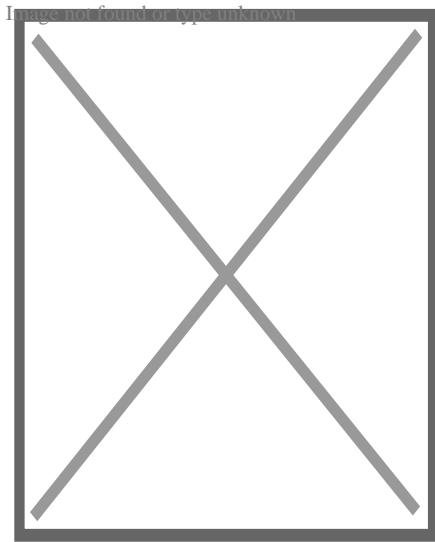
# Street View

[edit]
Main article: Google Street View
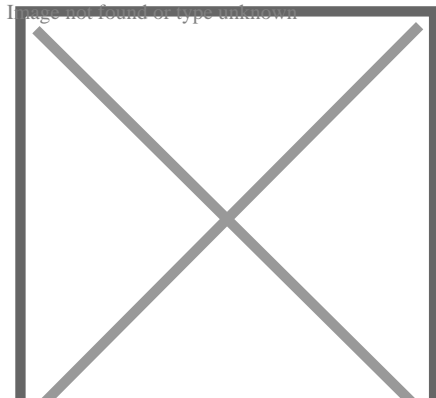
A Google Maps car at Googleplex, Mountain View

On May 25, 2007, Google released Google Street View, a feature of Google Maps providing 360° panoramic street-level views of various locations. On the date of release, the feature only included five cities in the U.S. It has since expanded to thousands of locations around the world. In July 2009, Google began mapping college campuses and surrounding paths and trails.

Street View garnered much controversy after its release because of privacy concerns about the uncensored nature of the panoramic photographs, although the views are only taken on public streets.[70][71] Since then, Google has blurred faces and license plates through automated facial recognition.[72][73][74]



Google Maps Street View Trekker backpack being implemented on the sidewalk of the Hudson River Greenway in New York City

In late 2014, Google launched Google Underwater Street View, including 2,300 kilometres (1,400 mi) of the Australian Great Barrier Reef in 3D. The images are taken by special cameras which turn 360 degrees and take shots every 3 seconds.[75]

In 2017, in both Google Maps and Google Earth, Street View navigation of the International Space Station interior spaces became available.

# 3D imagery

[edit]
Main article: Google Earth § 3D imagery

Google Maps has incorporated[*when?*] 3D models of hundreds of cities in over 40 countries from Google Earth into its satellite view. The models were developed using aerial photogrammetry techniques.[76][77]

# Immersive View

[edit]

At the I/O 2022 event, Google announced Immersive View, a feature of Google Maps which would involve composite 3D images generated from Street View and aerial images of locations using AI, complete with synchronous information. It was to be initially in five cities worldwide, with plans to add it to other cities later on.[78] The feature was previewed in September 2022 with 250 photorealistic aerial 3D images of landmarks,[79] and was full launched in February 2023.[80] An expansion of Immersive View to routes was announced at Google I/O 2023,[81] and was launched in October 2023 for 15 cities globally.[82]

The feature uses predictive modelling and neural radiance fields to scan Street View and aerial images to generate composite 3D imagery of locations, including both exteriors and interiors, and routes, including driving, walking or cycling, as well as generate synchronous information and forecasts up to a month ahead from historical and environmental data about both such as weather, traffic and busyness.

Immersive View has been available in the following locations:[*citation needed*]

Locations with Immersive View

| Country | Locations |
| --- | --- |
| Argentina | Buenos Aires |
| Australia | Melbourne, Sydney |
| Austria | Vienna |
| Belgium | Brussels |
| Brazil | Brasília, Rio de Janeiro, São Paulo |
| Canada | Calgary, Edmonton, Montreal, Ottawa, Toronto, Vancouver |
| Chile | Santiago |
| Czech Republic | Prague |
| France | Nice, Paris |
| Germany | Berlin, Cologne, Frankfurt, Munich |
| Greece | Athens |
| Hong Kong | Hong Kong |

![Image not found or type unknown] Hungary Budapest

![Image not found or type unknown] Italy Florence, Milan, Rome, Venice

![Image not found or type unknown] Japan Kyoto, Nagoya, Osaka, Tokyo

![Image not found or type unknown] Mexico Guadalajara, Mexico City

![Image not found or type unknown] Netherlands Amsterdam

![Image not found or type unknown] Norway Oslo

![Image not found or type unknown] Poland Warsaw

![Image not found or type unknown] Portugal Lisbon, Porto

![Image not found or type unknown] Romania Bucharest

![Image not found or type unknown] Singapore Singapore

![Image not found or type unknown] South Africa Cape Town, Johannesburg

![Image not found or type unknown] Spain Barcelona, Madrid

![Image not found or type unknown] Sweden Stockholm

![Image not found or type unknown] Switzerland Zurich

![Image not found or type unknown] Taiwan Taichung, Taipei

![Image not found or type unknown] United Kingdom Edinburgh, London

![Image not found or type unknown] United States Atlanta, Boston, Chicago, Detroit, Houston, Las Vegas, Los Angeles, Miami, New York City, Philadelphia, San Diego, San Francisco, Seattle

![Image not found or type unknown] Vatican City Vatican City

# Landmark Icons

[edit]

Google added icons of city attractions, in a similar style to Apple Maps, on October 3, 2019. In the first stage, such icons were added to 9 cities.[83]

# 45° imagery

[edit]
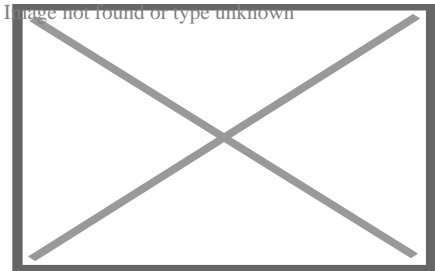
An example of the Leaning Tower of Pisa in the 45° view

In December 2009, Google introduced a new view consisting of 45° angle aerial imagery, offering a "bird's-eye view" of cities. The first cities available were San Jose and San Diego. This feature was initially available only to developers via the Google Maps API.[84] In February 2010, it was introduced as an experimental feature in Google Maps Labs.[85] In July 2010, 45° imagery was made available in Google Maps in select cities in South Africa, the United States, Germany and Italy.[86]

# Weather

[edit]

In February 2024, Google Maps incorporated a small weather icon on the top left corner of the Android and iOS mobile apps, giving access to weather and air quality index details.[87]

# Lens in Maps

[edit]

Previously called Search with Live View, Lens In Maps identifies shops, restaurants, transit stations and other street features with a phone's camera and places relevant information and a category pin on top, like closing/opening times, current busyness, pricing and reviews using AI and augmented reality. The feature, if available on the device, can be accessed through tapping the Lens icon in the search bar. It was expanded to 50 new cities in October 2023 in its biggest expansion yet, after initially being released in late 2022 in Los Angeles, San Francisco, New York, London, and Paris.[88][89] Lens in Maps shares features with Live View, which also displays information relating to street features while guiding a user to a selected destination with virtual arrows, signs and guidance.[90]

# Business listings

[edit]


Image not found or type unknown
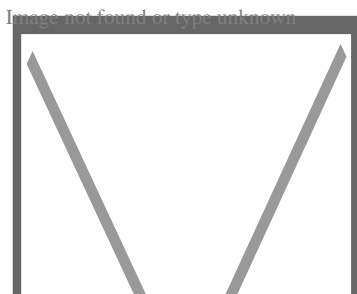
A business listing in Google Maps showing opening times, reviews and photos. This screenshot is from the Android mobile app.

Google collates business listings from multiple on-line and off-line sources. To reduce duplication in the index, Google's algorithm combines listings automatically based on address, phone number, or geocode,[91] but sometimes information for separate businesses will be inadvertently merged with each other, resulting in listings inaccurately incorporating elements from multiple businesses.[92] Google allows business owners to create and verify their own business data through *Google Business Profile* (*GBP*), formerly *Google My Business* (*GMB*).[93] Owners are encouraged to provide Google with business information including address, phone number, business category, and photos.[94] Google has staff in India who check and correct listings remotely as well as support businesses with issues.[95] Google also has teams on the ground in most countries that validate physical addresses in person.[96] In May 2024, Google announced it would discontinue the chat feature in Google Business Profile. Starting July 15, 2024, new chat conversations would be disabled, and by July 31, 2024, all chat functionalities would end.[97]

Google Maps can be manipulated by businesses that are not physically located in the area in which they record a listing. There are cases of people abusing Google Maps to overtake their competition by placing unverified listings on online directory sites, knowing the information will roll across to Google (duplicate sites). The people who update these listings do not use a registered business name. They place keywords and location details on their Google Maps business title, which can overtake credible business listings. In Australia in particular, genuine companies and businesses are noticing a trend of fake business listings in a variety of industries.[98]

Genuine business owners can also optimize their business listings to gain greater visibility in Google Maps, through a type of search engine marketing called local search engine optimization.[99]

# Indoor maps

[edit]

In March 2011, indoor maps were added to Google Maps, giving users the ability to navigate themselves within buildings such as airports, museums, shopping malls, big-box stores, universities, transit stations, and other public spaces (including underground facilities). Google encourages owners of public facilities to submit floor plans of their buildings in order to add them to the service.[100] Map users can view different floors of a building or subway station by clicking on a level selector that is displayed near any structures which are mapped on multiple levels.

# My Maps
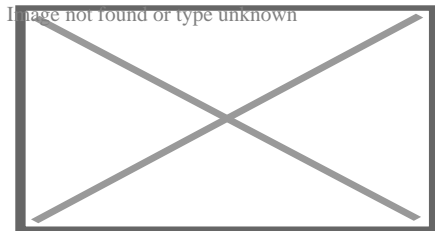
Google My Maps

My Maps is a feature in Google Maps launched in April 2007 that enables users to create custom maps for personal use or sharing. Users can add points, lines, shapes, notes and images on top of Google Maps using a WYSIWYG editor.[101] An Android app for My Maps, initially released in March 2013 under the name Google Maps Engine Lite, was available until its removal from the Play Store in October 2021.[102][103][104]

# Google Local Guides

Google Local Guides is a volunteer program launched by Google Maps[105] to enable users to contribute to Google Maps when registered. It sometimes provides them additional perks and benefits for their collaboration. Users can achieve Level 1 to 10, and be awarded with badges. The program is partially a successor to Google Map Maker as features from the former program became integrated into the website and app.[106]

The program consists of adding reviews, photos, basic information, and videos; and correcting information such as wheelchair accessibility.[107][108] Adding reviews, photos, videos, new places, new roads or providing useful information gives points to the users.[109] The level of users is upgraded when they get a certain amount of points.[110][111] Starting with Level 4, a star is shown near the avatar of the user.[111]

# Timelapse

Earth Timelapse, released in April 2021, is a program in which users can see how the earth has been changed in the last 37 years. They combined the 15 million satellite images (roughly ten quadrillion pixels) to create the 35 global cloud-free Images for this program.[112]

# Timeline

[edit]

If a user shares their location with Google, Timeline summarises this location for each day on a Timeline map.[113] Timeline estimates the mode of travel used to move between places and will also show photos taken at that location. In June 2024, Google started progressively removing access to the timeline on web browsers, with the information instead being stored on a local device.[114][115]

**Implementation**

[edit]
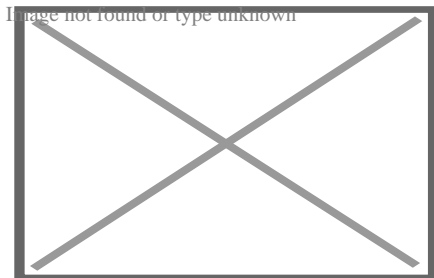


A split-view screenshot of Google Maps. In the bottom half *Street Maps* is shown, while in the top half *Street View* is shown. A user can zoom in and out of either of them independently of the zoom level of each.

As the user drags the map, the grid squares are downloaded from the server and inserted into the page. When a user searches for a business, the results are downloaded in the background for insertion into the side panel and map; the page is not reloaded. A hidden iframe with form submission is used because it preserves browser history. Like many other Google web applications, Google Maps uses JavaScript extensively.[116] The site also uses protocol buffers for data transfer rather than JSON, for performance reasons.

The version of Google Street View for classic Google Maps required Adobe Flash.[117] In October 2011, Google announced MapsGL, a WebGL version of Maps with better renderings and smoother transitions.[118] Indoor maps use JPG, .PNG, .PDF, .BMP, or .GIF, for floor plans.[119]

Users who are logged into a Google Account can save locations so that they are overlaid on the map with various colored "pins" whenever they browse the application. These "Saved places" can be organized into default groups or user named groups and shared with other users. "Starred places" is one default group example. It previously automatically created a record within the now-discontinued product Google Bookmarks.

# Map data and imagery

[edit]
See also: List of satellite map images with missing or unclear data

The Google Maps terms and conditions[120] state that usage of material from Google Maps is regulated by Google Terms of Service[121] and some additional restrictions. Google has either purchased local map data from established companies, or has entered into lease agreements to use copyrighted map data.[122] The owner of the copyright is listed at the bottom of zoomed maps. For example, street maps in Japan are leased from Zenrin. Street maps in China are leased from AutoNavi.[123] Russian street maps are leased from Geocentre Consulting and Tele Atlas. Data for North Korea is sourced from the companion project Google Map Maker.

Street map overlays, in some areas, may not match up precisely with the corresponding satellite images. The street data may be entirely erroneous, or simply out of date: "The biggest challenge is the currency of data, the authenticity of data," said Google Earth representative Brian McClendon. As a result, in March 2008 Google added a feature to edit the locations of houses and businesses.[124][125]

Restrictions have been placed on Google Maps through the apparent censoring of locations deemed potential security threats. In some cases the area of redaction is for specific buildings, but in other cases, such as Washington, D.C.,[126] the restriction is to use outdated imagery.

# Google Maps API

[edit]

Google Maps API, now called Google Maps Platform, hosts about 17 different APIs, which are themed under the following categories: Maps, Places and Routes.[127]

After the success of reverse-engineered mashups such as chicagocrime.org and housingmaps.com, Google launched the Google Maps API in June 2005[128] to allow developers to integrate Google Maps into their websites. It was a free service that did not require an API key until June 2018 (changes went into effect on July 16), when it was announced that an API key linked to a Google Cloud account with billing enabled would be required to access the API.[129] The API currently does not contain ads, but Google states in their terms of use that they reserve the right to display ads in the future.[130]

By using the Google Maps API, it is possible to embed Google Maps into an external website, onto which site-specific data can be overlaid.[131] Although initially only a JavaScript API, the Maps API was expanded to include an API for Adobe Flash applications (but this has been deprecated), a service for retrieving static map images, and web services for performing geocoding, generating driving directions, and obtaining elevation profiles. Over 1,000,000[132] web sites use the Google Maps API, making it the most heavily used web application development API.[133] In September 2011, Google announced it would deprecate the Google Maps API for Flash.[134]

The Google Maps API was free for commercial use, provided that the site on which it is being used is publicly accessible and did not charge for access, and was not generating more than 25,000 map accesses a day.[135][136] Sites that did not meet these requirements could purchase the Google Maps API for Business.[137]

As of June 21, 2018, Google increased the prices of the Maps API and requires a billing profile.[138]

# Google Maps in China

[edit]

Due to restrictions on geographic data in China, Google Maps must partner with a Chinese digital map provider in order to legally show Chinese map data. Since 2006, this partner has been AutoNavi.[123]

Within China, the State Council mandates that all maps of China use the GCJ-02 coordinate system, which is offset from the WGS-84 system used in most of the world. google.*cn*/maps (formerly Google Ditu) uses the GCJ-02 system for both its street maps[139] and satellite imagery.[140] google.*com*/maps also uses GCJ-02 data for the street map, but uses WGS-84 coordinates for satellite imagery,[141] causing the so-called China GPS shift problem.

Frontier alignments also present some differences between google.*cn*/maps and google.*com*/maps. On the latter, sections of the Chinese border with India and Pakistan are shown with dotted lines, indicating areas or frontiers in dispute. However, google.*cn* shows the Chinese

frontier strictly according to Chinese claims with no dotted lines indicating the border with India and Pakistan. For example, the South Tibet region claimed by China but administered by India as a large part of Arunachal Pradesh is shown inside the Chinese frontier by google. *cn*, with Indian highways ending abruptly at the Chinese claim line. Google.*cn* also shows Taiwan and the South China Sea Islands as part of China. Google Ditu's street map coverage of Taiwan no longer omits major state organs, such as the Presidential Palace, the five Yuans , and the Supreme Court.[142][*additional citation(s) needed*]

Feature-wise, google.*cn*/maps does not feature My Maps. On the other hand, while google.*cn* displays virtually all text in Chinese, google.*com*/maps displays most text (user-selectable real text as well as those on map) in English.[*citation needed*] This behavior of displaying English text is not consistent but intermittent – sometimes it is in English, sometimes it is in Chinese. The criteria for choosing which language is displayed are not known publicly.[*citation need*

**Criticism and controversies**

[edit]

# Incorrect location naming

[edit]

There are cases where Google Maps had added out-of-date neighborhood monikers. Thus, in Los Angeles, the name "Brooklyn Heights" was revived from its 1870s usage[143] and "Silver Lake Heights" from its 1920s usage,[144] or mistakenly renamed areas (in Detroit, the neighborhood "Fiskhorn" became "Fishkorn").[145] Because many companies utilize Google Maps data, these previously obscure or incorrect names then gain traction; the names are often used by realtors, hotels, food delivery sites, dating sites, and news organizations.

Google has said it created its maps from third-party data, public sources, satellites, and users, but many names used have not been connected to any official record.[143][145] According to a former Google Maps employee (who was not authorized to speak publicly), users can submit changes to Google Maps, but some submissions are ruled upon by people with little local knowledge of a place, such as contractors in India. Critics maintain that names likes "BoCoCa" (for the area in Brooklyn between Boerum Hill, Cobble Hill and Carroll Gardens), are "just plain puzzling" or simply made up.[145] Some names used by Google have been traced to non-professionally made maps with typographical errors that survived on Google Maps.[145]

# Potential misuse

[edit]

In 2005 the Australian Nuclear Science and Technology Organisation (ANSTO) complained about the potential for terrorists to use the satellite images in planning attacks, with specific reference to the Lucas Heights nuclear reactor; however, the Australian Federal government did not support the organization's concern. At the time of the ANSTO complaint, Google had colored over some areas for security (mostly in the U.S.), such as the rooftop of the White House and several other Washington, D.C. buildings.[146][147][148]

In October 2010, Nicaraguan military commander Edén Pastora stationed Nicaraguan troops on the Isla Calero (in the delta of the San Juan River), justifying his action on the border delineation given by Google Maps. Google has since updated its data which it found to be incorrect.[149]

On January 27, 2014, documents leaked by Edward Snowden revealed that the NSA and the GCHQ intercepted Google Maps queries made on smartphones, and used them to locate the users making these queries. One leaked document, dating to 2008, stated that "[i]t effectively means that anyone using Google Maps on a smartphone is working in support of a GCHQ system."[150]

In May 2015, searches on Google Maps for offensive racial epithets for African Americans such as "nigger", "nigger king", and "nigger house" pointed the user to the White House; Google apologized for the incident.[151][152]

In December 2015, 3 Japanese netizens were charged with vandalism after they were found to have added an unrelated law firm's name as well as indecent names to locations such as "Nuclear test site" to the Atomic Bomb Dome and "Izumo Satya" to the Izumo Taisha.[153][154]

In February 2020, the artist Simon Weckert[155] used 99 cell phones to fake a Google Maps traffic jam.[156]

In September 2024, several schools in Taiwan and Hong Kong were altered to incorrect labels, such as "psychiatric hospitals" or "prisons". Initially, it was believed to be the result of hacker attacks. However, police later revealed that local students had carried out the prank. Google quickly corrected the mislabeled entries. Education officials in Taiwan and Hong Kong expressed concern over the incident.[157][158][159]

# Misdirection incidents

[edit]

## Australia

[edit]

In August 2023, a woman driving from Alice Springs to the Harts Range Racecourse was stranded in the Central Australian desert for a night after following directions provided by Google Maps.[160][161] She later discovered that Google Maps was providing directions for the actual Harts Range instead of the rodeo. Google said it was looking into the naming of the two locations and consulting with "local and authoritative sources" to solve the issue.[160]

In February 2024, two German tourists were stranded for a week after Google Maps directed them to follow a dirt track through Oyala Thumotang National Park and their vehicle became trapped in mud.[162][163] Queensland Parks and Wildlife Service ranger Roger James said, "People should not trust Google Maps when they're travelling in remote regions of Queensland, and they need to follow the signs, use official maps or other navigational devices."[162]

## North America

[edit]

In June 2019, Google Maps provided nearly 100 Colorado drivers an alternative route that led to a dirt road after a crash occurred on Peña Boulevard. The road had been turned to mud by rain, resulting in nearly 100 vehicles being trapped.[164][161] Google said in a statement, "While we always work to provide the best directions, issues can arise due to unforeseen circumstances such as weather. We encourage all drivers to follow local laws, stay attentive, and use their best judgment while driving."[164]

In September 2023, Google was sued by a North Carolina resident who alleged that Google Maps had directed her husband over the Snow Creek Bridge in Hickory the year prior, resulting in him drowning. According to the lawsuit, multiple people had notified Google about the state of the bridge, which collapsed in 2013, but Google had not updated the route information and continued to direct users over the bridge.[165][166][161] At the time of the man's death, the barriers placed to block access to the bridge had been vandalized.[167][168]

In November 2023, a hiker was rescued by helicopter on the backside of Mount Fromme in Vancouver. North Shore Rescue stated on its Facebook page that the hiker had followed a non-existent hiking trail on Google Maps. This was also the second hiker in two months to require rescuing after following the same trail. The fake trail has since been removed from the app.[169][170]

Also in November 2023, Google apologized after users were directed through desert roads after parts of Interstate 15 were closed due to a dust storm.[171] Drivers became stranded after following the suggested detour route, which was a "bumpy dirt trail".[172] Following the incident, Google stated that Google Maps would "no longer route drivers traveling between Las Vegas and Barstow down through those roads."[171]

### Russia

[edit]

In 2020, a teenage motorist was found frozen to death while his passenger was still alive but suffered from severe frostbite after using Google Maps, which had led them to a shorter but abandoned section of the R504 Kolyma Highway, where their Toyota Chaser became disabled.[173]

### India

[edit]

In 2024, three men from Uttar Pradesh died after their car fell from an under-construction bridge. They were using Google Maps for driving which misdirected them and the car fell into the Ramganga river.[174][175]

# Renaming of the Gulf of Mexico

[edit]

In February 2025, as a response to Donald Trump's Executive Order 14172, the Gulf of Mexico was renamed to "Gulf of America" for US users and "Gulf of Mexico (Gulf of America)" elsewhere, except for Mexico itself where it remained the Gulf of Mexico. The decision received criticism, with Mexican president Claudia Sheinbaum asking Google to reconsider its decision.[176] Google subsequently blocked and deleted negative reviews of the gulf after the name change occurred.[177][178]

**Discontinued features**

[edit]

# Google Latitude

[edit]

Main article: Google Latitude

Google Latitude was a feature that let users share their physical locations with other people. This service was based on Google Maps, specifically on mobile devices. There was an iGoogle widget for desktops and laptops as well.[179] Some concerns were expressed about the privacy issues raised by the use of the service.[180] On August 9, 2013, this service was discontinued,[181] and on March 22, 2017, Google incorporated the features from Latitude into the Google Maps app.[182]

# Google Map Maker

[edit]

Main article: Google Map Maker

In areas where Google Map Maker was available, for example, much of Asia, Africa, Latin America and Europe as well as the United States and Canada, anyone who logged into their Google account could directly improve the map by fixing incorrect driving directions, adding biking trails, or adding a missing building or road. General map errors in Australia, Austria, Belgium, Denmark, France, Liechtenstein, Netherlands, New Zealand, Norway, South Africa, Switzerland, and the United States could be reported using the Report a Problem link in Google Maps and would be updated by Google.[183] For areas where Google used Tele Atlas data, map errors could be reported using Tele Atlas map insight.[184]

If imagery was missing, outdated, misaligned, or generally incorrect, one could notify Google through their contact request form.[185]

In November 2016, Google announced the discontinuation of Google Map Maker as of March 2017.[186]

**Mobile app**

[edit]

Screenshot
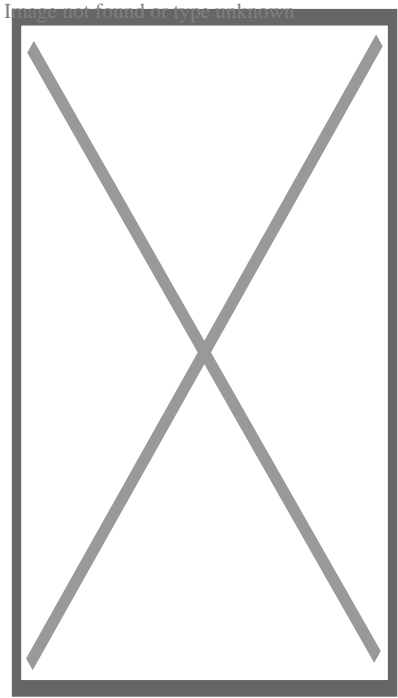
Screenshot of Google Maps on Android 14

| | |
|---|---|
| **Android** | 25.10.04 (Build 732665141) / 7 March 2025; 10 days ago[187][188] |
| **Wear OS** | 25.09.00 (Build 730474011) / 25 February 2025; 20 days ago[187][189] |
| **iOS** | 25.10.02 / 7 March 2025; 10 days ago[190] |
| **Android Go,[a] discontinued** | 161.1 / 13 October 2023; 17 months ago[191][192] |
| **Android (Beta)** | 11.143.0303 / 20 August 2024; 6 months ago[193] |

Google Maps
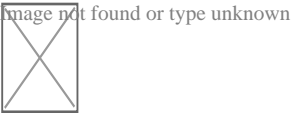


| | |
|---|---|
| **Original author(s)** | Google |
| **Initial release** | 2006; 19 years ago |

**Stable release(s) [±]**

**Preview release(s) [±]**

| | |
|---|---|
| **Operating system** | ○ Android<br>○ iOS<br>○ KaiOS Wear OS WatchOS Web Fitbit OS |

Formerly: Java ME, Symbian, Windows Mobile

Google Maps is available as a mobile app for the Android and iOS mobile operating systems. The first mobile version of Google Maps (then known as Google Local for Mobile) was launched in beta in November 2005 for mobile platforms supporting J2ME.[194][195][196] It was released as Google Maps for Mobile in 2006.[197] In 2007 it came preloaded on the first iPhone in a deal with Apple.[198] A version specifically for Windows Mobile was released in February 2007[199] and the Symbian app was released in November 2007.[200]

Version 2.0 of Google Maps Mobile was announced at the end of 2007, with a stand out *My Location* feature to find the user's location using the cell towers, without needing GPS.[201][202][203] In September 2008, Google Maps was released for and preloaded on Google's own new platform Android.[204][205]

Up until iOS 6, the built-in maps application on the iOS operating system was powered by Google Maps. However, with the announcement of iOS 6 in June 2012, Apple announced that they had created their own Apple Maps mapping service,[206] which officially replaced Google Maps when iOS 6 was released on September 19, 2012.[207] However, at launch, Apple Maps received significant criticism from users due to inaccuracies, errors and bugs.[208][209] One day later, *The Guardian* reported that Google was preparing its own Google Maps app,[210] which was released on December 12, 2012.[211][212] Within two days, the application had been downloaded over ten million times.[213]

# Features

[edit]

The Google Maps apps for iOS and Android have many of the same features, including turn-by-turn navigation, street view, and public transit information.[214][215] Turn-by-turn navigation was originally announced by Google as a separate beta testing app exclusive to Android 2.0 devices in October 2009.[216][217] The original standalone iOS version did not support the iPad,[215] but tablet support was added with version 2.0 in July 2013.[218] An update in June 2012 for Android devices added support for offline access to downloaded maps of certain regions,[219][220] a feature that was eventually released for iOS devices, and made more robust on Android, in May 2014.[221][222]

At the end of 2015 Google Maps announced its new offline functionality,[223] but with various limitations – downloaded area cannot exceed 120,000 square kilometers[224][225] and require a considerable amount of storage space.[226] In January 2017, Google added a feature exclusively to Android that will, in some U.S. cities, indicate the level of difficulty in finding available parking spots,[227] and on both Android and iOS, the app can, as of an April 2017 update, remember where users parked.[228][229] In August 2017, Google Maps for Android was updated with new functionality to actively help the user in finding parking lots and garages close to a destination.[230] In December 2017, Google added a new two-wheeler mode to its Android app, designed for users in India, allowing for more accessibility in traffic conditions.[231][232] In 2019 the Android version introduced the new feature called live view that allows to view directions directly on the road thanks to augmented reality.[233] Google Maps won the 2020 Webby Award for Best User Interface in the category Apps, Mobile & Voice.[234] In March 2021, Google added a feature in which users can draw missing roads.[235] In June 2022, Google implemented support for toll calculation. Both iOS and Android apps report how much the user has to pay in tolls when a route that includes toll roads is input. The feature is available for roads in the US, India, Japan and Indonesia with further expansion planned. As per reports the total number of toll roads covered in this phase is around 2000.[236]

# Reception

[edit]

USA Today welcomed the application back to iOS, saying: "The reemergence in the middle of the night of a Google Maps app for the iPhone is like the return of an old friend. Only your friend, who'd gone missing for three months, comes back looking better than ever."[237] Jason Parker of CNET, calling it "the king of maps", said, "With its iOS Maps app, Google sets the standard for what mobile navigation should be and more."[238] Bree Fowler of the Associated Press compared Google's and Apple's map applications, saying: "The one clear advantage that Apple has is style. Like Apple devices, the maps are clean and clear and have a fun, pretty element to them, especially in 3-D. But when it comes down to depth and information, Google still reigns superior and will no doubt be welcomed back by its fans."[239] Gizmodo gave it a ranking of 4.5 stars, stating: "Maps Done Right".[240] According to The New York Times, Google "admits that it's [iOS app is] even better than Google Maps for Android phones, which has accommodated its evolving feature set mainly by piling on menus".[241]

Google Maps' location tracking is regarded by some as a threat to users' privacy, with Dylan Tweney of VentureBeat writing in August 2014 that "Google is probably logging your location, step by step, via Google Maps", and linked users to Google's location history map, which "lets you see the path you've traced for any given day that your smartphone has been running

Google Maps". Tweney then provided instructions on how to disable location history.[242] The history tracking was also noticed, and recommended disabled, by editors at *CNET*[243] and *TechCrunch*.[244] Additionally, *Quartz* reported in April 2014 that a "sneaky new privacy change" would have an effect on the majority of iOS users. The privacy change, an update to the Gmail iOS app that "now supports sign-in across Google iOS apps, including Maps, Drive, YouTube and Chrome", meant that Google would be able to identify users' actions across its different apps.[245]

The Android version of the app surpassed five billion installations in March 2019.[246] By November 2021, the Android app had surpassed 10 billion installations.[247]

# Go version

[edit]

Google Maps Go, a version of the app designed for lower-end devices, was released in beta in January 2018.[248] By September 2018, the app had over 10 million installations.[249]

**Artistic and literary uses**

[edit]

The German "geo-novel" *Senghor on the Rocks* (2008) presents its story as a series of spreads showing a Google Maps location on the left and the story's text on the right. Annika Richterich explains that the "satellite pictures in *Senghor on the Rocks* illustrate the main character's travel through the West-African state of Senegal".[250]

Artists have used Google Street View in a range of ways. Emilio Vavarella's *The Google Trilogy* includes glitchy images and unintended portraits of the drivers of the Street View cars. [251] The Japanese band group inou used Google Street View backgrounds to make a music video for their song EYE.[252] The Canadian band Arcade Fire made a customized music video that used Street View to show the viewer their own childhood home.[253][254]

**See also**

[edit]

- icon
  Image not found or type unknown Internet portal

- Azure Maps
- Apple Maps

- Bing Maps
- Comparison of web map services
- GeoGuessr
- Google Earth
- *Google Maps Road Trip*, live-streaming documentary
- Here WeGo
- MapQuest
- OpenStreetMap
- Terravision (computer program)
- Wikiloc, a mashup that shows trails and waypoints on Google Maps
- Wikimapia, a mashup combining Google Maps and a wiki aimed at "describing the whole planet earth"
- Yandex Maps, popular in Russia and CIS

## Notes

[edit]

1. ^ Lite version for Android

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## External links

[edit]

- Official website
  - Official Google Maps blog
  - About Google Maps
  - Google Local Guides
  - Google Maps Platform

- v
- t
- e

Google Maps

- Waze
- Arts & Culture

**Related products**

**Discontinued**
- Latitude
- Maps Navigation
- Map Maker
- Mapathon

**Views and mapping sites**
- Earth
- Street View

link = Google Maps

Image not found or type unknown

**Street View**

**Coverage**
- Africa
- Antarctica
- Asia
  - Israel
- Europe
- North America
  - Canada
  - United States
- Oceania
- South America
  - Argentina
  - Chile
  - Colombia

- Privacy concerns
- Competing products

**Other**

- Historypin
- Google Maps pin
- *Google Maps Road Trip*
- Argleton

- **v**
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- **e**

Google

a subsidiary of Alphabet

**Company**

**Divisions**

- AI
- *Area 120*
- ATAP
- *Brain*
- China
- Cloud Platform
- Energy
- Google.org
    - Crisis Response
- *Health*
- Registry

**Active**

- Security Operations
- DeepMind
- Fitbit
- ITA Software
- Jigsaw
- Looker
- Mandiant
- Owlchemy Labs

**Subsidiaries**

- Actifio
- Adscape
- Akwan Information Technologies
- Anvato
- Apigee
- BandPage
- Bitium
- BufferBox
- Crashlytics
- Dodgeball
- DoubleClick
- Dropcam
- Endoxon
- Flutter
- Global IP Solutions
- Green Throttle Games
- GreenBorder
- Gridcentric
- ImageAmerica
- Impermium

**Development**

**Software**

**A**
- *Aardvark*
- Account
    - Dashboard
    - Takeout
- Ad Manager
- AdMob
- Ads
- AdSense
- *Affiliate Network*
- Alerts
- *Allo*
- Analytics
- Android Auto
- *Android Beam*
- *Answers*
- *Apture*
- Arts & Culture
- Assistant
- *Attribution*
- Authenticator

**B**
- *BebaPay*
- *BeatThatQuote.com*
- *Blog Search*
- Blogger
- *Body*
- *Bookmarks*
- Books
    - Ngram Viewer
- *Browser Sync*
- *Building Maker*
- *Bump*
- *BumpTop*
- *Buzz*

- Calendar
- Cast
- *Catalogs*
- Chat
- *Checkout*
- Chrome
- *Chrome Apps*

# Hardware

## Pixel

### Smartphones

- Pixel (2016)
- Pixel 2 (2017)
- Pixel 3 (2018)
- Pixel 3a (2019)
- Pixel 4 (2019)
- Pixel 4a (2020)
- Pixel 5 (2020)
- Pixel 5a (2021)
- Pixel 6 (2021)
- Pixel 6a (2022)
- Pixel 7 (2022)
- Pixel 7a (2023)
- Pixel Fold (2023)
- Pixel 8 (2023)
- Pixel 8a (2024)
- Pixel 9 (2024)
- Pixel 9 Pro Fold (2024)

### Smartwatches

- Pixel Watch (2022)
- Pixel Watch 2 (2023)
- Pixel Watch 3 (2024)

### Tablets

- Pixel C (2015)
- Pixel Slate (2018)
- Pixel Tablet (2023)

### Laptops

- Chromebook Pixel (2013–2015)
- Pixelbook (2017)
- Pixelbook Go (2019)

### Other

- Pixel Buds (2017–present)

### Smartphones

- Nexus One (2010)
- Nexus S (2010)
- Galaxy Nexus (2011)
- Nexus 4 (2012)
- Nexus 5 (2013)

**Litigation**

**Advertising**
- *Feldman v. Google, Inc.* (2007)
- *Rescuecom Corp. v. Google Inc.* (2009)
- *Goddard v. Google, Inc.* (2009)
- *Rosetta Stone Ltd. v. Google, Inc.* (2012)
- *Google, Inc. v. American Blind & Wallpaper Factory, Inc.* (2017)
- Jedi Blue

**Antitrust**
- European Union (2010–present)
- *United States v. Adobe Systems, Inc., Apple Inc., Google Inc., Intel Corporation, Intuit, Inc., and Pixar* (2011)
- *Umar Javeed, Sukarma Thapar, Aaqib Javeed vs. Google LLC and Ors.* (2019)
- *United States v. Google LLC* (2020)
- *United States v. Google LLC* (2023)

**Intellectual property**
- *Perfect 10, Inc. v. Amazon.com, Inc.* (2007)
- *Viacom International Inc. v. YouTube, Inc.* (2010)
- *Lenz v. Universal Music Corp.* (2015)
- *Authors Guild, Inc. v. Google, Inc.* (2015)
- *Field v. Google, Inc.* (2016)
- *Google LLC v. Oracle America, Inc.* (2021)
- Smartphone patent wars

**Privacy**
- *Rocky Mountain Bank v. Google, Inc.* (2009)
- *Hibnick v. Google, Inc.* (2010)
- *United States v. Google Inc.* (2012)
- Judgement of the German Federal Court of Justice on Google's autocomplete function (2013)
- *Joffe v. Google, Inc.* (2013)
- *Mosley v SARL Google* (2013)
- *Google Spain v AEPD and Mario Costeja González* (2014)
- *Frank v. Gaos* (2019)

**Other**
- *Garcia v. Google, Inc.* (2015)
- *Google LLC v Defteros* (2020)
- *Epic Games v. Google* (2021)
- *Gonzalez v. Google LLC* (2022)

**Related**

**Concepts**

- Beauty YouTuber
- BookTube
- BreadTube
- "Don't be evil"
- Gayglers
- *Google* as a verb
- Google bombing
    - 2004 U.S. presidential election
- Google effect
- Googlefight
- Google hacking
- Googleshare
- Google tax
- Googlewhack
- Googlization
- Illegal flower tribute
- Objectives and key results
- Rooting
- Search engine manipulation effect
- Side project time
- Sitelink
- Site reliability engineering
- StudyTube
- VTuber
- YouTube Poop
- YouTuber
    - list

**Android**

- Booting process
- Custom distributions
- Features
- Recovery mode
- Software development

**Street View coverage**

- Africa
- Antarctica
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    - Israel
- Europe
- North America
    - Canada

*Italics* denote discontinued products.

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- Outline

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Alphabet Inc.

**Subsidiaries**

**Current**

- Access
  - Google Fiber
- Calico
- CapitalG
- Google
  - DeepMind
    - AlphaFold
    - AlphaGo
      - vs. Fan Hui
      - vs. Ke Jie
      - vs. Lee Sedol
        - film
      - Future of Go Summit
    - AlphaGo Zero
    - AlphaStar
    - AlphaZero
    - Master
    - MuZero
    - WaveNet
  - DoubleClick
  - Firebase
  - Fitbit
  - Tenor
  - Waze
  - YouTube
- GV
- Isomorphic Labs
- Verily
  - Baseline Study
- X Development
- Waymo
- Wing

**Former**

- Boston Dynamics
- Chronicle Security
- Jigsaw
- Loon
- Makani
- Meka Robotics
- Nest Labs
- Sidewalk Labs
  - Toronto
- Vicarious

| | | |
|---|---|---|
| **Executives** | **Current** | ○ Sundar Pichai (CEO)<br>○ Ruth Porat (president and CIO)<br>○ Anat Ashkenazi (CFO) |
| | **Former** | ○ Larry Page (CEO)<br>○ Sergey Brin (President)<br>○ David Drummond (CLO) |

**People**

| | | |
|---|---|---|
| **Board of directors** | **Current** | ○ Frances Arnold<br>○ Sergey Brin<br>○ R. Martin Chavez<br>○ John Doerr<br>○ John L. Hennessy<br>○ Ann Mather<br>○ Larry Page<br>○ Sundar Pichai<br>○ Ram Shriram<br>○ Roger W. Ferguson Jr. |
| | **Former** | ○ Diane Greene<br>○ Alan Mulally<br>○ Eric Schmidt |
| **Others** | | ○ Andrew Conrad<br>○ Tony Fadell<br>○ Arthur D. Levinson<br>○ David Krane<br>○ Astro Teller |

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- Image not found or type unknown Companies portal icon Companies portal
- Image not found or type unknown Internet portal

- **v**
- **t**
- **e**

Android

- Android Go
    - Comparison of products

**Software development**

**Development tools**

**Official**
- Android Runtime (ART)
- Software development kit (SDK)
  - Android Debug Bridge (ADB)
  - Fastboot
  - Android App Bundle
  - Android application package (APK)
- Bionic
- Dalvik
- Firebase
  - Google Cloud Messaging (GCM)
  - Firebase Cloud Messaging (FCM)
- Google Mobile Services (GMS)
- Native development kit (NDK)
- Open accessory development kit (OADK)
- RenderScript
- Skia
- AdMob
- Material Design
- Fonts
  - Droid
  - Roboto
  - Noto
- Google Developers

**Other**
- OpenBinder
- Apache Harmony
- OpenJDK
- Gradle

**Integrated development environments (IDE)**
- Android Studio
  - IntelliJ IDEA
- Eclipse
  - Android Development Tools (ADT)
- MIT App Inventor

**Languages, databases**
- Java
- Kotlin
- XML
- C
- C++
- SQLite

| **Releases** | - Cupcake (1.5)<br>- Donut (1.6)<br>- Eclair (2.0–2.1)<br>- Froyo (2.2)<br>- Gingerbread (2.3)<br>- Honeycomb (3.x)<br>- Ice Cream Sandwich (4.0)<br>- Jelly Bean (4.1–4.3)<br>- KitKat (4.4)<br>- Lollipop (5.x)<br>- Marshmallow (6.0)<br>- Nougat (7.x)<br>- Oreo (8.x)<br>- Pie (9)<br>- 10<br>- 11<br>- 12<br>- 13<br>- 14<br>- 15<br>- 16 |
|---|---|
| **Derivatives** | - Android Automotive<br>- Android Things<br>- TV<br>  - devices<br>- Android XR<br>- Wear OS |

**Devices**

**Pixel**
- C
- Pixel & Pixel XL
- 2 & 2 XL
- 3 & 3 XL
  - 3a & 3a XL
- 4 & 4 XL
  - 4a & 4a (5G)
- 5
  - 5a
- 6 & 6 Pro
  - 6a
- 7 & 7 Pro
  - 7a
- Fold
- Tablet
- 8 & 8 Pro
  - 8a
- 9, 9 Pro & 9 Pro XL
  - 9 Pro Fold

**Nexus**
- One
- S
- Galaxy Nexus
- 4
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- Q
- 5
  - 5X
- 6
  - 6P
- 7
  - 2012
  - 2013
- 9
- Player

**Play edition**
- HTC One (M7)
- HTC One (M8)
- LG G Pad 8.3
- Moto G
- Samsung Galaxy S4
- Sony Xperia Z Ultra

- Android One

**Custom distributions**

- AliOS
- Android-x86
  - Remix OS
- AOKP
- Baidu Yi
- Barnes & Noble Nook
- CalyxOS
- ColorOS
  - realme UI
- CopperheadOS
- EMUI
  - Magic UI
- Fire OS
- Flyme OS
- GrapheneOS
- Xiaomi HyperOS
  - MIUI
  - MIUI for Poco
- LeWa OS
- LineageOS
  - /e/
  - CrDroid
  - CyanogenMod
  - DivestOS
  - iodéOS
  - Kali NetHunter
- LiteOS
- Meta Horizon OS
- MicroG
- Nokia X software platform
- OmniROM
- OPhone
- OxygenOS
- PixelExperience
- Pixel UI
- Replicant
- Resurrection Remix OS
- SlimRoms
- TCL UI
- Ubuntu for Android
- XobotOS
- ZUI

**Booting and recovery**

- Booting process
- Recovery mode
    - TWRP
    - ClockworkMod
- Fastboot

**APIs**

- Google Maps
- Google Play Services
    - SafetyNet
- Google Search

**Alternative UIs**

- Asus ZenFone
- Cherry OS
- ColorOS
- EMUI
- Funtouch OS
- Flyme OS
- HiOS
- Hive UI (XOLO Hive)
- HTC Sense
- LG UX
    - Optimus UI
- Motoblur
- One UI
- Origin OS
    - Experience
    - TouchWiz
- OxygenOS
- Pixel UI
- XOS
- Xperia UI

**Rooting**

- SuperSU
- Magisk
- Kingo Root

**Lists**
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- Features
- Free and open-source applications
- Google apps
- Launchers

**Related topics**
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- Androidland
- Chromecast
- Google
- Java vs. Android API
- Lawn statues
- BlueStacks
- Legal issues
  - *Google v. Oracle*
  - smartphone patent wars

- Category:Android development
- Category:Mobile telecommunications
- Software portal
- Telecommunication portal

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OpenStreetMap

**Organisations**
- Geochicas?
- Humanitarian OpenStreetMap Team
- Mapbox
- MapTiler
- Mapzen
- Missing Maps
- OpenStreetMap Foundation
- Ramani Huria
- Wikimedia Italia

**Software**

**Editing**
- iD
- JOSM
- KartaView
- Mapillary
- OpenDroneMap
- Potlatch
- StreetComplete

**Visualisation**
- Leaflet
- Mapnik
- Marble
- OpenLayers
- OpenRailwayMap
- OpenSeaMap

**Navigation**
- GNOME Maps
- GraphHopper
- Karta GPS
- Komoot
- Locus Map
- Maps.me
- Navit
- Neshan
- Open Source Routing Machine
- Organic Maps
- OsmAnd
- Wheelmap.org

**Derivations**
- FOSM
- OpenGeofiction
- OpenHistoricalMap
- Overture Maps

**People**
- Steve Coast
- Allan Mustard

**About Web crawler**

This article is about the internet bot. For the search engine, see WebCrawler. "Web spider" redirects here; not to be confused with Spider web. "Spiderbot" redirects here. For the video game, see Arac (video game).
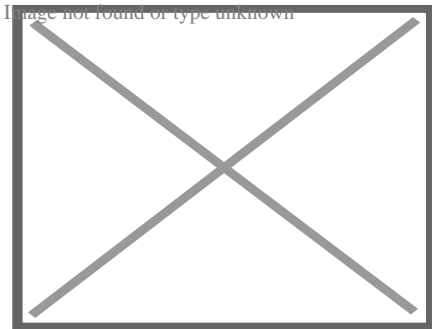


Architecture of a Web crawler

A **Web crawler**, sometimes called a **spider** or **spiderbot** and often shortened to **crawler**, is an Internet bot that systematically browses the World Wide Web and that is typically operated by search engines for the purpose of Web indexing (*web spidering*).[1]

Web search engines and some other websites use Web crawling or spidering software to update their web content or indices of other sites' web content. Web crawlers copy pages for processing by a search engine, which indexes the downloaded pages so that users can search more efficiently.

Crawlers consume resources on visited systems and often visit sites unprompted. Issues of schedule, load, and "politeness" come into play when large collections of pages are accessed. Mechanisms exist for public sites not wishing to be crawled to make this known to the crawling agent. For example, including a robots.txt file can request bots to index only parts of a website, or nothing at all.

The number of Internet pages is extremely large; even the largest crawlers fall short of making a complete index. For this reason, search engines struggled to give relevant search results in the early years of the World Wide Web, before 2000. Today, relevant results are given almost instantly.

Crawlers can validate hyperlinks and HTML code. They can also be used for web scraping and data-driven programming.

**Nomenclature**

[edit]

A web crawler is also known as a *spider*,[2] an *ant*, an *automatic indexer*,[3] or (in the FOAF software context) a *Web scutter*.[4]

**Overview**

[edit]

A Web crawler starts with a list of URLs to visit. Those first URLs are called the *seeds*. As the crawler visits these URLs, by communicating with web servers that respond to those URLs, it identifies all the hyperlinks in the retrieved web pages and adds them to the list of URLs to visit, called the *crawl frontier*. URLs from the frontier are recursively visited according to a set of policies. If the crawler is performing archiving of websites (or web archiving), it copies and saves the information as it goes. The archives are usually stored in such a way they can be viewed, read and navigated as if they were on the live web, but are preserved as 'snapshots'.[5]

The archive is known as the *repository* and is designed to store and manage the collection of web pages. The repository only stores HTML pages and these pages are stored as distinct files. A repository is similar to any other system that stores data, like a modern-day database. The only difference is that a repository does not need all the functionality offered by a database system. The repository stores the most recent version of the web page retrieved by the crawler.[*citation needed*]

The large volume implies the crawler can only download a limited number of the Web pages within a given time, so it needs to prioritize its downloads. The high rate of change can imply the pages might have already been updated or even deleted.

The number of possible URLs crawled being generated by server-side software has also made it difficult for web crawlers to avoid retrieving duplicate content. Endless combinations of HTTP GET (URL-based) parameters exist, of which only a small selection will actually return unique content. For example, a simple online photo gallery may offer three options to users, as specified through HTTP GET parameters in the URL. If there exist four ways to sort images, three choices of thumbnail size, two file formats, and an option to disable user-provided content, then the same set of content can be accessed with 48 different URLs, all of which may be linked on the site. This mathematical combination creates a problem for crawlers, as they must sort through endless combinations of relatively minor scripted changes in order to retrieve unique content.

As Edwards *et al.* noted, "Given that the bandwidth for conducting crawls is neither infinite nor free, it is becoming essential to crawl the Web in not only a scalable, but efficient way, if some reasonable measure of quality or freshness is to be maintained."[6] A crawler must carefully choose at each step which pages to visit next.

**Crawling policy**

[edit]

The behavior of a Web crawler is the outcome of a combination of policies:[7]

- ○ a *selection policy* which states the pages to download,
- ○ a *re-visit policy* which states when to check for changes to the pages,
- ○ a *politeness policy* that states how to avoid overloading websites.
- ○ a *parallelization policy* that states how to coordinate distributed web crawlers.

# Selection policy

[edit]

Given the current size of the Web, even large search engines cover only a portion of the publicly available part. A 2009 study showed even large-scale search engines index no more than 40–70% of the indexable Web;[8] a previous study by Steve Lawrence and Lee Giles showed that no search engine indexed more than 16% of the Web in 1999.[9] As a crawler always downloads just a fraction of the Web pages, it is highly desirable for the downloaded fraction to contain the most relevant pages and not just a random sample of the Web.

This requires a metric of importance for prioritizing Web pages. The importance of a page is a function of its intrinsic quality, its popularity in terms of links or visits, and even of its URL (the latter is the case of vertical search engines restricted to a single top-level domain, or search

engines restricted to a fixed Web site). Designing a good selection policy has an added difficulty: it must work with partial information, as the complete set of Web pages is not known during crawling.

Junghoo Cho *et al.* made the first study on policies for crawling scheduling. Their data set was a 180,000-pages crawl from the stanford.edu domain, in which a crawling simulation was done with different strategies.[10] The ordering metrics tested were breadth-first, backlink count and partial PageRank calculations. One of the conclusions was that if the crawler wants to download pages with high Pagerank early during the crawling process, then the partial Pagerank strategy is the better, followed by breadth-first and backlink-count. However, these results are for just a single domain. Cho also wrote his PhD dissertation at Stanford on web crawling.[11]

Najork and Wiener performed an actual crawl on 328 million pages, using breadth-first ordering.[12] They found that a breadth-first crawl captures pages with high Pagerank early in the crawl (but they did not compare this strategy against other strategies). The explanation given by the authors for this result is that "the most important pages have many links to them from numerous hosts, and those links will be found early, regardless of on which host or page the crawl originates."

Abiteboul designed a crawling strategy based on an algorithm called OPIC (On-line Page Importance Computation).[13] In OPIC, each page is given an initial sum of "cash" that is distributed equally among the pages it points to. It is similar to a PageRank computation, but it is faster and is only done in one step. An OPIC-driven crawler downloads first the pages in the crawling frontier with higher amounts of "cash". Experiments were carried in a 100,000-pages synthetic graph with a power-law distribution of in-links. However, there was no comparison with other strategies nor experiments in the real Web.

Boldi *et al.* used simulation on subsets of the Web of 40 million pages from the .it domain and 100 million pages from the WebBase crawl, testing breadth-first against depth-first, random ordering and an omniscient strategy. The comparison was based on how well PageRank computed on a partial crawl approximates the true PageRank value. Some visits that accumulate PageRank very quickly (most notably, breadth-first and the omniscient visit) provide very poor progressive approximations.[14][15]

Baeza-Yates *et al.* used simulation on two subsets of the Web of 3 million pages from the .gr and .cl domain, testing several crawling strategies.[16] They showed that both the OPIC strategy and a strategy that uses the length of the per-site queues are better than breadth-first crawling, and that it is also very effective to use a previous crawl, when it is available, to guide the current one.

Daneshpajouh *et al.* designed a community based algorithm for discovering good seeds.[17] Their method crawls web pages with high PageRank from different communities in less iteration in comparison with crawl starting from random seeds. One can extract good seed

from a previously-crawled-Web graph using this new method. Using these seeds, a new crawl can be very effective.

## Restricting followed links

[edit]

A crawler may only want to seek out HTML pages and avoid all other MIME types. In order to request only HTML resources, a crawler may make an HTTP HEAD request to determine a Web resource's MIME type before requesting the entire resource with a GET request. To avoid making numerous HEAD requests, a crawler may examine the URL and only request a resource if the URL ends with certain characters such as .html, .htm, .asp, .aspx, .php, .jsp, .jspx or a slash. This strategy may cause numerous HTML Web resources to be unintentionally skipped.

Some crawlers may also avoid requesting any resources that have a "?" in them (are dynamically produced) in order to avoid spider traps that may cause the crawler to download an infinite number of URLs from a Web site. This strategy is unreliable if the site uses URL rewriting to simplify its URLs.

## URL normalization

[edit]
Main article: URL normalization

Crawlers usually perform some type of URL normalization in order to avoid crawling the same resource more than once. The term *URL normalization*, also called *URL canonicalization*, refers to the process of modifying and standardizing a URL in a consistent manner. There are several types of normalization that may be performed including conversion of URLs to lowercase, removal of "." and ".." segments, and adding trailing slashes to the non-empty path component.[18]

## Path-ascending crawling

[edit]

Some crawlers intend to download/upload as many resources as possible from a particular web site. So *path-ascending crawler* was introduced that would ascend to every path in each URL that it intends to crawl.[19] For example, when given a seed URL of http://llama.org/hamster/monkey/page.html, it will attempt to crawl /hamster/monkey/, /hamster/, and /. Cothey found that a path-ascending crawler was very effective in finding

isolated resources, or resources for which no inbound link would have been found in regular crawling.

## Focused crawling

[edit]
Main article: Focused crawler

The importance of a page for a crawler can also be expressed as a function of the similarity of a page to a given query. Web crawlers that attempt to download pages that are similar to each other are called **focused crawler** or **topical crawlers**. The concepts of topical and focused crawling were first introduced by Filippo Menczer[20][21] and by Soumen Chakrabarti *et al.*[22]

The main problem in focused crawling is that in the context of a Web crawler, we would like to be able to predict the similarity of the text of a given page to the query before actually downloading the page. A possible predictor is the anchor text of links; this was the approach taken by Pinkerton[23] in the first web crawler of the early days of the Web. Diligenti *et al.*[24] propose using the complete content of the pages already visited to infer the similarity between the driving query and the pages that have not been visited yet. The performance of a focused crawling depends mostly on the richness of links in the specific topic being searched, and a focused crawling usually relies on a general Web search engine for providing starting points.

### Academic focused crawler

[edit]

An example of the focused crawlers are academic crawlers, which crawls free-access academic related documents, such as the *citeseerxbot*, which is the crawler of CiteSeer<sup>X</sup> search engine. Other academic search engines are Google Scholar and Microsoft Academic Search etc. Because most academic papers are published in PDF formats, such kind of crawler is particularly interested in crawling PDF, PostScript files, Microsoft Word including their zipped formats. Because of this, general open-source crawlers, such as Heritrix, must be customized to filter out other MIME types, or a middleware is used to extract these documents out and import them to the focused crawl database and repository.[25] Identifying whether these documents are academic or not is challenging and can add a significant overhead to the crawling process, so this is performed as a post crawling process using machine learning or regular expression algorithms. These academic documents are usually obtained from home pages of faculties and students or from publication page of research institutes. Because academic documents make up only a small fraction of all web pages, a

good seed selection is important in boosting the efficiencies of these web crawlers.[26] Other academic crawlers may download plain text and HTML files, that contains metadata of academic papers, such as titles, papers, and abstracts. This increases the overall number of papers, but a significant fraction may not provide free PDF downloads.

**Semantic focused crawler**

[edit]

Another type of focused crawlers is semantic focused crawler, which makes use of domain ontologies to represent topical maps and link Web pages with relevant ontological concepts for the selection and categorization purposes.[27] In addition, ontologies can be automatically updated in the crawling process. Dong et al.[28] introduced such an ontology-learning-based crawler using a support-vector machine to update the content of ontological concepts when crawling Web pages.

# Re-visit policy

[edit]

The Web has a very dynamic nature, and crawling a fraction of the Web can take weeks or months. By the time a Web crawler has finished its crawl, many events could have happened, including creations, updates, and deletions.

From the search engine's point of view, there is a cost associated with not detecting an event, and thus having an outdated copy of a resource. The most-used cost functions are freshness and age.[29]

**Freshness**: This is a binary measure that indicates whether the local copy is accurate or not. The freshness of a page $p$ in the repository at time $t$ is defined as:

$$\displaystyle F_p(t)=\begin{cases}1 & {\rm if}~p~{\rm ~is~equal~to~the~local~copy~at~time~}t\\0 & {\rm }\end{cases}$$

Image not found or type unknown

**Age**: This is a measure that indicates how outdated the local copy is. The age of a page $p$ in the repository, at time $t$ is defined as:

$$\displaystyle A_p(t)=\begin{cases}0 & {\rm if}~p~{\rm ~is~not~modified~at~time~}t\\t-{\rm modification}\end{cases}$$

Image not found or type unknown

Coffman *et al.* worked with a definition of the objective of a Web crawler that is equivalent to freshness, but use a different wording: they propose that a crawler must minimize the fraction of time pages remain outdated. They also noted that the problem of Web crawling can be modeled as a multiple-queue, single-server polling system, on which the Web crawler is the server and the Web sites are the queues. Page modifications are the arrival of the customers, and switch-over times are the interval between page accesses to a single Web site. Under this model, mean waiting time for a customer in the polling system is equivalent to the average age for the Web crawler.[30]

The objective of the crawler is to keep the average freshness of pages in its collection as high as possible, or to keep the average age of pages as low as possible. These objectives are not equivalent: in the first case, the crawler is just concerned with how many pages are outdated, while in the second case, the crawler is concerned with how old the local copies of pages are.
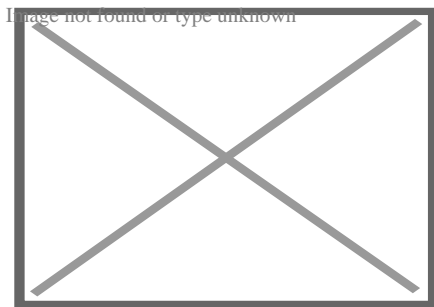


Evolution of Freshness and Age in a web crawler

Two simple re-visiting policies were studied by Cho and Garcia-Molina:[31]

- Uniform policy: This involves re-visiting all pages in the collection with the same frequency, regardless of their rates of change.
- Proportional policy: This involves re-visiting more often the pages that change more frequently. The visiting frequency is directly proportional to the (estimated) change frequency.

In both cases, the repeated crawling order of pages can be done either in a random or a fixed order.

Cho and Garcia-Molina proved the surprising result that, in terms of average freshness, the uniform policy outperforms the proportional policy in both a simulated Web and a real Web crawl. Intuitively, the reasoning is that, as web crawlers have a limit to how many pages they can crawl in a given time frame, (1) they will allocate too many new crawls to rapidly changing pages at the expense of less frequently updating pages, and (2) the freshness of rapidly changing pages lasts for shorter period than that of less frequently changing pages. In other words, a proportional policy allocates more resources to crawling frequently updating pages, but experiences less overall freshness time from them.

To improve freshness, the crawler should penalize the elements that change too often.[32] The optimal re-visiting policy is neither the uniform policy nor the proportional policy. The optimal method for keeping average freshness high includes ignoring the pages that change too often, and the optimal for keeping average age low is to use access frequencies that monotonically (and sub-linearly) increase with the rate of change of each page. In both cases, the optimal is closer to the uniform policy than to the proportional policy: as Coffman *et al.* note, "in order to minimize the expected obsolescence time, the accesses to any particular page should be kept as evenly spaced as possible".[30] Explicit formulas for the re-visit policy are not attainable in general, but they are obtained numerically, as they depend on the distribution of page changes. Cho and Garcia-Molina show that the exponential distribution is a good fit for describing page changes,[32] while Ipeirotis *et al.* show how to use statistical tools to discover parameters that affect this distribution.[33] The re-visiting policies considered here regard all pages as homogeneous in terms of quality ("all pages on the Web are worth the same"), something that is not a realistic scenario, so further information about the Web page quality should be included to achieve a better crawling policy.

# Politeness policy

[edit]

Crawlers can retrieve data much quicker and in greater depth than human searchers, so they can have a crippling impact on the performance of a site. If a single crawler is performing multiple requests per second and/or downloading large files, a server can have a hard time keeping up with requests from multiple crawlers.

As noted by Koster, the use of Web crawlers is useful for a number of tasks, but comes with a price for the general community.[34] The costs of using Web crawlers include:

- network resources, as crawlers require considerable bandwidth and operate with a high degree of parallelism during a long period of time;
- server overload, especially if the frequency of accesses to a given server is too high;
- poorly written crawlers, which can crash servers or routers, or which download pages they cannot handle; and
- personal crawlers that, if deployed by too many users, can disrupt networks and Web servers.

A partial solution to these problems is the robots exclusion protocol, also known as the robots.txt protocol that is a standard for administrators to indicate which parts of their Web servers should not be accessed by crawlers.[35] This standard does not include a suggestion for the interval of visits to the same server, even though this interval is the most effective way of avoiding server overload. Recently commercial search engines like Google, Ask Jeeves,

MSN and Yahoo! Search are able to use an extra "Crawl-delay:" parameter in the robots.txt file to indicate the number of seconds to delay between requests.

The first proposed interval between successive pageloads was 60 seconds.[36] However, if pages were downloaded at this rate from a website with more than 100,000 pages over a perfect connection with zero latency and infinite bandwidth, it would take more than 2 months to download only that entire Web site; also, only a fraction of the resources from that Web server would be used.

Cho uses 10 seconds as an interval for accesses,[31] and the WIRE crawler uses 15 seconds as the default.[37] The MercatorWeb crawler follows an adaptive politeness policy: if it took $t$ seconds to download a document from a given server, the crawler waits for $10t$ seconds before downloading the next page.[38] Dill *et al.* use 1 second.[39]

For those using Web crawlers for research purposes, a more detailed cost-benefit analysis is needed and ethical considerations should be taken into account when deciding where to crawl and how fast to crawl.[40]

Anecdotal evidence from access logs shows that access intervals from known crawlers vary between 20 seconds and 3–4 minutes. It is worth noticing that even when being very polite, and taking all the safeguards to avoid overloading Web servers, some complaints from Web server administrators are received. Sergey Brin and Larry Page noted in 1998, "... running a crawler which connects to more than half a million servers ... generates a fair amount of e-mail and phone calls. Because of the vast number of people coming on line, there are always those who do not know what a crawler is, because this is the first one they have seen."[41]

# Parallelization policy

[edit]
Main article: Distributed web crawling

A parallel crawler is a crawler that runs multiple processes in parallel. The goal is to maximize the download rate while minimizing the overhead from parallelization and to avoid repeated downloads of the same page. To avoid downloading the same page more than once, the crawling system requires a policy for assigning the new URLs discovered during the crawling process, as the same URL can be found by two different crawling processes.

### Architectures

[edit]

High-level architecture of a standard Web crawler

A crawler must not only have a good crawling strategy, as noted in the previous sections, but it should also have a highly optimized architecture.

Shkapenyuk and Suel noted that:[42]

> While it is fairly easy to build a slow crawler that downloads a few pages per second for a short period of time, building a high-performance system that can download hundreds of millions of pages over several weeks presents a number of challenges in system design, I/O and network efficiency, and robustness and manageability.

Web crawlers are a central part of search engines, and details on their algorithms and architecture are kept as business secrets. When crawler designs are published, there is often an important lack of detail that prevents others from reproducing the work. There are also emerging concerns about "search engine spamming", which prevent major search engines from publishing their ranking algorithms.

## Security

[edit]

While most of the website owners are keen to have their pages indexed as broadly as possible to have strong presence in search engines, web crawling can also have unintended consequences and lead to a compromise or data breach if a search engine indexes resources that should not be publicly available, or pages revealing potentially vulnerable versions of software.

Main article: Google hacking

Apart from standard web application security recommendations website owners can reduce their exposure to opportunistic hacking by only allowing search engines to index the public parts of their websites (with robots.txt) and explicitly blocking them from indexing transactional parts (login pages, private pages, etc.).

## Crawler identification

[edit]

Web crawlers typically identify themselves to a Web server by using the User-agent field of an HTTP request. Web site administrators typically examine their Web servers' log and use the user agent field to determine which crawlers have visited the web server and how often.

The user agent field may include a URL where the Web site administrator may find out more information about the crawler. Examining Web server log is tedious task, and therefore some administrators use tools to identify, track and verify Web crawlers. Spambots and other malicious Web crawlers are unlikely to place identifying information in the user agent field, or they may mask their identity as a browser or other well-known crawler.

Web site administrators prefer Web crawlers to identify themselves so that they can contact the owner if needed. In some cases, crawlers may be accidentally trapped in a crawler trap or they may be overloading a Web server with requests, and the owner needs to stop the crawler. Identification is also useful for administrators that are interested in knowing when they may expect their Web pages to be indexed by a particular search engine.

**Crawling the deep web**

[edit]

A vast amount of web pages lie in the deep or invisible web.[43] These pages are typically only accessible by submitting queries to a database, and regular crawlers are unable to find these pages if there are no links that point to them. Google's Sitemaps protocol and mod oai[44] are intended to allow discovery of these deep-Web resources.

Deep web crawling also multiplies the number of web links to be crawled. Some crawlers only take some of the URLs in <a href="URL"> form. In some cases, such as the Googlebot, Web crawling is done on all text contained inside the hypertext content, tags, or text.

Strategic approaches may be taken to target deep Web content. With a technique called screen scraping, specialized software may be customized to automatically and repeatedly query a given Web form with the intention of aggregating the resulting data. Such software can be used to span multiple Web forms across multiple Websites. Data extracted from the results of one Web form submission can be taken and applied as input to another Web form thus establishing continuity across the Deep Web in a way not possible with traditional web crawlers.[45]

Pages built on AJAX are among those causing problems to web crawlers. Google has proposed a format of AJAX calls that their bot can recognize and index.[46]

**Visual vs programmatic crawlers**

[edit]

There are a number of "visual web scraper/crawler" products available on the web which will crawl pages and structure data into columns and rows based on the users requirements. One of the main difference between a classic and a visual crawler is the level of programming ability required to set up a crawler. The latest generation of "visual scrapers" remove the

majority of the programming skill needed to be able to program and start a crawl to scrape web data.

The visual scraping/crawling method relies on the user "teaching" a piece of crawler technology, which then follows patterns in semi-structured data sources. The dominant method for teaching a visual crawler is by highlighting data in a browser and training columns and rows. While the technology is not new, for example it was the basis of Needlebase which has been bought by Google (as part of a larger acquisition of ITA Labs[47]), there is continued growth and investment in this area by investors and end-users.[*citation needed*]

**List of web crawlers**

[edit]
Further information: List of search engine software

The following is a list of published crawler architectures for general-purpose crawlers (excluding focused web crawlers), with a brief description that includes the names given to the different components and outstanding features:

# Historical web crawlers

[edit]

- WolfBot was a massively multi threaded crawler built in 2001 by Mani Singh a Civil Engineering graduate from the University of California at Davis.
- World Wide Web Worm was a crawler used to build a simple index of document titles and URLs. The index could be searched by using the grep Unix command.
- Yahoo! Slurp was the name of the Yahoo! Search crawler until Yahoo! contracted with Microsoft to use Bingbot instead.

# In-house web crawlers

[edit]

- Applebot is Apple's web crawler. It supports Siri and other products.[48]
- Bingbot is the name of Microsoft's Bing webcrawler. It replaced *Msnbot*.
- Baiduspider is Baidu's web crawler.
- DuckDuckBot is DuckDuckGo's web crawler.

- Googlebot is described in some detail, but the reference is only about an early version of its architecture, which was written in C++ and Python. The crawler was integrated with the indexing process, because text parsing was done for full-text indexing and also for URL extraction. There is a URL server that sends lists of URLs to be fetched by several crawling processes. During parsing, the URLs found were passed to a URL server that checked if the URL have been previously seen. If not, the URL was added to the queue of the URL server.
- WebCrawler was used to build the first publicly available full-text index of a subset of the Web. It was based on lib-WWW to download pages, and another program to parse and order URLs for breadth-first exploration of the Web graph. It also included a real-time crawler that followed links based on the similarity of the anchor text with the provided query.
- WebFountain is a distributed, modular crawler similar to Mercator but written in C++.
- Xenon is a web crawler used by government tax authorities to detect fraud.[49][50]

# Commercial web crawlers

[edit]

The following web crawlers are available, for a price::

- Diffbot - programmatic general web crawler, available as an API
- SortSite - crawler for analyzing websites, available for Windows and Mac OS
- Swiftbot - Swiftype's web crawler, available as software as a service
- Aleph Search - web crawler allowing massive collection with high scalability

# Open-source crawlers

[edit]

- Apache Nutch is a highly extensible and scalable web crawler written in Java and released under an Apache License. It is based on Apache Hadoop and can be used with Apache Solr or Elasticsearch.
- Grub was an open source distributed search crawler that Wikia Search used to crawl the web.
- Heritrix is the Internet Archive's archival-quality crawler, designed for archiving periodic snapshots of a large portion of the Web. It was written in Java.
- ht://Dig includes a Web crawler in its indexing engine.

- HTTrack uses a Web crawler to create a mirror of a web site for off-line viewing. It is written in C and released under the GPL.
- Norconex Web Crawler is a highly extensible Web Crawler written in Java and released under an Apache License. It can be used with many repositories such as Apache Solr, Elasticsearch, Microsoft Azure Cognitive Search, Amazon CloudSearch and more.
- mnoGoSearch is a crawler, indexer and a search engine written in C and licensed under the GPL (*NIX machines only)
- Open Search Server is a search engine and web crawler software release under the GPL.
- Scrapy, an open source webcrawler framework, written in python (licensed under BSD).
- Seeks, a free distributed search engine (licensed under AGPL).
- StormCrawler, a collection of resources for building low-latency, scalable web crawlers on Apache Storm (Apache License).
- tkWWW Robot, a crawler based on the tkWWW web browser (licensed under GPL).
- GNU Wget is a command-line-operated crawler written in C and released under the GPL. It is typically used to mirror Web and FTP sites.
- YaCy, a free distributed search engine, built on principles of peer-to-peer networks (licensed under GPL).

## See also

[edit]

- Automatic indexing
- Gnutella crawler
- Web archiving
- Webgraph
- Website mirroring software
- Search Engine Scraping
- Web scraping

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- **v**
- **t**
- **e**

Internet search

**Types**

- Web search engine (List)
- Metasearch engine
- Multimedia search
- Collaborative search engine
- Cross-language search
- Local search
- Vertical search
- Social search
- Image search
- Audio search
- Video search engine
- Enterprise search
- Semantic search
- Natural language search engine
- Voice search

**Tools**

- Cross-language information retrieval
- Search by sound
- Search engine marketing
- Search engine optimization
- Evaluation measures
- Search oriented architecture
- Selection-based search
- Document retrieval
- Text mining
- Web crawler
- Multisearch
- Federated search
- Search aggregator
- Index/Web indexing
- Focused crawler
- Spider trap
- Robots exclusion standard
- Distributed web crawling
- Web archiving
- Website mirroring software
- Web query
- Web query classification

| **Protocols and standards** | ○ Z39.50<br>○ Search/Retrieve Web Service<br>○ Search/Retrieve via URL<br>○ OpenSearch<br>○ Representational State Transfer<br>○ Wide area information server |
|---|---|
| **See also** | ○ Search engine<br>○ Desktop search<br>○ Online search |

- **v**
- **t**
- **e**

Web crawlers

Internet bots designed for Web crawling and Web indexing

| **Active** | ○ 80legs<br>○ bingbot<br>○ Crawljax<br>○ Fetcher<br>○ Googlebot<br>○ Heritrix<br>○ HTTrack<br>○ PowerMapper<br>○ Wget |
|---|---|
| **Discontinued** | ○ FAST Crawler<br>○ msnbot<br>○ RBSE<br>○ TkWWW robot<br>○ Twiceler |
| **Types** | ○ Distributed web crawler<br>○ Focused crawler |

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## Frequently Asked Questions

### What is a content agency in Sydney?

A content agency in Sydney focuses on creating high-quality, SEO-optimized content that resonates with your target audience. Their services typically include blog writing, website copy, video production, and other forms of media designed to attract traffic and improve search rankings.

### Why should I consider SEO packages in Australia?

SEO packages in Australia typically bundle essential optimization services such as keyword research, technical audits, content creation, and link building at a set price. They are designed to simplify the process, provide consistent results, and help businesses of all sizes improve their online visibility.

### What is involved in SEO consulting?

SEO consulting involves analyzing a website's current performance, identifying areas for improvement, and recommending strategies to boost search rankings. Consultants provide insights on keyword selection, on-page and technical optimization, content development, and link-building tactics.

### What are the benefits of working with an SEO consultant in Sydney?

An SEO consultant in Sydney can provide tailored advice and strategies that align with your business's goals and local market conditions. They bring expertise in keyword selection, content optimization, technical SEO, and performance monitoring, helping you achieve better search rankings and more organic traffic.

### What role do SEO consultants play in a digital marketing strategy?

SEO consultants are responsible for improving your website's visibility and performance in search engines. By analyzing data, refining keyword strategies, and optimizing site elements, they enhance your overall digital marketing efforts, leading to more traffic, better user engagement, and higher conversions.

## What are local SEO services in Sydney?

Local SEO services in Sydney focus on optimizing a business's online presence to attract local customers. This includes claiming local business listings, optimizing Google My Business profiles, using location-specific keywords, and ensuring consistent NAP (Name, Address, Phone) information across the web.

ecommerce SEO services

SEO Sydney

Phone : 1300 684 339

City : Sydney

State : NSW

Zip : 2000

Google Business Profile

Google Business Website

Company Website : https://sydney.website/seo-sydney/

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