Google Squared

Web scale, open domain information extraction and presentation

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Google
Project aims

- *Web scale*: extract from tens of billions of pages
- *Open domain*: answer questions on any topic

- Automatic extraction, no manual intervention
- Solve real user problems
- Learn from user feedback
- Not limited by traditional search UI
- No technology religion: solve problems using any methodology available
<table>
<thead>
<tr>
<th>Item Name</th>
<th>Image</th>
<th>Description</th>
<th>Symbol</th>
<th>Central Bank</th>
<th>Banknotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro</td>
<td><img src="https://www.google.com/s2/img" alt="Euro" /></td>
<td>The euro is the second largest reserve currency and the second most traded currency in the world after the U.S. dollar. As of October 2009, with more than 8.8% of global foreign-exchange reserves, the euro is the most traded currency in the world.</td>
<td>EUR</td>
<td>European Central Bank</td>
<td>€500 · €20 · €50 · €10 · €5 · €2 · €1</td>
</tr>
<tr>
<td>Japanese yen</td>
<td><img src="https://www.google.com/s2/img" alt="Japanese yen" /></td>
<td>The yen declined during the Japanese asset price bubble and continued to do so ... The exchange rate for the Japanese yen is <a href="https://en.wikipedia.org">en.wikipedia.org</a></td>
<td>JPY</td>
<td>Bank of Japan</td>
<td>¥1000, ¥2000, ¥5000, ¥10000</td>
</tr>
<tr>
<td>Australian dollar</td>
<td><img src="https://www.google.com/s2/img" alt="Australian dollar" /></td>
<td>American Dollar, Argentine Peso, Australian Dollar, Brazilian Real, British Pound, Bulgarian Lev, Canadian Dollar, Chilean Peso, Chinese Yuan ...</td>
<td>AUD</td>
<td>Reserve Bank of Australia</td>
<td>$5, $10, $20, $50, $100</td>
</tr>
<tr>
<td>Canadian dollar</td>
<td><img src="https://www.google.com/s2/img" alt="Canadian dollar" /></td>
<td>Argentine Peso, Australian Dollar, Bahraini Dinar, Botswana Pula, Brazilian Real, British Pound, Brunei dollar, Bulgarian Lev, Canadian Dollar ...</td>
<td>CAD</td>
<td>Bank of Canada</td>
<td>1 possible value</td>
</tr>
<tr>
<td>Swiss franc</td>
<td><img src="https://www.google.com/s2/img" alt="Swiss franc" /></td>
<td>The franc (German: Franken, French and Romansh: franc, Italian: franco; code: CHF) is the currency and legal tender of Switzerland and Liechtenstein; ...</td>
<td>CHF</td>
<td>Swiss National Bank</td>
<td>10, 20, 50, 100, 200 &amp; 1000 francs</td>
</tr>
<tr>
<td>Malaysian ringgit</td>
<td><img src="https://www.google.com/s2/img" alt="Malaysian ringgit" /></td>
<td>The Malaysian ringgit (plural: ringgit; currency code MYR; formerly the Malaysian dollar) is the currency of Malaysia. It is divided into 100 sen (cents). ...</td>
<td>RM</td>
<td>Bank Negara Malaysia</td>
<td>RM1, RM5, RM10, RM50, RM100</td>
</tr>
</tbody>
</table>
Comparison: an interesting search problem

Many users want to compare items in a topic:

- I'm going on safari in South Africa
- Write a school paper about the US presidents
- Research digital cameras
- Choose a restaurant near the British Museum
- Who were the conspirators in the Gunpowder Plot?
- Compare sedimentary rocks

Need to gather data from many sources and the same data about multiple objects

Tedious, time consuming, but high value
How users compare today

Users in "comparison mode" look for information, not pages

Two main phases:

- **Research** - learn about the domain
- **Acquire** - find specific answers

People use: spreadsheets, email, post-its, memory to record and organize searches

They are frustrated by the inability to find information, by the effort involved, give up before the task is complete

Oh, and, users love tables
What Google Squared does

Query to list of names:
[us presidents] -> Ford, Nixon
What Google Squared does

Extend list of names:

Ford, Nixon -> Obama, Carter, Reagan
Ford, Chrysler -> BMW, Honda, Audi
Find attributes:

Ford, Nixon, Obama, Carter, Reagan:

Date of birth
Preceded by
Party
Vice President
Religion
### Find values:

<table>
<thead>
<tr>
<th></th>
<th>Date of birth</th>
<th>Vice president</th>
<th>Party</th>
<th>Religion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ford</strong></td>
<td>14 July 1913</td>
<td>Nelson Rockefeller</td>
<td>Republican</td>
<td>Episcopalian</td>
</tr>
<tr>
<td><strong>Nixon</strong></td>
<td>9 January 1913</td>
<td>Gerald Ford</td>
<td>Republican</td>
<td>Quaker</td>
</tr>
<tr>
<td><strong>Obama</strong></td>
<td>4 August 1961</td>
<td>Joe Biden</td>
<td>Democrat</td>
<td>United Church of Christ</td>
</tr>
<tr>
<td><strong>Carter</strong></td>
<td>1 October 1924</td>
<td>Walter Mondale</td>
<td>Democrat</td>
<td>Baptist</td>
</tr>
</tbody>
</table>
How it works: query analysis

Is the query about an item or a category?
[Obama] or [US Presidents]?

Is this a product or a local query?
[mp3 players] or [cambridge restaurants]

If not, it's a web search query:
[active baseball players named in the mitchell report]
Extraction: Query to list of names

Offline:
- Find web pages that contain lists and tables
- Look for likely entity names
- Look for likely subject names (headers, page titles)
- Aggregate over the entire web
- Find synonyms and alternatives

Query time:
- Run searches, e.g. [List of <query>], Wikipedia category pages
- Find extracted lists from search results
Extraction: find attributes

Offline table extractor:
- Ignore layout tables
- Extract row and column headers
- Aggregate tables

Hundreds of millions of tables extracted

Query time:
- Search for tables containing list of items
- Look for attribute candidates in headers
Large scale synonym data to find canonical attribute:
  born, birthdate, birth date, birthday, date of birth     ->     date of birth
Extraction: find values

Offline:
- Table extractors
- NLP extractors (verb and possessive fact extraction)
- Type-specific extractors (dimensions, price, date, location...)
- Page structure analysis
- Score extractors using Rifle classifier

Web scale: tens of billions of extracted facts

Query time:
- Run: [context, item, attribute]
- Search snippets to find similar values
Learn from user feedback

Look for consistent value corrections, increase confidence

<table>
<thead>
<tr>
<th>Item Name</th>
<th>Image</th>
<th>Description</th>
<th>Preceded By</th>
<th>Vice President</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gerald Ford</td>
<td></td>
<td>&lt;p&gt;Gerald Rudolph Ford, Jr. (born Leslie Lynch King, Jr.; July 14, 1913 – December 26, 2006) was the 38th President of the United States, serving from 1974 to ...&lt;/p&gt;</td>
<td>Spiro Agnew</td>
<td>Nelson Rockefeller</td>
</tr>
<tr>
<td>James Monroe</td>
<td></td>
<td>On New Year's Day, 1825, at the last of his annual White House receptions, President James Monroe made a pleasing impression upon a Virginia lady who shook ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>John Tyler</td>
<td></td>
<td>Dubbed &quot;His Accidency&quot; by his detractors, John Tyler was the first Vice President to be elevated to the office of President by the death of his predecessor. ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dwight Eisenhower</td>
<td></td>
<td>Dwight David &quot;Ike&quot; Eisenhower (pronounced /aɪzənˈhɔːr/ EYE-zən-hɔːr; October 14, 1890 – March 28, 1969) was a five-star general in the United States Army ...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Enhancing search results

Bias the result snippet to show and highlight facts, where we have high confidence:

From:

How tall is the Eiffel tower? - Yahoo! Answers
According to The Oxford Dictionary of Phrase and Fable: "Eiffel Tower a wrought-iron structure erected in Paris for the World Exhibition of 1889, designed and built ...
answers.yahoo.com/question/index?qid... - Cached - Similar - 🚹 ⏰ ⏱

To:

How tall is the Eiffel tower? - Yahoo! Answers
How tall is the Eiffel tower? ... Including the 24 m (79 ft) antenna, the structure is 324 m (1063 ft) high. 2 years ago. 14% 1 Vote ...
answers.yahoo.com/question/index?qid... - Cached - Similar - 🚹 ⏰ ⏱
Evaluation

Continually evaluate precision and recall of individual components and overall system across sets of thousands of hand-evaluated questions.
Improving quality

Significant quality improvement:

- Search for more items and attributes than required
- Find values for all items and attributes then prune
- Remove items/attributes that are:
  - Wrong - radically different value types
  - Duplicates - likely synonyms
  - Not useful - no values available

Improves precision and recall around 20%
What we've learned: part I

- Precision is key:
  - Precision from 50%->60%; user satisfaction 50%-> 60%
- Recall also critical:
  - anesthetic solubility, titanium rings, design software, novels of kurt vonnegut, artificial tears, boutiques in san antonio texas, swiss cantons, japanese instruments, green rating systems...
- Deep semantics are hard to extract in the general case
  - We don't support computation across values
  - No-one seems to mind
- Small blacklists can greatly improve quality (uncyclopedia)
- Combine large-scale offline and query-time extraction
  - Search engine ranking is very effective
What we've learned: part II

- Context is important
  - helps disambiguate (Ford vs Ford)
  - Improves precision
- Scale allows you to aggregate the wisdom of the web:
  - Occurrence count
  - Web rank (∼authority)
- If you fail, you can always ask the user
- Users understand tables

- Open domain extraction is a hard and satisfying problem to work on