# Google Trends

Google offers public access to global search volumes through its search engine through the [Google Trends portal](http://www.google.com/trends). Users select up to five keywords for which they want to obtain search trend data and specific the timeframe and location (global, country, state, community) of interest. For these combinations of five keywords, period, and location Google Trends computes a Search Volume Index (SVI) that indicates the number of search queries submitted to the Google search engine. The `globaltrends` package downloads these SVIs provided by Google Trends and uses them to measure and analyze the distribution of search trends across countries or within countries. The output from `globaltrends` allows researchers and analysts to investigate patterns within these trends, such as degree of internationalization of firms and organizations or dissemination of political, social, or technological trends across the globe or within single countries.

Google Trends normalizes the SVI for any given keyword-period-location combination to a value between 0 and 100, where 100 corresponds to the greatest SVI for the time series. Due to this normalization, users cannot compare SVIs for two keyword-period-location combinations. The `globaltrends` package uses a group of baseline keywords that correspond to “standard” search traffic on Google and computes search scores for each keyword for a given date for a given location. These search scores allow direct interpretability and comparison of Google Trends data across keyword-period-location combinations.

# Analyze internationalization of firms

We demonstrate the functionality of the `globaltrends` package based on a sample of six large U.S. firms. In this brief case study, we analyze the degree of internationalization of \*Alaska Air Group Inc.\*, \*Coca-Cola Company\*, \*Facebook Inc.\*, \*Illinois Tools Works Inc.\*, \*J.M. Smucker Company\*, and \*Microsoft Corporation\*. The workflow consists of four major steps:

1. Setup and start database

2. Download data from Google Trends

3. Compute search score and internationalization

4. Exports and plots

## Setup and start database

Research projects that use Google Trends data to analyze global trends amass a substantial amount of data. To optimally handle this amount of data, the `globaltrends` package uses a [SQLite database]( https://www.sqlite.org/index.html) to store and handle all data. This ensures efficiency and portability on the one hand and seamless integration with the functions implemented in the `DBI` and `dplyr` packages on the other hand.

Users create the underlying database through the `initialize\_db` command. The command creates a folder named \*db\* within the current working directory and creates a SQLite database file named \*globaltrends\_db.sqlite\* within this folder. The command also creates all necessary tables within the database. To get more information on these tables refer to the built-in documentation, e.g. `?globaltrends::data\_score`. The database initialization is necessary only for the first usage of the `globaltrends` package.

[XXXXX CODE XXXXX]

Once the user has initialized the database or to resume work on an existing database it is sufficient to call `start\_db` from the respective working directory. This command connects to the \*globaltrends.sqlite\* database in the folder \*db\* and creates connections to all tables in the database.

[XXXXX CODE XXXXX]

After all work with the `globaltrends` package is complete, the user disconnects from the database with the command `disconnect\_db`.

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## Download data from Google Trends

The next step in the `globaltrends` workflow is the data download from Google Trends. The `globaltrends` package includes four types of download functions that we explain in detail below. Each of these functions uses the `gtrendsR::gtrends` function to access the Google Trends API. The Google Trends API allows inputs of up to five keywords for a given location and period. Therefore, the `globaltrends` package works with “keyword batches” that combine up to five keywords. The respective batch numbers are an input to all functions – either as `list` or as single `integer` objects. In the package, we distinguish two types of batches: \*\*control\*\* batches that include baseline keywords and \*\*object\*\* batches that include keywords relating to the objects of interest (e.g. firms, persons, trends…). Currently, `globaltrends` only includes two sets of locations. The \*countries\* set, which covers all countries that generated at least 0.1% of world GDP in 2018 and the \*us\_states\* set, covering all US states and Washington DC.

The download for a single keyword batch for a single location takes about 30 seconds. This includes a randomized waiting period of 20-30 seconds between downloads. Depending on the frequency of downloads, Google Trends might block users for some time. In this case, `globaltrends` waits 60 minutes before it retries the download.

### Download control data

First, we add a batch of control keywords to the database using `add\_control\_keyword`. We suggest \*gmail\*, \*maps\*, \*translate\*, \*wikipedia\*, and \*youtube\* as control keywords for global trend analysis. These keywords indicate the baseline search traffic on Google and should be adapted to the respective research setting at hand. The output of `add\_control\_keyword` is a `list` object that can serve as input for other functions.

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The function `add\_control\_keyword` also updates the `tibble` `keywords\_control` in the global environment. This `tibble` can be used for batch lookup.

[XXXXX CODE XXXXX]

As a second step, we download the control data with `download\_control`, using the output from `add\_control\_keyword` as `control` input. The input `locations` takes a vector of ISO2 country codes, please refer to `gtrendsR::countries` for possible inputs. The function defaults to `countries`.

[XXXXX CODE XXXXX]

A message indicates each successful download. The data is written directly to the database.

### Download object data

Also for object data, the first step is to add the keywords for the analysis. While we use one control batch for the entire analysis, there are more than one object batch (since the analysis covers more than five keywords). Before we add the object keywords, we clean them, deleting punctuation and form of incorporation: \*alaska air group\*, \*coca cola\*, \*facebook\*, \*Illinois tools works\*, \*jm smucker\*, and \*microsoft\*. Since these transformation affects search results, they require substantial consideration and depend on the respective research setting.

[XXXXX CODE XXXXX]

As for control keywords, the function `add\_object\_keyword` also updates the `tibble` `keywords\_object` in the global environment. This `tibble` can be used for batch lookup.

[XXXXX CODE XXXXX]

Again, the second step is to download the object data with `download\_object`, using the output from `add\_object\_keyword` as `object` input. As above, the input `locations` defaults to `countries`.

[XXXXX CODE XXXXX]

A message indicates each successful download. The data is written directly to the database.

### Download mapping data

The control and object data downloaded with the steps outline above, is normalized for each batch. Therefore, we cannot directly compare these data. To compute search scores for the object keywords ([see below](#compute-search-scores)), `globaltrends` downloads a mapping between control and object batches. The `download\_mapping` function downloads a two-keyword batch combining one keyword from the control batch and one keyword from the object batch. While the input for \*object\* can either be an `integer` or a `list`, \*control\* requires an `integer`. As above, the input `locations` defaults to `countries`.

[XXXXX CODE XXXXX]

A message indicates each successful download. The data is written directly to the database.

### Download global search data

The `globaltrends` package offers the opportunity to download global search data for object keywords. To avoid within batch normalization, `download\_global` runs separately for each keyword within an object batch.

[XXXXX CODE XXXXX]

A message indicates each successful download. The data is written directly to the database.

## Compute search scores and internationalization

Once the user has completed all control and object downloads, `globaltrends` computes search scores for each keyword-date-location combination. Next, the package uses the across-country distribution of these search scores to measure the degree of internationalization of an object keyword.

### Compute search scores

The function `compute\_score` divides the SVI for an object keyword by the sum of SVIs of the keywords in the respective control batch. The search score is interpretable as the ratio of interest in a given keyword compared to the interest in a set of baseline keyword. The search score therefore allows comparison across keywords, dates, and locations.

The search score computation proceeds in four steps. First, the function aggregates all SVIs as monthly data. Then, it applies some optional time series adjustments that we outline in greater detail [below](#time-series-adjustments). Next, it follows the procedure outlined by Castelnuovo and Tran [-@castel17, pp. A1-A2] to map control and object data. After the mapping, each object search score is divided by the sum of SVIs of the keywords in the respective control batch. We use the sum of SVIs for a set of keywords, rather than the SVI for a single control keyword, to smooth-out variation in the underlying control data. While the input for \*object\* can either be an `integer` or a `list`, \*control\* requires an `integer`. As above, the input `locations` defaults to `countries`.

[XXXXX CODE XXXXX]

Using the same approach, `compute\_score\_global` computes global search scores for object keywords.

[XXXXX CODE XXXXX]

A message indicates each successful computation. The data is written directly to the database.

### Compute degree of internationalization

The `globaltrends` package uses the distribution of search scores across countries to compute the degree of internationalization for object keywords. Following international business literature [@fisch12], `compute\_doi` uses an inverted Gini-coefficient as measure for the degree of internationalization. The more uniform the distribution of search scores across all countries, the higher the inverted Gini-coefficient and the greater the degree of internationalization. In addition to the Gini-coefficient, the package uses inverted Herfindahl–Hirschman index [@buhner87] and inverted entropy [@hitt97] as measures for internationalization ([details below](#alternative-dispersion-measures)). While the input for \*object\* can either be an `integer` or a `list`, \*control\* requires an `integer`. The input `locations` requires the name of a location set as `character` and defaults to `”countries”`.

[XXXXX CODE XXXXX]

A message indicates each successful computation. The data is written directly to the database.

## Exports and plots

export\_control

export\_object

export\_global

export\_mapping

export\_score

export\_score\_global

export\_doi

plot\_score

plot\_ts

plot\_box

plot\_trend

## Additional options

### Time series adjustments

### Alternative dispersion measures

### Changing locations

# Further applications

\* Explain difference between DOI and DOI-penetration -> run "download\_global()"

\* DOI of persons, organizations, and trends

\* DOI on within-country level

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