From company websites to business research: Beyond words

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Company websites are rich sources of information

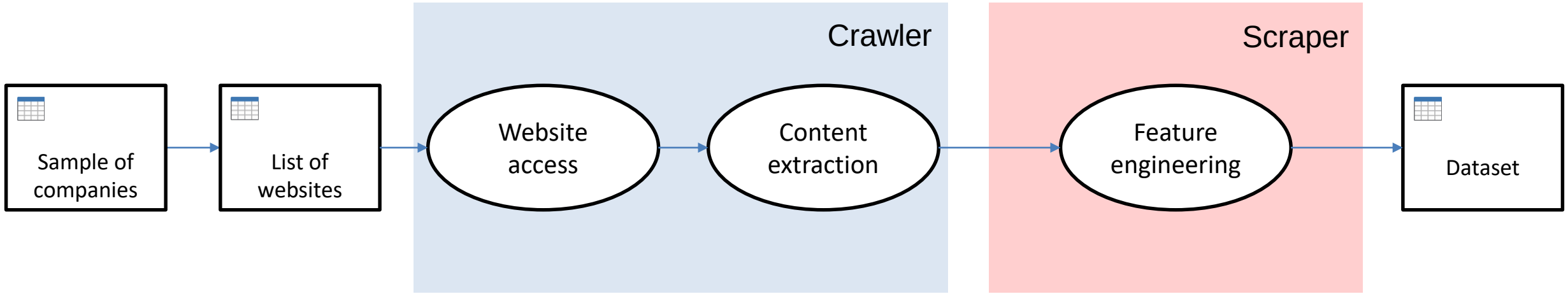
Main advantages

- Fresh information
- Very high granularity
- Wide coverage
- Non-intrusive
- Scalable
- Inexpensive

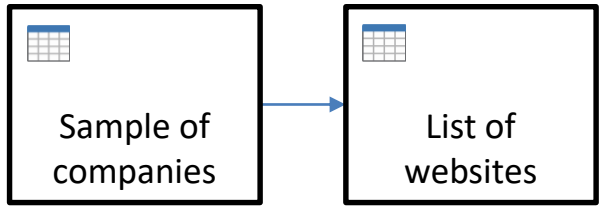
Limitations

- Sampling bias
  - Incomplete coverage
- Reporting bias
  - Most information is self-reported
  - Selective disclosure
  - Not conveninent for some topics
- URL changes
- URL ambiguity
- Language ambiguity

The process [1,9]

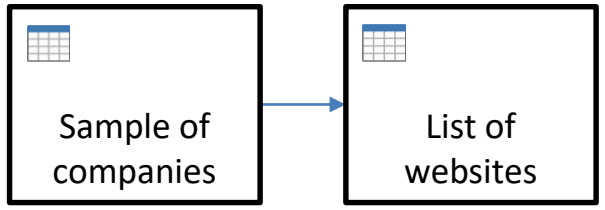


From the sample of companies to the list of websites



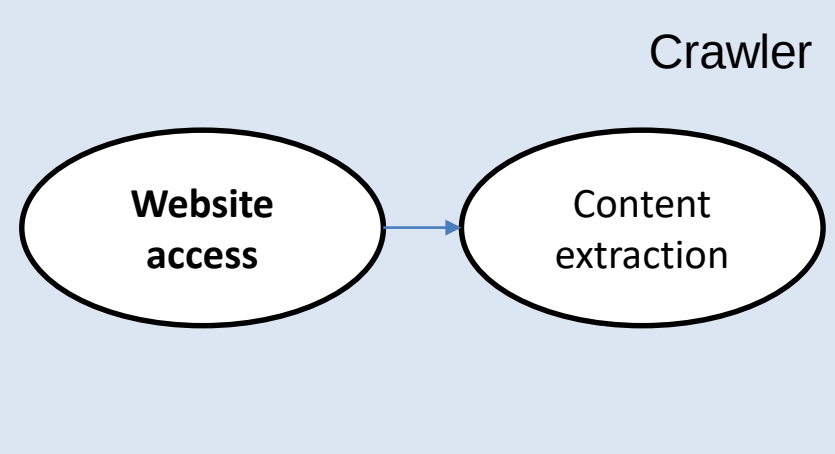
- Challenges
  1. What's the company's homepage URL?
     - Directories are not completely reliable
       - **Missing websites**: How to find them? → Search engines
       - **Old URLs**. HTTP redirects may help with this
       - **Inaccurate URLs**. Different approaches to check accuracy:
         - » Barcaroli et al. (2016)
         - » Bottai et al. (2022) [2]

From the sample of companies to the list of websites



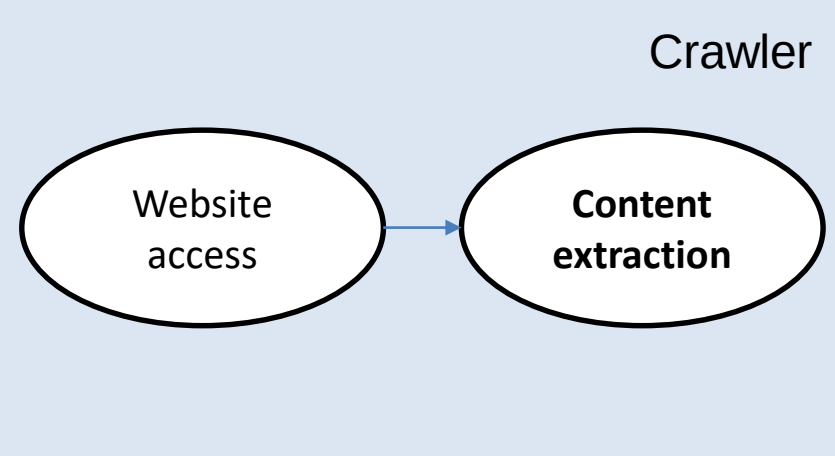
- Challenges
  2. Companies and websites are not one-to-one
     - One company with many websites
       - (e.g., one per brand)
     - One website for many companies
       - (e.g., franchisees)
     - Companies without website
       - No online activity or using third-party platforms

The Crawler



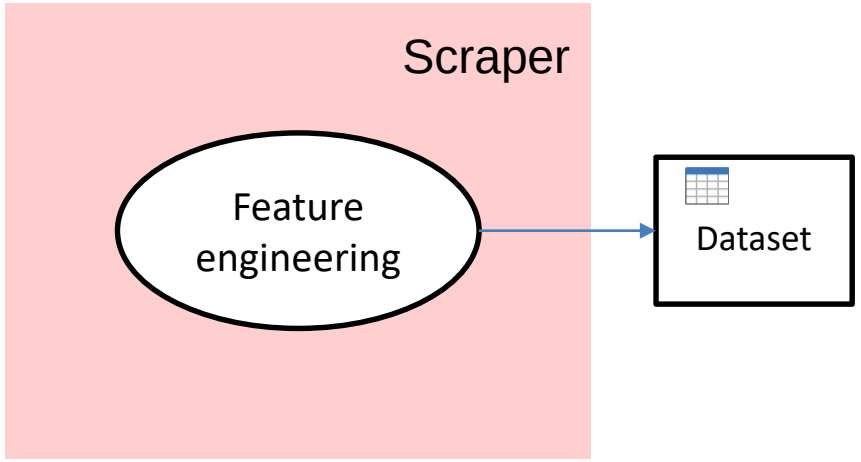
- Website access
  - Definition of website
    - Which domains and subdomains are included?
    - Which objects should be accessed? And processed?
      - Crawling depth
      - Content types of interest (generally HTML and PDF)
  - Technical challenges
    - Expired domains or unavailable servers
    - Browser technology (JavaScript or Flash)
    - Loops and content deduplication
    - CAPTCHAs (generally used by CDNs)
  - Ethical considerations
    - Netiquette
    - Avoiding server overload (and bans)

The Crawler



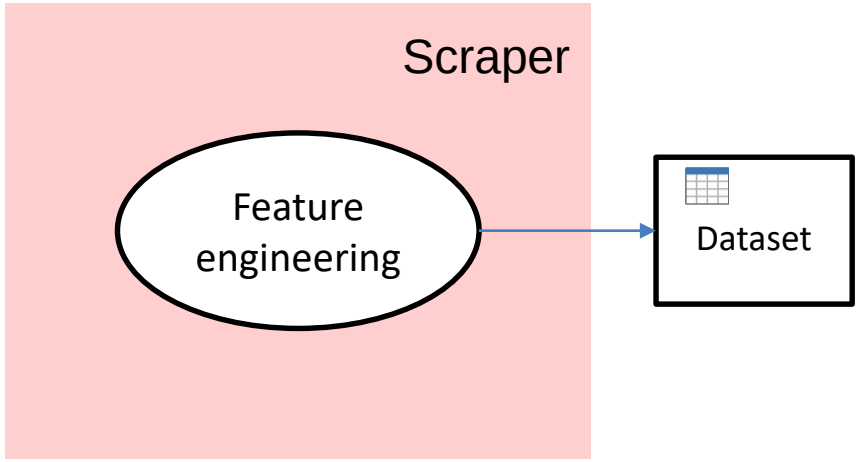
- Content extraction
  - Relevant contents:
    - DNS / Whois [3-7]
    - Server headers [1]
    - Content types
      - HTML
        - » **Text**[1-6,8-13]
        - » Links [1,9]
        - » Code [1-2,9-12]
      - PDF
        - » Text [8, 13]
        - » Metadata [8]
      - Other

The Scraper



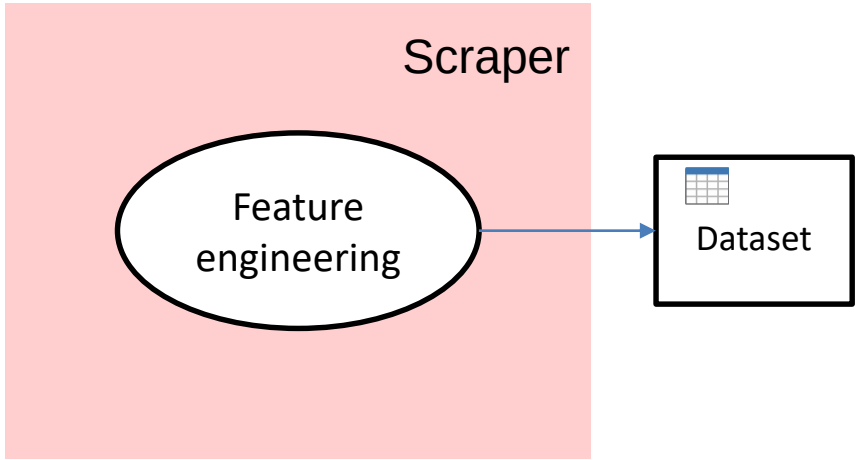
- Objective:
  - Create minable view from unstructured data
- Techniques for text (and code):
  1. Bag-of-Words[1-6,8-13]
     - Simple method: it just computes frequencies
     - Definition of a dictionary of words of interest
     - It may include a prior stemming process

The Scraper



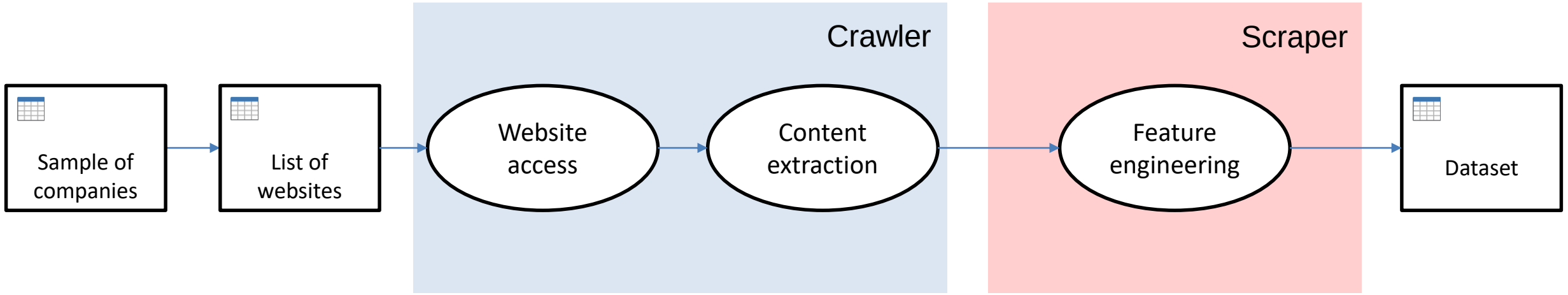
- Objective:
  - Create minable view from unstructured data
- Techniques for text (and code):
  2. Embeddings [*]
     - They may work at different level:
       - Word
       - Sentence
       - Document…
     - It transforms input into numeric vectors
     - Difficult interpretation
     - Good for clustering

The Scraper



- Objective:
  - Create minable view from unstructured data
- Techniques for text:
  3. Topic modeling (e.g., LDA)
  4. Transformers (e.g., BERT)
     - Applied to text classification

The process



How to consider a longitudinal approach?

Dynamics of companies through their websites

- Challenges regarding dynamic studies:
  - Access to website contents:
    - Past? → Wayback machine [2, 7, 21-23]
      - Works well for popular sites
      - Limited coverage both in terms of websites and time frequency
    - From now on
      - Which contents to crawl? All of them?
  - Storage of website contents:
    - Which contents to store?
    - Change detection?
  - Feature engineering of differences in contents: f(ΔW)
    - Or differences in features of contents: Δf(W) [10, 12]

Summary

- Company websites are a rich source of information about companies
- Sample Construction:
  - Challenges in mapping companies to websites
- Crawling Process:
  - Technical (e.g., expired domains, JavaScript-heavy sites) and ethical considerations
- Analysis Techniques:
  - Textual Content: NLP techniques from BoW to encoders.
  - Non-Textual Content reveals technological choices and .
- Dynamic vs. Static Analysis

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