Practical Use of Approximate Hash Based Matching in Digital Investigations

By

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About me

- MSc. student at Gjøvik University College, Norway
  - Information security, specialization in digital forensics
  - Currently writing my master thesis
- Software developer

Agenda

- Motivation and summary of contributions
- Approximate matching (Fuzzy hashing) - What is it and why do we care?
- What is similarity?
- Three modes of Approximate Hash Based Matching (AHBM)
- Practical scenarios with AHBM
- Open research questions

Motivation

- What we can use approximate matching for?

Summary of contributions (1/4)

- **Paper:** Exploration of modus operandi for AHBM in digital investigations.

Summary of contributions (2/4)

- **Tool:** sddiff
  - Visualize similarity between two files.
  - Based on the feature selection algorithm in sdhash.
  - Find positions of fragments from the smaller file within the larger file.
  - https://github.com/pcbje/sddiff

Summary of contributions (3/4)

- **Tool:** Autopsy AHBM
  - The Sleuth Kit Autopsy 3 module for doing approximate matching.
  - 2nd place in Basistech 2013 Autopsy module development contest
    - (Yes, out of two participants)
  - http://github.com/pcbje/autopsy-ahbm
  - Video presentation: http://youtu.be/GBmZRufH_3o

Summary of contributions (4/4)

- **Tool:** makecluster
  - Split network into disjunct clusters. Handy when dealing with large, sparse networks.
  - https://github.com/pcbje/makecluster

Approximate Matching

Approximate Matching

- Techniques for the identification of *similar* data
  - Updated documents
  - Fragments of files in memory or hard drives
  - Pictures
  - Videos
  - +++
- Degree of similarity
- Useful when cryptographic hashes aren’t well suited

What is similarity?

What is similarity?

- With documents, there are two types of similarity we can measure:
  - Semantic similarity
  - Syntactic similarity

Semantic similarity

- Similarity from the perspective of humans
- Two documents are semantically identical if they communicate the same meaning
  - Different formats of the same document

Semantic similarity

Merzouga, Morocco

Syntactic similarity

- Similarity from the perspective of computers.
- Two documents are syntactically identical if have the same binary representation.
- Generally not suited for matching media files like pictures and videos.
    - Exception: Fragments of deleted pictures on a hard drive.

Syntactic similarity

- The brown **fox** jumped over the lazy dog.
- The brown **cat** jumped over the lazy dog.

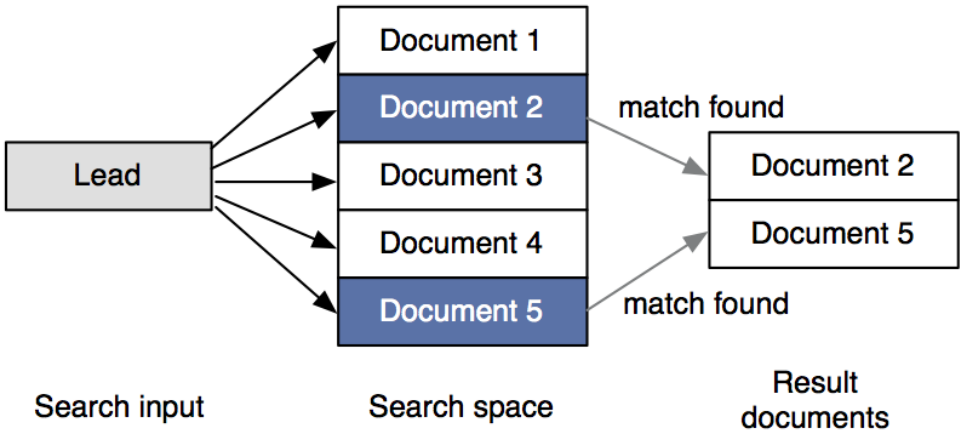
Modes of Approximate Hash Based Matching

Modes of Approximate Hash Based Matching

- Searching
- Streaming
- Clustering

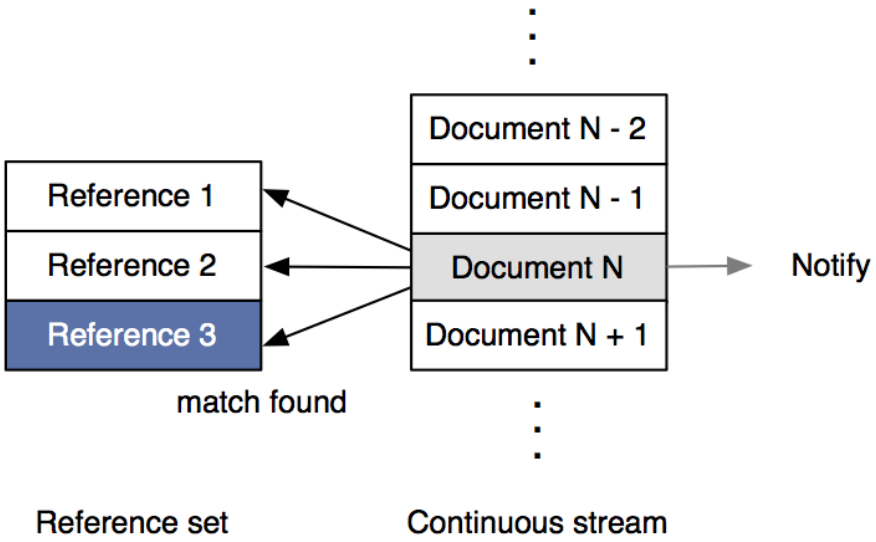
Mode: Searching

- Small input, large search space.
- Typically a query you perform once when you need it.



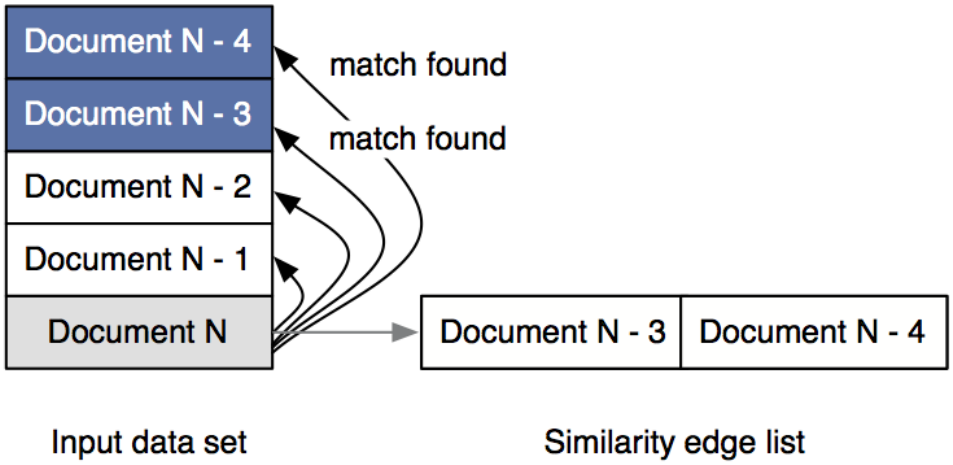
Mode: Streaming

- Large input, small search space.
- Typically a continuous query.



Mode: Clustering

- Large input, large search space.
- Organize and find patterns in unknown data.



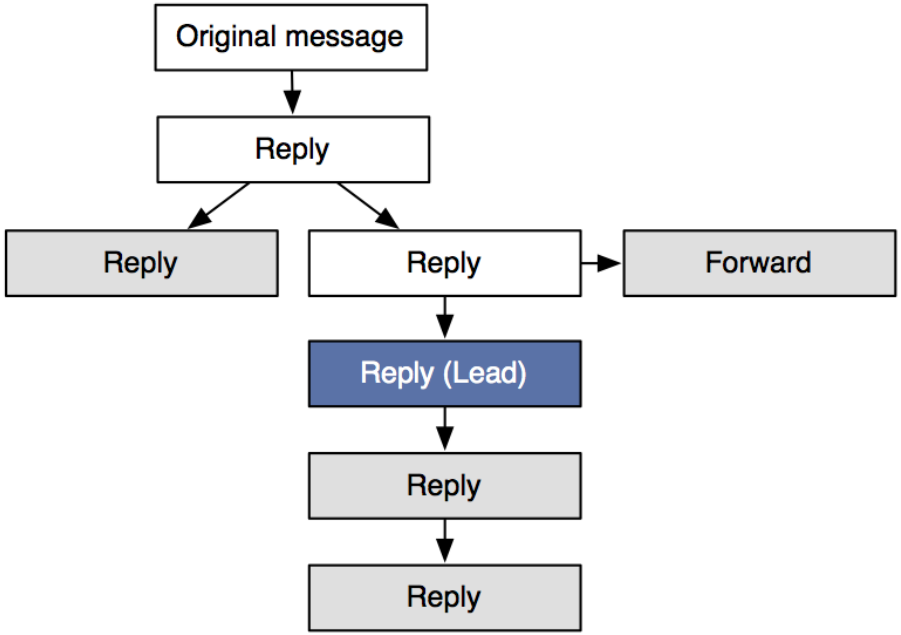
Practical scenarios with AHBM

Practical scenarios with AHBM

- Alternative versions detection
- File transfer detection
- Organization of documents

Alternative version detection

- We want to identify documents that are similar to one we have found.
- E.g. revisions of a PDF document or an email thread.



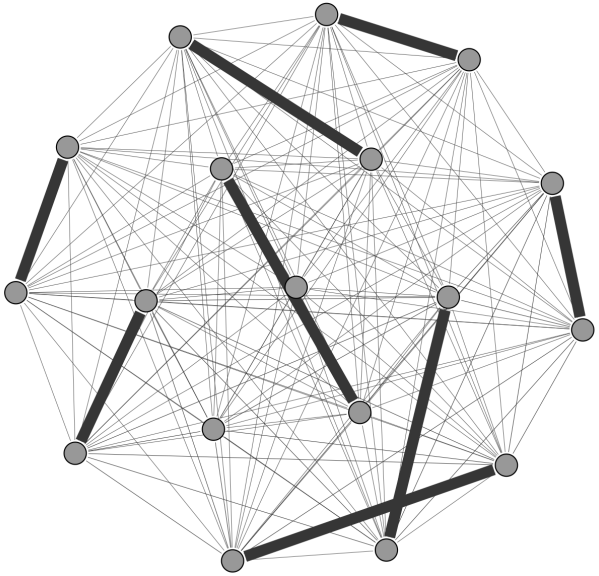
File transfer detection

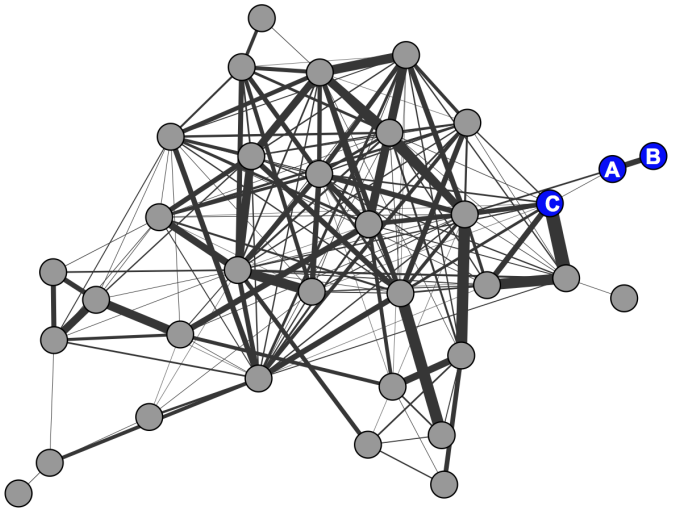
- Detect when traces of some specified data is transferred over the network.
- E.g. download of specific software packages.

Role	Filetype	Similarity score
Installer	Executable	31
Installed tool	Executable	1
User guide	PDF	2
Tool formatter	Executable	2

Organization of documents

- We are faced with a large, unknown corpus of data.
- We want to group together documents based on similarity.

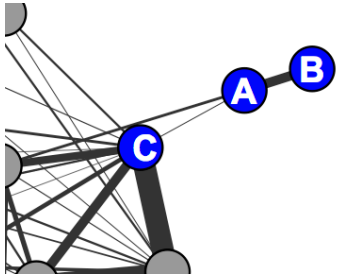




Organization of malicious PDFs with sdhash

Similarity scores among documents *A*, *B* and *C*.

Document 1	Document 2	Similarity score
A	*B*	027
A	*C*	010
B	*C*	001



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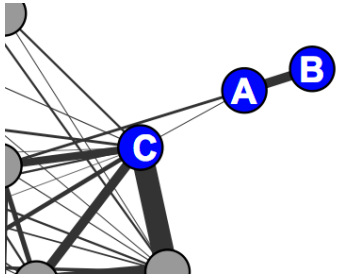

Position of fragments of B in A:

Organization of malicious PDFs with sdhash

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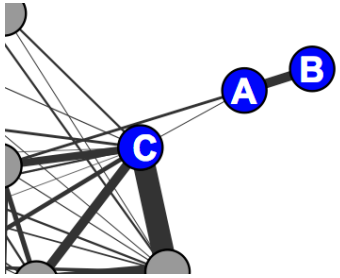
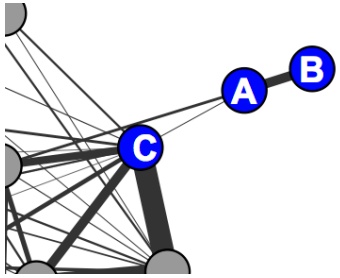


Position of fragments of C in A:

Organization of malicious PDFs with sdhash

Similarity scores among documents *A*, *B* and *C*.

Document 1	Document 2	Similarity score
A	*B*	027
A	*C*	010
B	*C*	001



Position of fragments of C in B:

Open research questions

Open research questions (1/2)

- How can we improve approximate matching efficiency?

Open research questions (2/2)

- Can approximate matching be used to detect variations of known malware?

Conclusions and resources

- **Three modes of approximate matching**
  - Searching (ad-hoc query)
  - Streaming (continuous query)
  - Clustering (organization of data)
- **Open source resources**:
  - http://sdhash.org (syntactic matching tool)
  - http://phash.org (semantic matching tool)
  - http://gephi.org (graph visualization tool)
  - https://github.com/pcbje (stuff)
- **Contact**:
  - petter.bjelland@hig.no