Machine Learning for Network Traffic Analysis and Scientific Metadata Extraction

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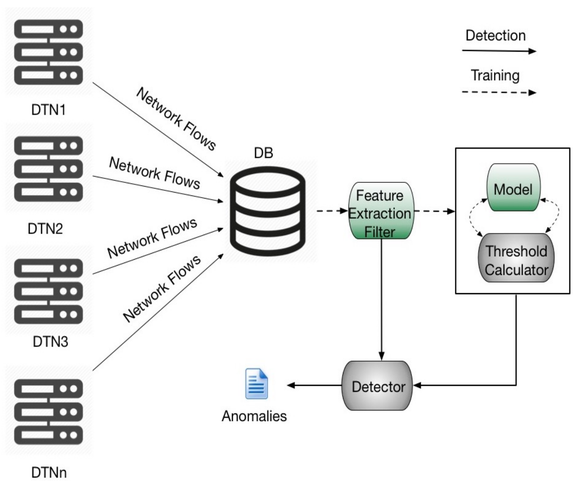
Flowzilla: A Methodology for Detecting Data Transfer Anomalies in Research Networks

Problem Statement

- Research networks enable large data transfers between endpoints
- Research networks get attacked just like any other network
- Establishing a profile for “normal” network behavior is hard
- Lack of ground truth generates many false positives

Approach

- Focus on volume anomalies, unexpected changes in the volume of data transfers
- Use machine learning to establish notion of normality (**Random Forest Regression**)
- Detect candidate anomalies (i.e. outliers) based on **distance** from normal profile
- Calculate distance based on adaptive threshold mechanism
  - Threshold definition is tricky
  - Too low → Increases the # of false negatives
  - Too high → Increases the # of false positives
  - Constant value does not account for seasonal trends
- Adapt threshold value based on detection results

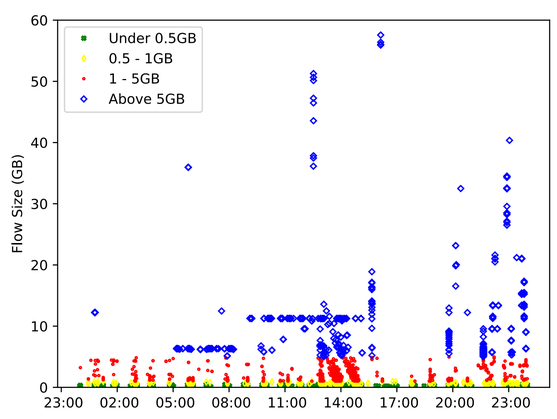


Flowzilla’s components for model training, threshold calculation and detection of anomalous flows

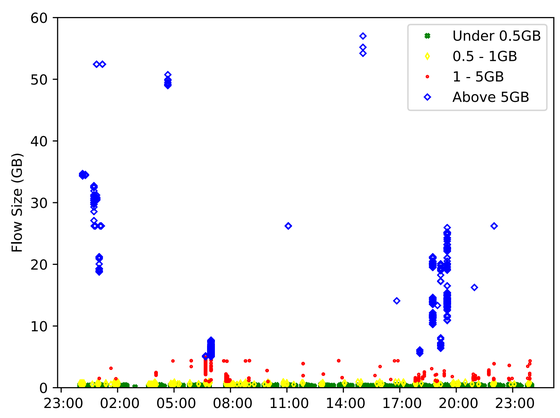
Next Steps

- Expand to other types of anomalies
- Detect anomalies that span across multiple flows

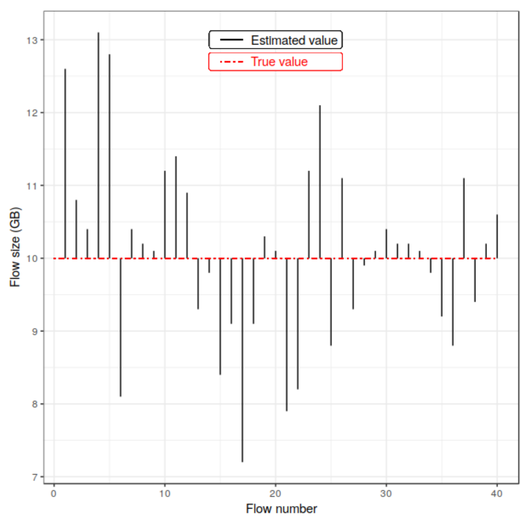
Evaluation - Results



Volume of data transfers on 29/05/2018



Volume of data transfers on 05/06/2018



Flowzilla’s prediction on anomalous flows sizes

- **Detection rate up to 92.5%**
- **Accuracy above 80%** in predicting anomaly sizes

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Giannakou Anna, Gunter Daniel, Peisert Sean. (2018). Flowzilla, A Methodology for Detecting Data Transfer Anomalies in Research Networks . INDIS

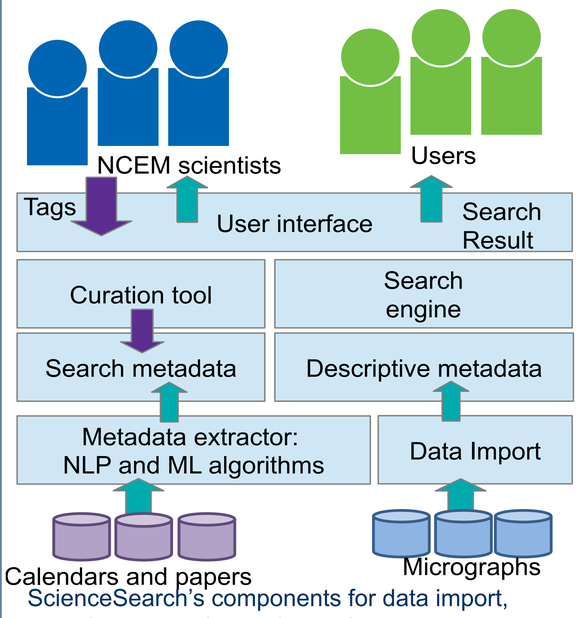
ScienceSearch: Enabling Search through Automatic Metadata Generation

Problem Statement

- Scientific discovery depends on exploring large amounts of data
- Adding the right metadata to large datasets is is done manually
- Automatic metadata creation requires tuning

Approach

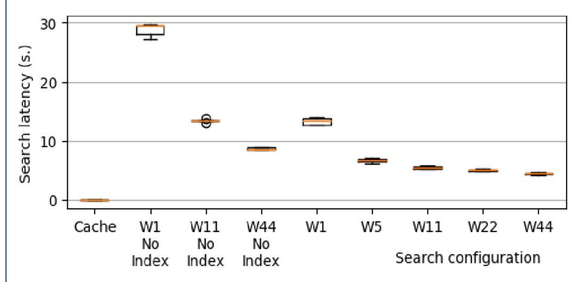
- Automate scientific data exploration through scalable search engine
- Incorporate user feedback in result verification and metadata analysis recalibration
- ScienceSearch features four components: **data import, metadata extraction, search engine** and **user feedback**
  - Data import: identify searchable data and related metadata
  - Metadata extraction: generate metadata that characterize searchable data. Metadata include information about the purpose and production conditions (e.g. experiment) of the data.
  - Search engine: enables search based on the generated metadata based on a hit score. Hit score represents the similarity between the search query and the metadata.
  - User feedback: users can modify and invalidate existing metadata or add new ones through a specific **tagging tool.**
- Metadata is extracted by using NLP tools **(TextRank, Spacy, Tf-idf).** A curated **feature detection model** describes relationships between data and metadata



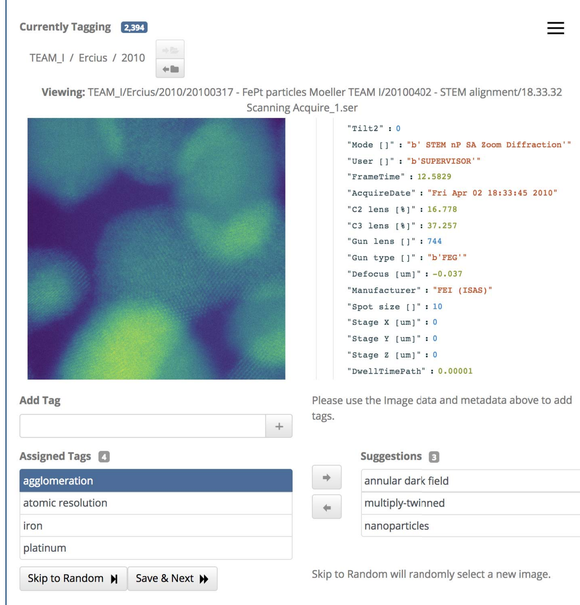
ScienceSearch’s components for data import, metadata extraction and search

Evaluation - Results

Measure search result latency for cached and not cached queries
Approve/invalidate generated tags through tagging tool



Search latency of a query is under 30s (worst case scenario). Parallelizing the hit score calculation and hit aggregation reduces latency up to 2/3 (under 10s).



ScienceSearch’s user tagging tool

Next Steps

- Expand metadata generation to other sources (e.g. file system structure) using machine learning **(unsupervised clustering, weighted clustering)** and natural language processing **(named entity recognition, chemical element extraction, word embedding creation)**
- Use deep learning to assign value scores to new metadata sources (**weighted classifier**)
- Explore relationship between data based on file system structure

Acknowledgements

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P. Rodrigo, Gonzalo & Henderson, Matt & Weber, Gunther & Ophus, Colin & Antypas, Katie & Ramakrishnan, Lavanya. (2018). ScienceSearch: Enabling Search through Automatic Metadata Generation. eScience

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