Automatic Prioritizing of Abnormal Situations in the Context of Fraudulent Claims (with Graph-of-relations Analysis)

Prepared by

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the co-operators
Expert, Claims Portfolio Analytics

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University of Bath
Ph.D. Student

Francis Duval
UQAM
Ph.D. Student

Bowei Zhang
University of Western Ontario
Master Student

2019-08-23

A win this morning ...

is that you

- understand the approach that the group took to make progress on the problem
- have fun listening to us

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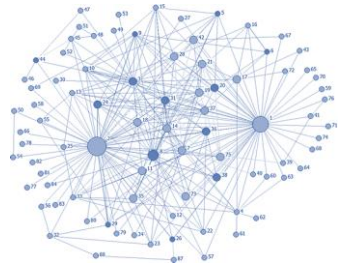
Problem re-statement



Produce an interpretable claim-level score that allows Special Investigation Unit analysts to decide which claims to investigate

The team

Fabian Ying, Lindon Roberts, Matthew Griffith, David Mazurkiewicz, Anthony Forgetta
Marc-André Desrosiers, Steven Côté, Anas Abdallah, Helen Samara Dos Santos
Mathilde Bourget, Manuel Morales, Caio De Naday Hornhardt, Bowei Zhang, Francis Duval

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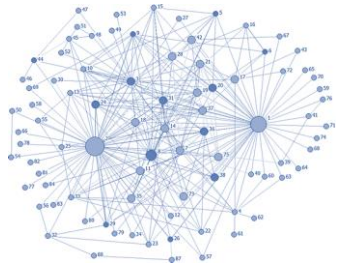
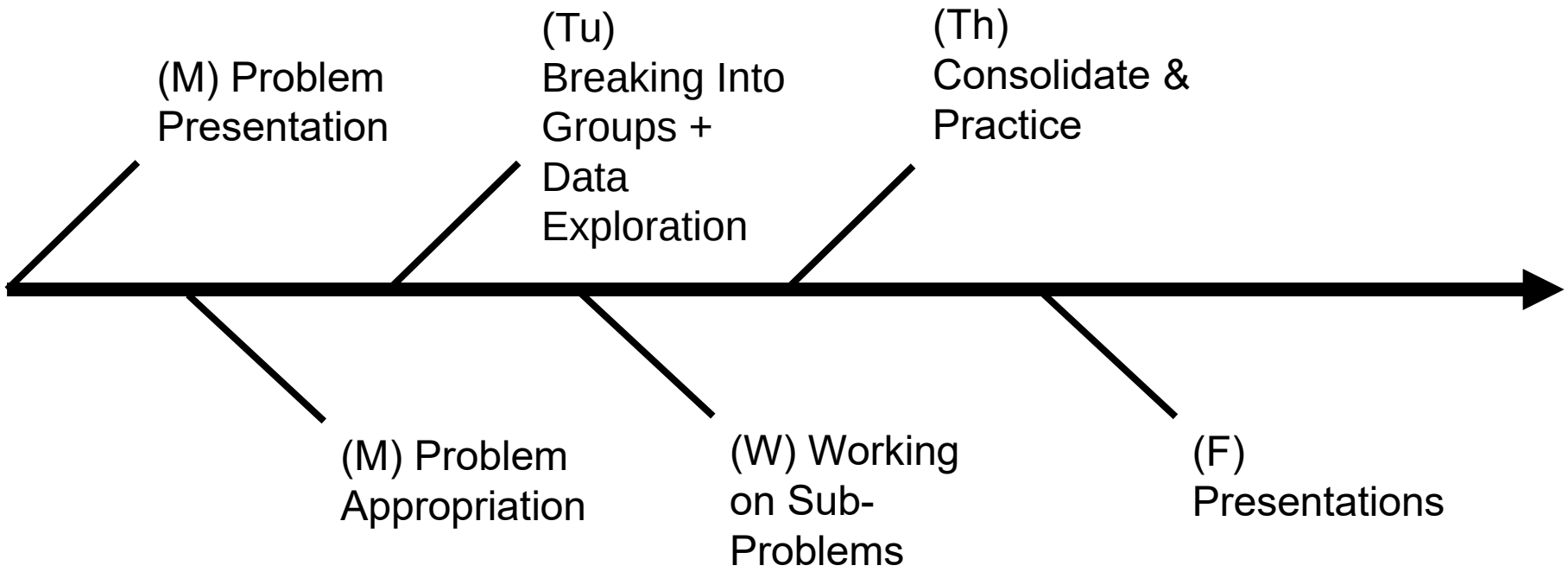
Timeline





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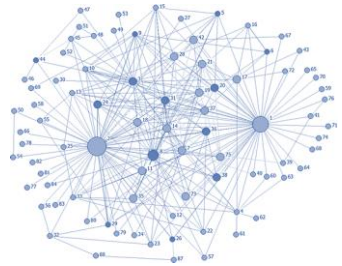
Academic point-of-view



- For supervised learning, more data!
- Better network data!
- More detailed annotations!
- High-dimensional anomaly detection is generally difficult!!!

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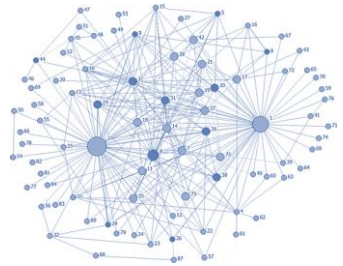
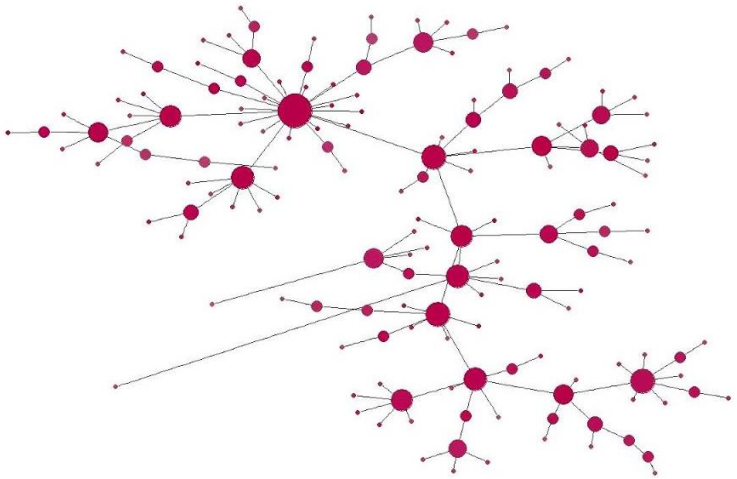
Taskforce creation



Data Exploration

Network Representation
Fabian, Matthew, Lindon



Anomaly Detection
Bowei, Anthony
Francis, Caio, Helen

Advanced Analytics
Bowei, Anthony
Francis, Caio, Helen

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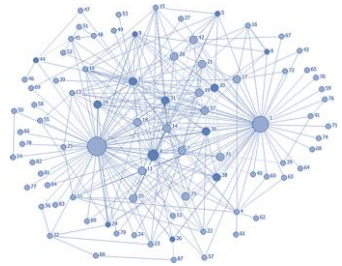
Scoring Methodology

Advanced Analytics



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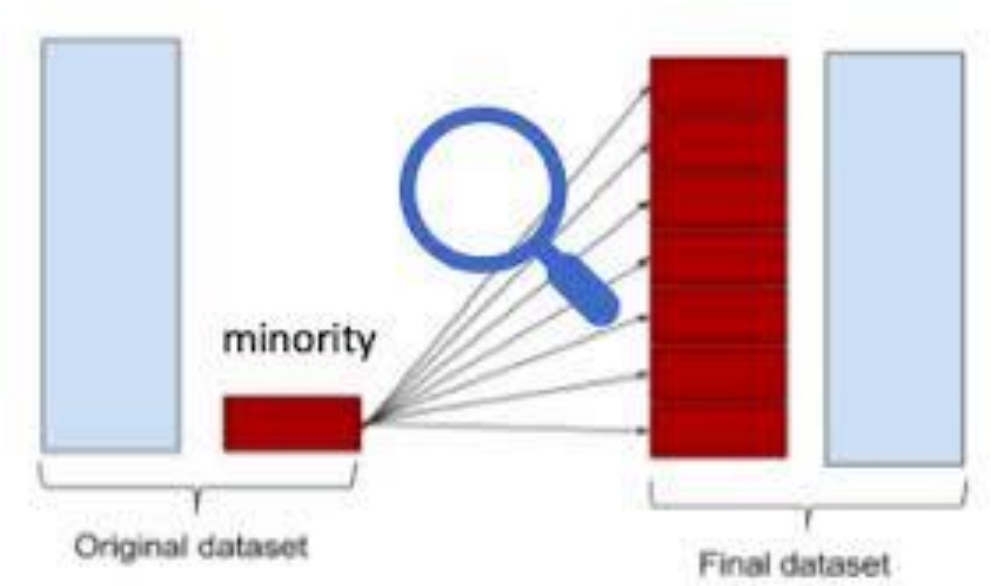
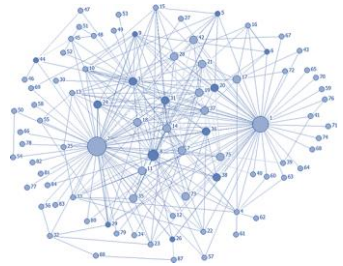
Uncommon events

Oversampling (on steroids)

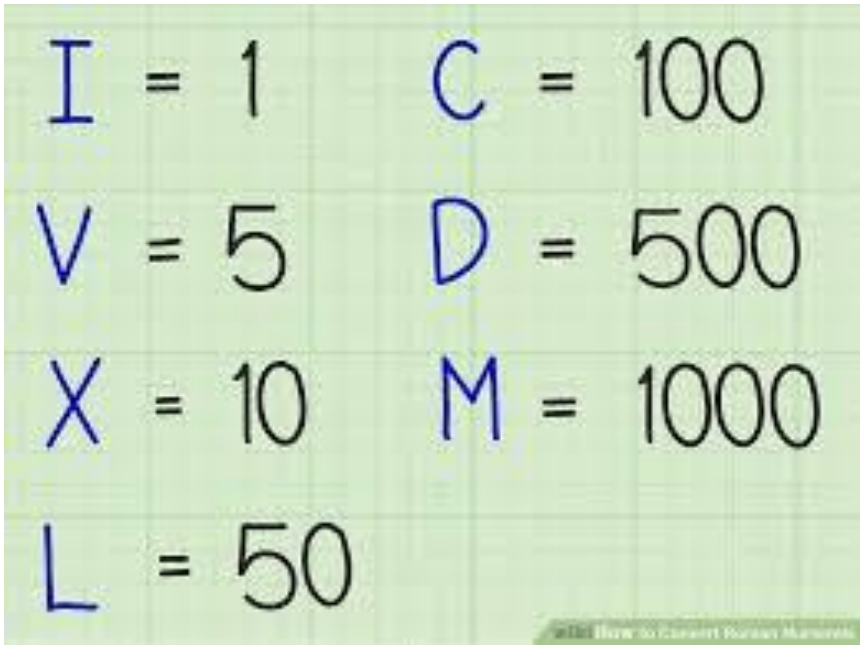


Advanced Analytics



Categorical variables

Target encoding



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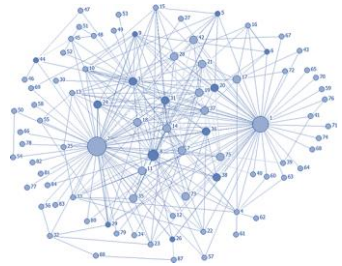
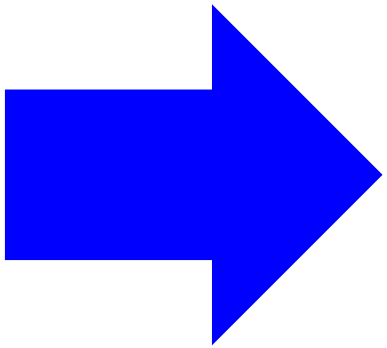


Missing values



Appropriate treatment

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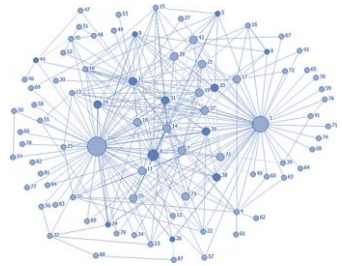
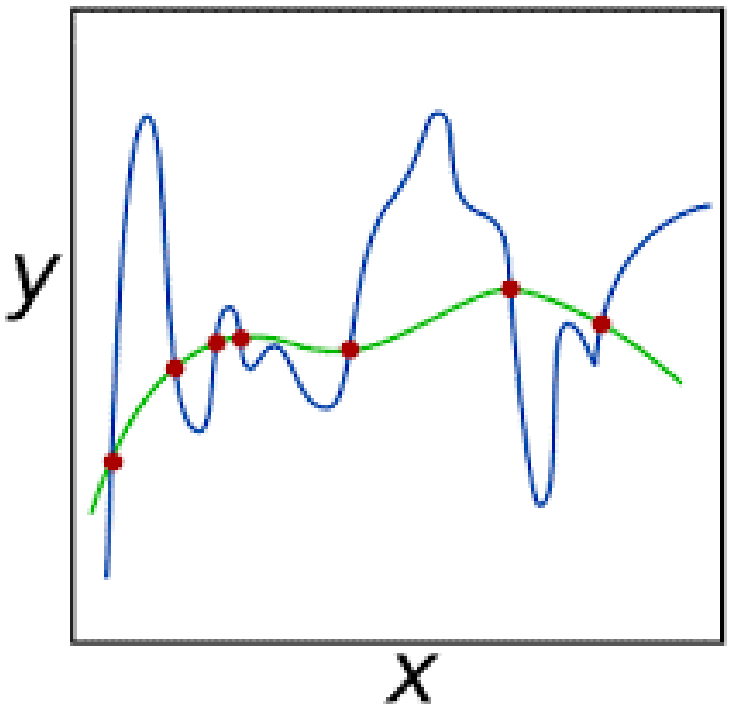
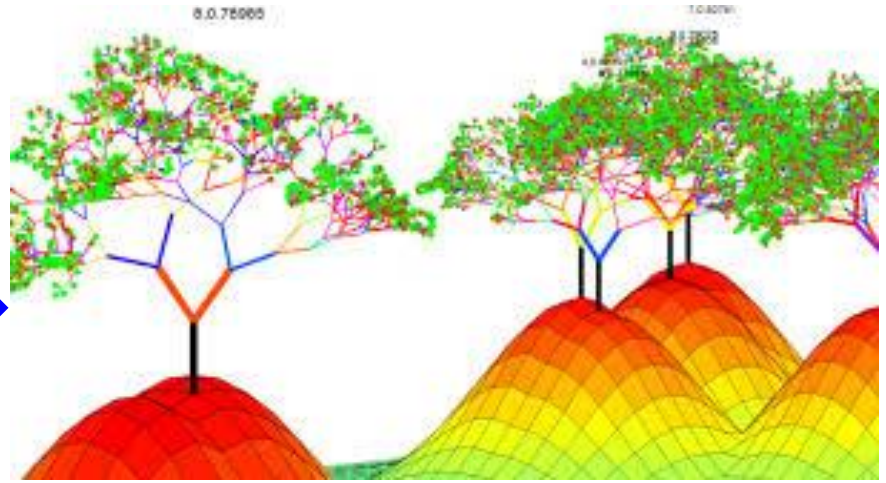


Selection of variables



Importance of variables



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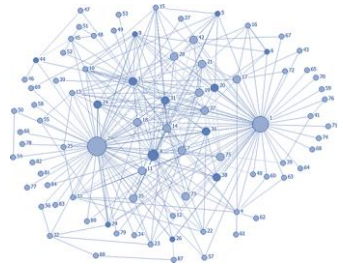

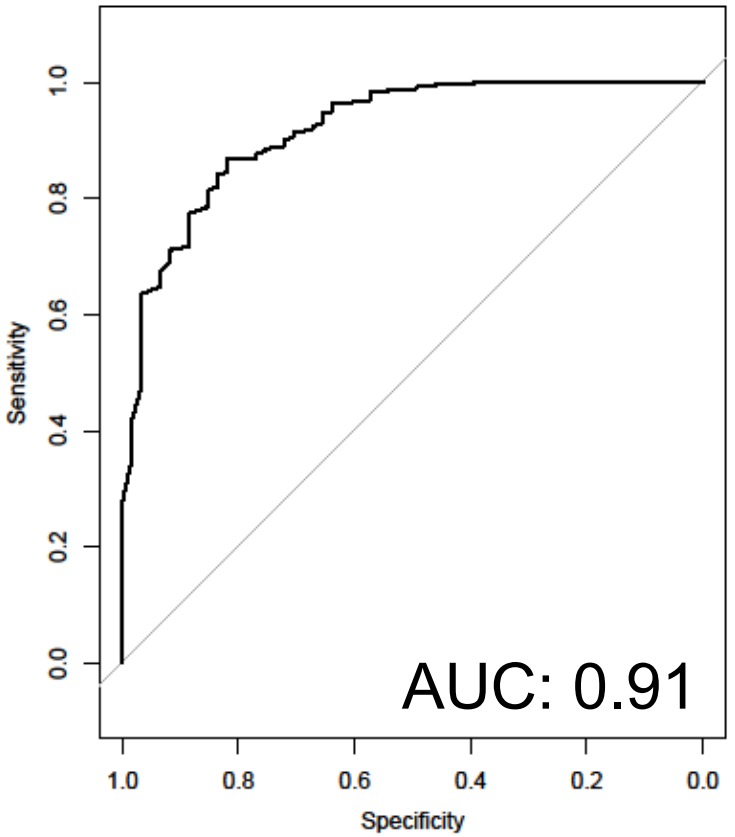

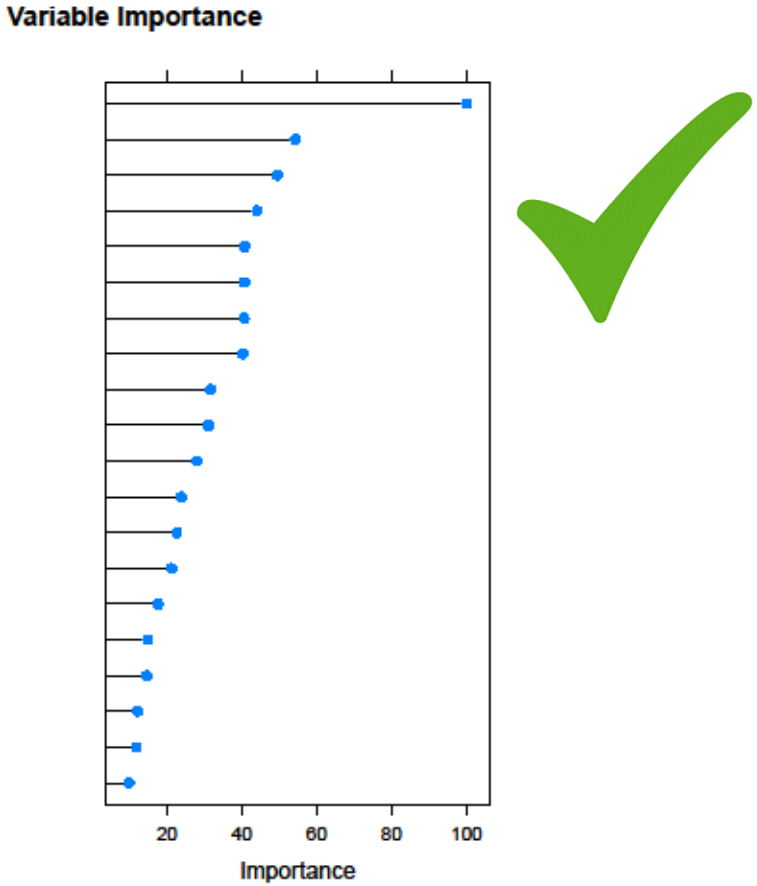

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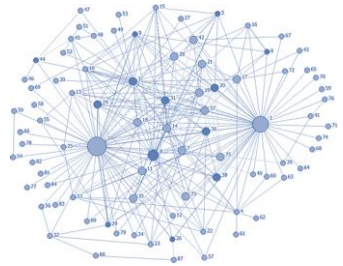

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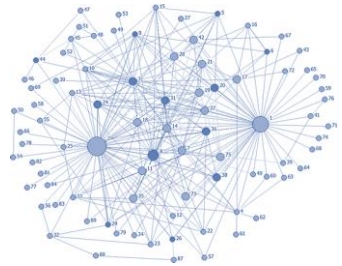
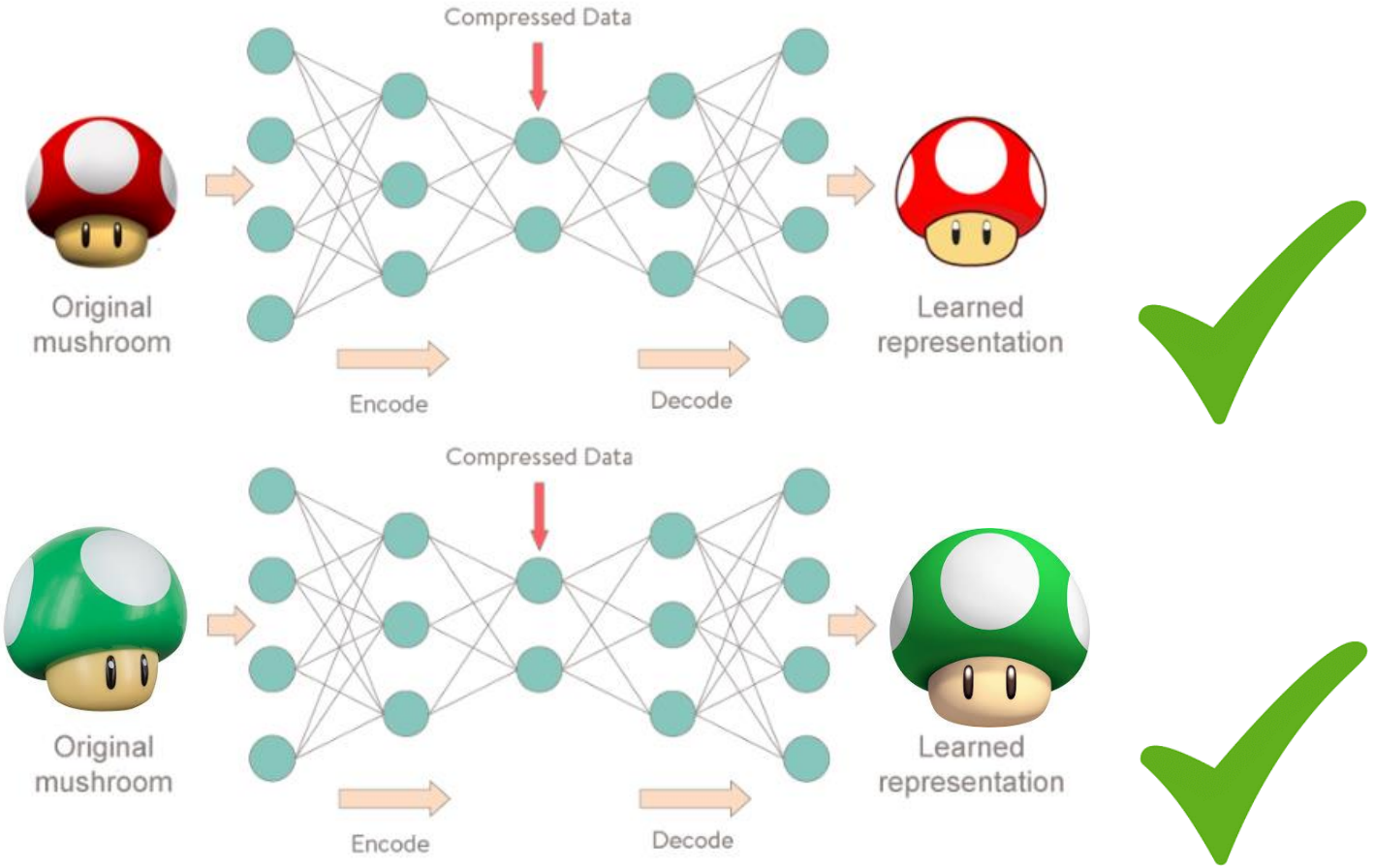
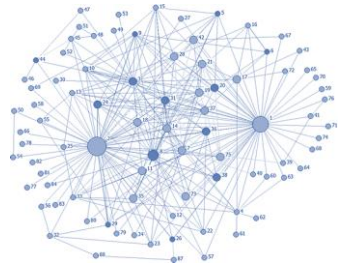
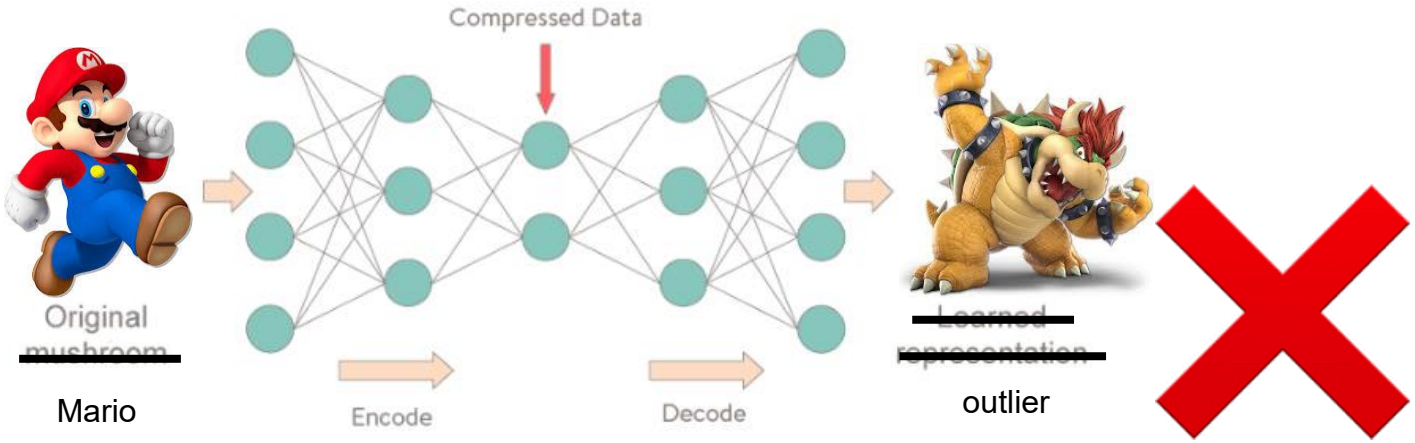


Autoencoder approach



Anomaly Detection





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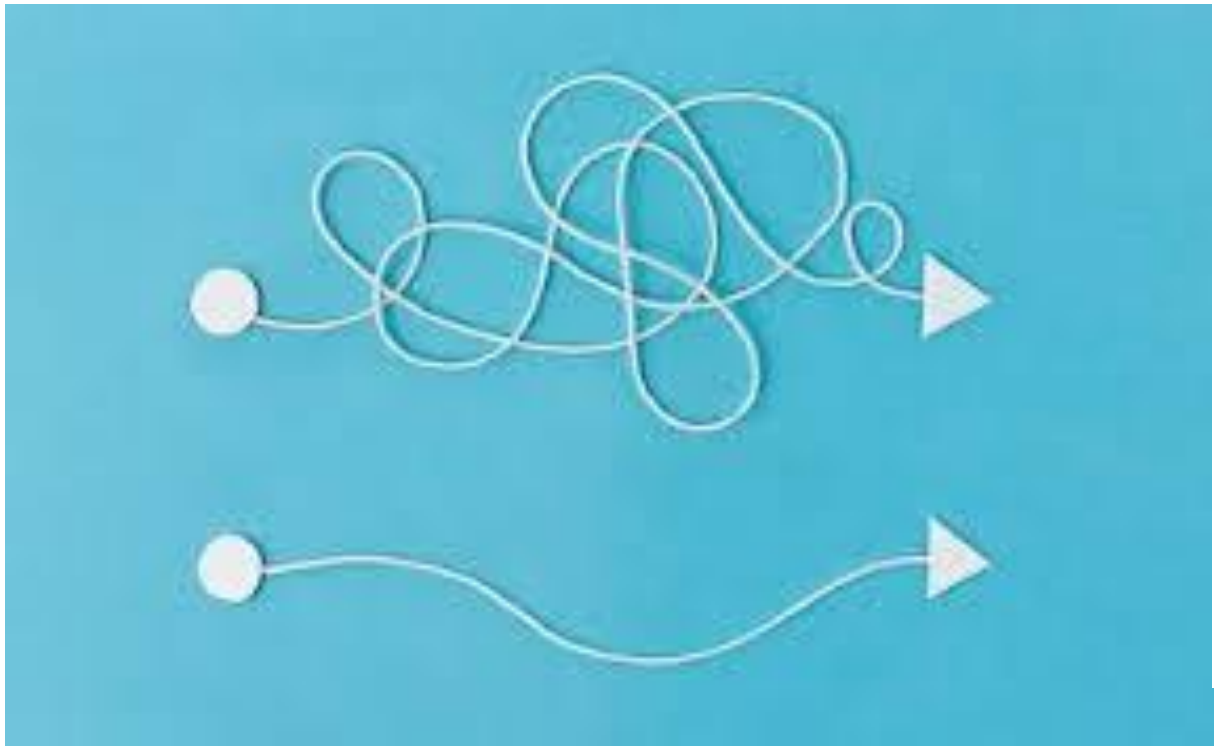

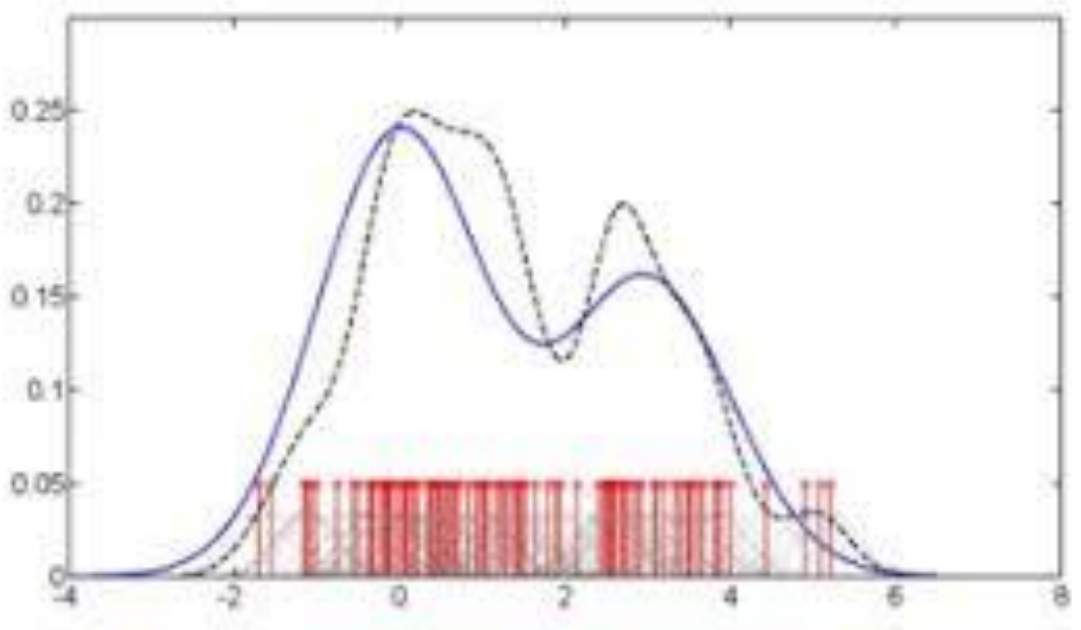

A couple of variables at a time

Worked with ~93 variables but not full dataset: convergence issues

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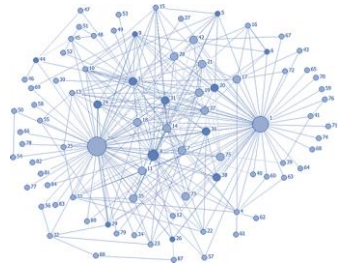
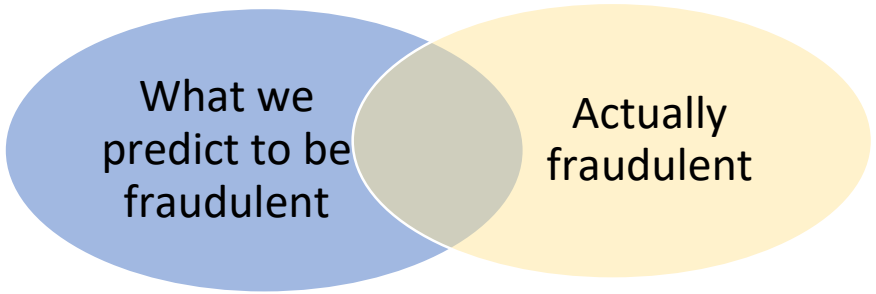
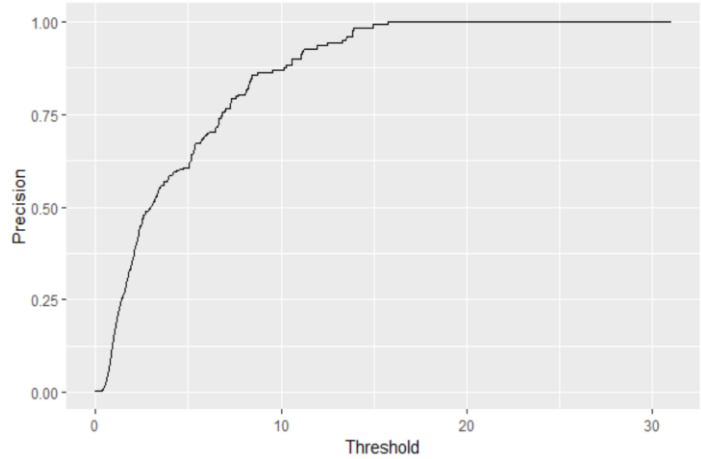
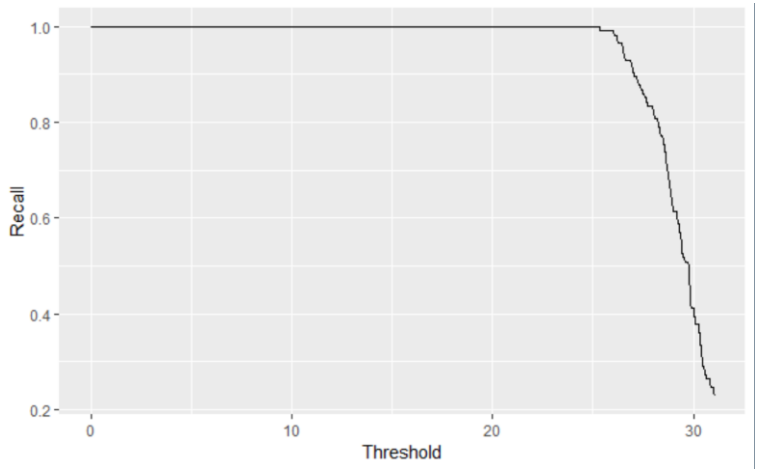


Precision = overlapping/BLUE



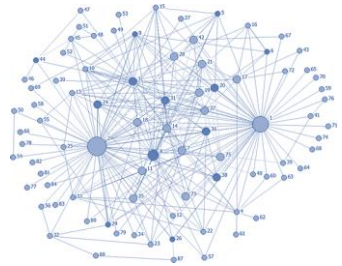
Recall = overlapping/YELLOW





(0.96; 1.00)

Network Representation



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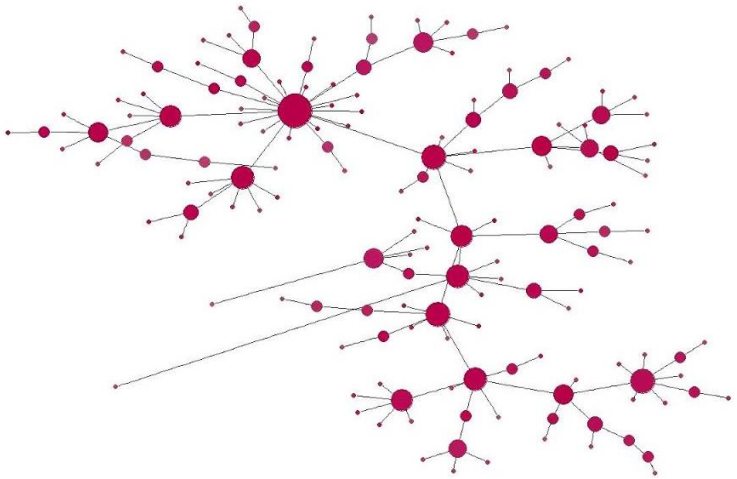

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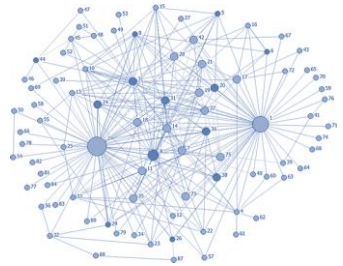
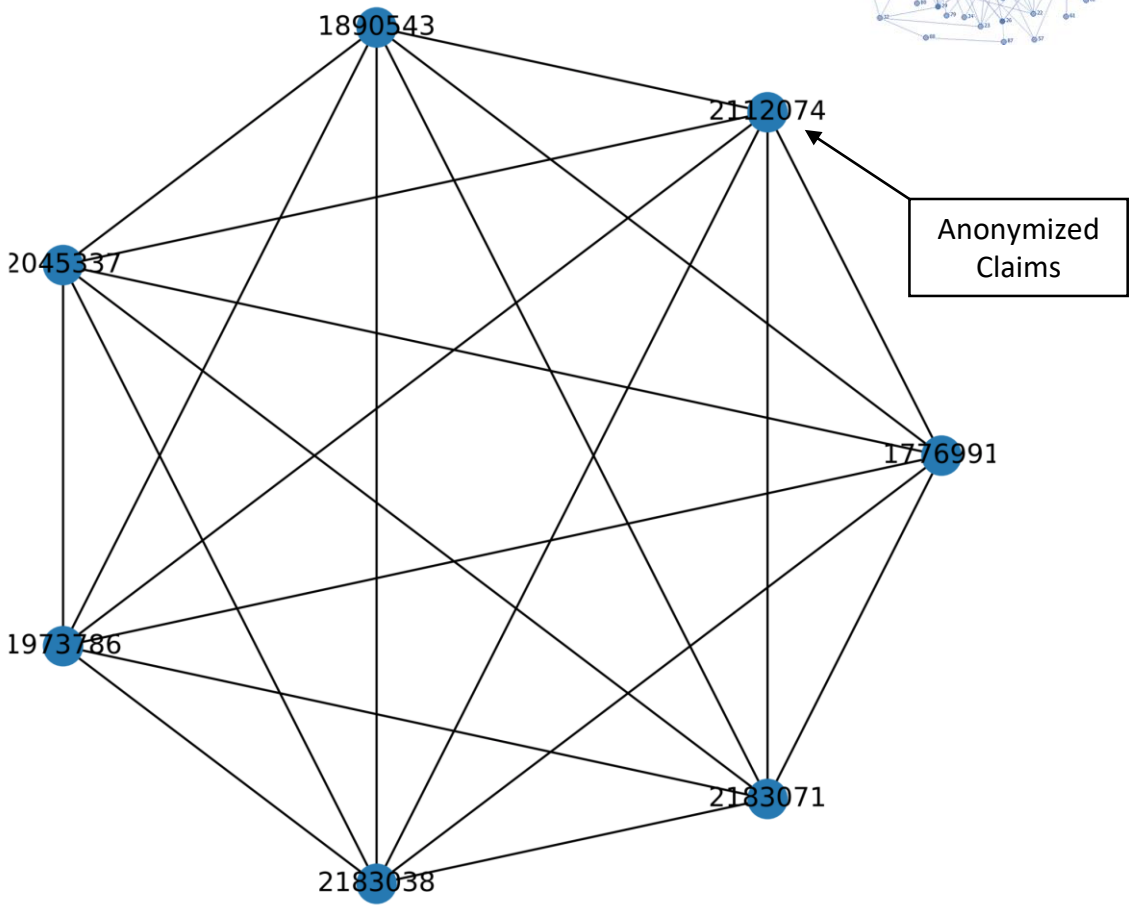
Network Representation

→ Motivation

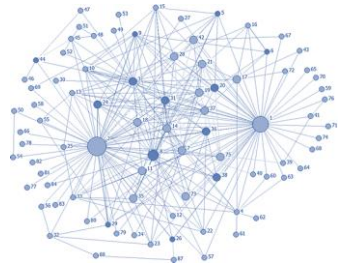


- Exploration of underlying network structure in data.
- Initial investigation using address.
- Important fraudulent case flagged. ⚠
- Suggestive of network structure being useful to detect fraudulent cases.
- Validated continuing with this method.



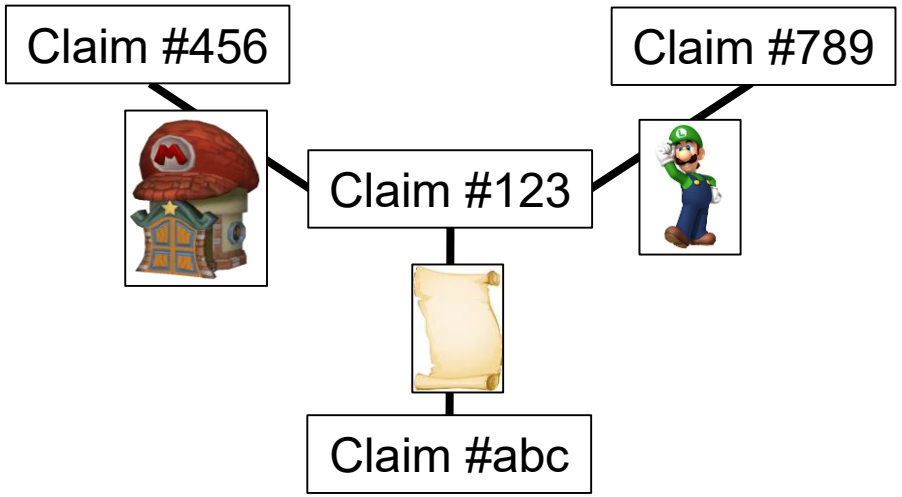
Network Representation

→ Construction



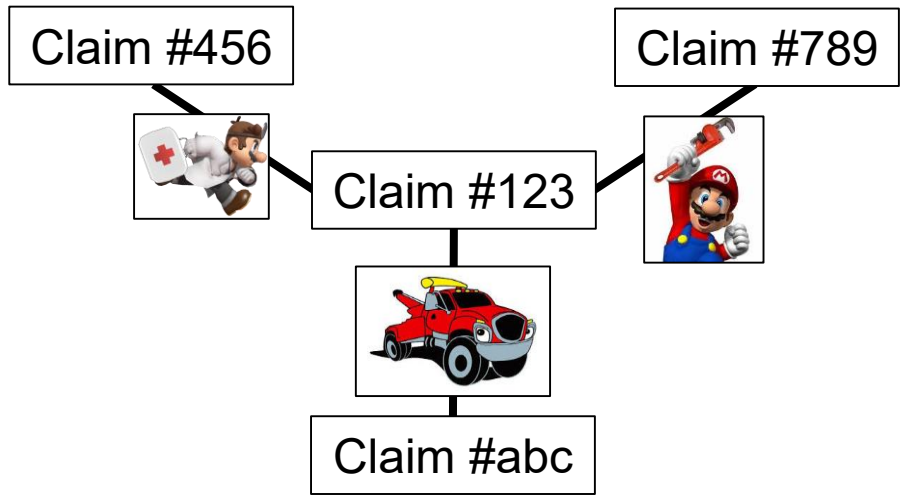
Personal Network

Connected by sharing personal properties



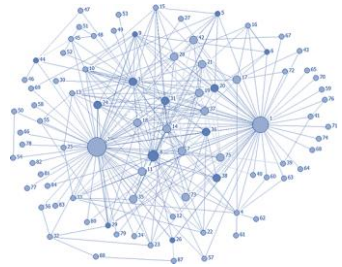
Vendor Network

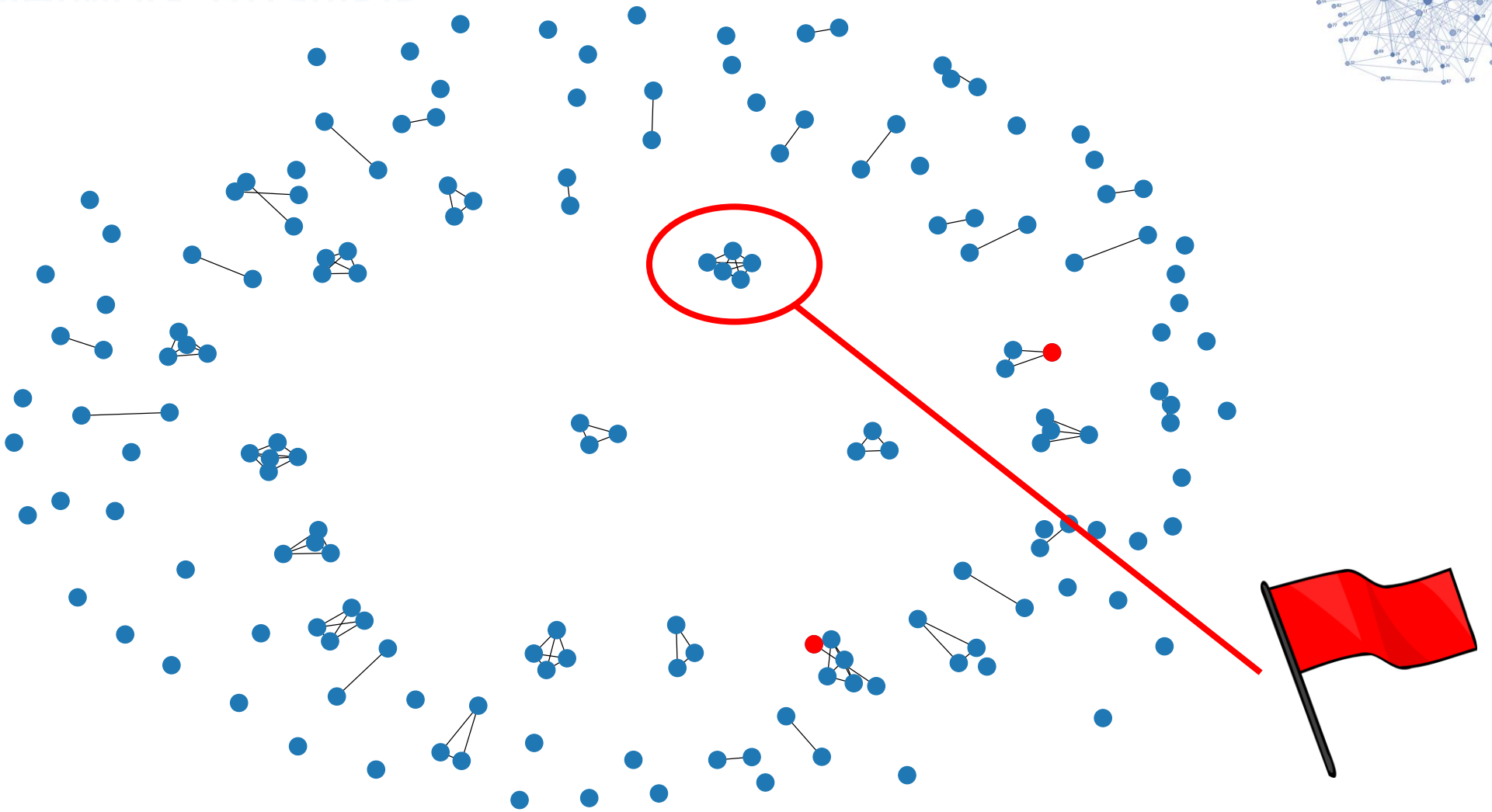
Connected by sharing other types of parties involved



Network Representation

→ Personal Network Analysis

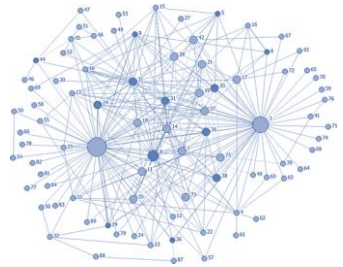


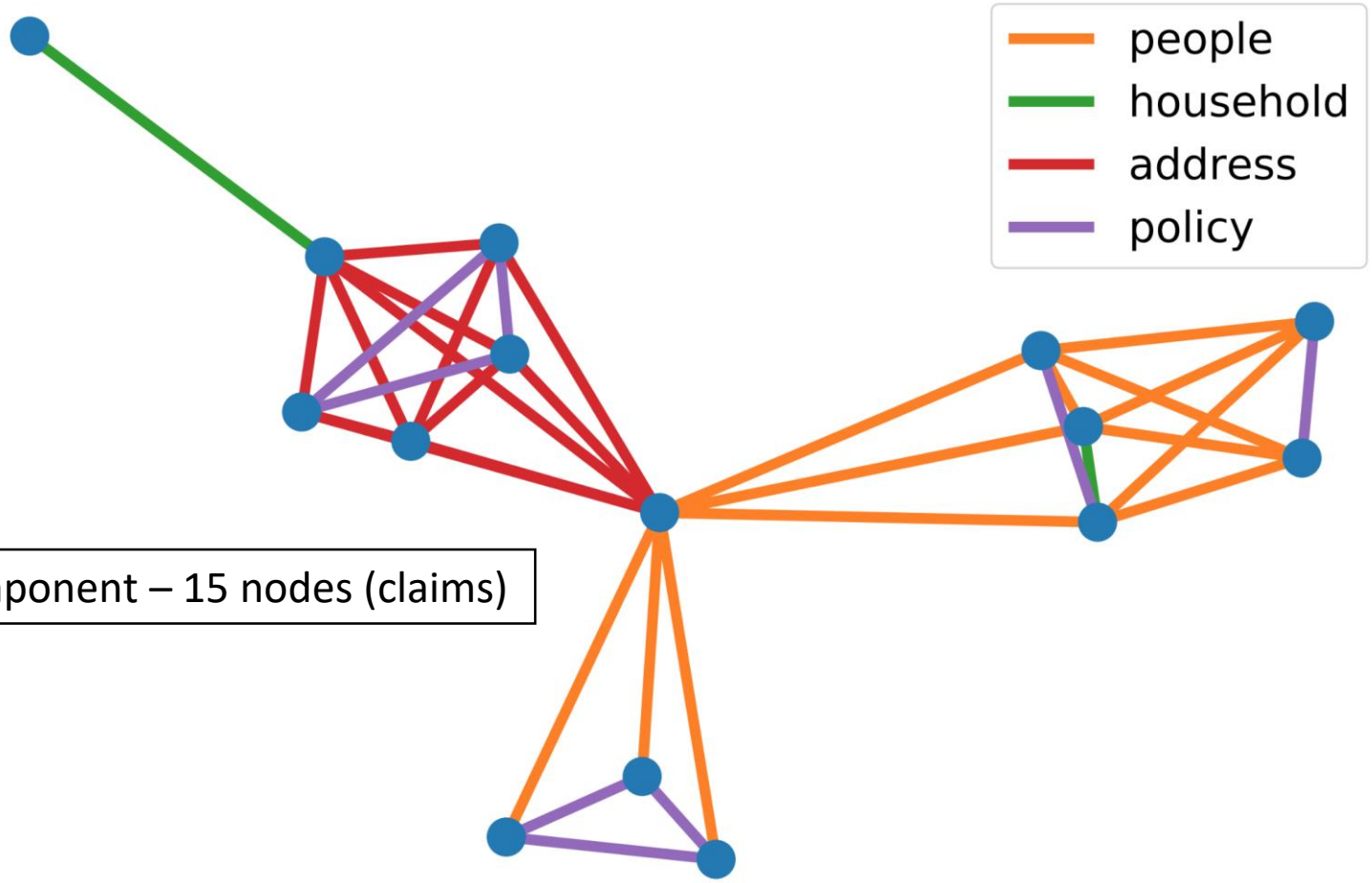


⚠ Component size provides good metric of cases to flag ⚠

Network Representation

→ Personal Network Analysis



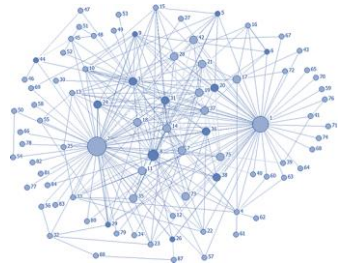


Largest Connected Component – 15 nodes (claims)

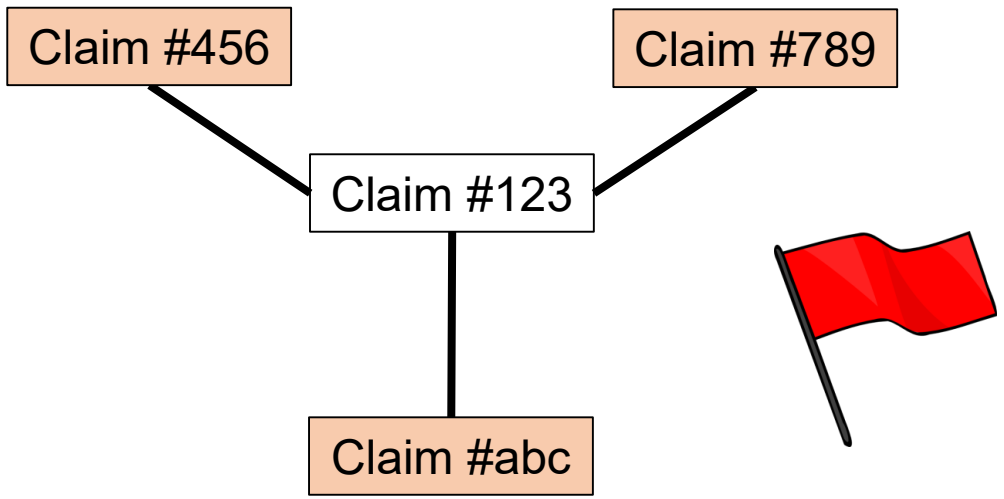
⚠ Typical cases worthy of escalation ⚠

Network Representation

→ Vendor Network Analysis

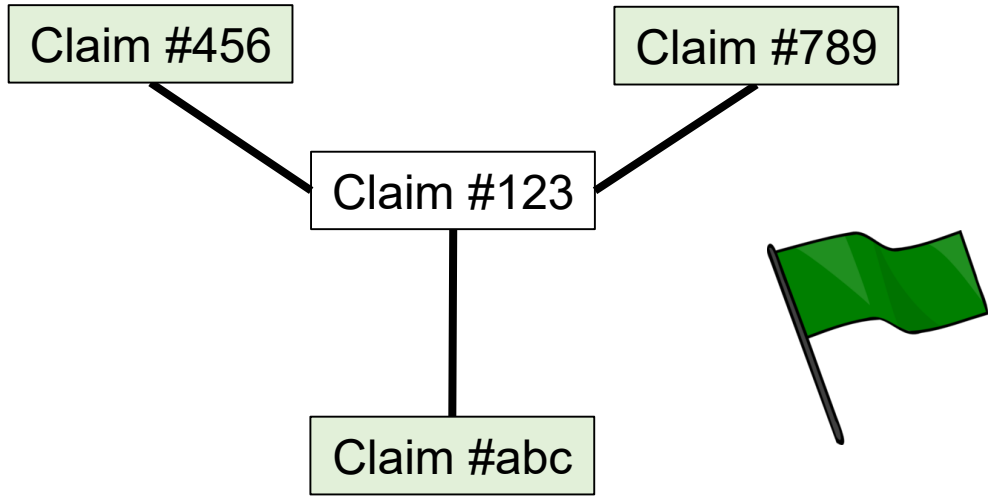


Claim surrounded by claims with 'bad' features



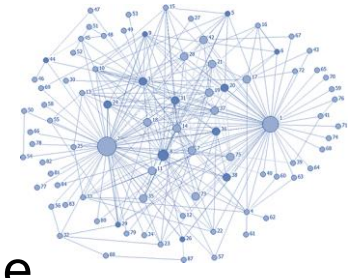
vs.

Claim surrounded by claims with**out** 'bad' features



⚠ Distance to labelled fraudulent cases provides good metric of cases to flag ⚠

Network Representation



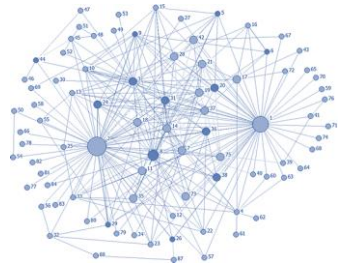
We combine information from all sources to provide a score to help SIU analysts decide which claims to investigate:

⚠ Average risk score of connected claims ⚠

Risk of a claim is then defined by

- A claim's well connectedness in the personal network
- More links to fraudulent cases in the vendor network
- Any other score of risk, e.g. results of regression model and auto-encoder.

Taskforce creation



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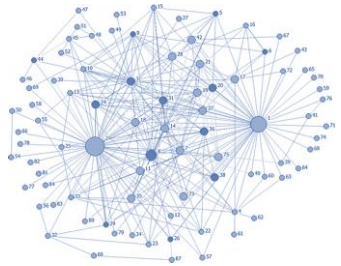
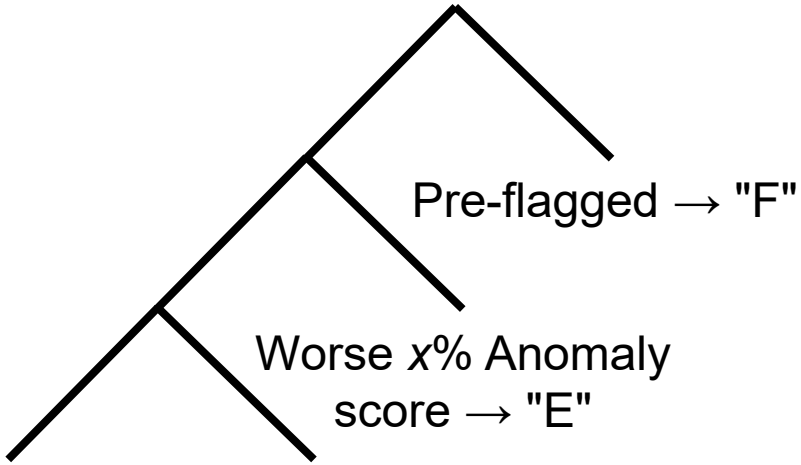
Prioritization (score)

Only reproduces what human flagged already: potentially missing new trends

While it is difficult how much fraud it will detect, we are willing to accept false positives

Prioritization (score)





$$\hat{p} = p_n \cdot \hat{n}_n + p_a \cdot \hat{a}_n + p_s \cdot \hat{s}_n$$

where $p_\pi + p_c + p_s = 1$ and subject to business decision, and

- $\blacksquare_n$ denotes normalized variables, that is, percentiles