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Tackling Cybersecurity Using Graph Mining

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Big Graphs are Ubiquitous

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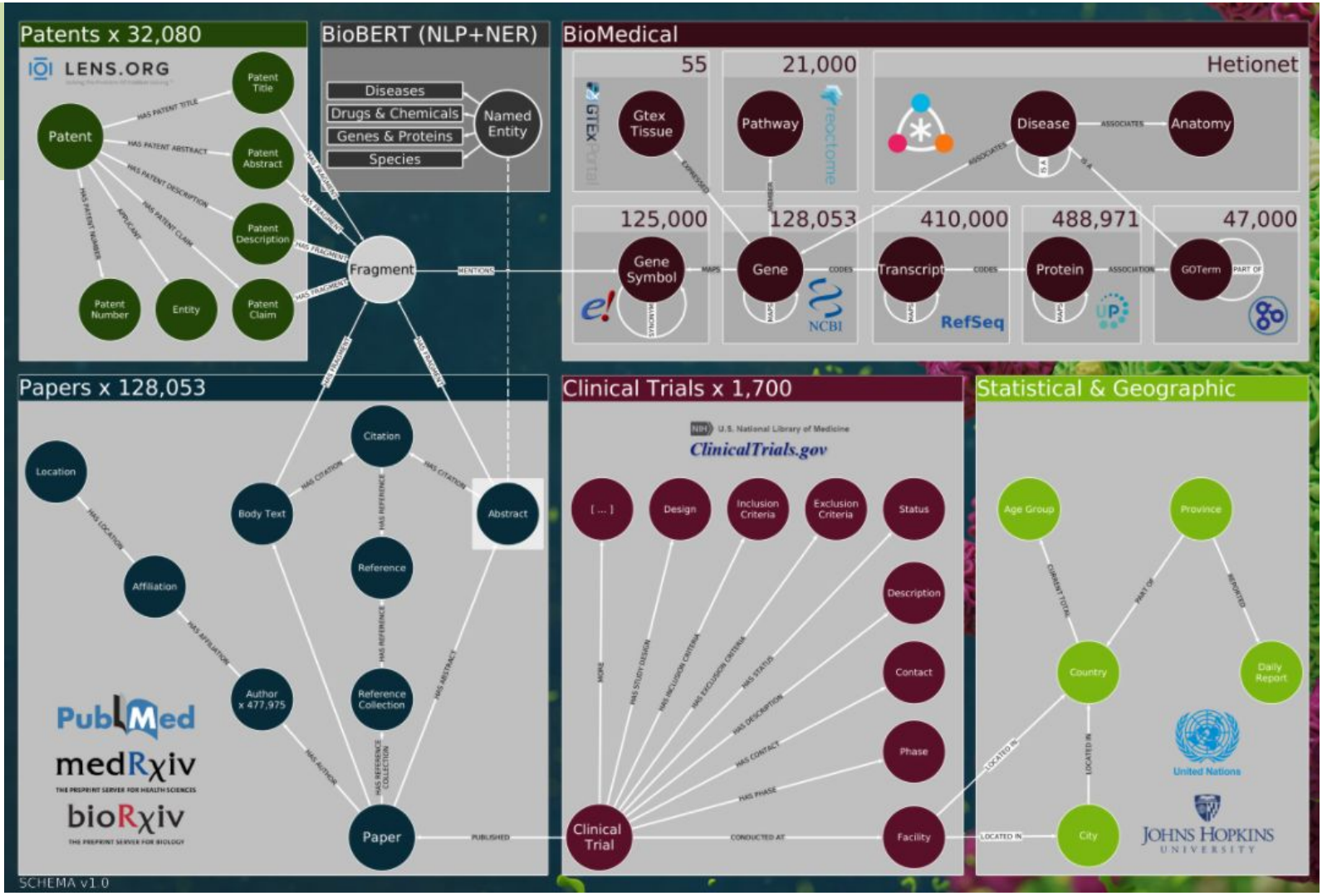
COVID GRAPH

covidgraph.org



The Future Is Big Graphs

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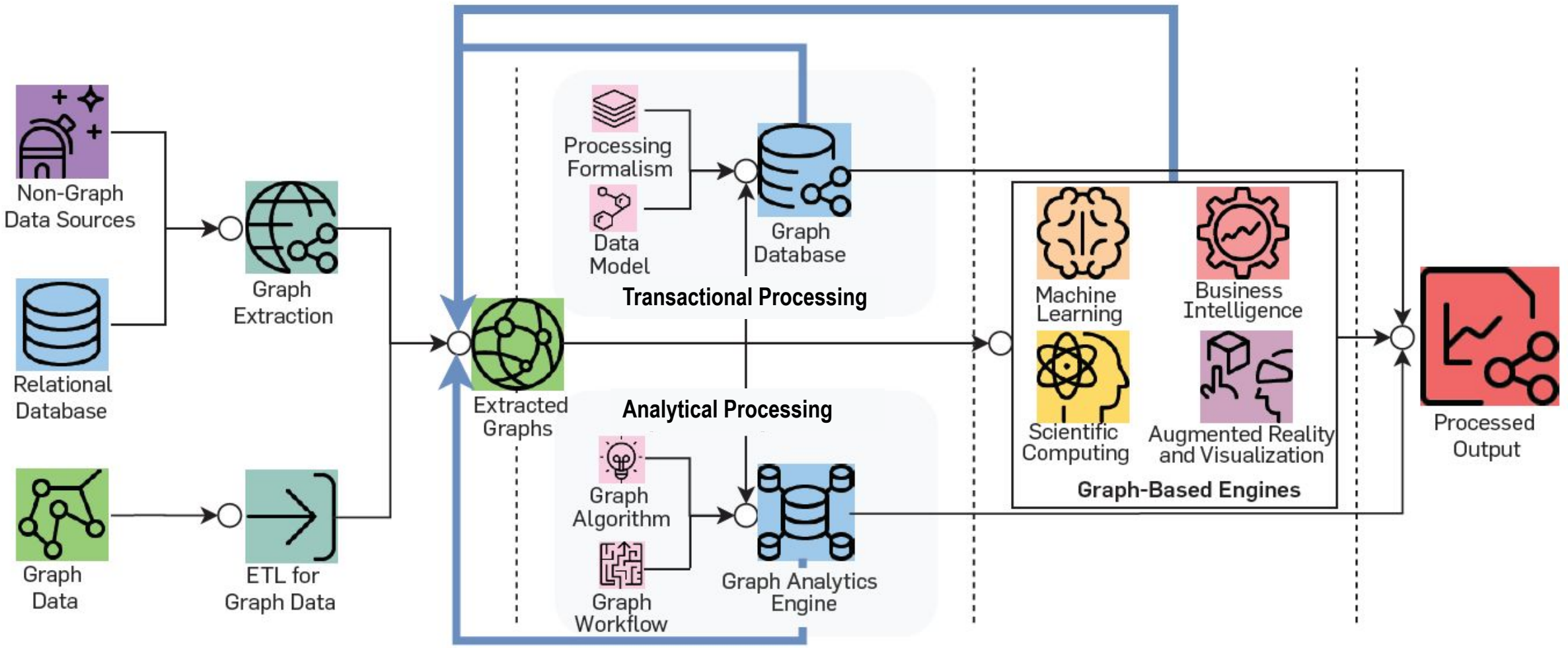

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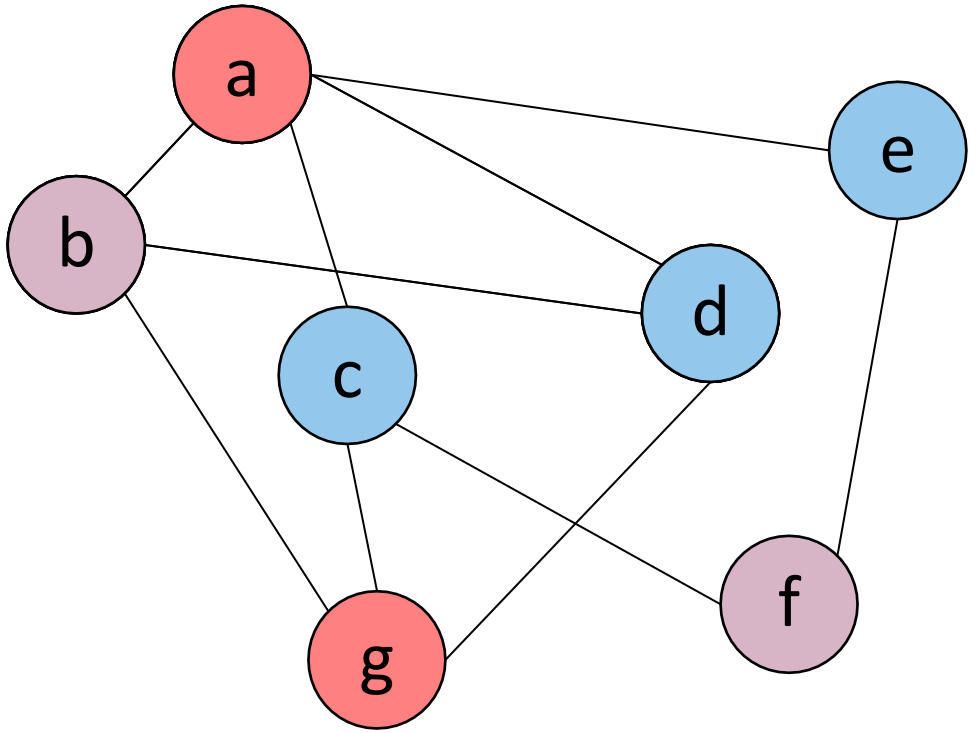
THEME:
GRAPH MINING & CYBERSECURITY

Graph Mining 101



Data Graph

Graph Mining 101

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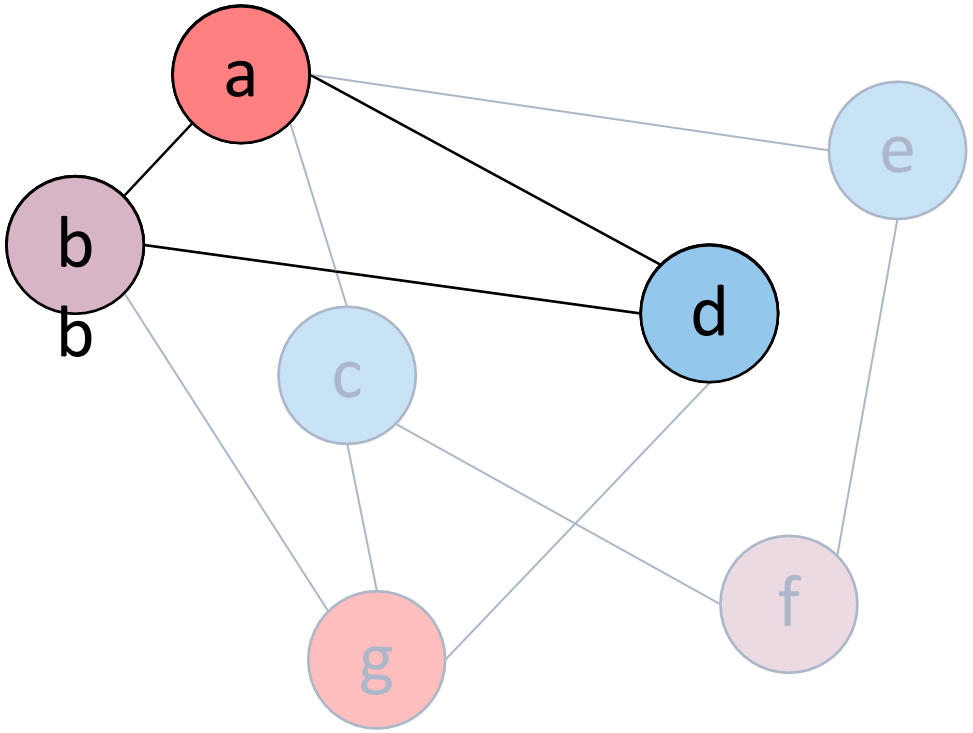

Data Graph

Graph Mining 101

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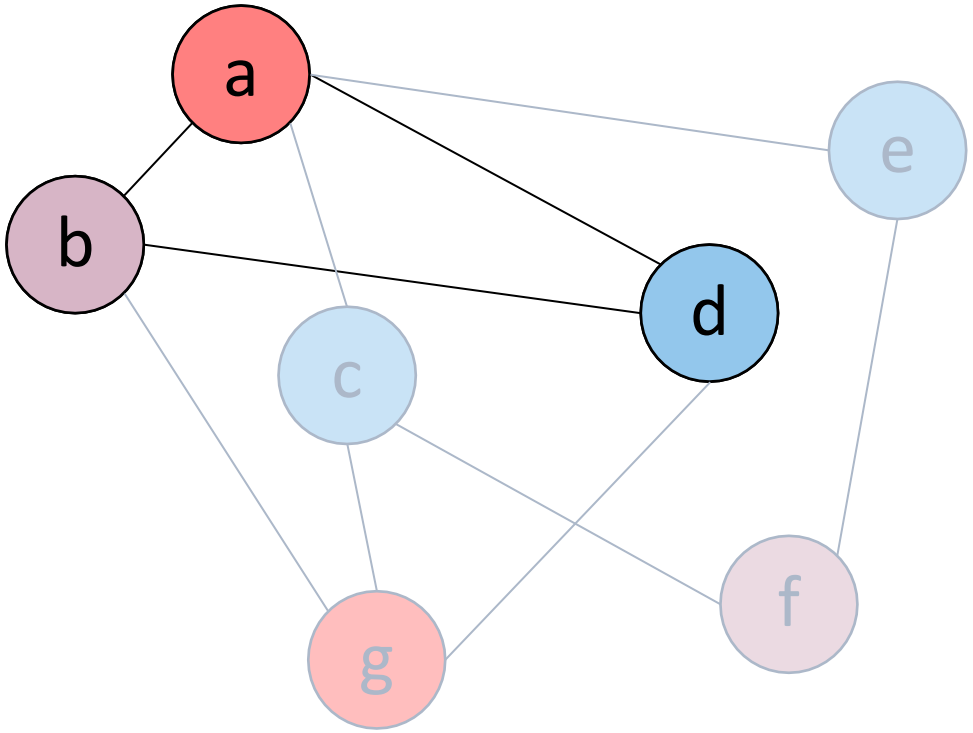
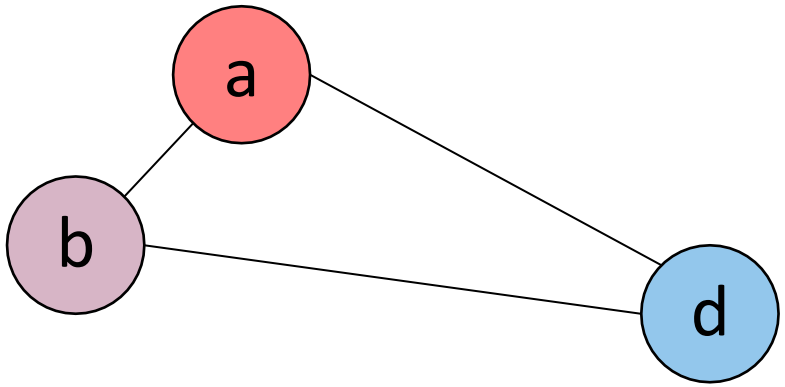


Data Graph



Subgraph

Graph Mining 101

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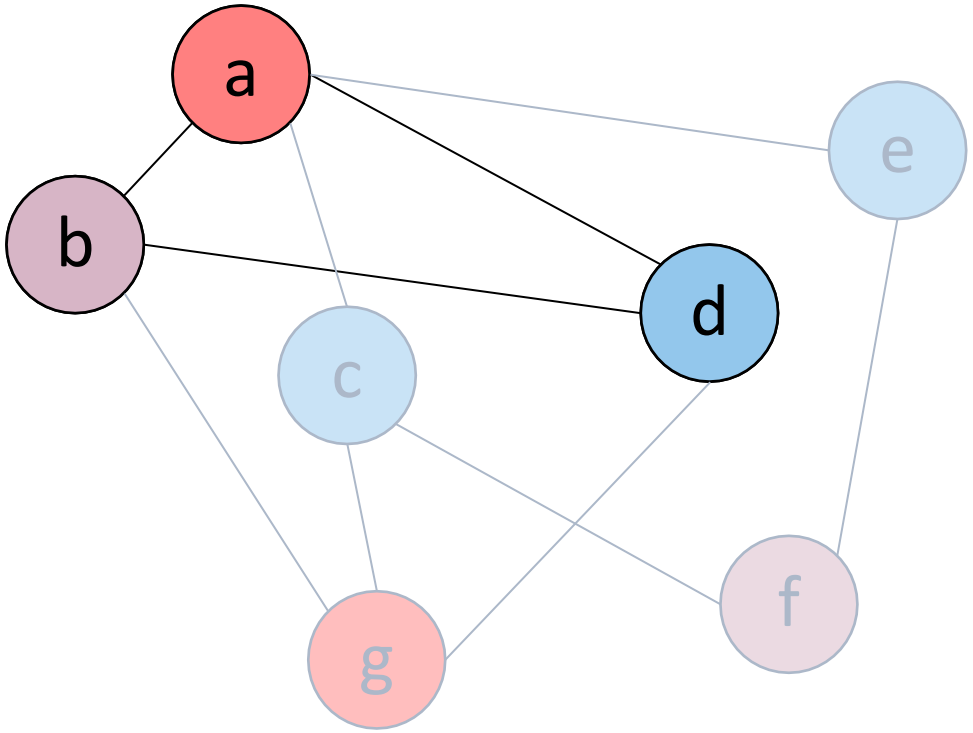
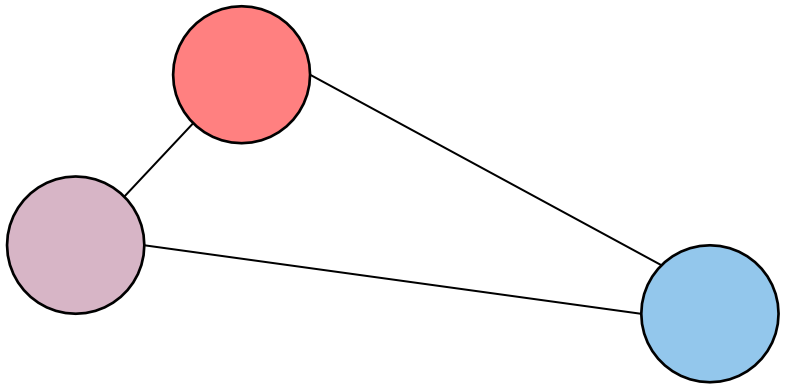
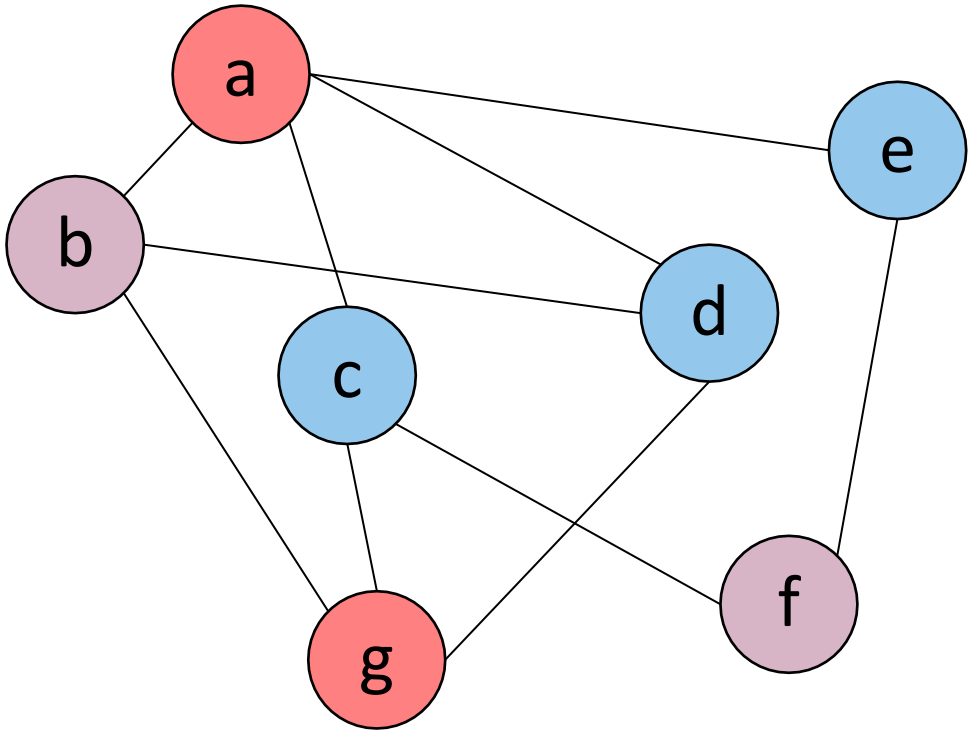


Data Graph

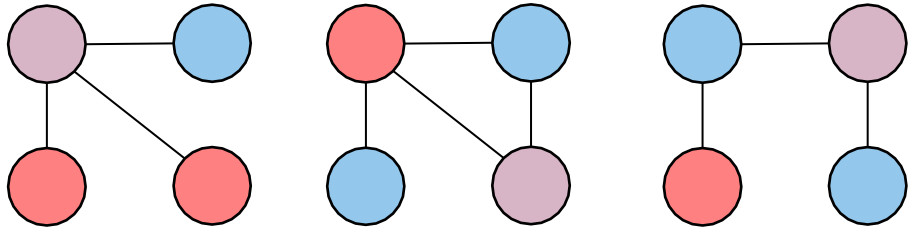


Pattern

FSM: Frequent Subgraph Mining



Data Graph



Frequent Patterns

Research Question #1

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Benign network

Under-attack network

Discriminative pattern?

Research Question #2

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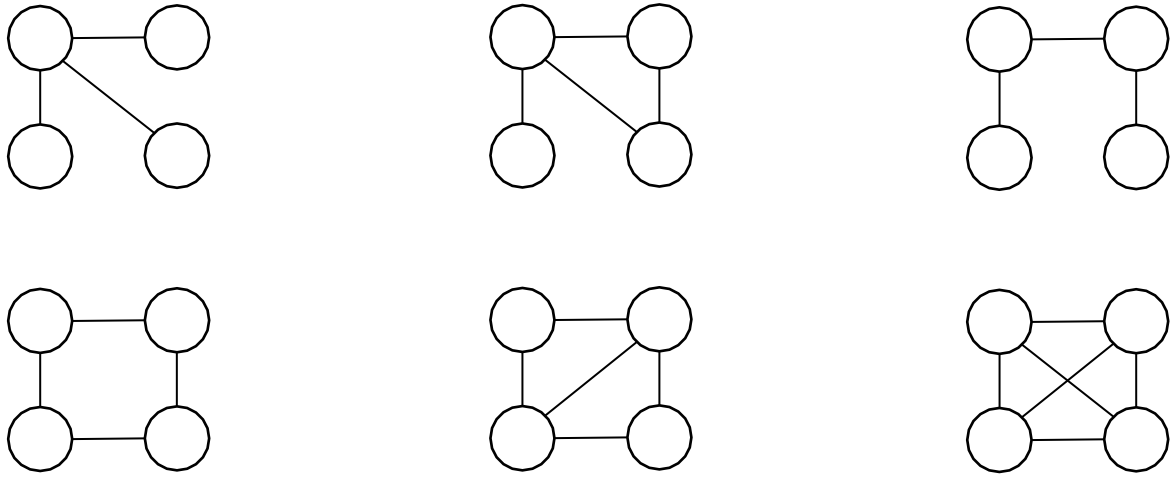
Statistical distribution of patterns?
(e.g., motif size 2,3,4;
FSM size 3,4,5; etc.)

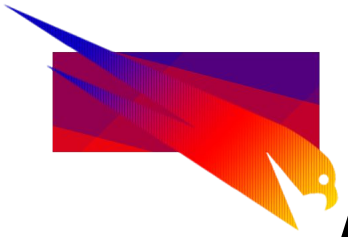
Processing Engines

Scalability Challenge

- 4-motif counting on Orkut graph (|V| = 13M, |E| = 117M)



123,503,340,341,270 subgraphs



PEREGRINE

Jamshidi et. al., EUROSYS'20

A Pattern-Aware Graph Mining System

- ✔ executes 700x faster
- ✔ consumes 100x less memory
- ✔ scales to 100x larger datasets

Unfortunately:

- ○ does not support (multiple) edge labels
- ○ performance suffers with multiple vertex labels: 10x memory overhead and 30x time overhead

https://github.com/pdclab/peregrine

Conclusion

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- Using a state-of-the-art graph mining system to investigate the role of graph patterns in cybersecurity:
  - Online detection
  - Analysis
- Work in progress

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