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Inferencing Cyber Attack Causal Relationship Using Cyber Threat Intelligence

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Outline

- Motivation
- Background
- Issues
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  - Status evaluation
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  - Generate and use CTI
- Solution approach
  - Evaluate the current status
  - infer causal relationship

Motivation

- CTI
  - knowledge, skills and experience-based information
  - help mitigate potential attacks and harmful events

- Forensics with CTI
  - manual, time consuming
  - large amount of data

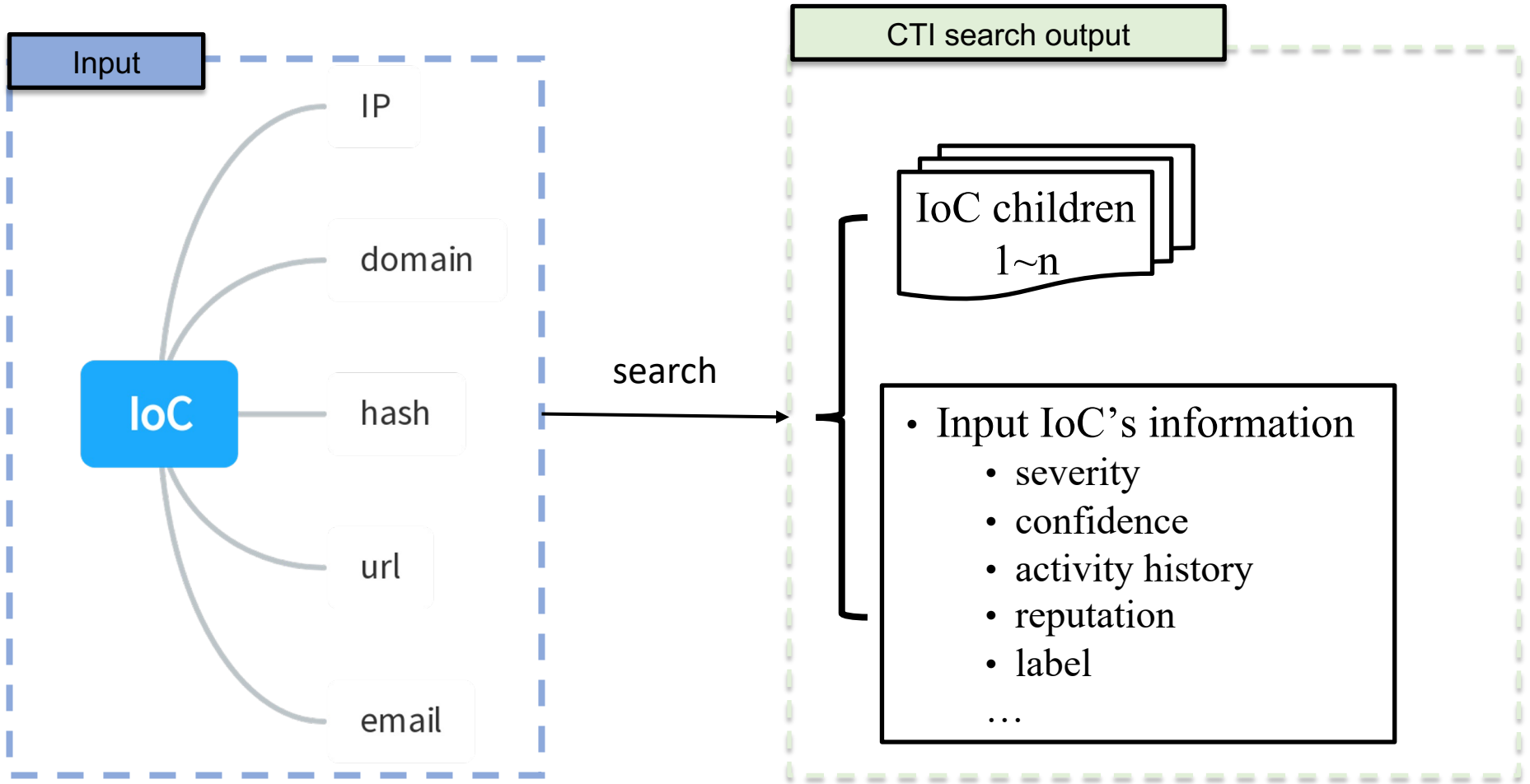
- Automatic use of CTI
  - Search, analyze and infer
  - Automation produces results

Background – CTI

- Has become an important issue for organizations[1]
- There are three overarching
  - Tactical: technical intelligence (IoC) which can be used to identify threat actors
  - Operational: details of the threat actors, including their tools, techniques and procedures
  - Strategic: intelligence about the overarching risks associated with cyber threats

- CTI application scenarios
  - Forensics and inference using CTI[5]

Background — CTI Unit

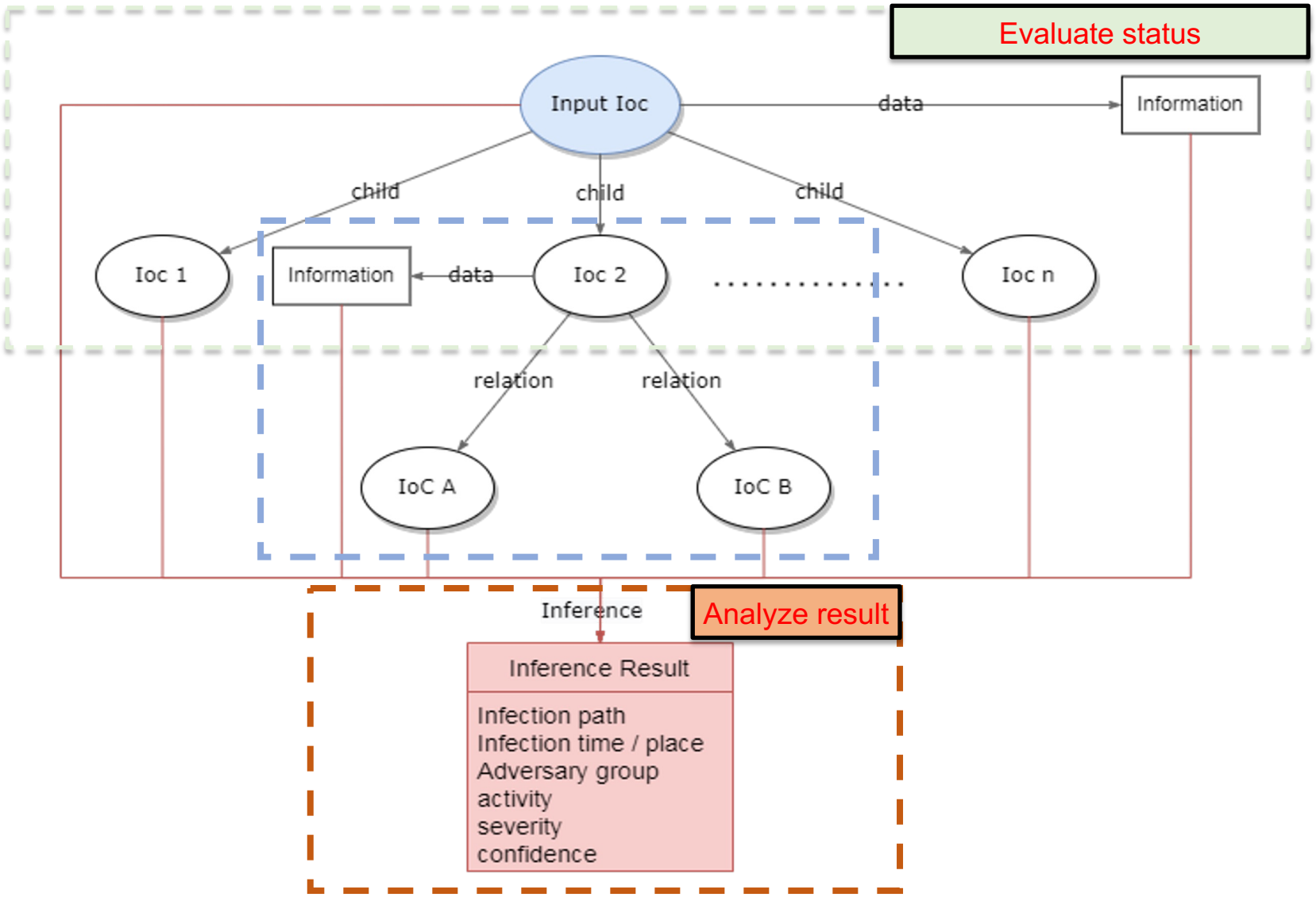


Issues – Automated inference causal relationship with CTI

- Basic vs. Expand steps
- Basic vs. Analyze result
- Basic vs. Inference
- Degree of automation
- Inference result

Approach	manual vs. automatic expand node	automatic analysis	manual vs. semi-automatic
basic	manual	No	manual
Expand steps	automatic	No	semi-automatic
Analyze result	manual	Yes	semi-automatic
Inference	automatic	Yes	automatic

Problem – Overview



Subproblem 0 – Node Expansion (development track)

- Subproblem
  - Input
    - target IoC to expand
  - Output
    - this node's children (other expandable IoCs)
    - information about target IoC
  - Objective
    - explore the profile of the target node
    - maintain all queried data on dynamic table
  - Constraint
    - None

Subproblem 1 – Status Evaluation

- Subproblem
  - Input
    - all queried data so far (current status)
  - Output
    - Determines the next node to be expanded
  - Objective
    - Analyze the results with the least number of expands
  - Constraint
    - None

Subproblem 2 – Result Analysis

- Subproblem
  - Input
    - all queried data so far (current status)
  - Output
    - Infection path
    - Infection time / location
    - Adversary group
    - Activity
    - Severity
    - Confidence
  - Objective
    - get inferences from the queried data
    - automate the inference process
  - Constraint
    - None

Related work – Generate and use CTI

paper	Input	Output	Objective			Method
	Structured CTI		Extract Information	Automation	efficiency	
[6]	X	threat action & TTPs	O	O	X	· context aware analytics · NLP · IR (Information Retrieval)
[7]	O	· standard CTI · detected threat	X	O	X	· automated threat detection tools · antivirus software
[8]	X	analyze result	O	X	X	· Open-CyKG : CTI KG
[9]	O	Maximum Entropy Model	X	O	X	· automatically label text · by leveraging related, domain-specific, structured data
[10]	X	automation CTI service platform	X	O	O	machine learning-based integrated framework
Ours	O	· causal relationship · confidence score	O	O	O	· search contacted IoCs · Infer from all queried data

Solution Approach

There are two **sections** in this solution:

- Evaluate the current status
  - Find the next node to expand
    - more than two input IoCs
    - AI solution
  - infer causal relationship

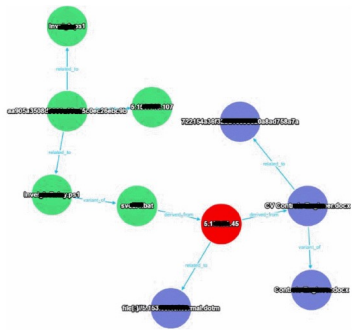
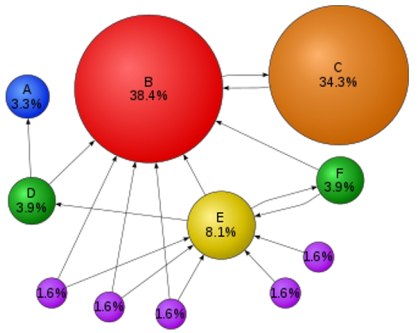
Sub-Solution 1 – Status Evaluation Method

- Find the next node to expand
  - more than two input IoCs
    - bidirectional depth limit search
  - AI solution
    - Use the expanded data as dataset
    - Train the model to output predicted high-value nodes

Algorithm	AI	Off-line learning	On-line learning
Calculation	-	-	-
Off-line learning	V	V	-
On-line learning	V	-	V
Off-line + On-line learning	V	V	V

Sub-Solution 2 – Result Analysis Method

- Infer causal relationship
  - Find the intersection of attack types
  - PageRank calculation
  - Betweenness centrality calculation
- The above method is currently used to find important nodes in graph.

Algorithm	intersection of attack types	PageRank	Betweenness
Description			$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$

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