ART: Learning Operation Tree Patterns for Cloud Remediation

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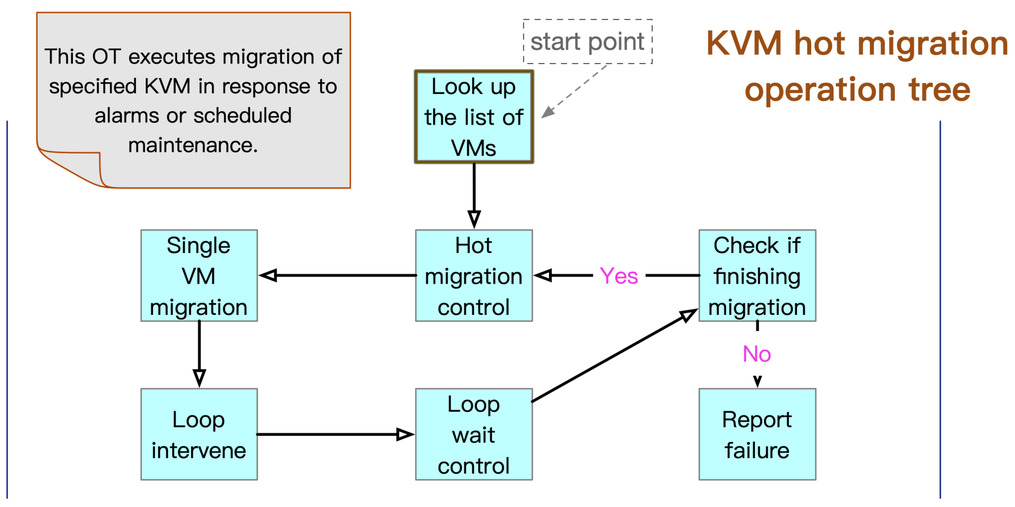
Background & Motivation

As IT service grows in a larger scale and more complex, **operation trees (OTs)** are raised to take place of IT operators in repeatable remediation tasks.

Operation trees are

- **tree**-organized
- configured with certain rules (**edges**) that determine the workflows and actions (**nodes**) that execute workflows on infrastructures
- in always-running states. The following is an OT example.



Even though some tools offer graphical interfaces to accelerate designing trees, they barely give deep insights into design patterns, which never ceases redundant construction and configuration.

Problem

IT operators have great difficulty in designing new operation trees targeting thousands of uncovered faulty scenarios.

Goal and Solution

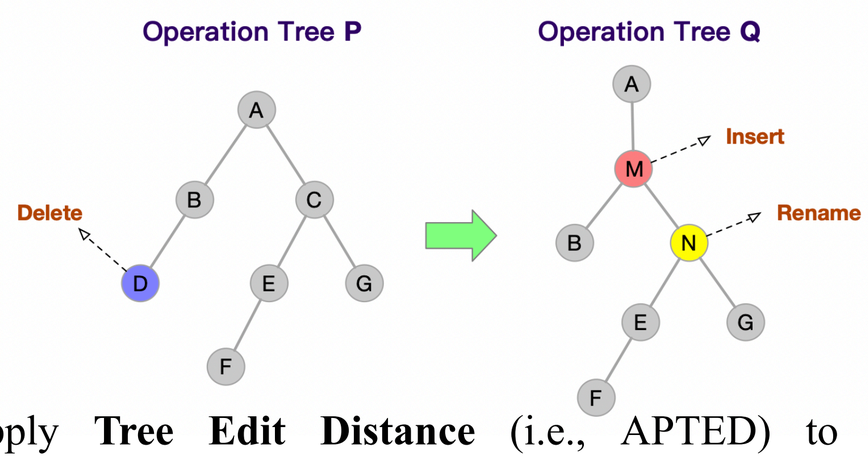
Our goal is to *leverage existing experience* for reusability to assist constructing new workflows that handle more cases or alarms.

We devise ART, a scheme to *learn instinct and structural patterns* from existing operation trees and *automatically generate trees* in demand in an advisory capacity.

How to Learn Patterns

- Structural Pattern:
  - Common attributes of nodes
  - Similar relationship of nodes (adjacency)
- Extraction from the attributes of nodes

  -- apply **NLP methods** to extract keywords that summarize the nodes

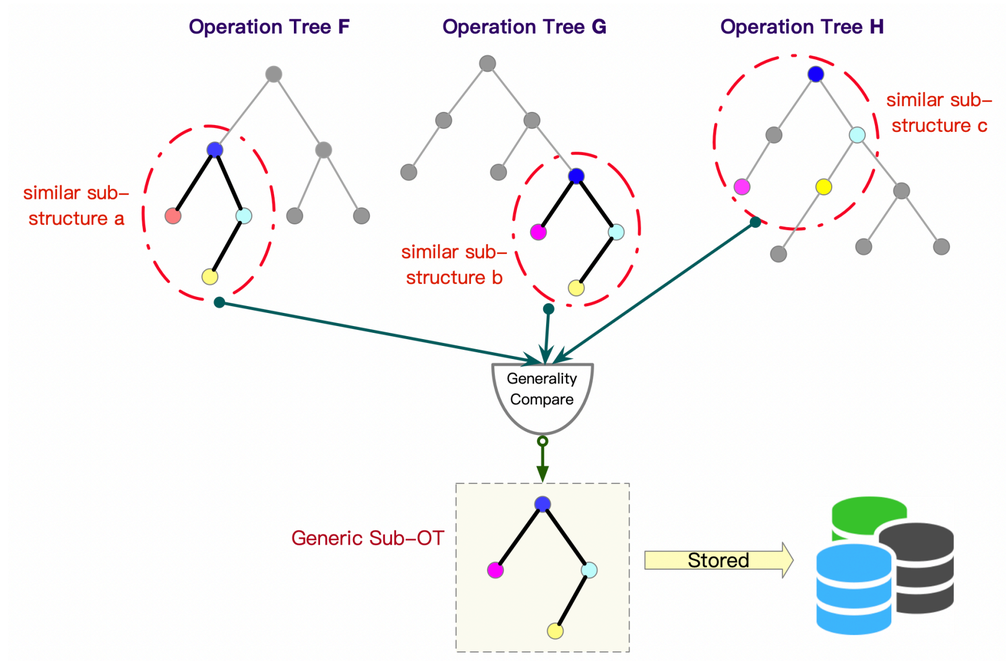


- Apply **Tree Edit Distance** (i.e., APTED) to measure relationship of nodes

  -- assign *add, delete and rename* operations to measure structural similarity between trees

Tree Pattern Mining

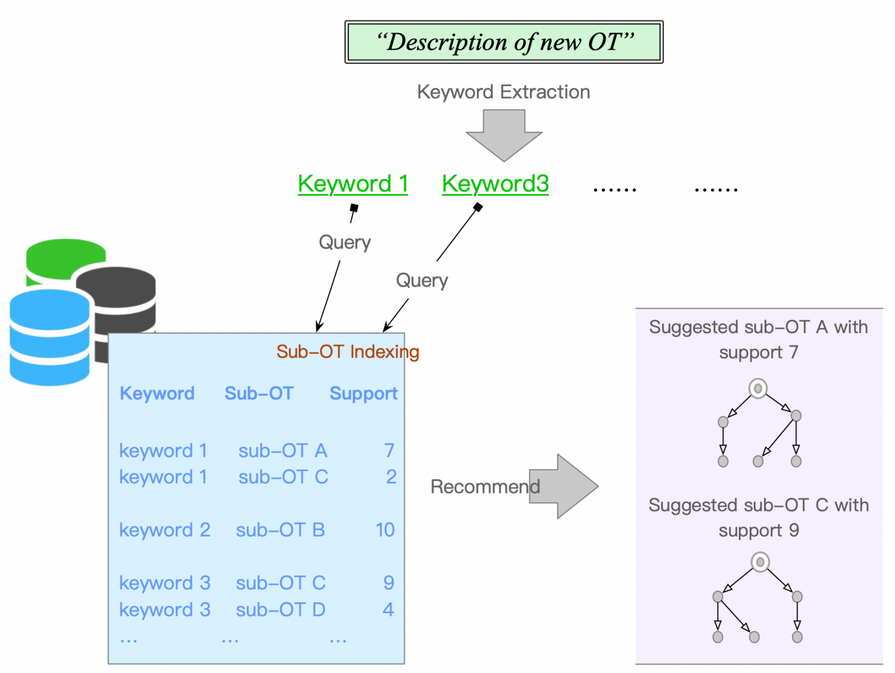
- redefine operations in APTED to better characterize the structural similarity between trees
- apply enhanced-APTED to each pairs of de facto trees to capture structural patterns
- exploited ***similar trees*** are classified into several clusters based on TED value
- representative trees (namely patterns) are elected in per-cluster manner and stored into the database
  - assign topics (keywords) as ***indexes*** to patterns for future retrieval
  - record occurrences of pattern workflows as ***support***



Operation Tree Generation

If operators is building up a new tree from scratch

- retrieve patterns based on the ***keywords*** that are extracted from description of the new tree
- recommend those matched patterns of high ***support***.



Operation Tree Completion

If a pending tree has partial structures completed

- decompose these structures
- find a match against any ***prefix*** of patterns by APTED