Case Study: Autonomic Network Configuration Using Machine Learning

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Devices Well Organized in Networks
Setup New Networks & Add/Remove Devices
Device Parameter Configuration

Input → Network Topology, Device Vendor, Type, etc.
Device Parameter Configuration

Output → Parameters: IP addresses, IGP Area ID, IGP Cost, etc.
Why Machine Learning?

Traditional: Program Aided Artificial Configuration

- Strictly Pre-defined Programs: inflexible adaption to new networks
- Long Artificial Processing Time: inefficient & huge cost

Machine Learning: Automatic Configuration

- Flexible & Universal: learning from exiting networks rather than strict pre-rules
- Incremental Learning: self-adaptive to new networks
- Quick Automatic Processing: efficient & low cost
Case Study: Automatic Device Configuration
(A project collaborated with Huawei)

- Adapt to Hierarchical Layers: Core Layer, Convergence Layer, Access Layer.
- Adapt to Diverse Topology: star, tree, bus, ring, mesh etc.
- Handle Global & Local Parameters: IP, IGP Area ID, IGP Cost
- Make Global Configuration: setup new networks
- Make Local Configuration: add & remove devices
Input: Network Topology
Input: Core Layer & Convergence Layer
Input: Access Layer
Output: Loopback IP (Core & Convergence Layer)
Output: Loopback IP (Access Layer)
Output: Interface IP (Core & Convergence Layer)
Output: Interface IP (Access Layer)
Output: IGP Area ID (Access Layer)
Output: IGP Cost
Local Update: Add New Device
Local Update: Add New Device
Add New Device: Interface IP
Add New Device: IGP Cost
Summary

- Flexible and Universal: learn from existing networks, taking common rules as prior-knowledge.
- Extensible: system considers extensibility and modularity.
- Balance global and local configuration
Whenever we have got adequate data, consider Machine Learning Systems.
Key Issues in Machine Learning Procedure

- Clear Problem Definition:

  Data never tell where to go.

  Make clear the learning aim (i.e. data distribution, patterns, decisions)

  Make clear how to evaluate the results.
Key Issues in Machine Learning Procedure

Adequate Representative Data

The learning data are expected to well represent the whole searching space. Random re-sampling is preferred, and data cleaning is necessary.

The training samples are expected to be much more than the testing samples & samples to be predicted.
Key Issues in Machine Learning Procedure

Proper Features: original & artificial features

Object and feature definition is the most essential part of system design.

Artificial features usually deliver more valuable information than original features. (Machine is not that clever!)

Collect relevant features as much as possible, figure out the most important ones, and transform them if possible.
Key Issues in Machine Learning Procedure

Database Design

Organize the data into relation tables to facilitate learning procedures.
Key Issues in Machine Learning Procedure

🗹 Suitable Methods & Algorithms

Try out effective methods & algorithms.

No prefect algorithms for application cases.

Data-oriented algorithm optimization.

Big data decrease effect of algorithm selection.
Key Issues in Machine Learning Procedure

- Statistically Significant Results

Machine learning delivers results of high statistical possibility rather than truth.

If the predictive results are not statistically significant, machine learning is in vain. That is, the predictive results should be of much higher possibility than random cases.
Thank You