Artificial Intelligence Enables a Network Revolution

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Network Technology Research Institute, China Unicom
Artificial Intelligence Enables a Network Revolution

Part 1
AI application in operators
Several Viewpoints on Artificial Intelligence

The third wave of AI
Deep learning proposed
Big data era coming
Computing power increased

Weak AI, Strong AI and Super AI
Weak AI, NOW
Strong AI, 2040
Super AI, 2060

AI enables the fourth industrial revolution
Goal: Intelligentization of Industrial Production, Intelligent Control, Intelligent Machines
Representative Technology: Artificial Intelligence

AI+ all walks of life
Important direction for digital transformation in all walks of life
Deeply affect retail, finance, transportation, manufacturing, medical, security, education, and telecom industries
Global Operators Applying AI Technology

- AI engine developed with Honda
- 50% of network operators optimized, 2019
- 1000 days

- The fourth platform named "Cognitive Power"
- Voice recognition customer service system "Aura"

- UAV tracking and control technology
- Fingerprint map, intelligent obstacle avoidance, traffic and business forecast, network parameter optimization

- Open source AI platform named “Acumos” cooperate with Tech Mahindra

- Automatically switch APP
- AI assistant

- AI platform named “Corevo”
- Intelligent driving and IIOT
Artificial Intelligence Enables a Network Revolution

Part 2
AI enables network revolution
In 2020, global mobile data traffic generated 35 EB per month. In 2020, global data amount to 40ZB, 50 times more than the data in 2011.

*Source: CompTIA and CISCO*
Mass growth of network complexity

The Trend of Internet Connection Evolution

- Internet
- Mobile Internet
- Internet of Things
- Internet of Intelligence

- 2G/3G
- xDSL/LAN
- Traditional connection
- Ubiquitous connection
- Satellite
- Balloon
- 4G/5G
- FTTx

The Trend of Network Architecture Evolution

- Traditional network architecture
- SDN/NFV
- Automatically Orchestrated and Managed

- Separation of control and data planes (SDN)
- Virtualization (NFV)
- Cloudification
- Openness and programmability
- Service diversity, diverse traffic requirements (e.g. MANO)
- Full end to end automation of network and service management (e.g. Zero-Touch Operations)
Network Intelligentization is Imperative

- AI could analyze massive data by heterogeneous computing and edge computing. AI could adaptively adjust and optimize network connections by combining optimal strategy learning algorithms such as reinforcement learning with SDN technology. AI could realize fully end to end automated network architecture by semantic understanding and auto-optimized technology.

- The challenges mentioned above are also the advantages of realizing network intelligentization.
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Part 3

The road of China Unicom network intelligentization
China Unicom Vision of AI Application in Network

AI +network planning
2020: 30% utilization

AI+ network design
2020: 30% utilization

AI+ network construction
2020: 40% utilization

AI+ network security
2020: 70% utilization

AI+SDN/NFV
2020: 50% utilization

AI+ network optimization
2020: 40% utilization

AI+ network maintenance
2020: 60% utilization

AI&5G network
2020: AI-enabled Mobile Edge Computing

AI-enabled network: overall utilization ratio will reach 45% in 2020
China Unicom Network Intelligent Application （1/2）

- Business intelligent recommendation capability
- Spam SMS intelligent diagnosis
- Customer churn prediction model
- Intelligent network optimization virtual testing
- Video stalling automated problem locating
- MR Intelligent positioning and analysis
- NPS derogate prediction model
- Content based charging correlation model
- IPTV user behavior and defect analysis
- Automated debug scenario self-learning
- Alarm Association Rule Machine Learning Model
- Customer resident location model
China Unicom Network Intelligent Application (2/2)

- Devices management based on image identification or NLP
- Multi-technology network fault tracing analysis based on network topology
- Roots-tracing of network alarm in UTN
- SOC situation awareness
- SDN/NFV network congestion prediction and traffic optimization
- Network routing optimization
- Real-time big data analysis system in smart city
- RF self-optimization technology
- Ongoing Research work
Part 4
Case study
Case Analysis: AI applied in Roots-tracing of Network Alarm

- Amounts of device alarms of UTN: UTN is the local integrated carrier transmission network of China Unicom. UTN is mainly used for 3G/4G mobile service, and VIP customer service, and UTN uses IP/MPLS dynamic protocol. Compared with the traditional network, the protocol used by UTN is relatively complex, and the logical connection of the network is complicated. Compared with the traditional network management system, the UTN network system receives a large number of device alarms, many of which are caused by the root alarm.

- The current processing method: For the alarms, the current method is to solve the alarms depending on the expert experience, which means transforming the expert experiences into rules, and filter out the non-critical alarm through the rules. The downside of this approach is that in order to avoid filtering out the important alarms, the filter rules are relatively relaxed, which means the rules have limited filtering ability.

- It is hoped that applying AI to trace the root alarm can form a more efficient solution.

Research Background

- Look for the rules with higher filtering capabilities
- Compress alarms to get the valuable ones
- Get the alarms collection that contains the root alarm

Research Objective
Fig. 1 Framework of technology scheme

Step One: Data preparation
- Identifying frequent alarms

Step Two: Correlation rules mining
- Improving PrefixSpan algorithm

Step Three: Alarm correlation rules confirming and storing
- Correlation rules
- Blacklist

Step Four: Root alarm identification
- Labelling alarms
Data Preparation

Frequent Alarms

➢ Problems and Analysis

Many alarms being discovered are frequently reported continuously at the same time or in a continuous period of time, such as alarm of link down. When the data is analyzed, it will only lead to the rule of “Link down -> Link down”. Such a rule is not a reflection of the derivative relationship.

✓ Solution

Compressing the same alarm on the same port for a period of time to be only one alarm. Others are marked as filterable alarms.

Fig. 2 Interface data preparation process
Correlation Rule Mining

Problems and Analysis
It was found that the rules obtained by the classic PreFixSpan algorithm do not have the corresponding trigger conditions in the early stage of the study, leading experts unable to determine the validity of the rules.

For example, there are two frequent item sets candidate objects: \([A \rightarrow B, \text{constraints } H1]\) (a), and \([A \rightarrow B, \text{constraints } H2]\) (b)

When the probability of \((a+b)\) occurrence exceeds the confidence interval, it will be recognized as one rule \([A \rightarrow B]\)

Solution
Improving the PreFixSpan algorithm, the same alarms with different trigger conditions do not appear to be considered as one rule, but two.
Current Results

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<th>Amount of Data</th>
<th>Time of Data</th>
<th>Total number of nodes</th>
<th>Total number of links</th>
<th>Numbers of rules before modification</th>
<th>Effective rules</th>
<th>Total rules of Industry standard and manufacturer</th>
<th>Total percentage of filtered by rules and frequent alarm recognition</th>
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<td>1135817</td>
<td>30 days</td>
<td>2681</td>
<td>3881</td>
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<td>148</td>
<td>61</td>
<td>19%</td>
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<tr>
<td>Numbers of rules after modification</td>
<td>179</td>
<td>Effective rules</td>
<td>148</td>
<td></td>
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<tr>
<td>Derivative alarm /Amount alarm (rules of data mining)</td>
<td>19%</td>
<td></td>
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<td>Total percentage of filtered by rules and frequent alarm recognition</td>
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</table>
Further Optimization Methods and Work

- Analyzing the time parameter in the frequent alarm model;
- Modifying alarm identification to simulate online mode;
- Analyzing the similarities and differences between the alarm rules of different equipment manufacturers in different regions;
  - Improving the algorithm according to the rules;
  - Adding VM network topology to display the related information of alarms, including the parameter of alarms, the performance parameter of network element, the correlation of other alarms;
  - Researching the method to deploy this system into existing network.
THANK YOU!

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