Toward Data-Driven Management

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Agenda

• Motivation
• Data-driven management
• Building block: machine learning
• Applications
  • Anomaly detection
  • Root cause analysis
  • Resource management
  • Knowledge discovery (Workflow, Policy, Intent, …)
Motivation

• Softwarization –Disaggregation-
  • SDN
    • Switch
    • Separation of control plane
  • NFV
    • Middlebox
    • Data plane as software

• How to deal with complex system?
Data-driven management

• Conventional Mechanism-driven approach
  • Given understanding precise mechanisms of components, build up a model of entire system.

• Towards holistic Data-driven approach
  • Mining data of inputs and outputs of Black-box
    • Given data, infer the relationship between inputs and outputs.
  • Machine learning is a key.
Data-driven management

• Mining data of inputs and outputs of Black-box
  • Machine learning & deep Learning

• Expectations
  • Anomaly detection
  • Root cause analysis/Correlation and causality inference
  • Traffic prediction
  • Resource management
  • Knowledge discovery
  • …
Building block: machine learning

• Big data accumulated in cloud [1]
• Scalable computing: Map reduce, GFS, Haddop,
• Framework: Spark, TensorFlow, Caffe, PyTorch, etc.
• Public cloud: AWS, Azure, etc.

Building block: machine learning

• Tasks:
  • Inference, Recognition, Prediction, Learning,

• Tools:
  • Supervised
    • Regression, Classification (Naïve Bayes, Neural Network, SVM,…), …
  • Unsupervised
    • Clustering (k-means, DBSCAN, Random forest, …), Model estimation, …
  • …
Applications

• Anomaly detection
• Root cause analysis
• Resource management
• Knowledge discovery (Workflow, Policy, Intent, …)
Applications
Anomaly detection

• Correlation detection: NICE [2], G-RCA[3]
• Syslog analytics: SyslogDigest [4], Spatio-Temporal [5]

Applications

Root cause analysis

• Inference graph & Bayesian network
  • How to build
  • How to solve
Applications
Root cause analysis

• IP over Fiber: SCORE [6], Shrink [7], BayesNet [8]
• Enterprise network: Sherlock [9]
• CDN: WISE [10]

Applications
Resource Management

• Deep Reinforcement Learning
  • Bandwidth calendaring
  • Adaptive streaming

Applications
Knowledge Discovery

• Trouble ticket analysis [12]
• Router config error detection: Mineral [13]
• Mobile network eNodeB: AESOP [14]

Closing Remarks

• Disaggregate vertically integrated system into components to achieve sustainable healthy growth.

• Machine learning & deep Learning
  • Mining data of inputs and outputs of Black-box

• How to collect data?
• Architecture for monitor, analytics, and actuator?
• Standard?