Cognitive Networks for Software Networks

Imen Grida Ben Yahia, IMT
Orange Expert, Future Network Community
Research project Manager on Cognitive & autonomic Management

@Imengby
Outline

1° Context
   o Software Networks and towards 5G

2° H2020 CogNet Cognitive Networks
   o Definition, Framework, Use cases,
   o Demo on SLA enforcement

3° Key messages
Context: Software Networks

SDN

NFV
In 2020 more than 70% of networks will rely on SDN, NFV and cloud infrastructure.

ref. CogNet D21 Deliverable December 2015
Context: Why we need Cognition

General statements:

— Technical complexity
  diverse design approach, interfaces, protocols, technologies,

— Business complexity
  Pervasive presence; Verticals & specialized slices, GAFA competition & cooperation, etc.

— Behavioral complexity
  Everything is connected; network element interdependencies; service composition; different lifecycles, etc.

Results:

Management that is Expensive, Fragile, Inflexible, etc.
Management softwares are semi-automated and still require human interactions to detect, correct problems and make decisions.

Management softwares are being stretched by 4G networks, and will be completely incapable of managing softwarized 5G/IoT networks.

CogNet
- aims at collecting massive data from networks and
- applying Machine Learning (AI) algorithms to detect and
- correct issues and allow the network to be Self-managed
Reminder: What is Autonomic & Cognitive Management?

- Data mining;
- Clustering,
- Dimensionality reduction,
- Ontological inference,
- Predictive models
- Classification, regression,
- Risk analysis,
- Reinforcement learning, etc.

- Service descriptors
- Service logic
- Network behavior
- Etc.

- Analyze
- Plan
- Execute

- Monitor

Managed elements

- Single resource: server, database, VM, interfaces,
- Heterogeneous group of resources
- Homogenous group of resources
- Business system (business processes)
- Service (service logic) and its underlying group of resources
- Specialized slice
Governance, and orchestration based on distributed, adaptive knowledge

- local control loop

- networked control loop
- heterogeneous
- hierarchical

- networked control loop/domain
- upper layer and E2E management
- aggregated/assembled/correlated Knowledge

Reminder: What is Autonomic & Cognitive Management?
data pre-processing

User inputs

Feature Selection and Evaluation
Data Normalization, Transformation

Model Selection

Hardware Analysis
Dataset Analysis
Computer Analysis
Model Evaluation

Batch Processing Engine

Distributed File System
(Semi) Supervised or Unsupervised ML

Batch processing

Data Collector

User inputs

E2E inputs

Frozen Data, Data Stream, Data from Network and Infrastructure

Adaptors

Data Cleaning, Filtering, Feature Extraction

Near-Real Time processing

NFV and SDN based testbeds, or data files

NFV and SDN based testbeds, or data files

Policy Engine

Policy Distribution
Policy Publisher
Policy Adaptor

Policy Engine

Functions/Policies

Policy Optimization

Policy Generation
(Semi-automated)

Policy Generation
Functions Generation

Scores

Recommendations
SUPA Policies

```
"supa-policy": {
  "supa-policy-validity-period": { // <- Coming from CSE
    "start": "2016-07-05T08:42:57.5274042"
  },
  "supa-policy-target": { // <- Coming from CSE
    "domainName": "system2",
    "subnetNetwork": "192.168.1.1",
    "instanceName": "devstack2"
  },
  "supa-policy-statement": {
    "event": { // <- Coming from CSE
      "event-name": "cpu perc",
      "event-value-type": "int",
      "event-value": "0.95", // CPU exhaust
      "instanceName": "compute2"
    },
    "condition": { // <- Coming from CSB and processed by Policy Engine
      "condition-name": "upper-operational-range",
      "condition-operator": ">",
      "condition-threshold": "0.90",
      "supa-script-content": {
        "script-Java": "if (Value > 0.90) return TRUE"
      }
    }
  },
  "action": { Coming from Python Policy Engine (Policy Engine)
    "action-name": "scale-up",
    "action-type": "deploy-node",
    "action-param1": {
      "param-type": "string",
      "param-value": "compute3",
      "instanceName": "ci-creator"
    }
  }
}
```
Platform for Cognitive Management

Towards Common Software Infrastructure

- Monasca, Kafka and InfluxDB for **data collection**
- PANDAS, Spark ML lib, Hive and Hadoop for the **machine learning process**
- Drools or Ponder2 as **policy engine**
- OpenDaylight
- Open **data models**: JSON for (most) interfaces;
- SUPA for policy descriptions

---

![Diagram of data flow](image-url)
Use cases

UC Optimized Services in Dynamic Environments
– Elastic scale up/down in NFVI for energy efficiency and performance. Noisy Neighbours in VMs.

UC Collaborative Resource Management
– Traffic identification without payload
– Deployment of a realistic network Lab to apply ML in a controlled way (lack of data and testbeds)

Orange UC SLA Enforcement
Ensure SLA compliancy and service availability in the context of softwarized 5G networks
– Predict SLA violation and SLOs breaches. Identify/compute and enforce corrective actions
Use cases

UC Situational Context

- **Scenario 1: Large-scale events**
  - Use Social Media data (Twitter, Foursquare,..) to predict large gatherings of people that might drastically affect traffic demand

- **Scenario 2: Geo-Analysis for Network Demand prediction**
  - Predict network demand according to various patterns. Smart resource placement and migration to optimize network performance and user experience
Use cases

Open5GCore by Fraunhofer Fokus
Usecase

*University of Trento, IBM,*
Conclusion: key/take away messages

- Cognitive management in the coming softwarised 5G is a must
  - new technologies and services
  - change of magnitude of managed objects
  - Autonomic management need to be enabled by machine learning/AI techniques and Big data where appropriate → **Cognitive Management**

- AI/Machine Learning techniques are NOT a magic black box
  → solutions are specific to datasets and to problems tackled

- Dedicated software infrastructure is needed: platform and suitable APIs to deploy machine learning/AI-based solutions

- Cognitive generation of corrective actions and configuration change
Merci