Edge & Fog Analytics

The New Analytics Interface

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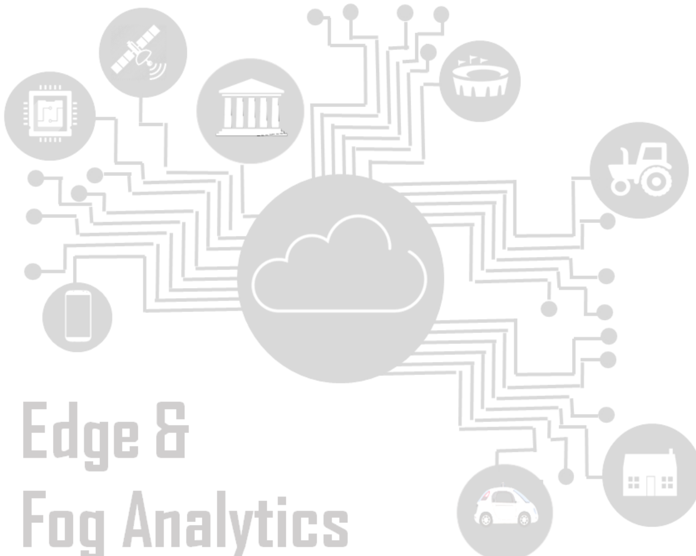

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Examples provided in this book are also available via internet and they can be downloaded from GitHub applications' development platform. These walkthrough examples cover data preparation, data parallel processing and data analytics including data stream analytics.

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CONTENTS

PREFACE

We are currently witnessing another change in the analytics landscape with big data analytics moving rapidly from the cloud to the edges. Both edge and fog analytics are on the rise as result of the increase of use of plethora of sensors, cameras and smart phones capturing and storing a never-ending flow of data. These devices are becoming the new analytics interface between the cloud and the real world to process and derive real time information and to solve problems at the edges where data originates. Data and will continue to grow but distributed more to the edge with analytics enabled by new ML and AI applications.

As of this year onwards edge and fog analytics are expected to spread all throughout, powered by ML and AI that are becoming a standard analytics feature of the Internet of Things and People's devices (IoT&P). This expansion includes the emerging of autonomous edge analytics, which is expected to grow even more rapidly as of next year onward.

This move of ML and AI to the edges has also allowed to explore other approaches in the edges such power-law like approaches or fractal geometry to address intermittent phenomena and reduce operational costs. These power-law like approaches can capture better natural phenomena. I have used, with colleagues, power-law like approaches in combination with ML to capture subtle variation, some years earlier.

Today, the opportunity of the increase in processing power at the edges, such that of as mobile phone, coupled with the use of different approaches and the advances made in AI, in particular reinforcement learning (RL) and Deep Learning are helping in the rapid growth and spread of edge and fog analytics. ML reinforcement learning, which is requiring little or no "ground truth" training data sets, is expected to account for 50% of the coming ML-based applications in the edges.

Embedded processing systems include object detection processors to filter instantly information for identification purposes. The filtering of information at that the edge has also the advantage of reducing the bulk of data transmitted to the cloud.

In contrast to cloud the processing power at the edges was made possible using relatively simpler architecture with low power consumption such as ARM architectures. ARM, which stands for Advanced Reduced Instruction Set Computing Machine, previously known as Acorn RISC Machine, is becoming dominant in the field of embedded computing, particularly mobile phone and mobile applications.

Processors that have a RISC architecture are considered as power-efficient processors as they require fewer transistors than those with a complex instruction set computing (CISC) architecture. Such features are sought-for to develop light, portable, battery-powered devices—including smartphones and other embedded systems.

The book focuses on edge and fog analytics to carry on-real time analytics where data originates. It consists of three sections: 1) the first section on the changing analytics landscape as a result of edge and fog analytics, 2) the second section on the implications (of edge and fog analytics) on cloud-to-edge architecture as well as privacy, and 3) the third section on data analytics powered ML and AI and in particular Deep Learning and Reinforcement Learning.

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Chapter 1

INTRODUCTION - ANALYTICS LANDSCAPE

Both edge and fog analytics are on the rise as result of continuous data flow from the Internet of Things devices. These devices are growing rapidly with the expansion of cloud-to-edge new range of machine learning (ML) chips that are built-in to accommodate high-performance computing (HPC) for processing data stream at the edges.[1] These MLs include deep learning (DL) and reinforcing learning (RL) to process data flow and carry out analytics on real time at the edges. This change in the analytics landscape is creating new analytics interface supported by new cloud-to-edge architecture.[2]

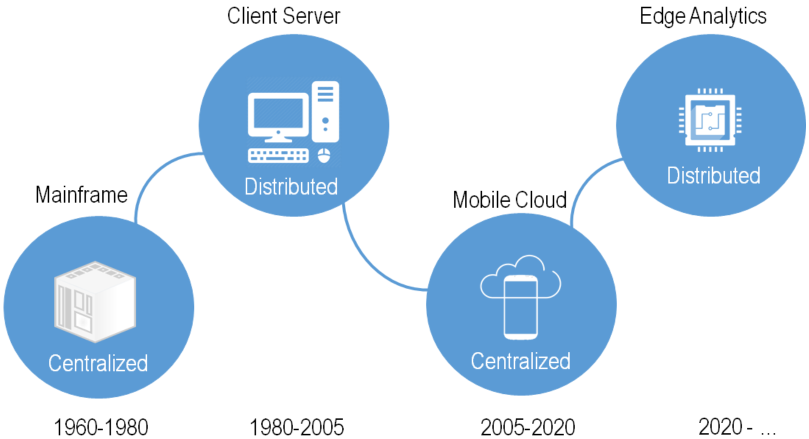

Figure 1.1 : Changing and evolving analytics landscape (Peter Levine 2017)

[1] Andy Patrizio (2018) Baidu takes a major leap as an AI player with new chip, Network World
[2] Frank X. Shaw (2018) Advancing the future of society with AI and the intelligent edge, Microsoft

The need to carry out real time analytics at the edge of networks is driven by the rapid proliferation of sensors and the increase of machine to machine communication. It is estimated that 40 percent of all data will be generated from sensors by 2020 and most of it as stream and massive data. A single jet engine for example may generate up to 1 terabyte of data in a single flight.[3] DataAge 2025 study reported that by 2025, 20 percent of data created will be real-time in nature that would not require sending it to the core of the network for processing.[4]

In this changing analytics landscape, there is a shift from cloud analytics to edge analytics to address latency issues as well as security issues.[5] With an unprecedented growth of data, the time that it will take for data to transit from a IoT device to "negotiate" a complex network topology at the cloud, it could be too lengthy for effective device management in remote locations. By the time data reaches the cloud for analysis, the opportunity to act on it may be also missed.[6]

For data to travel from the edge where it's generated to a cloud provider and back, it may take between 150 to 200 milliseconds, while at the edges it may take only between 2 and 5 milliseconds for data to transit back-and-forth locally. The implications can be enormous, when dealing of image-recognition to assess the quality of products and improve overall productivity (Table 1.1).

Table 1.1: Location and latency processing time - comparing edge/fog with cloud

	Time lag (response)	**Space (location)**
Edge	Milliseconds to sub-second	Local, such as a farm, a city block or a factory floor
Fog	Seconds to minutes	Wider – "County"
Cloud	Minutes to hours, days	Global

Source: CISCO[7] (2015) -
https://www.cisco.com/c/dam/en_us/solutions/trends/iot/docs/computing-overview.pdf

[3] Maciej Kranz (2015) Fog Analytics: Turning Data into Real-Time Insight and Action

[4] Raghavan Srinivasan (23 JULY 2018) Edge Computing and the Future of the Data Center, Seagate Technology.

[5] Sahni, Y et al. (2017) Edge mesh : a new paradigm to enable distributed intelligence in internet of things IEEE access, 2017, v. 5, p. 16441-16458)

[6] Sahni, Y et al. (2017) Edge mesh : a new paradigm to enable distributed intelligence in internet of things IEEE access, 2017, v. 5, p. 16441-16458)

[7] CISCO (2015) Fog Computing and the Internet of Things: Extend the Cloud to Where the Things Are