IOT & BIG DATA

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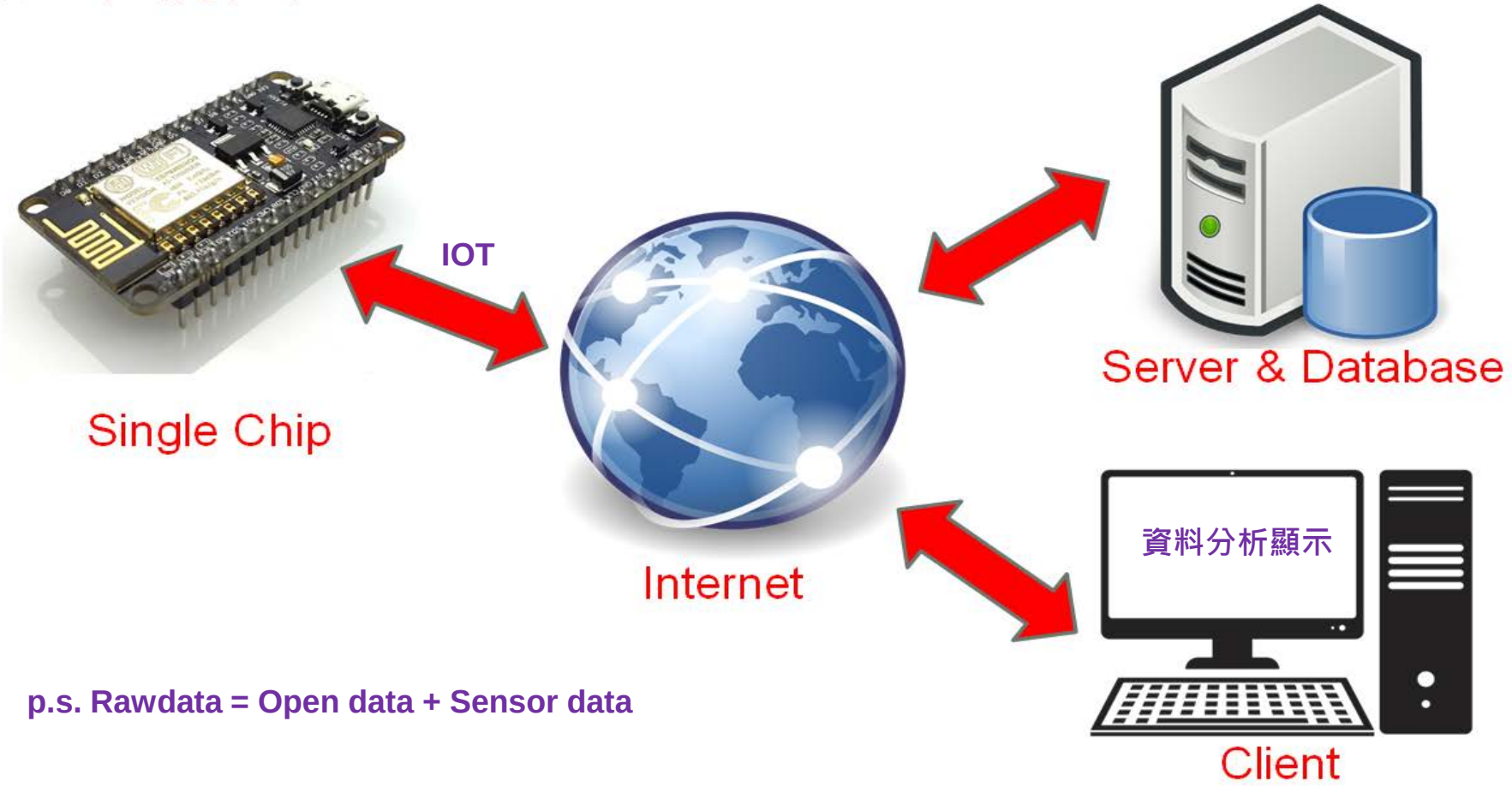
Contents

- Project Implementation Overview
- Course Overview
- Connectivity Models in IoT
- IoT Big Data

Project Implementation Overview

Implementation

- You need to accept the IOT data from sensors and a single chip, then send the data to the Big data environment to process and analyze it.



p.s. Rawdata = Open data + Sensor data

The tools you will use for this implementation

- The software +hardware and computer programs you will use
  - IOT
    - ✓ NODE MCU
    - ✓ Temperature and humidity sensor
    - ✓ Micro usb cable
    - ✓ Arduino platform
  - Server and DBMS
    - ✓ XAMPP
    - ✓ MySQL or Maria
    - ✓ php
    - ✓ html: likely
    - ✓ wireless usb adapter
  - Big Data
    - ✓ R
    - ✓ RStudio platform: We will use it most of time in this semester

The skills you need to learn

- Various data sources
- Data processing including data reshaping
- Data analysis
- AI model creation and evaluation

Course Overview

What is IOT?

- IOT: Internet of Things
- Definition: The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention. There is, however, no single, universal definition.

Enabling IOT **Technologies**

- The concept of combining computers, sensors, and networks to monitor and control devices has existed for decades.
- The recent confluence of several technology market trends, however, is bringing the Internet of Things closer to widespread reality. These include *Ubiquitous Connectivity*, *Widespread Adoption of IP-based Networking*, *Computing Economics*, *Miniaturization*, ***Advances in (Big) Data Analytics***, and the *Rise of Cloud Computing*.

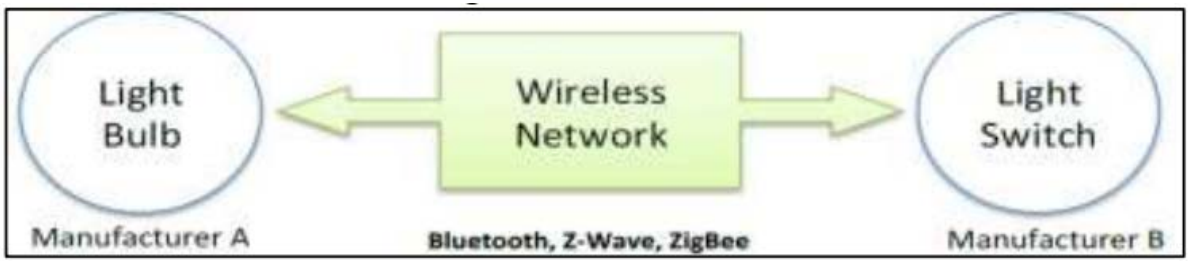
Connectivity Models in IoT

Connectivity Models in IoT

- IoT implementations use different technical communications models, each with its own characteristics.
- Four common communications models described by the Internet Architecture Board include: *Device-to-Device*, *Device-to-Cloud*, *Device-to-Gateway*, and ***Back-End Data-Sharing***. These models highlight the flexibility in the ways that IoT devices can connect and provide value to the user.
- *Big Data Analytics and processed is needed!*

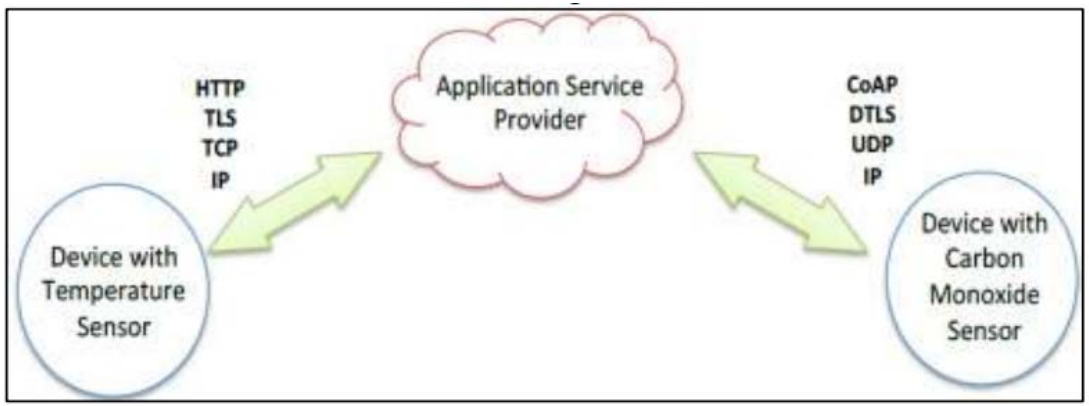
Connectivity Models in IoT

- Device-to-device communication model: The device-to-device communication model represents two or more devices that directly connect and communicate between one another, rather than through an intermediary application server. These devices communicate over many types of networks, including IP networks or the Internet. Often, however these devices use protocols like Bluetooth, Z-Wave, or ZigBee to establish direct device-to-device communications as shown.



Connectivity Models in IoT

- Device-to-Cloud Communications: In a device-to-cloud communication model, the IoT device connects directly to an Internet cloud service like an application service provider to exchange data and control message traffic. This approach frequently takes advantage of existing communications mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the device and the IP network, **which ultimately connects to the cloud service.**

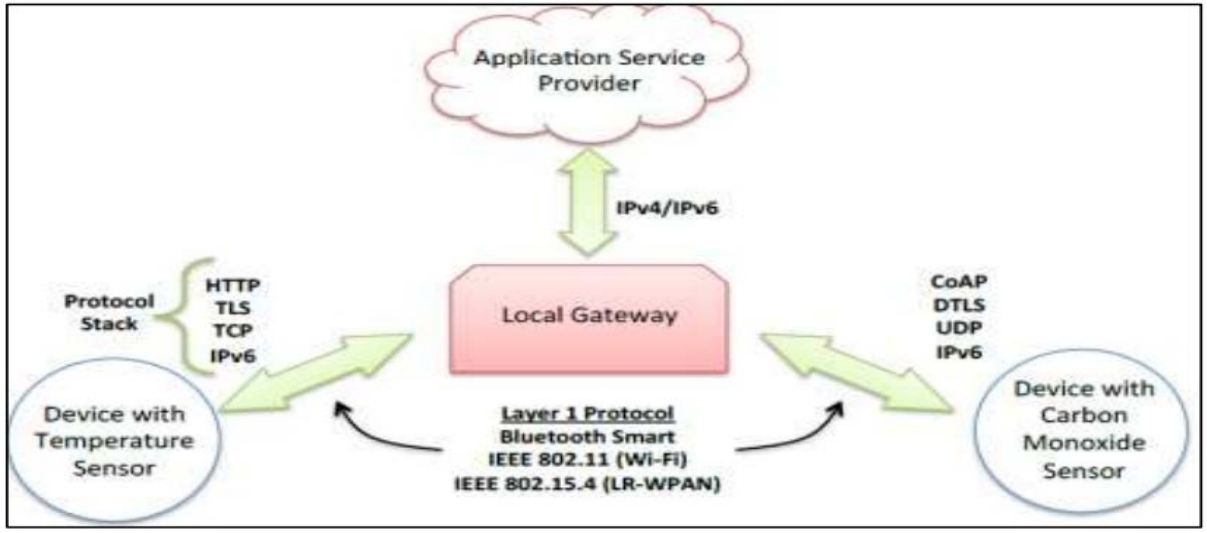


Connectivity Models in IoT

- Device-to-Cloud Communications: This communication model is employed by some popular consumer IoT devices like the Nest Labs Learning Thermostat and the Samsung Smart TV.
- Further, this cloud connection enables the user to obtain remote access to their thermostat via a smartphone or Web interface, and it also supports software updates to the thermostat. Similarly with the Samsung Smart TV technology, the television uses an Internet connection to transmit user viewing information to Samsung for analysis and to enable the interactive voice recognition features of the TV. In these cases, the device-to-cloud model adds value to the end user by extending the capabilities of the device beyond its native features
- However, interoperability challenges can arise while attempting to integrate devices made by different manufacturers.

Connectivity Models in IoT

- Device-to-Gateway Model: In the device-to-gateway model, or more typically, the device-to-application-layer gateway (ALG) model, the IoT device connects through an ALG service as a conduit to reach a cloud service. In simpler terms, this means that there is application software operating on a local gateway device, which acts as an intermediary between the device and the cloud service and provides security and other functionality such as data or protocol translation.

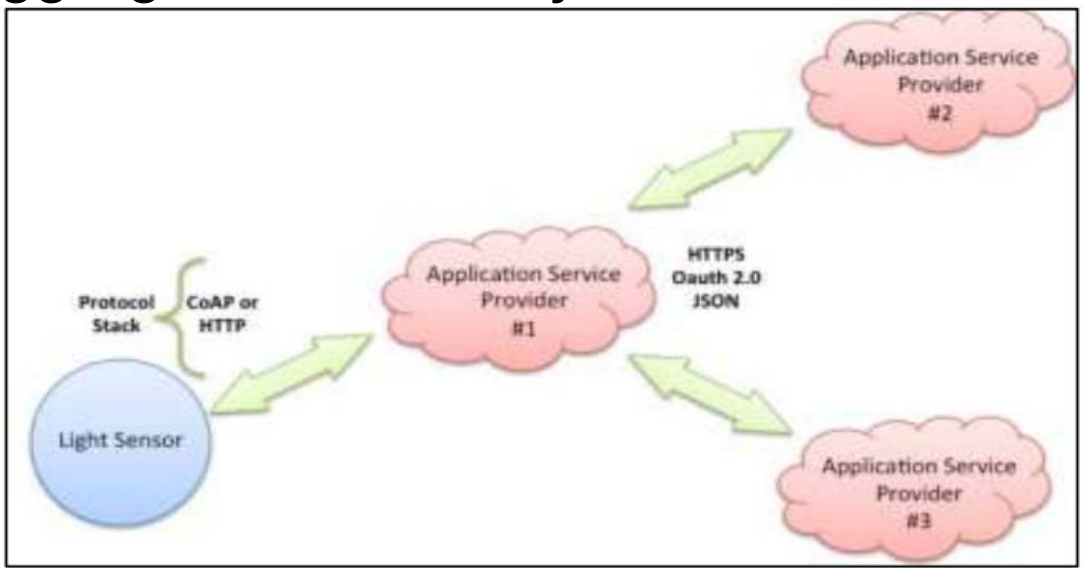


Connectivity Models in IoT

- Device-to-Gateway Model: In many cases, the local gateway device is a smartphone running an app to communicate with a device and relay data to a cloud service. This is often the model employed with popular consumer items like personal fitness trackers. These devices do not have the native ability to connect directly to a cloud service, so they frequently rely on smartphone app software to serve as an intermediary gateway to connect the fitness device to the cloud.

Connectivity Models in IoT

- Back-End Data-Sharing Model: The back-end data-sharing model refers to a communication architecture that enables users to export and analyze smart object data from a cloud service in combination. This approach is an extension of the single device-to-cloud communication model, which can lead to data silos where “IoT devices upload data only to a single application service provider”. A back-end sharing architecture allows the data collected from single IoT device data streams to be aggregated and analyzed.



Connectivity Models in IoT

- Back-End Data-Sharing Model: For example, a corporate user in charge of an office complex would be interested in consolidating and analyzing the energy consumption and utilities data produced by all the IoT sensors and Internet-enabled utility systems on the premises.

IoT Big Data

What is IoT Big Data?

- Big data analytics is emerging as a key to analyzing IoT generated data from “connected devices” which helps to take the initiative to improve decision making. ... A large amount of unstructured data is generated by IoT devices which are collected in the big data system.
- unstructured data: is information that either does not have a pre-defined data model or is not organized in a pre-defined manner. Unstructured information is typically text-heavy, but may contain data such as dates, numbers, and facts as well.
- Big data means a large set (petabytes or gigabytes) of structured, unstructured or semi-structured data and analyzing those data to get the insights of the business trend.

IoT and Big Data – Better Together

- IoT and Big Data are buzzing the technology world for quite a time now, and these are no longer a "*nice to have*" technology but a necessity.
- There is a drive to adopt big data within organizations which has triggered the use of big data analysis tremendously in the past few years. Hence, businesses are also rapidly catching on to what they need for it.

New in the world of Big Data?

- At the same time, the Internet of Things (IoT) has sparked the world by showing what a fully interconnected world can offer us. Though IoT and Big data evolved independently, they have become interrelated over the period.
- Furthermore, the relation between big data and IoT has shown a convergence of the two technologies which is aligning the technologies in the best possible way. Hence, if IoT big data combination separately gives plenty of reasons for excitement, then combining the two technologies multiplies the anticipation.

The Relation between Big Data and IoT

- Around 4.4 trillion GB of data will be generated by the year 2020 through the Internet of Things. This is no doubt difficult to comprehend easily. However, with the growing number of connected devices it is not surprising that by 2020, more than ten billions of sensors and devices will be connected to the internet. Furthermore, all of these devices will gather, analyze, share, and transmit data in real time. Hence, without the data, IoT devices would not hold the functionalities and capabilities which have made them achieve so much worldwide attention. (p.s. a Terabyte is a trillion bytes)

Unit	Value	Example
Kilobytes (KB)	1,000 bytes	a paragraph of a text document
Megabytes (MB)	1,000 Kilobytes	a small novel
Gigabytes (GB)	1,000 Megabytes	Beethoven's 5th Symphony
Terabytes (TB)	1,000 Gigabytes	all the X-rays in a large hospital
Petabytes (PB)	1,000 Terabytes	half the contents of all US academic research libraries
Exabytes (EB)	1,000 Petabytes	about one fifth of the words people have ever spoken
Zettabytes (ZB)	1,000 Exabytes	as much information as there are grains of sand on all the world's beaches
Yottabytes (YB)	1,000 Zettabytes	as much information as there are atoms in 7,000 human bodies

Role of Big Data in IoT

- When organizations are grabbing hold of the data for analysis purpose, IoT is acting as a major source for that data, and this is the point where the role of big data in IoT comes into the picture. Big data analytics is emerging as a key to analyzing IoT generated data from “connected devices” which helps to take the initiative to improve decision making.
- The role of big data in IoT is to process a large amount of data on a real-time basis and storing them using different storage technologies.

IoT Big data processing and analysis

IoT Big data processing

- *IoT big data processing follows four sequential steps –*
  1. A large amount of unstructured data is generated by IoT devices which are collected in the big data system. This IoT generated big data largely depends on their 3V factors that are volume, velocity, and variety.
  2. In the big data system which is basically a shared distributed database, the huge amount of data is stored in big data files.
  3. Data processing and Analyzing the stored IoT big data using analytic tools like Hadoop MapReduce, R, Python or Spark
  4. Generating the reports of analyzed data.
- Data analysis by using AI way ? Or DataMining way?

  How about machine learning? Deep learning? Statistics?

  Can they be implemented in Big Data?

DataMining way

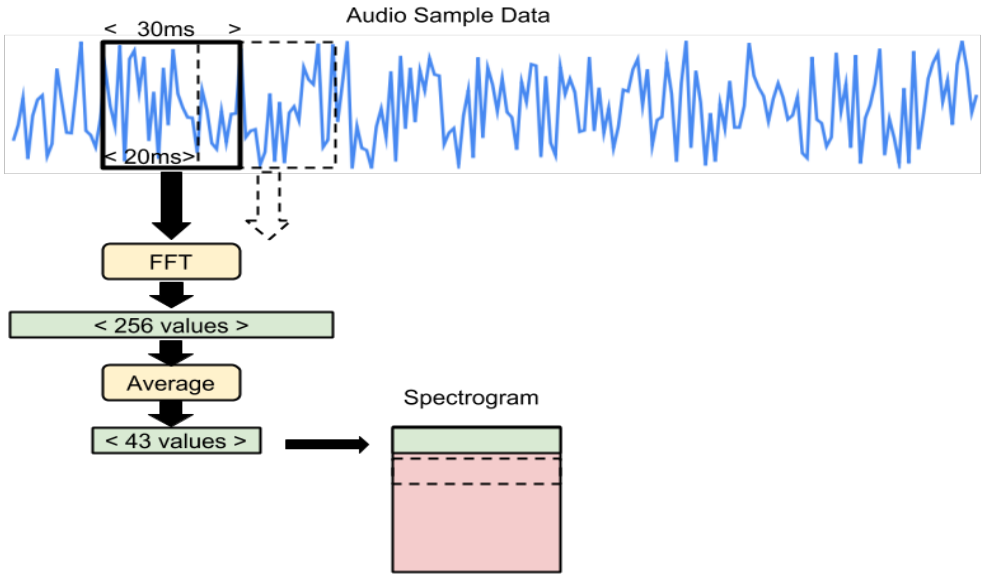
- The goal of data mining is to discover previously unseen patterns and relationships from large datasets and derive a business value from these.
- It focuses on uncovering relationships between two or more variables in your dataset and extracting insights.
- These insights include mapping the data into information which is directly relevant to a particular use case such as predicting outcomes from incoming events and prescribing actions.

AI way

- Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. Specific applications of AI include expert systems, natural language processing (NLP), speech recognition and machine vision.
- AI programming focuses on three cognitive skills: learning, reasoning and self-correction.

An Example of AI

- Speech recognition: Arduino nano 33 ble sense + Tensorflow ➔ Fourier transform +TensorFlow Lite netual nework model



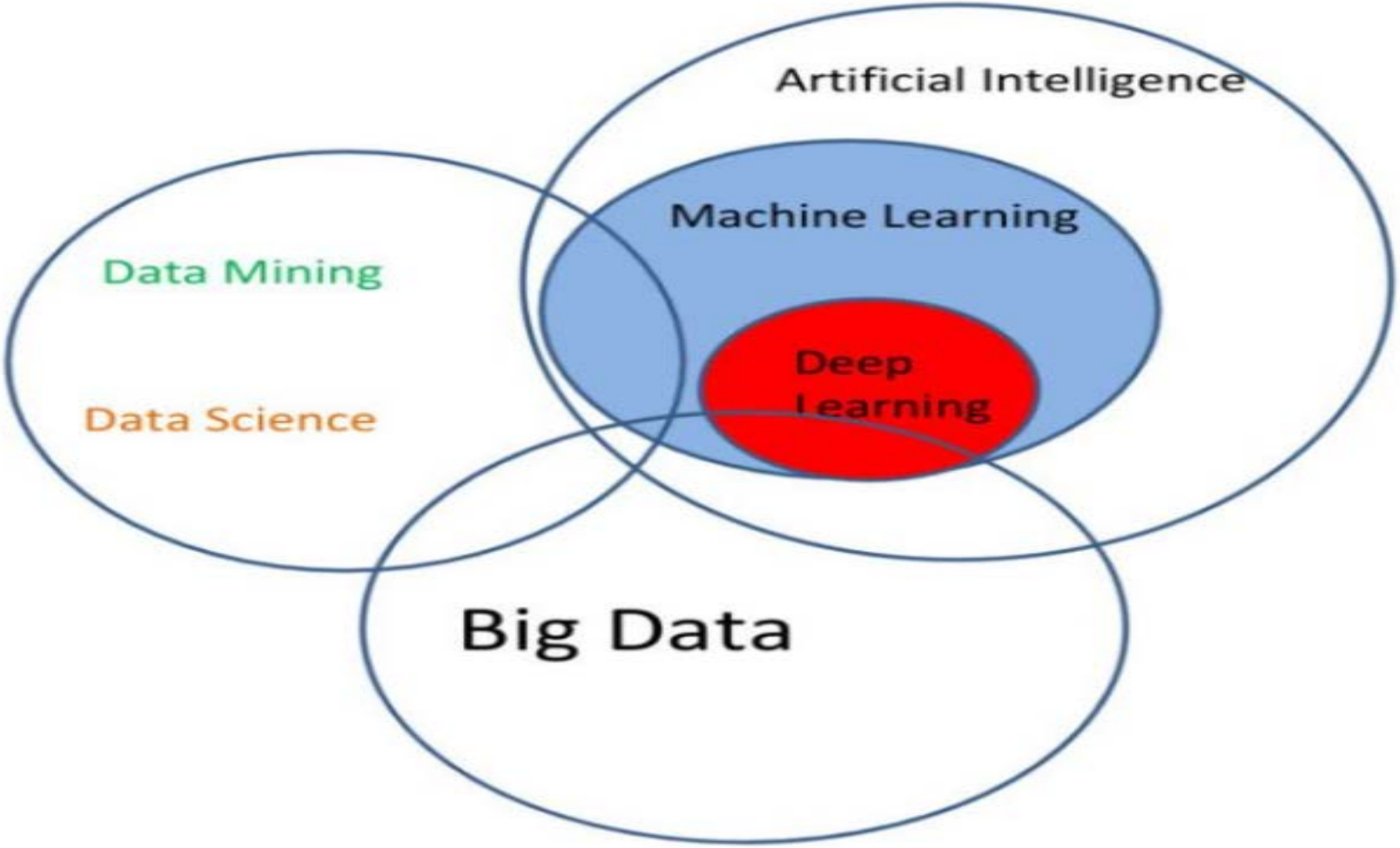
Arduino Nano 33 BLE Sense

playrobot.com

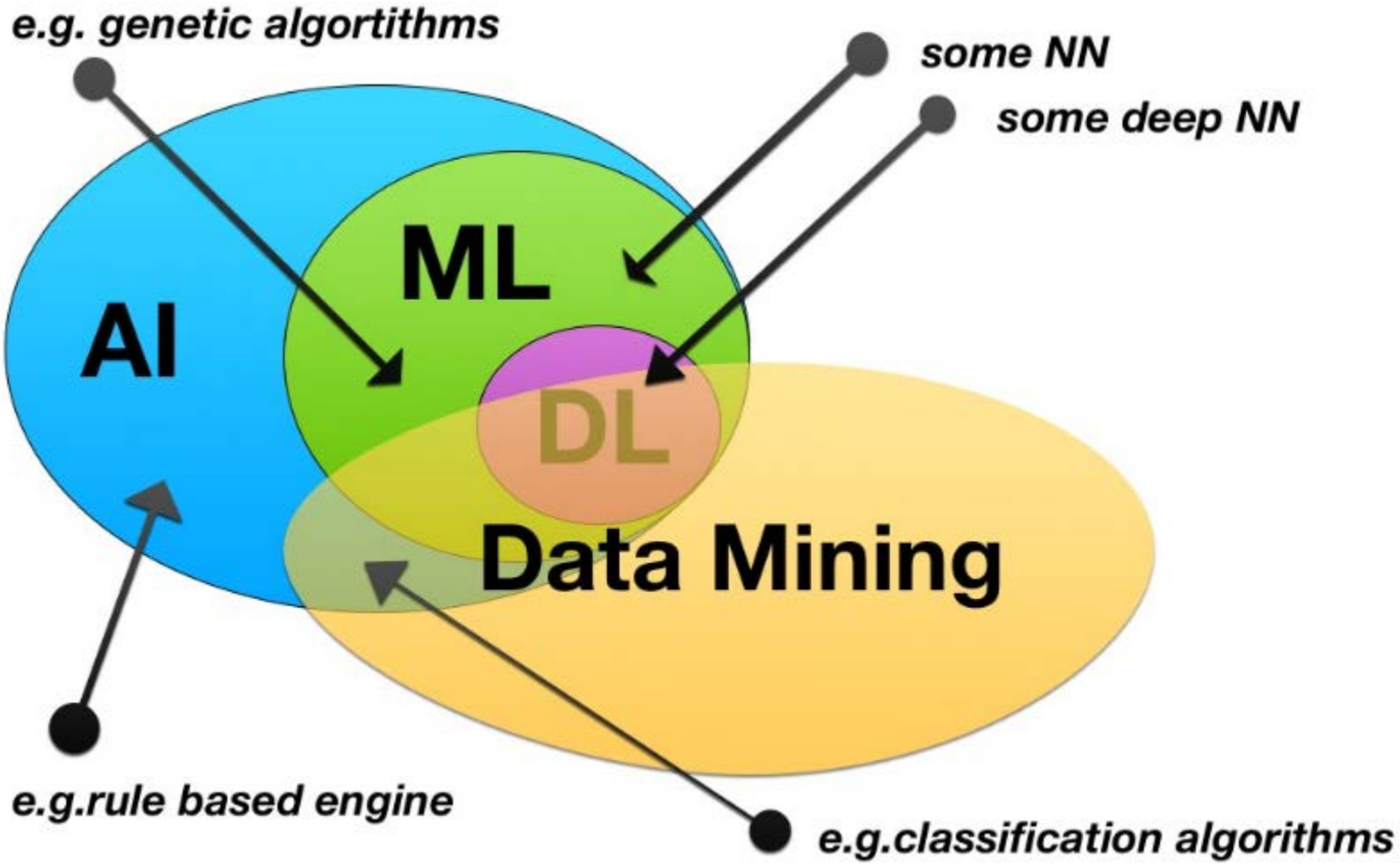
Machine Learning

- Machine learning and data mining use the same key algorithms to discover patterns in the data. However their process, and consequently utility, differ. Unlike data mining, in machine learning, the machine must automatically learn the parameters of models from the data. Machine learning uses self-learning algorithms to improve its performance at a task with experience over time. It can be used to reveal insights and provide feedback in near real-time.
- Generally speaking, the larger the datasets, the better the accuracy and performance. Learning can be by batch wherein the models are trained once, or continuous wherein the models evolve as more data is ingested with time. In the latter mode, based on the new data and feedback received, the machine constantly improves itself and the results increase in accuracy with time.

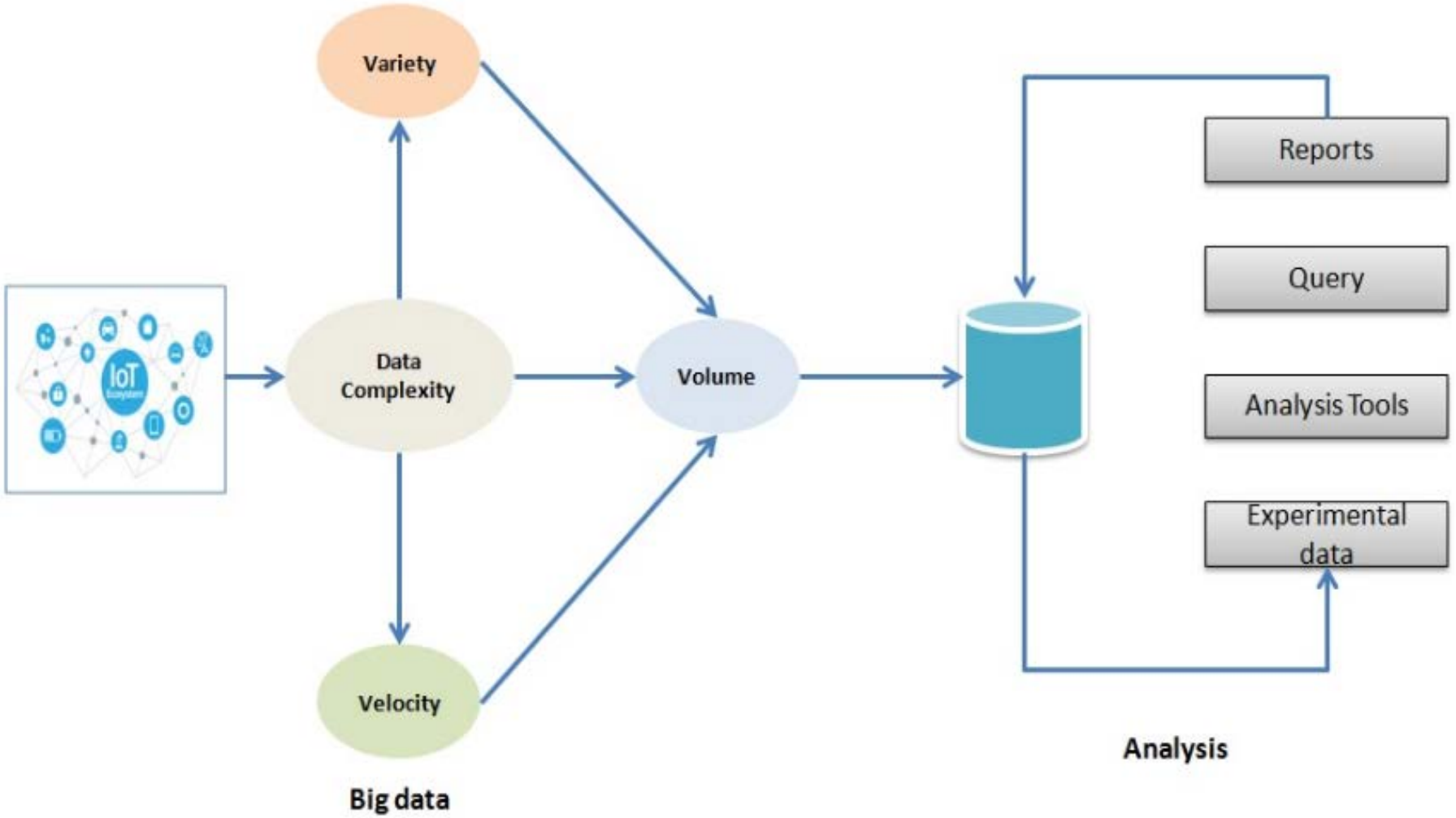
Relationship for them



Nowadays for Deep Learning



IoT big data processing Model



Nowadays: what is Big data 5V?

- The five V's of big data: Volume, velocity, variety, veracity and value are the five keys to making big data a huge business.
- Big Data Veracity refers to the biases, noise and abnormality in data.

IoT big data processing and analysis

- Since in IoT the unstructured data are collected via the internet, hence, big data for the internet of things need lightning-fast analysis with large queries to gain rapid insights (e.g. decision insights) from data to make quick decisions. Hence the need for big data in IoT is compelling.
- lightning-fast analysis: real time?
  - cloud/ server computing: parallel computing + distributed computing
  - the insights are embedded in a optimzed SQL
  - software automation in single chip or Server

How do IoT and Big Data Impact Each Other?

- It's not just that there is the only interdependent relation between big data and IoT. As they help each other, in addition to that they hugely impact each other. Fact is the more the IoT grows it will place more demand on businesses regarding big data capabilities.
- For example, as the IoT generated data is increasing at a huge rate, conventional data storage technology is already being pushed to its limits. As a result, it demands more advanced and innovative storage solutions to handle these growing workloads resulting in updating the infrastructure of an organization's big data storage.
- Similarly, the IoT big data combined applications accelerate the scope of research in both the fields. So, IoT and big data both the technologies carry inter-dependency and need further development.

How are IoT and Big Data Together Beneficial for Companies?

- IoT big data analytics can be useful for a variety of IoT data to –
  1. Examine
  2. Reveal trends
  3. Find unseen patterns
  4. Find hidden correlations
  5. Reveal new information
- Hence, companies can benefit from analyzing large amounts of IoT big data and managing them to identify how they affect businesses. As a result, it assists business and other organizations to achieve an improved understanding of data, and thus, making efficient and well-informed decisions. Every segment of businesses and industries can achieve some benefits.

An Example

- squash: Steel sheet → Wheel cover

Benefits of IoT and Big Data for Companies in Different Sectors

- Helps to increase the ROI for the Businesses
  - IoT and big data analytics are transforming how businesses are adding value by extracting maximum information from data to get better business insights. With the increased demand for data storage companies prefers big data cloud storage which ultimately lowers the implementation cost for them. p.s. ROI: Return On Investment/投資報酬率
- It will reshape the future e-health system
  - The combined features of the IoT and big data can reshape the next generation of e-health care systems. Big data will lead to hypothesis-driven research to data-driven research transformation. On the other hand, IoT will help to control and analyze the different levels of connections between various sensor signals and existing big data. This will enable new ways of remote diagnosis with a better understanding of the disease which will lead to the development of innovative solutions in the healthcare field.

Benefits of IoT and Big Data for Companies in Different Sectors

- Advantages in manufacturing companies
  - If manufacturing companies install IoT sensors within its equipment, they can collect significant operational data on the machines. This helps them to have an in-depth look at how the business is performing and enable them to find out which equipments need repairing before much problems arise. This prevents them from more significant expenses by skipping the downtime or replacement of the equipment. Hence, investment in IoT and big data causes saving businesses money.
- Internet of things and big data will raise self-service analytics
  - With more inventions in the IoT field, most of the IT functions can be handled with data automation and integration. Additionally, big data tools will increasingly become self-sufficient and straightforward to perform basic functions. Hence, analytics as a service will become more of a self-service type.

Benefits of IoT and Big Data for Companies in Different Sectors

- Benefits in the transportation industry
  - In the transportation sector, IoT sensors have been installed in the vehicles as a way to track them the go and around the world. This doesn't only help companies to keep a closer eye on the vehicles, but it also provides the data regarding fuel efficiency, how drivers utilize their time and delivery routes. This information can be indispensable for optimizing fleets and for the improvement of organizational productivity.

Benefits of IoT and Big Data for Companies in Different Sectors

- More benefits in Industrial internet of things (IIoT)
  - IIoT is related with various connected devices which help following tasks to control the behavior of the industrial devices –
    - ✓Monitoring
    - ✓Collecting
    - ✓Exchanging
    - ✓Analyzing
    - ✓Instantly acting on information
    - ✓Hence, the convergence of IoT and big data in IIoT is an important component.

Benefits of IoT and Big Data for Companies in Different Sectors

- Edge-Computing will be in high demand
  - Working on real-time data is a high priority today and a necessity as well. As IoT and Big data both enable on-demand and real-time action, the importance of deployment of these technologies is high. In this view, the popularity of edge computing is also becoming very high.
  - As the IoT and big data are closely linked, there are many examples out there of organizational benefits to put them to good use.

Conclusion

- The convergence of IoT and big data can provide new opportunities and applications in all the sectors. Along with that, it has the potential to revolutionize many aspects of our society. As an aspiring technology professional if you want to dig these promising areas, then at Whizlabs we leverage the facilities to gain knowledge in latest technologies like big data.

The End