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MATERI SEMINAR NASIONAL TEKNOLOGI INFORMASI DAN KOMUNIKASI (SENATIK 2020)

Oleh Pemateri 1

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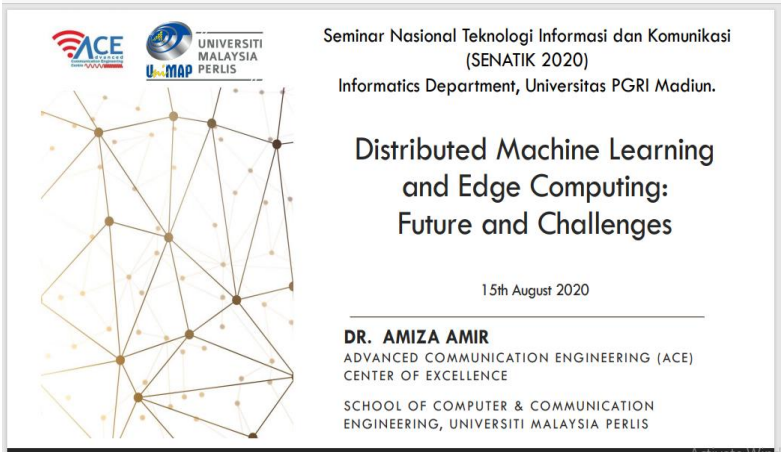
School Of Computer & Communication Engineering, Universiti Malaysia Perlis



The Future of Edge Computing

According to market research group IDC, companies in many industries around the globe are embracing edge computing and hybrid multicloud. By 2023, the cloud industry is expected to grow to $652 billion, with edge networks representing 60% of all deployed infrastructures.

Source: https://www.equinix.nl/resources/webinars/idc-predictions-cloud-edge-computing-2020/

What is Edge Computing

Microsoft: *"Edge computing is where compute resources, ranging from credit-card-size computers to micro data centers, are placed closer to information-generation sources, to reduce network latency and bandwidth usage generally associated with cloud computing"*

Source: https://www.microsoft.com/en-us/research/project/edge-computing/

Research firm IDC: *"mesh network of micro data centers that process or store critical data locally and push all received data to a central data center or cloud storage repository, in a footprint of less than **100 square feet**."*

Source: https://www.cbinsights.com/research/what-is-edge-computing/

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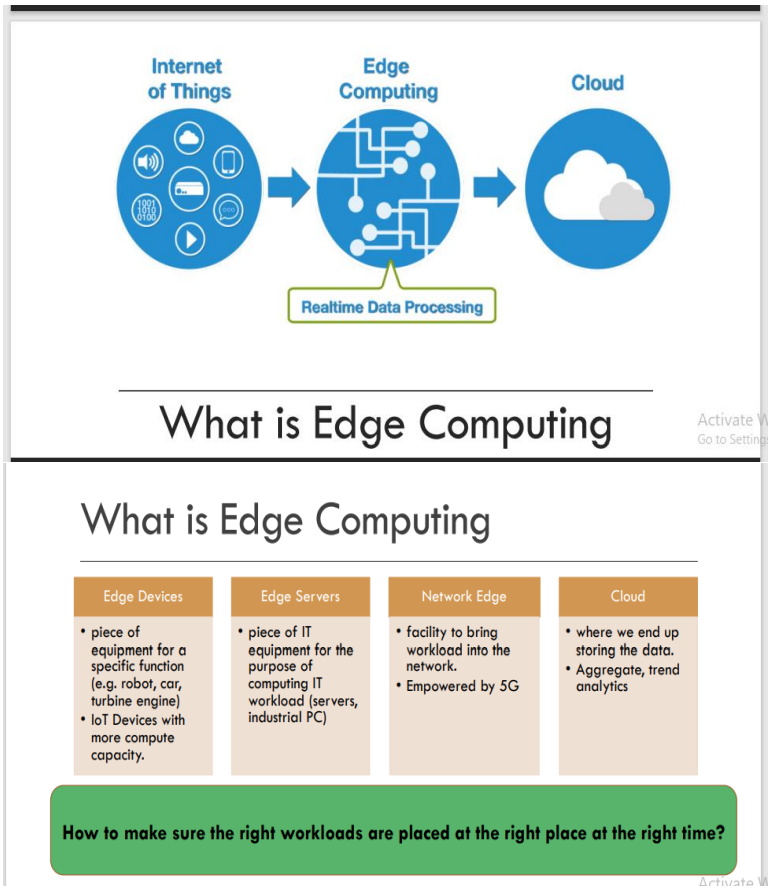

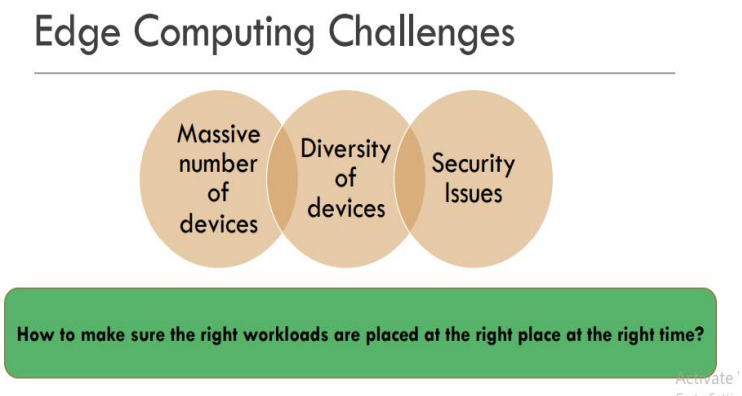

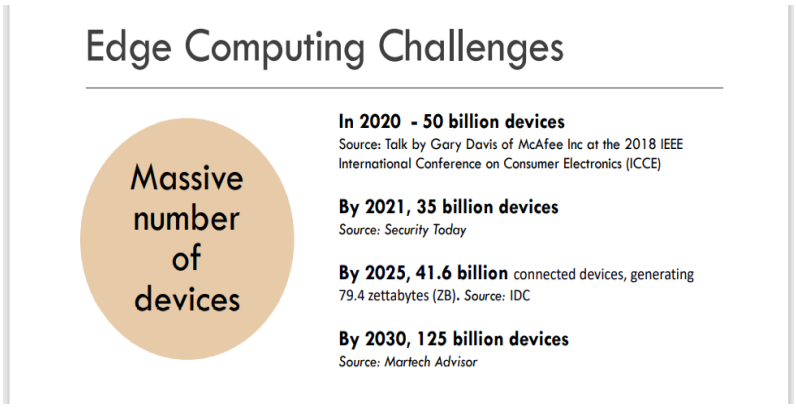

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Edge Computing Challenges

- Edge devices outside the boundary without security protection as in IT data center.
- IoT-based DDoS attacks (e.g. Mirai malware)?
- More 5G IoT devices will connect directly to the 5G network than via a Wi-Fi router → more vulnerable to direct attack

Security Issues

- How to ensure the the workload does not get tempered?
- How to ensure the security against the IoT-based attacks?
- How to ensure that we can detect any attacks and response to immediately?
- How to ensure the data associated with the workload is properly protected?

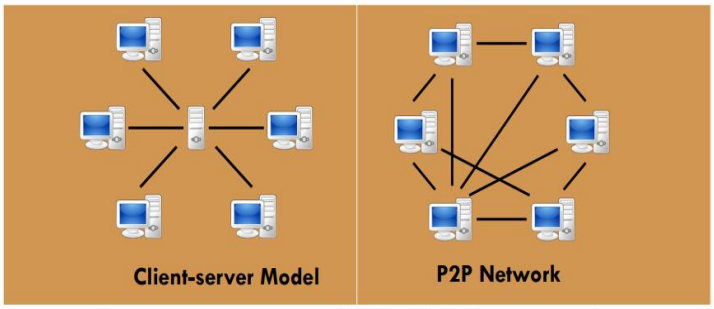
Edge Computing Challenges

Diversity of devices

- Different purpose, utility
- Different Operating System
- Different compute capability

Edge Computing: Benefits

- Speed and fast data analysis
- Balance network traffic
- Lowered operational cost
- Security
- Improve reliability
- Scalability



Peer-to-peer(P2P) Networks

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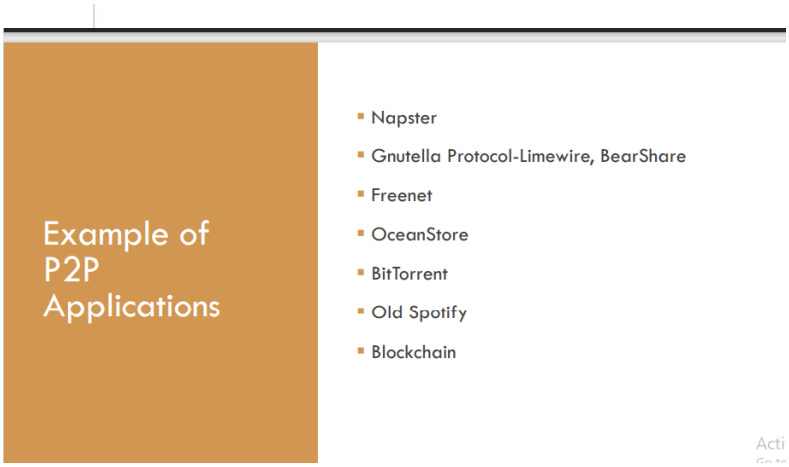

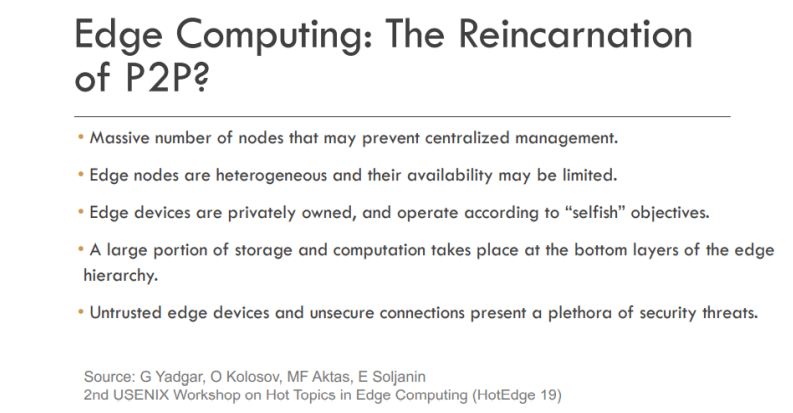

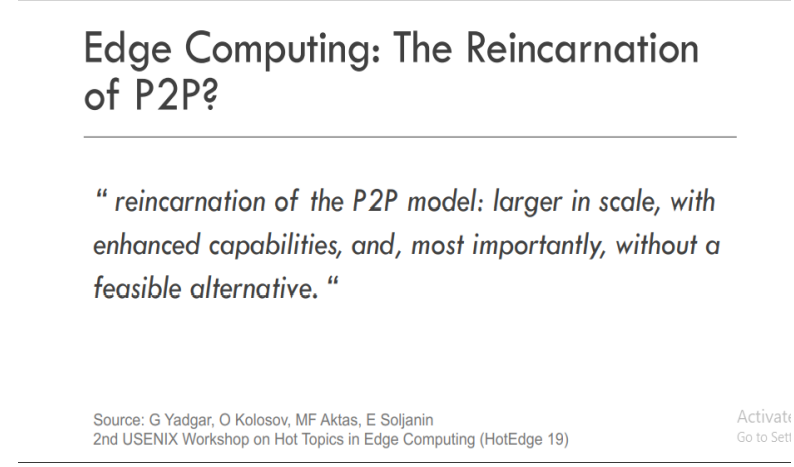

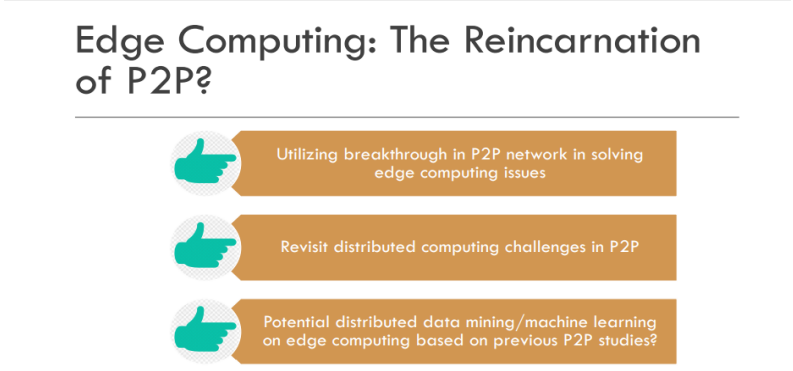

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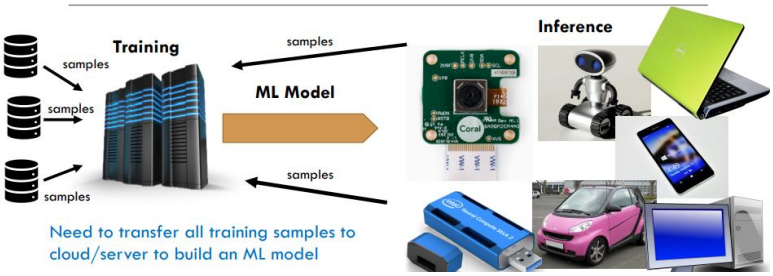
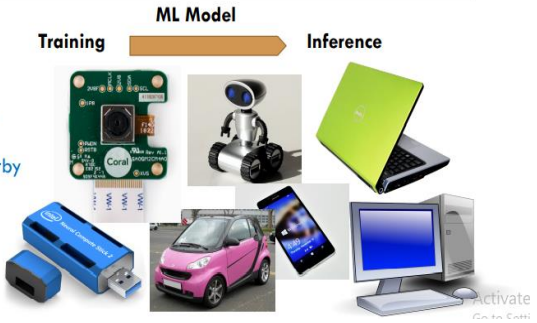
Machine Learning in Edge Computing



Distributed Machine Learning in Edge Computing?

- Don't need to transfer all training instances to cloud/server to build an ML model
- Process locally or at a nearby PC/server



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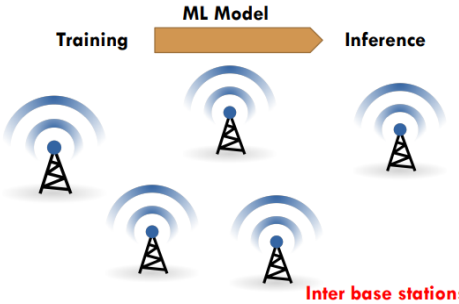

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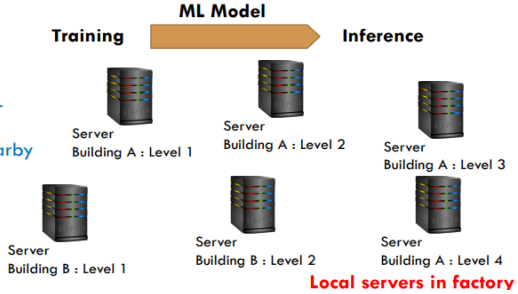

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Why people work on distributed machine learning?

- to speed up the computation– divide & conquer, parallel processing.
- to improve the classification accuracy - to iteratively build a more accurate classifier from many classifiers - ensemble learning or a multi-classifier approach is used.
- building a global classifier from a large, naturally distributed network.
- to improve the system scalability in dealing with large datasets without sending all data to cloud. – P2P Cloud system, edge computing

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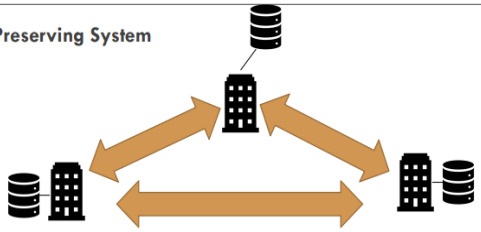
Distributed Machine Learning within Large Networks: Motivation

- **In naturally-distributed environment:** to process the data locally at their locations without moving entire raw datasets to a single location.
- **An economical alternative for large-scale pattern classification (P2P Cloud)** : we may use the available computational resources (e.g., P2P computing) to develop such system.
- Our dependence on expensive high performance servers and cloud-based system can be reduced drastically
- **Blockchain**
- **Edge computing**

Distributed Machine Learning within Large Networks: Motivation

- **Privacy Preserving System**



Compare and analyze data from different organizations without disclosing the private data to any other party

Structured or Unstructured Distributed ML System

Well-structured into a **fixed architecture**

- usually designed to improve accuracy, speed up computation and process large datasets.

Unstructured system with **dynamic architecture**

- expands and shrinks depending on the network
- usually used for large distributed networks.

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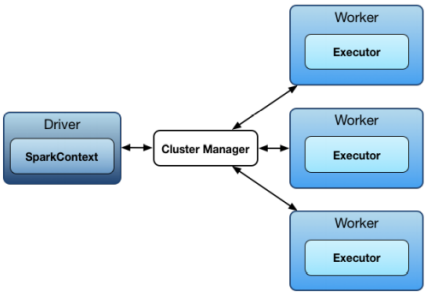
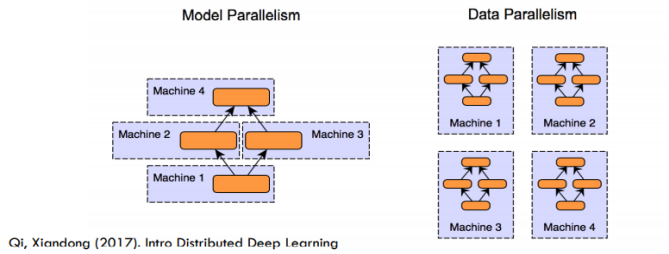
Distributed ML within Well-Structured Architecture



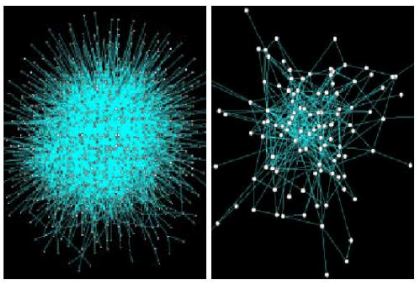
Distributed ML within Well-Structured Architecture



Qi, Xiandong (2017). Intro Distributed Deep Learning
https://xiandong79.github.io/Intro-Distributed-Deep-Learning

Distributed Machine Learning within Large Networks: Challenges

What about large and unstructured networks?



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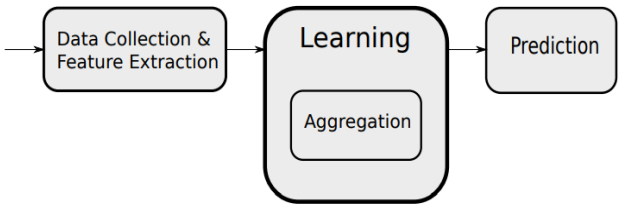
Distributed Aggregation

- How to combine models/inference?
- Calculate global statistics to combine results from distributed sites.
- Within large networks, distributed aggregation is usually aims to obtain an approximation of global statistics instead of exact values.

Distributed aggregation problems

During learning - to obtain a global classifier $\mathcal{C}_{G_P}$ which represents the generalisation of training datasets from all nodes in G_P, $\mathcal{C}_{G_P} = \mathcal{C}(\mathcal{D}_{G_P}) = \bigcup_{i \in G_P} \mathcal{D}_i$ where $\mathcal{D}_i$ is the training dataset at node i; or $\mathcal{C}_{G_P} = \bigcup_{i \in G_P} \mathcal{C}_i$ where $\mathcal{C}_i$ is a local classifier at node i.



Components of Distributed Machine Learning

AGGREGATION DURING LEARNING

Distributed aggregation problems

During classification - to obtain a global classification result $\hat{R}_{G_P}$ which represents the generalisation of local results from all nodes in G_P, $\hat{R}_{G_P} = \bigcup_{i \in G_P} \hat{r}_i$ where $\hat{r}_i$ is a local classification result at node i .

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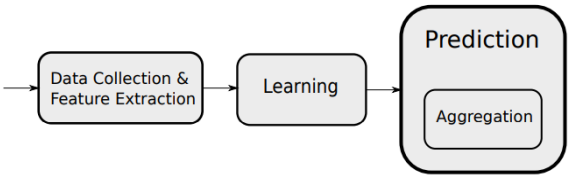
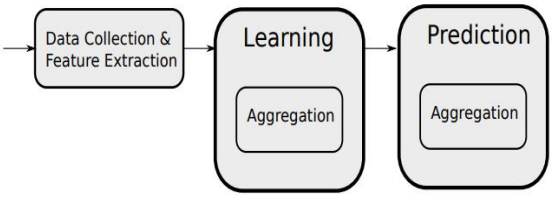


Components of Distributed Machine Learning

AGGREGATION DURING PREDICTION



Components of Distributed Machine Learning

AGGREGATION DURING LEARNING AND PREDICTION

Distributed ML Topologies within a Large Distributed System

semi-distributed : a single host to coordinate or perform some parts of the computation while some parts of the computation are performed in distributed among nodes.

Cluster-based : a group of nodes (which form a cluster) perform a fully-distributed computation in collaboration among nodes within the group.

local algorithm : every nodes builds its own global classifier or prediction by communicating with a small set of nodes.

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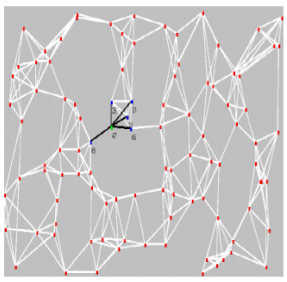
Locality Sensitive Distributed Algorithm

Local algorithms: communication within the local neighborhood.

Global algorithms : know everything about the entire network.



Source: Distributed data mining in peer-to-peer networks
S Datta, K Bhaduri, C Giannella, R Wolff, H Kargupta - IEEE internet computing, 2006

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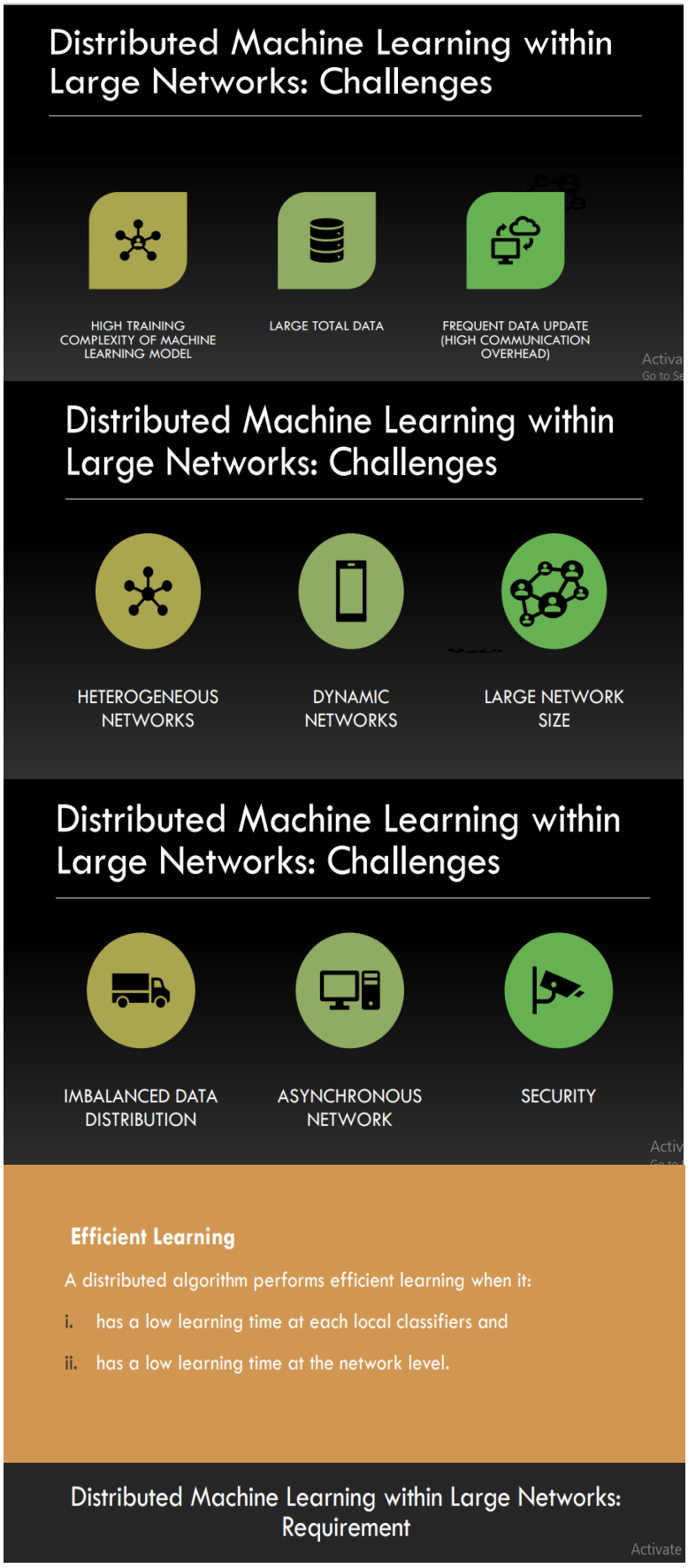

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Lack of synchronisation

The algorithm should have a lack of synchronisation to fit in the asynchronous network.

Distributed Machine Learning within Large Networks: Requirement

Scalability within Large Networks

A distributed algorithm is network-scalable if the communication per host is independent of the network size (N).

Distributed Machine Learning within Large Networks: Requirement

Model Update with Low Communication Overhead

Only significant updates among nodes must be shared, i.e. updates that has an effect during learning.

Reduce the frequency of data sharing (statistics, models of complex models) among nodes.

Distributed Machine Learning within Large Networks: Requirement

Scalability For Large Dataset

- Algorithm needs to be communication-efficient and resource-efficient in dealing with a large number of training data and a high-dimensional dataset (a dataset with a large number of attributes).
- Can be measured based on its resource efficiency per peer and its communication efficiency for large dataset

Distributed Machine Learning within Large Networks: Requirement

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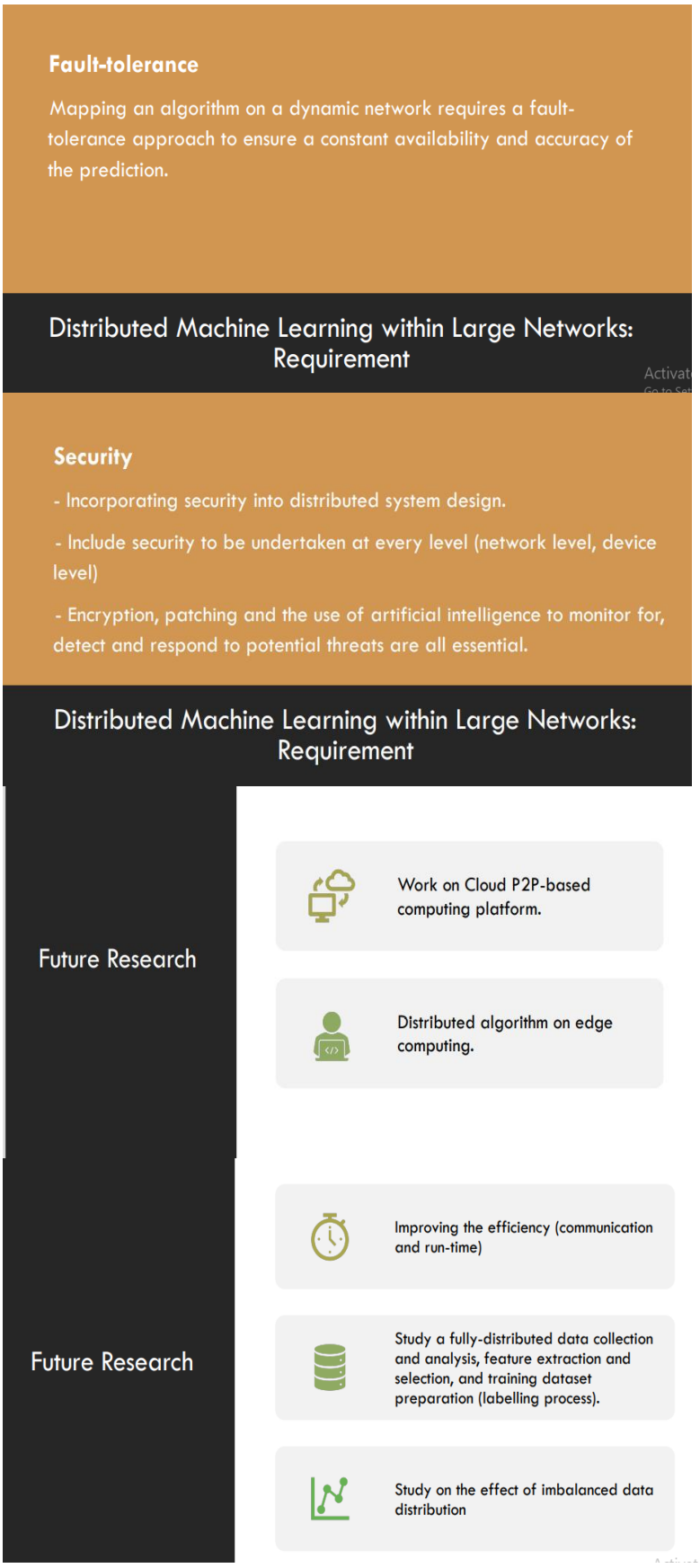

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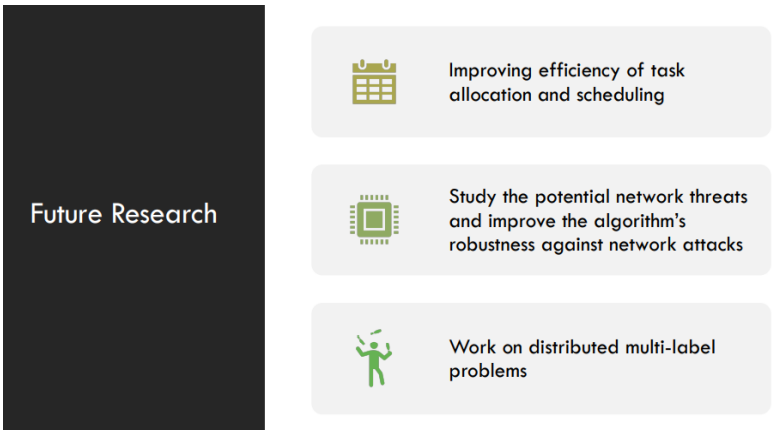

Thanks for listening and
we are looking forward for future collaboration!!!