SOON CHUN HYANG UNIVERSITY

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Federated learning for smart cities: A comprehensive survey

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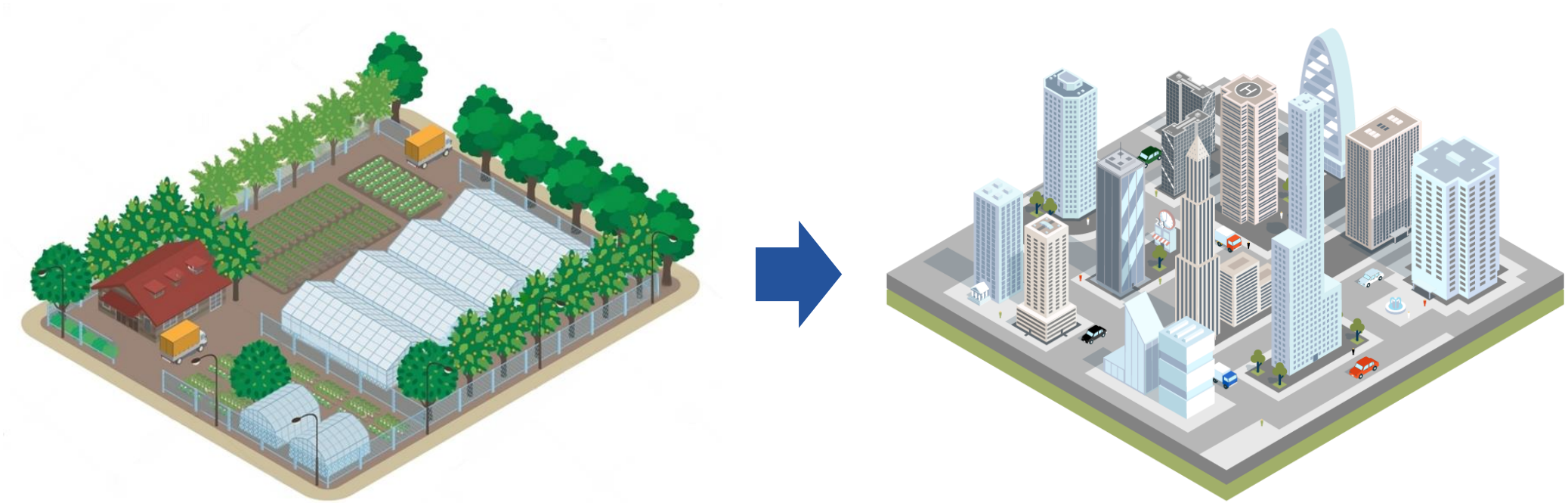
1. Introduction

Background

Paragraph #1

Growth of the urban population

- Worldwide, 53.7% of people live in urban areas in 2020
- Urbanization often encounters challenges such as traffic jams, health problems, environmental destruction, etc.



1. Introduction

Background

Paragraph #2

Smart Cities

- Smart cities utilize data collection and analytics to solve existing problems and improve the quality of life
  - Collect data by utilizing sensors and IoT devices
  - Using ML/DL algorithms to find hidden patterns in the data

1. Introduction

Challenges

Paragraph #3

Challenges for Smart Cities

- Smart city applications require real-time decision making, such as traffic forecasting and disaster management
- However, Cloud-based storage (centralized) can result in analysis delays
- Other challenges include data loss, complex computation and communication, and high energy requirements

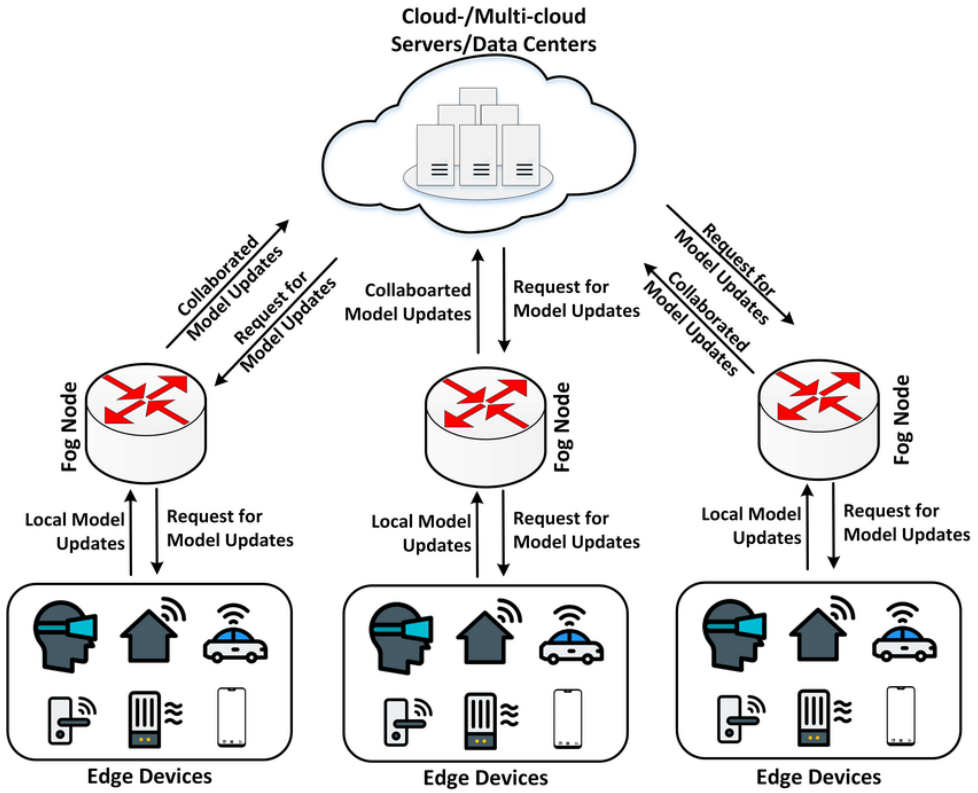
The Need for Federated Learning

1. Introduction

What is federated learning?

Paragraph #4

Federated Learning(FL)



1. Introduction

Research on the Importance of FL

Table 1
Summary of related reviews on FL for smart cities.

Research	Contributions	Limitations
[28]	A review of FL in various fields, such as the IoT, transportation, communications, finance, and medicine.	The applicability of FL for smart cities was not explored.
[27]	A surveys on smart city applications where FL is integrated with Digital Twins (DTs).	The applicability of FL for smart cities was not explored in detail.
[24]	Smart city sensing approaches, challenges faced, advantages of FL.	The potential of FL for smart cities and vertical applications was not studied.
[18]	Emerging applications of FL in IoT, FL-IoT services.	Limited to the FL-IoT services like IoT data sharing, and data offloading, while applications of FL for smart cities were not studied.
[32]	FL techniques in the healthcare systems (e.g., drug development, clinical diagnosis, digital health monitoring, disease predictions and detection system).	Did not focus on the potential applications and enabling technologies of FL for smart cities.
[15]	The importance of FL in Big Data.	Focused mainly on FL for big data services and applications.
[33]	A review on integrating FL with IIoT in terms of privacy, resource and data management.	Did not focus on FL for smart cities and applications.
[34]	Highlighted the applications of FL.	Focused on different applications of FL, while the review of FL for smart cities was ignored.
[28]	Presented an extensive review of FL and its applications in IoT, Transportation, Communication and Healthcare.	Focused on FL implementations in various aspects on smart city but did not include issues pertinent to heterogeneous communication, preservation of privacy and security.
[29]	Emphasized on reviewing the role of FL in the privacy preservation of IoT devices.	Concentrated primarily on privacy preservation techniques, methods and applications relevant to FL implementation but the aspect of its plausible use in smart city was not explored.
[30]	The various enabling technologies that helped in the implementation of blockchain based FL implementation and the relevant architecture model was presented.	The primary focus was on privacy preservation application in general and smart city perspective was excluded.
[31]	The survey focused on blockchain integrated with FL applications in Vehicular (IoT) Networks.	Did not have an extensive review of versatile smart city applications while the scope of review was narrowed only to transportation.
Our survey	A comprehensive survey of FL for smart cities, societal, industrial, and technological trends driving FL for smart cities. We also discuss the concept of FL for smart city applications, including smart transportation systems, smart healthcare, smart grid, smart governance, smart disaster management, smart industries, and UAVs for smart city monitoring. We also highlight several key challenges and potential solutions to stimulate further research on this interesting topic.	–

No survey exists on FL for smart city-based applications

1. Introduction

Contribution

Motivation of FL for Smart Cities

- A summary of the above description

Contributions

1. Importance of FL in Smart Cities
2. Importance of FL in Smart City Applications
3. Smart city related projects utilizing FL
4. Challenges, Problems, and Future Directions of FL for Smart City Applications

2 FL for smart city applications

2. FL for smart city applications

FL for smart transportation systems

Topics included in this paper

- Smart transportation(ST)
- Smart healthcare
- Smart grid
- Smart governance
- Smart disaster management
- Smart industries
- UAV for smart city monitoring
- Smart buildings

Topics included in this presentation

- Smart transportation(ST)
- Smart healthcare

2. FL for smart city applications

FL for smart transportation systems

Smart transportation(ST)

- Intelligent transportation systems use a variety of technologies to monitor, evaluate, and manage transportation systems to improve efficiency and safety

- The Application Areas of Smart Transportation
  - Navigation of cars
  - Control system for Traffic Signals
  - Automatic recognition of number plates
  - Cameras for Speeding Vehicles

2. FL for smart city applications

FL for smart transportation systems

The state-of-the-art FL methods for ST

- Liu et al. [35]
  - Proposed privacy-preserving approach for traffic forecasting in smart cities(FedGRU)
- Hua et al. [36]
  - Proposed approach based on blockchain and FL to automatic control of heavy haul railway system
- Manias et al. [40]
  - Demonstrate the potential for FL methods to leverage intelligence based on groups of connected vehicles to enable recovery from errors

Computational efficiency, privacy, proposed novel FL framework, and more

2. FL for smart city applications

FL for smart healthcare

Smart healthcare

- Smart healthcare is a system that uses technology, including wearable devices and IoT, to integrate people, infrastructure, systems, and healthcare organizations

- ML-based smart healthcare applications cannot use centralized servers to manage data due to privacy problems
  - Unable to implement real-time healthcare applications
  - Biased data leads to incorrect solutions

2. FL for smart city applications

FL for smart healthcare

The state-of-the-art FL methods for smart healthcare

- [43]
  - Proposed FL system with hierarchical model aggregation process
- [44]
  - Proposed FL system for unified computation and processing of heterogeneous data
- [46]
  - Integrating the concept of blockchain with a decentralized healthcare system to prevent adversarial attacks

Computational efficiency, privacy, proposed novel FL framework, and more

2. FL for smart city applications

Application limitations in FL

Limitations

- FL collects sensitive data, making it difficult to provide security
- When performing real-time analytics, delays can lead to poor decision-making that reduces system throughput
- FL systems encounter multiple challenges, including increased delay, connectivity, bandwidth, and data migration

3 Lessons learned, open issues, challenges, future directions

3. Lessons learned, open issues, challenges, future directions

How FL has been helpful for smart city-based applications

The advantages of FL

1. Keep local data secure on local devices
2. Reduce communication overhead and decrease bandwidth usage
3. Increase user computational power while protecting privacy

3. Lessons learned, open issues, challenges, future directions

Challenges and future directions

Challenges and open issues related to FL

1. Privacy issues
2. Security issues
3. Issues related to big and complex data
4. Issues related to performance of FL algorithms
5. Statistical heterogeneity in FL
6. Communication overhead in FL
7. Availability of data
8. Regulatory compliance
9. FL for 5G and beyond technologies
10. Estimation deviation and energy-saving issues in FL integrated DT systems

5 Conclusion

5. Conclusion

Conclusion

- A detailed introduction to FL and its benefits for smart cities
- Survey the importance of FL for several smart city applications
- Discuss several EU and DARPA smart city-based projects and use cases utilizing FL
- Discuss challenges and open issues in FL for smart city applications and provide future directions

How to apply?

※ How to apply?

리뷰 논문 선정 배경

- 스마트시티에 대한 이해 부족 -> 논문 작성 간 어려움

리뷰 목적

- 스마트 시티 관련 Introduction, Related works, 용어 등 정리
- TRB 논문을 위한 연구 확장 방향성 확립

리뷰 결과

- Introduction에 인용할 문장, 논문을 정리할 수 있었음 (Notion 댓글)
- FL을 어디서 언급해야 하는지에 대한 인사이트를 얻었음
- FL 관련 새롭게 알게 된 연구는 없었음
- 스마트시티에서만 사용하는 전문 용어는 교통, 의료 관련분야에서는 딱히 없었음
- 논문에 오탈자, 전문용어가 많아서 읽기 어려웠음

※ How to apply?

Introduction

- 스마트시티는 첨단 기술을 활용하여 도시의 효율성을 극대화하고 시민의 삶의 질을 향상시키는 것을 목표로 함
- 고령화로 인해 스마트 시티 내의 공공 안전 및 건강 관리에 관심이 커짐. 특히 낙상은 심각한 부상을 초래
- 딥러닝의 발전 + 기존 스마트시티의 운영방식(센서, 카메라, IoT 기반)을 기반으로 한 낙상 감지
- 그러나 기존의 방식은 -> 개인정보, 통신 효율성, 실제 적용가능성 등의 문제가 존재(관련 연구)
- 비전 + FL 모델 접근 방법을 통해 이를 해결할 수 있으나, 여전히 가려짐, 폐색 등의 문제가 존재 (관련 연구)
- 본 논문에서는 이를 해결하기 위해 Multi View – FL 방법 기반 시스템 제안. 장점 어필
- 따라서, 본 논문의 기여는 다음과 같다.
- 나머지 섹션은 ~~

Thanks