Developing Accelerators for Homomorphic Encryption

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Outline

1. Homomorphic Encryption
    1.1. Examples
    1.2. Schemes
    1.3. Advantages
    1.4. Disadvantages
2. Research Question
3. Hardware Acceleration
4. Our Progress and Aim

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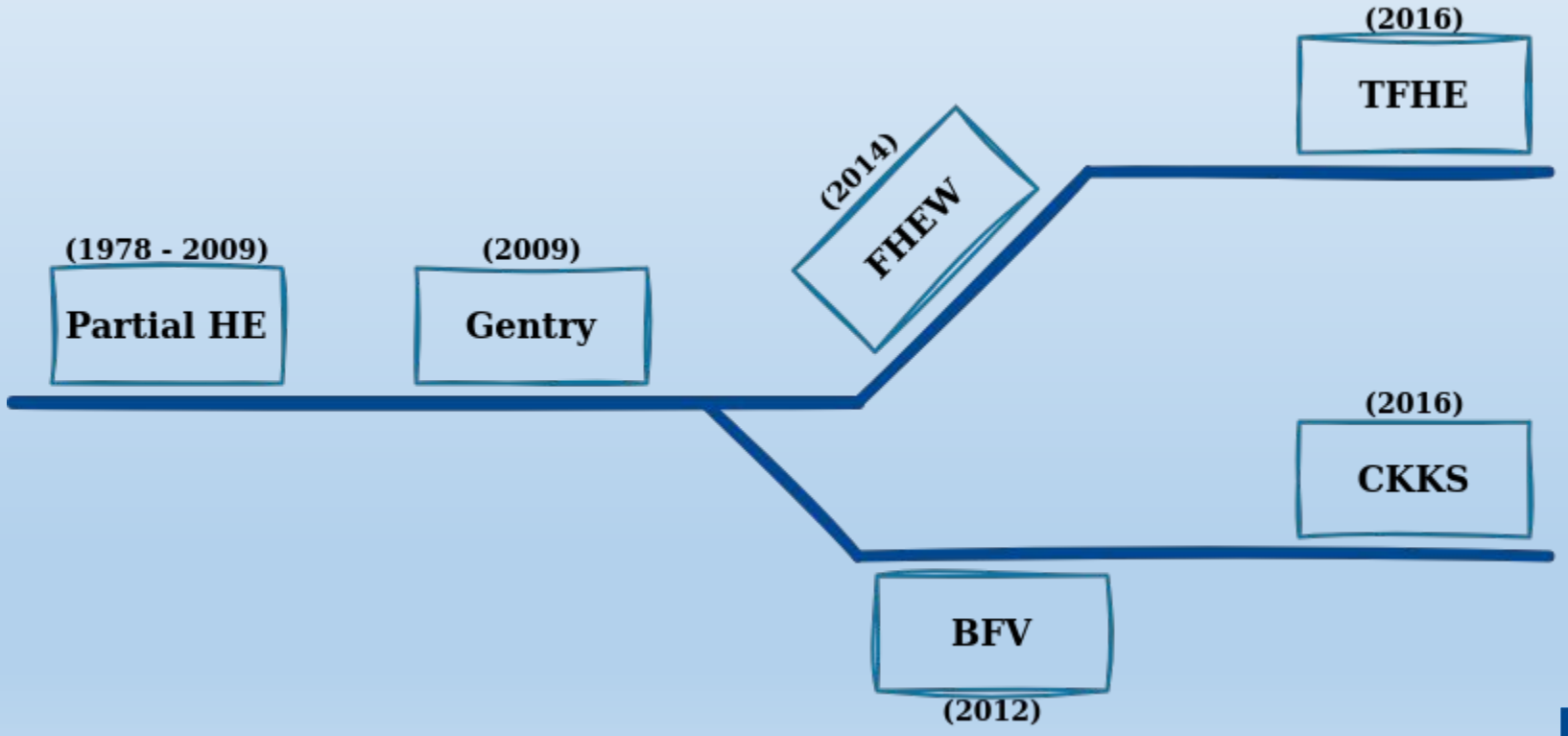
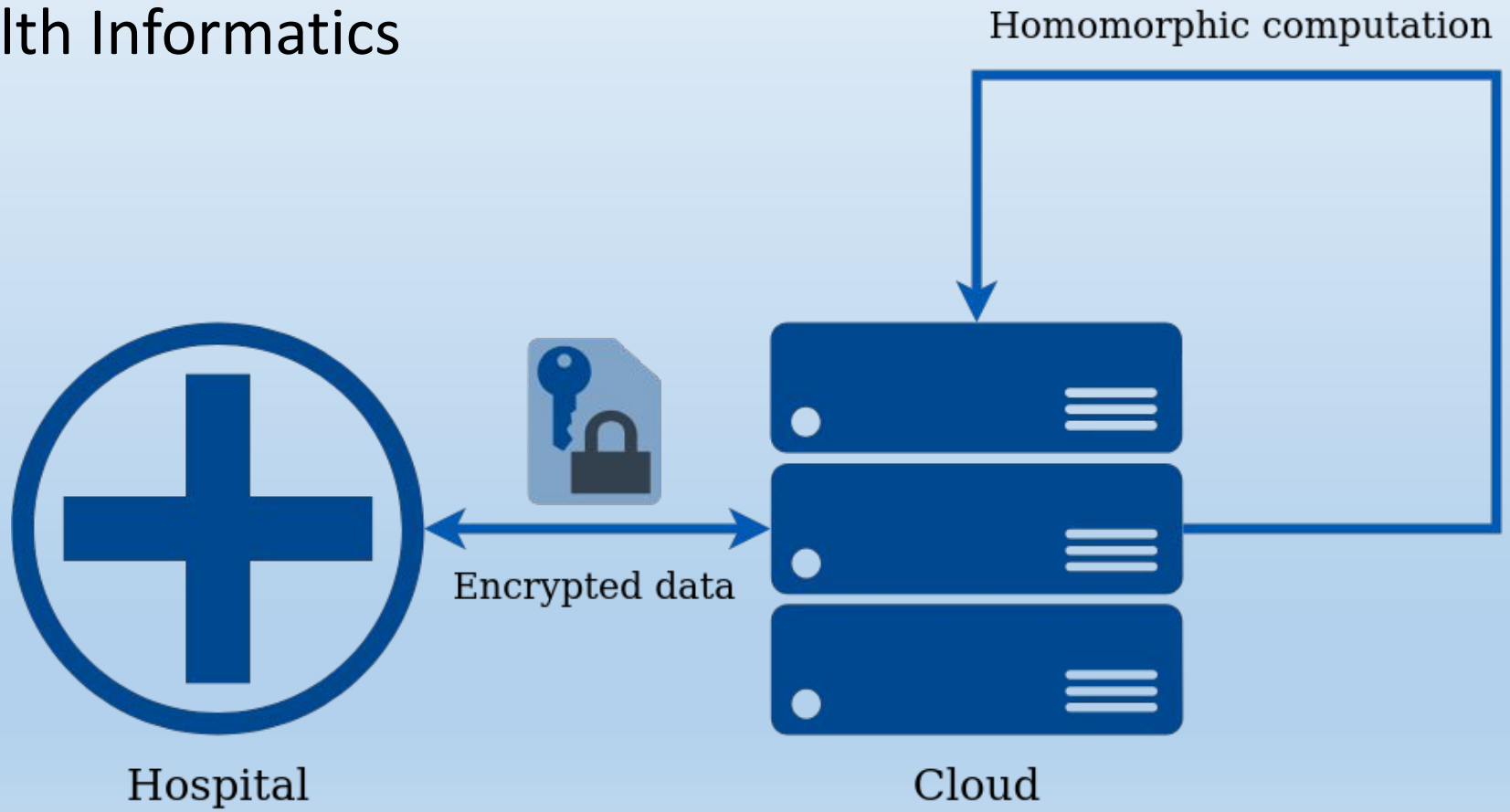
What is Homomorphic Encryption?

- Encryption schemes which allow a third-party to perform computation on encrypted data



Examples of Homomorphic Encryption

- Health Informatics



Examples of Homomorphic Encryption

- Health Informatics
- Privacy-Preserving Machine Learning

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- Privacy-Preserving Machine Learning
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- Financial Transactions and Fraud Detection

Advantages of Homomorphic Encryption

- Confidential computing

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- Reduced trust requirements

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- Data Monetization
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- Interoperability

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Advantages of Homomorphic Encryption

- Confidential computing
- Data Monetization
- Reduced trust requirements
- Interoperability
- Integrity assurance

Homomorphic Encryption Schemes

- CKKS (Cheon-Kim-Kim-Song) (Cheon et al., 2017):
  - Approximate computation
  - Leveled encryption scheme
  - Appropriate for machine learning, scientific computation
- TFHE (Fast Fully Homomorphic Encryption over the Torus) (Chillotti et al., 2019):
  - Exact computation
  - Fast bootstrapping
  - General use case

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Disadvantages of Homomorphic Encryption

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- High Computational Cost
- Performance Overhead
- Complexity of Implementation
- Increased Data Size

Research Question

How can we accelerate homomorphic encryption?

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Hardware Acceleration

- Using specialized hardware to perform tasks more efficiently

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- Using specialized hardware to perform tasks more efficiently
- Three main types:
  - CUDA
  - FPGA
  - ASIC

Our Progress and Aim

- Python implementations of homomorphic encryption algorithms
- Python wrapper for CUDA HE library
- Hardware implementations of algorithms with Verilog

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Chillotti, I., Gama, N., Georgieva, M., & Izabachène, M. (2019). TFHE: Fast fully homomorphic encryption over the torus. *Journal of Cryptology*, *33*(1), 34–91. https://doi.org/10.1007/s00145-019-09319-x

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