TU Graz

SCIENCE
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TECHNOLOGY

Application-based comparative study of FHE schemes

Vincent Pischler

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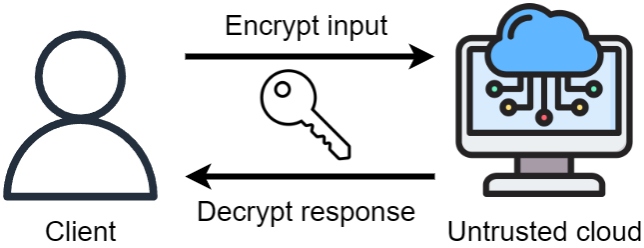
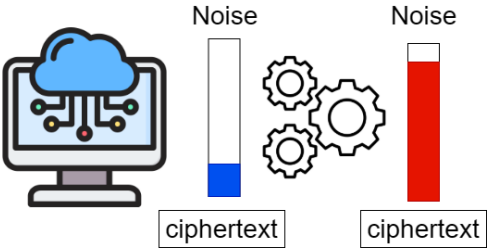
Motivation and Main Question

- Improve performance
- Efficiently manage noise



Methodology

- Error growth analysis
- Compare CKKS, BFV and BGV

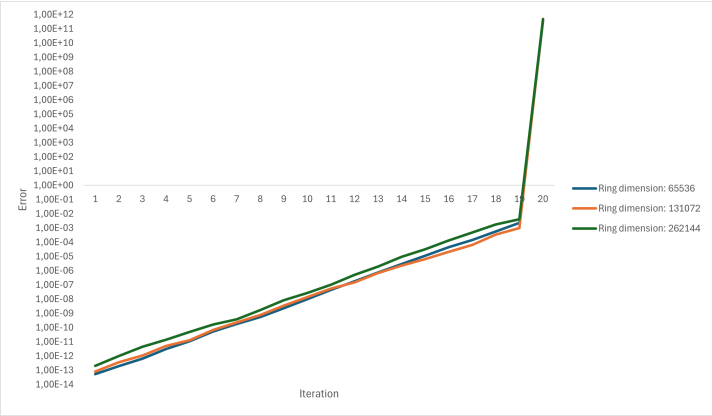


Error growth analysis

- Influence of scheme parameters on noise
- Setup
  - Iterative multiplication
  - Log error
  - Empirical analysis

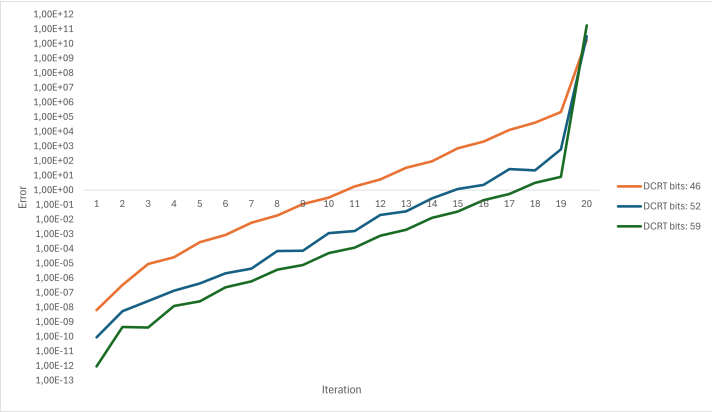
Iteration 0: $ct_0 = ct_{init} \times ct_{fact}$
Iteration i: $ct_i = ct_{i-1} \times ct_{fact}$

Ring dimension



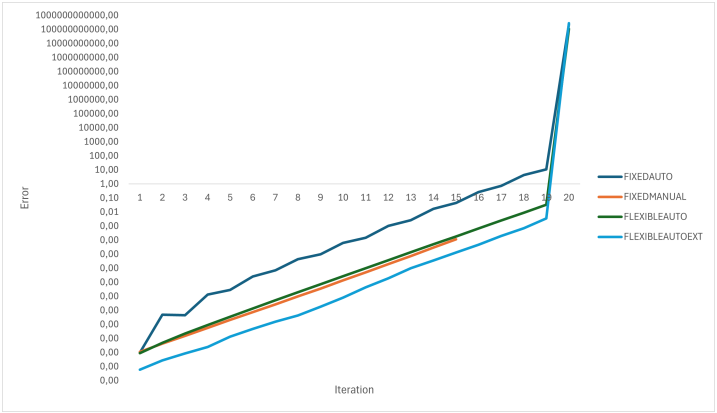
Ring Dim.	Avg. time
2^{16}	5402 ms
2^{17}	13031 ms
2^{18}	29091 ms

ScalingModSize



Determines size of Scaling Factor Δ

ScalingTechnique



Fixed	Flexible
Same Δ	Different Δ

Compare CKKS, BFV and BGV

- Calculate real numbers
  - Internal scale CKKS
  - External scale BFV / BGV

Compare CKKS, BFV and BGV

$$\sigma(x) = \frac{1}{1 + e^{-x}}, \quad pred(x) = \sigma(b + x * w)$$

$$P(x) = \frac{1}{2} + \frac{1}{4} * x \rightarrow pred(x) = \frac{1}{2} + \frac{1}{4} * (b + x * w)$$

x	CKKS	BFV / BGV
0.467143	0.558393	0.558375
-0.774431	0.403196	0.40325

- Computation time and memory
  - Ring dimension
  - Multiplicative Depth
- Precision
  - ScalingTechnique
  - ScaleModSize
- External scale depends on situation