A study of some practical impacts of twisted embeddings in lattice-based cryptography

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March 12, 2021

Twisted embeddings

Lattices

Objectives

Main goal

- Validate the idea of using twisted embeddings in cryptography
- Explore the theoretical and the practical aspects of this proposal

Practical aspects

- Compare implementations and instances of the Twisted Ring-LWE and Ring-LWE
- Maximum realsubfield versus the cyclotomic power-of-tw
- Search for proper sizes of keys and messages

Theoretical aspects

- Study the polynomial arithmetic of themaximal real subfield
- Study the relation between the orthonormal basis and the efficient conversion between latticepoints and elements of number field
- Examine if it is possible toachieve a satisfactory efficiency with non-orthonormal basis

Methodology and timeline

Methodology

- **Literature Review:** review proposals of new cryptosystems, such as *NTTRU*.
- **Theoretical experiments:** perform experiments using algebra libraries to discover twist factors and to discover orthonormal bases.
- **Experimental outcome:** to calculate the expansion factor of the polynomial $f(x)$ that defines the ring $\mathbb{Z}[x]/f(x)$. Adapt or develop algorithms for polynomial multiplication.
- **Implementation:** implement a Twisted Ring-LWE based cryptosystem.
- **Practical experiments:** to estimate the cost in terms of clock cycles, also key and message sizes.

Timeline

- First and second semesters of 2021
  - Study the Twisted Ring LWE problem and implementation.
  - Perform theoretical experiments with number fields, twist factors and lattices.
  - Calculate the expansion factor and adapt/develop algorithms for polynomial multiplication.
- First and second semesters of 2022
  - Implement a Twisted Ring-LWE based cryptosystem.
  - Compare instances of Ring LWE and Twisted Ring LWE, *i.e.*, analyze the cryptosystem in both terms of clock cycles and key sizes.
  - Defense of dissertation.

Thank you!