Johanna Loyer, Inria Paris

Lattice sieving via quantum walks

Joint work with André Chailloux

QUANTUM COMPUTERS

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efficiently solves

Factorization
Discrete logarithm

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Need to standardize **quantum resistant** cryptosystems

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Factorization
Discrete logarithm

Need to standardize quantum resistant cryptosystems

NIST PQC

Post-quantum cryptography international contest
to standardize the most secure cryptosystems

QUANTUM COMPUTERS

Factorization
Discrete logarithm

Need to standardize **quantum resistant** cryptosystems

NIST PQC

Lattice-based problems

NTRU

LWE

SIS

SVP

One of the categories of problems that resist to quantum attacks

QUANTUM COMPUTERS

Factorization
Discrete logarithm

Need to standardize **quantum resistant** cryptosystems

NIST PQC

Lattice-based problems

NTRU

LWE

SIS

SVP

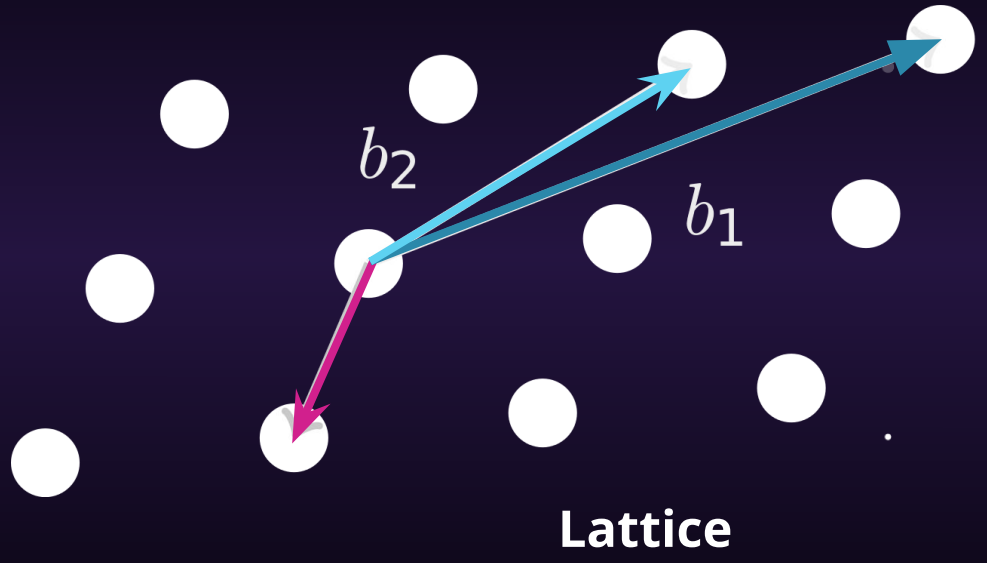
Efficiently solving SVP implies efficiently solving any lattice problem

SVP hardness

Tomorrow world cybersecurity

Shortest Vector Problem

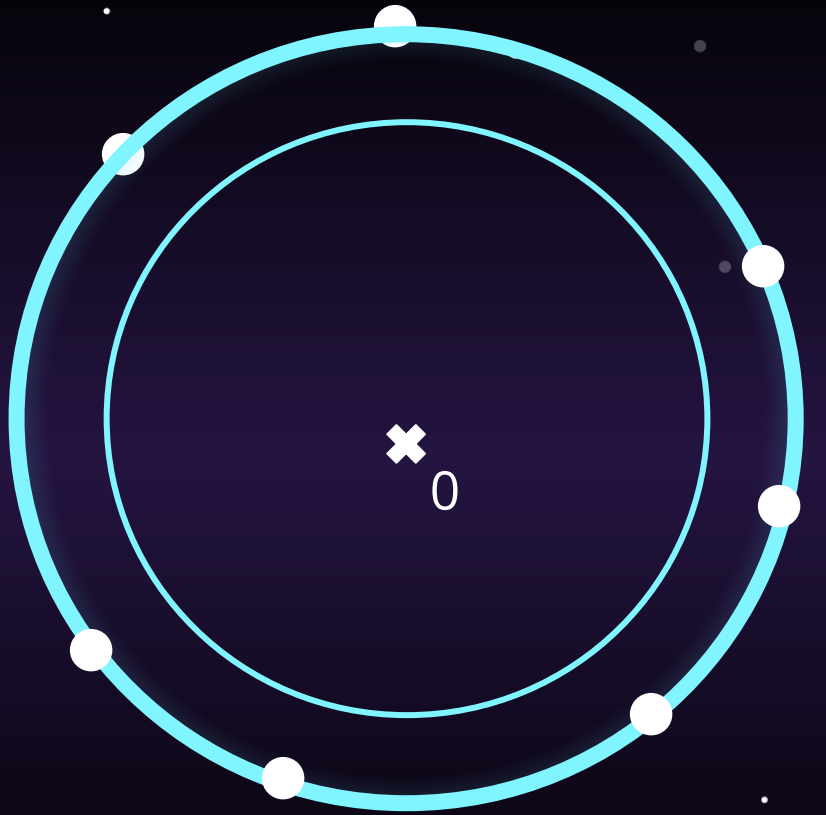
Given a basis of vectors, find its shortest (non-zero) integer linear combination.



Sieving
[NV08]

In: N lattice vectors of norm $\leq R$
$y < 1$

Out: N lattice vectors of norm $\leq y \cdot R < R$



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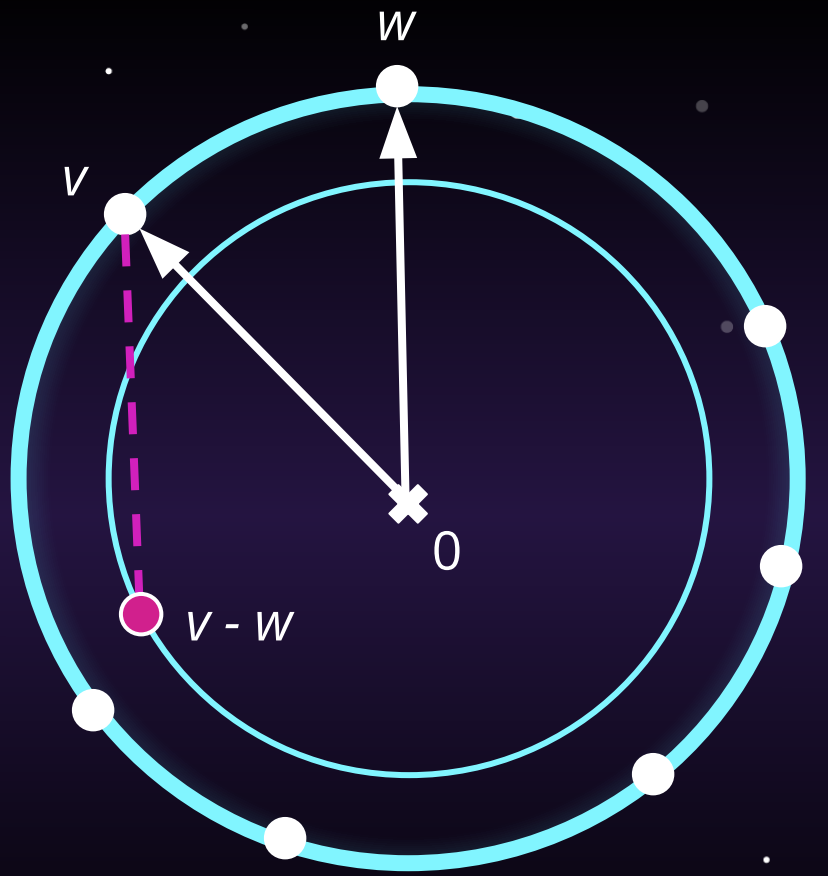

Sieving [NV08]

In: N lattice vectors of norm $\leq R$
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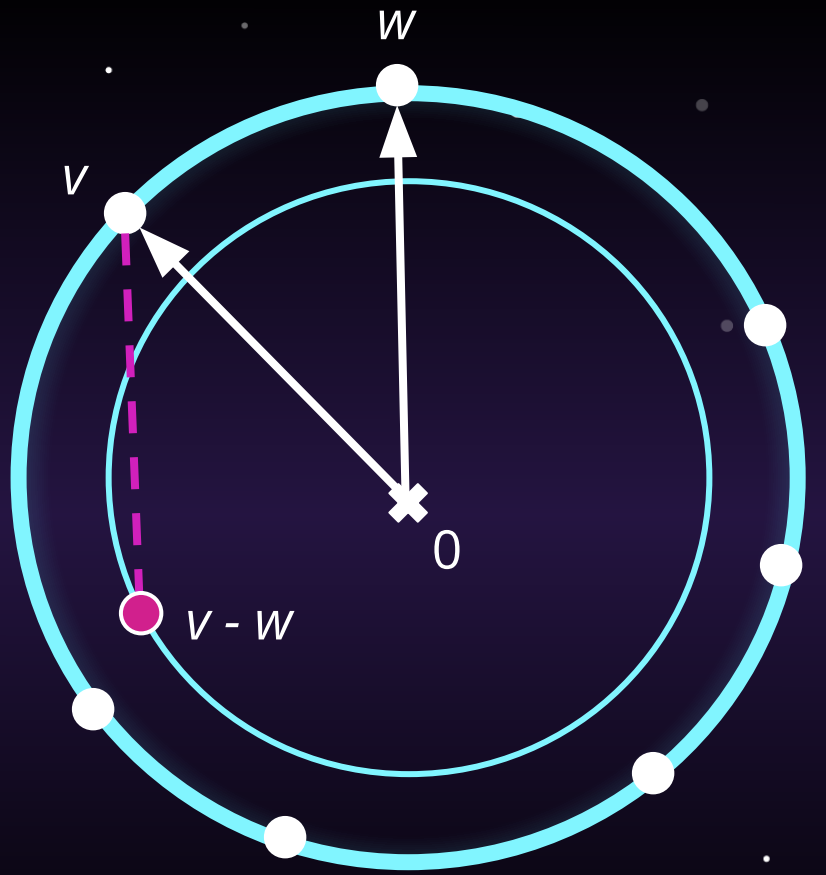
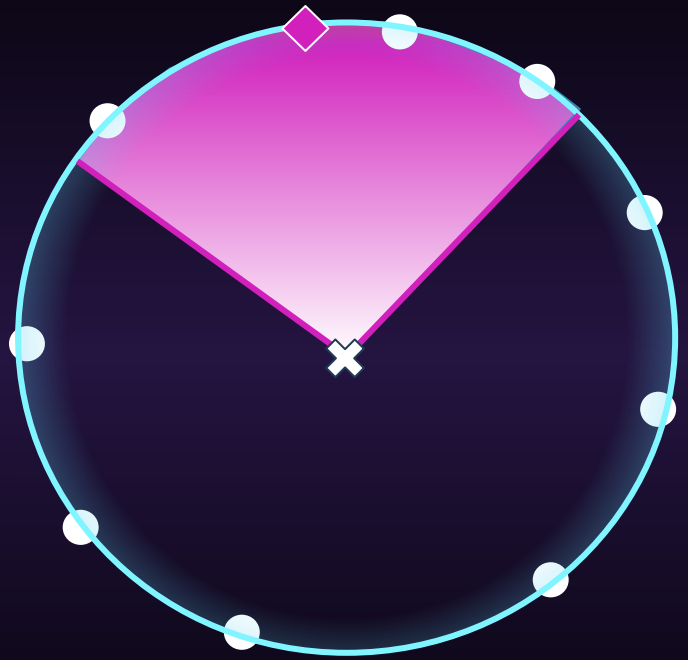
Out: N lattice vectors of norm $\leq y \cdot R < R$

Apply sieve steps until we find a short vector



Locality sensitive filters [BDGL16]



OUR ALGORITHM

1. Separate the sphere in large areas using **locality sensitive filters**

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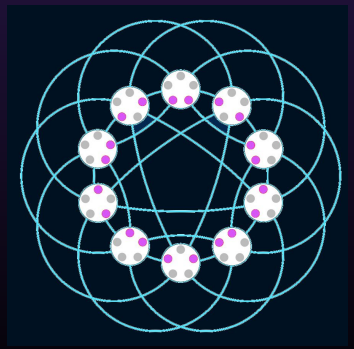

2. In each area, run **quantum walks** to find all the pairs of close vectors.

COMPLEXITY

$2^{c\,d + o(d)}$, d dimension of the lattice

	CLASSIC	QUANTUM (previous)	QUANTUM (new)
Time exponent	0.293	0.265	0.257
Q. space & QRAM exp.	0	0.05	0.07

128 bits of security → 124

THANK YOU FOR YOUR ATTENTION!