An alternative to Gentry's fully homomorphic encryption scheme (We Do Exist!)

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What are we talking about ?

Group Homomorphic Encryption Scheme

Allows to evaluate monomials or degree 1 polynomials over encrypted data

Leveled Fully Homomorphic Encryption Scheme

For any d there is an instance allowing to evaluate polynomials of degree d

Fully Homomorphic Encryption Scheme

An instance can evaluate any polynomial

Gentry's amazing result

Existence of a fully homomorphic encryption scheme (1978) [Gentry 09]

Based on two new problems :

- The Ideal Coset Problem (close to decisional SVP)
- The SplitKey Distinguishing Problem (close to SSSP)

Theoretical achievement

"Making the full scheme practical remains an open problem" [Gentry 09]

A less theoretical leveled fully homomorphic scheme

Polynomials of degree d: SVP gap of $n^{2(d-1)}$
For $d = 3$ we must have $n^4 \sim O(1.01^n) \rightarrow n \simeq 6500$ [Gama and Nguyen 08]
A ciphertext : A few megabits

The proposed alternative

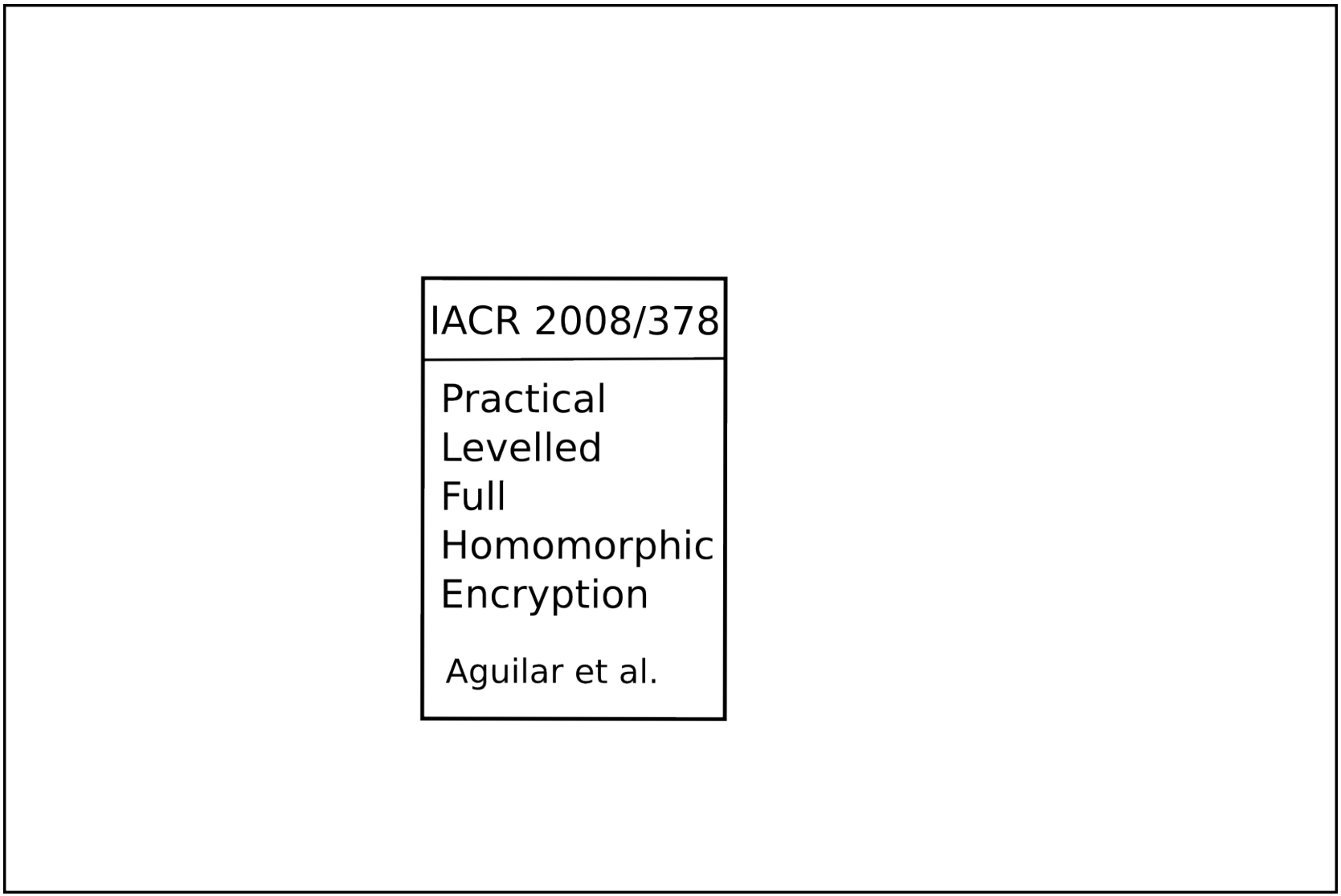
Additive Homomorphic Encryption with t-Operand Multiplications

Aguilar Melchor C., Gaborit P., Herranz J.
`http://eprint.iacr.org/2008/378`

We propose

- A Generic construction to obtain leveled fully homomorphic schemes
- Two instances :
  - One based on a worst case/average case reduction to uSVP
  - One based on the DKVP

For $d = 3$: Ciphertexts of a few megabits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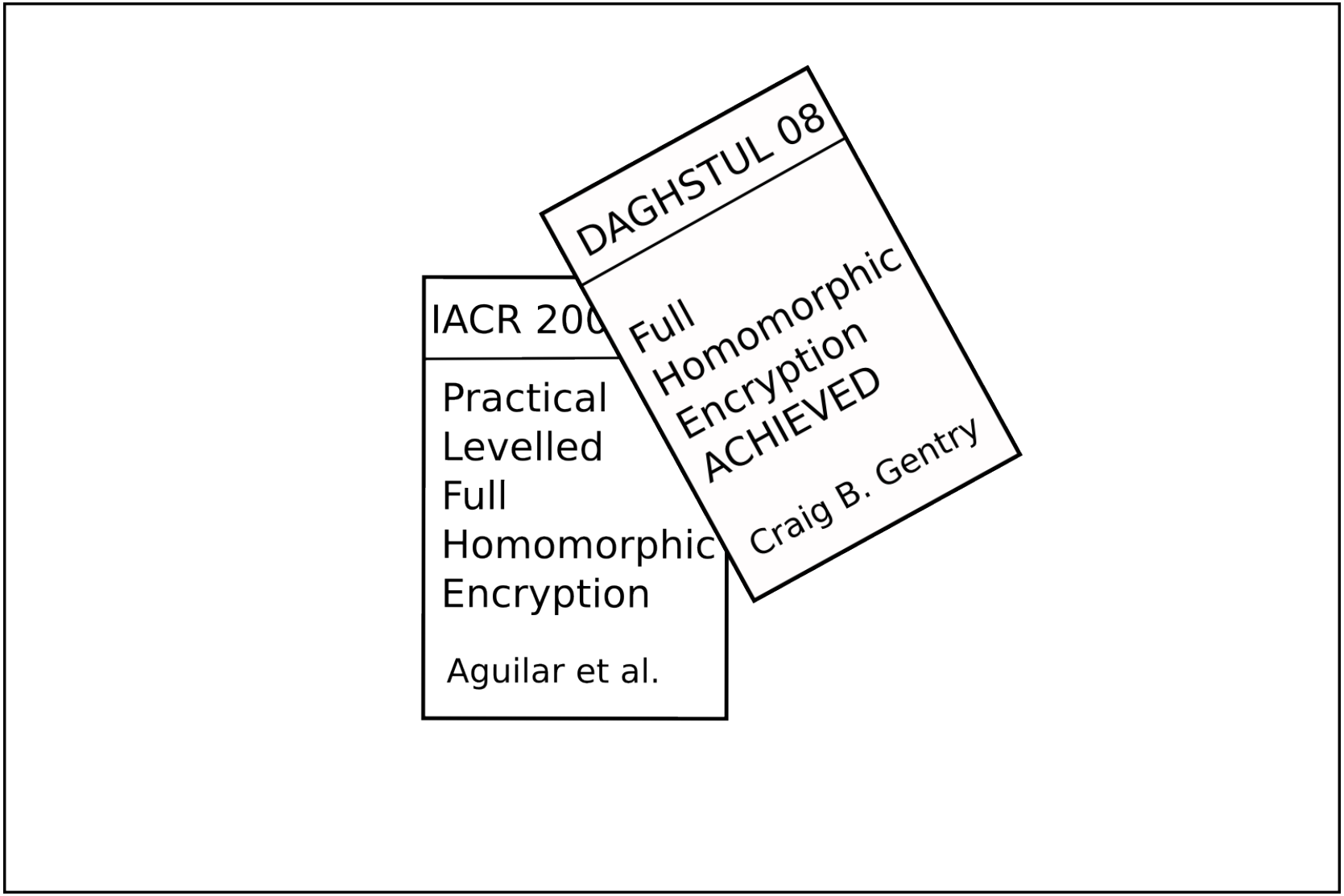
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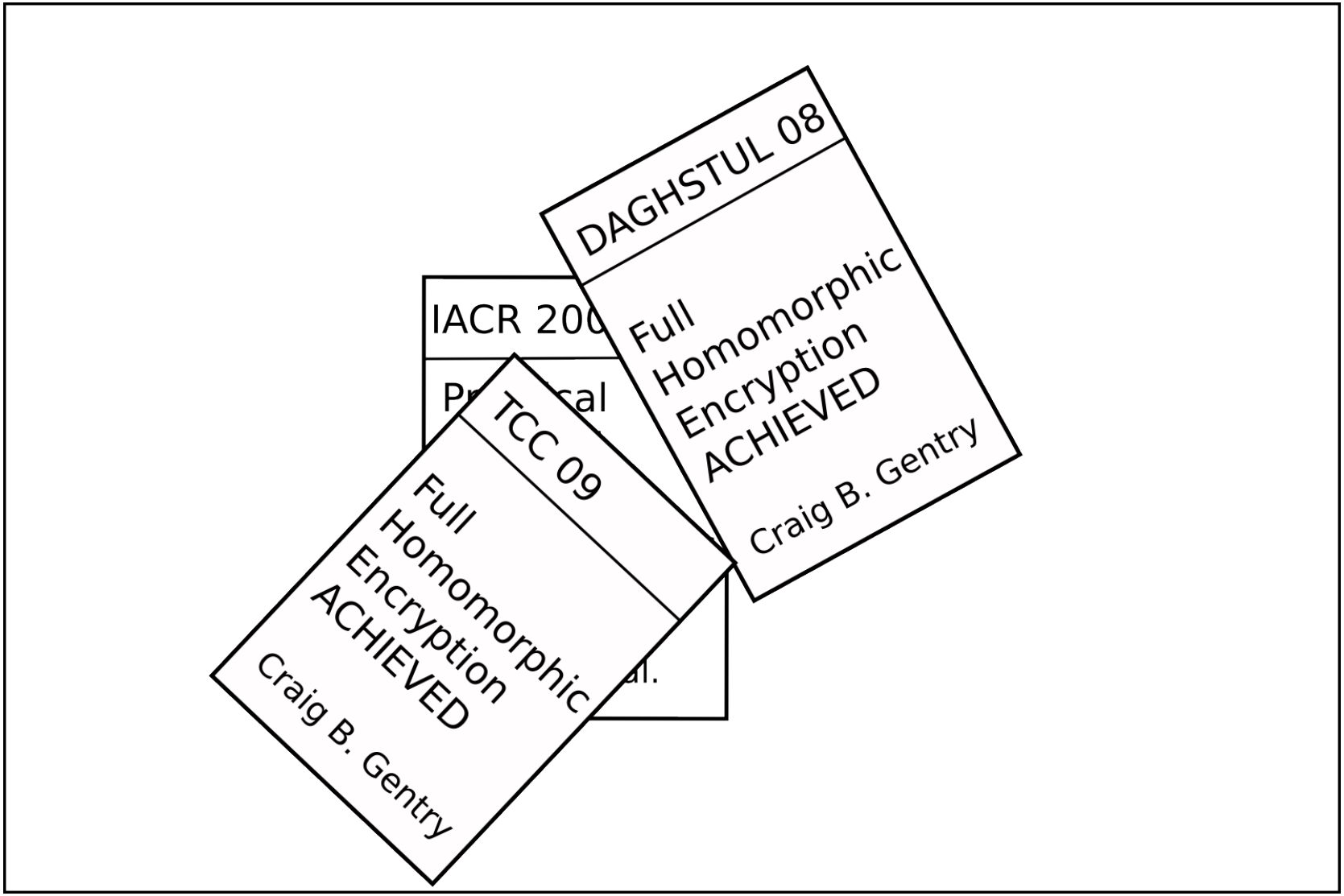
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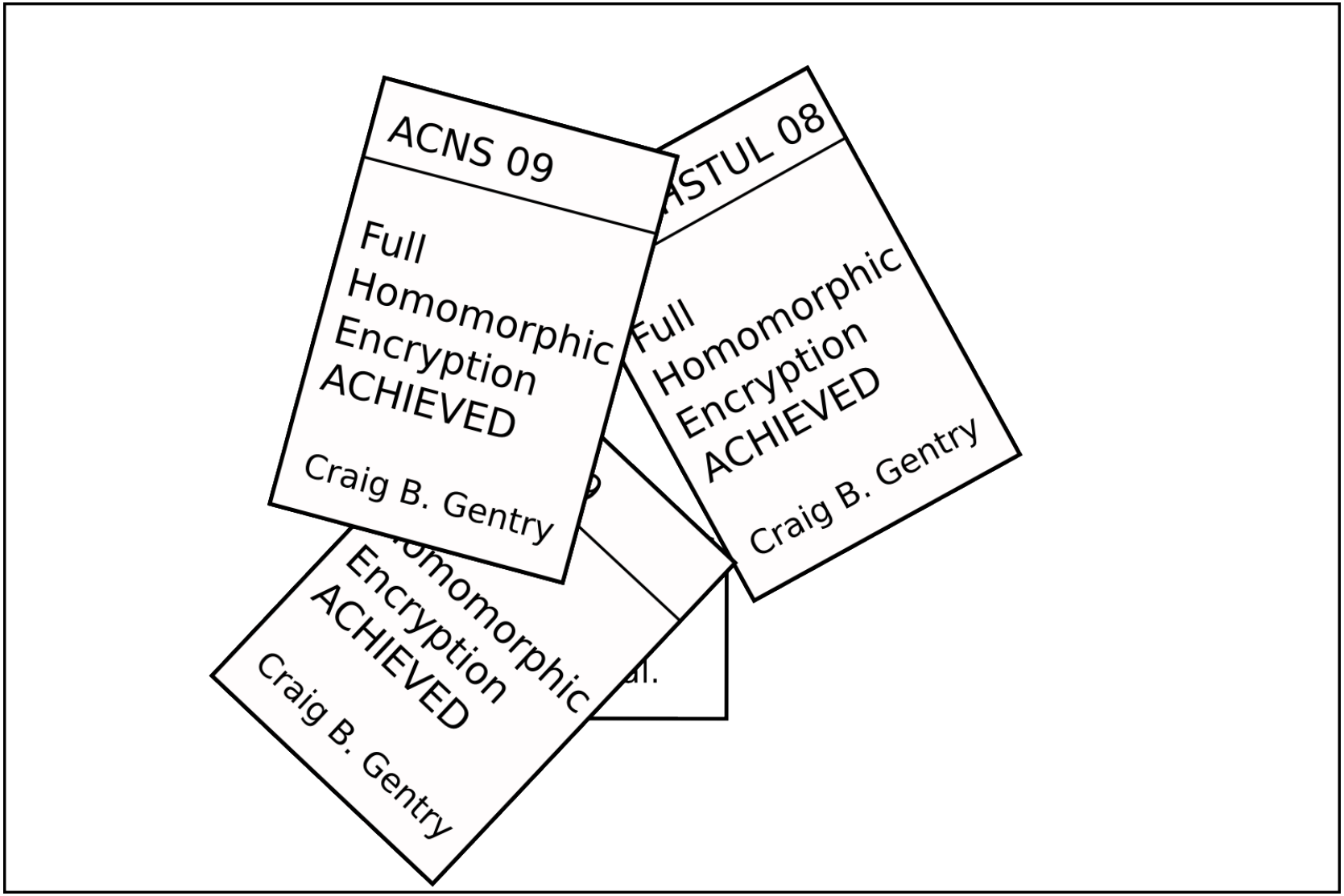
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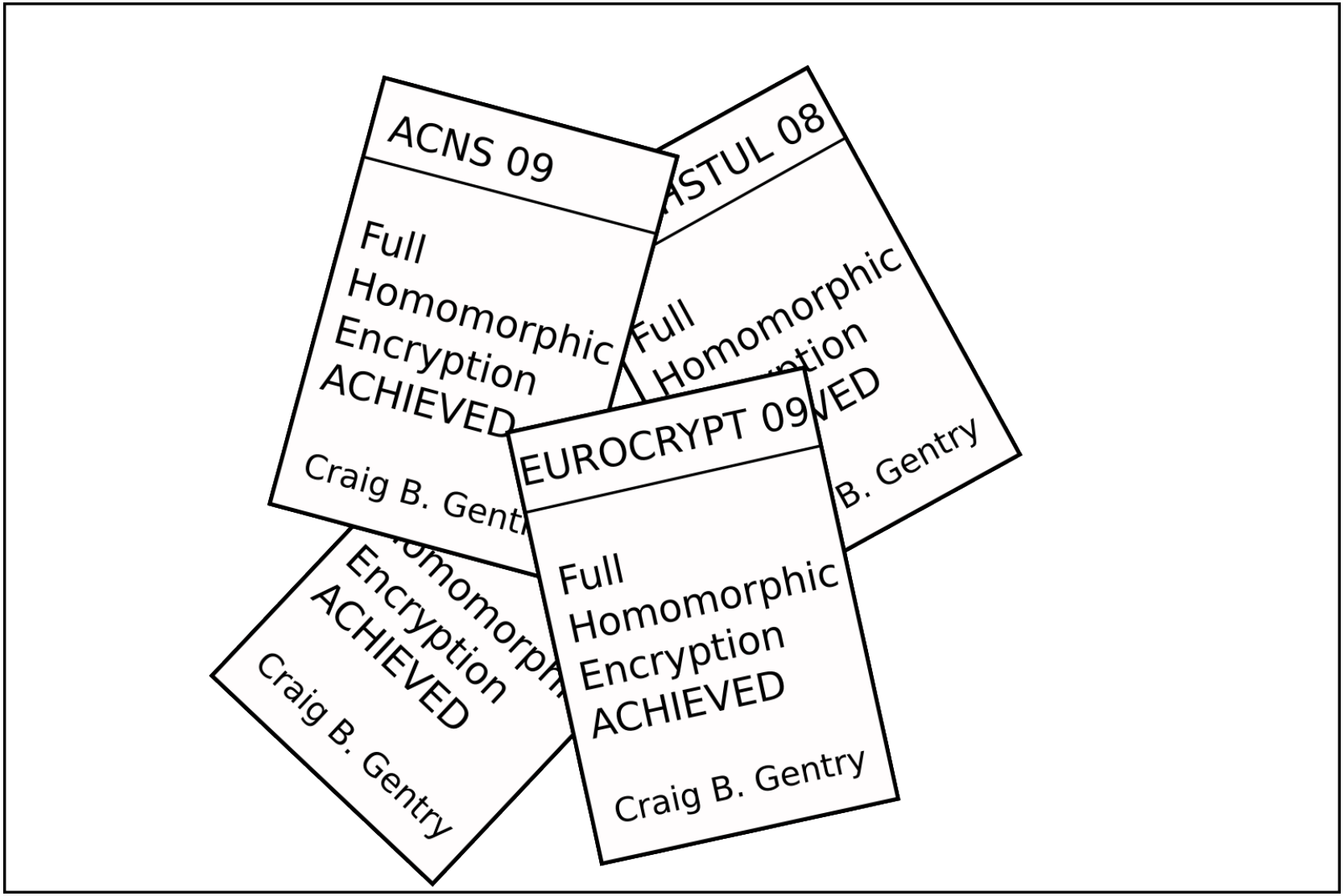
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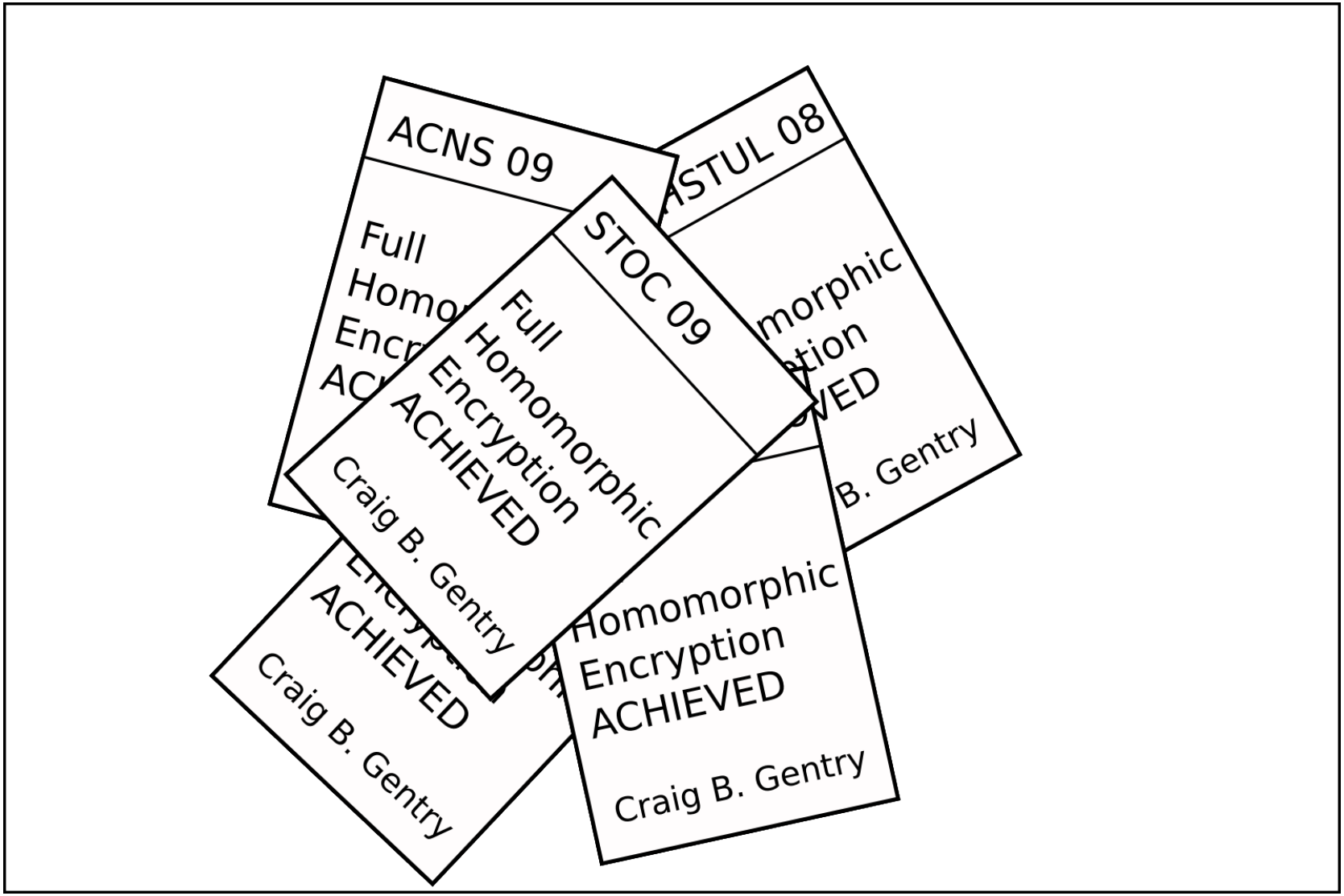
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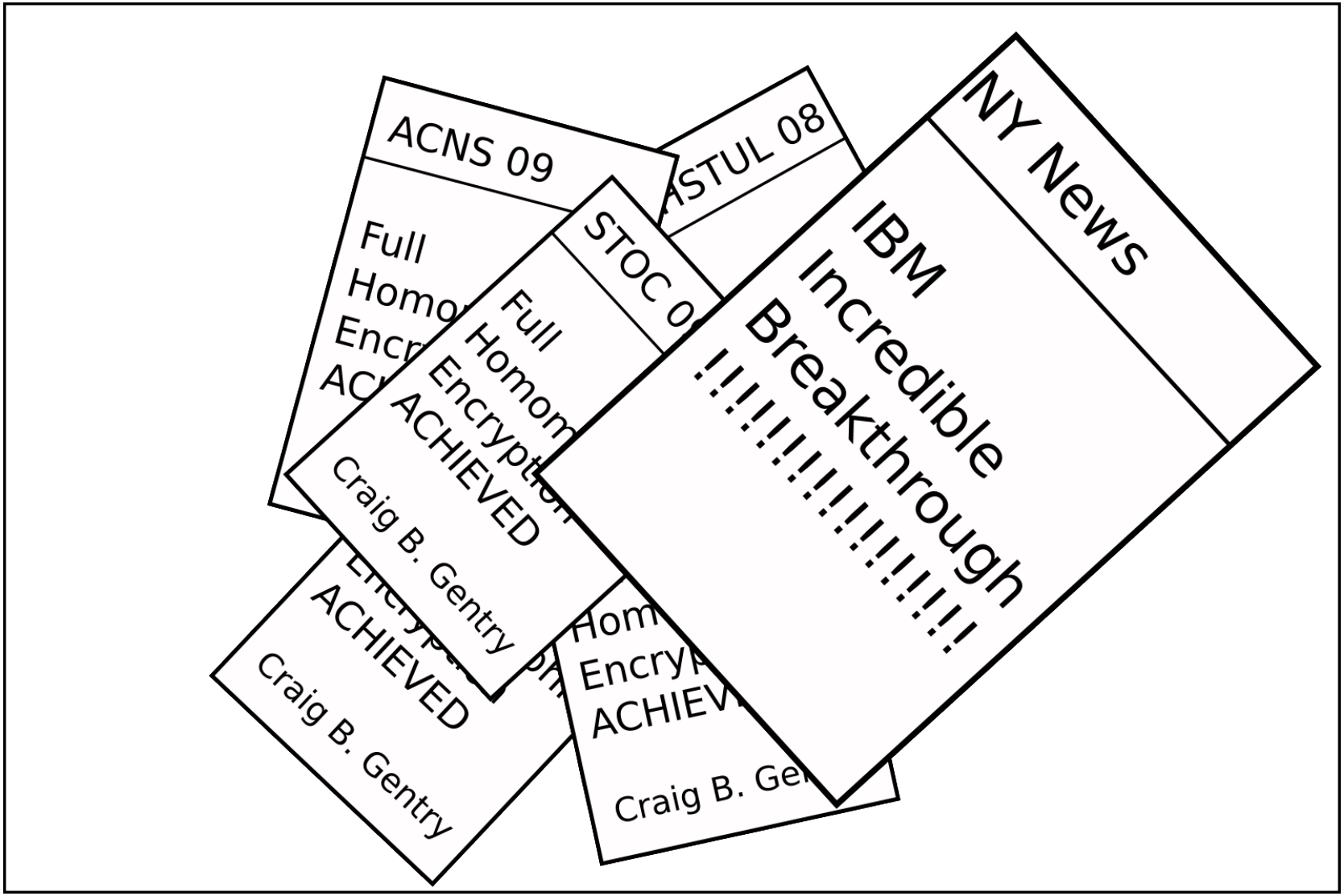
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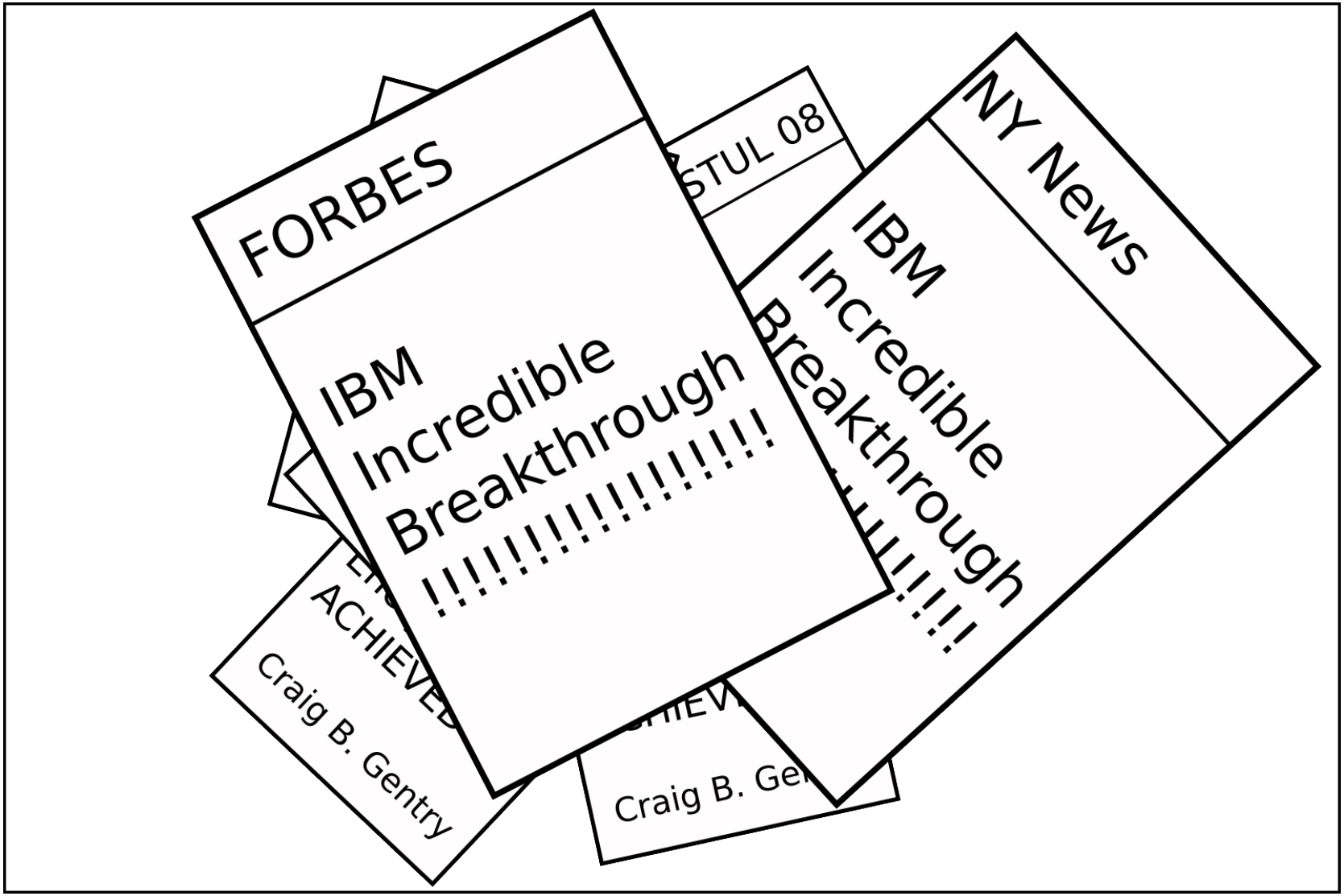
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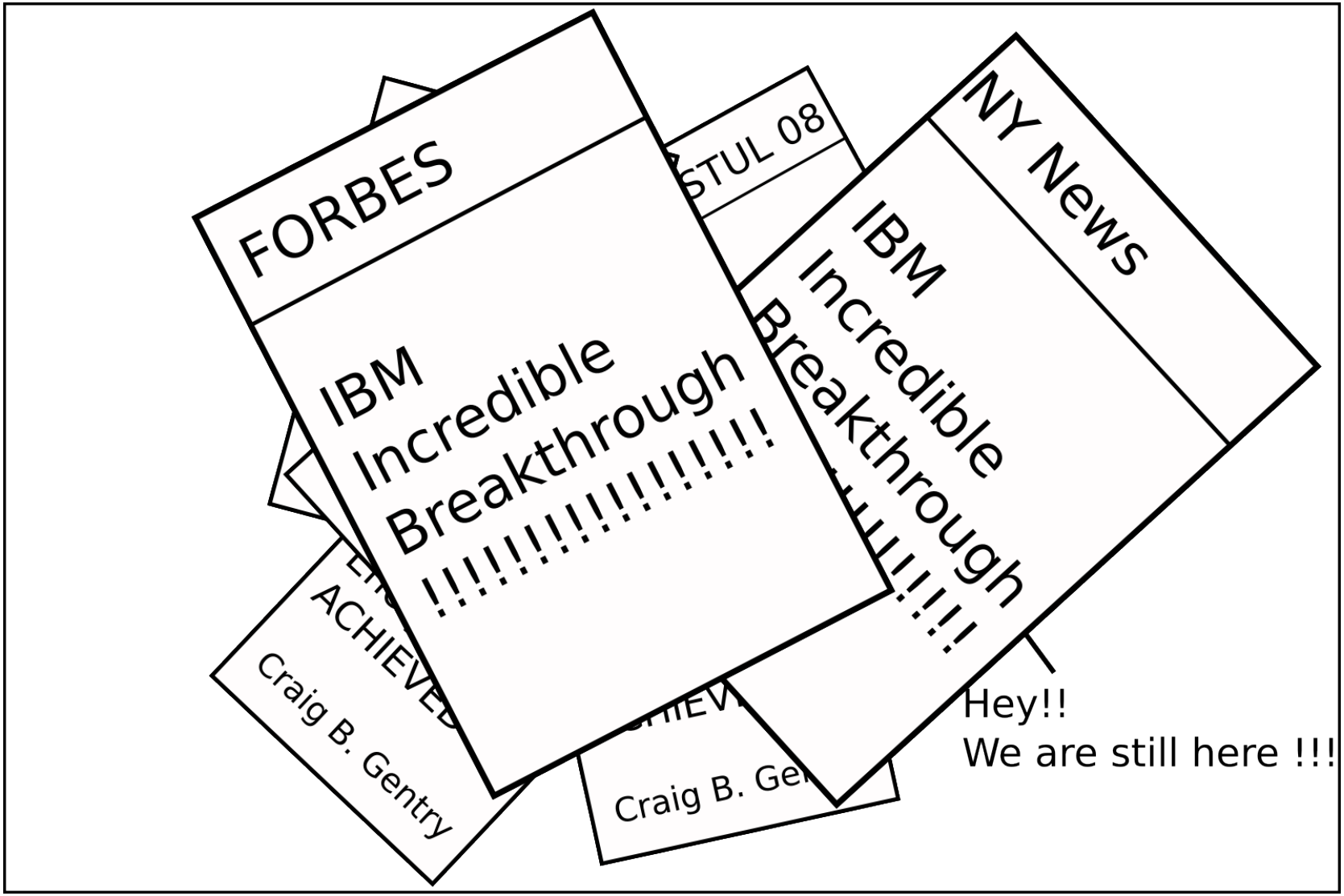
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Hey!!
We are still here !!!
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Recent changes (for submission)

Complexity evaluation of LLL

uSVP-based instance is only theoretical

Introduction of ICP by Gentry

DKVP can be replaced by ICP

New practical construction

Polynomials can be evaluated in practice for $d \leq 10$