Title: DNA Cipher, a secure DNA data storage chain, from digital to molecular

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Abstract:

Storing data into DNA is a promising solution, due to its high density and longevity. But, to realize its full potential, robust security solutions integrated natively to the DNA storage support have to be developed, to do better than adding security after developing the technology, as has been done for hard disk drives.

To ensure data confidentiality, we present DNA-Cipher, a biomolecular security solution whose originality lies in forcing biological manipulations to decrypt DNA molecules before they are sequenced to allow data recovery. DNA-Cipher relies on a digital cipher that prepares encrypted DNA sequences next synthesized, and on a biomolecular DNA-Decipher module that uses biomolecular rotations and permutations to re-organize nucleotide data blocks in all DNA sequences, to make possible the consensus after sequencing.

Our solution is based on multiple “biomolecular operators” (e.g., enzymes, restriction sites, and so on) that we diverted from their primary use to engineer biomolecular rotations and permutations that re-organize all blocks of a DNA molecule at the same time. We tested our solution both by simulation, and by a biomolecular proof of concept. This later demonstrates that DNA-Decipher outputs a large percentage of the decrypted molecule, easily isolated from intermediate forms. These experiments show that our proposal is a step towards natively securing DNA data storage.