A first proposal for secure data storage into DNA molecules compliant with biological constraints

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Digital data production rises exponentially. From 33ZB of data produced in 2018, 175ZB are envisioned in 2025. To respond to associated storage needs, technologies as flash memory and hard drives reach their limits in terms of: density; energy and ecological costs; durability for long term storage. In this context, data storage on DNA molecules has recently been shown as very promising. DNA storage could be 10^6 times more dense than hard drives, with a lifetime 10 to 20 times longer and an energy consumption closed to zero (molecules can be kept at room temperature with no maintenance).

In this work, we are interested in securing archived data. DNA storage being a new technology, the opportunity presents itself to integrate this critical aspect at the biological level, contrarily to what has been done for electronical storage means. In fact, information must be secured at every step of the DNA data storage chain. Data integrity and confidentiality are among the main issues with threats like data modification (e.g. writing of new data) or the theft of the DNA storage support by an attacker. Herein, we propose a solution for writing encrypted data onto synthetic DNA molecules considering DNA synthesis and the error-correction code constraints. Indeed, DNA sequences should conform to structural constraints dictated by this biological process and sequencing.

Our solution consists in an encoding process positioned after data encryption. This one takes into account the fact that any cryptosystems lead to encoded DNA sequences uniformly distributed, with a non-null probability to produce forbidden DNA sequences or patterns. Even though this process adds some data overhead, it demonstrates a good information rate compared to existing works. Our solution has been successfully tested on a state-of-the-art DNA storage chain simulator from synthesis to sequencing.