

# 11<sup>th</sup> Annual Conference on Foundations of Nano-Science: Self-Assembled Architectures and Devices (FNANO14)

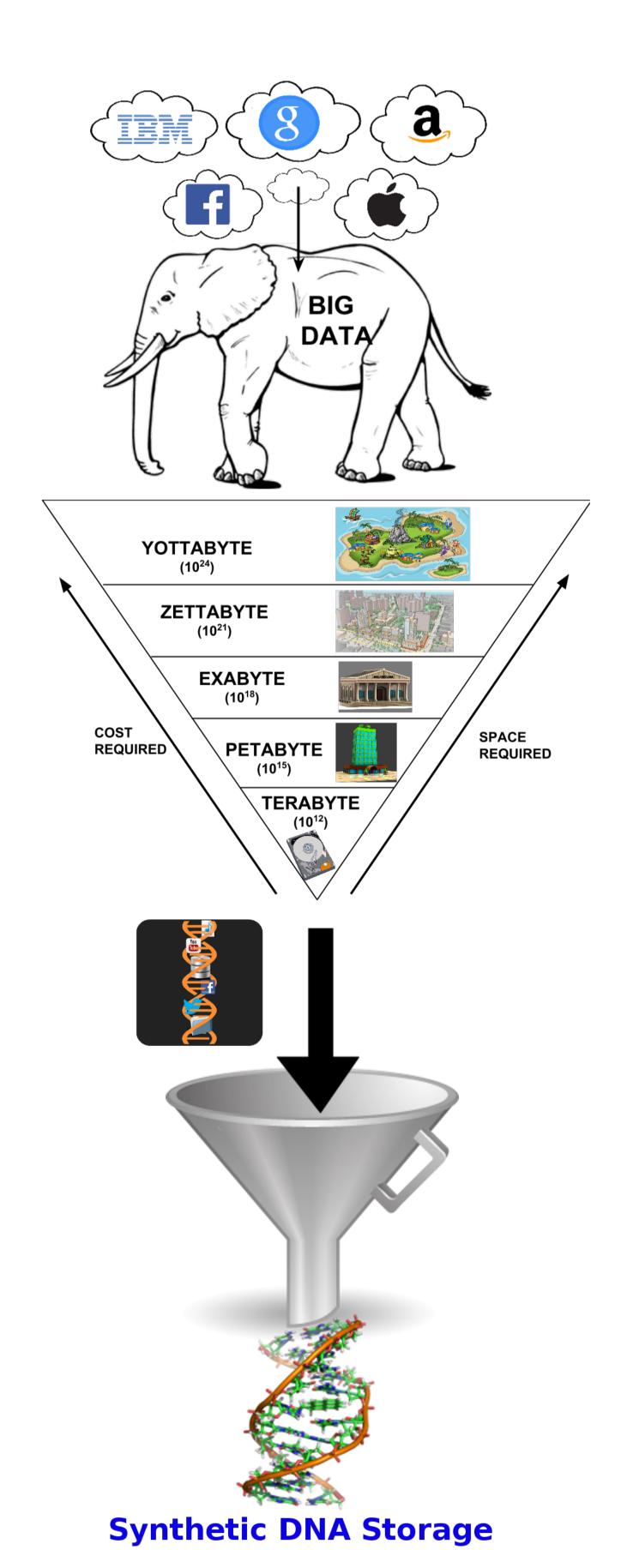
## DNACloud: A Potential Tool to Store Big Data on DNA

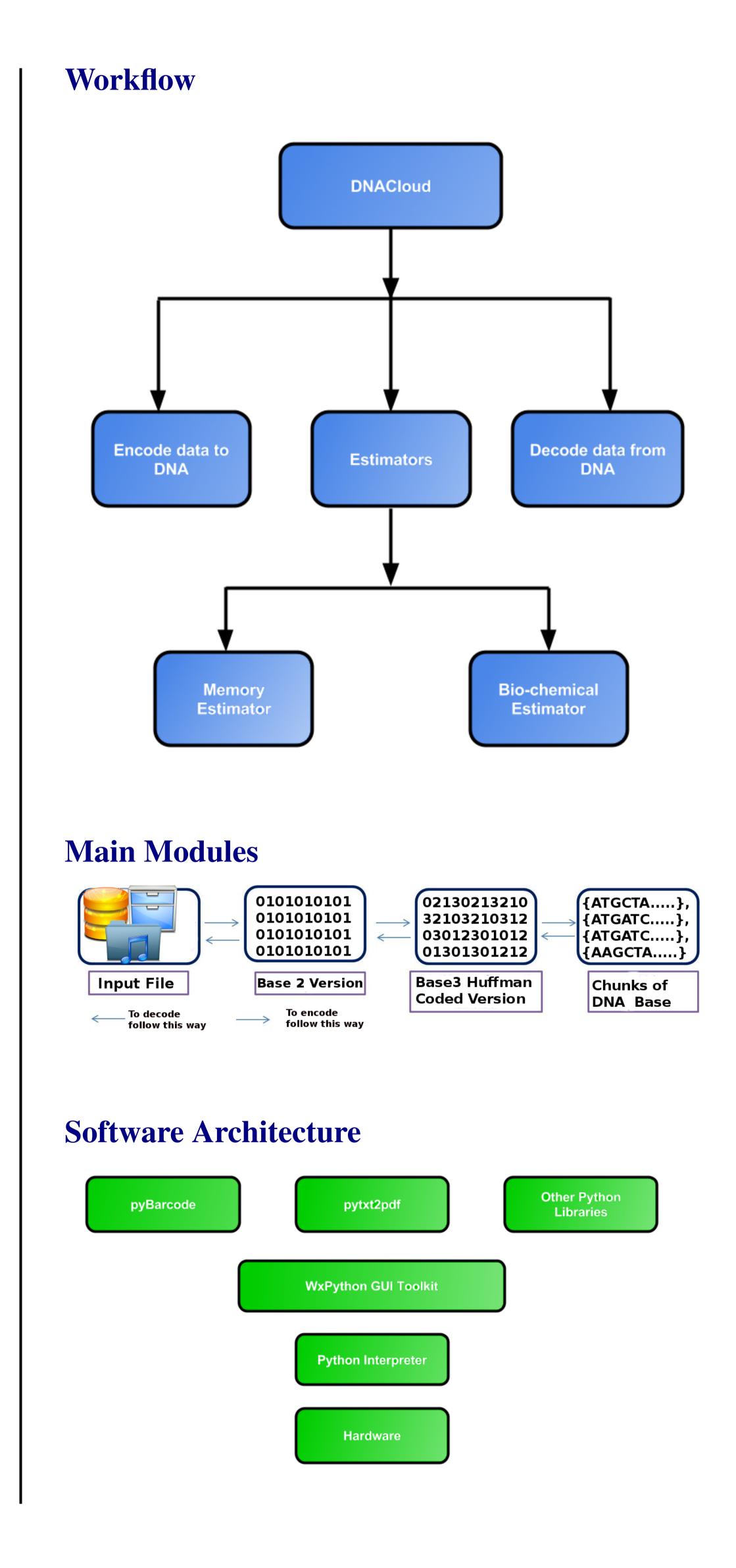
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#### **Abstract**

The term Big Data is usually used to describe huge amount of data that is generated by humans from digital media such as cameras, internet, phones, sensors etc. However before one can use the data, one has to address many issues for big data storage. Motivated by Goldman and his team [1], we have developed a software called DNACloud which makes it easy to store the data on the DNA.





#### **Software Output**

DNACloud produces three different types of output files apart from .dnac file one of them is the figure . Other files which are generated by the software include output text file of Memory and pdf file generated by Biochemical Estimator.

#### **Output of LATEX file generated using DNACloud**

Seq ID	DNA Chunk Sequence		
1	ATCTGCGATA CAGATGAGATCATGTCACTAGCTGCGACAGCACGACTATCATGCGACGACGACGTAGTAGTAGCGATGCGACGACGATGCGACGATGCGATGCGATGCGATGCGATGCGACGTACGT		
2	*TTGATCGACGCTGTGGTGGTGATAGTACGCTGCTGCATCATACGCTACGCTGCGCTGCGTATCATACGCTACGCTAGACGATGGTACGTGAGCAGTACGTAC		
3	'ATGCGACGACGTAGTATGCGATGCGACGCACTAGTAGTATGCGATGCGATGCGATGCGACTCGTGATCGACGCGCGCG		
4	TGGTGCGTATCATCATCATCAGACGTAGACGTTACGCTGAGACATAGCTCGCGCGGGTATATACCTGACGTCACATCACATCACGATCGTATCCTGCGATACGTACG		
K	*ATCTGCTACGATGCGACTCGTGATCGACGCGCGCTATATATGCACTCCACTGTAGTGCTAGCATGCAT		
6	*TTGCGCGCGGATATATACGTGACGTGCACATCACGATCGTATCGTGCGTACGGTTCGGTTCAGGTACAGGACTATACGGTGCTGCTGCTGCTGCTACGTACG		
7	AGTA GTGTAGTGCTAGCATAGCACGCATGTCATGTCATG		
8	*TTA CAGTA CAGTA CAGTA CAGTATA CGCTGAT CTCCTCGTCTA CAGTA CTCACGTGACGTG		
9	ACTAGACGAGGAGGAGGAGTGTGATGAGTGCACTGCACT		
10	TACGTGACGTGACGTGAGGTCGTATCGTATCGTATCGCGATGACGCGTACGTGATGATGATGTACAGTACAGTACAGCACTGTACAGTACAGTACAGTACAGTTACAGCTACGGTACAGGTACG		
11	AGCATAGCATAGCGCTACTGCGCGCATGCACTACTACATGTCATGTCATGTCGTGACATGTCATGTCATGTCATGTCATGTCATGTCATGTCTGTC		
12	${}^{TACGTGATGATGTACAGTACAGTACAGTACAGTACAGTA$		
13	ACCTGA CATCTCATCTCATCTCATCTCATCTCATCTCAT		
14	TGTA CAGTA CAGTA CAGTA CAGA CAGTA CACTGCATCGCTATCGCTATCTCGTACAGTACA		
15	'ACCTAGOGAGATCGCATAGAGCATGTCATCTCGTGAGCATAGCAT		
16	TGTA CA GCACTCGTA TCCTATCACATA CGTCTGTA CAGTGTACGTATCGTAT		
17	'ATGCAGACATCTCACATAGCATAGCATAGCATAGACTGCTCTAGAGACTCGATGTGACGTGTATGCAGACATCTCATATGCATAGCATAGCATAGCATAGCATAGCATCACCTACCT		
18	**TTCGTATCTGACGAGATCTCTGAGCTACACTGCACATACGTCTGTACACTATACGTATCGTATCGTATCGTACCGTACACTACACTACAGAGCGTATCACGTACCGTACGTA		
19	'ATGTGACGTGTATGCAGACATGTCATATGCATAGCATAG		
20	TINGGTATCGTATCGTATCGTACAGTACAGTACAGTACAGGGCGTATCACGTACACGTACACTACAGTACA		
21	AGTCATGTCATGTCTCGCATAGTGCATGTCATGTCATGT		
22	TAGA TACGCTACACGTACACTACAGTACAGTACAGTACA		
23	*ATGTCATATCATGTCATGTCATGTCATGTCATGTCATGT		
24	TACAGTACAGTACAGTACAGTATGACGATCGTGCGCAGGACAGCACAGCTGCGCACCTACAGCGTCGTACAGACGTGTACAGCTGTATCGCTATCAGCGTACGCTACACACAC		
25	A CTAGCACGCGTCGTCGA CGACGCGTGCATGTCGCAGCATGTCTCGCAGATGTCTAGCATGTCGACATAGCATAGCTGCACTGTCTACGACGTACGT		
26	TCACCTACA GCCTCCTACA GACCTCTACA GATCCTACGCTATCCTATC		
27	ATTETA GCATGCG ACATGCG ACTA GCATA CGACTGCTCTA CCACGATGCACTACTA CGACTGCACTACTA TA CTACACACCTACTA GCATTGCACTCGTCTA GCCTACCTA GCATACCTA GCCATACTA GCCTACCTA GCCTACCTA GCCATACCTA GCATACCTA GCATACCTACATAC		
28	TTCGACGTGACAGATGCTGCTATCTACGCTACGTACGTATGATGTGTGCATCATCGATACGTACG		
29 30	*AGCGATCGATGGACTACTATACTACACACCTAGTAGCTAGC		
31	'ACTAGGCTACGAGGTAGTAGAGTGTAGTACGACGCTGTATACTACGTCTGTAGTACACGAGTACTACACGAGGTACTACTACTACGATCACGAGTACGTAGTACGATCACGTAGTACGATCACGTAGTACACGTAGTACGTAGTACGTAGTACGTAGTACACGTAGTACGTAGTACACACGTACACACAC		
32	TTCATGCTGCACATATGATGCAGCACATGTGCTCCATCATGTTTAGTAGCTGTCTATGATATGCATACGCTACGCTTTAGTTTAGTTTAGTTGCTTGC		
33	ATACAGGACGTAGTACACATCATCACAGATA CTATACTATCGCATGCGATGCG		
34	TGTCTATGATATGATACGCTACGCTACGCTACGCTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTACGTCG		
35	AGGGACATCA CATCA C		
36	*TTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTA		
37	A ATCACATCA CATCACATCA CATCA CATCACATCA		
38			
39	A ATCACATCA CATCACATCACATCA CATCA CATCACATCACATCACATCA CATCACATCA CATCA CATCACATCA CATCACATCA CATCATCTCGTAGTGCATA GCTGTA CGTACGAGTG		
40	TEAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAGTGTAG		
41	A ATCACATCA CATCACATCACATCA CATCA CATCACATCTGCTA GTGCATA GCACAGCATA GTATCTCTGGGA GCACATA CATCTA GCACGCA TA CATCTATGA TA CGTACGTACGTCTCT		
42	"TEAGTGTAGTAGAGGATCAGGTATCGTGTGGTATCATAGAGAGCGCTGTGTATGTA		
43	A ACAGCATA GTATCTCTGCGAGCA CATACATGTAGCACGCATACATGTATGCGTGCACGCATA CATGTATGCGTGCACGCATACATGTATGCGTGCACGCAGCGTACCTACTCA		
44	TATCTACATCGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACGTAC		
48	*ACGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTACATGTATGATACGTACG		
46	TTGCGTATGTA CATACGCACGTGCGTATGTA CATACGCACGTGCGTATGTACATA CGCACGTGCGTATGTACATA CGCACGTGCGTATGTACATACGCACGATACGTACGTCACC		
47	*ATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCATACATGTATCGCTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCAC		
48	TCATAOGCACGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACATACGCACGTGCGTATGTACGTAC		
49	*ACGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGCATACATGTATGCGTGCACGATGTATGCGTGCACGTACGT		
80	TTGCCTATCTACATACGCACCTCCCTATCTACATACCCCACCTCCCTATCTACATACCCCACCTCCT		
81	1ATA CATGTATGCCTGCAGCATA CATGTATGCGTGCACGATGTATGCGTGCACCCATACACACTACACTACACTATACGTGCTGCAGCCTCATACTGATACGTACCTACGTACG		
52	TCATACGCACGTGCTACATACGCACGTGCGTATGTGCATGTCATGTCATGTCATACGCACACCACTCGCAGTATGACGCACTATGACGCACGTGCGCGATGTCACGTACGT		
53 54	A ACCCATAC ACA GTACA GTACA GTATCTATGCGTTGTGA GCGTCATACTGCGTGATA CTGCGTGCA CGCGCTACATA CA CGACGTATCTGTGCATATGCGATACGTACGTACGTACGTA		
134	Continued on next page, generate by DNA-Cloud, http://www.guptalab.org/dnacloud		

#### **Testing**

We have performed some encoding and decoding operation on some sample data files, results for which are shown in the table below.

File_Type	File size(Bytes)	DNA required
Text	48680	$1.06 \times 10^{-16} \text{gms}$
Audio	85799	$1.88 \times 10^{-16} \text{ gms}$
Video	33745571	$7.41 \times 10^{-14} \text{ gms}$
Image (HD)	473206	$1.04 \times 10^{-15} \text{ gms}$

Comparison of the file formats encoded by DNACloud. Different file types were encoded and decoded using this tool.

#### Advantages

DNA data storage is a stellar technology when it comes to data store, some of them are as follows:

- 1. Dense storage medium
- 2. No maintenance, electricity requirement
- 3. Long term data storage
- 4. Portable

#### **Future Challenges**

DNA data storage technology has many forthcoming challenges, some of them are as follows:

- 1. Re-writable
- 2. Cost-effective
- 3. Cheap synthesizing and sequencing techniques
- 4. Length of DNA string
- 5. Data security
- 6. Efficient encoding and decoding algorithm

#### **Estimator**

Our tool, DNACloud, consists of two storage estimators which are described as below:

- 1. Memory Estimator: This estimator provides approximate values for the amount of physical memory required, amount of secondary memory required, amount of DNA required etc.
- 2. Biochemical Properties Estimator: This module provides the minimum and maximum boiling point among-st all the oligonucleotides residing in the .dnac files.

#### References

[1] Nick Goldman, Paul Bertone, Siyuan Chen, Christophe Dessimoz, Emily M LeProust, Botond Sipos, and Ewan Birney. Towards practical, high-capacity, low-maintenance information storage in synthesized DNA. *Nature*, 2013.



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