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(54) **SYSTEM FOR LEVERAGING SYNTHETIC DNA FOR COMPUTER STORAGE**

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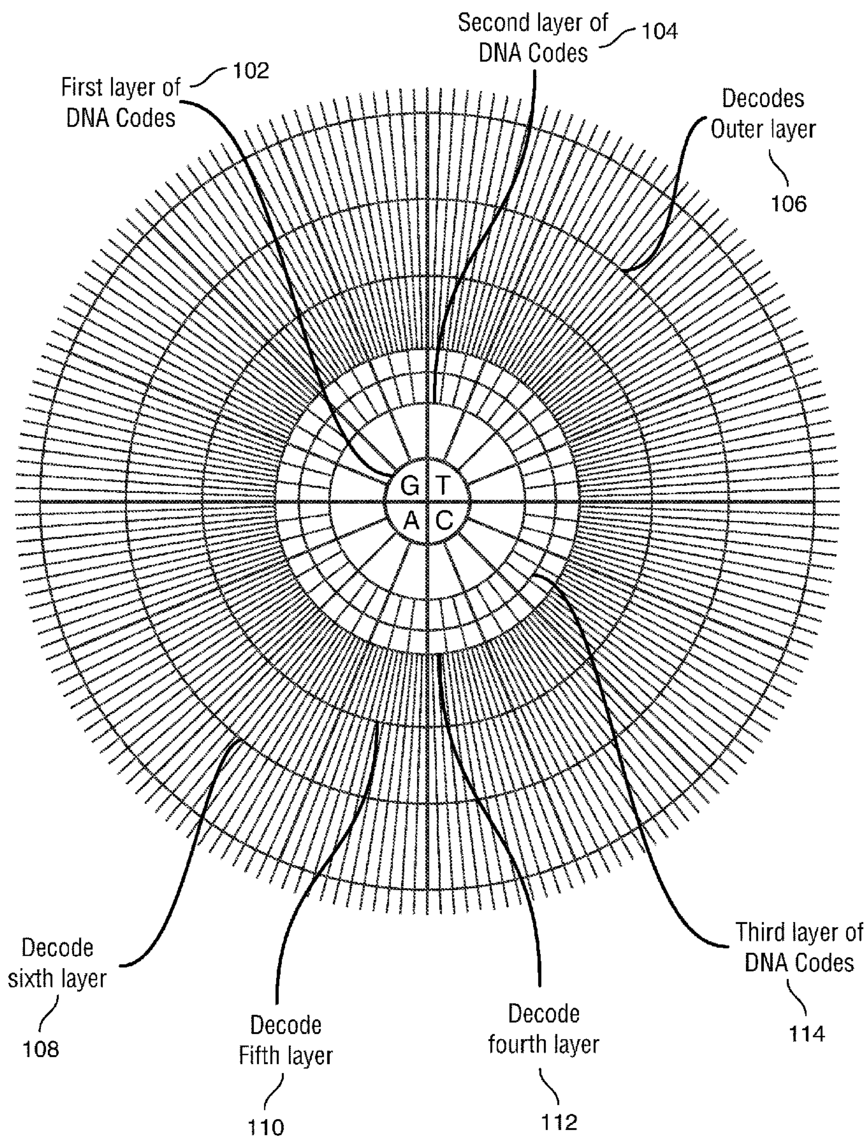
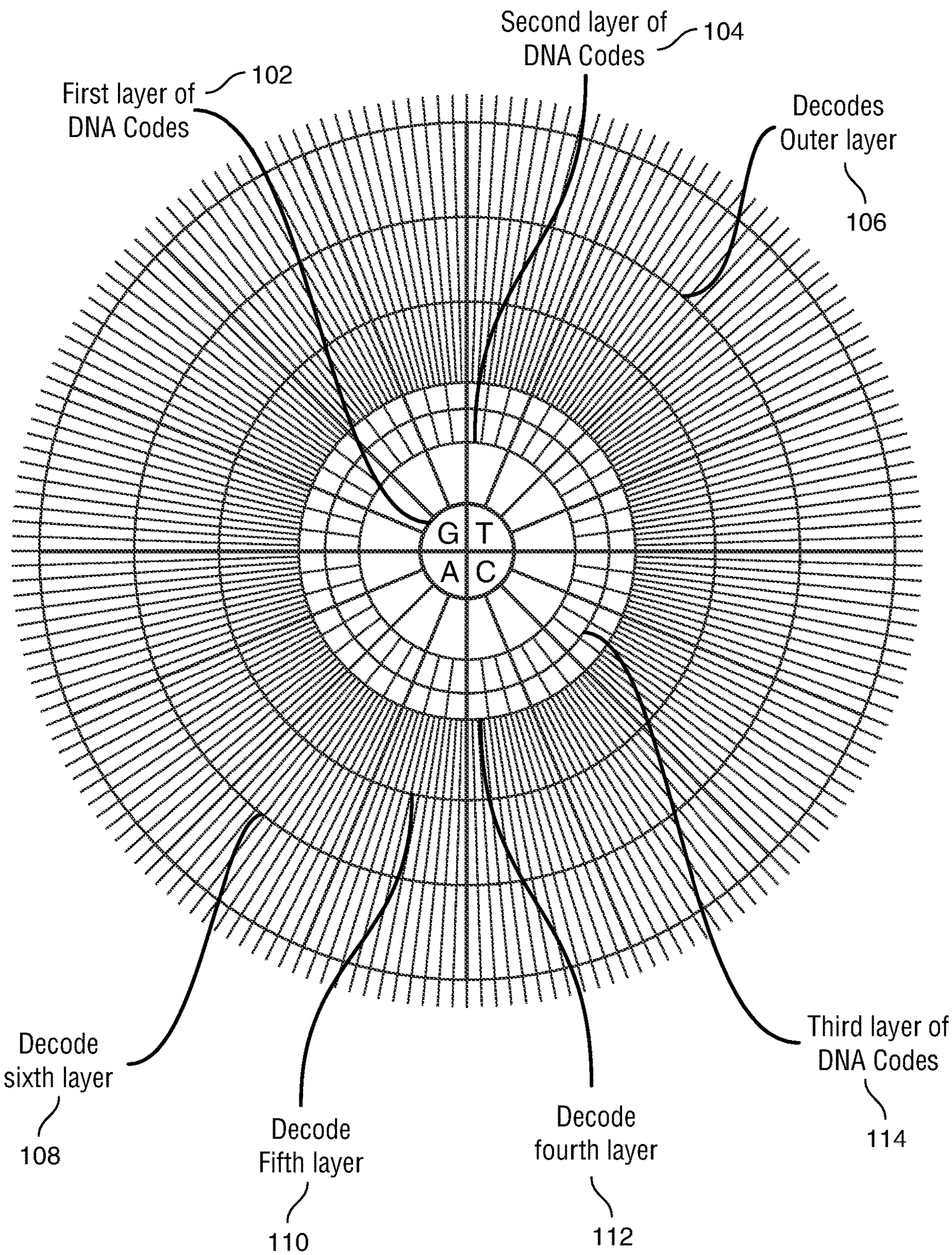
(57) **ABSTRACT**

A system for storing data on deoxyribonucleic acid ("DNA") may include a receiver, a processor and/or a DNA synthesizer. The receiver may receive data files. The processor may segment the data files into a plurality of data packets. The processor may randomly select one or more packets from the plurality of data packets. The processor may combine the selected packets into an output. The processor may attach a random seed to the output. The processor may derive a sequence from the seeded output. The processor may identify the sequence as a valid sequence or a homopolymer. The processor may discard the sequence when the sequence is identified as a homopolymer. The DNA synthesizer may convert the sequence into a DNA quaternary sequence when the sequence is identified as a valid sequence. A DNA quaternary sequence may include DNA bases. The DNA synthesizer may synthesize and store the DNA sequence.





Second layer of DNA Codes
104
First layer of DNA Codes
102
Decodes Outer layer
106
G
T
A
C
Decode sixth layer
108
Decode Fifth layer
110
Decode fourth layer
112
Third layer of DNA Codes
114

FIG. 1A

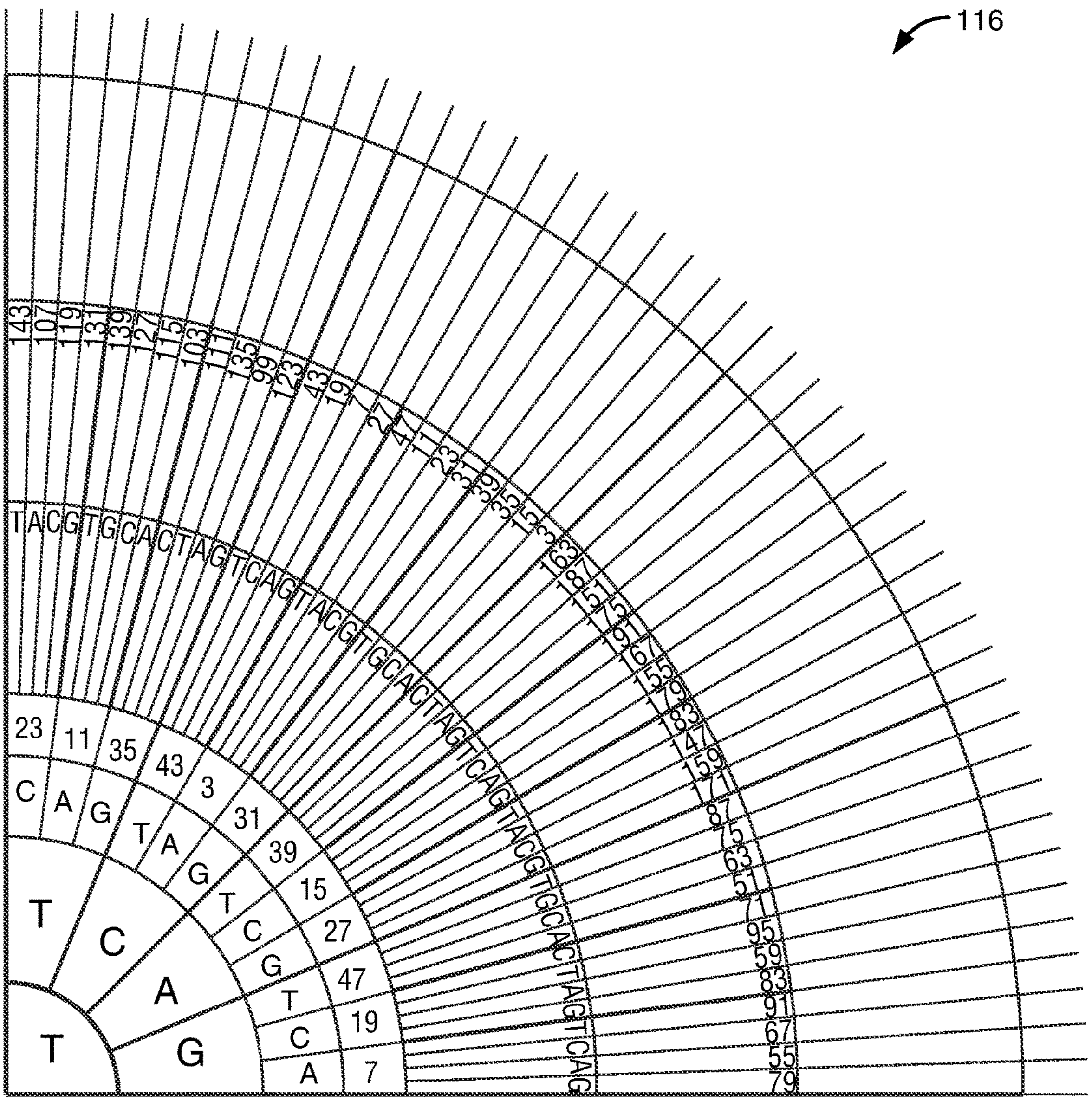


FIG. 1B

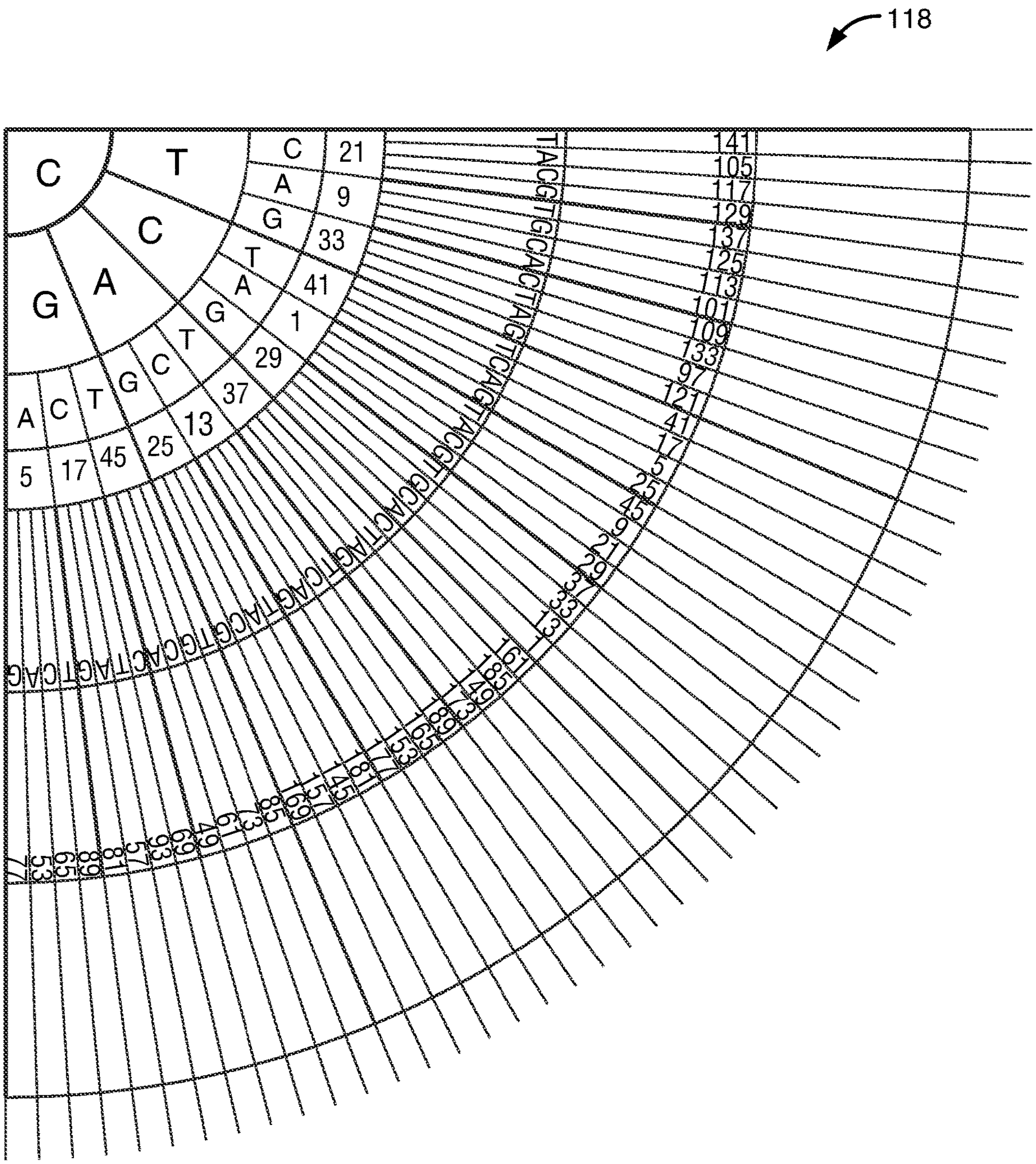


FIG. 1C

120

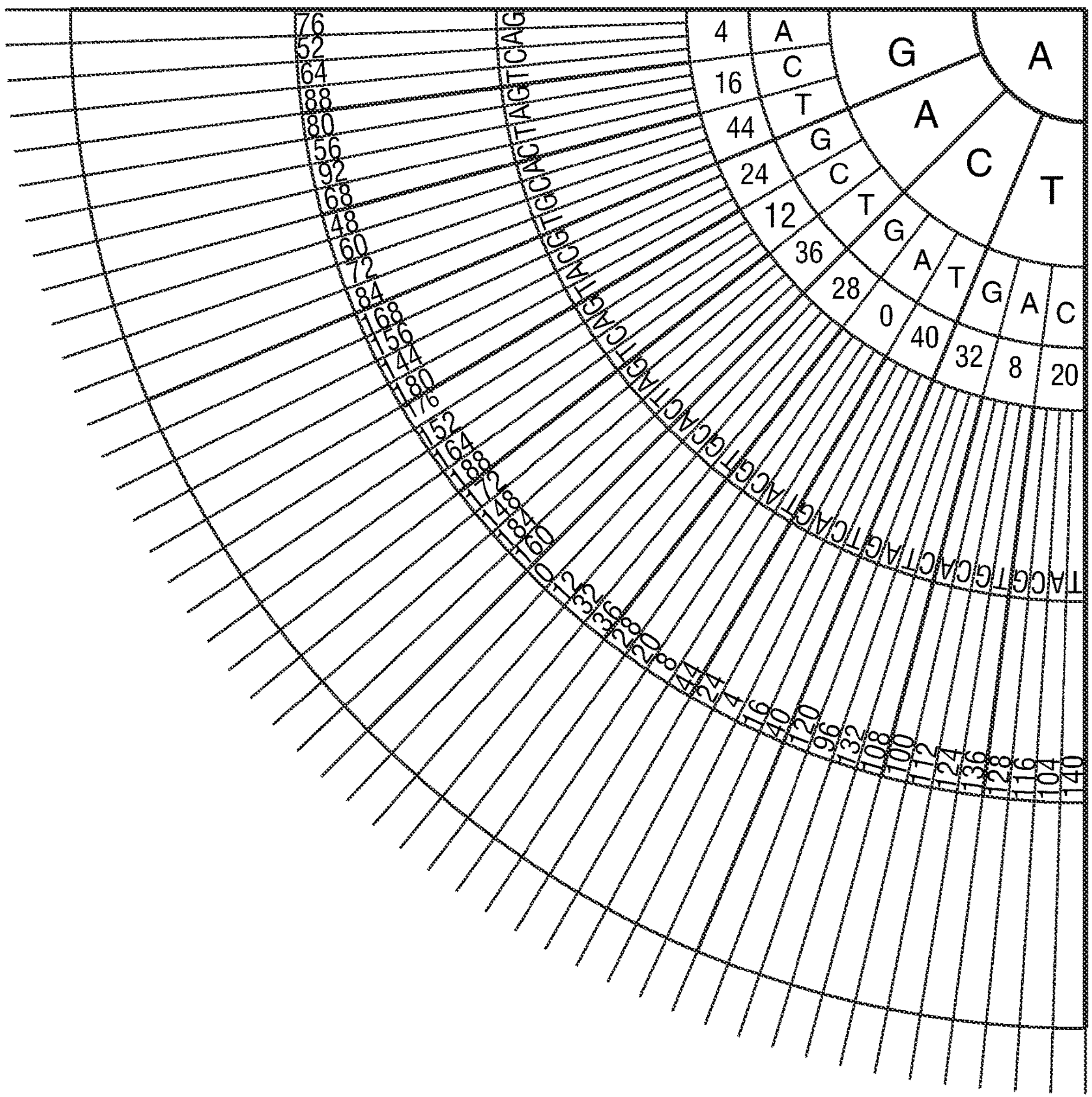


FIG. 1D

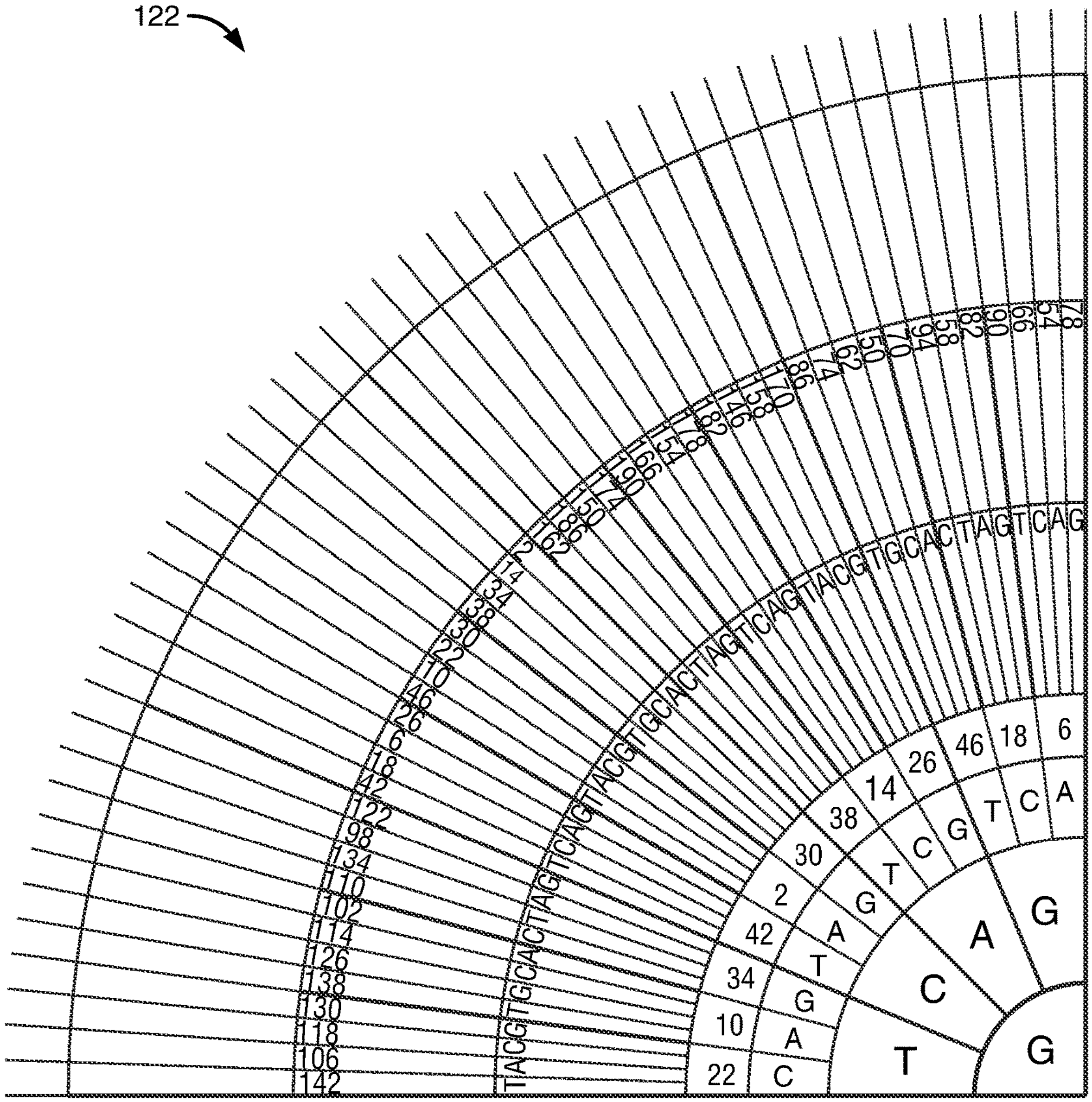


FIG. 1E

202

Quaternary Code	Decode Equivalent
ACGA	0
CCGA	1
GCGA	2
TCGA	3
ACTA	4
CCTA	5
GCTA	6
TCTA	7
ACAA	8
CCAA	9
GCAA	10
TCAA	11
ACGC	12
CCGC	13
GCGC	14
TCGC	15
ACTC	16
CCTC	17
GCTC	18
TCTC	19
ACAC	20
CCAC	21
GCAC	22
TCAC	23
ACTG	24
CCTG	25
GCTG	26
TCTG	27

204

Quaternary Code	Decode Equivalent
ACAG	28
CCAG	29
GCAG	30
TCAG	31
ACGG	32
CCGG	33
GCGG	34
TCGG	35
ACGT	36
CCGT	37
GCGT	38
TCGT	39
ACTT	40
CCTT	41
GCTT	42
TCTT	43
ACAT	44
CCAT	45
GCAT	46
TCAT	47
AGTA	48
CGTA	49
GGTA	50
TGTA	51
AGAA	52
CGAA	53
GGAA	54
TGAA	55

206

Quaternary Code	Decode Equivalent
AGCA	56
CGCA	57
GGCA	58
TGCA	59
AGTC	60
CGTC	61
GGTC	62
TGTC	63
AGAC	64
CGAC	65
GGAC	66
TGAC	67
AGCC	68
CGCC	69
GGCC	70
TGCC	71
AGTG	72
CGTG	73
GGTG	74
TGTG	75
AGAG	76
CGAG	77
GGAG	78
TGAG	79
AGCG	80
CGCG	81
GGCG	82
TGCG	83

FIG. 2A

208

Quaternary Code	Decode Equivalent
AGTT	84
CGTT	85
GGTT	86
TGTT	87
AGAT	88
CGAT	89
GGAT	90
TGAT	91
AGCT	92
CGCT	93
GGCT	94
TGCT	95
ATGA	96
CTGA	97
GTGA	98
TTGA	99
ATAA	100
CTAA	101
GTAA	102
TTAA	103
ATCA	104
CTCA	105
GTCA	106
TTCA	107
ATGC	108
CTGC	109
GTGC	110
TTGC	111

210

Quaternary Code	Decode Equivalent
ATAC	112
CTAC	113
GTAC	114
TTAC	115
ATCC	116
CTCC	117
GTCC	118
TTCC	119
ATGG	120
CTGG	121
GTGG	122
TTGG	123
ATAG	124
CTAG	125
GTAG	126
TTAG	127
ATCG	128
CTCG	129
GTCG	130
TTCG	131
ATGT	132
CTGT	133
GTGT	134
TTGT	135
ATAT	136
CTAT	137
GTAT	138
TTAT	139

212

Quaternary Code	Decode Equivalent
ATCT	140
CTCT	141
GTCT	142
TTCT	143
AAGA	144
CAGA	145
GAGA	146
TAGA	147
AATA	148
CATA	149
GATA	150
TATA	151
AACA	152
CACA	153
GACA	154
TACA	155
AAGC	156
CAGC	157
GAGC	158
TAGC	159
AATC	160
CATC	161
GATC	162
TATC	163
AACC	164
CACC	165
GACC	166
TACC	167

FIG. 2B

214

Quaternary Code	Decode Equivalent
AAGG	168
CAGG	169
GAGG	170
TAGG	171
AATG	172
CATG	173
GATG	174
TATG	175
AACG	176
CACG	177
GACG	178
TACG	179
AAGT	180
CAGT	181
GAGT	182
TAGT	183
AATT	184
CATT	185
GATT	186
TATT	187
AACT	188
CACT	189
GACT	190
TACT	191

FIG. 2C

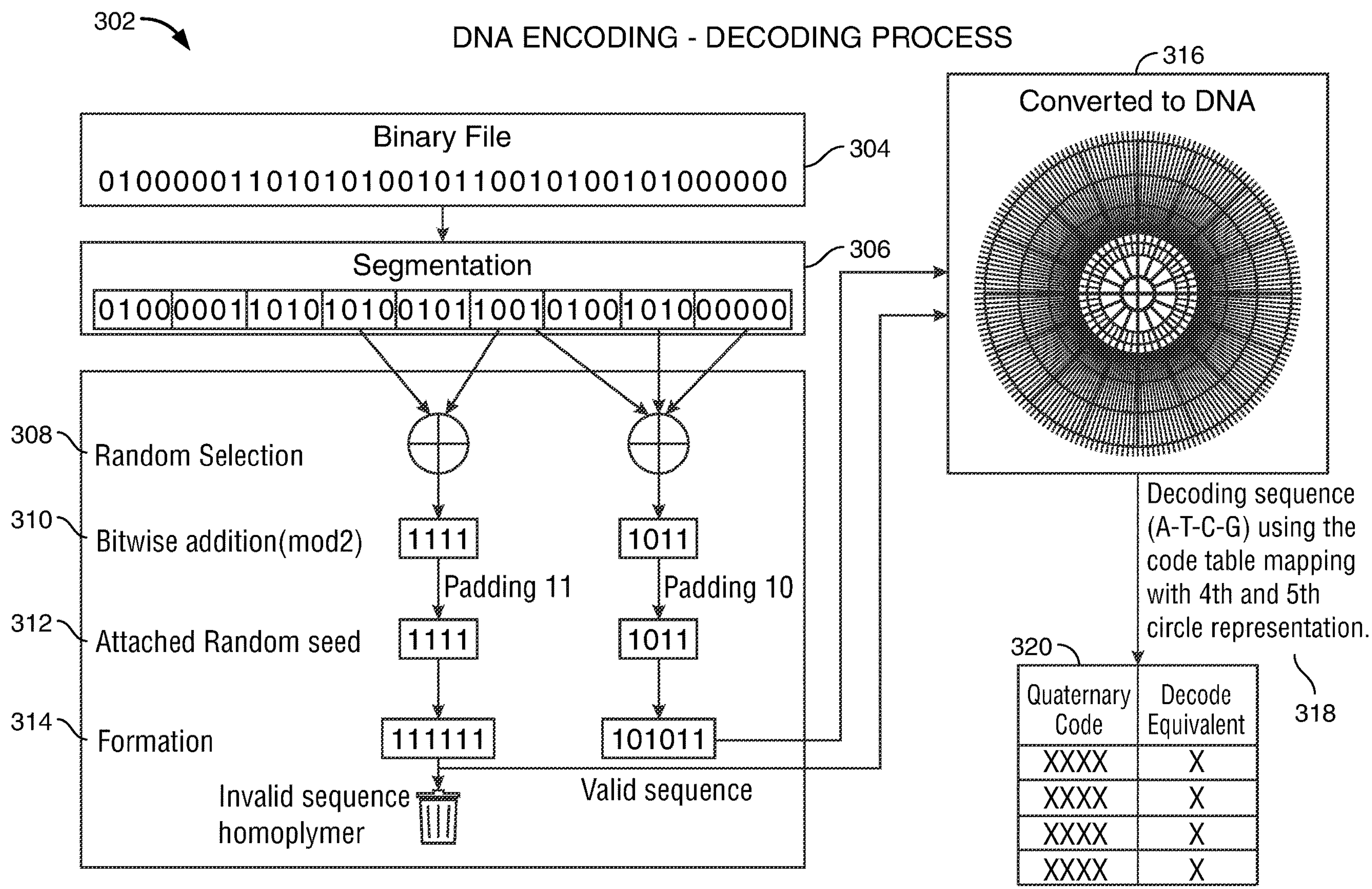

302
DNA ENCODING - DECODING PROCESS
Binary File
0100000110101010010110010100101000000
304
Segmentation
0100 0001 1010 1010 0101 1001 0100 1010 00000
306
308 Random Selection
310 Bitwise addition(mod2)
312 Attached Random seed
314 Formation
1111
Padding 11
1111
111111
Invalid sequence homoplymer
1011
Padding 10
1011
101011
Valid sequence
316
Converted to DNA
Decoding sequence (A-T-C-G) using the code table mapping with 4th and 5th circle representation.
318
320
Quaternary Code
Decode Equivalent
XXXX
X
XXXX
X
XXXX
X
XXXX
X

FIG. 3

SYSTEM FOR LEVERAGING SYNTHETIC DNA FOR COMPUTER STORAGE

FIELD OF TECHNOLOGY

[0001] Aspects of the disclosure relate to synthetic deoxyribonucleic acid ("DNA").

BACKGROUND OF THE DISCLOSURE

[0002] Recently, the amount of data generated daily is rapidly increasing. As such, the rapid increase in generated data has created a need for more efficient storage structures.

[0003] DNA is a carrier of natural genetic information. As such, DNA provides a stable, resource-efficient, energy-efficient and sustainable storage structure.

[0004] It would be desirable to use DNA to store data.

[0005] It would be yet further desirable to encode electronic computer sequences on strands of DNA.

SUMMARY OF THE DISCLOSURE

[0006] Systems, apparatus and methods for leveraging synthetic DNA for computer storage may be provided.

[0007] Methods may include receiving one or more data files. The data files may include text files, image files, portable document format ("pdf") files, video files, audio files and any other suitable files.

[0008] Methods may include converting the data files binary files. It should be noted that the binary files may encode data using zeros and ones.

[0009] Methods may include segmenting the binary file into a plurality of data packets. Methods may include randomly selecting packets from the plurality of data packets. The random selection may include retrieving one, two, three or more packets from the plurality of data packets.

[0010] Methods may include combining the selected one or more packets into an output. The combining may utilize an algorithm. The algorithm may be used to process the combination. The algorithm may be an exclusive or operation. The algorithm may be a bitwise addition operation. In some embodiments, an exclusive or operation may be referred to as a bitwise addition operation.

[0011] Methods may include attaching a four-byte random seed to the output. Attaching the four-byte random seed to the output may form a seeded output. It should be noted that random seeds greater than, or less than, four bytes may be used in certain embodiments.

[0012] Methods may include identifying the sequence as a valid sequence or as an invalid sequence. It should be noted that certain sequences, within DNA, may be difficult to process and error-prone. These sequences may be referred to as homopolymers. Homopolymers may be stretches of DNA bases (mono nucleotides) greater than two bases long which occur together. The DNA bases may include adenine ("A"), thymine ('T'), cytosine ('C') and guanine ('G'). For example, a 'ATCCCGC' may include a homopolymer. The homopolymer may be base 'C' with a length of three. These stretches may cause errors when sequencing DNA. Specifically, DNA sequencing technologies read DNA bases by reconstructing the DNA by referring to a sample. Since the bases used for reconstruction are attached with a fluorophore, upon the addition of each subsequent base, the intensity of emitted fluorescence is recorded. The cumulative intensity increases linearly with the number of bases added. However, when a series (greater than two) of identical bases is added, the linearity may be lost. As such, the sequencer may be unable to, over a threshold level of confidence, distinguish between 3 As and 7 As or 8 Ts and 9 Ts. Therefore, methods may include discarding sequences that include homopolymers. Such sequences may be identified as invalid sequences.

[0013] The invalid sequence may be a homopolymer. The invalid sequence may include greater than a threshold number of duplicate bases.

[0014] Methods may include converting the sequence into a DNA quaternary sequence. As such, the binary sequence, including zeros and ones, may be converted into a DNA quaternary sequence, including As, Ts, Cs and Gs. The converting may be based on a code table.

[0015] Methods may include synthesizing the DNA sequence. Methods may include storing the DNA sequence.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The objects and advantages of the invention will be apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

[0017] FIGS. **1**A, **1**B, **1**C, **1**D and **1**E show illustrative diagrams in accordance with principles of the disclosure;

[0018] FIGS. **2**A, **2**B and **2**C shows an illustrative listing in accordance with principles of the disclosure; and

[0019] FIG. **3** shows an illustrative hybrid diagram/flow chart in accordance with principles of the disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0020] Apparatus, systems and methods for storing data on DNA is provided. The system may include a receiver operable to receive one or more data files.

[0021] The system may include a processing element. The processing element may be operable to segment the one or more data files into a plurality of data packets. The processing element may be operable to randomly select one or more packets from the plurality of data packets. The processing element may be operable to combine the selected one or more packets into an output. The processing element may use an algorithm to combine the selected one or more packets. The algorithm may be an exclusive or operation. The algorithm may be a bitwise addition operation.

[0022] The processing element may attach a four-byte random seed to the output. The processing element may derive a sequence from the seeded output. The processing element may identify the sequence as a valid sequence or as an invalid sequence. The invalid sequence may be a homopolymer. The invalid sequence may include greater than a threshold number of duplicate bases. The threshold number may be two, three or any other suitable number. The processing element may discard the sequence when the sequence is identified as an invalid sequence.

[0023] The system may include a DNA synthesizer. The DNA synthesizer may, when the sequence is identified as a valid sequence, convert the sequence into a DNA quaternary sequence. The DNA synthesizer may synthesize the DNA sequence. The DNA synthesizer may store the DNA sequence.

[0024] Converting the sequence into a DNA quaternary sequence may be based on a code table. The code table may be included as table A.

TABLE A

Quaternary Code	Decode Equivalent
ACGA	0
CCGA	1
GCGA	2
TCGA	3
ACTA	4
CCTA	5
GCTA	6
TCTA	7
ACAA	8
CCAA	9
GCAA	10
TCAA	11
ACGC	12
CCGC	13
GCGC	14
TCGC	15
ACTC	16
CCTC	17
GCTC	18
TCTC	19
ACAC	20
CCAC	21
GCAC	22
TCAC	23
ACTG	24
CCTG	25
GCTG	26
TCTG	27
ACAG	28
CCAG	29
GCAG	30
TCAG	31
ACGG	32
CCGG	33
GCGG	34
TCGG	35
ACGT	36
CCGT	37
GCGT	38
TCGT	39
ACTT	40
CCTT	41
GCTT	42
TCTT	43
ACAT	44
CCAT	45
GCAT	46
TCAT	47
AGTA	48
CGTA	49
GGTA	50
TGTA	51
AGAA	52
CGAA	53
GGAA	54
TGAA	55
AGCA	56
CGCA	57
GGCA	58
TGCA	59
AGTC	60
CGTC	61
GGTC	62
TGTC	63
AGAC	64
CGAC	65
GGAC	66
TGAC	67
AGCC	68
CGCC	69
GGCC	70
TGCC	71

TABLE A-continued

Quaternary Code	Decode Equivalent
AGTG	72
CGTG	73
GGTG	74
TGTG	75
AGAG	76
CGAG	77
GGAG	78
TGAG	79
AGCG	80
CGCG	81
GGCG	82
TGCG	83
AGTT	84
CGTT	85
GGTT	86
TGTT	87
AGAT	88
CGAT	89
GGAT	90
TGAT	91
AGCT	92
CGCT	93
GGCT	94
TGCT	95
ATGA	96
CTGA	97
GTGA	98
TTGA	99
ATAA	100
CTAA	101
GTAA	102
TTAA	103
ATCA	104
CTCA	105
GTCA	106
TTCA	107
ATGC	108

TABLE A-continued

Quaternary Code	Decode Equivalent
CTGC	109
GTGC	110
TTGC	111
ATAC	112
CTAC	113
GTAC	114
TTAC	115
ATCC	116
CTCC	117
GTCC	118
TTCC	119
ATGG	120
CTGG	121
GTGG	122
TTGG	123
ATAG	124
CTAG	125
GTAG	126
TTAG	127
ATCG	128
CTCG	129
GTCG	130
TTCG	131
ATGT	132
CTGT	133
GTGT	134
TTGT	135
ATAT	136
CTAT	137
GTAT	138
TTAT	139
ATCT	140
CTCT	141
GTCT	142
TTCT	143
AAGA	144
CAGA	145

TABLE A-continued

Quaternary Code	Decode Equivalent
GAGA	146
TAGA	147
AATA	148
CATA	149
GATA	150
TATA	151
AACA	152
CACA	153
GACA	154
TACA	155
AAGC	156
CAGC	157
GAGC	158
TAGC	159
AATC	160
CATC	161
GATC	162
TATC	163
AACC	164
CACC	165
GACC	166
TACC	167
AAGG	168
CAGG	169
GAGG	170
TAGG	171
AATG	172
CATG	173
GATG	174
TATG	175
AACG	176
CACG	177
GACG	178
TACG	179
AAGT	180
CAGT	181
GAGT	182

TABLE A-continued

Quaternary Code	Decode Equivalent
TAGT	183
AATT	184
CATT	185
GATT	186
TATT	187
AACT	188
CACT	189
GACT	190
TACT	191

[0025] Apparatus and methods described herein are illustrative. Apparatus and methods in accordance with this disclosure will now be described in connection with the figures, which form a part hereof. The figures show illustrative features of apparatus and method steps in accordance with the principles of this disclosure. It is to be understood that other embodiments may be utilized and that structural, functional and procedural modifications may be made without departing from the scope and spirit of the present disclosure.

[0026] The steps of methods may be performed in an order other than the order shown or described herein. Embodiments may omit steps shown or described in connection with illustrative methods. Embodiments may include steps that are neither shown nor described in connection with illustrative methods.

[0027] Illustrative method steps may be combined. For example, an illustrative method may include steps shown in connection with another illustrative method.

[0028] Apparatus may omit features shown or described in connection with illustrative apparatus. Embodiments may include features that are neither shown nor described in connection with the illustrative apparatus. Features of illustrative apparatus may be combined. For example, an illustrative embodiment may include features shown in connection with another illustrative embodiment.

[0029] FIGS. **1**A, **1**B, **1**C, **1**D, **1**E show illustrative diagrams in accordance with principles of the disclosure. FIG. **1**A shows an illustrative diagram. The illustrative diagram may be used to convert binary sequences to DNA quaternary codes. The illustrative diagram may also be used to decode DNA sequences to binary numbers.

[0030] The illustrative diagram includes multiple layers of DNA codes. The illustrative diagram includes binary (numerical) equivalents.

[0031] The first layer of DNA codes is shown at **102**. The first layer of DNA codes may include four DNA bases (A, T, C and G). The first layer of DNA codes may correspond to the first digit in a four-digit binary number.

[0032] The second layer of DNA codes is shown at **104**. The second layer of DNA codes may include an option of selecting one of four DNA bases (A, T, C and G). The second layer of DNA codes may correspond to the second digit in a four-digit binary number.

[0033] The third layer of DNA codes is shown at **114**. The third layer of DNA codes may include an option for selecting one of three DNA bases (A, T, C and G). The third layer of DNA codes may correspond to third digit in a four-digit binary number. It should be noted that removing the option of one DNA code from the third layer of DNA codes may remove the possibility of creating a homopolymer.

[0034] The fourth layer of the diagram, shown at **112**, includes a decode layer. The decode layer is a numeric layer. The numbers included in the decode layer may be used to identify a binary number when decoding a sequence created from DNA codes.

[0035] The fifth layer of the diagram, shown at **110**, may include DNA codes. The fifth layer of the diagram may include an option for selection one of four DNA bases (A, T, C and G). The fifth layer of the DNA codes may correspond to a fourth digit in a four-digit binary number.

[0036] The sixth layer of the diagram, shown at **108**, may include numerals. The numerals may correspond to a binary equivalent to a four-digit quaternary code. For example, quaternary code CGTA may correspond to numeral 49.

[0037] The outer layer of the diagram may be shown at **106**.

[0038] FIG. **1**B shows an illustrative diagram. The illustrative diagram shows quadrant **116**. Quadrant **116** may be a detailed section of the diagram shown in FIG. **1**A. Quadrant **116** may correspond to quaternary codes that begin with a T.

[0039] FIG. **1**C shows an illustrative diagram. The illustrative diagram shows quadrant **118**. Quadrant **118** may be a detailed section of the diagram shown in FIG. **1**A. Quadrant **118** may correspond to quaternary codes that begin with a C.

[0040] FIG. **1**D shows an illustrative diagram. The illustrative diagram shows quadrant **120**. Quadrant **120** may be a detailed section of the diagram shown in FIG. **1**A. Quadrant **120** may correspond to quaternary codes that begin with an A.

[0041] FIG. **1**E shows an illustrative diagram. The illustrative diagram shows quadrant **122**. Quadrant **122** may be a detailed section of the diagram shown in FIG. **1**A. Quadrant **120** may correspond to quaternary codes that begin with a G.

[0042] FIGS. **2**A, **2**B, **2**C shows an illustrative listing in accordance with principles of the disclosure.

[0043] FIG. **2**A shows a first portion of a listing of quaternary codes and decode equivalents. FIG. **2**A shows sections **202**, **204** and **206**. Section **202** shows a listing ranging from numerical decode zero to numerical decode 27. Section **204** shows a listing ranging from numerical decode 28 to numerical decode 55. Section **206** shows a listing ranging from numerical decode 56 to numerical decode 83.

[0044] FIG. **2**B shows a second portion of the listing of quaternary codes and decode equivalents. FIG. **2**B shows sections **208**, **210** and **212**. Section **208** shows a listing ranging from numerical decode 84 to numerical decode 111. Section **210** shows a listing ranging from numerical decode 112 to numerical decode 139. Section **212** shows a listing ranging from numerical decode 140 to numerical decode 167.

[0045] FIG. **2**C shows a third portion of the listing of quaternary codes and decode equivalents. FIG. **2**C shows section **214**. Section **214** shows a listing ranging from numerical decode 168 to numerical decode 191.

[0046] FIG. **3** shows an illustrative hybrid diagram/flow chart in accordance with principles of the disclosure.

[0047] The hybrid diagram/flow chart may include DNA encoding/decoding process **302**. The process may initiate with receipt of a binary file, shown at **304**. A binary file may include one or more zeros and ones.

[0048] The process may include segmenting the binary file, as shown at **306**. The binary file may be segmented into a plurality of segments. The segments may be the same in length. The segments may be different in length.

[0049] The process may include random selection of segments, as shown at **308**. One, two or any other suitable number of segments may be selected.

[0050] The process may include executing bitwise addition (mod 2) to combine one or more segments, as shown at **310**.

[0051] The process may include attaching a random seed to each combined segment, as shown at **312**.

[0052] The process may include forming an output, as shown at **314**. The output may include the random seed and the combined segment. The output may identify a binary sequence.

[0053] Invalid sequences may be discarded. Invalid sequences may include binary sequences that would generate homopolymers when converted to DNA sequences.

[0054] Valid sequences may be converted to DNA sequences using a DNA mapping, as shown at **316**. The DNA sequences may be encoded on synthetic DNA. The synthetic DNA may be stored. The stored DNA may be read and decoded at another instance. The stored DNA may be read and decoded using a DNA mapping. The DNA mapping may be the same mapping used to convert the DNA sequence. As such, the 4^{th} and 5^{th} circle representation, indicated at **318**, and the code table, shown at **320**, may be used to decode stored DNA.

[0055] Thus, systems and methods for leveraging synthetic DNA for computer storage are provided. Persons skilled in the art will appreciate that the present invention can be practiced by other than the described embodiments, which are presented for purposes of illustration rather than of limitation. The present invention is limited only by the claims that follow.

What is claimed is:

1. An encoding method for storing data on deoxyribonucleic acid ("DNA"), the method comprising:

receiving one or more data files;

segmenting the one or more data files into a plurality of data packets;

randomly selecting one or more packets from the plurality of data packets;

combining, using an algorithm, the selected one or more packets into an output;

attaching a four-byte random seed to the output;

deriving a sequence from the seeded output;

identifying the sequence as a valid sequence or an invalid sequence;

converting the sequence into a DNA quaternary sequence, said DNA quaternary sequence comprising one or more DNA bases;

synthesizing the DNA sequence; and

storing the DNA sequence.

2. The encoding method of claim **1**, wherein the algorithm is an exclusive or operation.

3. The encoding method of claim 1, wherein the algorithm is a bitwise addition operation.

4. The encoding method of claim 1, wherein the invalid sequence is a homopolymer.

5. The encoding method of claim 1, wherein the invalid sequence comprises greater than a threshold number of duplicate bases.

6. The encoding method of claim 1, wherein the one or more DNA bases include adenine, thymine, cytosine and guanine.

7. The encoding method of claim 1, wherein the converting is based on a code table.

8. The encoding method of claim 7 wherein the code table comprises the following code table:

Quaternary Code	Decode Equivalent
ACGA	0
CCGA	1
GCGA	2
TCGA	3
ACTA	4
CCTA	5
GCTA	6
TCTA	7
ACAA	8
CCAA	9
GCAA	10
TCAA	11
ACGC	12
CCGC	13
GCGC	14
TCGC	15
ACTC	16
CCTC	17
GCTC	18
TCTC	19
ACAC	20
CCAC	21
GCAC	22
TCAC	23
ACTG	24
CCTG	25
GCTG	26
TCTG	27

-continued

Quaternary Code	Decode Equivalent
ACAG	28
CCAG	29
GCAG	30
TCAG	31
ACGG	32
CCGG	33
GCGG	34
TCGG	35
ACGT	36
CCGT	37
GCGT	38
TCGT	39
ACTT	40
CCTT	41
GCTT	42
TCTT	43
ACAT	44
CCAT	45
GCAT	46
TCAT	47
AGTA	48
CGTA	49
GGTA	50
TGTA	51
AGAA	52
CGAA	53
GGAA	54
TGAA	55
AGCA	56
CGCA	57
GGCA	58
TGCA	59
AGTC	60
CGTC	61
GGTC	62
TGTC	63
AGAC	64

-continued

Quaternary Code	Decode Equivalent
CGAC	65
GGAC	66
TGAC	67
AGCC	68
CGCC	69
GGCC	70
TGCC	71
AGTG	72
CGTG	73
GGTG	74
TGTG	75
AGAG	76
CGAG	77
GGAG	78
TGAG	79
AGCG	80
CGCG	81
GGCG	82
TGCG	83
AGTT	84
CGTT	85
GGTT	86
TGTT	87
AGAT	88
CGAT	89
GGAT	90
TGAT	91
AGCT	92
CGCT	93
GGCT	94
TGCT	95
ATGA	96
CTGA	97
GTGA	98
TTGA	99
ATAA	100

-continued

Quaternary Code	Decode Equivalent
CTAA	101
GTAA	102
TTAA	103
ATCA	104
CTCA	105
GTCA	106
TTCA	107
ATGC	108
CTGC	109
GTGC	110
TTGC	111
ATAC	112
CTAC	113
GTAC	114
TTAC	115
ATCC	116
CTCC	117
GTCC	118
TTCC	119
ATGG	120
CTGG	121
GTGG	122
TTGG	123
ATAG	124
CTAG	125
GTAG	126
TTAG	127
ATCG	128
CTCG	129
GTCG	130
TTCG	131
ATGT	132
CTGT	133
GTGT	134
TTGT	135
ATAT	136
CTAT	137

-continued

Quaternary Code	Decode Equivalent
GTAT	138
TTAT	139
ATCT	140
CTCT	141
GTCT	142
TTCT	143
AAGA	144
CAGA	145
GAGA	146
TAGA	147
AATA	148
CATA	149
GATA	150
TATA	151
AACA	152
CACA	153
GACA	154
TACA	155
AAGC	156
CAGC	157
GAGC	158
TAGC	159
AATC	160
CATC	161
GATC	162
TATC	163
AACC	164
CACC	165
GACC	166
TACC	167
AAGG	168
CAGG	169
GAGG	170
TAGG	171
AATG	172
CATG	173

-continued

Quaternary Code	Decode Equivalent
GATG	174
TATG	175
AACG	176
CACG	177
GACG	178
TACG	179
AAGT	180
CAGT	181
GAGT	182
TAGT	183
AATT	184
CATT	185
GATT	186
TATT	187
AACT	188
CACT	189
GACT	190
TACT	191

9. A system for storing data on deoxyribonucleic acid ("DNA"), the system comprising:
- a receiver operable to receive one or more data files;
- a processing element operable to:
  - segment the one or more data files into a plurality of data packets;
  - randomly select one or more packets from the plurality of data packets;
  - combine, using an algorithm, the selected one or more packets into an output;
  - attach a four-byte random seed to the output;
  - derive a sequence from the seeded output;
  - identify the sequence as a valid sequence or an invalid sequence; and
  - discard the sequence when the sequence is identified as an invalid sequence;
- a DNA synthesizer operable to:
  - when the sequence is identified as a valid sequence, convert the sequence into a DNA quaternary sequence, said DNA quaternary sequence comprising two or more DNA bases;
  - synthesize the DNA sequence; and
  - store the DNA sequence.

10. The system of claim **9**, wherein the algorithm is an exclusive or operation.

11. The system of claim **9**, wherein the algorithm is a bitwise addition operation.

12. The system of claim **9**, wherein the invalid sequence is a homopolymer.

13. The system of claim **9**, wherein the invalid sequence comprises greater than a threshold number of duplicate bases.

14. The system of claim **9**, wherein the two or more DNA bases include adenine, thymine, cytosine and guanine.

15. The system of claim **9**, wherein the converting is based on a code table.

16. The system of claim **15** wherein the code table comprises the following code table:

Quaternary Code	Decode Equivalent
ACGA	0
CCGA	1
GCGA	2
TCGA	3
ACTA	4
CCTA	5
GCTA	6
TCTA	7
ACAA	8
CCAA	9
GCAA	10
TCAA	11
ACGC	12
CCGC	13
GCGC	14
TCGC	15
ACTC	16
CCTC	17
GCTC	18
TCTC	19
ACAC	20
CCAC	21
GCAC	22
TCAC	23
ACTG	24
CCTG	25
GCTG	26
TCTG	27
ACAG	28
CCAG	29
GCAG	30

-continued

Quaternary Code	Decode Equivalent
TCAG	31
ACGG	32
CCGG	33
GCGG	34
TCGG	35
ACGT	36
CCGT	37
GCGT	38
TCGT	39
ACTT	40
CCTT	41
GCTT	42
TCTT	43
ACAT	44
CCAT	45
GCAT	46
TCAT	47
AGTA	48
CGTA	49
GGTA	50
TGTA	51
AGAA	52
CGAA	53
GGAA	54
TGAA	55
AGCA	56
CGCA	57
GGCA	58
TGCA	59
AGTC	60
CGTC	61
GGTC	62
TGTC	63
AGAC	64
CGAC	65
GGAC	66
TGAC	67

-continued

Quaternary Code	Decode Equivalent
AGCC	68
CGCC	69
GGCC	70
TGCC	71
AGTG	72
CGTG	73
GGTG	74
TGTG	75
AGAG	76
CGAG	77
GGAG	78
TGAG	79
AGCG	80
CGCG	81
GGCG	82
TGCG	83
AGTT	84
CGTT	85
GGTT	86
TGTT	87
AGAT	88
CGAT	89
GGAT	90
TGAT	91
AGCT	92
CGCT	93
GGCT	94
TGCT	95
ATGA	96
CTGA	97
GTGA	98
TTGA	99
ATAA	100
CTAA	101
GTAA	102
TTAA	103

-continued

Quaternary Code	Decode Equivalent
ATCA	104
CTCA	105
GTCA	106
TTCA	107
ATGC	108
CTGC	109
GTGC	110
TTGC	111
ATAC	112
CTAC	113
GTAC	114
TTAC	115
ATCC	116
CTCC	117
GTCC	118
TTCC	119
ATGG	120
CTGG	121
GTGG	122
TTGG	123
ATAG	124
CTAG	125
GTAG	126
TTAG	127
ATCG	128
CTCG	129
GTCG	130
TTCG	131
ATGT	132
CTGT	133
GTGT	134
TTGT	135
ATAT	136
CTAT	137
GTAT	138
TTAT	139
ATCT	140

-continued

Quaternary Code	Decode Equivalent
CTCT	141
GTCT	142
TTCT	143
AAGA	144
CAGA	145
GAGA	146
TAGA	147
AATA	148
CATA	149
GATA	150
TATA	151
AACA	152
CACA	153
GACA	154
TACA	155
AAGC	156
CAGC	157
GAGC	158
TAGC	159
AATC	160
CATC	161
GATC	162
TATC	163
AACC	164
CACC	165
GACC	166

-continued

Quaternary Code	Decode Equivalent
TACC	167
AAGG	168
CAGG	169
GAGG	170
TAGG	171
AATG	172
CATG	173
GATG	174
TATG	175
AACG	176
CACG	177
GACG	178
TACG	179
AAGT	180
CAGT	181
GAGT	182
TAGT	183
AATT	184
CATT	185
GATT	186
TATT	187
AACT	188
CACT	189
GACT	190
TACT	191

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