



The Genomics Toolkit

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Chapter 1

Introduction

Recent advances in DNA sequencing have revolutionized the field of genomics, making it possible for research groups to generate large amounts of sequenced data, very rapidly and at substantially lower cost [?]. The storage of genomic data is being addressed using specific file formats, such as FASTQ and FASTA. Therefore, its analysis and manipulation is crucial [?]. Many frameworks for analysis and manipulation emerged, namely GALAXY [?], GATK [?], HTSeq [?], MEGA [?], among others. Several of these frameworks require licenses, while others do not provide a low level access to the information, since they are commonly approached by scripting or programming languages not efficient for the purpose. Moreover, several lack on variety, namely the ability to perform multiple tasks using only one toolkit.

We describe **GTO**, a complete toolkit for genomics, namely for FASTA-FASTQ formats and sequences (DNA, amino acids, text), with many complementary tools. The toolkit is for Linux- and Unix-based systems, built for ultra-fast computations. **GTO** supports pipes for easy integration with the sub-programs belonging to **GTO** as well as external tools. **GTO** works as the *LEGOs*, since it allows the construction of multiple pipelines with many combinations.

GTO includes tools for information display, randomization, edition, conversion, extraction, search, calculation, and visualization. **GTO** is prepared to deal with very large datasets, typically in the scale Gigabytes or Terabytes (but not limited).

The complete toolkit is an optimized command line version, using the prefix “gto_” followed by the suffix with the respective name of the program. **GTO** is implemented in C language and it is available, under the MIT license, at:

```
https://pratas.github.io/GTO
```

1.1 Installation

For **GTO** installation, run:

```
git clone https://github.com/pratas/GTO.git
cd GTO/src/
```

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Chapter 2

Amino acid sequence tools

Current available amino acid sequence tools, for analysis and manipulation, are:

1. `gto_amino_acid_to_group`: it converts an amino acid sequence to a group sequence.
2. `gto_amino_acid_to_pseudo_dna`: it converts an amino acid (protein) sequence to a pseudo DNA sequence.

2.1 Program `gto_amino_acid_to_group`

The `gto_amino_acid_to_group` converts an amino acid sequence to a group sequence.

For help type:

```
./gto_amino_acid_to_group -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_amino_acid_to_group` program needs two streams for the computation, namely the input and output standard. The input stream is an amino acid sequence. The attribution is given according to:

```
Usage: ./gto_amino_acid_to_group [options] [--] args]
or: ./gto_amino_acid_to_group [options]

It converts a amino acid sequence to a group sequence.

    -h, --help                show this help message and exit

Basic options
    < input.prot              Input amino acid sequence file (stdin)
    > output.group            Output group sequence file (stdout)

Example: ./gto_amino_acid_to_group < input.prot > output.group
Table:
Prot      Group
```

R	P	
H	P	Amino acids with electric charged side chains: POSITIVE
K	P	
-	-	
D	N	
E	N	Amino acids with electric charged side chains: NEGATIVE
-	-	
S	U	
T	U	
N	U	Amino acids with electric UNCHARGED side chains
Q	U	
-	-	
C	S	
U	S	
G	S	Special cases
P	S	
-	-	
A	H	
V	H	
I	H	
L	H	
M	H	Amino acids with hydrophobic side chains
F	H	
Y	H	
W	H	
-	-	
*	*	Others
X	X	Unknown

It can be used to group amino acids by properties, such as electric charge (positive and negative), uncharged side chains, hydrophobic side chains and special cases. An example on such an input file is:

```
IPFLKKQFALADKLVL SKLRQLLGGR IKMMPCGGAKLEPAIGLFFHAIGINIKLGYGMTETTATVSCWHDFQFNPN SIG
TLMPKAEVKIGENNEILVRGGMVMKGYKKPEETAQAFTEDGFLKTGDAGEFDEQGNLFITDRIKELMKTSNGKYIAPQY
IESKIGKDKFIEQIAIIADAKKYVSALIVPCFDSLEEYAKQLNIKYHDRLELLKNSDILKMFE
```

Output

The output of the gto_amino_acid_to_group program is a group sequence. An example, for the input, is:

```
HSHHHPPUHHHHNPHHHUPHPUHHSSPHPHSSSSHPHNSHHSHHHPHHSHUHPHSHSHUNU UHUHUSHPNHUHUSUUHS
UHHSPHNHPSNUUNHHHPSSHHPSPHPPSNNUHUHHUNNSHHPUSNHSNNHNUSHHHUNPHPNHHPUUUSPHHHSUH
HNUPHSPNPHHNUHHHHHNPPHHUHHHHSSHNUHNNHHPUHUHPHPNPHNHHPUUNHHPHHN
```

2.2 Program gto_amino_acid_to_pseudo_dna

The gto_amino_acid_to_pseudo_dna converts an amino acid (protein) sequence to a pseudo DNA sequence. For help type:


```
./gto_amino_acid_to_pseudo_dna -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_amino_acid_to_pseudo_dna` program needs two streams for the computation, namely the input and output standard. The input stream is an amino acid sequence. The attribution is given according to:

```
Usage: ./gto_amino_acid_to_pseudo_dna [options] [--] args]
or: ./gto_amino_acid_to_pseudo_dna [options]

It converts a protein sequence to a pseudo DNA sequence.

    -h, --help          show this help message and exit

Basic options
    < input.prot        Input amino acid sequence file (stdin)
    > output.dna         Output DNA sequence file (stdout)

Example: ./gto_amino_acid_to_pseudo_dna < input.prot > output.dna
Table:
```

Prot	DNA
A	GCA
C	TGC
D	GAC
E	GAG
F	TTT
G	GGC
H	CAT
I	ATC
K	AAA
L	CTG
M	ATG
N	AAC
P	CCG
Q	CAG
R	CGT
S	TCT
T	ACG
V	GTA
W	TGG
Y	TAC
*	TAG
X	GGG

It can be used to generate pseudo-DNA with characteristics passed by amino acid (protein) sequences. An example on such an input file is:

```
IPFLLKKQFALADKLVL SKLRQLLGGR IKMMP CGGAKLEPAIGLFFHAIGINIKLGYGMTETTATVSCWHDFQFNPN SIG
TLMPKAEVKIGENNEILVRGGMVMKGYKKPEETAQAFTEDGFLKTGDAGEFDEQGNLFITDRIKELMKTSNGKYIAPQY
IESKIGKDKFIEQIAIIADAKKYVSALIVPCFDSLEEYAKQLNIKYHDRLELLKNSDILKMFE
```

Output

The output of the `gto_amino_acid_to_pseudo_dna` program is a DNA sequence.

An example, for the input, is:

```
ATCCCGTTTCTGCTGAAAAACAGTTTGC ACTGGCAGACAACTGGTACTGTCTAACTGCGTCAGCTGCTGGGCGGCCG
TATCAAAATGATGCCGTGCGGCGGCGCAAACTGGAGCCGGCAATCGGCCTGTTTTTTCATGCAATCGGCATCAACATCA
AACTGGGCTACGGCATGACGGAGACGACGGCAACGGTATCTTGCTGGCATGACTTTCAGTTTAACCCGAACTCTATCGGC
ACGCTGATGCCGAAAGCAGAGGTAAAAATCGGCGAGACAACGAGATCCTGGTACGTGGCGGCATGGTAATGAAAGGCTA
CTACAAAAAACCGGAGGAGACGGCACAGGCATTTACGGAGGACGGCTTCTGAAAACGGGCGACGCAGGCGAGTTTGACG
AGCAGGGCAACCTGTTTATCACGGACCGTATCAAAAGAGCTGATGAAAACGTCTAACGGCAAATACATCGCACCGCAGTAC
ATCGAGTCTAAAATCGGCAAAGACAAATTTATCGAGCAGATCGCAATCATCGCAGACGCAAAAAATACGTATCTGCACT
GATCGTACCGTGCTTTGACTCTCTGGAGGAGTACGCAAAACAGCTGAACATCAAATACCATGACCGTCTGGAGCTGCTGA
AAAACTCTGACATCCTGAAAAATGTTTGAG
```

Chapter 3

FASTQ tools

Current available tools for FASTQ format analysis and manipulation include:

1. `gto_fastq_to_fasta`: it converts a FASTQ file format to a pseudo FASTA file.
2. `gto_fastq_to_mfasta`: it converts a FASTQ file format to a pseudo Multi-FASTA file.
3. `gto_fastq_exclude_n`: it discards the FASTQ reads with the minimum number of "N" symbols.
4. `gto_fastq_extract_quality_scores`: it extracts all the quality-scores from FASTQ reads.
5. `gto_fastq_info`: it analyses the basic information of FASTQ file format.
6. `gto_fastq_maximum_read_size`: it filters the FASTQ reads with the length higher than the value defined.
7. `gto_fastq_minimum_quality_score`: it discards reads with average quality-score below of the defined.
8. `gto_fastq_minimum_read_size`: it filters the FASTQ reads with the length smaller than the value defined.
9. `gto_fastq_rand_extra_chars`: it substitutes in the FASTQ files, the DNA sequence the outside ACGT chars by random ACGT symbols.
10. `gto_fastq_from_seq`: it converts a genomic sequence to pseudo FASTQ file format.
11. `gto_fastq_mutate`: it creates a synthetic mutation of a FASTQ file given specific rates of mutations, deletions and additions.
12. `gto_fastq_split`: it splits Paired End files according to the direction of the strand ('/1' or '/2').
13. `gto_fastq_pack`: it packages each FASTQ read in a single line.
14. `gto_fastq_unpack`: it unpacks the FASTQ reads packaged using the `gto_fastq_pack` tool.

15. `gto_fastq_quality_score_info`: it analyses the quality-scores of a FASTQ file.
16. `gto_fastq_quality_score_min`: it analyses the minimal quality-scores of a FASTQ file.
17. `gto_fastq_quality_score_max`: it analyses the maximal quality-scores of a FASTQ file.
18. `gto_fastq_cut`: it cuts read sequences in a FASTQ file.
19. `gto_fastq_minimum_local_quality_score_forward`: it filters the reads considering the quality score average of a defined window size of bases.
20. `gto_fastq_minimum_local_quality_score_reverse`: it filters the reverse reads, considering the average window size score defined by the bases.
21. `gto_fastq_clust_reads`: it agroups reads and creates an index file.

3.1 Program `gto_fastq_to_fasta`

The `gto_fastq_to_fasta` converts a FASTQ file format to a pseudo FASTA file. However, it does not align the sequence. Also, it extracts the sequence and adds a pseudo header.

For help type:

```
./gto_fastq_to_fasta -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_to_fasta` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_to_fasta [options] [--] args]
or: ./gto_fastq_to_fasta [options]

It converts a FASTQ file format to a pseudo FASTA file.
It does NOT align the sequence.
It extracts the sequence and adds a pseudo header.

    -h, --help                show this help message and exit

Basic options
    < input.fastq             Input FASTQ file format (stdin)
    > output.fasta            Output FASTA file format (stdout)

Example: ./gto_fastq_to_fasta < input.fastq > output.fasta
```

An example on such an input file is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I

```

Output

The output of the `gto_fastq_to_fasta` program a FASTA file.

An example, for the input, is:

```

GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
GTTTCAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT

```

3.2 Program `gto_fastq_to_mfasta`

The `gto_fastq_to_mfasta` onverts a FASTQ file format to a pseudo Multi-FASTA file. However, it does not align the sequence. Also, it extracts the sequence and adds a pseudo header.

For help type:

```
./gto_fastq_to_mfasta -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_to_mfasta` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```

Usage: ./gto_fastq_to_mfasta [options] [-- args]
or: ./gto_fastq_to_mfasta [options]

```

```

It converts a FASTQ file format to a pseudo Multi-FASTA file.
It does NOT align the sequence.
It extracts the sequence and adds each header in a Multi-FASTA format.

```

```
-h, --help          show this help message and exit
```

Basic options

```

< input.fastq      Input FASTQ file format (stdin)
> output.mfasta    Output Multi-FASTA file format (stdout)

```

```
Example: ./gto_fastq_to_mfasta < input.fastq > output.mfasta
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTACAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I
```

Output

The output of the `gto_fastq_to_mfasta` program a Multi-FASTA file.

An example, for the input, is:

```
>SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCCTTAACAACCTTAAGGGTTTTCAAATAGA
>SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTACAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
```

3.3 Program `gto_fastq_exclude_n`

The `gto_fastq_exclude_n` discards the FASTQ reads with the minimum number of "N" symbols. Also, if present, it will erase the second header (after +).

For help type:

```
./gto_fastq_exclude_n -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_exclude_n` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_exclude_n [options] [--] args]
or: ./gto_fastq_exclude_n [options]
```

It discards the FASTQ reads with the minimum number of "N" symbols.
If present, it will erase the second header (after +).

```
-h, --help          show this help message and exit
```

Basic options

```
-m, --max=<int>      The maximum of of "N" symbols in the read
< input.fastq        Input FASTQ file format (stdin)
> output.fastq       Output FASTQ file format (stdout)
```

```
Example: ./gto_fastq_exclude_n < input.fastq > output.fastq
```

```
Console output example :
<FASTQ non-filtered reads>
Total reads      : value
Filtered reads   : value
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCAACCAANATACCCCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTTATCAN
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I
```

Output

The output of the `gto_fastq_exclude_n` program is a set of all the filtered FASTQ reads, followed by the execution report. The execution report only appears in the console.

Using the max value as 5, an example for this input, is:

```
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTTATCAN
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I
Total reads      : 2
Filtered reads   : 1
```

3.4 Program `gto_fastq_extract_quality_scores`

The `gto_fastq_extract_quality_scores` extracts all the quality-scores from FASTQ reads.

For help type:

```
./gto_fastq_extract_quality_scores -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_extract_quality_scores` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```

Usage: ./gto_fastq_extract_quality_scores [options] [--] args]
       or: ./gto_fastq_extract_quality_scores [options]

It extracts all the quality-scores from FASTQ reads.

    -h, --help                show this help message and exit

Basic options
    < input.fastq             Input FASTQ file format (stdin)
    > output.fastq            Output FASTQ file format (stdout)

Example: ./gto_fastq_extract_quality_scores < input.fastq > output.fastq

Console output example:
<FASTQ quality scores>
Total reads                : value
Total Quality-Scores      : value

```

An example on such an input file is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGGGATACGACGTTTGTATTTTAAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I

```

Output

The output of the `gto_fastq_extract_quality_scores` program is a set of all the quality scores from the FASTQ reads, followed by the execution report. The execution report only appears in the console.

An example, for the input, is:

```

IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I
Total reads                : 2
Total Quality-Scores      : 144

```

3.5 Program `gto_fastq_info`

The `gto_fastq_info` analyses the basic information of FASTQ file format.

For help type:

```
./gto_fastq_info -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_info` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_info [options] [--] args]
      or: ./gto_fastq_info [options]

It analyses the basic information of FASTQ file format.

      -h, --help                show this help message and exit

Basic options
      < input.fastq            Input FASTQ file format (stdin)
      > output                  Output read information (stdout)

Example: ./gto_fastq_info < input.fastq > output

Output example:
Total reads      : value
Max read length : value
Min read length : value
Min QS value     : value
Max QS value     : value
QS range         : value
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTACAGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
```

Output

The output of the `gto_fastq_info` program is a set of information related to the file read.

An example, for the input, is:

```
Total reads      : 2
Max read length  : 72
Min read length  : 72
Min QS value     : 41
Max QS value     : 73
QS range         : 33
```

3.6 Program gto_fastq_maximum_read_size

The `gto_fastq_maximum_read_size` filters the FASTQ reads with the length higher than the value defined. For help type:

```
./gto_fastq_maximum_read_size -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_maximum_read_size` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_maximum_read_size [options] [--] args]
      or: ./gto_fastq_maximum_read_size [options]
```

It filters the FASTQ reads with the length higher than the value defined. If present, it will erase the second header (after +).

```
-h, --help      show this help message and exit
```

Basic options

```
-s, --size=<int>      The maximum read length
< input.fastq         Input FASTQ file format (stdin)
> output.fastq        Output FASTQ file format (stdout)
```

Example: `./gto_fastq_maximum_read_size -s <size> < input.fastq > output.fastq`

Console output example :

```
<FASTQ non-filtered reads>
```

```
Total reads      : value
```

Filtered reads : value

An example on such an input file is:

[illegible]

Output

The output of the `gto_fastq_maximum_read_size` program is a set of all the filtered FASTQ reads, followed by the execution report. The execution report only appears in the console.

Using the size value as 60, an example for this input, is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=60
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCACCAAGTTACCTTAACAACCTTAAGGG
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII9IG9ICIIIIIIIIIIIIIIIIIIIDIII
Total reads      : 2
Filtered reads   : 1
```

3.7 Program gto_fastq_minimum_quality_score

The `gto_fastq_minimum_quality_score` discards reads with average quality-score below of the defined. For help type:

```
./gto_fastq_minimum_quality_score -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_minimum_quality_score` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_minimum_quality_score [options] [--] args]
      or: ./gto_fastq_minimum_quality_score [options]

It discards reads with average quality-score below value.

      -h, --help                show this help message and exit

Basic options
      -m, --min=<int>          The minimum average quality-score (Value 25 or 30 is commonly used)
      < input.fastq            Input FASTQ file format (stdin)
      > output.fastq           Output FASTQ file format (stdout)

Example: ./gto_fastq_minimum_quality_score -m <min> < input.fastq > output.fastq

Console output example:
<FASTQ non-filtered reads>
Total reads      : value
Filtered reads   : value
```

It discards reads with average quality-score below value.

```
-h, --help      show this help message and exit
```

Basic options

```
-m, --min=<int>      The minimum average quality-score (Value 25 or 30 is commonly used)
< input.fastq        Input FASTQ file format (stdin)
> output.fastq        Output FASTQ file format (stdout)
```

Example: `./gto_fastq_minimum_quality_score -m <min> < input.fastq > output.fastq`

Console output example:

<FASTQ non-filtered reads>

```
Total reads      : value
```

```
Filtered reads : value
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAAATCCCACCAAGTTACCCTTAACAACTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTCAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAATCGATGATAATACGCGTCGTTTTATCAT
```

```
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
54599<>77977==6=?I6IBI::33344235521677999>>><<@@A@BBCDGGBFH>IIIII-I)8I
```

Output

The output of the `gto_fastq_minimum_quality_score` program is a set of all the filtered FASTQ reads, followed by the execution report.

Using the minimum average value as 30, an example for this input, is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII9IG9ICIIIIIIIIIIIIIIIIIIIIIDIIIIIII>IIIIII/
Total reads      : 2
Filtered reads   : 1
```

3.8 Program `gto_fastq_minimum_read_size`

The `gto_fastq_minimum_read_size` filters the FASTQ reads with the length smaller than the value defined. For help type:

```
./gto_fastq_minimum_read_size -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_minimum_read_size` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_minimum_read_size [options] [--] args]
or: ./gto_fastq_minimum_read_size [options]

It filters the FASTQ reads with the length smaller than the value defined.
If present, it will erase the second header (after +).

-h, --help          show this help message and exit

Basic options
-s, --size=<int>    The minimum read length
< input.fastq      Input FASTQ file format (stdin)
> output.fastq      Output FASTQ file format (stdout)

Example: ./gto_fastq_minimum_read_size -s <size> < input.fastq > output.fastq

Console output example:
<FASTQ non-filtered reads>
Total reads      : value
```

Filtered reads	value
----------------	-------

An example on such an input file is:

[illegible]

Output

The output of the `gto_fastq_minimum_read_size` program is a set of all the filtered FASTQ reads, followed by the execution report. The execution report only appears in the console.

Using the size value as 65, an example for this input, is:

```
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTCCAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAATCGATGATAATACGCGTCGTTTTATCAT
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII6IBIIIIIIIIIIIIIIIIIIIIIGII>IIIII-I)8I
Total reads      : 2
Filtered reads   : 1
```

3.9 Program gto_fastq_rand_extra_chars

The `gto_fastq_rand_extra_chars` substitutes in the FASTQ files, the DNA sequence the outside ACGT chars by random ACGT symbols.

For help type:

```
./gto_fastq_rand_extra_chars -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `goto_fastq_rand_extra_chars` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_rand_extra_chars [options] [--] args]
      or: ./gto_fastq_rand_extra_chars [options]
```

It substitutes in the FASTQ files, the DNA sequence the outside ACGT chars by random ACGT symbols.

```
-h, --help          show this help message and exit
```

```

Basic options
  < input.fastq          Input FASTQ file format (stdin)
  > output.fastq         Output FASTQ file format (stdout)

Example: ./gto_fastq_rand_extra_chars < input.fastq > output.fastq

```

An example on such an input file is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTTAAGGGTTNTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I

```

Output

The output of the `gto_fastq_rand_extra_chars` program is a FASTQ file.

An example, for the input, is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GTGTGATGGCCGCTGCCGATGGCGCATAATCCCACCAACATACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGGGATACGACGATTGTATTTTAAGAATCTGCAGCAGAAGTCGATGATAATACGCGCCGTTTATCAG
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I

```

3.10 Program `gto_fastq_from_seq`

The `gto_fastq_from_seq` converts a genomic sequence to pseudo FASTQ file format.

For help type:

```
./gto_fastq_from_seq -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_from_seq` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence group file.

The attribution is given according to:

```

Usage: ./gto_fastq_from_seq [options] [--] args]
       or: ./gto_fastq_from_seq [options]

It converts a genomic sequence to pseudo FASTQ file format.

    -h, --help                show this help message and exit

Basic options
    < input.seq                Input sequence file (stdin)
    > output.fastq             Output FASTQ file format (stdout)

Optional options
    -n, --name=<str>          The read's header
    -l, --lineSize=<int>      The maximum of chars for line

Example: ./gto_fastq_from_seq -l <lineSize> -n <name> < input.seq > output.fastq

```

An example on such an input file is:

```

ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
CTGCTGCTCCTCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCAGGCCAGTGCCG
GGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAAACCTCACCCATGAATGCTCACGCAAGTT
TAATTACAGACCTGAA

```

Output

The output of the `gto_fastq_from_seq` program is a pseudo FASTQ file.

An example, using the size line as 80 and the read's header as "SeqToFastq", for the input, is:

```

@SeqToFastq1
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq2
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq3
GTGGTTTGAGTGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq4
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq5

```

```

TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq6
CTGCTGCTCTCCGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq7
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCCAGGCCAGTGCCG
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq8
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq9
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAACCTCACCCATGAATGCTCACGCAAGTT
+
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
@SeqToFastq10
TAATTACAGACCTGAA
+
FFFFFFFFFFFFFFFFFFFF

```

3.11 Program gto_fastq_mutate

The `gto_fastq_mutate` creates a synthetic mutation of a FASTQ file given specific rates of mutations, deletions and additions. All these parameters are defined by the user, and they are optional.

For help type:

```
./gto_fastq_mutate -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_mutate` program needs two streams for the computation, namely the input and output standard. However, optional settings can be supplied too, such as the starting point to the random generator, and the edition, deletion and insertion rates. Also, the user can choose to use the ACGTN alphabet in the synthetic mutation. The input stream is a FASTQ File.

The attribution is given according to:

```

Usage: ./gto_fastq_mutate [options] [--] args]
      or: ./gto_fastq_mutate [options]

Creates a synthetic mutation of a FASTQ file given specific rates of mutations,
deletions and additions

      -h, --help                show this help message and exit

```



```

Basic options
  < input.fasta          Input FASTQ file format (stdin)
  > output.fasta         Output FASTQ file format (stdout)

Optional
  -s, --seed=<int>       Starting point to the random generator
  -m, --mutation-rate=<dbl> Defines the mutation rate (default 0.0)
  -d, --deletion-rate=<dbl> Defines the deletion rate (default 0.0)
  -i, --insertion-rate=<dbl> Defines the insertion rate (default 0.0)
  -a, --ACGTN-alphabet   When active, the application uses the ACGTN alphabet

Example: ./gto_fastq_mutate -s <seed> -m <mutation rate> -d <deletion rate> -i
<insertion rate> -a < input.fastq > output.fastq

```

An example on such an input file is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCGCTGCCGATGGCGTCAAAATCCCACCAAGTTACCCTTAACCACTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII9IG9ICIIIIIIIIIIIIIIIIIIIIIDIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII6IBIIIIIIIIIIIIIIIIIIIIIIIGII>IIIII-I)8I

```

Output

The output of the `gto_fastq_mutate` program is a FASTQ file with the synthetic mutation of input file. Using the seed value as 1 and the mutation rate as 0.5, an example for this input, is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGACTTTGAGGTGTGGCGATAGACTGAAACACTTCAGGGTAAATCACTCGCAAAAGTGCTATGGTTATGG
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII9IG9ICIIIIIIIIIIIIIIIIIIIIIDIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGAGCCTTTACCGTAGGGGTGTAAGATTTTATACAAAAAGTCCAGGTCAAGAGGAATCGGACAACCGA
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII6IBIIIIIIIIIIIIIIIIIIIIIIIGII>IIIII-I)8I

```

3.12 Program `gto_fastq_split`

The `gto_fastq_split` splits Paired End files according to the direction of the strand ('/1' or '/2'). It writes by default singleton reads as forward stands.

For help type:

```
./gto_fastq_split -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_split` program needs a stream for the computation, namely the input standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_split [options] [--] args]
       or: ./gto_fastq_split [options]

It writes by default singleton reads as forward stands.

    -h, --help                show this help message and exit

Basic options
    -f, --forward=<str>      Output forward file
    -r, --reverse=<str>      Output reverse file
    < input.fastq            Input FASTQ file format (stdin)
    > output                  Output read information (stdout)

Example: ./gto_fastq_split -t <output_forward.fastq> -r <output_reverse.fastq> < input.fastq > output

Output example :
Total reads      : value
Singleton reads  : value
Forward reads    : value
Reverse reads    : value
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72 1
GNNTGATGGCCGCTGCCGATGGCGNANAAATCCCACCAANATACCCCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72 2
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTTATCAN
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-1)8I
```

Output

The output of the `gto_fastq_split` program is a set of information related to the file read.

An example, for the input, is:

```
Total reads      : 2
Singleton reads  : 0
Forward reads    : 65536
Reverse reads    : 1
```

Also, this program generates two FASTQ files, with the reverse and forward reads.

An example of the forward reads, for the input, is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72 1
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
```

3.13 Program gto_fastq_pack

The `gto_fastq_pack` packages each FASTQ read in a single line. It can show the read score first or the dna sequence, depending on the execution mode.

For help type:

```
./gto_fastq_pack -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_pack` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_pack [options] [--] args]
or: ./gto_fastq_pack [options]

It packages each FASTQ read in a single line.

    -h, --help                show this help message and exit

Basic options
    < input.fastq            Input FASTQ file format (stdin)
    > output.fastq           Output FASTQ file format (stdout)

Optional
    -s, --scores              When active, the application show the scores first

Example: ./gto_fastq_pack -s < input.fastq > output.fastq
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
NTTCAGGGATACGACGNTTGTATTTTAAAGATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-1)8I
```

Output

The output of the `gto_fastq_pack` program is a packaged FASTQ file.

An example, for the input, is:

```
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTTAAGGGTTNTCAAATAGA
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72+ 0
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72+ 1
```

Another example for the same input, but using the scores first (flag "s"), is:

```
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTTAAGGGTTNTCAAATAGA
SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72+ 0
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72+ 1
```

3.14 Program `gto_fastq_unpack`

The `gto_fastq_unpack` unpacks the FASTQ reads packaged using the `gto_fastq_pack` tool.

For help type:

```
./gto_fastq_unpack -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_unpack` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_unpack [options] [--] args
or: ./gto_fastq_unpack [options]
```

It unpacks the FASTQ reads packaged using the `gto_fastq_pack` tool.

```
-h, --help          show this help message and exit
```

Basic options

```
< input.fastq      Input FASTQ file format (stdin)
> output.fastq     Output FASTQ file format (stdout)
```

Optional

```
-s, --scores        When active, the application show the scores first
```

```
Example: ./gto_fastq_unpack -s < input.fastq > output.fastq
```

An example on such an input file is:

```
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTAAGGGTTNTCAAATAGA
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72+ 0
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72+ 1
```

Output

The output of the `gto_fastq_unpack` program is a packaged FASTQ file.

An example, for the input, is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTAAGGGTTNTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
```

3.15 Program `gto_fastq_quality_score_info`

The `gto_fastq_quality_score_info` analyses the quality-scores of a FASTQ file.

For help type:

```
./gto_fastq_quality_score_info -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_quality_score_info` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_quality_score_info [options] [--] args]
or: ./gto_fastq_quality_score_info [options]
```

It analyses the quality-scores of a FASTQ file.

```
-h, --help          show this help message and exit
```

Basic options

```

< input.fastq      Input FASTQ file format (stdin)
> output           Output read information (stdout)

Optional
-m, --max=<int>    The lenght of the maximum window

Example: ./gto_fastq_quality_score_info -m <max> < input.fastq > output

Output example :
Total reads      : value
Max read length : value
Min read length : value
Min QS value     : value
Max QS value     : value
QS range        : value

```

An example on such an input file is:

```

@111 071112_SLXA-EAS1_s_7:5:1:817:345 length=72 1
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCAACCAANATACCCTTAACAACCTTAAGGGTTNTCAAATAGA
+111
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@222 071112_SLXA-EAS1_s_7:5:1:801:338 length=72 2
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTTATCAN
+222
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I

```

Output

The output of the `gto_fastq_quality_score_info` program is a set of information related to the file read. Using the max window value as 30, an example for this input, is:

```

Total reads      : 2
Max read length : 72
Min read length : 72
Min QS value     : 41
Max QS value     : 73
QS range        : 33
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
--+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73

```

3.16 Program `gto_fastq_quality_score_max`

The `gto_fastq_quality_score_max` analyses the maximal quality-scores of a FASTQ file. For help type:

```
./gto_fastq_quality_score_max -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_quality_score_max` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_quality_score_max [options] [--] args]
       or: ./gto_fastq_quality_score_max [options]

It analyses the maximal quality-scores of a FASTQ file.

    -h, --help                show this help message and exit

Basic options
    < input.fastq             Input FASTQ file format (stdin)
    > output                   Output read information (stdout)

Optional
    -m, --max=<int>          The maximum window length (default 40)

Example: ./gto_fastq_quality_score_max -m <max> < input.fastq > output
```

An example on such an input file is:

```
@111 071112_SLXA-EAS1_s_7:5:1:817:345 length=72 1
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIII9IG9ICIIIIIIIIIIABAAABCIIIIFFGIIAACBBIIII6IBIIIIII>IIIIII/
@222 071112_SLXA-EAS1_s_7:5:1:801:338 length=72 2
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTATCAN
+
IIIIIIIIABAAABCIIIIFFGIIAACBBIIII6IBIIIIIIIIIIIIIIIIIIIIIGII>IIIII-I)8I
```

Output

The output of the `gto_fastq_quality_score_max` program is a set of information related to the file read, considering the maximal quality scores.

Using the max window value as 30, an example for this input, is:

```
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
--+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
73 73 73 73 73 73 73 73 73 73 73 73 66 73 73 73 73 73 73 73 73 73 73 73 73 73 73 73
```

3.17 Program `gto_fastq_quality_score_min`

The `gto_fastq_quality_score_min` analyses the minimal quality-scores of a FASTQ file.

For help type:

```
./gto_fastq_quality_score_min -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_quality_score_min` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_quality_score_min [options] [--] args]
       or: ./gto_fastq_quality_score_min [options]

It analyses the minimal quality-scores of a FASTQ file.

-h, --help                show this help message and exit

Basic options
  < input.fastq           Input FASTQ file format (stdin)
  > output                 Output read information (stdout)

Optional
  -m, --max=<int>         The maximum window length (default 40)

Example: ./gto_fastq_quality_score_min -m <max> < input.fastq > output
```

An example on such an input file is:

```
@111 071112_SLXA-EAS1_s_7:5:1:817:345 length=72 1
GNNTGATGGCCGCTGCCGATGGCGNANAATCCCACCAANATACCCCTTAACAACCTTAAGGGTTNTCAAATAGA
+
IIIIIIIIII9IG9ICIIIIIIIIIIABAAABCIIIIFFGIIAACBBIIII6IBIIIIII>IIIIII/
@222 071112_SLXA-EAS1_s_7:5:1:801:338 length=72 2
NTTCAGGGATACGACGNTTGTATTTTAAGAATCTGNAGCAGAAGTCGATGATAATACGCGNCGTTTTATCAN
+
IIIIIIIIABAAABCIIIIFFGIIAACBBIIII6IBIIIIIIIIIIIIIIIIIIIIIGII>IIIII-I)8I
```

Output

The output of the `gto_fastq_quality_score_min` program is a set of information related to the file read, considering the minimum quality scores.

Using the max window value as 30, an example for this input, is:

```
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
--+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
73 73 73 73 73 73 73 65 66 65 65 65 57 67 71 57 73 67 70 70 71 73 73 65 65 67 66 66 73 65
```


3.18 Program gto_fastq_cut

The `gto_fastq_cut` cuts read sequences in a FASTQ file. It requires that the initial and end positions for the cut.

For help type:

```
./gto_fastq_cut -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_cut` program needs program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_cut [options] [--] args]
      or: ./gto_fastq_cut [options]

It cuts read sequences in a FASTQ file.

      -h, --help                show this help message and exit

Basic options
      -i, --initial=<int>      Starting position to the cut
      -e, --end=<int>          Ending position to the cut
      < input.fastq            Input FASTQ file format (stdin)
      > output.fastq           Output FASTQ file format (stdout)

Example: ./gto_fastq_cut -i <initial> -e <end> < input.fastq > output.fastq
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTCAAGGATACGACGTTTGTATTTTAAAGATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-1)8I
```

Output

The output of the `gto_fastq_cut` program is a FASTQ file cut.

Using the initial value as 10 and the end value as 30, an example for this input, is:

```

@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
CGCTGCCGATGGCGTCAAATC
+
IIIIIIIIIIIIIIIIIIII
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
ACGACGTTTGTATTTAAGAA
+
IIIIIIIIIIIIIIIIIIII

```

3.19 Program gto_fastq_minimum_local_quality_score_forward

The `gto_fastq_minimum_local_quality_score_forward` filters the reads considering the quality score average of a defined window size of bases.

For help type:

```
./gto_fastq_minimum_local_quality_score_forward -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_minimum_local_quality_score_forward` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```

Usage: ./gto_fastq_minimum_local_quality_score_forward [options] [--] args]
or: ./gto_fastq_minimum_local_quality_score_forward [options]

```

It filters the reads considering the quality score average of a defined window size of bases.

```
-h, --help          show this help message and exit
```

Basic options

```

-k, --windowsize=<int>    The window size of bases (default 5)
-w, --minavg=<int>        The minimum average of quality score (default 25)
-m, --minqs=<int>         The minimum value of the quality score (default 33)
< input.fastq             Input FASTQ file format (stdin)
> output.fastq            Output FASTQ file format (stdout)

```

```

Example: ./gto_fastq_minimum_local_quality_score_forward -k <windowsize> -w <minavg>
-m <minqs> < input.fastq > output.fastq

```

Console output example:

```

Minimum QS      : value
<FASTQ output>
Total reads     : value
Trimmed reads   : value

```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTCAAGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII-I)8I
```

Output

The output of the `gto_fastq_minimum_local_quality_score_forward` program is a FASTQ file with the reads filtered following a quality score average of a defined window of bases. The execution report only appears in the console.

An example using the default values, for the input, is:

```
Minimum QS      : 33
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCCTTAACAACCTTAAGGGTTTTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTCAAGGATACGACGTTTGTATTTTAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTT
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIII
Total reads     : 2
Trimmed reads   : 1
```

3.20 Program `gto_fastq_minimum_local_quality_score_reverse`

The `gto_fastq_minimum_local_quality_score_reverse` filters the reverse reads, considering the quality score average of a defined window size of bases.

For help type:

```
./gto_fastq_minimum_local_quality_score_reverse -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fastq_minimum_local_quality_score_reverse` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
Usage: ./gto_fastq_minimum_local_quality_score_reverse [options] [--] args]
       or: ./gto_fastq_minimum_local_quality_score_reverse [options]
```

It filters the reverse reads, considering the quality score average of a defined window size of bases.

```
-h, --help                show this help message and exit
```

Basic options

```
-k, --windowsize=<int>    The window size of bases (default 5)
-w, --minavg=<int>        The minimum average of quality score (default 25)
-m, --minqs=<int>         The minimum value of the quality score (default 33)
< input.fastq             Input FASTQ file format (stdin)
> output.fastq            Output FASTQ file format (stdout)
```

```
Example: ./gto_fastq_minimum_local_quality_score_reverse -k <windowsize> -w <minavg>
-m <minqs> < input.fastq > output.fastq
```

Console output example:

```
Minimum QS      : value
<FASTQ output>
Total reads     : value
Trimmed reads   : value
```

An example on such an input file is:

```
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
@SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
GTTTCAGGATACGACGTTTGTATTTTAAAGAATCTGAAGCAGAAGTCGATGATAATACGCGTCGTTTATCAT
+SRR001666.2 071112_SLXA-EAS1_s_7:5:1:801:338 length=72
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIII-I)8I
```

Output

The output of the `gto_fastq_minimum_local_quality_score_reverse` program is a FASTQ file with the reads filtered following a quality score average of a defined window of bases. The execution report only appears in the console.

An example using the default values, for the input, is:

```
Minimum QS: 33
@SRR001666.1 071112_SLXA-EAS1_s_7:5:1:817:345 length=72
GGGTGATGGCCGCTGCCGATGGCGTCAAATCCCACCAAGTTACCCTTAACAACCTTAAGGGTTTTCAAATAGA
+
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII>IIIIII/
Total reads      : 2
Trimmed reads    : 1
```

3.21 Program `gto_fastq_clust_reads`

The `gto_fastq_clust_reads` agroups reads and creates an index file. It cluster reads in terms of Seq k-mer Lexicographical order.

For help type:

```
./gto_fastq_clust_reads -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fastq_clust_reads` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTQ file.

The attribution is given according to:

```
TODO
```

An example on such an input file is:

```
TO DO
```

Output

The output of the `gto_fastq_clust_reads` program is ...

An example, for the input, is:

```
TO DO
```

Chapter 4

FASTA tools

Current available FASTA tools, for analysis and manipulation, are:

1. `gto_fasta_to_seq`: it converts a FASTA or Multi-FASTA file format to a seq.
2. `gto_fasta_from_seq`: it converts a genomic sequence to pseudo FASTA file format.
3. `gto_fasta_extract`: it extracts sequences from a FASTA file, which the range is defined by the user in the parameters.
4. `gto_fasta_extract_by_read`: it extracts sequences from each read in a Multi-FASTA file (splited by `\n`), which the range is defined by the user in the parameters.
5. `gto_fasta_info`: it shows the readed information of a FASTA or Multi-FASTA file format.
6. `gto_fasta_mutate`: it reates a synthetic mutation of a fasta file given specific rates of editions, deletions and additions.
7. `gto_fasta_rand_extra_chars`: it substitues in the DNA sequence the outside ACGT chars by random ACGT symbols.
8. `gto_fasta_extract_read_by_pattern`: it extracts reads from a Multi-FASTA file format given a pattern in the header.
9. `gto_fasta_find_n_pos`: it reports the "N" regions in a sequence or FASTA (seq) file.
10. `gto_fasta_split_reads`: it splits a Multi-FASTA file to multiple FASTA files.
11. `gto_fasta_rename_human_headers`: it changes the headers of FASTA or Multi-FASTA file to simple chrX by order, where X is the number.
12. `gto_fasta_extract_pattern_coords`: it extracts the header and coordinates from a Multi-FASTA file format given a pattern/motif in the sequence.

4.1 Program gto_fasta_to_seq

The `gto_fasta_to_seq` converts a FASTA or Multi-FASTA file format to a sequence.

For help type:

```
./gto_fasta_to_seq -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_to_seq` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTA or Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_to_seq [options] [--] args]
      or: ./gto_fasta_to_seq [options]

It converts a FASTA or Multi-FASTA file format to a seq.

      -h, --help                show this help message and exit

Basic options
      < input.fasta             Input FASTA or Multi-FASTA file format (stdin)
      > output.seq              Output sequence file (stdout)

Example: ./gto_fasta_to_seq < input.fasta > output.seq
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGAACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCCGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCACCGCTGCCCTGCCCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTG
GTGGTTTGAGTGGAACCTCCAGGCCAGTGCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_to_seq` program is a group sequence.

An example, for the input, is:

```

ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
CTGCTGCTCCTCGGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAAACCTCACCCATGAATGCTCACGCAAGTT
TAATTACAGACCTGAA

```

4.2 Program gto_fasta_from_seq

The `gto_fasta_from_seq` converts a genomic sequence to pseudo FASTA file format.

For help type:

```
./gto_fasta_from_seq -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_from_seq` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence group file.

The attribution is given according to:

```

Usage: ./gto_fasta_from_seq [options] [--] args]
       or: ./gto_fasta_from_seq [options]

It converts a genomic sequence to pseudo FASTA file format.

    -h, --help                show this help message and exit

Basic options
    < input.seq              Input sequence file (stdin)
    > output.fasta           Output FASTA file format (stdout)

Optional options
    -n, --name=<str>         The read's header
    -l, --lineSize=<int>     The maximum of chars for line

Example: ./gto_fasta_from_seq -l <lineSize> -n <name> < input.seq > output.fasta

```

An example on such an input file is:

```

ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC

```



```
TAAAACCTCACCCTGAATGCTCAGCAAGTTTAAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAAACCTCACCCTGAATGCTCAGCAAGTT
TAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_from_seq` program is a pseudo FASTA file.

An example, using the size line as 80 and the read's header as "SeqToFasta", for the input, is:

```
>SeqToFasta
ACAAGACGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC
TAAAACCTCACCCTGAATGCTCAGCAAGTTTAAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAAACCTCACCCTGAATGCTCAGCAAGTT
TAATTACAGACCTGAA
```

4.3 Program `gto_fasta_extract`

The `gto_fasta_extract` extracts sequences from a FASTA file, which the range is defined by the user in the parameters.

For help type:

```
./gto_fasta_extract -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_extract` program needs two parameters, which defines the begin and the end of the extraction, and two streams for the computation, namely the input and output standard. The input stream is a FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_extract [options] [--] args]
       or: ./gto_fasta_extract [options]

It extracts sequences from a FASTA file.

-h, --help          show this help message and exit
```

```

Basic options
-i, --init=<int>      The first position to start the extraction (default 0)
-e, --end=<int>      The last extract position (default 100)
< input.fasta        Input FASTA or Multi-FASTA file format (stdin)
> output.seq          Output sequence file (stdout)

```

```

Example: ./gto_fasta_extract -i <init> -e <end> < input.fasta > output.seq

```

An example on such an input file is:

```

>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGTCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA

```

Output

The output of the `gto_fasta_extract` program is a group sequence.

An example, using the value 0 as extraction starting point and the 50 as the end, for the provided input, is:

```

ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGG

```

4.4 Program `gto_fasta_extract_by_read`

The `gto_fasta_extract_by_read` extracts sequences from a FASTA or Multi-FASTA file, which the range is defined by the user in the parameters.

For help type:

```

./gto_fasta_extract_by_read -h

```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fasta_extract_by_read` program needs two paramenters, which defines the begin and the end of the extraction, and two streams for the computation, namely the input and output standard. The input stream is a FASTA or Multi-FASTA file.

The attribution is given according to:

```

Usage: ./gto_fasta_extract_by_read [options] [--] args]
or: ./gto_fasta_extract_by_read [options]

```

```

It extracts sequences from each read in a Multi-FASTA file (splited by \n)

```

```
-h, --help          show this help message and exit
```

Basic options

```
-i, --init=<int>    The first position to start the extraction (default 0)
-e, --end=<int>     The last extract position (default 100)
< input.fasta       Input FASTA or Multi-FASTA file format (stdin)
> output.fasta      Output FASTA or Multi-FASTA file format (stdout)
```

```
Example: ./gto_fasta_extract_by_read -i <init> -e <end> < input.fasta > output.fasta
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCCGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTG
GTGGTTTGAGTGGACCTCCAGGCCAGTGCCGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_extract_by_read` program is FASTA or Multi-FASTA file with the extracted sequences.

An example, using the value 0 as extraction starting point and the 50 as the end, for the provided input, is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGG
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCCGGCCTCCTGCTGCTGCTCTCCGGGGCC
```

4.5 Program `gto_fasta_info`

The `gto_fasta_info` shows the readed information of a FASTA or Multi-FASTA file format. For help type:

```
./gto_fasta_info -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_info` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTA or Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_info [options] [--] args]
      or: ./gto_fasta_info [options]

It shows read information of a FASTA or Multi-FASTA file format.

      -h, --help                show this help message and exit

Basic options
      < input.fasta             Input FASTA or Multi-FASTA file format (stdin)
      > output                  Output read information (stdout)

Example: ./gto_fasta_info < input.fasta > output

Output example :
Number of reads      : value
Number of bases      : value
MIN of bases in read : value
MAX of bases in read : value
AVG of bases in read : value
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTG
GTGGTTTGAGTGGACCTCCCAGGCCAGTGCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_info` program is a set of information related to the file read.

An example, for the input, is:

```
Number of reads      : 2
Number of bases      : 736
MIN of bases in read : 368
```

```
MAX of bases in read : 368
AVG of bases in read : 368.0000
```

4.6 Program `gto_fasta_mutate`

The `gto_fasta_mutate` creates a synthetic mutation of a FASTA file given specific rates of editions, deletions and additions. All these parameters are defined by the user, and their are optional.

For help type:

```
./gto_fasta_mutate -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_mutate` program needs two streams for the computation, namely the input and output standard. However, optional settings can be supplied too, such as the starting point to the random generator, and the edition, deletion and insertion rates. Also, the user can choose to use the ACGTN alphabet in the synthetic mutation. The input stream is a FASTA or Multi-FASTA File.

The attribution is given according to:

```
Usage: ./gto_fasta_mutate [options] [--] args]
or: ./gto_fasta_mutate [options]

Creates a synthetic mutation of a fasta file given specific rates of editions,
deletions and additions

    -h, --help                show this help message and exit

Basic options
    < input.fasta             Input FASTA or Multi-FASTA file format (stdin)
    > output.fasta            Output FASTA or Multi-FASTA file format (stdout)

Optional
    -s, --seed=<int>          Starting point to the random generator
    -e, --edit-rate=<dbl>     Defines the edition rate (default 0.0)
    -d, --deletion-rate=<dbl> Defines the deletion rate (default 0.0)
    -i, --insertion-rate=<dbl> Defines the insertion rate (default 0.0)
    -a, --ACGTN-alphabet      When active, the application uses the ACGTN alphabet

Example: ./gto_fasta_mutate -s <seed> -e <edit rate> -d <deletion rate> -i
<insertion rate> -a < input.fasta > output.fasta
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAAGTGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
```

```
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCCGGCCTCCTGTGTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCCCTGGAGGGT
GGCCCCACCGCGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCTCGCTTG
GTGGTTTGAGTGGACCTCCCAGGCCAGTGCCGGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_mutate` program is a FASTA or Multi-FASTA file with the synthetic mutation of input file.

Using the seed value as 1 and the edition rate as 0.5, an example for this input, is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACGCAACGNATTCTGTGATCATANTGTNCCGCNCCCCNGCGACGGGNGCTCNCNNGCACACATNGTACCATTGTCCAC
NCTTNCANGTNANCGCTAGCAGGCTACNGTTTNTCCTCNCCATANNCCAANCNGGCGTNNNTACTGTCACGTGCAGGCA
TNGGTGCGCNGGNNCCTCCGGNAACGGCACCGGAGACGAAGCTCGGNGGNTATACAGGTGTCANGAAACATCCCCGCGNC
GNGTGNCNNGAANCCANAGAGTATCTCACTCACAAACCTGCGTGACNTCTAGAGNANGACCTTACNCACNTCCCNNT
NNGTACCACACCAATGAACGCTGCAGAAAGTCTGTTTNNAGGNGNGCA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ATTTGAAGGCAANCGGNCCAGNAATNCGGNGGGTGCGNGCTCNTGTNGGCTACGGNCATCGCGGCCCTGCTNTANTAAGCN
TGAACCACCGNTCGNNGCACTTAGCAATNGCGNAANCCGTCGGGCACGGCGGAGACNAANCCGCTANTNNTTTCCCGCTNA
ATGGNTGTACAAGACCNACTANACCANCCCTCCGTCACCACACTGGAGCGCANGATGGNNGCGCTGNCTAGNAGNCNNTGAG
GCGCTCCNTCCTANAAANCCGTGGNCGAGCNCCCTATGGNAGNGTGGGGGTTTTACCGGAAGACCNCTCGNGCCCTATGGG
AGCAATCANAANCTAGAAAGCTTACNGATGGTGANGAANTAGACTANG
```

4.7 Program `gto_fasta_rand_extra_chars`

The `gto_fasta_rand_extra_chars` substitutes in the DNA sequence the outside ACGT chars by random ACGT symbols. It works both in FASTA and Multi-FASTA file formats.

For help type:

```
./gto_fasta_rand_extra_chars -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_rand_extra_chars` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTA or Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_rand_extra_chars [options] [--] args]
or: ./gto_fasta_rand_extra_chars [options]
```

It substitutes in the DNA sequence the outside ACGT chars by random ACGT symbols.

It works both in FASTA and Multi-FASTA file formats

```
-h, --help          show this help message and exit
```

Basic options

```
< input.fasta      Input FASTA or Multi-FASTA file format (stdin)
> output.fasta     Output FASTA or Multi-FASTA file format (stdout)
```

Example: `./gto_fasta_rand_extra_chars < input.fasta > output.fasta`

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ANAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGNCCCTGGAGGGTCCNCCGCTGCCCTGCTGCCATTGNCNCC
NGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCNGGAAGCGGCAGGAA
GNGGTTTGAAGTGGACCTCCNGGCCCTCATAGGAGAGGAAGCNGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGNC
GCGAATCCGNGCGCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCACCCCCCENN
TAAANNNTACCCATGAATGCTCAGCAANTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
GCGAATCCGNGCGCGGGACAGAATCTCCTTCTCCACCCCCCENNNTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACC
NGCCCCACCTAAGGAAAAGCAGCCTCCAGGAACTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCNGGAAGCGG
ANAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGNCCCTGGCNCAGGGTCCNCCGCTGCCCTGCTGCCATTGN
GAGGAAGCNGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGNCNGGTTTGAGTGGACCTCCNGGCCCTCATAGGA
TCACGCAANTTTAATTACAGACCTGAATAAANNNTACCCATGAATGC
```

Output

The output of the `gto_fasta_rand_extra_chars` program is a FASTA or Multi-FASTA file.

An example, for the input, is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ATAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCCCCGCTGCCCTGCTGCCATTGTCCCC
TGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCGGGAAGCGGCAGGAA
GAGGTTTGAAGTGGACCTCCCGGCCCTCATAGGAGAGGAAGCCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGTC
GCGAATCCGGGCGCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCACCCCCCTTG
TAAAAGATCACCCATGAATGCTCAGCAAAATTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
GCGAATCCGTGCGCGGGACAGAATCTCCTTCTCCACCCCCCATCTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACC
GGCCCCACCTAAGGAAAAGCAGCCTCCAGGAACTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCGGGAAGCGG
AGAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGTCCCTGGCTCCAGGGTCCCTCGCTGCCCTGCTGCCATTGC
GAGGAAGCGGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCGCGGTTTGAGTGGACCTCCTGGCCCTCATAGGA
TCACGCAACTTTAATTACAGACCTGAATAAATGTCACCCATGAATGC
```

4.8 Program `gto_fasta_extract_read_by_pattern`

The `gto_fasta_extract_read_by_pattern` extracts reads from a Multi-FASTA file format given a pattern in the header. Also, this pattern is case insensitive.

For help type:

```
./gto_fasta_extract_read_by_pattern -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_extract_read_by_pattern` program needs two streams for the computation, namely the input and output standard. The input stream is a Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_extract_read_by_pattern [options] [--] args]
       or: ./gto_fasta_extract_read_by_pattern [options]

It extracts reads from a Multi-FASTA file format given a pattern in the header (ID).

-h, --help                show this help message and exit

Basic options
-p, --pattern=<str>       Pattern to search in the file header
< input.fasta             Input Multi-FASTA file format (stdin)
> output.fasta            Output Multi-FASTA file format (stdout)

Example: ./gto_fasta_extract_read_by_pattern -p <pattern> < input.fasta > output.fasta
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGT
GGCCCCACCGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTG
GTGGTTTGAGTGGACCTCCAGGCCAGTGCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_extract_read_by_pattern` program is a Multi-FASTA file.

An example, using the pattern "264", for the provided input, is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```


4.9 Program gto_fasta_find_n_pos

The `gto_fasta_find_n_pos` reports the "N" regions in a sequence or FASTA (seq) file.

For help type:

```
./gto_fasta_find_n_pos -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_find_n_pos` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTA file or a sequence.

The attribution is given according to:

```
Usage: ./gto_fasta_find_n_pos [options] [--] args]
      or: ./gto_fasta_find_n_pos [options]

It reports the 'N' regions in a sequence or FASTA (seq) file.

      -h, --help                show this help message and exit

Basic options
      < input.fasta             Input FASTQ file format or a sequence (stdin)
      > output                  Output report of 'N' positions (stdout)

Example: ./gto_fasta_find_n_pos < input.fasta > output

The output obeys the following structure:
Begin      End Positions
<value> <value> <value>
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
NCNNNACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GNCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTNGTTTGAGTGGACCTCCGGGCCCCCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACNTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAN
```

Output

The output of the `gto_fasta_find_n_pos` program is a structured report of "N" appearances in the sequence or FASTA file. The first column is the first position of the "N" appearance, the second is the position of the last "N" in the interval found, and the last column is the count of "N" in this interval.

An example, for the input, is:

```

1    1    1
3    5    3
82   82   1
163  163  1
289  289  1

```

4.10 Program gto_fasta_split_reads

The `gto_fasta_split_reads` splits a Multi-FASTA file to multiple FASTA files.

For help type:

```
./gto_fasta_split_reads -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_split_reads` program needs one stream for the computation, namely the input standard. This input stream is a Multi-FASTA file.

The attribution is given according to:

```

Usage: ./gto_fasta_split_reads [options] [--] args]
       or: ./gto_fasta_split_reads [options]

It splits a Multi-FASTA file to multiple FASTA files.

    -h, --help                show this help message and exit

Basic options
    < input.fasta             Input Multi-FASTA file format (stdin)

Optional options
    -l, --location=<str>     Location to store the files

Example: ./gto_fasta_split_reads < input.fasta

```

An example on such an input file is:

```

>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>AB000263 |acc=AB000263|descr=Homo sapiens mRNA
ACAAGATGCCATTGTCCCCGGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCCTCGCTTG
GTGGTTTGAGTGGACCTCCAGGCCAGTGCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA

```

```
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_split_reads` program is a report summary of the execution, and the files created in the defined location.

An example, for the input, is:

```
1 : Splitting to file:./out1.fasta
2 : Splitting to file:./out2.fasta
```

4.11 Program `gto_fasta_rename_human_headers`

The `gto_fasta_rename_human_headers` changes the headers of FASTA or Multi-FASTA file to simple chrX by order, where X is the number.

For help type:

```
./gto_fasta_rename_human_headers -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_fasta_rename_human_headers` program needs two streams for the computation, namely the input and output standard. The input stream is a FASTA or Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_rename_human_headers [options] [--] args]
or: ./gto_fasta_rename_human_headers [options]

It changes the headers of FASTA or Multi-FASTA file to simple chr$1 by order.

-h, --help          show this help message and exit

Basic options
< input.fasta      Input FASTA or Multi-FASTA file format (stdin)
> output.fasta     Output FASTA or Multi-FASTA file format (stdout)

Example: ./gto_fasta_rename_human_headers < input.fasta > output.fasta
```

An example on such an input file is:

```
> AB000264 | acc = AB000264 | descr = Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

```
> AB000263 | acc = AB000263 | descr = Homo sapiens mRNA
ACAAGATGCCATTGTCCCCGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTG
GTGGTTTGAGTGGACCTCCCAGGCCAGTGCCGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

Output

The output of the `gto_fasta_rename_human_headers` program is a FASTA or Multi-FASTA file. An example, for the input, is:

```
>chr1
ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAAGCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
>chr2
ACAAGATGCCATTGTCCCCGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCCTGGAGGGT
GGCCCCACCGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTG
GTGGTTTGAGTGGACCTCCCAGGCCAGTGCCGGGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAG
GCGCACCCCCCAGCAATCCGCGCGCCGGGACAGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAA
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAA
```

4.12 Program `gto_fasta_extract_pattern_coords`

The `gto_fasta_extract_pattern_coords` extracts the header and coordinates from a Multi-FASTA file format given a pattern/motif in the sequence.

For help type:

```
./gto_fasta_extract_pattern_coords -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_fasta_extract_pattern_coords` program needs two streams for the computation, namely the input and output standard. The input stream is a Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_fasta_extract_pattern_coords [options] [--] args]
or: ./gto_fasta_extract_pattern_coords [options]
```

It extracts the header and coordinates from a Multi-FASTA file format given a pattern/motif in the sequence.

```
-h, --help          show this help message and exit
```

Basic options

```
-p, --pattern=<str>   Pattern to search in the file header  
< input.fasta         Input Multi-FASTA file format (stdin)  
> output.coords       Output coordinates (stdout)
```

```
Example: ./gto_fasta_extract_pattern_coords -p <pattern> < input.fasta > output.coords
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA  
ACAAGACGGCCTCCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC  
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA  
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC  
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCACCCCCCAGC  
TAAACCTCACCCATGAATGCTCGCAACACGCAAGTTTAATTCGCAAGTTAGACCTGAACGGGAGGTGGCCACGCAAGTT
```

Output

The output of the `gto_fasta_extract_pattern_coords` program is a Multi-FASTA file.

An example, for the input, is:

```
177 183 >AB000264 |acc=AB000264|descr=Homo sapiens mRNA
```

Chapter 5

Genomic sequence tools

Current available genomic sequence tools, for analysis and manipulation, are:

1. `gto_genomic_gen_random_dna`: it generates a synthetic DNA.
2. `gto_genomic_rand_seq_extra_chars`: it substitutes in the DNA sequence the outside ACGT chars by random ACGT symbols.
3. `gto_genomic_dna_mutate`: it creates a synthetic mutation of a sequence file given specific rates of mutations, deletions and additions.
4. `gto_genomic_extract`: it extracts sequences from a sequence file, which the range is defined by the user in the parameters.
5. `gto_genomic_period`: it calculates the best order depth of a sequence, using FCMs.

5.1 Program `gto_genomic_gen_random_dna`

The `gto_genomic_gen_random_dna` generates a synthetic DNA.

For help type:

```
./gto_genomic_gen_random_dna -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_genomic_gen_random_dna` program needs one stream for the computation, namely the output standard.

The attribution is given according to:

```
Usage: ./gto_genomic_gen_random_dna [options] [--] args]
or: ./gto_genomic_gen_random_dna [options]
```

It generates a synthetic DNA.

```
-h, --help                show this help message and exit
```

Basic options

```
> output.seq              Output synthetic DNA sequence (stdout)
```

Optional

```
-s, --seed=<int>          Starting point to the random generator (Default 0)
-n, --nSymbols=<int>      Number of symbols generated (Default 100)
-f, --frequency=<str>     The frequency of each base. It should be represented
                           in the following format: <fa,fc,fg,ft>.
```

Example: `./gto_genomic_gen_random_dna > output.seq`

Output

The output of the `gto_genomic_gen_random_dna` program is a sequence group file with the synthetic DNA.

Using the seed value as 1 and the number of symbols as 400, an example of an execution, is:

```
TCTTTACTCGCGCGTTGGAGAAAATACAATAGTGGCGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
TCTTTACTCGCGCGTTGGAGAAAATACAATAGTGGCGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
GACTTCATCGTGGTCTCTGTCTATTATGCGCTCCAAACGCATAACTTTGCGCCAGAAGATAGATAGAATGGTGTAAGAACT
GTAATATATATAATGAACTTCGGCGAGTCTGTGGAGTTTTTGTGTCATTAGAGAGCCAAGAGGTCGGACGTCCTCACGTA
GCCCCGAGACGGGCAGGGCGATGGCGACTGAACGGGCTCCATATCACTTTGAGCTTTTATGCTTTTCGACTCCTCCAGGAGC
TGAACAACCTTGTTCCTCCGGCAAAGCCCCTGCGTCATGGAGCTCACGGTCTACATTGACTGACTAACCGTAAACTGC
```

5.2 Program `gto_genomic_rand_seq_extra_chars`

The `gto_genomic_rand_seq_extra_chars` substitutes in the DNA sequence the outside ACGT chars by random ACGT symbols. It works in sequence file formats.

For help type:

```
./gto_genomic_rand_seq_extra_chars -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_genomic_rand_seq_extra_chars` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence file.

The attribution is given according to:

```
Usage: ./gto_genomic_rand_seq_extra_chars [options] [--] args]
or: ./gto_genomic_rand_seq_extra_chars [options]
```

It substitutes in the DNA sequence the outside ACGT chars by random ACGT symbols.

It works in sequence file formats

```
-h, --help          show this help message and exit
```

Basic options

```
< input.seq        Input sequence file (stdin)
> output.seq       Output sequence file (stdout)
```

Example: `./gto_genomic_rand_seq_extra_chars < input.seq > output.seq`

An example on such an input file is:

```
ANAAGACGNNNTCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
NNCCCCACCTAAGGAAAAGCAGCCTCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAAGTGGACCTCCGGGGCCCCNNNNNGGAGAGGAAGCTCGGGAGNGTNNNGGCCAGGCGGCAGNNNNCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TANNNNCTCACCCATGAATGCTCACGCAAGTTTAAATTACAGACCTGAAACAAGATGCCATTGTCCCCCGGCCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGNNNAAGCAGCCTCTGACTTTCTCGCTTGNNNNTTGAAGTGGACCTCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCTCTGCAAATAAAACCTCACCCATGAATGCTCACGCAAGTT
NNATTACNNNCCTGNN
```

Output

The output of the `gto_genomic_rand_seq_extra_chars` program is a sequence file.

An example, for the input, is:

```
ATAAGACGGCTTCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
CTCCCCACCTAAGGAAAAGCAGCCTCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAAGTGGACCTCCGGGGCCCCGACCGGGAGAGGAAGCTCGGGAGTGTGTTGGCCAGGCGGCAGGAGACCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAATATCTCACCCATGAATGCTCACGCAAGTTTAAATTACAGACCTGAAACAAGATGCCATTGTCCCCCGGCCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCCTGCCCCTGGAGGGTGGCCCCACCGGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGCGGAAGCAGCCTCTGACTTTCTCGCTTGGTTTTTTGAAGTGGACCTCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCTCTGCAAATAAAACCTCACCCATGAATGCTCACGCAAGTT
CGATTACGGCCCTGTC
```

5.3 Program `gto_genomic_dna_mutate`

The `gto_genomic_dna_mutate` creates a synthetic mutation of a sequence file given specific rates of mutations, deletions and additions. All these parameters are defined by the user, and they are optional.

For help type:

```
./gto_genomic_dna_mutate -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_genomic_dna_mutate` program needs two streams for the computation, namely the input and output standard. However, optional settings can be supplied too, such as the starting point to the random generator, and the edition, deletion and insertion rates. Also, the user can choose to use the ACGTN alphabet in the synthetic mutation. The input stream is a sequence File.

The attribution is given according to:

```
Usage: ./gto_genomic_dna_mutate [options] [--] args]
       or: ./gto_genomic_dna_mutate [options]

Creates a synthetic mutation of a sequence file given specific rates of mutations,
deletions and additions

    -h, --help                show this help message and exit

Basic options
    < input.seq              Input sequence file (stdin)
    > output.seq             Output sequence file (stdout)

Optional
    -s, --seed=<int>        Starting point to the random generator
    -m, --mutation-rate=<dbl> Defines the mutation rate (default 0.0)
    -d, --deletion-rate=<dbl> Defines the deletion rate (default 0.0)
    -i, --insertion-rate=<dbl> Defines the insertion rate (default 0.0)
    -a, --ACGTN-alphabet    When active, the application uses the ACGTN alphabet

Example: ./gto_genomic_dna_mutate -s <seed> -m <mutation rate> -d <deletion rate> -i
<insertion rate> -a < input.seq > output.seq
```

An example on such an input file is:

```
TCTTTACTCGCGCGTTGGAGAAATACAATAGTGC GGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
TCTTTACTCGCGCGTTGGAGAAATACAATAGTGC GGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
GACTTCATCGTGGTCTCTGTGCATTATGCGCTCCAACGCATAACTTTGCGCCAGAAGATAGATAGAATGGTGTAAAGAACT
GTAATATATATAATGAACCTTCGGCGAGTCTGTGGAGTTTTTGTGTCATTAGAGAGCCAAGAGGTCGGACGTCCTCACGTA
GCCCCGAGACGGGCAGGGCGATGGCGACTGAACGGGCTCCATATCACTTTGAGCTTTTATGCTTTGACTCCTCCAGGAGC
TGAACAACCTTGTTCCCGGCAAAGCCCACTGCGTCATGGAGCTCACGGTCTACATTGACTGACTAACCGTAAACTGC
```

Output

The output of the `gto_genomic_dna_mutate` program is a sequence file with the synthetic mutation of input file.

Using the seed value as 1 and the mutation rate as 0.5, an example for this input, is:

```
TCACGACTGTGCGGTTGGCACACCAGATAGGTGCTTCTACGTTTTGTATCTAATTTACAATTCTCGCTGGGAGTTCATTC
GCTATTGATGGGACTAGAAACCCATCCGTAGCTTGCCGCCGTTTAAAGAATAAACACTCCACTTGCACCGAGACGTAGCGC
AACCAAGGCTATGTTCTTTGACCTTATGCGGTCCAACGCAGGAGTAGACCCCGTAGTTAGGTACTATCGCAGAATAGGC
TTAAGCAGCCGTGCTGAACGCTGGAGGGTCTGTTTAATTACTGAGTGAATGGAGAGCTAAGAGTTCGGAGCACCGCACGA
GGCTCAAGAGCGGAAGGGCGTCAGCCTGGCGACCACCTGCCTACCGCTCGAGTCTGTCTTCACTACAGTCCGTGGAGGAC
```

```
CCCCAACGACCTAGTATCCTACAAAGCCGCATACGACTTACAGAACAGGCTGTATCGTCAGGAGTGTGTACACGAAGAGT
A
```

5.4 Program `gto_genomic_extract`

The `gto_genomic_extract` extracts sequences from a sequence file, which the range is defined by the user in the parameters.

For help type:

```
./gto_genomic_extract -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_genomic_extract` program needs two parameters, which defines the begin and the end of the extraction, and two streams for the computation, namely the input and output standard. The input stream is a sequence file.

The attribution is given according to:

```
Usage: ./gto_genomic_extract [options] [--] args]
or: ./gto_genomic_extract [options]

It extracts sequences from a sequence file.

-h, --help          show this help message and exit

Basic options
-i, --init=<int>    The first position to start the extraction (default 0)
-e, --end=<int>     The last extract position (default 100)
< input.seq        Input sequence file (stdin)
> output.seq       Output sequence file (stdout)

Example: ./gto_genomic_extract -i <init> -e <end> < input.seq > output.seq
```

An example on such an input file is:

```
TCTTTACTCGCGCGTTGGAGAAAATACAATAGTGCGGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
TCTTTACTCGCGCGTTGGAGAAAATACAATAGTGCGGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
GACTTCATCGTGGTCTCTGTCTATTATGCGCTCCAACGCATAACTTTGCGCCAGAAGATAGATAGAATGGTGTAAAGAACT
GTAATATATATAATGAACTTCGGCGAGTCTGTGGAGTTTTTGTGTCATTAGAGAGCCAAGAGGTCGGACGTCCTCACGTA
GCCCCGAGACGGGCAGGGCGATGGCGACTGAACGGGCTCCATATCACTTTGAGCTTTTATGCTTTTCGACTCCTCCAGGAGC
TGAACAACCTTGTTCCCGGCAAAGCCCCTGCGTCATGGAGCTCACGGTCTACATTCATGACTGACTAACCGTAAACTGC
```

Output

The output of the `gto_genomic_extract` program is a group sequence.

An example, using the value 0 as extraction starting point and the 50 as the end, for the provided input, is:

```
TCTTTACTCGCGCGTTGGAGAAATACAATAGTGCGGCTCTGTCTCCTTAT
```

5.5 Program gto_genomic_period

The `gto_genomic_period` calculates the best order depth of a sequence, using FCMs. It only works "ACGT", while the rest will be discarded.

This application has a dependency to represent the results. It requires the Gnuplot to show the execution result.

For help type:

```
./gto_genomic_period -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_genomic_period` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence file.

The attribution is given according to:

```
Usage: ./gto_genomic_period [options] [--] args]
or: ./gto_genomic_period [options]

It calculates the best order depth of a sequence, using FCMs. It only works "ACGT",
while the rest will be discarded.

    -h, --help            show this help message and exit

Basic options
    < input.seq           Input sequence file format (stdin)
    > output              Output is given by log2(4)*K(x)/|x| (stdout)

Example: ./gto_genomic_period < input.seq > output
```

An example on such an input file is:

```
TCTTTACTCGCGCGTTGGAGAAATACAATAGTGCGGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
TCTTTACTCGCGCGTTGGAGAAATACAATAGTGCGGCTCTGTCTCCTTATGAAGTCAACAATTTGCTGGGACTTGCGGC
GACTTCATCGTGGTCTCTGTCTCATTATGCGCTCCAAACGCATAACTTTGCGCCAGAAGATAGATAGAATGGTGTAAGAACT
GTAATATATATAATGAACTTCGGCGAGTCTGTGGAGTTTTTGTGTCATTAGAGAGCCAAGAGGTCGGACGTCCTCACGTA
GCCCCGAGACGGGCAGGGCGATGGCGACTGAACGGGCTCCATATCACTTTGAGCTTTTATGCTTTTCTGACTCCTCCAGGAGC
TGAACAACCTTGTTCCCGGCAAAGCCCACTGCGTCATGGAGCTCACGGTCTACATTCATGACTGACTAACCGTAAACTGC
```

Output

The output of the `gto_genomic_period` program is a execution report, followed by the plot with this information.

An example of the report, for the input, is:

```
Running order: 1 ... Done!
Running order: 2 ... Done!
Running order: 3 ... Done!
Running order: 4 ... Done!
Running order: 5 ... Done!
Running order: 6 ... Done!
Running order: 7 ... Done!
Running order: 8 ... Done!
Running order: 9 ... Done!
Running order: 10 ... Done!
Running order: 11 ... Done!
Running order: 12 ... Done!
Running order: 13 ... Done!
Running order: 14 ... Done!
Running order: 15 ... Done!
Running order: 16 ... Done!
Running order: 17 ... Done!
Running order: 18 ... Done!
Running order: 19 ... Done!
Running order: 20 ... Done!
 1  2.246
 2  2.225
 3  2.237
 4  2.079
 5  1.821
 6  1.733
 7  1.717
 8  1.708
 9  1.717
10  1.712
11  1.717
12  1.721
13  1.725
14  1.729
15  1.733
16  1.738
17  1.742
18  1.746
19  1.75
20  1.754
```

In the Figure 5.1 is represented the plot for the execution above.

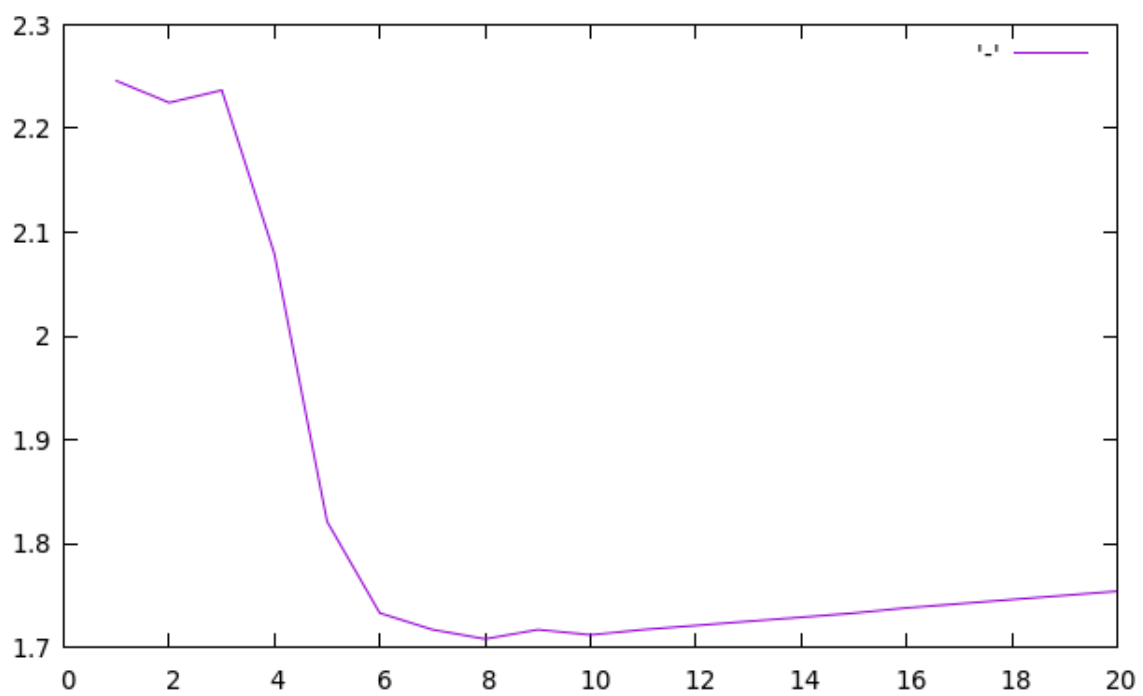


Figure 5.1: `gto_genomic_period` execution plot.

Chapter 6

General purpose tools

1. `gto_char_to_line`: it splits a sequence into lines, creating an output sequence which has a char for each line.
2. `gto_reverse`: it reverses the order of a sequence.
3. `gto_new_line_on_new_x`: it splits different rows with a new empty row.
4. `gto_upper_bound`: it sets an upper bound in a file with a value per line.
5. `gto_lower_bound`: it sets an lower bound in a file with a value per line.
6. `gto_brute_force_string`: it generates all combinations, line by line, for an inputted alphabet and specific size.
7. `gto_real_to_binary_with_threshold`: it converts a sequence of real numbers into a binary sequence, given a threshold.
8. `gto_sum`: it adds decimal values in file, line by line, splitted by spaces or tabs.
9. `gto_filter`: it filters numerical sequences.
10. `gto_word_search`: it search for a word in a file.
11. `gto_permute_by_blocks`: it permutates by block sequence, FASTA and Multi-FASTA files.
12. `gto_info`: it gives the basic properties of the file, namely size, cardinality, distribution percentage of the symbols, among others.
13. `gto_segment`: it segments a filtered sequence.
14. `gto_comparative_map`: it creates a visualization for comparative maps.
15. `gto_xs`: it ...
16. `gto_geco`: it ...
17. `gto_gede`: it ...

6.1 Program gto_char_to_line

The `gto_char_to_line` splits a sequence into lines, creating an output sequence which has a char for each line.

For help type:

```
./gto_char_to_line -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_char_to_line` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence file.

The attribution is given according to:

```
Usage: ./gto_char_to_line [options] [--] args]
      or: ./gto_char_to_line [options]

It splits a sequence into lines, creating an output sequence which has a char for each line.

      -h, --help          show this help message and exit

Basic options
      < input.seq          Input sequence file (stdin)
      > output.seq         Output sequence file (stdout)

Example: ./gto_char_to_line < input.seq > output.seq
```

An example on such an input file is:

```
ACAAGACGGGCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGTAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCACGCAAGTTTAATTACAGACCTGAAACAAGATGCCATTGTCCCCGGCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGTGGCCCCACCGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCGCTTGGTGGTTTGAGTGGACCTCCCAGGCCAGTGCCG
GGCCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAACCTCACCCATGAATGCTCACGCAAGTT
TAATTACAGACCTGAA
```

Output

The output of the `gto_char_to_line` program is a group sequence splited by `\n` foreach character.

An example, for the input, is:

```
A
C
A
A
G
A
C
G
G
C
C
T
C
C
T
G
C
T
G
C
T
...
```

6.2 Program `gto_reverse`

The `gto_reverse` reverses the order of a sequence file.

For help type:

```
./gto_reverse -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_reverse` program needs two streams for the computation, namely the input and output standard.

The input stream is a sequence file.

The attribution is given according to:

```
Usage: ./gto_reverse [options] [--] args]
       or: ./gto_reverse [options]
```

It reverses the order of a sequence file.

```
-h, --help          show this help message and exit
```

Basic options

```
< input.seq        Input sequence file (stdin)
> output.seq        Output sequence file (stdout)
```



```
Example: ./gto_reverse < input.seq > output.seq
```

An example on such an input file is:

```
ACAAGACGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCTCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAAACCTCACCCTGAATGCTCACGCAAGTTTAATTACAGACCTGAAACAAGATGCCATTGTCCCCCGGCCTCCTGCTG
CTGCTGCTCTCCGGGGCCACGGCCACCGCTGCCCTGCCCTGGAGGGTGGCCCCACCGGCCGAGACAGCGAGCATATGCA
GGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCTCTCGCTTGGTGGTTTGAGTGGACCTCCAGGCCAGTGCCG
GGCCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGGCGCACCCCCCAGCAATCCGCGCGCCGGGAC
AGAATGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCTCTGCAAATAAAACCTCACCCTATGAATGCTCACGCAAGTT
TAATTACAGACCTGAA
```

Output

The output of the `gto_reverse` program is a group sequence.

An example, for the input, is:

```
AAGTCCAGACATTAATTTGAACGCACTCGTAAGTACCCACTCCAAAATAAACGTCTCTCTTCCAGAAGGTCTTCTTCA
AGGACGTCCCGTAAGACAGGGCCGCGGCCTAACGACCCCCCACGCGGAAGGACGGCGGACCGGTGGAGGGCTCGAAGG
AGAGGATACTCCCCGGGCGGTGACCGGACCCCTCCAGGTGAGTTTGGTGGTTTCGCTCCTTTCAGTCCTCCGACGAAAAGGA
ATAAGGACGGCGAAGGACGTATACGAGCGACAGAGCCGGCCACCCGGTGGGAGGTCCCCGTCCCGTCGCCACCGGCACC
GGGGCCTCTCGTCGTCGTCCTCCTCCGGCCCCCTGTTACCGTAGAACAAAGTCCAGACATTAATTTGAACGCACTCGTAA
GTACCCACTCCAAAATCGACCCCCCACCTCTTCCAGAAGGTCTTCTTCAAGGACGTCCCGAAACGTCTCTAAGACAGG
GCCGCGCGCCTAAGCGCGGTGACCGGACGAAGGACGGCGGACCGGTGGAGGGCTCGAAGGAGAGGATACTCCCCGGGCCT
CCAGGTGAGTTTGGTGAAGGACGGCGAAGGACGTATACGAGCGACAGAGCCGGGTTCGCTCCTTTTCAGTCCTCCGACGAA
AAGGAATCCACCCCGGCCCTGTTACCGTCGTCCTCGCCACCTGGGAGGTCCCGGCACCGGGGCCTCTCGTCGTCGTC
GTCCTCCGGCAGAAACA
```

6.3 Program `gto_new_line_on_new_x`

The `gto_new_line_on_new_x` splits different rows with a new empty row.

For help type:

```
./gto_new_line_on_new_x -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_new_line_on_new_x` program needs two streams for the computation, namely the input and output standard. The input stream is a matrix file format with 3 columns.

The attribution is given according to:

```
Usage: ./gto_new_line_on_new_x [options] [--] args]
      or: ./gto_new_line_on_new_x [options]

It splits different rows with a new empty row.

-h, --help      show this help message and exit

Basic options
  < input        Input file with 3 column matrix format (stdin)
  > output        Output file with 3 column matrix format (stdout)

Example: ./gto_new_line_on_new_x < input > output
```

An example on such an input file is:

```
1  2  2
1  2  2
4  4  1
10 12  2
15 15  1
45 47  3
45 47  3
45 47  3
45 47  3
55 55  1
```

Output

The output of the `gto_new_line_on_new_x` program is a 3 column matrix, with an empty line between different rows.

An example, for the input, is:

```
1.000000    2.000000    2.000000
1.000000    2.000000    2.000000

4.000000    4.000000    1.000000

10.000000   12.000000    2.000000

15.000000   15.000000    1.000000

45.000000   47.000000    3.000000
45.000000   47.000000    3.000000
45.000000   47.000000    3.000000
45.000000   47.000000    3.000000

55.000000   55.000000    1.000000
```

6.4 Program gto_upper_bound

The `gto_upper_bound` sets an upper bound in a file with a value per line.

For help type:

```
./gto_upper_bound -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_upper_bound` program needs two streams for the computation, namely the input and output standard. The input stream is a numeric file.

The attribution is given according to:

```
Usage: ./gto_upper_bound [options] [--] args]
or: ./gto_upper_bound [options]

It sets an upper bound in a file with a value per line.

-h, --help                show this help message and exit

Basic options
-u, --upperbound=<int>    The upper bound value
< input                  Input numeric file (stdin)
> output                  Output numeric file (stdout)

Example: ./gto_upper_bound -u <upperbound> < input > output
```

An example on such an input file is:

```
0.123
3.432
2.341
1.323
7.538
4.122
0.242
0.654
5.633
```

Output

The output of the `gto_upper_bound` program is a set of numbers truncated at the a defined upper bound.

An example, for the input, is:

```
Using upper bound: 4
0.123000
3.432000
2.341000
```

```
1.323000
4.000000
4.000000
0.242000
0.654000
4.000000
```

6.5 Program `gto_lower_bound`

The `gto_lower_bound` sets an lower bound in a file with a value per line.

For help type:

```
./gto_lower_bound -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_lower_bound` program needs two streams for the computation, namely the input and output standard. The input stream is a numeric file.

The attribution is given according to:

```
Usage: ./gto_lower_bound [options] [--] args]
       or: ./gto_lower_bound [options]

It sets an lower bound in a file with a value per line.

    -h, --help                show this help message and exit

Basic options
    -u, --lowerbound=<int>    The lower bound value
    < input                  Input numeric file (stdin)
    > output                  Output numeric file (stdout)

Example: ./gto_lower_bound -u <lowerbound> < input > output
```

An example on such an input file is:

```
0.123
3.432
2.341
1.323
7.538
4.122
0.242
0.654
5.633
```

Output

The output of the `gto_lower_bound` program is a set of numbers truncated at the a defined lower bound. An example, for the input, is:

```
Using lower bound: 2
2.000000
3.432000
2.341000
2.000000
7.538000
4.122000
2.000000
2.000000
5.633000
```

6.6 Program `gto_brute_force_string`

The `gto_brute_force_string` generates all combinations, line by line, for an inputted alphabet and specific size.

For help type:

```
./gto_brute_force_string -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_brute_force_string` program needs some paramenters for the computation, namely the alphabet and the key size.

The attribution is given according to:

```
Usage: ./gto_brute_force_string [options] [--] args]
or: ./gto_brute_force_string [options]

It generates all combinations, line by line, for an inputted alphabet and specific size.

-h, --help          show this help message and exit

Basic options
-a, --alphabet=<str> The input alphabet
-s, --size=<int>     The combinations size
> output            Output all the combinations (stdout)

Example: ./gto_brute_force_string -a <alphabet> -s <size> > output
```

Output

The output of the `gto_brute_force_string` program is a set of all possible word combinations with a defined size, using the input alphabet.

Using the alphabet "abAB" with the word size of 3, an example of this program, the output is:

```
aaa
aab
aaA
aaB
aba
...
BBb
BBA
BBB
```

6.7 Program `gto_real_to_binary_with_threshold`

The `gto_real_to_binary_with_threshold` converts a sequence of real numbers into a binary sequence, given a threshold. The numbers below to the threshold will be 0.

For help type:

```
./gto_real_to_binary_with_threshold -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_real_to_binary_with_threshold` program needs two streams for the computation, namely the real sequence as input. These numbers should be splitted by lines.

The attribution is given according to:

```
Usage: ./gto_real_to_binary_with_threshold [options] [--] args]
or: ./gto_real_to_binary_with_threshold [options]

It converts a sequence of real numbers into a binary sequence given a threshold.

-h, --help                show this help message and exit

Basic options
-t, --threshold=<dbl>     The threshold in real format
< input.num              Input numeric file (stdin)
> output.bin              Output binary file (stdout)

Example: ./gto_real_to_binary_with_threshold -t <threshold> < input.num > output.bin
```

An example on such an input file is:

```
12.25
1.2
5.44
5.51
7.97
2.34
8.123
```

Output

The output of the `gto_real_to_binary_with_threshold` program is a binary sequence.

An example, for the input using the threshold of 5.5, is:

```
1
0
0
1
1
0
1
```

6.8 Program `gto_sum`

The `gto_sum` adds decimal values in file, line by line, splitted by spaces or tabs.

For help type:

```
./gto_sum -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_sum` program needs program needs two streams for the computation, namely the input, which is a decimal file.

The attribution is given according to:

```
Usage: ./gto_sum [options] [--] args]
or: ./gto_sum [options]
```

It adds decimal values in file, line by line, splitted by spaces or tabs.

```
-h, --help          show this help message and exit
```

Basic options

```
< input.num        Input numeric file (stdin)
> output.num       Output numeric file (stdout)
```

Optional

```
-r, --sumrows      When active, the application adds all the values line by line
-a, --sumall       When active, the application adds all values
```

```
Example: ./gto_sum -a < input.num > output.num
```

An example on such an input file is:

```
0.123   5   5
3.432
2.341   3   2
1.323
7.538   5
4.122
0.242
0.654
5.633   10
```

Output

The output of the `gto_sum` program is a sum of the elements in the input file.

Executing the application with the provided input and with the flag to add only the elements in each row (-r), the output of this execution is:

```
10.123000
3.432000
7.341000
1.323000
12.538000
4.122000
0.242000
0.654000
15.633000
```

6.9 Program `gto_filter`

The `gto_filter` filters numerical sequences using a low-pass filter.

For help type:

```
./gto_filter -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_filter` program needs two streams for the computation, namely the input and output standard.

The input stream is a numeric file.

The attribution is given according to:


```
Usage: ./gto_filter [options] [--] args]
       or: ./gto_filter [options]
```

It filters numerical sequences using a low-pass filter.

```
-h, --help                show this help message and exit
```

Basic options

```
< input.num              Input numeric file (stdin)
> output.num             Output numeric file (stdout)
```

Optional

```
-w, --windowsize=<int>   Window size (default 0)
-d, --drop=<int>         Discard elements (default 0.0)
-t, --windowtype=<int>   Window type (0=Hamm, 1=Hann, 2=Black, 3=rec) (default 0 (Hamm))
-c, --onecolumn          Read from one column
-p, --printone           Print one column
-r, --reverse            Reverse mode
```

```
Example: ./gto_filter -w <windowsize> -d <drop> -t <windowtype> -c -p -r < input.num > output.num
```

An example on such an input file is:

```
1    1.77
5    2.18
10   2.32
15   3.15
20   2.52
25   4.43
30   1.23
```

Output

The output of the `gto_filter` program is a numeric file, identical of the input.

An example, for the input using a window size of 3, is:

```
Got 7 entries from file
1    2.085
5    2.256
10   2.507
15   2.757
20   2.905
25   2.860
30   2.674
```

6.10 Program `gto_word_search`

The `gto_word_search` search for a word in a file. It is case sensitive.

For help type:

```
./gto_word_search -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_word_search` program needs two streams for the computation, namely the input and output standard. The input stream is a text file.

The attribution is given according to:

```
Usage: ./gto_word_search [options] [--] args]
      or: ./gto_word_search [options]

Searching for a word in a text file. It is case sensitive.

      -h, --help          show this help message and exit

Basic options
      -w, --word=<str>    Word to search in the file
      < input.txt         Input text file (stdin)
      > output.txt        Output text file (stdout)

Example: ./gto_word_search -w <word> < input.txt > output.txt
```

An example on such an input file is:

```
No guts, no story. Chris Brady
My life is my message. Mahatma Gandhi
Screw it, let's do it. Richard Branson
Boldness be my friend. William Shakespeare
Keep going. Be all in. Bryan Hutchinson
My life is my argument. Albert Schweitzer
Fight till the last gasp. William Shakespeare
Leave no stone unturned. Euripides
```

Output

The output of the `gto_word_search` program is a text file with the matching paragraphs and the location of the word found.

An example, for the input using the word "Shakespeare", is:

```
Found match in range [ 1536 : 2048 ]
Boldness be my friend. William Shakespeare

Found match in range [ 3072 : 3584 ]
Fight till the last gasp. William Shakespeare
```

6.11 Program gto_permute_by_blocks

The `gto_permute_by_blocks` permutes by block sequence, FASTA and Multi-FASTA files. For help type:

```
./gto_ -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_permute_by_blocks` program needs two streams for the computation, namely the input and output standard. The input stream is a sequence, FASTA or Multi-FASTA file.

The attribution is given according to:

```
Usage: ./gto_permute_by_blocks [options] [--] args]
      or: ./gto_permute_by_blocks [options]

It permutes by block sequence, FASTA and Multi-FASTA files.

    -h, --help                show this help message and exit

Basic options
    -b, --numbases=<int>      The number of bases in each block
    -s, --seed=<int>          Starting point to the random generator
    < input                    Input sequence, FASTA or Multi-FASTA file format (stdin)
    > output                  Output sequence, FASTA or Multi-FASTA file format (stdout)

Example: ./gto_permute_by_blocks -b <numbases> -s <seed> < input.fasta > output.fasta
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAAACCTCACCCATGAATGCTCGCAACACGCAAGTTTAATTCGCAAGTTAGACCTGAACGGGAGGTGGCCACGCAAGTT
```

Output

The output of the `gto_permute_by_blocks` program is a sequence, FASTA or Multi-FASTA file permuted following some parameters.

An example, for the input using the base number as 80 (-b), is:

```
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGACCTCCGGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAACCTTCTTCTGGAAGACCTTCTCCACCCCCCAGC
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
```

```
TAAACCTCACCCATGAATGCTCGCAACACGCAAGTTTAATTGCGCAAGTTAGACCTGAACGGGAGGTGGCCACGCAAGTT
```

6.12 Program gto_info

The `gto_info` gives the basic properties of the file, namely size, cardinality, distribution percentage of the symbols, among others.

For help type:

```
./gto_info -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_info` program needs two streams for the computation, namely the input and output standard. The input stream is a file withou any specific format.

The attribution is given according to:

```
Usage: ./gto_info [options] [--] args
      or: ./gto_info [options]

It gives the basic properties of the file, namely size, cardinality, distribution
percentage of the symbols, among others.

      -h, --help      show this help message and exit

Basic options
      < input          Input file (stdin)
      > output          Output read information (stdout)

Optional
      -a, --ascii      When active, the application shows the ASCII codes

Example: ./gto_info < input > output

Output example :
Number of symbols   : value
Alphabet size       : value
Alphabet            : value
Symbol distribution:
<Symbol/Code ASCII> <Symbol count> <Distribution percentage>
```

An example on such an input file is:

```
>AB000264 |acc=AB000264|descr=Homo sapiens mRNA
ACAAGACGGCCTCCTGCTGCTGCTGCTCCTCGGGGCCACGGCCCTGGAGGGTCCACCGCTGCCCTGCTGCCATTGTCCCC
GGCCCCACCTAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGGCCGAGACAGCGAGCATATGCAGGAAGCGGCAGGAA
GTGGTTTGAGTGGACCTCCGGGCCCTCATAGGAGAGGAAGCTCGGGAGGTGGCCAGGCGGCAGGAAGCAGGCCAGTGCC
```

```
GCGAATCCGCGCGCCGGGACAGAATCTCCTGCAAAGCCCTGCAGGAAC TTCTTCTGGAAGACCTTCTCCACCCCCCAGC
TAAACCTCACCCATGAATGCTCGCAACACGCAAGTTTAATTCGCAAGTTAGACCTGAACGGGAGGTGGCCACGCAAGTT
```

Output

The output of the `gto_info` program is a set of information related to the file read.

An example, for the input, is:

```
Number of symbols : 453
Alphabet size      : 28
Alphabet           : |srponmiedcaTRNHGCBA>=6420 \n
Symbol distribution:
| : 2      0.4415011
s : 3      0.66225166
r : 1      0.22075055
p : 1      0.22075055
o : 2      0.4415011
n : 1      0.22075055
m : 2      0.4415011
i : 1      0.22075055
e : 2      0.4415011
d : 1      0.22075055
c : 3      0.66225166
a : 2      0.4415011
T : 66     14.569536
R : 1      0.22075055
N : 1      0.22075055
H : 1      0.22075055
G : 117    25.827815
C : 131    28.918322
B : 2      0.4415011
A : 89     19.646799
> : 1      0.22075055
= : 2      0.4415011
6 : 2      0.4415011
4 : 2      0.4415011
2 : 2      0.4415011
0 : 6      1.3245033
  : 4      0.88300221
\n : 5     1.1037528
```

6.13 Program `gto_segment`

The `gto_segment` segments a filtered sequence.

For help type:

```
./gto_segment -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_segment` program needs two streams for the computation, namely the input and output standard.

The input stream is a numeric file.

The attribution is given according to:

```
Usage: ./gto_segment [options] [--] args]
      or: ./gto_segment [options]

It segments a filtered sequence.

      -h, --help                show this help message and exit

Basic options
      -t, --threshold=<dbl>    The segment threshold
      < input.num              Input numeric file (stdin)
      > output                  Output the segment file (stdout)

Example: ./gto_segment -t <threshold> < input.num > output
```

An example on such an input file is:

```
1    1.77
5    2.18
10   2.32
15   3.15
20   2.52
25   4.43
30   1.23
```

Output

The output of the `gto_segment` program is the interval of values “below the threshold.

An example, for the input using a threshold of 3, is:

```
0:10
```

6.14 Program `gto_comparative_map`

The `gto_comparative_map` creates a visualization for comparative maps.

For help type:

```
./gto_comparative_map -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_comparative_map` program needs an input file with the plot positions, respecting a defined structure.

The attribution is given according to:

```
Usage: ./gto_comparative_map [options] [--] args]
       or: ./gto_comparative_map [options]

It creates a visualization for comparative maps.

    -h, --help                Show this help message and exit

Basic options
    <FILE>                    Contigs filename with positions (.pos),

Optional

    -h                        Give this help,
    -V                        Display version number,
    -v                        Verbose mode (more information),
    -l <link>                 Link type between maps [0;4],
    -w <width>                Chromosome width,
    -s <space>                Space between chromosomes,
    -m <mult>                 Color id multiplication factor,
    -b <begin>                Color id beggining,
    -c <minimum>              Minimum block size to consider,
    -i                        Do NOT show inversion maps,
    -r                        Do NOT show regular maps,
    -o <FILE>                 Output image filename with map,

Example: ./gto_comparative_map -o map.svg map.config
```

The input file needs to have the following structure:

```
todo
```

An example on such an input file is:

```
#SCF      5000000 5000000
aaa       1      1000000 1      1000000 bbbb      3000000 4000000 3000000 4000000
bbb       1500000 2000000 1500000 2000000 cccc      1500000 2000000 1500000 2000000
aaa       2000000 3000000 2000000 3000000 bbbb      3000000 2000000 3000000 2000000
```

Output

The output of the `gto_comparative_map` program is a executing report, and a svg plot with the maps. An example, for the input, is:

```

==[ PROCESSING ]=====
Printing plot ...
Found 2 regular regions.
Found 1 inverted regions.
Done!

==[ STATISTICS ]=====
Total cpu time: 0 second(s).

```

In the Figure 6.1 is represented the plot for the execution above.

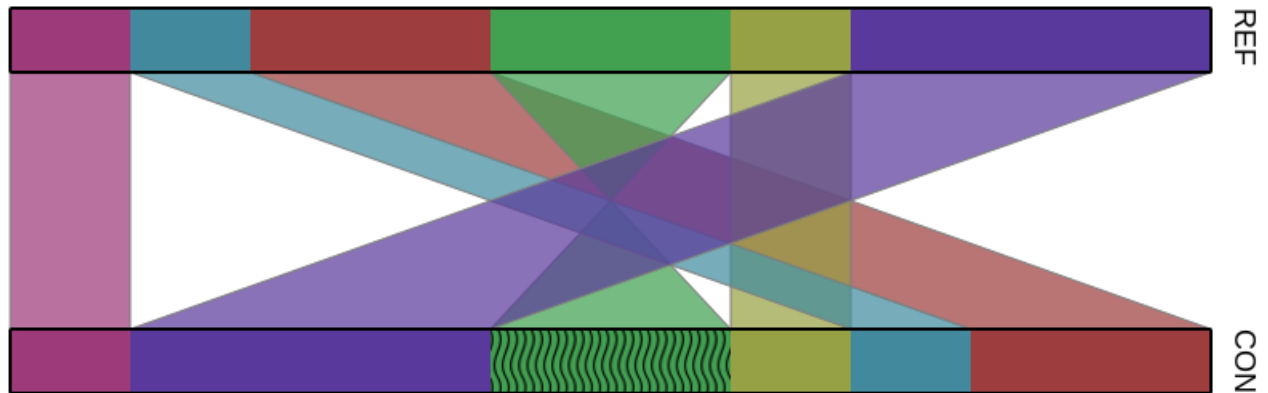


Figure 6.1: `gto_comparative_map` execution plot.

6.15 Program `gto_xs`

The `gto_xs` .

For help type:

```
./gto_xs -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_xs` program needs program needs two streams for the computation, namely the input and output standard. ...

The attribution is given according to:

```
TODO
```

An example on such an input file is:


```
TO DO
```

Output

The output of the `gto_xs` program is ...

An example, for the input, is:

```
TO DO
```

6.16 Program `gto_geco`

The `gto_geco` .

For help type:

```
./gto_geco -h
```

In the following subsections, we explain the input and output paramters.

Input parameters

The `gto_geco` program needs program needs two streams for the computation, namely the input and output standard. ...

The attribution is given according to:

```
TODO
```

An example on such an input file is:

```
TO DO
```

Output

The output of the `gto_geco` program is ...

An example, for the input, is:

```
TO DO
```

6.17 Program `gto_gede`

The `gto_gede` .

For help type:

```
./gto_gede -h
```

In the following subsections, we explain the input and output parameters.

Input parameters

The `gto_gede` program needs two streams for the computation, namely the input and output standard. ...

The attribution is given according to:

```
TODO
```

An example on such an input file is:

```
TO DO
```

Output

The output of the `gto_gede` program is ...

An example, for the input, is:

```
TO DO
```