

CHOLAR: Characterization of LncRNA from raw reads

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Summary

RNA-sequencing has found numerous implementations in research, from distinguishing immune cell subtypes to differential gene expression between cancer versus normal tissue types (Villani et al. 2017; Bao et al. 2021). Another application of RNA-seq is to identify novel transcripts involved in various biological processes (Gupta, Kleinjans, and Caiment 2021). The most relevant is context and cell-type-specific non-coding RNAs, such as long non-coding RNAs (lncRNAs), which have become a case-point for most transcriptomic studies proving their role in regulating gene expression, post-transcriptional regulation, and epigenetic regulation (Engreitz et al. 2016; Zhu et al. 2019). It is becoming crucial to check the relative expression of lncRNAs in transcriptome-wide studies. Our group has developed an automated lncRNA expression pipeline. The only requirement from the user-side is raw data in FASTQ format. The user will get a list of known and novel lncRNAs, and differential gene expression between condition(s). The pipelines come with a user-friendly GUI, thereby eliminating the need for the user to be versed in complex transcriptome analysis and UNIX environment. The source code is available under an open-source licence at <https://github.com/schosio/CHOLAR>.

Statement of need

The number of inferences generated from RNA-seq datasets is countless. The software used in the RNA-seq analysis pipeline requires a UNIX-based command-line interactive (CLI) environment, with each software executed in succession. Installing multiple CLI tools, handling various file formats, and plotting graphs re-

quire understanding of Linux and R programming language. Moreover, no tool identifies novel lncRNAs from raw transcriptomic data to the best of our knowledge. LncRNA identification tools such as CPAT (Wang et al. 2013) (and other tools) take either transcript sequence (FASTA) or transcript coordinate (BED, GTF) as input and provide a list of predicted lncRNAs. To address these issues, we developed CHOLAR which is a tool for characterization of LncRNA from raw reads . CHOLAR i) identifies novel lncRNAs from raw reads ii) provides a user-friendly GUI interface to make changes at every step iii) allows to identify differentially expressed genes and lists known and novel lncRNAs iv) generates publication-quality plots such as MA plot, Volcano plot and heatmap.

Implementation

The CHOLAR pipeline is implemented in bash and R, where it first reads the input FASTQ files(s) to check the quality of reads using FastQC (Fiancette et al. 2021). Bad quality (< 28) reads and adaptors are removed using Trimmomatic (Bolger, Lohse, and Usadel 2014). HISAT2 performs the mapping of reads on the human reference genome (hg38) (Zhang et al. 2021). The SAM files generated from HISAT2 are converted to BAM, and PCR duplicates are removed utilising the samtools toolkit (Danecek et al. 2021). The transcript assembly is done using Stringtie, and the resulting GTF files are merged using the merge utility of Stringtie (Pertea et al. 2015). The merged GTF file is compared against the reference annotation file from GENCODE (Frankish et al. 2021) to filter novel transcripts using GFFCOMPARE. The coding potential of novel transcripts is predicted using CPAT (Wang et

al. 2013). The gene counts are calculated using HTSeq (Putri et al. 2022), and subsequent differential gene expression analysis (DGEA) is done using packages from R statistical language. The DESeq2 package is used for performing DGEA (Love, Huber, and Anders 2014), and ggplot and dplyr libraries for plotting graphs. The Graphical user interface is built using zenity in bash. The schematic of the tool is given in figure 1.

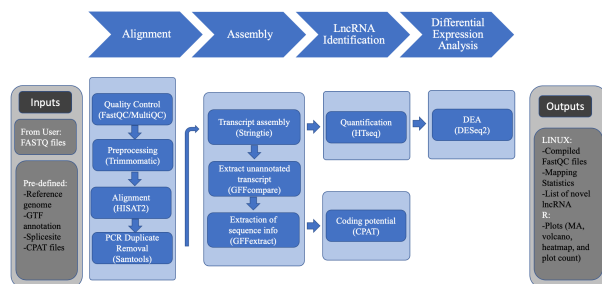


Figure 1: Schematic of the tool CHOLAR. It starts from input files, performs alignment; assembly; LncRNA identification; differential expression analysis and provides output files and plots

Example

We chose the GSE147761 dataset from the GEO database (NCBI) to showcase the CHOLAR tool. A sample of results and plots generated by the tool are given in figure 2. The GUI of the tool is shown in figure 3.

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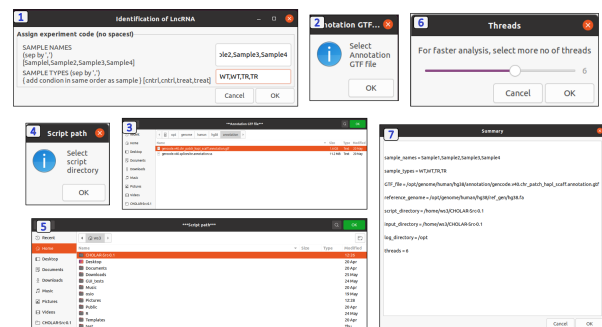


Figure 2: From top left clockwise: sample name input, gtf file dialog, threads slider, summary of all inputs, directory selection for script, script dialog, file selection for gtf

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