Teaching with Galaxy in a High School Setting

Christine Cucinotta, Postdoc Fellow, Tsukiyama Lab
Fred Hutchinson Cancer Center

Labs can support projects for high school students

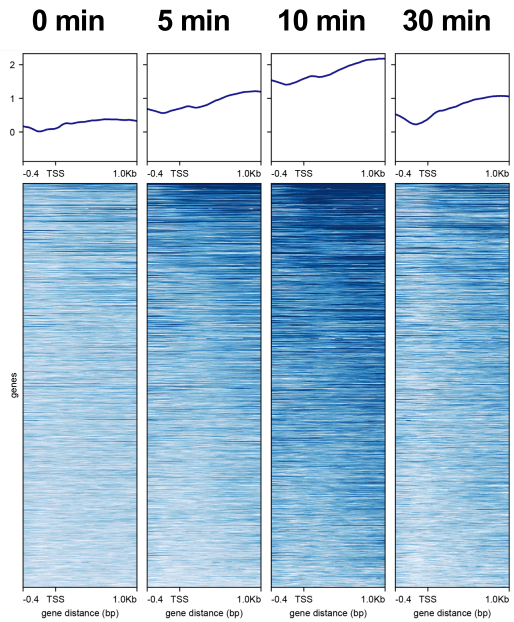
- The Fred Hutchinson Cancer Research Center’s Science Education Partnership runs a program for high school students to work with researchers at the Hutch. This year it was **completely virtual**
    - Pathways to cancer research: https://www.fredhutch.org/en/about/education-outreach/science-education-partnership/pathways-to-cancer-research.html
    - Mentors can be group leaders, staff scientists, postdocs, grad students, and technicians.
    - The Pathways to Cancer Research High School program runs during the entire school year.
    - I meet with my two students one-on-one and in a group setting once a week and they meet with program leaders once per week.
    - Students spend ~6 hours per week reading and working on their analyses for their projects.

Designing a project for virtual research experiences for high school students

- Like many genomics labs, we have a lot of data to analyze, probably more than we can handle!
- This gives us a great opportunity to teach students about gene expression, give them a research experience, and gain new insights into data we already have.
- My research area focuses on understanding how cells re-activate from periods of dormancy.
    - Datasets we work with in the lab include: ChIP-seq, MNase-seq, and RNase-seq datasets.

Creating a project for high school students using existing datasets

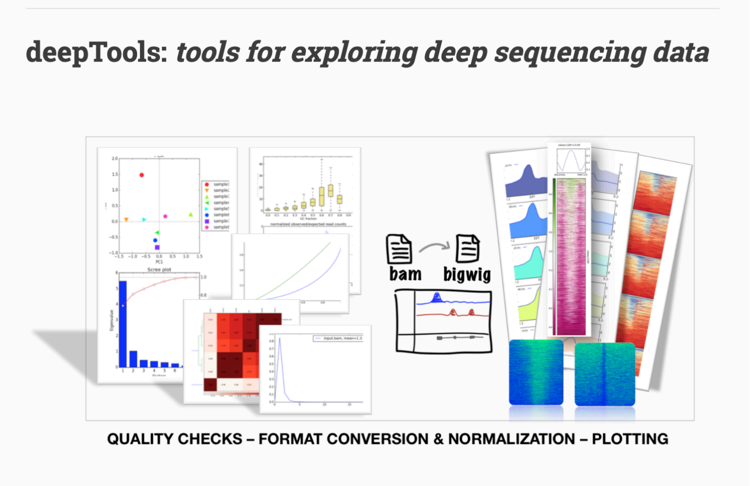
- With this project, students learn the central dogma of biology, how genes are transcribed, and how DNA is occluded or accessible to transcription factors
- At the beginning of the project, students were initially given .fastq files of Pol II ChIP-seq single-end datasets from an existing paper from the lab
- Students learned basics of high throughput sequencing and how to perform genome alignments using **Bowtie2** and used **DeepTools** for further processing



https://doi.org/10.1101/2021.01.28.428695

Identifying transcription factors regulating reactivation from dormancy

- Using Pol II ChIP-seq data, students performed clustering analysis to identify genes induced, not induced, etc. **Most analyses were contained in DeepTools**
- Here is a point where you can give students freedom to choose gene sets of interest and have them formulate their own hypotheses.
- Questions students can ask:
    - Which genes are induced?
    - Which genes never induce?
    - What is the chromatin state at selected genes?
    - What sequence motifs are present at genes of interest?



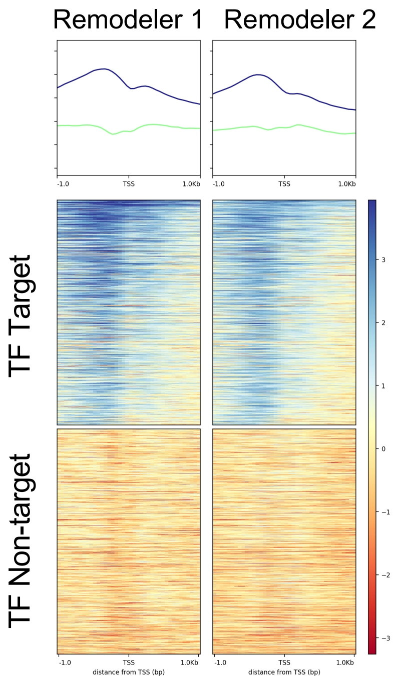
deepTools: ***tools for exploring deep sequencing data***

QUALITY CHECKS – FORMAT CONVERSION & NORMALIZATION – PLOTTING

https://deeptools.readthedocs.io/en/develop/

Identifying transcription factors regulating reactivation from dormancy

- One high school student, found ~800 activated genes with motifs for a yeast transcription factor (TF). This is 30-fold higher than what has been seen in normal growth conditions.
- He further analyzed paired-end MNase-seq data and found the chromatin architecture was likely being remodeled at these sites
- Our lab has a lot of chromatin factor data, so he then re-analyzed the data with his gene lists and saw striking co-localizations!
- In the lab **we are testing his hypothesis** that this transcription factor candidate targets remodeling factors
- Tip: give students projects where they can take ownership of the ideas!



J. Mulenga

Virtual mentoring programs & the power of Galaxy in creating research experiences for all

- With Galaxy being so accessible and system agnostic, there are many opportunities for mentoring virtual research projects!
- No need to acquire university access to computing centers (sometimes this process can be difficult at places)
- Can get projects up and running quickly, important for short-term programs or courses
- A couple online mentoring programs include:
    - **Undergraduate Level**: National summer undergraduate research program (NSURP): https://nsurp.org/
    - **High School Level**: Athena women in STEM program: https://www.athenabywistem.org/