

Canadian Bioinformatics Workshops

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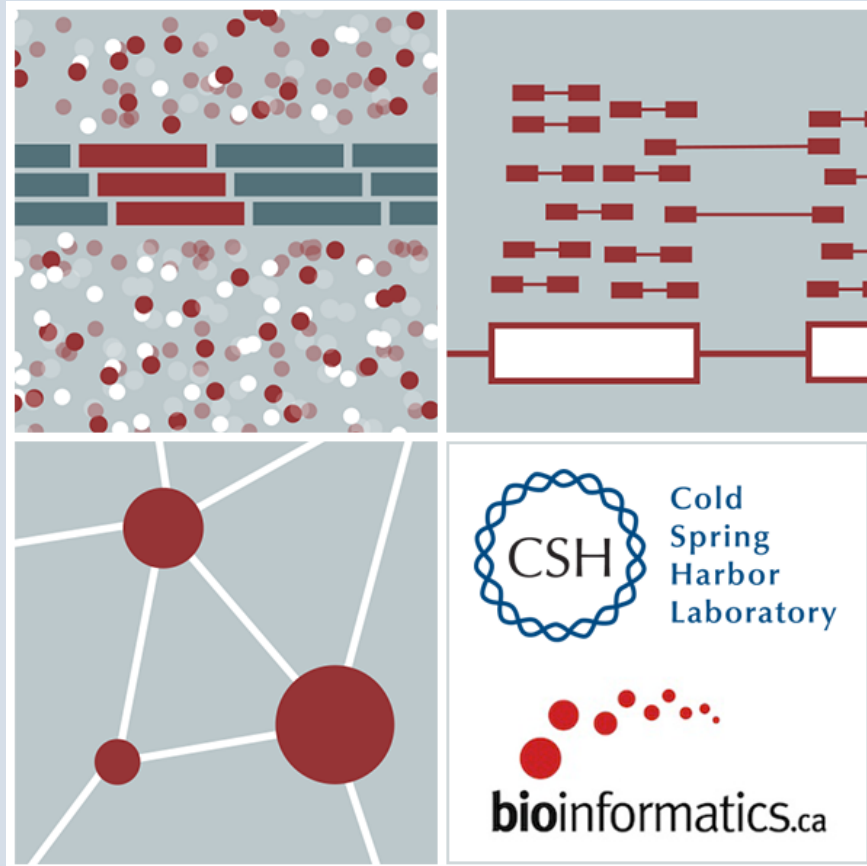
RNA-Seq Module 4

Isoform Discovery and Alternative Expression (tutorial)

Malachi Griffith, Obi Griffith, Fouad Yousif

High-Throughput Biology: From Sequence to Networks

March 20-26, 2017



Learning Objectives of Tutorial

- Learn how to run StringTie in 'reference only', 'reference guided', and 'de novo' modes
- Learn how to use Cuffmerge to combine transcriptomes from multiple Cufflinks runs and compare assembled transcripts to known transcripts
- Learn how to perform differential splicing analysis with Ballgown
- Examine junctions counts with RegTools and StringTie alternative transcript files at the command line
- Visualize junction counts and StringTie assembled transcripts in IGV

5-i,ii. Running stringtie in 'ref-guided' and 'de-novo' mode

- In Module 3 we ran StringTie in 'ref-only' mode. This mode gives us an expression estimate for each known gene/transcript
- Now we want to be able to potentially identify novel genes, and novel isoforms of known genes
- To accomplish this we will re-run cufflinks in 'ref-guided' and 'de-novo' modes
 - In 'ref-guided' mode a known transcriptome will be used as a guide
 - In 'de-novo' mode no knowledge of the transcriptome will be used at all

Options that govern use of existing transcript information

- During indexing of the genome with hisat2, transcript information is provided
 - A transcriptome GTF file is used to extract splice sites and exons
 - These are supplied during the index step to build a better index
 - These will be used to **assist the alignment** step by allowing alignment to both transcriptome and genome sequences
 - Coordinates from alignments to transcriptomes will be converted back to genome coordinates
 - Even though we supply transcriptome info, hisat2 will not be limited in to known transcripts or splice sites
- Stringtie '-G' option
 - Used to supply a transcriptome GTF file
 - If specified, uses the reference annotation file (in GTF or GFF3 format) to guide the assembly process. We call this the '**ref-guided**' analysis mode
- Stringtie '-e' option
 - Limits the processing of read alignments to only estimate and output the assembled transcripts matching the reference transcripts given with the -G option
 - We call this '**reference-only**' analysis mode
- Running StringTie with neither '-G' or '-e'
 - We call this '**de-novo**' analysis mode

A 'junctions.bed' file

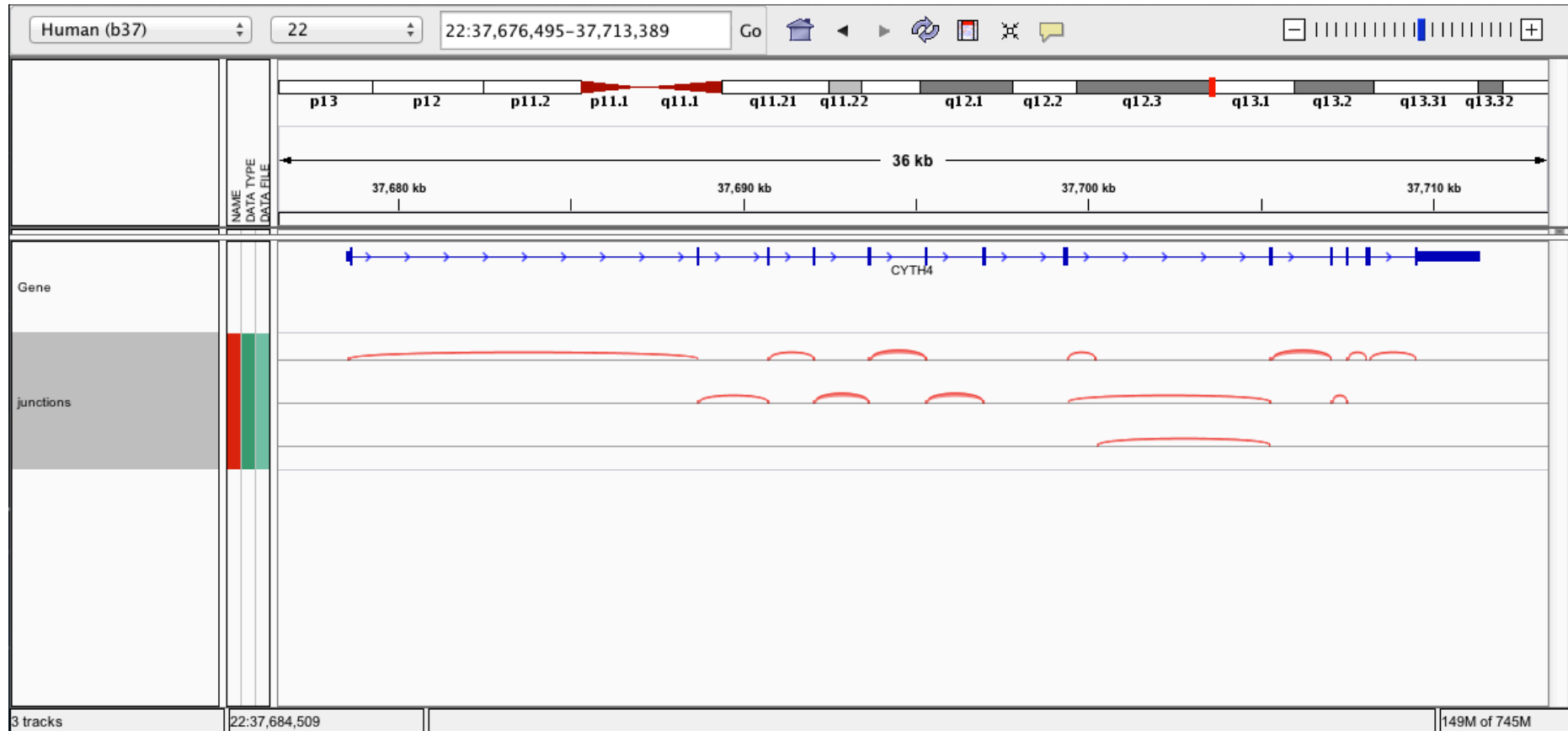
- After alignment, we can create a summary of all reads that support exon-exon junctions
 - e.g. exon1-exon2 has 5 reads
 - e.g. exon1-exon3 has 9 reads
- This file reports all of the unique exon-exon junctions observed and the read counts for each
 - In BED format

```
track name=junctions description="TopHat junctions"
22 17062079 17063415 JUNC00000001 3 - 17062079 17063415 255,0,0 2 98,19 0,1317
22 17092740 17095057 JUNC00000002 5 + 17092740 17095057 255,0,0 2 43,91 0,2226
22 17117940 17119543 JUNC00000003 6 + 17117940 17119543 255,0,0 2 40,75 0,1528
22 17152466 17156100 JUNC00000004 3 - 17152466 17156100 255,0,0 2 12,88 0,3546
22 17525819 17528242 JUNC00000005 1 + 17525819 17528242 255,0,0 2 71,29 0,2394
22 17528261 17538007 JUNC00000006 1 + 17528261 17538007 255,0,0 2 55,45 0,9701
22 17566071 17577976 JUNC00000007 10 + 17566071 17577976 255,0,0 2 48,25 0,11880
22 17577951 17578785 JUNC00000008 24 + 17577951 17578785 255,0,0 2 25,99 0,735
22 17578093 17578710 JUNC00000009 1 + 17578093 17578710 255,0,0 2 76,24 0,593
```



Junction read count

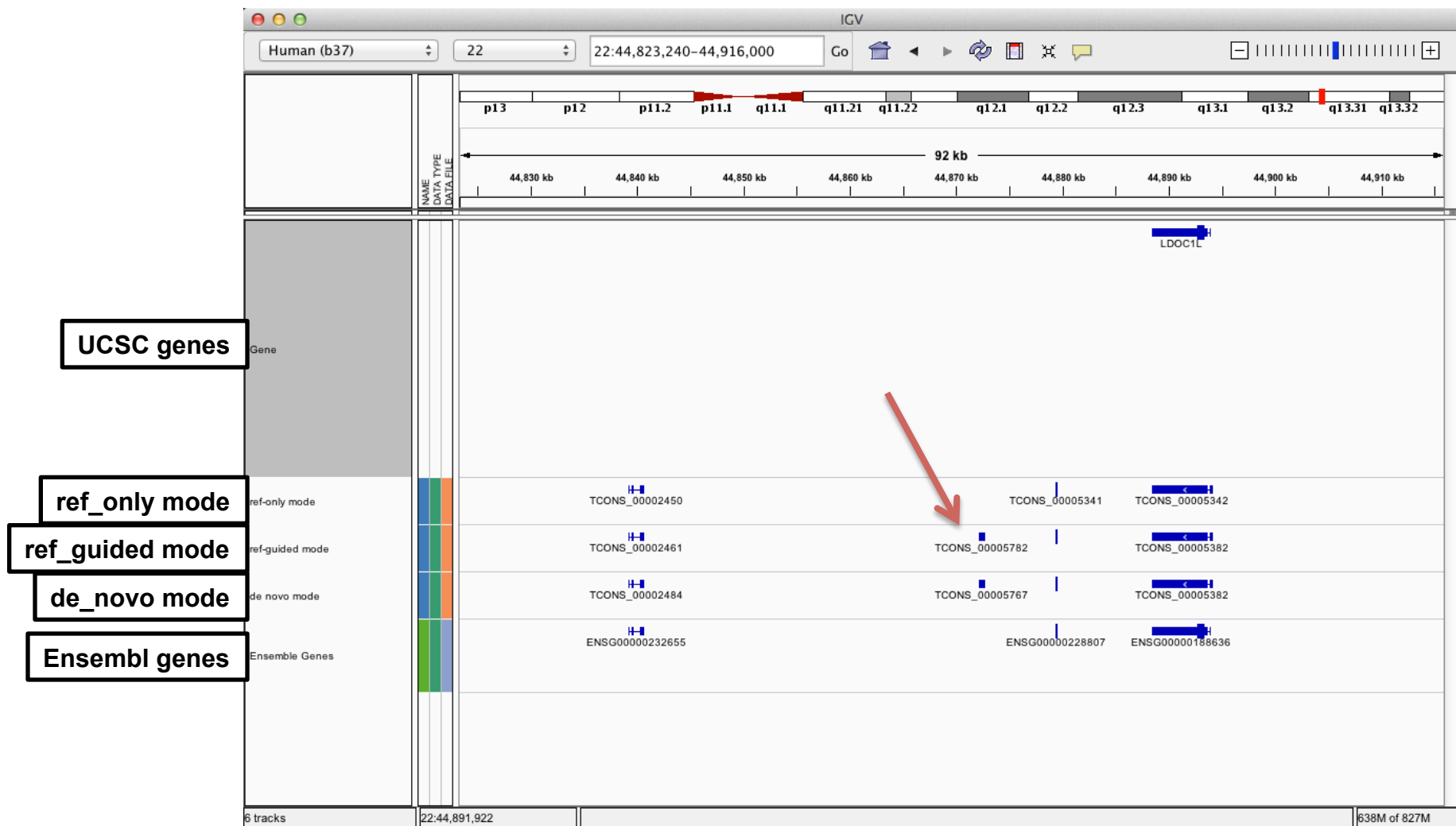
Viewing the junctions.bed in IGV



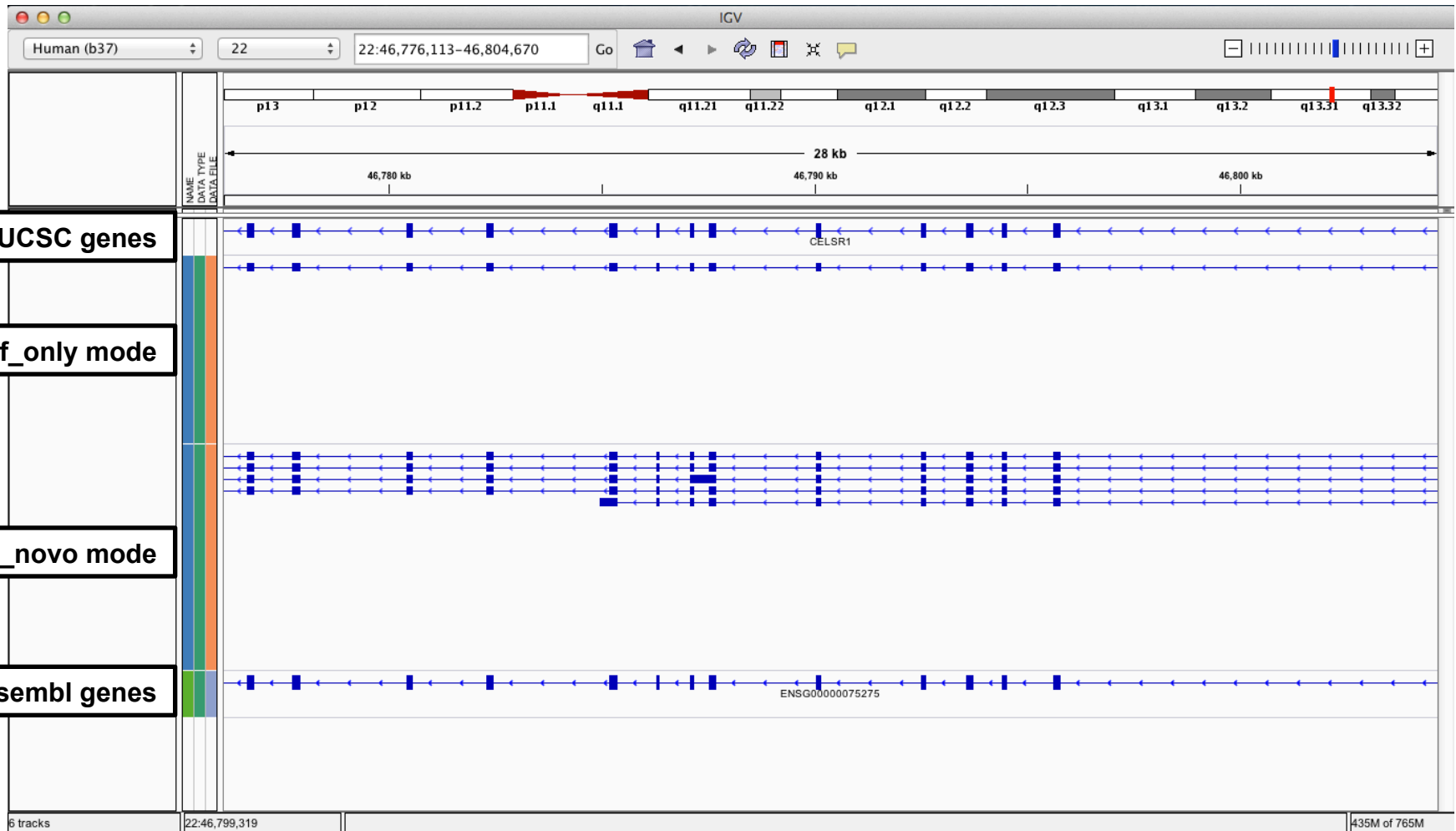
5-iii,iv. Cuffmerge

- <http://cufflinks.cbcb.umd.edu/manual.html#cuffmerge>
- Cuffmerge combines transcripts predicted from multiple RNA-seq data sets into one view of the transcriptome
 - Do this before running cuffdiff to compare between multiple conditions
- Cuffmerge can also simultaneously compare transcripts to the known transcripts GTF file from Ensembl, etc.
 - http://cufflinks.cbcb.umd.edu/manual.html#class_codes

5-v. Comparison of merged GTFs from each StringTie mode



Comparison of merged GTFs from each StringTie mode



We are on a Coffee Break &
Networking Session