Run GENESPACE vignettes- 26 Maize NAM founders

JTLovell

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1. Global Parameters

```
baseDir <- "/Users/jlovell/Desktop/GENESPACE_data/results/"
rawAnnotationDir <- "/Users/jlovell/Desktop/GENESPACE_data"
mcscanDir <- "/Users/jlovell/Documents/comparative_genomics/programs/MCScanX"
nThreads <- 4
path2of <- "orthofinder" # since orthofinder is in the path via conda
```

2. Set parameters

```
gens <- c(
  "B73", "B97", "CML103", "CML228", "CML247", "CML277", "CML322", "CML333",
  "CML52", "CML69", "HP301", "Il14H", "Ki11", "Ki3", "Ky21", "M162W", "M37W",
  "Mo18W", "Ms71", "NC350", "NC358", "Oh43", "Oh7B", "P39", "Tx303", "Tzi8")
Maize <- list(
  wd = file.path(baseDir, "maize"),
  speciesIDs = "maize",
  genomes = data.table(cbind(genome = gens, version = gens, ploidy = 1)))

MaizeParams <- list(
  orthofinderMethod = "fast", # only uni-directional blast hits, only orthofinder -og
  diamondMode = "fast", # use default diamond2 --fast
  pepString = "fa",
  blkSize = 10)
```

3 Initialize the Maize run with the above specified parameters

```
gparMaize <- with(Maize, init_genespace(
  genomeIDs = genomes$genome,
  versionIDs = genomes$version,
  ploidy = genomes$ploidy,
  speciesIDs = rep(speciesIDs, length(genomes$genome)),
  pepString = MaizeParams$pepString,
  diamondMode = MaizeParams$diamondMode,
  orthofinderMethod = MaizeParams$orthofinderMethod,
  wd = wd,
```

```
  nCores = nThreads,
  path2orthofinder = path2of,
  path2mcscanx = mcscanDir,
  rawGenomeDir = rawAnnotationDir))
```

```
## set working directory to /Users/jlovell/Desktop/GENESPACE_data/results/maize
##
## found raw gff files:
##   /Users/jlovell/Desktop/GENESPACE_data/maize/B73/annotation/Zm-B73-REFERENCE-NAM-5.0_Zm00001eb.1.gff
##  /Users/jlovell/Desktop/GENESPACE_data/maize/B97/annotation/Zm-B97-REFERENCE-NAM-1.0_Zm00018ab.1.gff3
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML103/annotation/Zm-CML103-REFERENCE-NAM-1.0_Zm00021ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML228/annotation/Zm-CML228-REFERENCE-NAM-1.0_Zm00022ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML247/annotation/Zm-CML247-REFERENCE-NAM-1.0_Zm00023ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML277/annotation/Zm-CML277-REFERENCE-NAM-1.0_Zm00024ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML322/annotation/Zm-CML322-REFERENCE-NAM-1.0_Zm00025ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML333/annotation/Zm-CML333-REFERENCE-NAM-1.0_Zm00026ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML52/annotation/Zm-CML52-REFERENCE-NAM-1.0_Zm00019ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML69/annotation/Zm-CML69-REFERENCE-NAM-1.0_Zm00020ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/HP301/annotation/Zm-HP301-REFERENCE-NAM-1.0_Zm00027ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Il14H/annotation/Zm-Il14H-REFERENCE-NAM-1.0_Zm00028ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ki11/annotation/Zm-Ki11-REFERENCE-NAM-1.0_Zm00030ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ki3/annotation/Zm-Ki3-REFERENCE-NAM-1.0_Zm00029ab.1.gff3
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ky21/annotation/Zm-Ky21-REFERENCE-NAM-1.0_Zm00031ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/M162W/annotation/Zm-M162W-REFERENCE-NAM-1.0_Zm00033ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/M37W/annotation/Zm-M37W-REFERENCE-NAM-1.0_Zm00032ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Mo18W/annotation/Zm-Mo18W-REFERENCE-NAM-1.0_Zm00034ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ms71/annotation/Zm-Ms71-REFERENCE-NAM-1.0_Zm00035ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/NC350/annotation/Zm-NC350-REFERENCE-NAM-1.0_Zm00036ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/NC358/annotation/Zm-NC358-REFERENCE-NAM-1.0_Zm00037ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Oh43/annotation/Zm-Oh43-REFERENCE-NAM-1.0_Zm00039ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Oh7B/annotation/Zm-Oh7B-REFERENCE-NAM-1.0_Zm00038ab.1.g
##  /Users/jlovell/Desktop/GENESPACE_data/maize/P39/annotation/Zm-P39-REFERENCE-NAM-1.0_Zm00040ab.1.gff3
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Tx303/annotation/Zm-Tx303-REFERENCE-NAM-1.0_Zm00041ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Tzi8/annotation/Zm-Tzi8-REFERENCE-NAM-1.0_Zm00042ab.1.g
##
## found raw peptide files:
##   /Users/jlovell/Desktop/GENESPACE_data/maize/B73/annotation/Zm-B73-REFERENCE-NAM-5.0_Zm00001eb.1.pro
##  /Users/jlovell/Desktop/GENESPACE_data/maize/B97/annotation/Zm-B97-REFERENCE-NAM-1.0_Zm00018ab.1.prot
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML103/annotation/Zm-CML103-REFERENCE-NAM-1.0_Zm00021ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML228/annotation/Zm-CML228-REFERENCE-NAM-1.0_Zm00022ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML247/annotation/Zm-CML247-REFERENCE-NAM-1.0_Zm00023ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML277/annotation/Zm-CML277-REFERENCE-NAM-1.0_Zm00024ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML322/annotation/Zm-CML322-REFERENCE-NAM-1.0_Zm00025ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML333/annotation/Zm-CML333-REFERENCE-NAM-1.0_Zm00026ab
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML52/annotation/Zm-CML52-REFERENCE-NAM-1.0_Zm00019ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/CML69/annotation/Zm-CML69-REFERENCE-NAM-1.0_Zm00020ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/HP301/annotation/Zm-HP301-REFERENCE-NAM-1.0_Zm00027ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Il14H/annotation/Zm-Il14H-REFERENCE-NAM-1.0_Zm00028ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ki11/annotation/Zm-Ki11-REFERENCE-NAM-1.0_Zm00030ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ki3/annotation/Zm-Ki3-REFERENCE-NAM-1.0_Zm00029ab.1.prot
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ky21/annotation/Zm-Ky21-REFERENCE-NAM-1.0_Zm00031ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/M162W/annotation/Zm-M162W-REFERENCE-NAM-1.0_Zm00033ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/M37W/annotation/Zm-M37W-REFERENCE-NAM-1.0_Zm00032ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Mo18W/annotation/Zm-Mo18W-REFERENCE-NAM-1.0_Zm00034ab.1
```

```
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Ms71/annotation/Zm-Ms71-REFERENCE-NAM-1.0_Zm00035ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/NC350/annotation/Zm-NC350-REFERENCE-NAM-1.0_Zm00036ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/NC358/annotation/Zm-NC358-REFERENCE-NAM-1.0_Zm00037ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Oh43/annotation/Zm-Oh43-REFERENCE-NAM-1.0_Zm00039ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Oh7B/annotation/Zm-Oh7B-REFERENCE-NAM-1.0_Zm00038ab.1.pr
##  /Users/jlovell/Desktop/GENESPACE_data/maize/P39/annotation/Zm-P39-REFERENCE-NAM-1.0_Zm00040ab.1.prot
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Tx303/annotation/Zm-Tx303-REFERENCE-NAM-1.0_Zm00041ab.1
##  /Users/jlovell/Desktop/GENESPACE_data/maize/Tzi8/annotation/Zm-Tzi8-REFERENCE-NAM-1.0_Zm00042ab.1.pr
##
##
## Can't find all parsed annotation files ... need to run parse_annotations, parse_ncbi or parse_phytoz
##
## GENESPACE run initialized:
##  Initial orthofinder database generation method: fast
##  Orthology graph method: global
```

4 Parse the raw annotations.

Here, we need to specify some custom fields to get the right output. Also, for simplicity, we'll drop any chromosomes with the string "alt", as the ploidy in these regions is known to be > 1.

```
parse_annotations(
  gsParam = gparMaize, gffEntryType = "gene", gffIdColumn = "ID",
  headerSep = "_", headerEntryIndex = 1)
```

```
## Parsing annotation files ...
##  B73 ...
##      Importing gff ... found 39756 gff entires, and 39756 gene entries
##      Importing fasta ... found 72539 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      39756 gff-peptide matches
##  Done!
##  B97 ...
##      Importing gff ... found 40368 gff entires, and 40368 gene entries
##      Importing fasta ... found 71813 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40368 gff-peptide matches
##  Done!
##  CML103 ...
##      Importing gff ... found 40013 gff entires, and 40013 gene entries
##      Importing fasta ... found 71007 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40013 gff-peptide matches
##  Done!
##  CML228 ...
##      Importing gff ... found 41577 gff entires, and 41577 gene entries
##      Importing fasta ... found 56346 fasta entires
```

```
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41575 gff-peptide matches
##  Done!
##  CML247 ...
##      Importing gff ... found 40383 gff entires, and 40383 gene entries
##      Importing fasta ... found 71424 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40383 gff-peptide matches
##  Done!
##  CML277 ...
##      Importing gff ... found 40325 gff entires, and 40325 gene entries
##      Importing fasta ... found 54933 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40325 gff-peptide matches
##  Done!
##  CML322 ...
##      Importing gff ... found 41122 gff entires, and 41122 gene entries
##      Importing fasta ... found 72133 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41122 gff-peptide matches
##  Done!
##  CML333 ...
##      Importing gff ... found 40428 gff entires, and 40428 gene entries
##      Importing fasta ... found 71057 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40428 gff-peptide matches
##  Done!
##  CML52 ...
##      Importing gff ... found 40473 gff entires, and 40473 gene entries
##      Importing fasta ... found 70952 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40473 gff-peptide matches
##  Done!
##  CML69 ...
##      Importing gff ... found 40272 gff entires, and 40272 gene entries
##      Importing fasta ... found 71747 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40272 gff-peptide matches
##  Done!
##  HP301 ...
```

```
##      Importing gff ... found 39785 gff entires, and 39785 gene entries
##      Importing fasta ... found 70886 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      39785 gff-peptide matches
##  Done!
##  Il14H ...
##      Importing gff ... found 40290 gff entires, and 40290 gene entries
##      Importing fasta ... found 71539 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40290 gff-peptide matches
##  Done!
##  Ki11 ...
##      Importing gff ... found 39868 gff entires, and 39868 gene entries
##      Importing fasta ... found 70337 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      39868 gff-peptide matches
##  Done!
##  Ki3 ...
##      Importing gff ... found 41059 gff entires, and 41059 gene entries
##      Importing fasta ... found 72225 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41059 gff-peptide matches
##  Done!
##  Ky21 ...
##      Importing gff ... found 40778 gff entires, and 40778 gene entries
##      Importing fasta ... found 72846 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40778 gff-peptide matches
##  Done!
##  M162W ...
##      Importing gff ... found 41486 gff entires, and 41486 gene entries
##      Importing fasta ... found 72750 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41486 gff-peptide matches
##  Done!
##  M37W ...
##      Importing gff ... found 40905 gff entires, and 40905 gene entries
##      Importing fasta ... found 72362 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40905 gff-peptide matches
```

```
##  Done!
##  Mo18W ...
##      Importing gff ... found 41204 gff entires, and 41204 gene entries
##      Importing fasta ... found 73048 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41204 gff-peptide matches
##  Done!
##  Ms71 ...
##      Importing gff ... found 41247 gff entires, and 41247 gene entries
##      Importing fasta ... found 72927 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41247 gff-peptide matches
##  Done!
##  NC350 ...
##      Importing gff ... found 40484 gff entires, and 40484 gene entries
##      Importing fasta ... found 71620 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40484 gff-peptide matches
##  Done!
##  NC358 ...
##      Importing gff ... found 39787 gff entires, and 39787 gene entries
##      Importing fasta ... found 71137 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      39787 gff-peptide matches
##  Done!
##  Oh43 ...
##      Importing gff ... found 39973 gff entires, and 39973 gene entries
##      Importing fasta ... found 71367 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      39973 gff-peptide matches
##  Done!
##  Oh7B ...
##      Importing gff ... found 40334 gff entires, and 40334 gene entries
##      Importing fasta ... found 71755 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      40334 gff-peptide matches
##  Done!
##  P39 ...
##      Importing gff ... found 41478 gff entires, and 41478 gene entries
##      Importing fasta ... found 73162 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
```

```
## subsetting to longest model for each gene
##      41478 gff-peptide matches
##  Done!
##  Tx303 ...
##      Importing gff ... found 41164 gff entires, and 41164 gene entries
##      Importing fasta ... found 72716 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41164 gff-peptide matches
##  Done!
##  Tzi8 ...
##      Importing gff ... found 41593 gff entires, and 41593 gene entries
##      Importing fasta ... found 73551 fasta entires
##
## **FOUND DUPLICATE PEPTIDE FASTA HEADERS. IS THIS JUST A PRIMARY TRANSCRIPT FILE?***
## subsetting to longest model for each gene
##      41592 gff-peptide matches
##  Done!
```

```
# -- drop alt chromosomes
for(i in gparMaize$genomes$genomeIDs){
  gf <- gparMaize$paths$gff[i]
  pf <- gparMaize$paths$peptide[i]
  g <- fread(gf, showProgress = F, na.strings = c("", "NA"))
  n <- sum(grepl("-alt_",g$chr, fixed = T))
  cat(sprintf("\t%s:\t%s alt scaffold genes\n",i, n))
  if(n > 0){
    p <- Biostrings::readAAStringSet(pf)
    g <- subset(g, !grepl("-alt_",g$chr, fixed = T))
    p <- p[g$id]
    Biostrings::writeXStringSet(p, filepath = pf)
    fwrite(g, file = gf, sep = "\t", quote = F)
  }
}
```

```
##  B73:    0 alt scaffold genes
##  B97:    0 alt scaffold genes
##  CML103: 0 alt scaffold genes
##  CML228: 566 alt scaffold genes
##  CML247: 0 alt scaffold genes
##  CML277: 0 alt scaffold genes
##  CML322: 0 alt scaffold genes
##  CML333: 0 alt scaffold genes
##  CML52:  442 alt scaffold genes
##  CML69:  0 alt scaffold genes
##  HP301:  0 alt scaffold genes
##  Il14H:  0 alt scaffold genes
##  Ki11:   0 alt scaffold genes
##  Ki3:    0 alt scaffold genes
##  Ky21:   0 alt scaffold genes
##  M162W:  0 alt scaffold genes
##  M37W:   6 alt scaffold genes
##  Mo18W:  4 alt scaffold genes
##  Ms71:   266 alt scaffold genes
```

```
##  NC350:  0 alt scaffold genes
##  NC358:  0 alt scaffold genes
##  Oh43:   0 alt scaffold genes
##  Oh7B:   0 alt scaffold genes
##  P39:    0 alt scaffold genes
##  Tx303:  156 alt scaffold genes
##  Tzi8:   263 alt scaffold genes
```

5 Run OrthoFinder from within R.

Also set the synteny parameters as default.

```
gparMaize <- set_syntenyParams(gsParam = gparMaize, blkSize = MaizeParams$blkSize)
gparMaize <- run_orthofinder(gsParam = gparMaize)
```

```
##  Running 'draft' a.k.a 'fast' genespace orthofinder method
##  ############################################################
##  ***NOTE***
##  This method should only be used for:
##      (1) closely related diploid species,
##      (2) visualization/genome QC purposes, or
##      (3) inferring orthogroups WITHIN syntenic regions
##  ############################################################
##      Running 1/351 (M162W vs. M162W)
##      Running 2/351 (M162W vs. P39)
##      Running 3/351 (P39 vs. P39)
##      Running 4/351 (M162W vs. Tzi8)
##      Running 5/351 (P39 vs. Tzi8)
##      Running 6/351 (M162W vs. Mo18W)
##      Running 7/351 (P39 vs. Mo18W)
##      Running 8/351 (Tzi8 vs. Tzi8)
##      Running 9/351 (M162W vs. CML322)
##      Running 10/351 (P39 vs. CML322)
##      Running 11/351 (M162W vs. Ki3)
##      Running 12/351 (P39 vs. Ki3)
##      Running 13/351 (Tzi8 vs. Mo18W)
##      Running 14/351 (M162W vs. CML228)
##      Running 15/351 (M162W vs. Tx303)
##      Running 16/351 (P39 vs. CML228)
##      Running 17/351 (P39 vs. Tx303)
##      Running 18/351 (M162W vs. Ms71)
##      Running 19/351 (P39 vs. Ms71)
##      Running 20/351 (Tzi8 vs. CML322)
##      Running 21/351 (Mo18W vs. Mo18W)
##      Running 22/351 (Tzi8 vs. Ki3)
##      Running 23/351 (M162W vs. M37W)
##      Running 24/351 (P39 vs. M37W)
##      Running 25/351 (Tzi8 vs. CML228)
##      Running 26/351 (Tzi8 vs. Tx303)
##      Running 27/351 (Mo18W vs. CML322)
##      Running 28/351 (Tzi8 vs. Ms71)
##      Running 29/351 (M162W vs. Ky21)
##      Running 30/351 (Mo18W vs. Ki3)
```

```
##       Running 31/351 (P39 vs. Ky21)
##       Running 32/351 (CML322 vs. CML322)
##       Running 33/351 (Tzi8 vs. M37W)
##       Running 34/351 (Mo18W vs. CML228)
##       Running 35/351 (Mo18W vs. Tx303)
##       Running 36/351 (CML322 vs. Ki3)
##       Running 37/351 (Mo18W vs. Ms71)
##       Running 38/351 (CML322 vs. CML228)
##       Running 39/351 (CML322 vs. Tx303)
##       Running 40/351 (Ki3 vs. Ki3)
##       Running 41/351 (Tzi8 vs. Ky21)
##       Running 42/351 (CML322 vs. Ms71)
##       Running 43/351 (Mo18W vs. M37W)
##       Running 44/351 (Ki3 vs. CML228)
##       Running 45/351 (Ki3 vs. Tx303)
##       Running 46/351 (Ki3 vs. Ms71)
##       Running 47/351 (CML322 vs. M37W)
##       Running 48/351 (CML228 vs. CML228)
##       Running 49/351 (CML228 vs. Tx303)
##       Running 50/351 (Tx303 vs. Tx303)
##       Running 51/351 (CML228 vs. Ms71)
##       Running 52/351 (Tx303 vs. Ms71)
##       Running 53/351 (Mo18W vs. Ky21)
##       Running 54/351 (M162W vs. NC350)
##       Running 55/351 (Ms71 vs. Ms71)
##       Running 56/351 (P39 vs. NC350)
##       Running 57/351 (Ki3 vs. M37W)
##       Running 58/351 (M162W vs. CML333)
##       Running 59/351 (CML228 vs. M37W)
##       Running 60/351 (Tx303 vs. M37W)
##       Running 61/351 (P39 vs. CML333)
##       Running 62/351 (CML322 vs. Ky21)
##       Running 63/351 (Ms71 vs. M37W)
##       Running 64/351 (M162W vs. CML247)
##       Running 65/351 (P39 vs. CML247)
##       Running 66/351 (M162W vs. B97)
##       Running 67/351 (P39 vs. B97)
##       Running 68/351 (Ki3 vs. Ky21)
##       Running 69/351 (M162W vs. Oh7B)
##       Running 70/351 (Tzi8 vs. NC350)
##       Running 71/351 (P39 vs. Oh7B)
##       Running 72/351 (M162W vs. CML277)
##       Running 73/351 (P39 vs. CML277)
##       Running 74/351 (M37W vs. M37W)
##       Running 75/351 (CML228 vs. Ky21)
##       Running 76/351 (Tx303 vs. Ky21)
##       Running 77/351 (M162W vs. Il14H)
##       Running 78/351 (P39 vs. Il14H)
##       Running 79/351 (Ms71 vs. Ky21)
##       Running 80/351 (M162W vs. CML69)
##       Running 81/351 (Tzi8 vs. CML333)
##       Running 82/351 (P39 vs. CML69)
##       Running 83/351 (Tzi8 vs. CML247)
##       Running 84/351 (Tzi8 vs. B97)
```

```
##      Running 85/351 (Mo18W vs. NC350)
##      Running 86/351 (M37W vs. Ky21)
##      Running 87/351 (Tzi8 vs. Oh7B)
##      Running 88/351 (Tzi8 vs. CML277)
##      Running 89/351 (Mo18W vs. CML333)
##      Running 90/351 (Tzi8 vs. Il14H)
##      Running 91/351 (CML322 vs. NC350)
##      Running 92/351 (Tzi8 vs. CML69)
##      Running 93/351 (Mo18W vs. CML247)
##      Running 94/351 (Mo18W vs. B97)
##      Running 95/351 (Ky21 vs. Ky21)
##      Running 96/351 (CML322 vs. CML333)
##      Running 97/351 (Ki3 vs. NC350)
##      Running 98/351 (Mo18W vs. Oh7B)
##      Running 99/351 (Mo18W vs. CML277)
##      Running 100/351 (M162W vs. CML52)
##      Running 101/351 (P39 vs. CML52)
##      Running 102/351 (CML322 vs. CML247)
##      Running 103/351 (M162W vs. CML103)
##      Running 104/351 (CML228 vs. NC350)
##      Running 105/351 (Tx303 vs. NC350)
##      Running 106/351 (P39 vs. CML103)
##      Running 107/351 (CML322 vs. B97)
##      Running 108/351 (Mo18W vs. Il14H)
##      Running 109/351 (Ki3 vs. CML333)
##      Running 110/351 (Mo18W vs. CML69)
##      Running 111/351 (Ms71 vs. NC350)
##      Running 112/351 (M162W vs. Oh43)
##      Running 113/351 (CML322 vs. Oh7B)
##      Running 114/351 (P39 vs. Oh43)
##      Running 115/351 (CML322 vs. CML277)
##      Running 116/351 (Ki3 vs. CML247)
##      Running 117/351 (CML228 vs. CML333)
##      Running 118/351 (Tx303 vs. CML333)
##      Running 119/351 (Ki3 vs. B97)
##      Running 120/351 (CML322 vs. Il14H)
##      Running 121/351 (Ms71 vs. CML333)
##      Running 122/351 (CML322 vs. CML69)
##      Running 123/351 (Ki3 vs. Oh7B)
##      Running 124/351 (CML228 vs. CML247)
##      Running 125/351 (Tx303 vs. CML247)
##      Running 126/351 (Ki3 vs. CML277)
##      Running 127/351 (M37W vs. NC350)
##      Running 128/351 (CML228 vs. B97)
##      Running 129/351 (Tx303 vs. B97)
##      Running 130/351 (Ms71 vs. CML247)
##      Running 131/351 (Tzi8 vs. CML52)
##      Running 132/351 (M162W vs. Ki11)
##      Running 133/351 (Ki3 vs. Il14H)
##      Running 134/351 (Ms71 vs. B97)
##      Running 135/351 (P39 vs. Ki11)
##      Running 136/351 (CML228 vs. Oh7B)
##      Running 137/351 (Tx303 vs. Oh7B)
##      Running 138/351 (Tzi8 vs. CML103)
```

```
##       Running 139/351 (CML228 vs. CML277)
##       Running 140/351 (Tx303 vs. CML277)
##       Running 141/351 (Ki3 vs. CML69)
##       Running 142/351 (M37W vs. CML333)
##       Running 143/351 (Ms71 vs. Oh7B)
##       Running 144/351 (Ms71 vs. CML277)
##       Running 145/351 (Tzi8 vs. Oh43)
##       Running 146/351 (CML228 vs. Il14H)
##       Running 147/351 (Tx303 vs. Il14H)
##       Running 148/351 (M37W vs. CML247)
##       Running 149/351 (CML228 vs. CML69)
##       Running 150/351 (Tx303 vs. CML69)
##       Running 151/351 (M162W vs. NC358)
##       Running 152/351 (M162W vs. HP301)
##       Running 153/351 (Ms71 vs. Il14H)
##       Running 154/351 (M37W vs. B97)
##       Running 155/351 (P39 vs. NC358)
##       Running 156/351 (P39 vs. HP301)
##       Running 157/351 (Ky21 vs. NC350)
##       Running 158/351 (Ms71 vs. CML69)
##       Running 159/351 (M162W vs. B73)
##       Running 160/351 (P39 vs. B73)
##       Running 161/351 (M37W vs. Oh7B)
##       Running 162/351 (Mo18W vs. CML52)
##       Running 163/351 (M37W vs. CML277)
##       Running 164/351 (Mo18W vs. CML103)
##       Running 165/351 (Ky21 vs. CML333)
##       Running 166/351 (Tzi8 vs. Ki11)
##       Running 167/351 (M37W vs. Il14H)
##       Running 168/351 (Mo18W vs. Oh43)
##       Running 169/351 (M37W vs. CML69)
##       Running 170/351 (Ky21 vs. CML247)
##       Running 171/351 (CML322 vs. CML52)
##       Running 172/351 (Ky21 vs. B97)
##       Running 173/351 (CML322 vs. CML103)
##       Running 174/351 (Tzi8 vs. NC358)
##       Running 175/351 (Tzi8 vs. HP301)
##       Running 176/351 (Ky21 vs. Oh7B)
##       Running 177/351 (Ky21 vs. CML277)
##       Running 178/351 (CML322 vs. Oh43)
##       Running 179/351 (Ki3 vs. CML52)
##       Running 180/351 (Tzi8 vs. B73)
##       Running 181/351 (Ki3 vs. CML103)
##       Running 182/351 (Ky21 vs. Il14H)
##       Running 183/351 (Mo18W vs. Ki11)
##       Running 184/351 (Ky21 vs. CML69)
##       Running 185/351 (CML228 vs. CML52)
##       Running 186/351 (Tx303 vs. CML52)
##       Running 187/351 (Ki3 vs. Oh43)
##       Running 188/351 (CML228 vs. CML103)
##       Running 189/351 (Tx303 vs. CML103)
##       Running 190/351 (Ms71 vs. CML52)
##       Running 191/351 (Ms71 vs. CML103)
##       Running 192/351 (CML322 vs. Ki11)
```

```
##       Running 193/351 (Mo18W vs. NC358)
##       Running 194/351 (Mo18W vs. HP301)
##       Running 195/351 (CML228 vs. Oh43)
##       Running 196/351 (Tx303 vs. Oh43)
##       Running 197/351 (NC350 vs. NC350)
##       Running 198/351 (Mo18W vs. B73)
##       Running 199/351 (Ms71 vs. Oh43)
##       Running 200/351 (M37W vs. CML52)
##       Running 201/351 (Ki3 vs. Ki11)
##       Running 202/351 (M37W vs. CML103)
##       Running 203/351 (NC350 vs. CML333)
##       Running 204/351 (CML322 vs. NC358)
##       Running 205/351 (CML322 vs. HP301)
##       Running 206/351 (CML322 vs. B73)
##       Running 207/351 (CML228 vs. Ki11)
##       Running 208/351 (Tx303 vs. Ki11)
##       Running 209/351 (M37W vs. Oh43)
##       Running 210/351 (NC350 vs. CML247)
##       Running 211/351 (CML333 vs. CML333)
##       Running 212/351 (NC350 vs. B97)
##       Running 213/351 (Ms71 vs. Ki11)
##       Running 214/351 (Ki3 vs. NC358)
##       Running 215/351 (Ki3 vs. HP301)
##       Running 216/351 (NC350 vs. Oh7B)
##       Running 217/351 (Ki3 vs. B73)
##       Running 218/351 (CML333 vs. CML247)
##       Running 219/351 (Ky21 vs. CML52)
##       Running 220/351 (NC350 vs. CML277)
##       Running 221/351 (CML228 vs. NC358)
##       Running 222/351 (CML333 vs. B97)
##       Running 223/351 (Tx303 vs. NC358)
##       Running 224/351 (CML228 vs. HP301)
##       Running 225/351 (Tx303 vs. HP301)
##       Running 226/351 (Ky21 vs. CML103)
##       Running 227/351 (NC350 vs. Il14H)
##       Running 228/351 (Ms71 vs. NC358)
##       Running 229/351 (M37W vs. Ki11)
##       Running 230/351 (CML247 vs. CML247)
##       Running 231/351 (Ms71 vs. HP301)
##       Running 232/351 (CML228 vs. B73)
##       Running 233/351 (Tx303 vs. B73)
##       Running 234/351 (CML333 vs. Oh7B)
##       Running 235/351 (NC350 vs. CML69)
##       Running 236/351 (CML333 vs. CML277)
##       Running 237/351 (CML247 vs. B97)
##       Running 238/351 (Ky21 vs. Oh43)
##       Running 239/351 (Ms71 vs. B73)
##       Running 240/351 (B97 vs. B97)
##       Running 241/351 (CML333 vs. Il14H)
##       Running 242/351 (CML247 vs. Oh7B)
##       Running 243/351 (CML247 vs. CML277)
##       Running 244/351 (B97 vs. Oh7B)
##       Running 245/351 (CML333 vs. CML69)
##       Running 246/351 (B97 vs. CML277)
```

```
##      Running 247/351 (M37W vs. NC358)
##      Running 248/351 (M37W vs. HP301)
##      Running 249/351 (CML247 vs. Il14H)
##      Running 250/351 (Oh7B vs. Oh7B)
##      Running 251/351 (Oh7B vs. CML277)
##      Running 252/351 (B97 vs. Il14H)
##      Running 253/351 (CML247 vs. CML69)
##      Running 254/351 (M37W vs. B73)
##      Running 255/351 (CML277 vs. CML277)
##      Running 256/351 (Ky21 vs. Ki11)
##      Running 257/351 (B97 vs. CML69)
##      Running 258/351 (Oh7B vs. Il14H)
##      Running 259/351 (CML277 vs. Il14H)
##      Running 260/351 (Oh7B vs. CML69)
##      Running 261/351 (CML277 vs. CML69)
##      Running 262/351 (Il14H vs. Il14H)
##      Running 263/351 (Ky21 vs. NC358)
##      Running 264/351 (Ky21 vs. HP301)
##      Running 265/351 (Il14H vs. CML69)
##      Running 266/351 (CML69 vs. CML69)
##      Running 267/351 (Ky21 vs. B73)
##      Running 268/351 (NC350 vs. CML52)
##      Running 269/351 (NC350 vs. CML103)
##      Running 270/351 (CML333 vs. CML52)
##      Running 271/351 (NC350 vs. Oh43)
##      Running 272/351 (CML333 vs. CML103)
##      Running 273/351 (CML247 vs. CML52)
##      Running 274/351 (CML333 vs. Oh43)
##      Running 275/351 (B97 vs. CML52)
##      Running 276/351 (CML247 vs. CML103)
##      Running 277/351 (B97 vs. CML103)
##      Running 278/351 (Oh7B vs. CML52)
##      Running 279/351 (CML247 vs. Oh43)
##      Running 280/351 (CML277 vs. CML52)
##      Running 281/351 (NC350 vs. Ki11)
##      Running 282/351 (Oh7B vs. CML103)
##      Running 283/351 (B97 vs. Oh43)
##      Running 284/351 (CML277 vs. CML103)
##      Running 285/351 (Il14H vs. CML52)
##      Running 286/351 (Oh7B vs. Oh43)
##      Running 287/351 (CML69 vs. CML52)
##      Running 288/351 (Il14H vs. CML103)
##      Running 289/351 (CML277 vs. Oh43)
##      Running 290/351 (CML333 vs. Ki11)
##      Running 291/351 (CML69 vs. CML103)
##      Running 292/351 (NC350 vs. NC358)
##      Running 293/351 (NC350 vs. HP301)
##      Running 294/351 (Il14H vs. Oh43)
##      Running 295/351 (CML247 vs. Ki11)
##      Running 296/351 (CML69 vs. Oh43)
##      Running 297/351 (NC350 vs. B73)
##      Running 298/351 (B97 vs. Ki11)
##      Running 299/351 (CML333 vs. NC358)
##      Running 300/351 (CML333 vs. HP301)
```

```
##      Running 301/351 (Oh7B vs. Ki11)
##      Running 302/351 (CML277 vs. Ki11)
##      Running 303/351 (CML333 vs. B73)
##      Running 304/351 (CML247 vs. NC358)
##      Running 305/351 (CML247 vs. HP301)
##      Running 306/351 (Il14H vs. Ki11)
##      Running 307/351 (B97 vs. NC358)
##      Running 308/351 (B97 vs. HP301)
##      Running 309/351 (CML69 vs. Ki11)
##      Running 310/351 (CML247 vs. B73)
##      Running 311/351 (B97 vs. B73)
##      Running 312/351 (Oh7B vs. NC358)
##      Running 313/351 (Oh7B vs. HP301)
##      Running 314/351 (CML277 vs. NC358)
##      Running 315/351 (CML277 vs. HP301)
##      Running 316/351 (Oh7B vs. B73)
##      Running 317/351 (CML277 vs. B73)
##      Running 318/351 (Il14H vs. NC358)
##      Running 319/351 (Il14H vs. HP301)
##      Running 320/351 (CML52 vs. CML52)
##      Running 321/351 (CML69 vs. NC358)
##      Running 322/351 (CML69 vs. HP301)
##      Running 323/351 (Il14H vs. B73)
##      Running 324/351 (CML52 vs. CML103)
##      Running 325/351 (CML69 vs. B73)
##      Running 326/351 (CML103 vs. CML103)
##      Running 327/351 (CML52 vs. Oh43)
##      Running 328/351 (CML103 vs. Oh43)
##      Running 329/351 (Oh43 vs. Oh43)
##      Running 330/351 (CML52 vs. Ki11)
##      Running 331/351 (CML103 vs. Ki11)
##      Running 332/351 (Oh43 vs. Ki11)
##      Running 333/351 (CML52 vs. NC358)
##      Running 334/351 (CML52 vs. HP301)
##      Running 335/351 (CML103 vs. NC358)
##      Running 336/351 (CML103 vs. HP301)
##      Running 337/351 (CML52 vs. B73)
##      Running 338/351 (CML103 vs. B73)
##      Running 339/351 (Oh43 vs. NC358)
##      Running 340/351 (Oh43 vs. HP301)
##      Running 341/351 (Ki11 vs. Ki11)
##      Running 342/351 (Oh43 vs. B73)
##      Running 343/351 (Ki11 vs. NC358)
##      Running 344/351 (Ki11 vs. HP301)
##      Running 345/351 (Ki11 vs. B73)
##      Running 346/351 (NC358 vs. NC358)
##      Running 347/351 (NC358 vs. HP301)
##      Running 348/351 (HP301 vs. HP301)
##      Running 349/351 (NC358 vs. B73)
##      Running 350/351 (HP301 vs. B73)
##      Running 351/351 (B73 vs. B73)
##      Done!
##  Inverting intergenomic files ... Done!
##  Running orthofinder -og on pre-computed blast:
```

```
##
##
##  OrthoFinder version 2.5.4 Copyright (C) 2014 David Emms
##
##  2022-02-12 10:26:06 : Starting OrthoFinder 2.5.4
##  4 thread(s) for highly parallel tasks (BLAST searches etc.)
##  1 thread(s) for OrthoFinder algorithm
##
##  Checking required programs are installed
##  ----------------------------------------
##  Test can run "mcl -h" - ok
##  Using previously calculated BLAST results in /Users/jlovell/Desktop/GENESPACE_data/results/maize/or
##
##  Running OrthoFinder algorithm
##  -----------------------------
##  2022-02-12 10:26:11 : Initial processing of each species
##  2022-02-12 10:28:40 : Initial processing of species 0 complete
##  2022-02-12 10:31:08 : Initial processing of species 1 complete
##  2022-02-12 10:33:38 : Initial processing of species 2 complete
##  2022-02-12 10:36:06 : Initial processing of species 3 complete
##  2022-02-12 10:38:36 : Initial processing of species 4 complete
##  2022-02-12 10:41:04 : Initial processing of species 5 complete
##  2022-02-12 10:43:38 : Initial processing of species 6 complete
##  2022-02-12 10:46:09 : Initial processing of species 7 complete
##  2022-02-12 10:48:39 : Initial processing of species 8 complete
##  2022-02-12 10:51:10 : Initial processing of species 9 complete
##  2022-02-12 10:53:40 : Initial processing of species 10 complete
##  2022-02-12 10:56:10 : Initial processing of species 11 complete
##  2022-02-12 10:58:41 : Initial processing of species 12 complete
##  2022-02-12 11:01:11 : Initial processing of species 13 complete
##  2022-02-12 11:03:40 : Initial processing of species 14 complete
##  2022-02-12 11:06:11 : Initial processing of species 15 complete
##  2022-02-12 11:08:47 : Initial processing of species 16 complete
##  2022-02-12 11:11:25 : Initial processing of species 17 complete
##  2022-02-12 11:14:07 : Initial processing of species 18 complete
##  2022-02-12 11:16:51 : Initial processing of species 19 complete
##  2022-02-12 11:19:36 : Initial processing of species 20 complete
##  2022-02-12 11:22:20 : Initial processing of species 21 complete
##  2022-02-12 11:25:03 : Initial processing of species 22 complete
##  2022-02-12 11:27:43 : Initial processing of species 23 complete
##  2022-02-12 11:30:24 : Initial processing of species 24 complete
##  2022-02-12 11:33:05 : Initial processing of species 25 complete
##  2022-02-12 11:38:41 : Connected putative homologues
##  2022-02-12 11:39:04 : Written final scores for species 0 to graph file
##  2022-02-12 11:39:27 : Written final scores for species 1 to graph file
##  2022-02-12 11:39:49 : Written final scores for species 2 to graph file
##  2022-02-12 11:40:12 : Written final scores for species 3 to graph file
##  2022-02-12 11:40:34 : Written final scores for species 4 to graph file
##  2022-02-12 11:40:56 : Written final scores for species 5 to graph file
##  2022-02-12 11:41:20 : Written final scores for species 6 to graph file
##  2022-02-12 11:41:43 : Written final scores for species 7 to graph file
##  2022-02-12 11:42:06 : Written final scores for species 8 to graph file
##  2022-02-12 11:42:28 : Written final scores for species 9 to graph file
##  2022-02-12 11:42:50 : Written final scores for species 10 to graph file
```

```
##  2022-02-12 11:43:13 : Written final scores for species 11 to graph file
##  2022-02-12 11:43:35 : Written final scores for species 12 to graph file
##  2022-02-12 11:43:59 : Written final scores for species 13 to graph file
##  2022-02-12 11:44:21 : Written final scores for species 14 to graph file
##  2022-02-12 11:44:45 : Written final scores for species 15 to graph file
##  2022-02-12 11:45:07 : Written final scores for species 16 to graph file
##  2022-02-12 11:45:30 : Written final scores for species 17 to graph file
##  2022-02-12 11:45:53 : Written final scores for species 18 to graph file
##  2022-02-12 11:46:16 : Written final scores for species 19 to graph file
##  2022-02-12 11:46:38 : Written final scores for species 20 to graph file
##  2022-02-12 11:47:00 : Written final scores for species 21 to graph file
##  2022-02-12 11:47:23 : Written final scores for species 22 to graph file
##  2022-02-12 11:47:46 : Written final scores for species 23 to graph file
##  2022-02-12 11:48:09 : Written final scores for species 24 to graph file
##  2022-02-12 11:48:32 : Written final scores for species 25 to graph file
##  2022-02-12 12:01:22 : Ran MCL
##
##  Writing orthogroups to file
##  ---------------------------
##  OrthoFinder assigned 1043270 genes (98.9% of total) to 50690 orthogroups. Fifty percent of all genes
##
##  2022-02-12 12:02:22 : Done orthogroups
##
##  Results:
##      /Users/jlovell/Desktop/GENESPACE_data/results/maize/orthofinder/OrthoFinder/Results_Feb12/
##
##  CITATION:
##   When publishing work that uses OrthoFinder please cite:
##   Emms D.M. & Kelly S. (2019), Genome Biology 20:238
##
##   If you use the species tree in your work then please also cite:
##   Emms D.M. & Kelly S. (2017), MBE 34(12): 3267-3278
##   Emms D.M. & Kelly S. (2018), bioRxiv https://doi.org/10.1101/267914
```

6 Build synteny data

```
gparMaize <- find_orthofinderResults(gsParam = gparMaize)
gparMaize <- synteny(gsParam = gparMaize, overwrite = T)
```

```
## Parsing the gff files ...
##  Reading the gffs and adding orthofinder IDs ... Done!
##  Found 61866 global OGs for 1054446 genes
##  QC-ing genome to ensure chromosomes/scaffolds are big enough...
##              Genome: n. chrs PASS/FAIL, n. genes PASS/FAIL, n. OGs PASS/FAIL
##      B73: 27/163, 39236/520, 36794/292
##      B97: 22/78, 40239/129, 37651/126
##      CML103: 27/98, 39813/200, 37280/177
##      CML228: 98/330, 40374/635, 37795/603
##      CML247: 28/137, 40127/256, 37591/240
##      CML277: 33/143, 40076/249, 37507/237
##      CML322: 31/153, 40835/287, 37333/239
##      CML333: 27/115, 40213/215, 37290/197
```

```
##      CML52: 122/437, 39098/933, 36792/874
##      CML69: 34/183, 39941/331, 37466/296
##      HP301: 25/99, 39597/188, 37122/150
##      Il14H: 20/66, 40144/146, 37485/131
##      Ki11: 29/175, 39571/297, 37168/269
##      Ki3: 35/184, 40741/318, 37652/264
##      Ky21: 32/87, 40618/160, 38016/150
##      M162W: 25/138, 41167/319, 37638/261
##      M37W: 24/91, 40742/157, 38013/149
##      Mo18W: 27/150, 40863/337, 38102/302
##      Ms71: 47/131, 40751/230, 37721/218
##      NC350: 32/147, 40232/252, 37349/232
##      NC358: 29/160, 39509/278, 37160/258
##      Oh43: 28/112, 39759/214, 37316/201
##      Oh7B: 31/107, 40123/211, 37539/183
##      P39: 35/78, 41304/174, 38200/156
##      Tx303: 39/163, 40693/315, 38082/297
##      Tzi8: 55/268, 40855/474, 38087/449
##  All look good!
##  Defining collinear orthogroup arrays ...
##  Found the following counts of arrays / genome:
##      B73: 2862 genes in 1116 collinear arrays
##      B97: 2630 genes in 1086 collinear arrays
##      CML103: 2657 genes in 1103 collinear arrays
##      CML228: 2854 genes in 1217 collinear arrays
##      CML247: 2707 genes in 1097 collinear arrays
##      CML277: 2611 genes in 1071 collinear arrays
##      CML322: 3613 genes in 1303 collinear arrays
##      CML333: 2896 genes in 1190 collinear arrays
##      CML52: 2834 genes in 1185 collinear arrays
##      CML69: 2549 genes in 1034 collinear arrays
##      HP301: 2599 genes in 1020 collinear arrays
##      Il14H: 2779 genes in 1156 collinear arrays
##      Ki11: 2532 genes in 1053 collinear arrays
##      Ki3: 3100 genes in 1245 collinear arrays
##      Ky21: 2664 genes in 1122 collinear arrays
##      M162W: 3645 genes in 1298 collinear arrays
##      M37W: 2829 genes in 1161 collinear arrays
##      Mo18W: 2779 genes in 1148 collinear arrays
##      Ms71: 2993 genes in 1231 collinear arrays
##      NC350: 3004 genes in 1201 collinear arrays
##      NC358: 2506 genes in 1019 collinear arrays
##      Oh43: 2618 genes in 1075 collinear arrays
##      Oh7B: 2756 genes in 1117 collinear arrays
##      P39: 3012 genes in 1211 collinear arrays
##      Tx303: 2648 genes in 1116 collinear arrays
##      Tzi8: 2863 genes in 1176 collinear arrays
## Pulling synteny for 351 unique pairwise combinations of genomes
##  Running 88 chunks of 4 combinations each:
##  Chunk 1 / 88 (12:03:56) ... Done!
##  M162W   -M162W   : 564374 (tot), 60820/153 (reg), 41412/153 (blk)
##  M162W   -P39     : 442385 (tot), 46251/11 (reg), 29134/22 (blk)
##  P39     -P39     : 542583 (tot), 58663/113 (reg), 41471/113 (blk)
##  M162W   -Tzi8    : 446962 (tot), 47043/10 (reg), 29367/18 (blk)
```

```
##  Chunk 2 / 88 (12:04:52) ... Done!
##  P39     -Tzi8    : 435274 (tot), 45183/11 (reg), 28833/26 (blk)
##  M162W   -Mo18W   : 448036 (tot), 47076/13 (reg), 29453/28 (blk)
##  P39     -Mo18W   : 433488 (tot), 44961/14 (reg), 29038/29 (blk)
##  Tzi8    -Tzi8    : 538096 (tot), 58460/323 (reg), 41326/323 (blk)
##  Chunk 3 / 88 (12:05:45) ... Done!
##  M162W   -CML322  : 443729 (tot), 47404/15 (reg), 29471/26 (blk)
##  P39     -CML322  : 430025 (tot), 44840/12 (reg), 28933/28 (blk)
##  M162W   -Ki3     : 444679 (tot), 46492/10 (reg), 29454/16 (blk)
##  P39     -Ki3     : 430696 (tot), 44601/11 (reg), 28845/25 (blk)
##  Chunk 4 / 88 (12:06:40) ... Done!
##  Tzi8    -Mo18W   : 433930 (tot), 45846/12 (reg), 29594/18 (blk)
##  M162W   -CML228  : 446446 (tot), 46097/12 (reg), 29262/27 (blk)
##  M162W   -Tx303   : 444268 (tot), 46012/10 (reg), 29427/18 (blk)
##  P39     -CML228  : 435813 (tot), 44478/11 (reg), 28601/25 (blk)
##  Chunk 5 / 88 (12:07:36) ... Done!
##  P39     -Tx303   : 435211 (tot), 45125/12 (reg), 29126/25 (blk)
##  M162W   -Ms71    : 441792 (tot), 46168/11 (reg), 29418/20 (blk)
##  P39     -Ms71    : 432614 (tot), 45712/12 (reg), 29370/27 (blk)
##  Tzi8    -CML322  : 430583 (tot), 45632/14 (reg), 29484/20 (blk)
##  Chunk 6 / 88 (12:08:31) ... Done!
##  Mo18W   -Mo18W   : 527925 (tot), 57869/177 (reg), 41197/177 (blk)
##  Tzi8    -Ki3     : 430126 (tot), 45429/10 (reg), 29546/12 (blk)
##  M162W   -M37W    : 445002 (tot), 46503/10 (reg), 29516/16 (blk)
##  P39     -M37W    : 433953 (tot), 45457/12 (reg), 29132/24 (blk)
##  Chunk 7 / 88 (12:09:20) ... Done!
##  Tzi8    -CML228  : 433235 (tot), 45594/10 (reg), 29400/19 (blk)
##  Tzi8    -Tx303   : 433910 (tot), 45473/10 (reg), 29474/14 (blk)
##  Mo18W   -CML322  : 424020 (tot), 45736/16 (reg), 29482/24 (blk)
##  Tzi8    -Ms71    : 430164 (tot), 45391/10 (reg), 29314/14 (blk)
##  Chunk 8 / 88 (12:10:13) ... Done!
##  M162W   -Ky21    : 445553 (tot), 47948/10 (reg), 29772/18 (blk)
##  Mo18W   -Ki3     : 426154 (tot), 45191/12 (reg), 29454/16 (blk)
##  P39     -Ky21    : 432923 (tot), 45772/12 (reg), 29433/22 (blk)
##  CML322  -CML322  : 562391 (tot), 59905/181 (reg), 41075/181 (blk)
##  Chunk 9 / 88 (12:11:02) ... Done!
##  Tzi8    -M37W    : 432556 (tot), 46125/10 (reg), 29568/14 (blk)
##  Mo18W   -CML228  : 426842 (tot), 44873/13 (reg), 29184/22 (blk)
##  Mo18W   -Tx303   : 426848 (tot), 45331/12 (reg), 29661/18 (blk)
##  CML322  -Ki3     : 443807 (tot), 46337/12 (reg), 29594/18 (blk)
##  Chunk 10 / 88 (12:11:56) ... Done!
##  Mo18W   -Ms71    : 422292 (tot), 45138/13 (reg), 29357/19 (blk)
##  CML322  -CML228  : 446368 (tot), 45647/13 (reg), 29306/23 (blk)
##  CML322  -Tx303   : 446289 (tot), 45732/14 (reg), 29413/20 (blk)
##  Ki3     -Ki3     : 547666 (tot), 57066/212 (reg), 41018/212 (blk)
##  Chunk 11 / 88 (12:12:48) ... Done!
##  Tzi8    -Ky21    : 430208 (tot), 45823/10 (reg), 29558/16 (blk)
##  CML322  -Ms71    : 442264 (tot), 45666/12 (reg), 29401/16 (blk)
##  Mo18W   -M37W    : 425520 (tot), 45447/12 (reg), 29525/18 (blk)
##  Ki3     -CML228  : 435448 (tot), 46097/11 (reg), 30424/18 (blk)
##  Chunk 12 / 88 (12:13:42) ... Done!
##  Ki3     -Tx303   : 436734 (tot), 44788/10 (reg), 29404/12 (blk)
##  Ki3     -Ms71    : 431990 (tot), 44982/11 (reg), 29331/13 (blk)
##  CML322  -M37W    : 444304 (tot), 45607/14 (reg), 29411/20 (blk)
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##  CML228  -CML228  : 526978 (tot), 56758/428 (reg), 41006/428 (blk)
##  Chunk 13 / 88 (12:14:28) ... Done!
##  CML228  -Tx303   : 426638 (tot), 44725/11 (reg), 29189/20 (blk)
##  Tx303   -Tx303   : 523642 (tot), 56330/202 (reg), 41006/202 (blk)
##  CML228  -Ms71    : 423944 (tot), 44491/11 (reg), 29027/17 (blk)
##  Tx303   -Ms71    : 422481 (tot), 44926/10 (reg), 29537/14 (blk)
##  Chunk 14 / 88 (12:15:17) ... Done!
##  Mo18W   -Ky21    : 425730 (tot), 46009/12 (reg), 29640/20 (blk)
##  M162W   -NC350   : 443165 (tot), 47029/10 (reg), 29295/18 (blk)
##  Ms71    -Ms71    : 538385 (tot), 56691/178 (reg), 40977/178 (blk)
##  P39     -NC350   : 431723 (tot), 45373/12 (reg), 28884/26 (blk)
##  Chunk 15 / 88 (12:16:09) ... Done!
##  Ki3     -M37W    : 435558 (tot), 45193/10 (reg), 29414/12 (blk)
##  M162W   -CML333  : 443328 (tot), 47117/10 (reg), 29349/20 (blk)
##  CML228  -M37W    : 426964 (tot), 44992/11 (reg), 29242/17 (blk)
##  Tx303   -M37W    : 424687 (tot), 45263/10 (reg), 29559/14 (blk)
##  Chunk 16 / 88 (12:17:06) ... Done!
##  P39     -CML333  : 430664 (tot), 44881/13 (reg), 28880/27 (blk)
##  CML322  -Ky21    : 445462 (tot), 47540/14 (reg), 29402/24 (blk)
##  Ms71    -M37W    : 433081 (tot), 45472/11 (reg), 29474/15 (blk)
##  M162W   -CML247  : 444507 (tot), 47590/10 (reg), 29399/16 (blk)
##  Chunk 17 / 88 (12:18:03) ... Done!
##  P39     -CML247  : 430341 (tot), 44708/11 (reg), 28688/24 (blk)
##  M162W   -B97     : 445260 (tot), 47963/11 (reg), 29410/18 (blk)
##  P39     -B97     : 431503 (tot), 45748/10 (reg), 29320/24 (blk)
##  Ki3     -Ky21    : 433786 (tot), 45216/10 (reg), 29479/16 (blk)
##  Chunk 18 / 88 (12:19:00) ... Done!
##  M162W   -Oh7B    : 444500 (tot), 47494/14 (reg), 29621/26 (blk)
##  Tzi8    -NC350   : 430727 (tot), 46606/10 (reg), 29648/14 (blk)
##  P39     -Oh7B    : 431827 (tot), 45133/12 (reg), 29271/24 (blk)
##  M162W   -CML277  : 443453 (tot), 47222/11 (reg), 29278/20 (blk)
##  Chunk 19 / 88 (12:19:54) ... Done!
##  P39     -CML277  : 429915 (tot), 44543/12 (reg), 28746/26 (blk)
##  M37W    -M37W    : 523887 (tot), 57481/115 (reg), 40897/115 (blk)
##  CML228  -Ky21    : 424801 (tot), 44735/11 (reg), 29217/18 (blk)
##  Tx303   -Ky21    : 423570 (tot), 45324/10 (reg), 29716/18 (blk)
##  Chunk 20 / 88 (12:20:40) ... Done!
##  M162W   -Il14H   : 441510 (tot), 46521/12 (reg), 29087/20 (blk)
##  P39     -Il14H   : 432923 (tot), 47639/10 (reg), 30750/20 (blk)
##  Ms71    -Ky21    : 431457 (tot), 45445/11 (reg), 29718/19 (blk)
##  M162W   -CML69   : 442092 (tot), 46967/10 (reg), 29309/24 (blk)
##  Chunk 21 / 88 (12:21:36) ... Done!
##  Tzi8    -CML333  : 428624 (tot), 45624/10 (reg), 29533/14 (blk)
##  P39     -CML69   : 430221 (tot), 44801/10 (reg), 28702/30 (blk)
##  Tzi8    -CML247  : 429608 (tot), 46134/10 (reg), 29655/12 (blk)
##  Tzi8    -B97     : 430814 (tot), 45953/10 (reg), 29319/16 (blk)
##  Chunk 22 / 88 (12:22:29) ... Done!
##  Mo18W   -NC350   : 424867 (tot), 46147/12 (reg), 29493/18 (blk)
##  M37W    -Ky21    : 425054 (tot), 45897/10 (reg), 29790/18 (blk)
##  Tzi8    -Oh7B    : 429918 (tot), 45322/13 (reg), 29343/18 (blk)
##  Tzi8    -CML277  : 427698 (tot), 45371/10 (reg), 29499/14 (blk)
##  Chunk 23 / 88 (12:23:16) ... Done!
##  Mo18W   -CML333  : 422277 (tot), 45844/12 (reg), 29415/18 (blk)
##  Tzi8    -Il14H   : 425853 (tot), 44794/12 (reg), 28832/20 (blk)
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##  CML322  -NC350   : 444278 (tot), 46784/14 (reg), 29506/20 (blk)
##  Tzi8    -CML69   : 429558 (tot), 46114/10 (reg), 29591/20 (blk)
##  Chunk 24 / 88 (12:24:08) ... Done!
##  Mo18W   -CML247  : 423228 (tot), 46025/12 (reg), 29448/16 (blk)
##  Mo18W   -B97     : 426015 (tot), 46223/12 (reg), 29340/20 (blk)
##  Ky21    -Ky21    : 516203 (tot), 57143/119 (reg), 40775/119 (blk)
##  CML322  -CML333  : 444456 (tot), 46957/14 (reg), 29506/20 (blk)
##  Chunk 25 / 88 (12:24:57) ... Done!
##  Ki3     -NC350   : 432456 (tot), 45722/10 (reg), 29740/12 (blk)
##  Mo18W   -Oh7B    : 425446 (tot), 45915/17 (reg), 29459/25 (blk)
##  Mo18W   -CML277  : 422071 (tot), 45781/12 (reg), 29479/18 (blk)
##  M162W   -CML52   : 443277 (tot), 46318/14 (reg), 28731/24 (blk)
##  Chunk 26 / 88 (12:25:51) ... Done!
##  P39     -CML52   : 429328 (tot), 44123/14 (reg), 28275/30 (blk)
##  CML322  -CML247  : 444858 (tot), 47480/14 (reg), 29536/18 (blk)
##  M162W   -CML103  : 442767 (tot), 46635/10 (reg), 29294/16 (blk)
##  CML228  -NC350   : 424684 (tot), 45538/11 (reg), 29442/18 (blk)
##  Chunk 27 / 88 (12:26:45) ... Done!
##  Tx303   -NC350   : 423706 (tot), 45524/10 (reg), 29398/14 (blk)
##  P39     -CML103  : 430305 (tot), 44729/10 (reg), 28897/23 (blk)
##  CML322  -B97     : 444575 (tot), 47410/12 (reg), 29320/22 (blk)
##  Mo18W   -Il14H   : 420548 (tot), 45049/14 (reg), 29066/24 (blk)
##  Chunk 28 / 88 (12:27:36) ... Done!
##  Ki3     -CML333  : 430020 (tot), 45431/11 (reg), 29616/14 (blk)
##  Mo18W   -CML69   : 422851 (tot), 45982/12 (reg), 29475/24 (blk)
##  Ms71    -NC350   : 430109 (tot), 45652/11 (reg), 29335/15 (blk)
##  M162W   -Oh43    : 442505 (tot), 47332/10 (reg), 29393/26 (blk)
##  Chunk 29 / 88 (12:28:27) ... Done!
##  CML322  -Oh7B    : 444665 (tot), 47368/14 (reg), 29392/20 (blk)
##  P39     -Oh43    : 429760 (tot), 45077/12 (reg), 29405/22 (blk)
##  CML322  -CML277  : 443006 (tot), 47076/14 (reg), 29392/16 (blk)
##  Ki3     -CML247  : 436366 (tot), 45674/10 (reg), 29455/10 (blk)
##  Chunk 30 / 88 (12:29:23) ... Done!
##  CML228  -CML333  : 423993 (tot), 45167/11 (reg), 29411/17 (blk)
##  Tx303   -CML333  : 421436 (tot), 45000/10 (reg), 29402/14 (blk)
##  Ki3     -B97     : 431599 (tot), 45468/10 (reg), 29319/14 (blk)
##  CML322  -Il14H   : 441700 (tot), 45920/12 (reg), 28967/22 (blk)
##  Chunk 31 / 88 (12:30:15) ... Done!
##  Ms71    -CML333  : 430260 (tot), 45086/11 (reg), 29362/15 (blk)
##  CML322  -CML69   : 443710 (tot), 47022/12 (reg), 29555/22 (blk)
##  Ki3     -Oh7B    : 431878 (tot), 44758/13 (reg), 29263/18 (blk)
##  CML228  -CML247  : 424168 (tot), 45300/10 (reg), 29364/14 (blk)
##  Chunk 32 / 88 (12:31:07) ... Done!
##  Tx303   -CML247  : 422199 (tot), 45102/10 (reg), 29499/12 (blk)
##  Ki3     -CML277  : 435265 (tot), 45574/10 (reg), 29474/12 (blk)
##  M37W    -NC350   : 423466 (tot), 45902/10 (reg), 29389/14 (blk)
##  CML228  -B97     : 423413 (tot), 45337/11 (reg), 29092/20 (blk)
##  Chunk 33 / 88 (12:31:57) ... Done!
##  Tx303   -B97     : 422356 (tot), 45425/10 (reg), 29559/16 (blk)
##  Ms71    -CML247  : 430212 (tot), 45037/10 (reg), 29236/12 (blk)
##  Tzi8    -CML52   : 427716 (tot), 45177/13 (reg), 29018/19 (blk)
##  M162W   -Ki11    : 440379 (tot), 45941/10 (reg), 29283/20 (blk)
##  Chunk 34 / 88 (12:32:50) ... Done!
##  Ki3     -Il14H   : 428729 (tot), 44290/10 (reg), 28852/18 (blk)
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##  Ms71    -B97     : 430997 (tot), 46185/10 (reg), 29931/16 (blk)
##  P39     -Ki11    : 429932 (tot), 44616/11 (reg), 28795/28 (blk)
##  CML228  -Oh7B    : 423788 (tot), 44541/12 (reg), 29192/21 (blk)
##  Chunk 35 / 88 (12:33:44) ... Done!
##  Tx303   -Oh7B    : 422118 (tot), 44908/14 (reg), 29486/18 (blk)
##  Tzi8    -CML103  : 429342 (tot), 45872/10 (reg), 29507/12 (blk)
##  CML228  -CML277  : 423734 (tot), 44928/12 (reg), 29442/20 (blk)
##  Tx303   -CML277  : 421816 (tot), 44626/10 (reg), 29437/14 (blk)
##  Chunk 36 / 88 (12:34:33) ... Done!
##  Ki3     -CML69   : 428299 (tot), 45391/10 (reg), 29674/18 (blk)
##  M37W    -CML333  : 422555 (tot), 45200/10 (reg), 29406/14 (blk)
##  Ms71    -Oh7B    : 431113 (tot), 45567/13 (reg), 29923/19 (blk)
##  Ms71    -CML277  : 428299 (tot), 44762/10 (reg), 29197/10 (blk)
##  Chunk 37 / 88 (12:35:25) ... Done!
##  Tzi8    -Oh43    : 428725 (tot), 44988/10 (reg), 29207/22 (blk)
##  CML228  -Il14H   : 421273 (tot), 44162/10 (reg), 28587/18 (blk)
##  Tx303   -Il14H   : 419411 (tot), 44577/12 (reg), 29102/16 (blk)
##  M37W    -CML247  : 422862 (tot), 45323/10 (reg), 29381/12 (blk)
##  Chunk 38 / 88 (12:36:17) ... Done!
##  CML228  -CML69   : 423645 (tot), 45389/11 (reg), 29541/23 (blk)
##  Tx303   -CML69   : 422358 (tot), 45007/10 (reg), 29437/20 (blk)
##  M162W   -NC358   : 442416 (tot), 46707/10 (reg), 29481/20 (blk)
##  M162W   -HP301   : 439810 (tot), 45823/10 (reg), 29380/18 (blk)
##  Chunk 39 / 88 (12:37:05) ... Done!
##  Ms71    -Il14H   : 429254 (tot), 45379/10 (reg), 29324/20 (blk)
##  M37W    -B97     : 423654 (tot), 45923/10 (reg), 29523/16 (blk)
##  P39     -NC358   : 429810 (tot), 44750/12 (reg), 28927/25 (blk)
##  P39     -HP301   : 427805 (tot), 44899/11 (reg), 29331/26 (blk)
##  Chunk 40 / 88 (12:37:52) ... Done!
##  Ky21    -NC350   : 418831 (tot), 45859/10 (reg), 29491/16 (blk)
##  Ms71    -CML69   : 427831 (tot), 45048/10 (reg), 29259/16 (blk)
##  M162W   -B73     : 440623 (tot), 46674/10 (reg), 28880/20 (blk)
##  P39     -B73     : 428197 (tot), 44413/10 (reg), 28619/26 (blk)
##  Chunk 41 / 88 (12:38:40) ... Done!
##  M37W    -Oh7B    : 422490 (tot), 45101/13 (reg), 29533/20 (blk)
##  Mo18W   -CML52   : 421900 (tot), 44934/15 (reg), 28933/23 (blk)
##  M37W    -CML277  : 421684 (tot), 45075/10 (reg), 29384/14 (blk)
##  Mo18W   -CML103  : 422614 (tot), 45347/12 (reg), 29417/16 (blk)
##  Chunk 42 / 88 (12:39:24) ... Done!
##  Ky21    -CML333  : 418486 (tot), 45625/10 (reg), 29409/16 (blk)
##  Tzi8    -Ki11    : 429226 (tot), 45796/10 (reg), 29528/16 (blk)
##  M37W    -Il14H   : 422501 (tot), 45084/12 (reg), 29145/20 (blk)
##  Mo18W   -Oh43    : 422567 (tot), 45096/12 (reg), 29299/26 (blk)
##  Chunk 43 / 88 (12:40:09) ... Done!
##  M37W    -CML69   : 421998 (tot), 45711/10 (reg), 29454/16 (blk)
##  Ky21    -CML247  : 418680 (tot), 45329/10 (reg), 29347/16 (blk)
##  CML322  -CML52   : 443780 (tot), 46581/12 (reg), 28945/16 (blk)
##  Ky21    -B97     : 420052 (tot), 46380/10 (reg), 29781/18 (blk)
##  Chunk 44 / 88 (12:40:59) ... Done!
##  CML322  -CML103  : 442876 (tot), 46250/12 (reg), 29399/18 (blk)
##  Tzi8    -NC358   : 428834 (tot), 46009/10 (reg), 29683/14 (blk)
##  Tzi8    -HP301   : 425588 (tot), 44787/10 (reg), 29208/18 (blk)
##  Ky21    -Oh7B    : 419615 (tot), 45814/14 (reg), 29744/22 (blk)
##  Chunk 45 / 88 (12:41:48) ... Done!
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##  Ky21    -CML277  : 417155 (tot), 45326/11 (reg), 29307/17 (blk)
##  CML322  -Oh43    : 442912 (tot), 46747/14 (reg), 29168/28 (blk)
##  Ki3     -CML52   : 430196 (tot), 44270/13 (reg), 28975/17 (blk)
##  Tzi8    -B73     : 425589 (tot), 44440/10 (reg), 28762/18 (blk)
##  Chunk 46 / 88 (12:42:39) ... Done!
##  Ki3     -CML103  : 430250 (tot), 44904/10 (reg), 29414/10 (blk)
##  Ky21    -Il14H   : 418286 (tot), 45690/12 (reg), 29484/20 (blk)
##  Mo18W   -Ki11    : 421292 (tot), 44923/12 (reg), 29418/20 (blk)
##  Ky21    -CML69   : 417208 (tot), 45454/10 (reg), 29341/22 (blk)
##  Chunk 47 / 88 (12:43:30) ... Done!
##  CML228  -CML52   : 423706 (tot), 44123/14 (reg), 28905/26 (blk)
##  Tx303   -CML52   : 421670 (tot), 44089/12 (reg), 28819/18 (blk)
##  Ki3     -Oh43    : 434894 (tot), 45159/10 (reg), 29270/20 (blk)
##  CML228  -CML103  : 424516 (tot), 45180/11 (reg), 29290/18 (blk)
##  Chunk 48 / 88 (12:44:24) ... Done!
##  Tx303   -CML103  : 421911 (tot), 44805/10 (reg), 29511/12 (blk)
##  Ms71    -CML52   : 429356 (tot), 44165/15 (reg), 28709/17 (blk)
##  Ms71    -CML103  : 429533 (tot), 44489/11 (reg), 29182/13 (blk)
##  CML322  -Ki11    : 442201 (tot), 45786/13 (reg), 29444/22 (blk)
##  Chunk 49 / 88 (12:45:22) ... Done!
##  Mo18W   -NC358   : 422258 (tot), 45567/12 (reg), 29572/18 (blk)
##  Mo18W   -HP301   : 420809 (tot), 44616/12 (reg), 29226/24 (blk)
##  CML228  -Oh43    : 421811 (tot), 44280/11 (reg), 29045/23 (blk)
##  Tx303   -Oh43    : 421859 (tot), 44709/10 (reg), 29497/18 (blk)
##  Chunk 50 / 88 (12:46:22) ... Done!
##  NC350   -NC350   : 533432 (tot), 57936/179 (reg), 40484/179 (blk)
##  Mo18W   -B73     : 419152 (tot), 44655/12 (reg), 28704/22 (blk)
##  Ms71    -Oh43    : 428495 (tot), 44901/11 (reg), 29667/23 (blk)
##  M37W    -CML52   : 421798 (tot), 44618/13 (reg), 28854/19 (blk)
##  Chunk 51 / 88 (12:47:12) ... Done!
##  Ki3     -Ki11    : 431818 (tot), 45747/10 (reg), 29904/14 (blk)
##  M37W    -CML103  : 424236 (tot), 45672/10 (reg), 29454/12 (blk)
##  NC350   -CML333  : 426415 (tot), 45996/10 (reg), 29561/14 (blk)
##  CML322  -NC358   : 443975 (tot), 46683/14 (reg), 29483/20 (blk)
##  Chunk 52 / 88 (12:48:18) ... Done!
##  CML322  -HP301   : 438851 (tot), 45077/14 (reg), 29047/20 (blk)
##  CML322  -B73     : 441108 (tot), 46497/12 (reg), 28740/20 (blk)
##  CML228  -Ki11    : 423972 (tot), 45622/11 (reg), 29813/20 (blk)
##  Tx303   -Ki11    : 422479 (tot), 44926/10 (reg), 29460/12 (blk)
##  Chunk 53 / 88 (12:49:20) ... Done!
##  M37W    -Oh43    : 420877 (tot), 44939/10 (reg), 29441/22 (blk)
##  NC350   -CML247  : 427136 (tot), 46065/10 (reg), 29611/12 (blk)
##  CML333  -CML333  : 529335 (tot), 56849/142 (reg), 40427/142 (blk)
##  NC350   -B97     : 426763 (tot), 45896/10 (reg), 29300/16 (blk)
##  Chunk 54 / 88 (12:50:06) ... Done!
##  Ms71    -Ki11    : 428619 (tot), 44915/11 (reg), 29244/17 (blk)
##  Ki3     -NC358   : 428889 (tot), 45205/10 (reg), 29665/12 (blk)
##  Ki3     -HP301   : 433829 (tot), 44501/10 (reg), 29141/16 (blk)
##  NC350   -Oh7B    : 427431 (tot), 45216/14 (reg), 29308/20 (blk)
##  Chunk 55 / 88 (12:51:02) ... Done!
##  Ki3     -B73     : 427437 (tot), 43830/10 (reg), 28681/16 (blk)
##  CML333  -CML247  : 426146 (tot), 45606/10 (reg), 29419/12 (blk)
##  Ky21    -CML52   : 418161 (tot), 44672/14 (reg), 28797/22 (blk)
##  NC350   -CML277  : 426660 (tot), 45809/10 (reg), 29703/14 (blk)
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##  Chunk 56 / 88 (12:51:56) ... Done!
##  CML228  -NC358   : 423498 (tot), 45151/11 (reg), 29527/18 (blk)
##  CML333  -B97     : 426174 (tot), 46061/11 (reg), 29327/18 (blk)
##  Tx303   -NC358   : 422082 (tot), 45065/10 (reg), 29593/14 (blk)
##  CML228  -HP301   : 420129 (tot), 43911/10 (reg), 28949/20 (blk)
##  Chunk 57 / 88 (12:52:50) ... Done!
##  Tx303   -HP301   : 418568 (tot), 44152/10 (reg), 29268/14 (blk)
##  Ky21    -CML103  : 419188 (tot), 45301/10 (reg), 29417/14 (blk)
##  NC350   -Il14H   : 424155 (tot), 45105/12 (reg), 28816/20 (blk)
##  Ms71    -NC358   : 428580 (tot), 45118/11 (reg), 29341/15 (blk)
##  Chunk 58 / 88 (12:53:43) ... Done!
##  M37W    -Ki11    : 422039 (tot), 45645/10 (reg), 29426/16 (blk)
##  CML247  -CML247  : 513214 (tot), 57316/165 (reg), 40382/165 (blk)
##  Ms71    -HP301   : 425657 (tot), 44558/11 (reg), 29380/15 (blk)
##  CML228  -B73     : 419706 (tot), 43541/10 (reg), 28446/18 (blk)
##  Chunk 59 / 88 (12:54:30) ... Done!
##  Tx303   -B73     : 419213 (tot), 43962/10 (reg), 28851/14 (blk)
##  CML333  -Oh7B    : 426256 (tot), 45369/15 (reg), 29399/20 (blk)
##  NC350   -CML69   : 426478 (tot), 45814/10 (reg), 29491/20 (blk)
##  CML333  -CML277  : 424999 (tot), 45279/10 (reg), 29412/14 (blk)
##  Chunk 60 / 88 (12:55:29) ... Done!
##  CML247  -B97     : 416419 (tot), 46098/10 (reg), 29202/14 (blk)
##  Ky21    -Oh43    : 417309 (tot), 45562/10 (reg), 29642/18 (blk)
##  Ms71    -B73     : 426271 (tot), 44553/11 (reg), 29137/14 (blk)
##  B97     -B97     : 513243 (tot), 57211/100 (reg), 40365/100 (blk)
##  Chunk 61 / 88 (12:56:17) ... Done!
##  CML333  -Il14H   : 424167 (tot), 44696/12 (reg), 28794/20 (blk)
##  CML247  -Oh7B    : 417302 (tot), 45698/14 (reg), 29191/18 (blk)
##  CML247  -CML277  : 417840 (tot), 46476/10 (reg), 29704/12 (blk)
##  B97     -Oh7B    : 417795 (tot), 46374/12 (reg), 29929/16 (blk)
##  Chunk 62 / 88 (12:57:16) ... Done!
##  CML333  -CML69   : 424785 (tot), 45448/10 (reg), 29429/20 (blk)
##  B97     -CML277  : 414631 (tot), 45357/10 (reg), 29186/16 (blk)
##  M37W    -NC358   : 422541 (tot), 45679/10 (reg), 29591/14 (blk)
##  M37W    -HP301   : 418904 (tot), 44593/10 (reg), 29276/18 (blk)
##  Chunk 63 / 88 (12:58:14) ... Done!
##  CML247  -Il14H   : 414788 (tot), 44959/12 (reg), 28708/18 (blk)
##  Oh7B    -Oh7B    : 514807 (tot), 60291/137 (reg), 40311/137 (blk)
##  Oh7B    -CML277  : 417923 (tot), 47172/13 (reg), 29287/18 (blk)
##  B97     -Il14H   : 414376 (tot), 45538/10 (reg), 29291/18 (blk)
##  Chunk 64 / 88 (12:59:08) ... Done!
##  CML247  -CML69   : 416003 (tot), 46222/10 (reg), 29501/18 (blk)
##  M37W    -B73     : 419001 (tot), 44404/10 (reg), 28945/18 (blk)
##  CML277  -CML277  : 516987 (tot), 56925/176 (reg), 40323/176 (blk)
##  Ky21    -Ki11    : 417302 (tot), 45092/10 (reg), 29388/18 (blk)
##  Chunk 65 / 88 (12:59:57) ... Done!
##  B97     -CML69   : 414438 (tot), 45568/10 (reg), 29183/18 (blk)
##  Oh7B    -Il14H   : 416062 (tot), 46199/12 (reg), 29284/16 (blk)
##  CML277  -Il14H   : 412661 (tot), 44670/12 (reg), 28706/20 (blk)
##  Oh7B    -CML69   : 418244 (tot), 46837/12 (reg), 29300/26 (blk)
##  Chunk 66 / 88 (13:00:53) ... Done!
##  CML277  -CML69   : 415376 (tot), 45700/10 (reg), 29512/16 (blk)
##  Il14H   -Il14H   : 517261 (tot), 56027/86 (reg), 40285/86 (blk)
##  Ky21    -NC358   : 417642 (tot), 45274/10 (reg), 29522/16 (blk)
```

```
##  Ky21    -HP301   : 415176 (tot), 44990/10 (reg), 29579/22 (blk)
##  Chunk 67 / 88 (13:01:38) ... Done!
##  Il14H   -CML69   : 415504 (tot), 44521/10 (reg), 28809/26 (blk)
##  CML69   -CML69   : 509881 (tot), 56659/216 (reg), 40259/216 (blk)
##  Ky21    -B73     : 415233 (tot), 44859/10 (reg), 29175/20 (blk)
##  NC350   -CML52   : 426157 (tot), 44984/13 (reg), 28969/19 (blk)
##  Chunk 68 / 88 (13:02:24) ... Done!
##  NC350   -CML103  : 425960 (tot), 45618/10 (reg), 29390/12 (blk)
##  CML333  -CML52   : 426188 (tot), 44862/14 (reg), 29018/20 (blk)
##  NC350   -Oh43    : 426475 (tot), 45051/10 (reg), 29245/22 (blk)
##  CML333  -CML103  : 426217 (tot), 44930/10 (reg), 29297/12 (blk)
##  Chunk 69 / 88 (13:03:14) ... Done!
##  CML247  -CML52   : 416981 (tot), 45337/13 (reg), 29047/17 (blk)
##  CML333  -Oh43    : 423768 (tot), 44962/10 (reg), 29139/22 (blk)
##  B97     -CML52   : 414986 (tot), 44543/12 (reg), 28660/20 (blk)
##  CML247  -CML103  : 416189 (tot), 45461/10 (reg), 29300/10 (blk)
##  Chunk 70 / 88 (13:04:05) ... Done!
##  B97     -CML103  : 415926 (tot), 45571/10 (reg), 29359/14 (blk)
##  Oh7B    -CML52   : 417405 (tot), 46480/17 (reg), 28755/23 (blk)
##  CML247  -Oh43    : 415836 (tot), 45438/10 (reg), 29107/20 (blk)
##  CML277  -CML52   : 415490 (tot), 45342/14 (reg), 29065/16 (blk)
##  Chunk 71 / 88 (13:04:57) ... Done!
##  NC350   -Ki11    : 426413 (tot), 45712/10 (reg), 29546/16 (blk)
##  Oh7B    -CML103  : 417736 (tot), 45993/13 (reg), 29312/18 (blk)
##  B97     -Oh43    : 414931 (tot), 45795/10 (reg), 29678/20 (blk)
##  CML277  -CML103  : 415146 (tot), 45203/10 (reg), 29376/12 (blk)
##  Chunk 72 / 88 (13:05:51) ... Done!
##  Il14H   -CML52   : 417476 (tot), 43744/13 (reg), 28305/23 (blk)
##  Oh7B    -Oh43    : 418108 (tot), 47338/14 (reg), 29676/26 (blk)
##  CML69   -CML52   : 414661 (tot), 44713/12 (reg), 28930/20 (blk)
##  Il14H   -CML103  : 417560 (tot), 44343/10 (reg), 28899/18 (blk)
##  Chunk 73 / 88 (13:06:46) ... Done!
##  CML277  -Oh43    : 415260 (tot), 45376/10 (reg), 29147/22 (blk)
##  CML333  -Ki11    : 424236 (tot), 45017/10 (reg), 29343/16 (blk)
##  CML69   -CML103  : 414632 (tot), 45206/10 (reg), 29423/18 (blk)
##  NC350   -NC358   : 427190 (tot), 46641/10 (reg), 30030/14 (blk)
##  Chunk 74 / 88 (13:07:40) ... Done!
##  NC350   -HP301   : 423585 (tot), 44755/10 (reg), 29060/18 (blk)
##  Il14H   -Oh43    : 415938 (tot), 44866/12 (reg), 29424/20 (blk)
##  CML247  -Ki11    : 415684 (tot), 45293/10 (reg), 29402/14 (blk)
##  CML69   -Oh43    : 413217 (tot), 44526/10 (reg), 29108/24 (blk)
##  Chunk 75 / 88 (13:08:38) ... Done!
##  NC350   -B73     : 422777 (tot), 44547/10 (reg), 28632/18 (blk)
##  B97     -Ki11    : 413675 (tot), 45367/10 (reg), 29270/18 (blk)
##  CML333  -NC358   : 425181 (tot), 45589/10 (reg), 29563/14 (blk)
##  CML333  -HP301   : 421702 (tot), 44559/10 (reg), 29129/20 (blk)
##  Chunk 76 / 88 (13:09:44) ... Done!
##  Oh7B    -Ki11    : 415749 (tot), 45354/13 (reg), 29312/22 (blk)
##  CML277  -Ki11    : 414195 (tot), 44975/10 (reg), 29462/16 (blk)
##  CML333  -B73     : 421736 (tot), 44511/10 (reg), 28653/18 (blk)
##  CML247  -NC358   : 416382 (tot), 45805/10 (reg), 29610/12 (blk)
##  Chunk 77 / 88 (13:10:40) ... Done!
##  CML247  -HP301   : 413807 (tot), 44651/10 (reg), 29141/16 (blk)
##  Il14H   -Ki11    : 415556 (tot), 44238/12 (reg), 28834/18 (blk)
```

```
##  B97     -NC358   : 414222 (tot), 45515/10 (reg), 29320/12 (blk)
##  B97     -HP301   : 413085 (tot), 45073/10 (reg), 29471/16 (blk)
##  Chunk 78 / 88 (13:11:36) ... Done!
##  CML69   -Ki11    : 414388 (tot), 45378/10 (reg), 29519/22 (blk)
##  CML247  -B73     : 413019 (tot), 44777/10 (reg), 28515/16 (blk)
##  B97     -B73     : 412078 (tot), 45302/10 (reg), 29153/14 (blk)
##  Oh7B    -NC358   : 417575 (tot), 46383/15 (reg), 29440/20 (blk)
##  Chunk 79 / 88 (13:12:30) ... Done!
##  Oh7B    -HP301   : 414666 (tot), 45300/13 (reg), 29504/20 (blk)
##  CML277  -NC358   : 414894 (tot), 45398/10 (reg), 29567/14 (blk)
##  CML277  -HP301   : 413093 (tot), 44452/10 (reg), 29122/14 (blk)
##  Oh7B    -B73     : 415224 (tot), 47026/13 (reg), 29186/20 (blk)
##  Chunk 80 / 88 (13:13:27) ... Done!
##  CML277  -B73     : 412485 (tot), 44661/10 (reg), 28617/14 (blk)
##  Il14H   -NC358   : 416750 (tot), 44261/12 (reg), 28850/20 (blk)
##  Il14H   -HP301   : 413893 (tot), 44232/12 (reg), 29259/16 (blk)
##  CML52   -CML52   : 515899 (tot), 57219/559 (reg), 40029/559 (blk)
##  Chunk 81 / 88 (13:14:14) ... Done!
##  CML69   -NC358   : 414819 (tot), 45363/10 (reg), 29561/16 (blk)
##  CML69   -HP301   : 410564 (tot), 44222/10 (reg), 29093/22 (blk)
##  Il14H   -B73     : 414028 (tot), 44195/10 (reg), 28660/16 (blk)
##  CML52   -CML103  : 419299 (tot), 44488/12 (reg), 28778/16 (blk)
##  Chunk 82 / 88 (13:15:15) ... Done!
##  CML69   -B73     : 411134 (tot), 44080/10 (reg), 28614/20 (blk)
##  CML103  -CML103  : 513347 (tot), 55795/125 (reg), 40011/125 (blk)
##  CML52   -Oh43    : 416871 (tot), 44514/12 (reg), 28597/26 (blk)
##  CML103  -Oh43    : 414206 (tot), 44373/10 (reg), 29152/20 (blk)
##  Chunk 83 / 88 (13:16:01) ... Done!
##  Oh43    -Oh43    : 504891 (tot), 55471/140 (reg), 39971/140 (blk)
##  CML52   -Ki11    : 417476 (tot), 44631/13 (reg), 28948/21 (blk)
##  CML103  -Ki11    : 415671 (tot), 45145/10 (reg), 29393/14 (blk)
##  Oh43    -Ki11    : 411508 (tot), 44536/10 (reg), 29251/20 (blk)
##  Chunk 84 / 88 (13:16:51) ... Done!
##  CML52   -NC358   : 418929 (tot), 44884/13 (reg), 29064/19 (blk)
##  CML52   -HP301   : 414731 (tot), 43893/13 (reg), 28569/19 (blk)
##  CML103  -NC358   : 416428 (tot), 45175/10 (reg), 29483/12 (blk)
##  CML103  -HP301   : 412782 (tot), 43963/10 (reg), 29099/16 (blk)
##  Chunk 85 / 88 (13:17:43) ... Done!
##  CML52   -B73     : 414925 (tot), 44183/13 (reg), 28156/19 (blk)
##  CML103  -B73     : 412556 (tot), 43999/10 (reg), 28740/15 (blk)
##  Oh43    -NC358   : 410762 (tot), 44534/10 (reg), 29233/18 (blk)
##  Oh43    -HP301   : 410482 (tot), 44270/10 (reg), 29374/22 (blk)
##  Chunk 86 / 88 (13:18:35) ... Done!
##  Ki11    -Ki11    : 510636 (tot), 55524/198 (reg), 39854/198 (blk)
##  Oh43    -B73     : 409055 (tot), 44342/10 (reg), 29065/22 (blk)
##  Ki11    -NC358   : 415769 (tot), 45499/10 (reg), 29633/16 (blk)
##  Ki11    -HP301   : 412225 (tot), 44194/10 (reg), 29046/16 (blk)
##  Chunk 87 / 88 (13:19:20) ... Done!
##  Ki11    -B73     : 412800 (tot), 44002/10 (reg), 28667/16 (blk)
##  NC358   -NC358   : 504884 (tot), 55686/189 (reg), 39784/189 (blk)
##  NC358   -HP301   : 409408 (tot), 44368/10 (reg), 29267/20 (blk)
##  HP301   -HP301   : 511168 (tot), 54958/119 (reg), 39746/119 (blk)
##  Chunk 88 / 88 (13:20:04) ... Done!
##  NC358   -B73     : 409742 (tot), 44091/10 (reg), 28873/18 (blk)
```

```
##  HP301   -B73     : 409828 (tot), 43728/10 (reg), 28909/12 (blk)
##  B73     -B73     : 509668 (tot), 58048/167 (reg), 39490/167 (blk)
## Defining synteny-constrained orthogroups ...
##  Found 145408 synteny-split OGs for 1054446 genes
## Found 145408 OGs across 1054446 genes. gff3-like text file written to:
##  /Users/jlovell/Desktop/GENESPACE_data/results//maize/results/gffWithOgs.txt.gz
## Calculating syntenic block breakpoints ...
##  Found 16845 blocks. Text file written to:
##  /Users/jlovell/Desktop/GENESPACE_data/results//maize/results/syntenicBlocks.txt.gz:
```

7 Build pangenome against B73

```
    tmp <- pangenome(gsParam = gparMaize, refGenome = "B73")
```

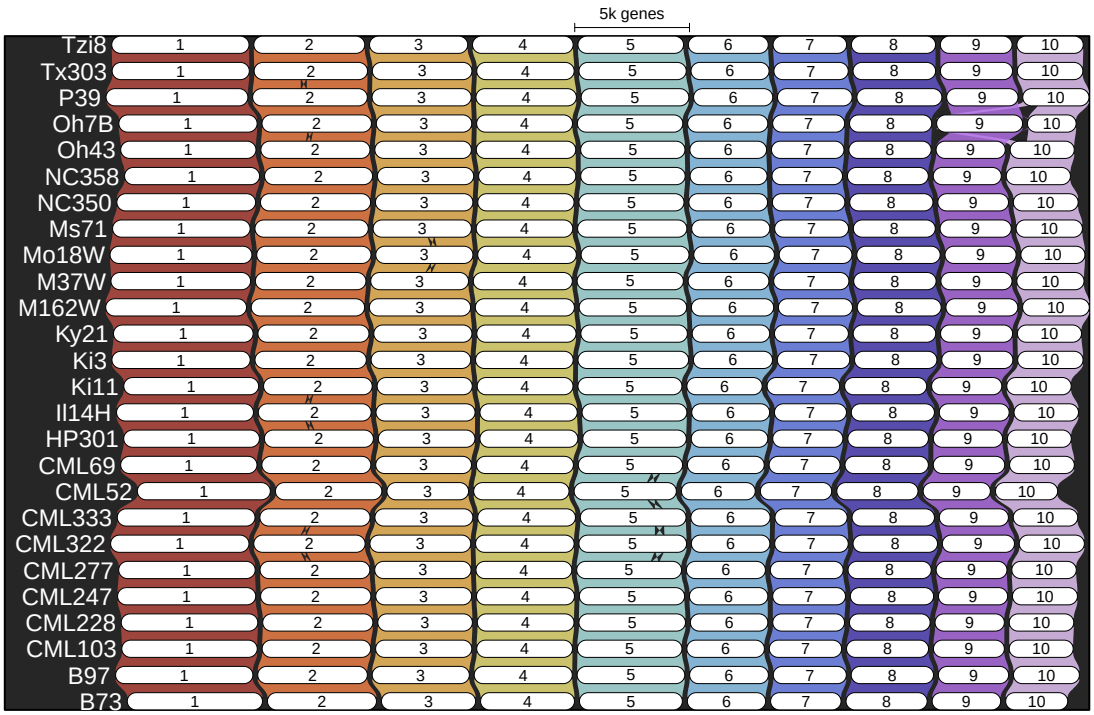
```
## Building reference-anchored scaffold against B73
##  n. ref positions = 38010
##  Reading in hits against B73 ... found 739589
##  Interpolating positions ... n. genes mapped: 1x = 958668, 2+x = 315, 0x = 51674
##  Forming ref.-anchored db ... found 719147 genes for 37966 placements
## Completing the pan-genome annotation ...
##  Adding non-anchor entries ... found 19909 genes and 4877 placements
##  Checking missing direct ref. syn. OGs ... found 3484 genes and 1043 placements
##  Adding indirect syn. OGs ... found 592 genes and 148 placements
##  Adding syn. OGs without ref. anchor ... found 254036 genes and 97786 placements
##  Adding missing genes by synOG identity ... found 13489 genes and 140 placements
## Annotating and formatting pan-genome
##  Adding non-anchor entries ... found 43789 genes and 9451 placements
##  No orthologue file available. Will ignore
##  Writing pangenome to results/B73_pangenomeDB.txt.gz
##  Returning wide-format with only syntenic array reps
##  Done!
```

8 Make riparian plot

Also, write the parameters to file

```
plot_riparian(gsParam = gparMaize)
```

```
##  Loading the gff ... Done!
##  Mapping genes against B73 chromosomes ... Done!
##  Projecting linear coordinate system ... Done!
##  Generating block coordinates ... Done!
##  Rendering plot ...
```



Chromosomes scaled by gene rank order

```
## Done!
```

```
save(gparMaize, file = file.path(baseDir, "gparMaize.rda"))
```

9 Print session info

```
sessionInfo()
```

```
## R version 4.1.2 (2021-11-01)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS Big Sur 10.16
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] GENESPACE_0.9.3   data.table_1.14.2
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.8                  highr_0.9
##  [3] compiler_4.1.2              restfulr_0.0.13
```

```
##  [5] GenomeInfoDb_1.30.1         XVector_0.34.0
##  [7] MatrixGenerics_1.6.0        R.methodsS3_1.8.1
##  [9] bitops_1.0-7                R.utils_2.11.0
## [11] tools_4.1.2                 zlibbioc_1.40.0
## [13] digest_0.6.29               lattice_0.20-45
## [15] evaluate_0.14               pkgconfig_2.0.3
## [17] rlang_1.0.0                 Matrix_1.4-0
## [19] igraph_1.2.11               DelayedArray_0.20.0
## [21] cli_3.1.1                   rstudioapi_0.13
## [23] yaml_2.2.2                  parallel_4.1.2
## [25] xfun_0.29                   fastmap_1.1.0
## [27] GenomeInfoDbData_1.2.7      rtracklayer_1.54.0
## [29] stringr_1.4.0               knitr_1.37
## [31] Biostrings_2.62.0           S4Vectors_0.32.3
## [33] IRanges_2.28.0              grid_4.1.2
## [35] stats4_4.1.2                Biobase_2.54.0
## [37] BiocParallel_1.28.3         XML_3.99-0.8
## [39] rmarkdown_2.11              magrittr_2.0.2
## [41] matrixStats_0.61.0          GenomicAlignments_1.30.0
## [43] Rsamtools_2.10.0            GenomicRanges_1.46.1
## [45] htmltools_0.5.2             BiocGenerics_0.40.0
## [47] SummarizedExperiment_1.24.0 stringi_1.7.6
## [49] RCurl_1.98-1.5              rjson_0.2.21
## [51] crayon_1.4.2                dbscan_1.1-10
## [53] BiocIO_1.4.0                R.oo_1.24.0
```