data tracks

SESSION 3

MARTIN KRZYWINSKI
Genome Sciences Center
BC Cancer Agency
Vancouver, Canada

EMBO PRACTICAL COURSE:
BIOINFORMATICS AND COMPARATIVE GENOME ANALYSES
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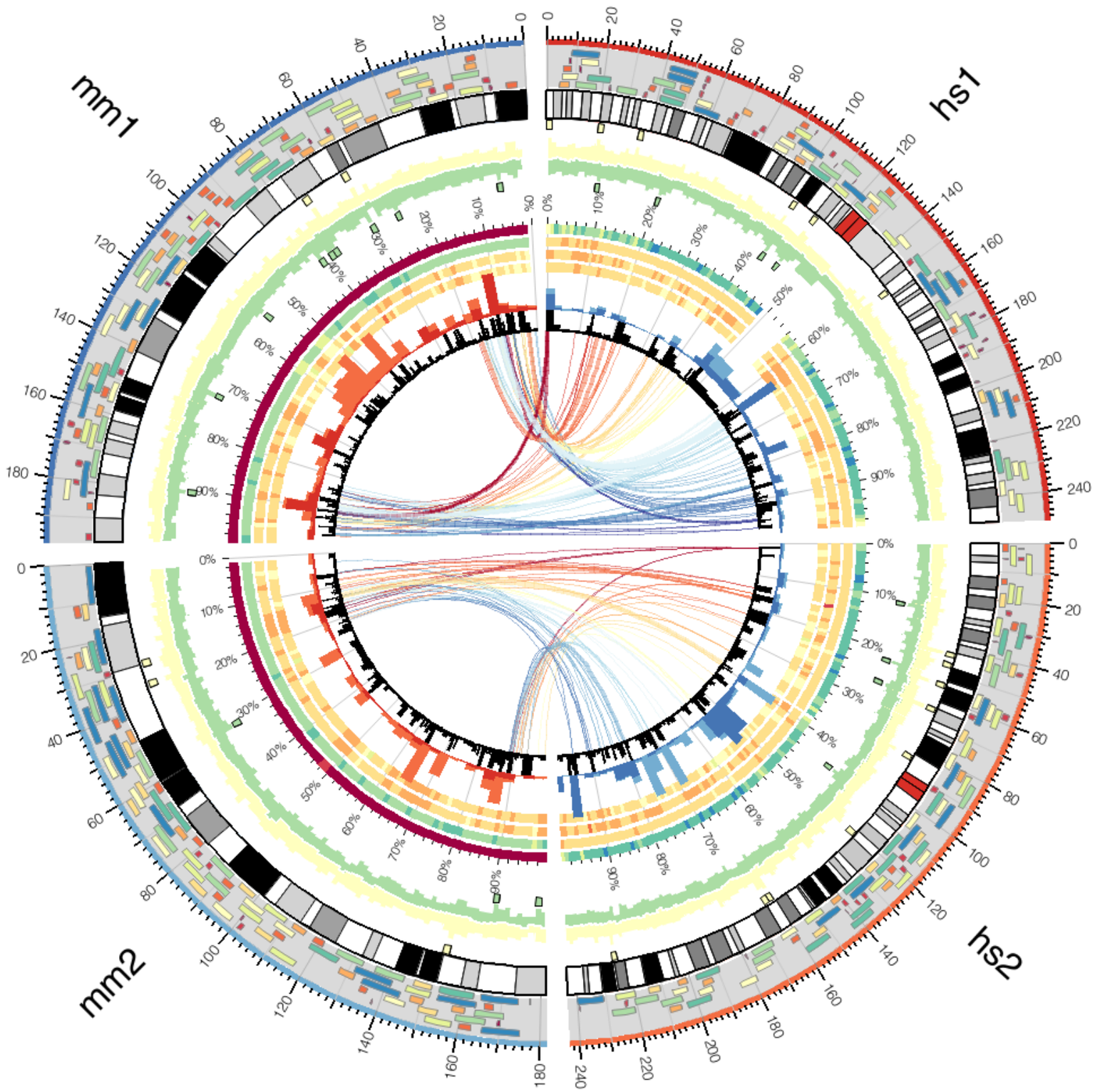
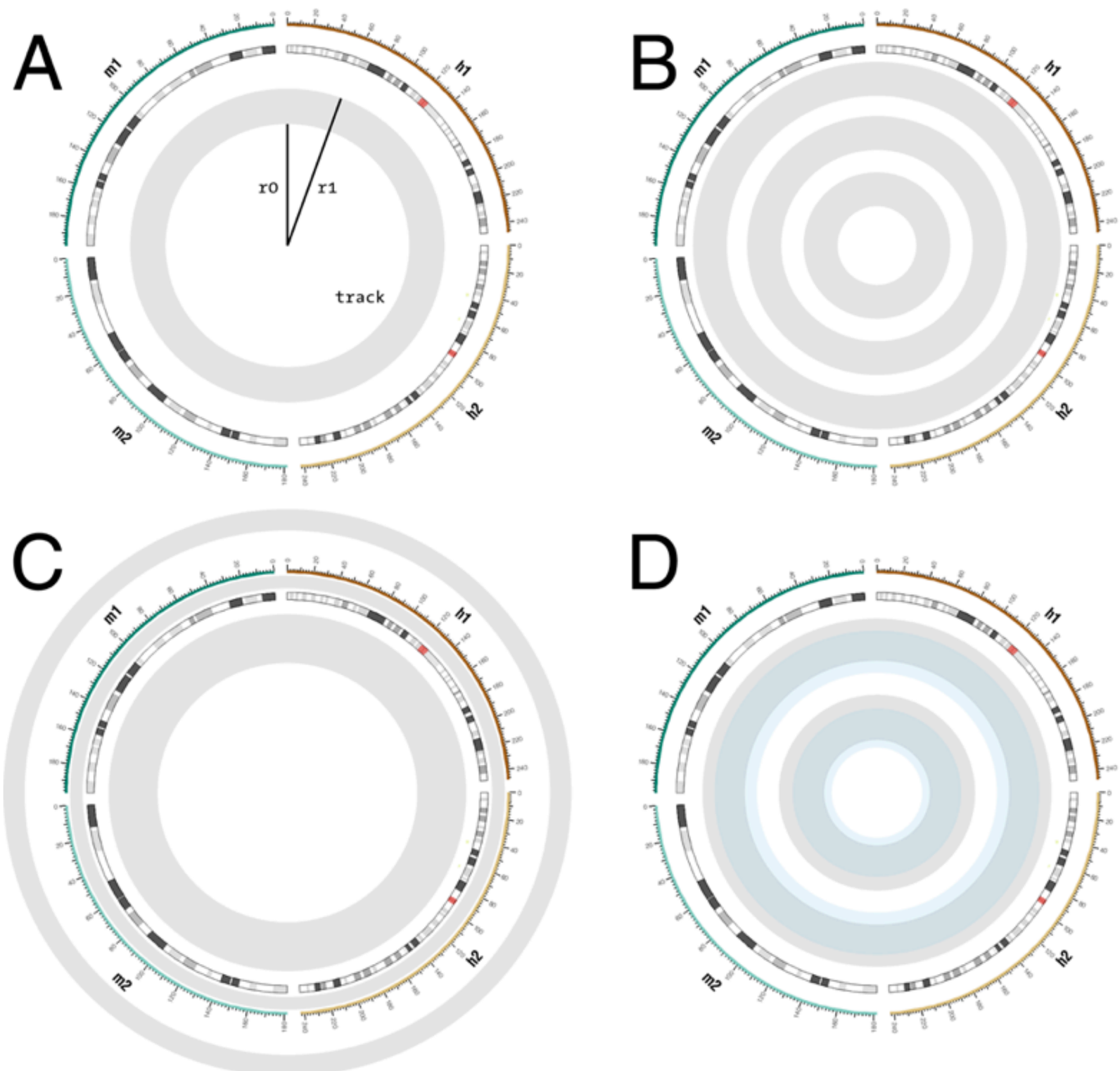
SESSION FINAL IMAGE



histograms
heatmaps
histograms
tiles
links
dynamic rules
highlights

.

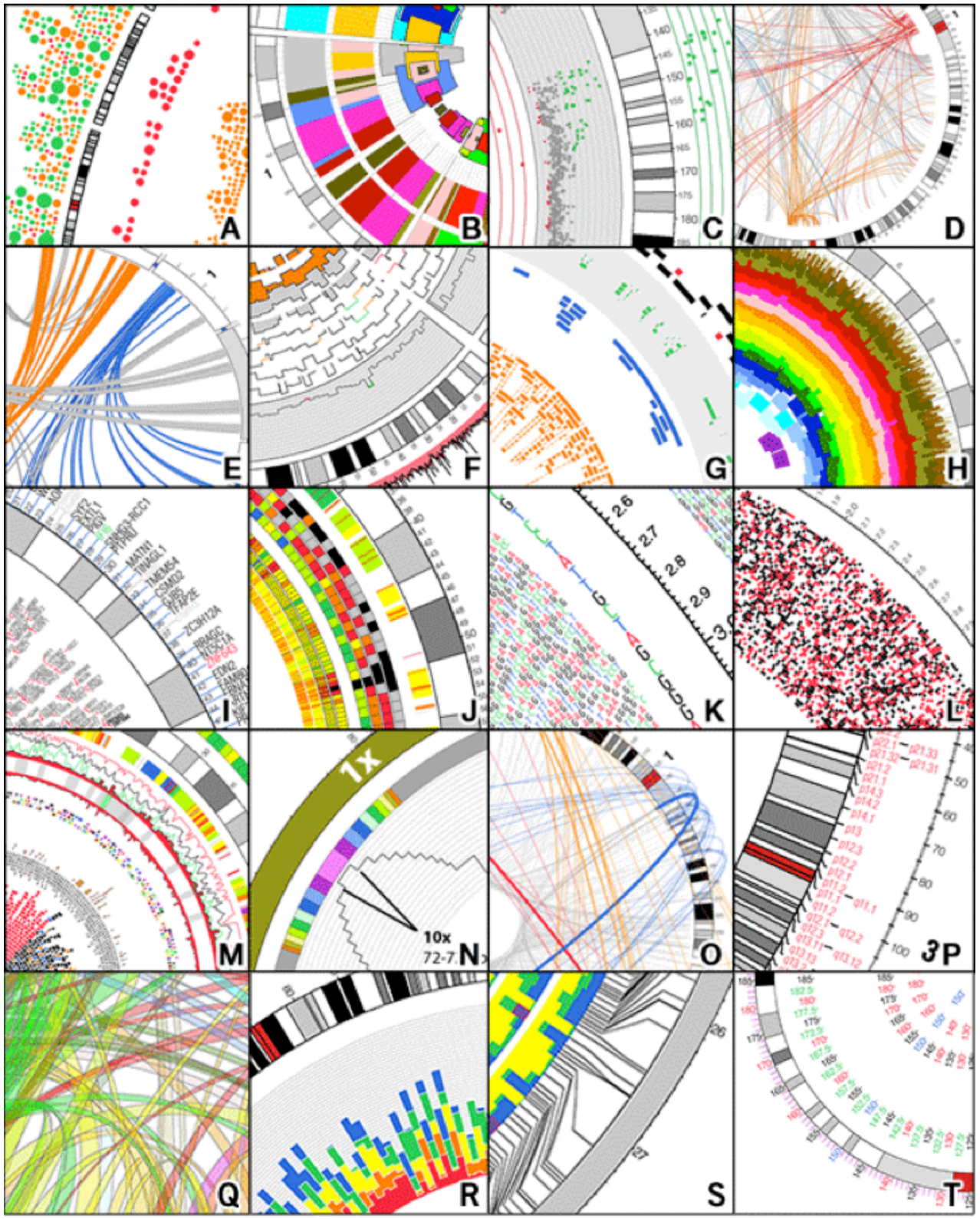
DATA TRACK LAYOUT



(A) Each data track confined to an annulus bounded by radii r0 and r1. (B) Any number of tracks can be placed on the figure, and (C) at any radial position, including inside/outside ideogram circle and inside/outside ticks. (D) Tracks can be made to overlap and the order in which they are drawn is controlled by the z parameter.

.

DATA TRACK TYPES



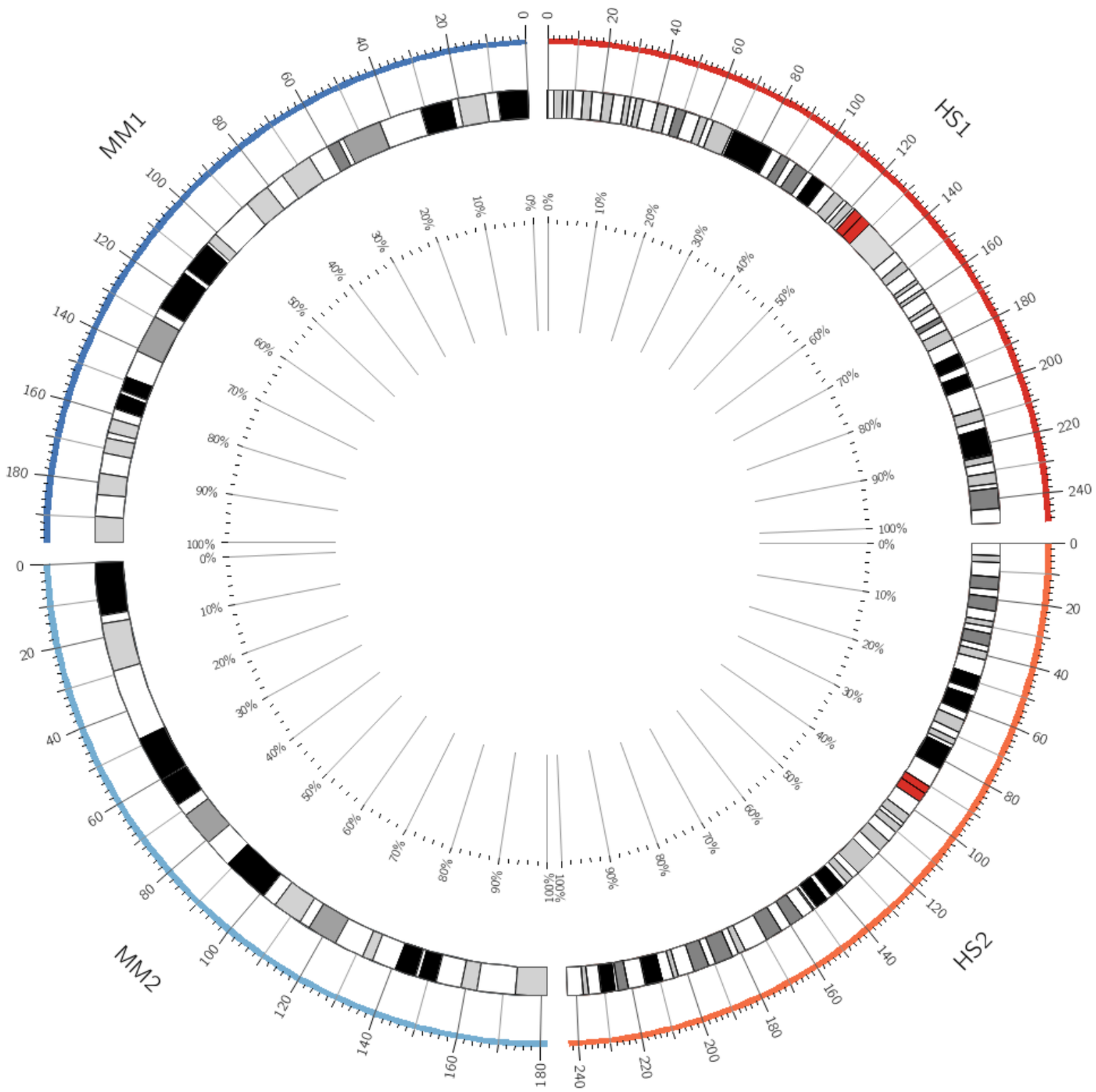
(A) glyph (B) highlight with depth control (C) scatter (D) paired-location (E) ribbon (F) histogram (G) tile (H) highlight with auto depth (I) text with auto arrange (J) heat map (K) high-density text (L) high-density glyph (M) multi-type composite (N) variable scale control (O) fine geometry control (P) flexible text and element placement (Q) transparent ribbons (R) stacked histogram (S) connectors (T) tick rings

.

ideogram layout

LESSON 1

IDEOGRAM LAYOUT



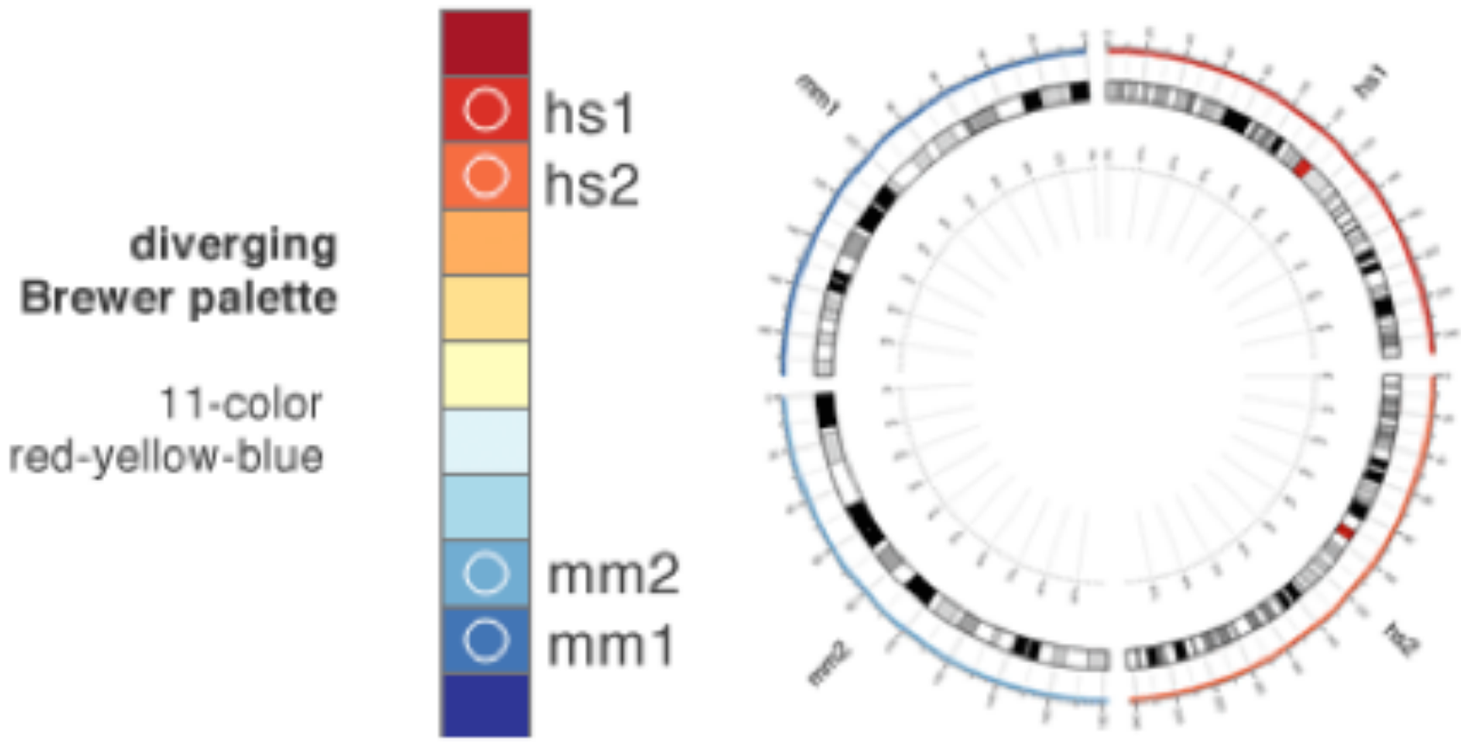

```
# <<include>> directives keep the
# configuration file short and modular

<<include ../etc/karyotype.and.layout.conf>>

<<include ../etc/ideogram.conf>>

<<include ../etc/ticks.conf>>

<<include ../../etc/image.conf>>

<<include etc/colors_fonts_patterns.conf>>

<<include etc/housekeeping.conf>>
```

.

LAYOUT PARAMETERS VIA <<INCLUDE>>

```
# 3/1/etc/circos.conf

<<include ../etc/karyotype.and.layout.conf>>

# 3/etc/karyotype.and.layout.conf

karyotype = ../../data/karyotype/karyotype.human.txt,../../data/karyotype/karyotype.mouse.txt

chromosomes_units           = 1000000
chromosomes_display_default = no

chromosomes       = hs1;hs2;mm1;mm2
chromosomes_order = hs1,hs2,mm2,mm1
chromosomes_color = hs1=rdylbu-11-div-2,hs2=rdylbu-11-div-3,mm1=rdylbu-11-div-10,mm2=rdylbu-11-div-9

chromosomes_reverse = /mm/
chromosomes_scale   = /./=0.25r

<highlights>
<highlight>
file = ../data/highlight.txt
r0   = 1r+40p
r1   = 1r+45p
</highlight>
</highlights>
```

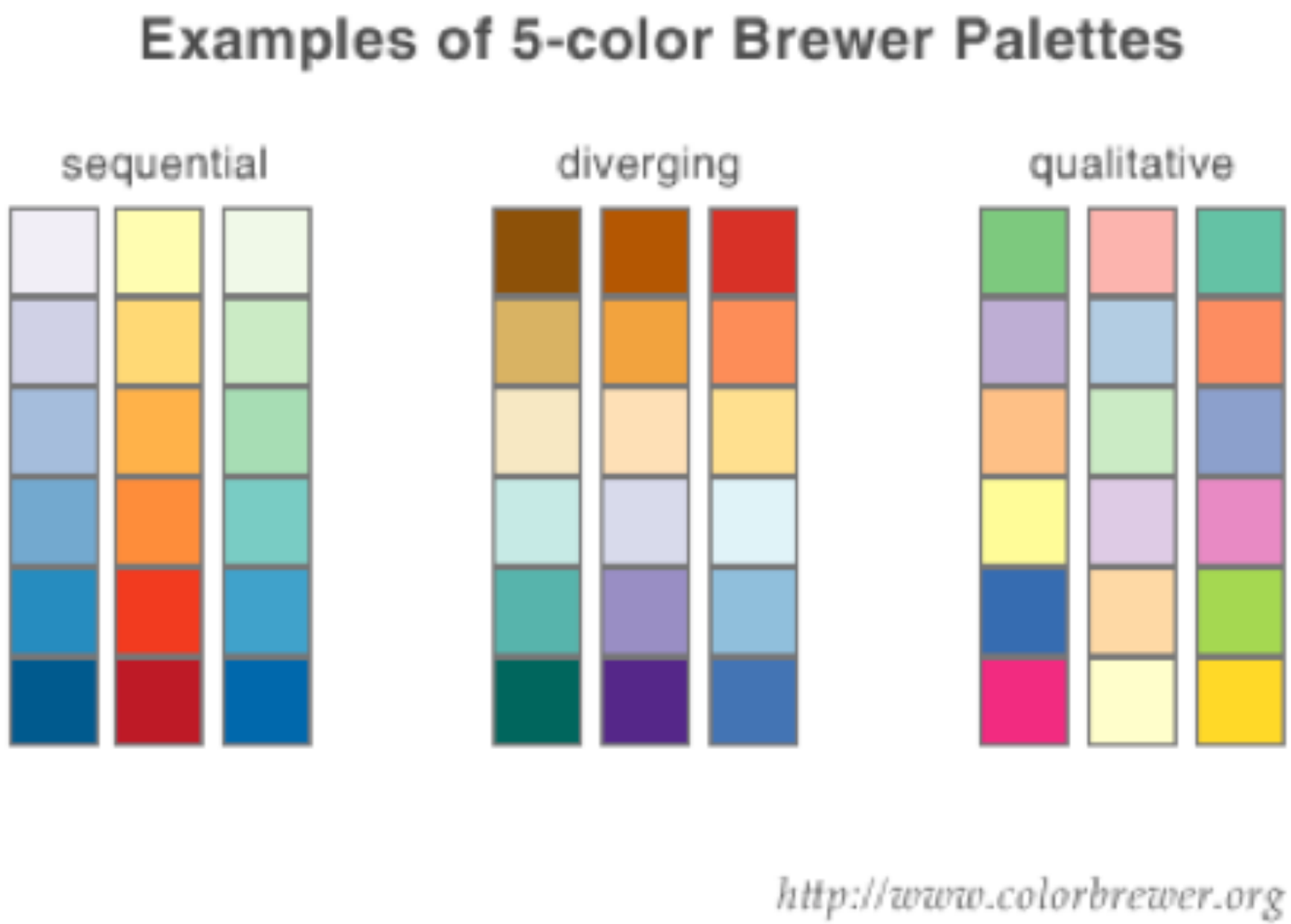
BREWER COLOR PALETTE FOR IDEOGRAMS



chromosome	color name
hs1	rdylbu-11-div-2
hs2	rdylbu-11-div-3
mm1	rdylbu-11-div-10
mm2	rdylbu-11-div-9

.

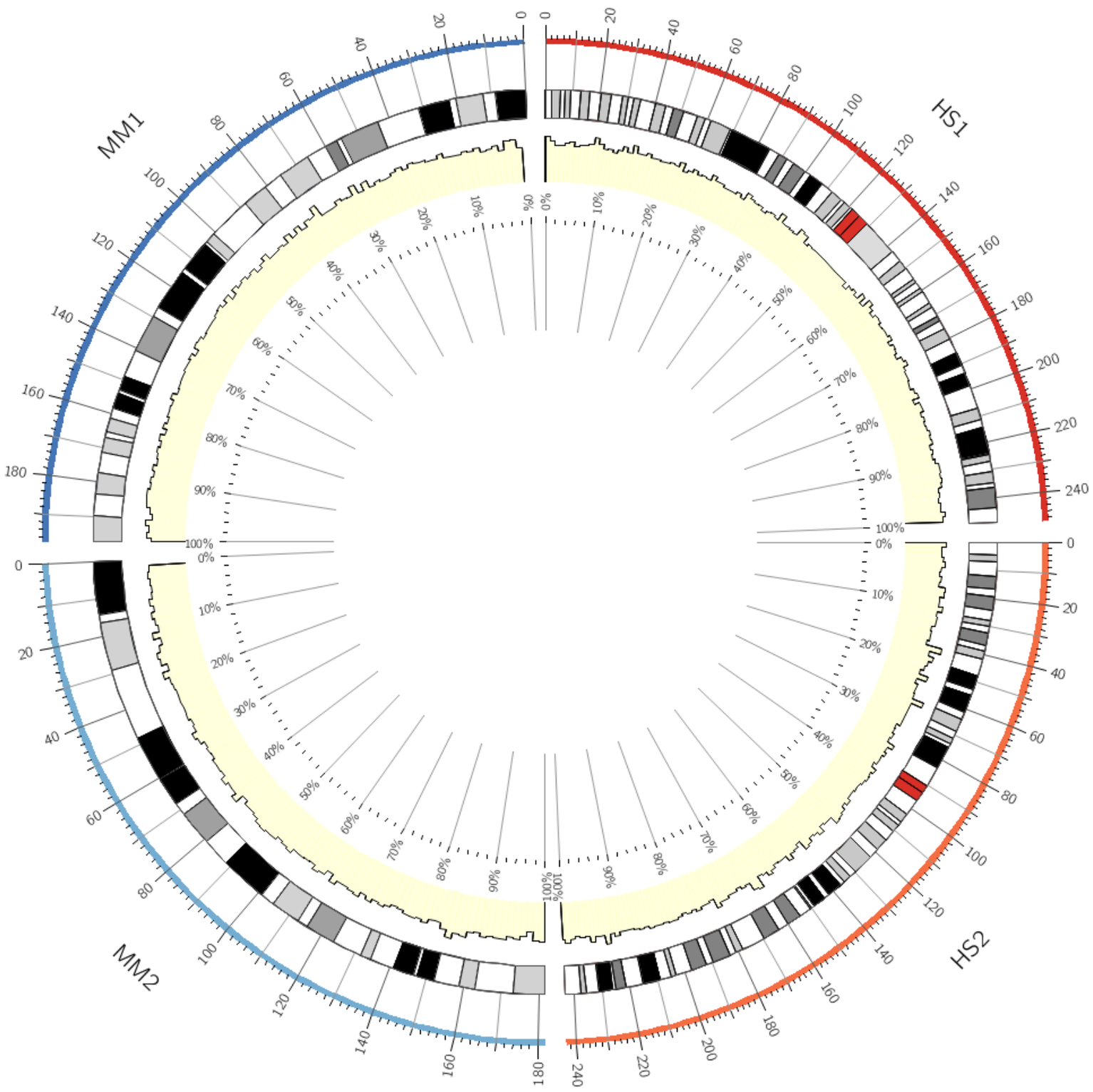
OTHER BREWER PALETTES



histograms

LESSON 2

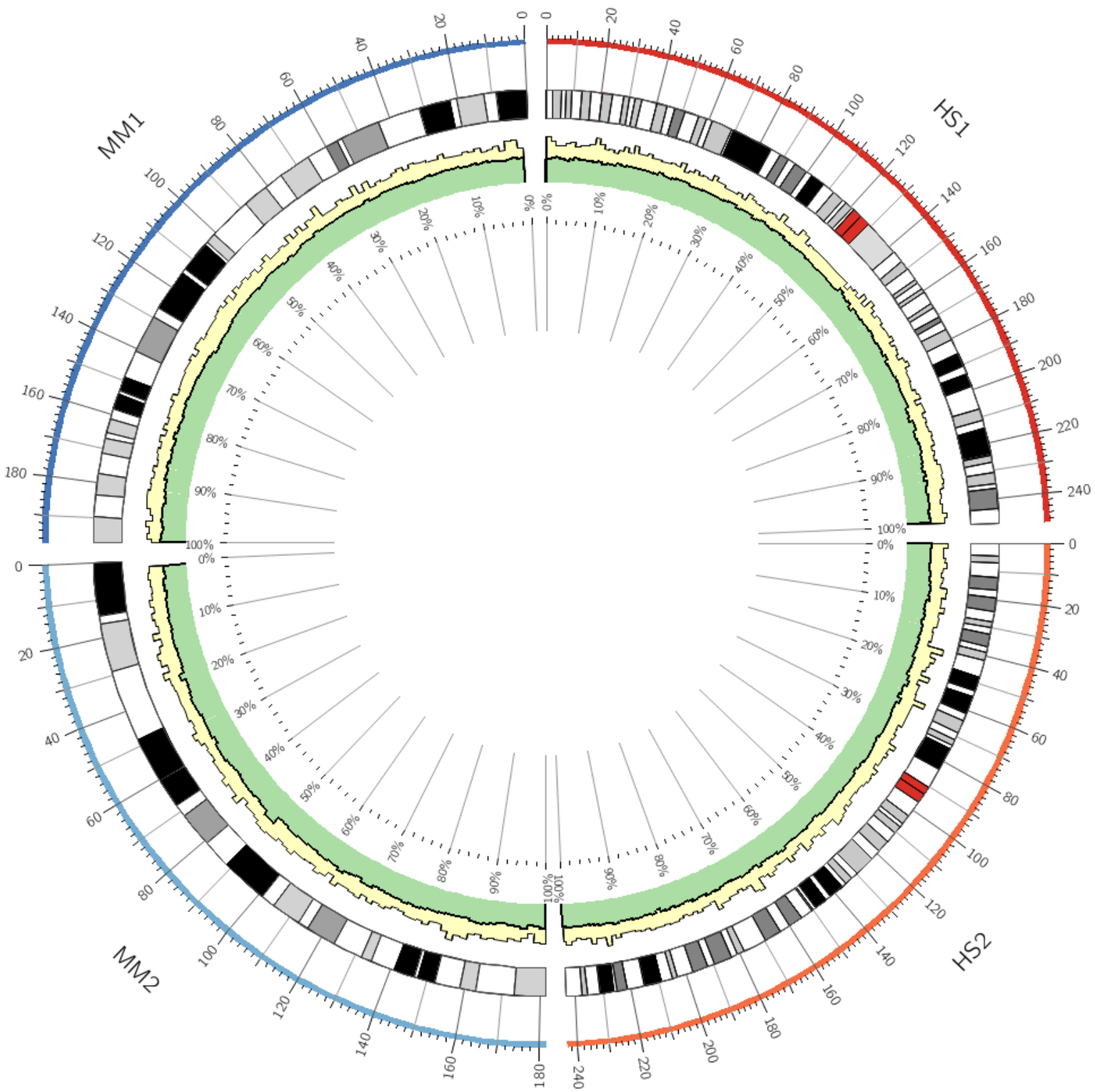
HISTOGRAMS




```
<plots>

type        = histogram
thickness   = 1p
color       = black
#color       = white
min         = 0
max         = 1
r0          = 0.85r
r1          = 0.975r

<plot>
file        = ../data/both.cons.2e6.max.txt
fill_color  = spectral-5-div-3 # yellow
</plot>

<plot>
show        = no
file        = ../data/both.cons.2e6.avg.txt
fill_color  = spectral-5-div-4 # green
thickness   = 2p
</plot>

<plot>
show        = no
file        = ../data/both.cons.2e6.min.txt
fill_color  = spectral-5-div-5 # blue
#fill_color  = white
</plot>

</plots>
```

.

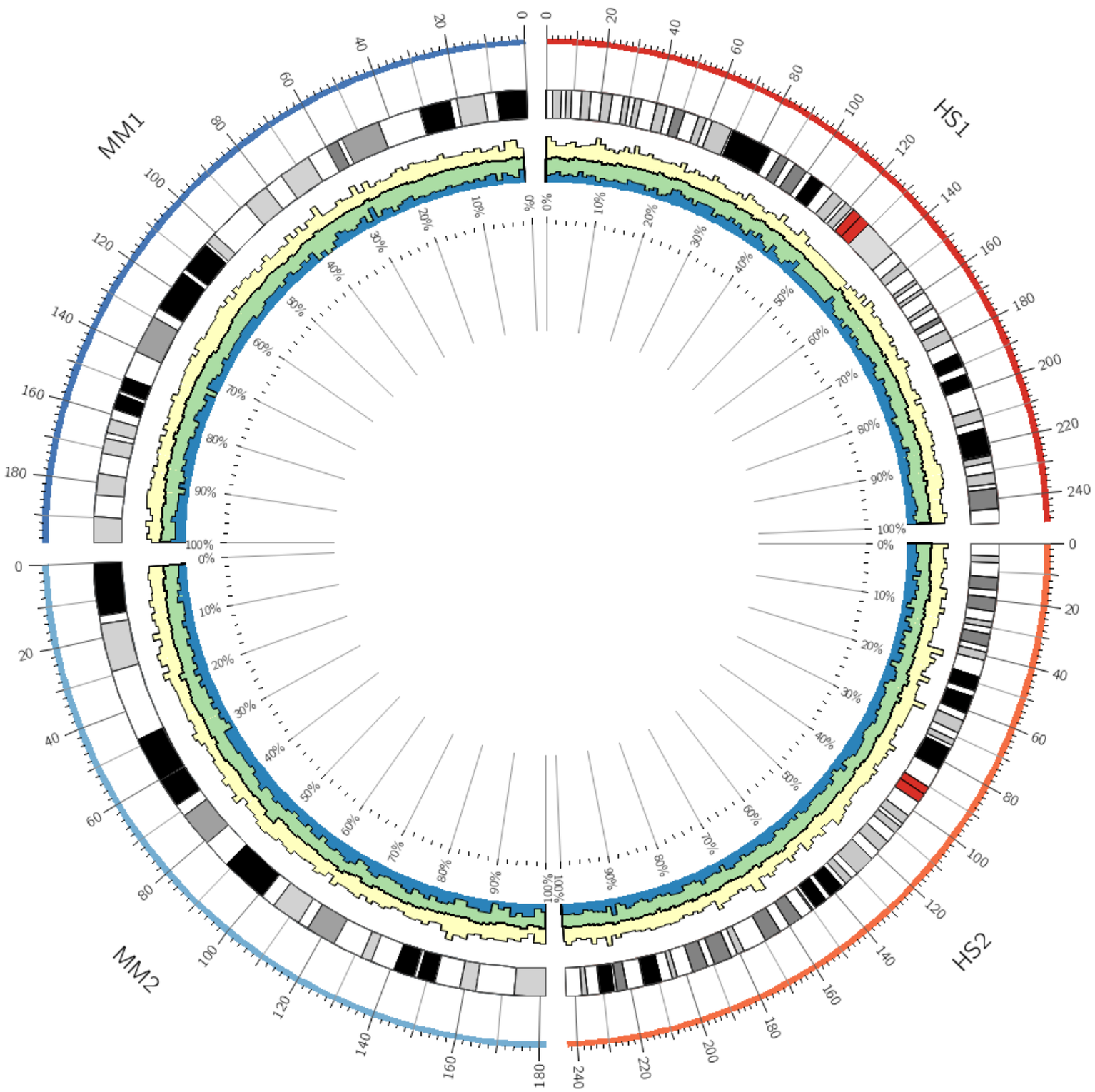
HISTOGRAMS




```
<plots>

type        = histogram
thickness   = 1p
color       = black
#color       = white
min         = 0
max         = 1
r0          = 0.85r
r1          = 0.975r

<plot>
file        = ../data/both.cons.2e6.max.txt
fill_color  = spectral-5-div-3 # yellow
</plot>

<plot>
show        = yes
file        = ../data/both.cons.2e6.avg.txt
fill_color  = spectral-5-div-4 # green
thickness   = 2p
</plot>

<plot>
show        = no
file        = ../data/both.cons.2e6.min.txt
fill_color  = spectral-5-div-5 # blue
#fill_color  = white
</plot>

</plots>
```

.

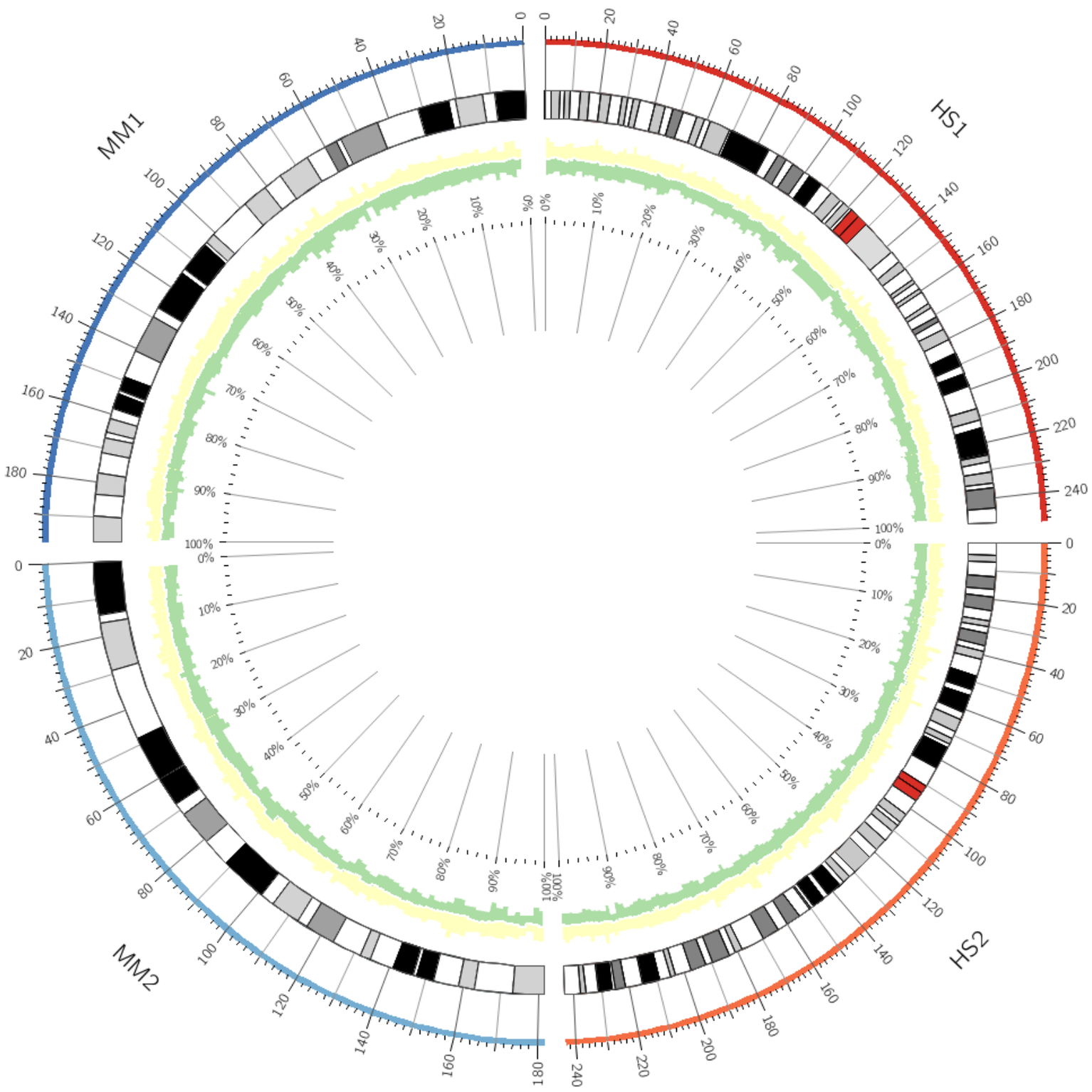
HISTOGRAMS




```
<plots>

type        = histogram
thickness   = 1p
color       = black
#color       = white
min         = 0
max         = 1
r0          = 0.85r
r1          = 0.975r

<plot>
file        = ../data/both.cons.2e6.max.txt
fill_color  = spectral-5-div-3 # yellow
</plot>

<plot>
show        = yes
file        = ../data/both.cons.2e6.avg.txt
fill_color  = spectral-5-div-4 # green
thickness   = 2p
</plot>

<plot>
show        = yes
file        = ../data/both.cons.2e6.min.txt
fill_color  = spectral-5-div-5 # blue
#fill_color  = white
</plot>

</plots>
```

.

HISTOGRAMS



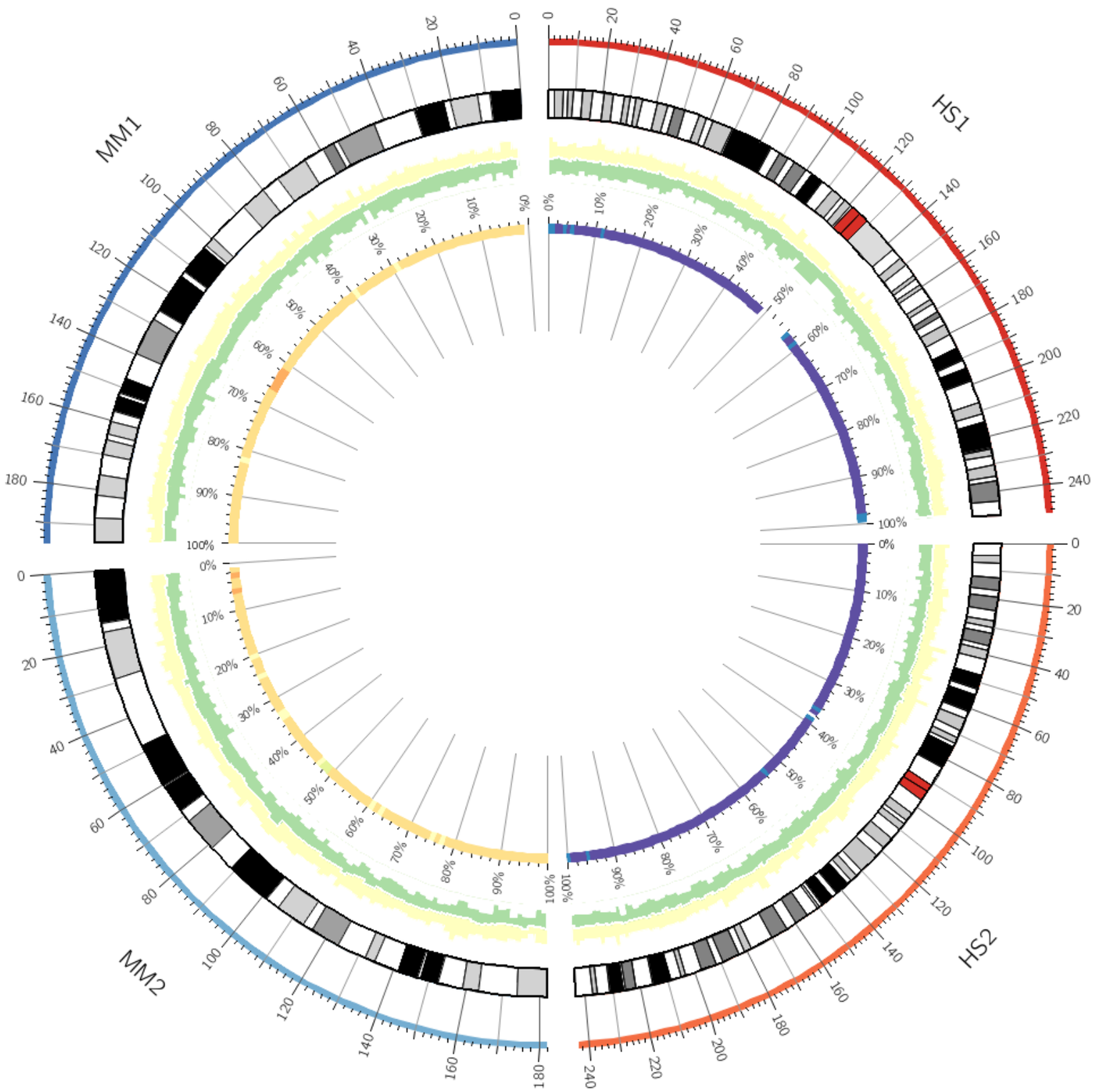

```
<plots>

type        = histogram
thickness   = 1p
#color       = black
color       = white
min         = 0
max         = 1
r0          = 0.85r
r1          = 0.975r

<plot>
file        = ../data/both.cons.2e6.max.txt
fill_color  = spectral-5-div-3 # yellow
</plot>

<plot>
show        = yes
file        = ../data/both.cons.2e6.avg.txt
fill_color  = spectral-5-div-4 # green
thickness   = 2p
</plot>

<plot>
show        = yes
file        = ../data/both.cons.2e6.min.txt
#fill_color  = spectral-5-div-5 # blue
fill_color  = white
</plot>

</plots>
```

.

heatmaps

LESSON 3

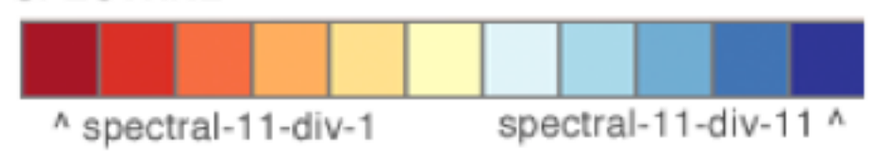
HEATMAPS




```
# heatmaps map a range of values onto
# a list of colors

<plot>
type  = heatmap
file  = ../data/both.cons.2e6.rhe.avg.txt
min   = 0.1
max   = 0.9
r0    = 0.73r
r1    = 0.75r
color = spectral-11-div
#color = spectral-11-div-rev
#scale_log_base = 0.500
</plot>
```

11-color Sequential Brewer Palette

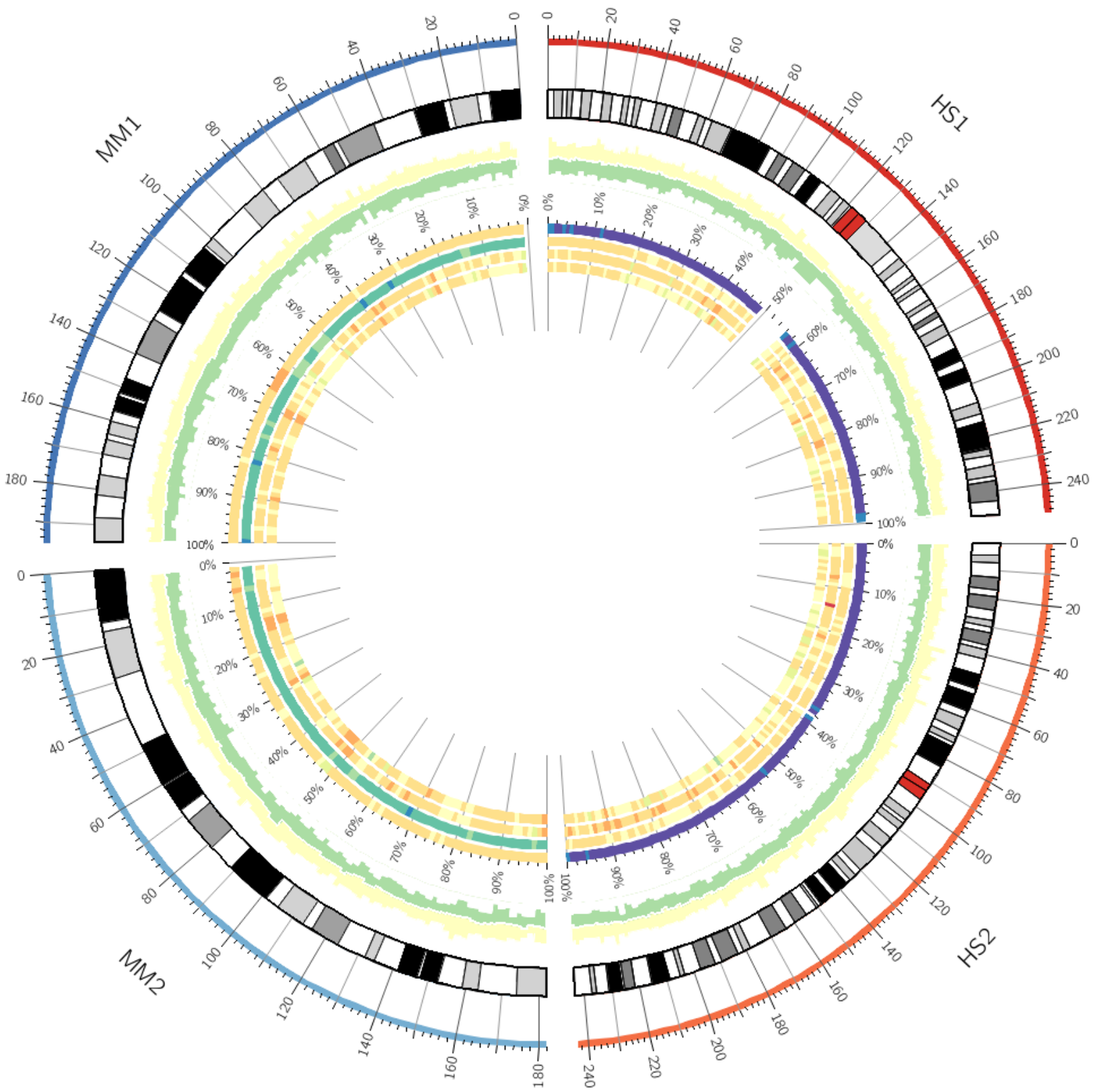
SPECTRAL



http://www.colorbrewer.org

.

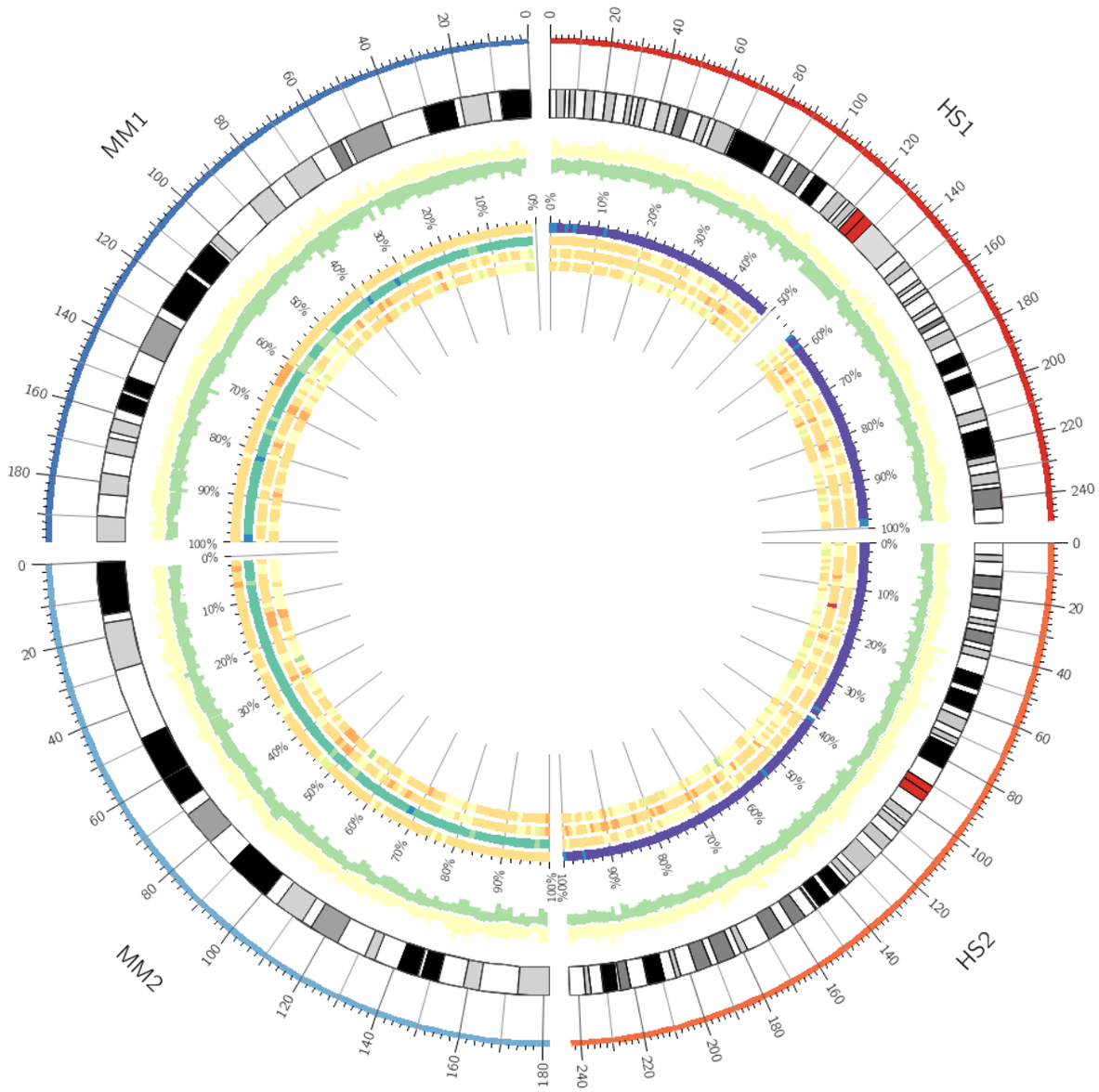
HEATMAPS

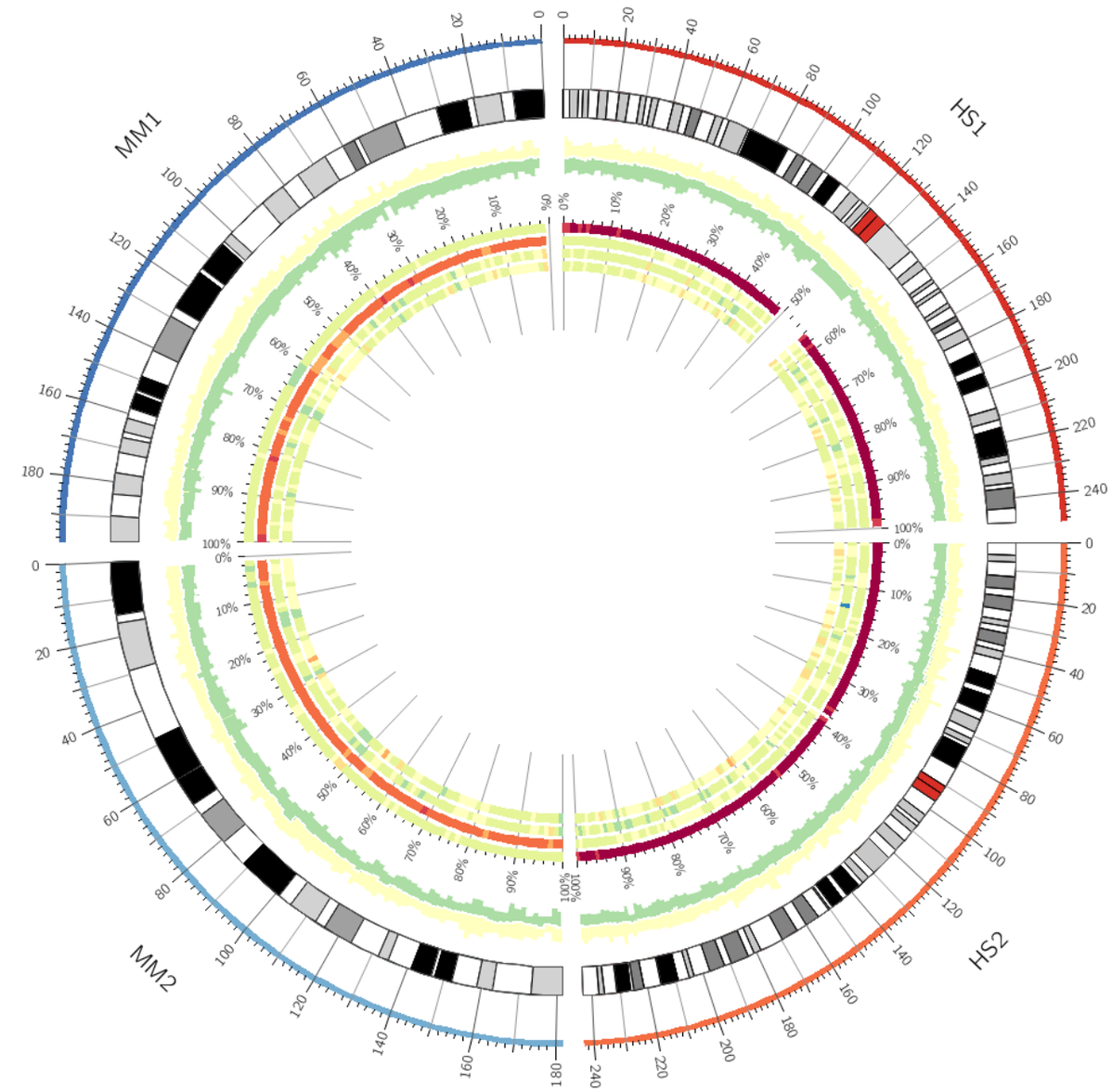



```
<plot>
type  = heatmap
file  = ../data/both.cons.2e6.rn.avg.txt
min   = 0.1
max   = 0.9
r0    = 0.70r
r1    = 0.72r
color = spectral-11-div
</plot>

<plot>
type = heatmap
file  = ../data/both.cons.2e6.danrer.avg.txt
min  = 0.1
max  = 0.9
r0   = 0.67r
r1   = 0.69r
color = spectral-11-div
</plot>

<plot>
type = heatmap
file  = ../data/both.cons.2e6.fr.avg.txt
min  = 0.1
max  = 0.9
r0   = 0.64r
r1   = 0.66r
color = spectral-11-div
</plot>
```

.

REVERSE COLOR LISTS

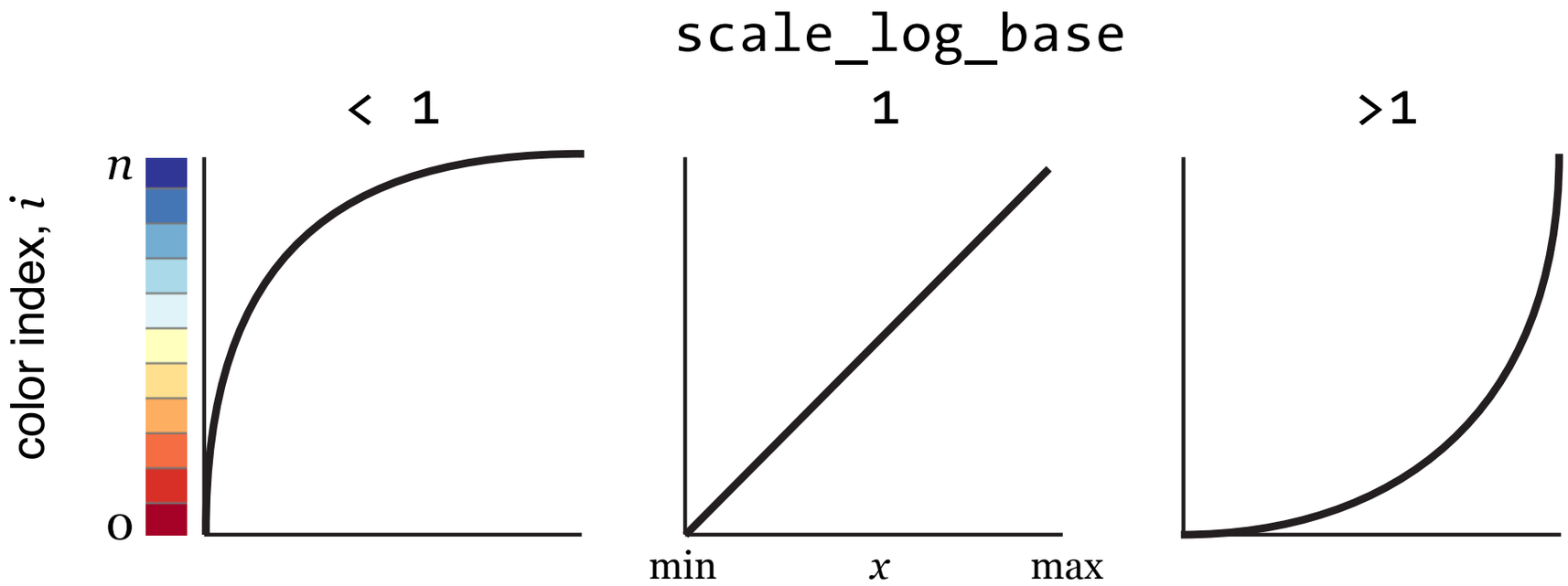




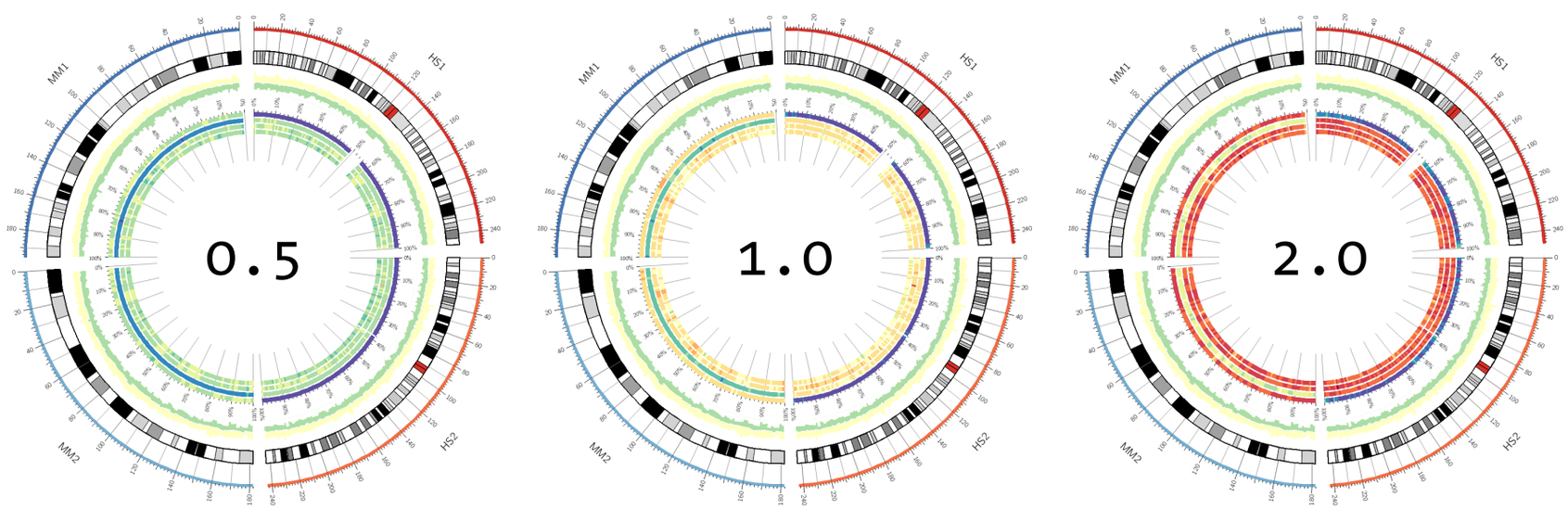

```
<plot>
...
color = spectral-11-div
...
</plot>
```

```
# each color list has a corresponding reverse version
# suffixed with -rev

<plot>
...
color = spectral-11-div-rev
...
</plot>
```

LOG COLOR MAPPING



$$i = n \left(\frac{x - \min}{\max - \min} \right)^{\frac{1}{\text{scale\_log\_base}}}$$



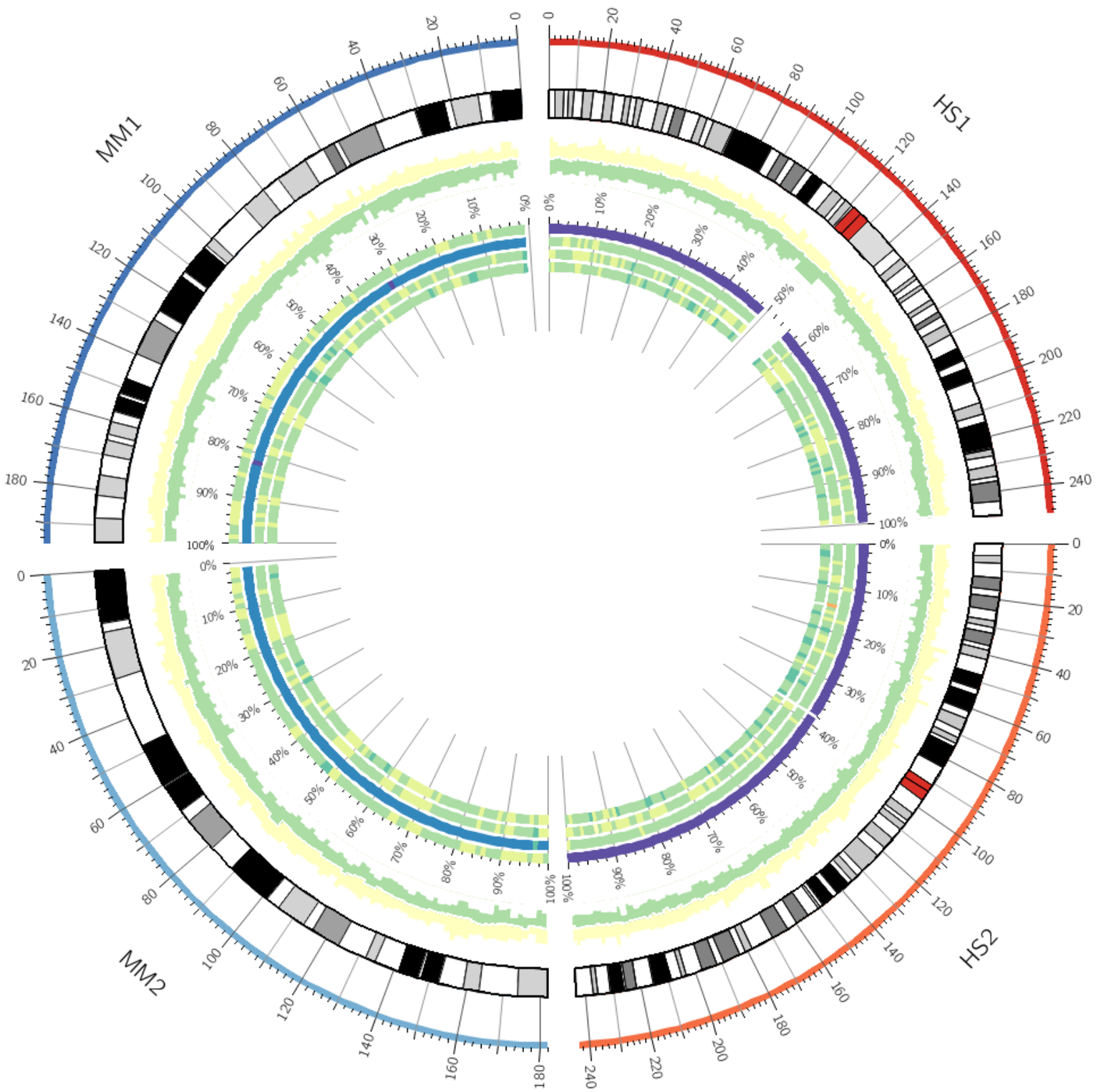
greater dynamic range of color for smaller values

colors uniformly distributed across range of values

greater dynamic range of color for larger values

.

LOG COLOR MAPPING



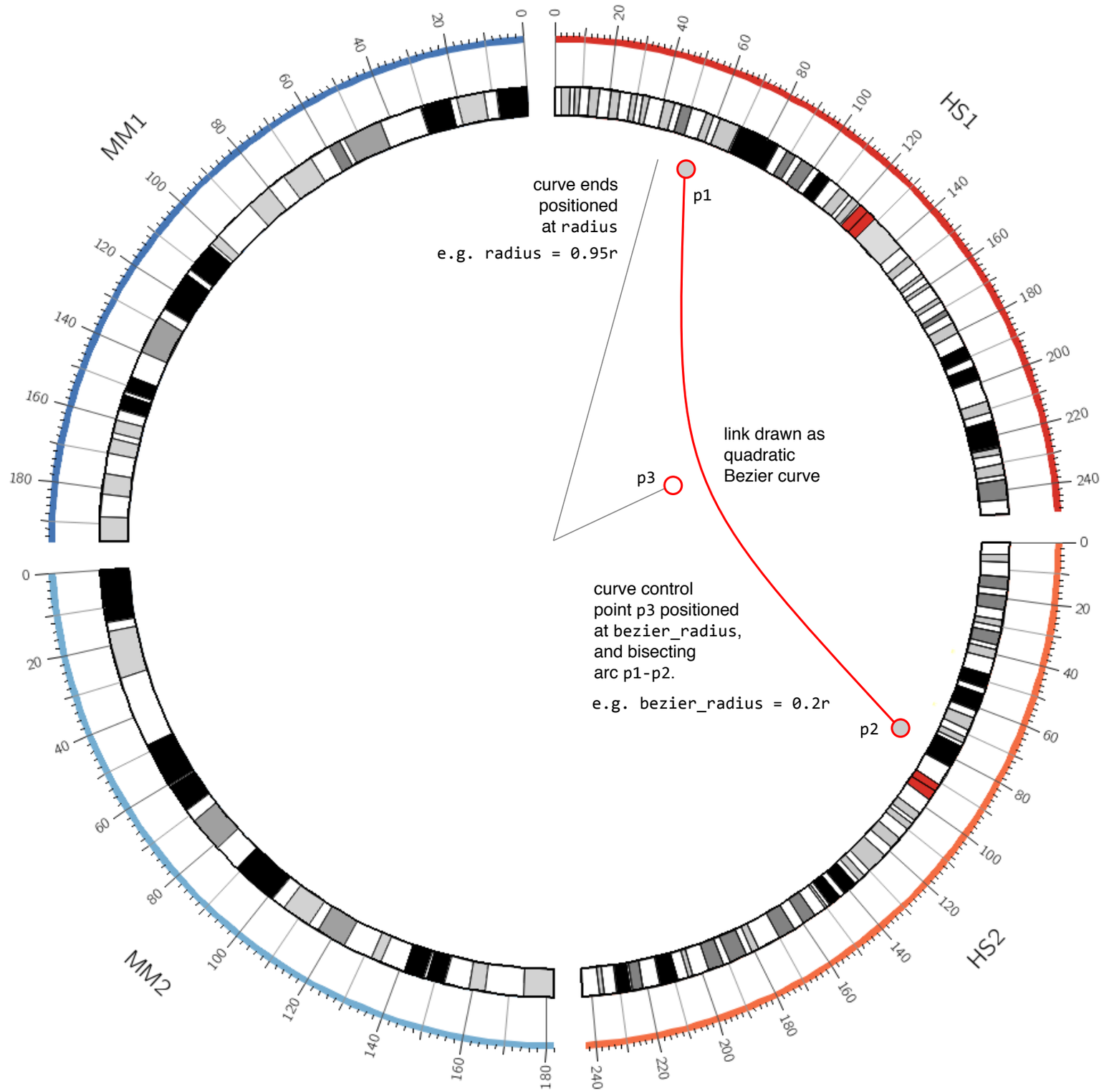

```
<plot>
...
scale_log_base = 0.5
...
</plot>
```

.

links

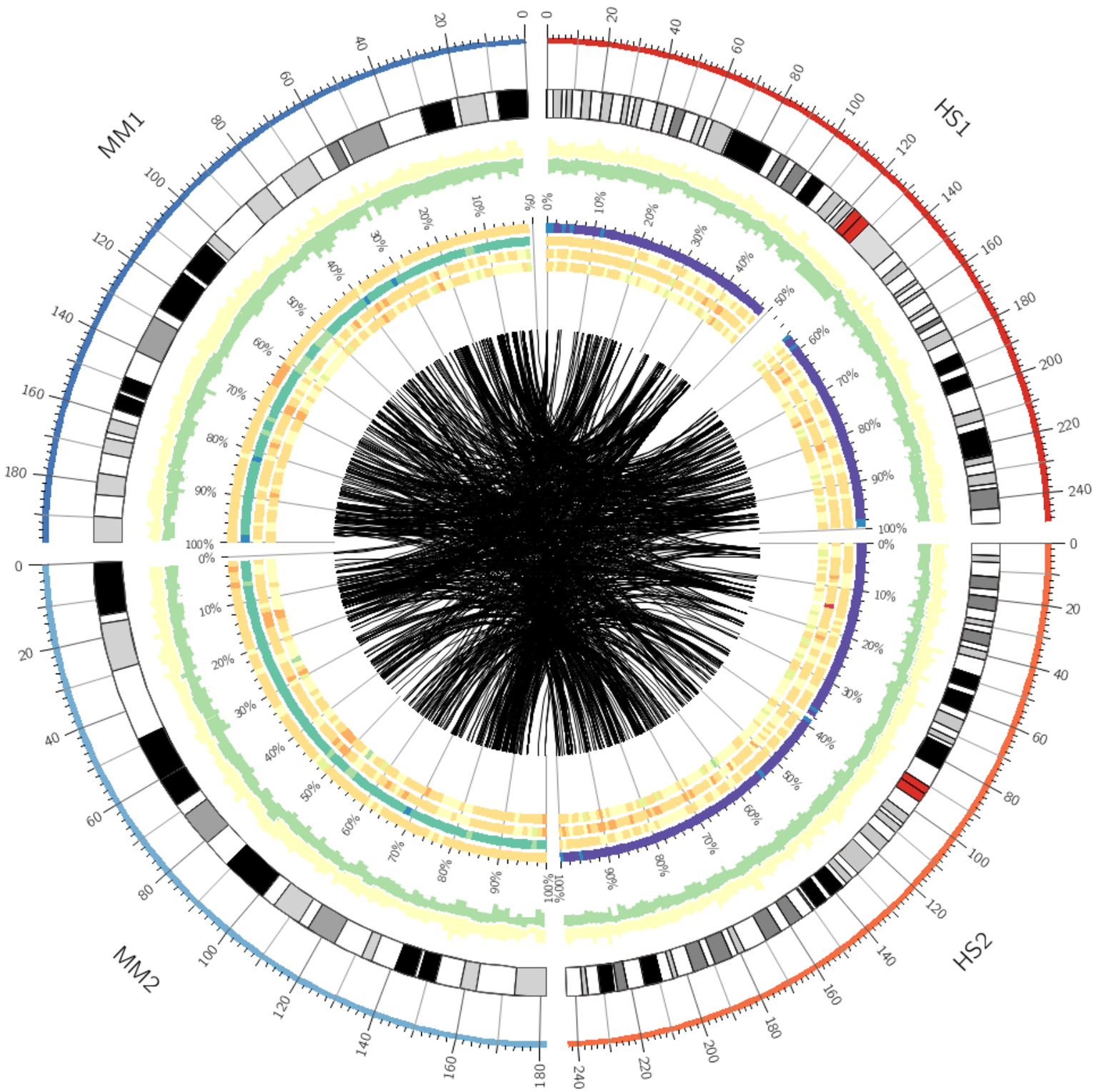
LESSON 4

LINK GEOMETRY



.

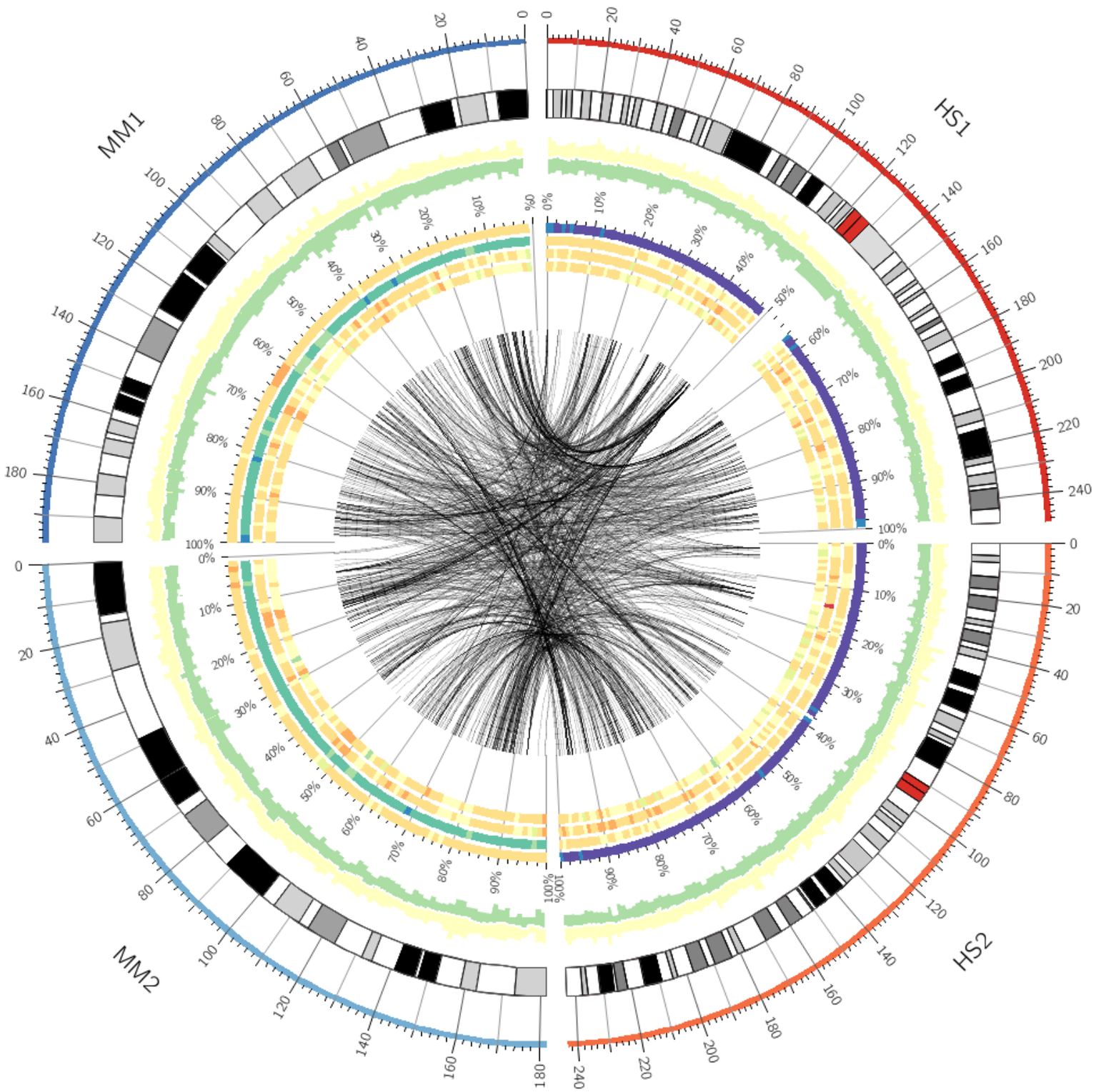
LINKS




```
<links>

<link>
file            = ../data/links.txt
bezier_radius   = 0r
radius          = 0.5r
thickness       = 1p
color           = black
#color          = black_a5
</link>

</links>
```

.

LINKS



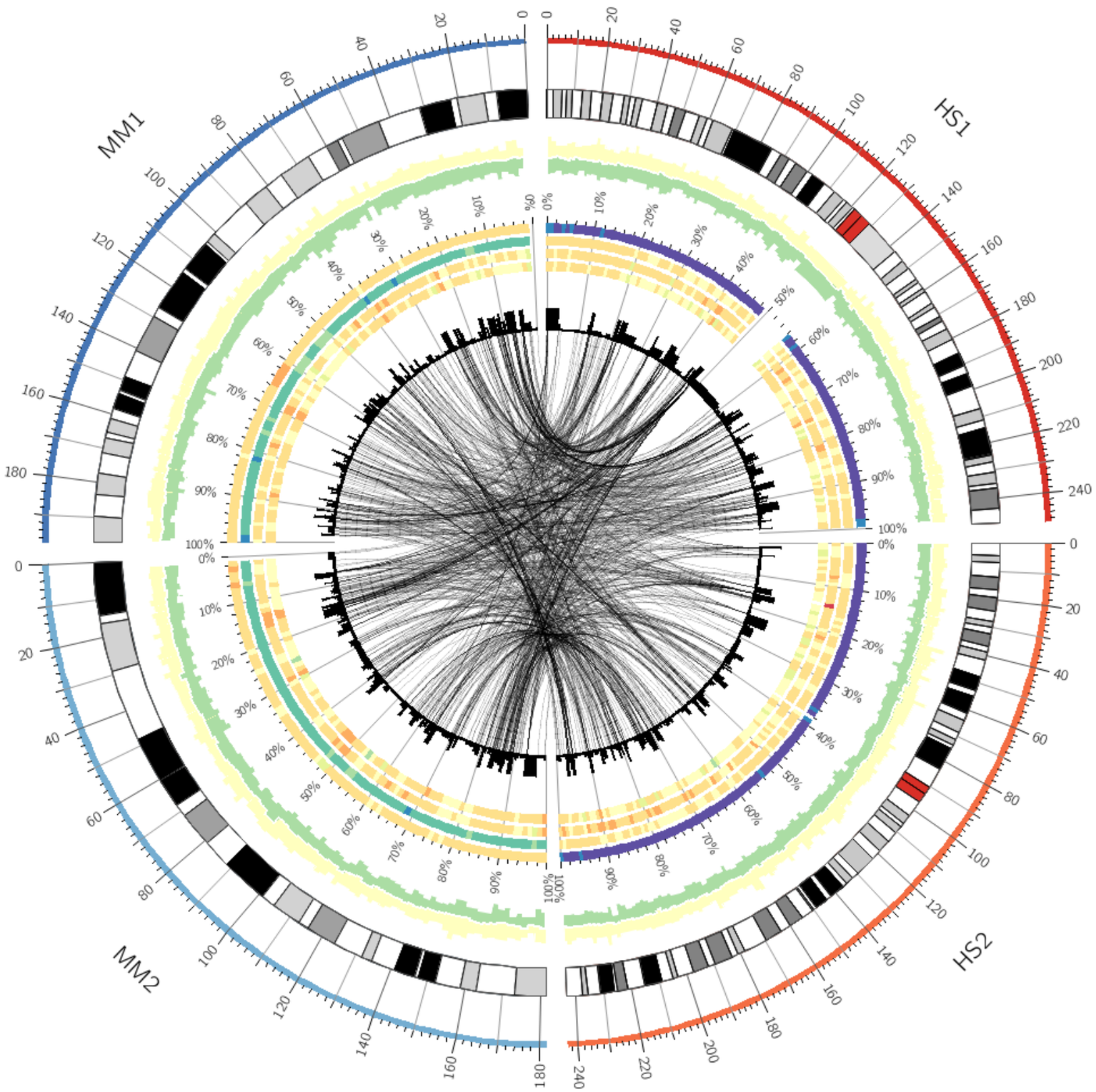

```
<links>

<link>
file            = ../data/links.txt
bezier_radius   = 0r
radius          = 0.5r
thickness       = 1p
#color          = black
color           = black_a5
</link>

</links>
```

.

density histograms & axis grids

LESSON 5

DENSITY HISTOGRAMS



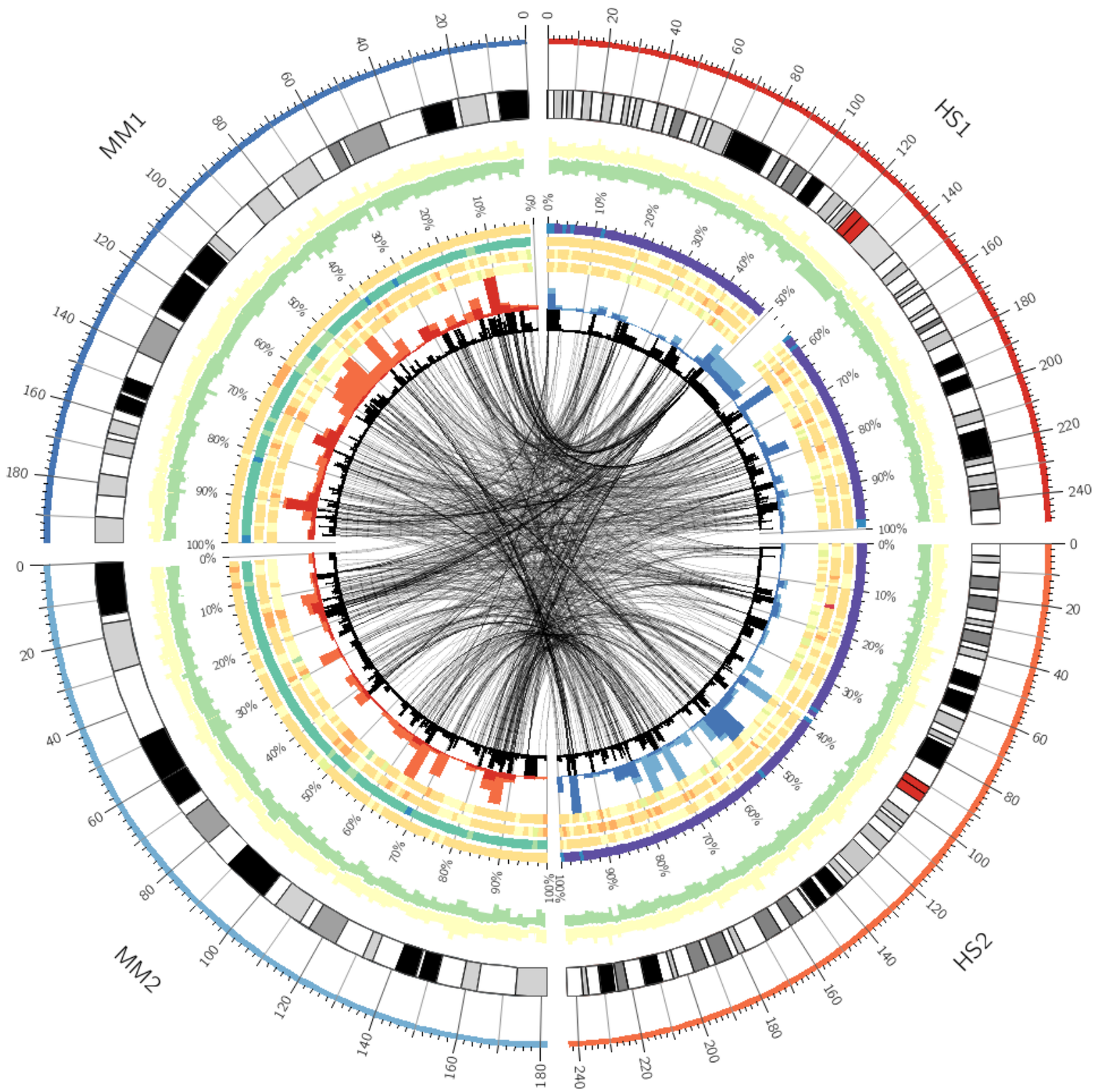

```
<plot>
type      = histogram
file      = ../data/links.density.txt
min       = 0
max       = 10
r0        = 0.5r
r1        = 0.55r
thickness = 0
fill_color = black
</plot>
```

.

DENSITY HISTOGRAMS - BINLINKS

```
# 3/data/ucsc/create.tracks

#################################################################
# Lesson 5

echo "Creating density tracks for Lesson 5"

$PERL $CIRCOSTOOLS/binlinks/bin/binlinks -links ../links.txt -link_end 2 -output_style 0 -bin 1e6 -num
   > ../links.density.txt

$PERL $CIRCOSTOOLS/binlinks/bin/binlinks -links ../links.txt -link_end 2 -output_style 3 -bin 5e6
   > ../links.density.stacked.txt
```

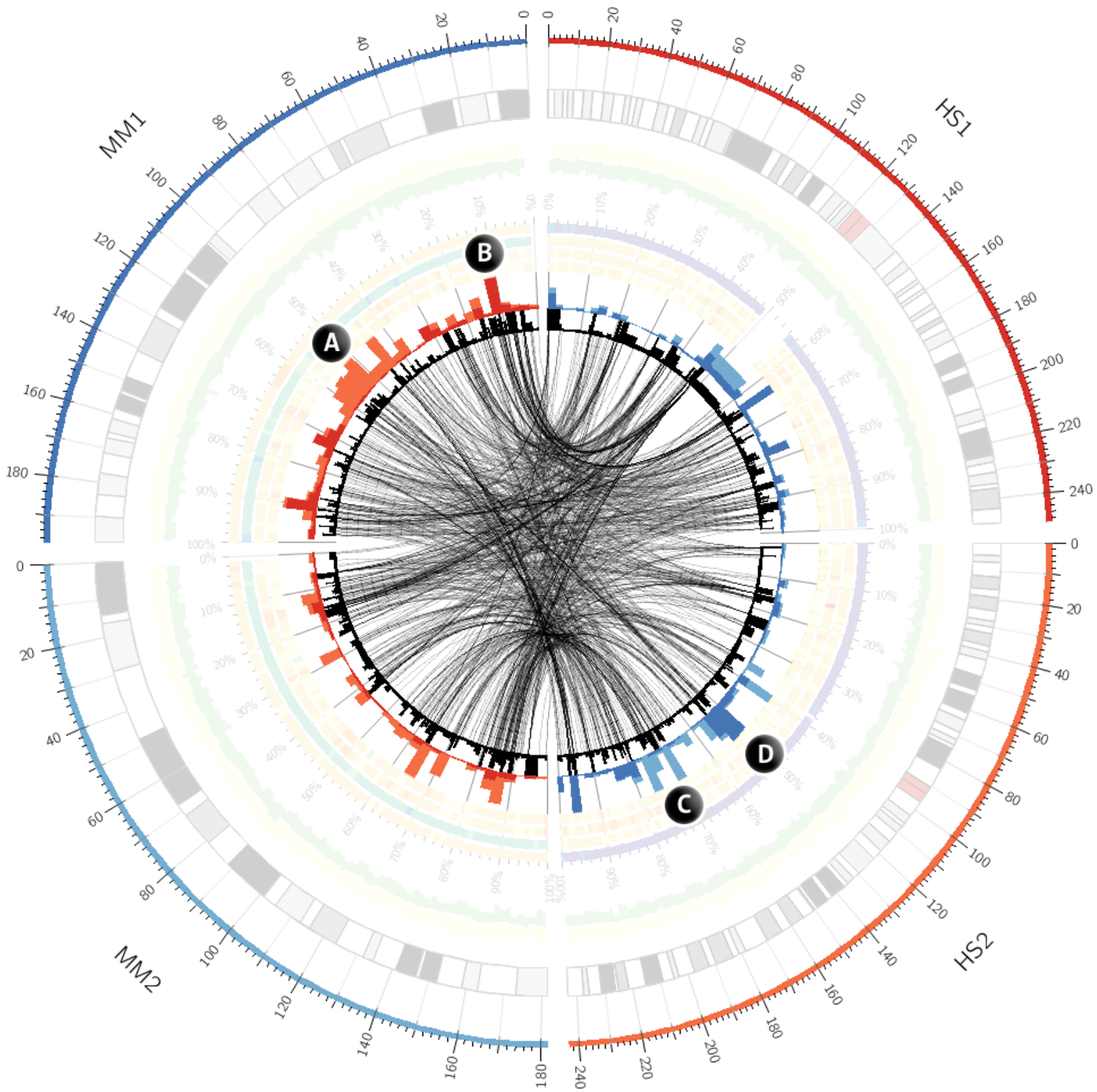
DENSITY HISTOGRAMS




```
<plot>
type        = histogram
file        = ../data/links.density.txt
min         = 0
max         = 10
r0          = 0.5r
r1          = 0.55r
thickness   = 0
fill_color  = black
</plot>

<plot>
show        = yes
type        = histogram
file        = ../data/links.density.stacked.txt
min         = 0
max         = 300000
r0          = 0.55r
r1          = 0.65r
thickness   = 0
fill_color  = rdylbu-11-div-10,
              rdylbu-11-div-2,
              rdylbu-11-div-3,
              rdylbu-11-div-9
</plot>
```

.

DENSITY HISTOGRAMS




```
<plot>
type        = histogram
file        = ../data/links.density.txt
min         = 0
max         = 10
r0          = 0.5r
r1          = 0.55r
thickness   = 0
fill_color  = black
</plot>

<plot>
show        = yes
type        = histogram
file        = ../data/links.density.stacked.txt
min         = 0
max         = 300000
r0          = 0.55r
r1          = 0.65r
thickness   = 0
fill_color  = rdylbu-11-div-10,
              rdylbu-11-div-2,
              rdylbu-11-div-3,
              rdylbu-11-div-9
</plot>
```

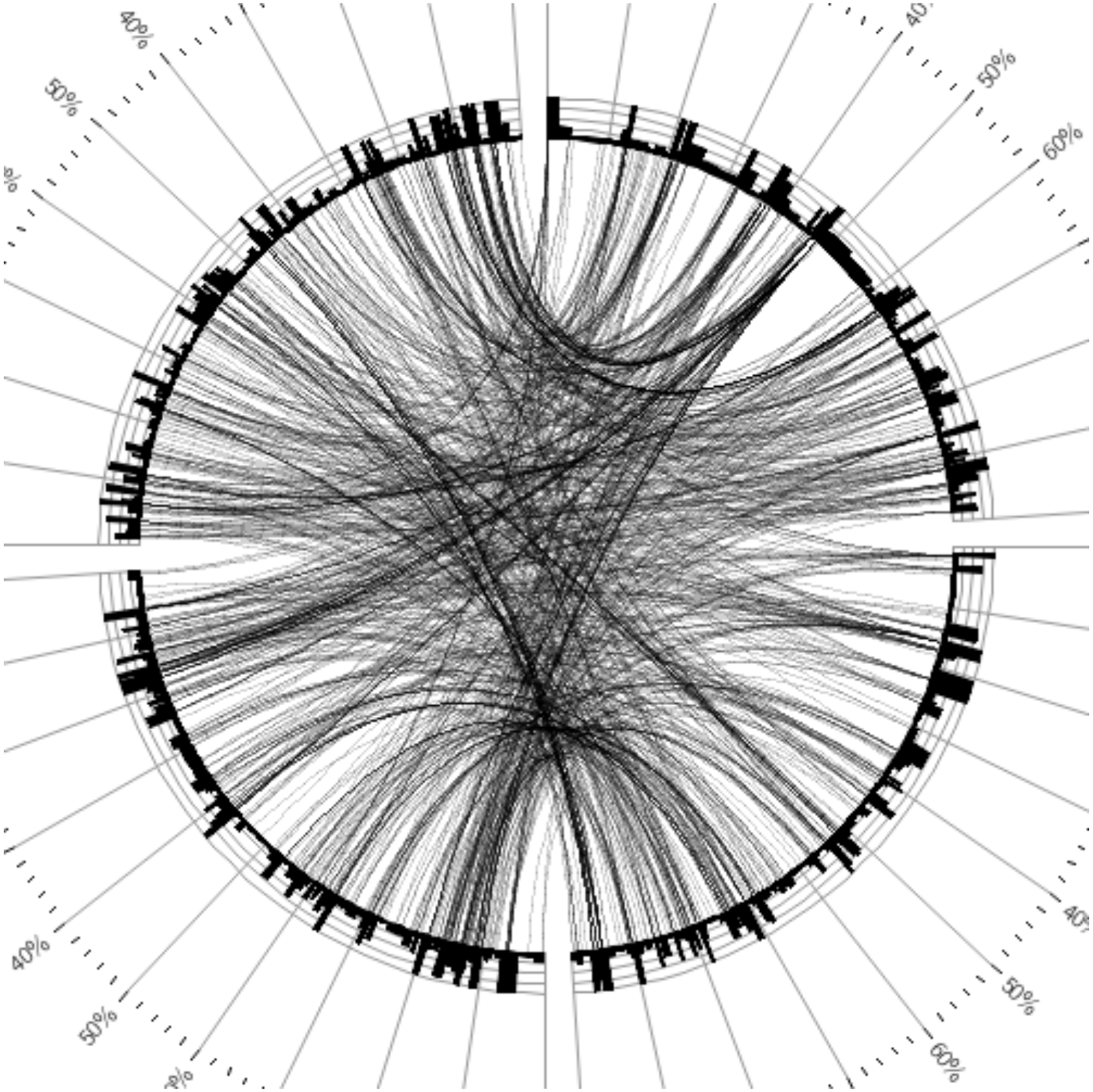
Histogram bars are colored by color of ideogram corresponding to the link's other end. (A) most links from hs2 (B) most links from hs1 (C) most links from mm2 (D) most links from mm1

STACKED HISTOGRAM DATA FORMAT

```
# 3/data/links.density.txt
# - normal histogram

hs2 3000000 3999999 15.0000
hs2 4000000 4999999 1.0000
hs2 6000000 6999999 1.0000
hs2 9000000 9999999 7.0000
hs2 10000000 10999999 1.0000
hs2 11000000 11999999 1.0000
hs2 25000000 25999999 1.0000
```

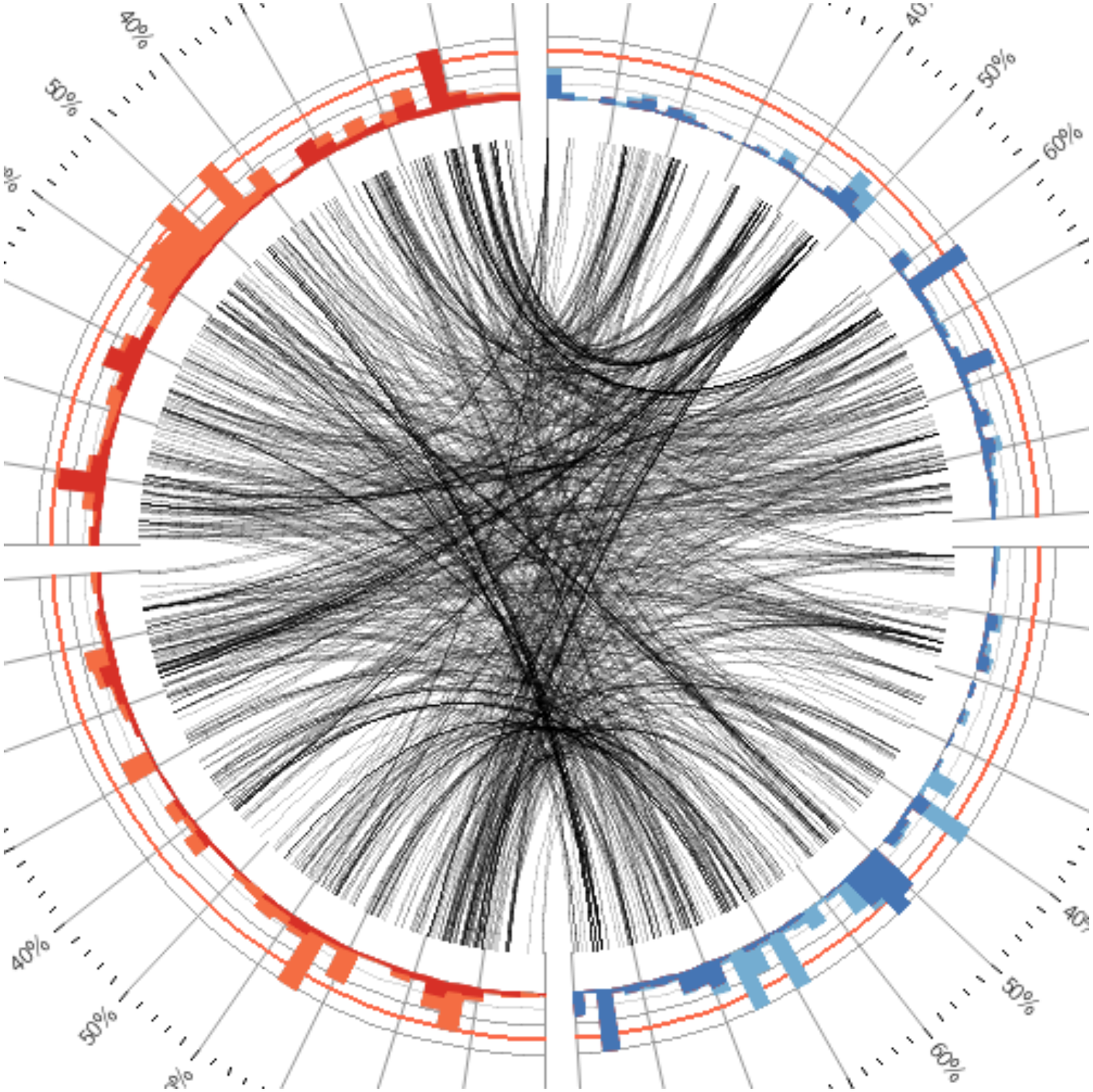
```
# 3/data/links.density.stacked.txt
# - stacked histogram

hs2 0 4999999 7755.0000,0.0000,0.0000,15461.0000
hs2 5000000 9999999 7877.0000,0.0000,0.0000,9648.0000
hs2 10000000 14999999 4877.0000,0.0000,0.0000,1319.0000
hs2 25000000 29999999 40722.0000,0.0000,0.0000,20747.0000
hs2 30000000 34999999 7664.0000,0.0000,0.0000,2691.0000
hs2 35000000 39999999 11408.0000,0.0000,0.0000,23640.0000
hs2 40000000 44999999 42742.0000,0.0000,0.0000,16721.0000
hs2 50000000 54999999 7745.0000,0.0000,0.0000,7684.0000
hs2 60000000 64999999 7016.0000,0.0000,0.0000,23395.0000
hs2 70000000 74999999 2685.0000,0.0000,0.0000,5510.0000
hs2 80000000 84999999 950.0000,0.0000,0.0000,12583.0000
hs2 85000000 89999999 0.0000,0.0000,0.0000,123674.0000
hs2 90000000 94999999 0.0000,0.0000,0.0000,8511.0000
```

DENSITY HISTOGRAMS




```
<plot>

...

<axes>
<axis>
color     = grey
spacing   = 0.25r
thickness = 1
</axis>
</axes>

...

</plot>
```

DENSITY HISTOGRAMS

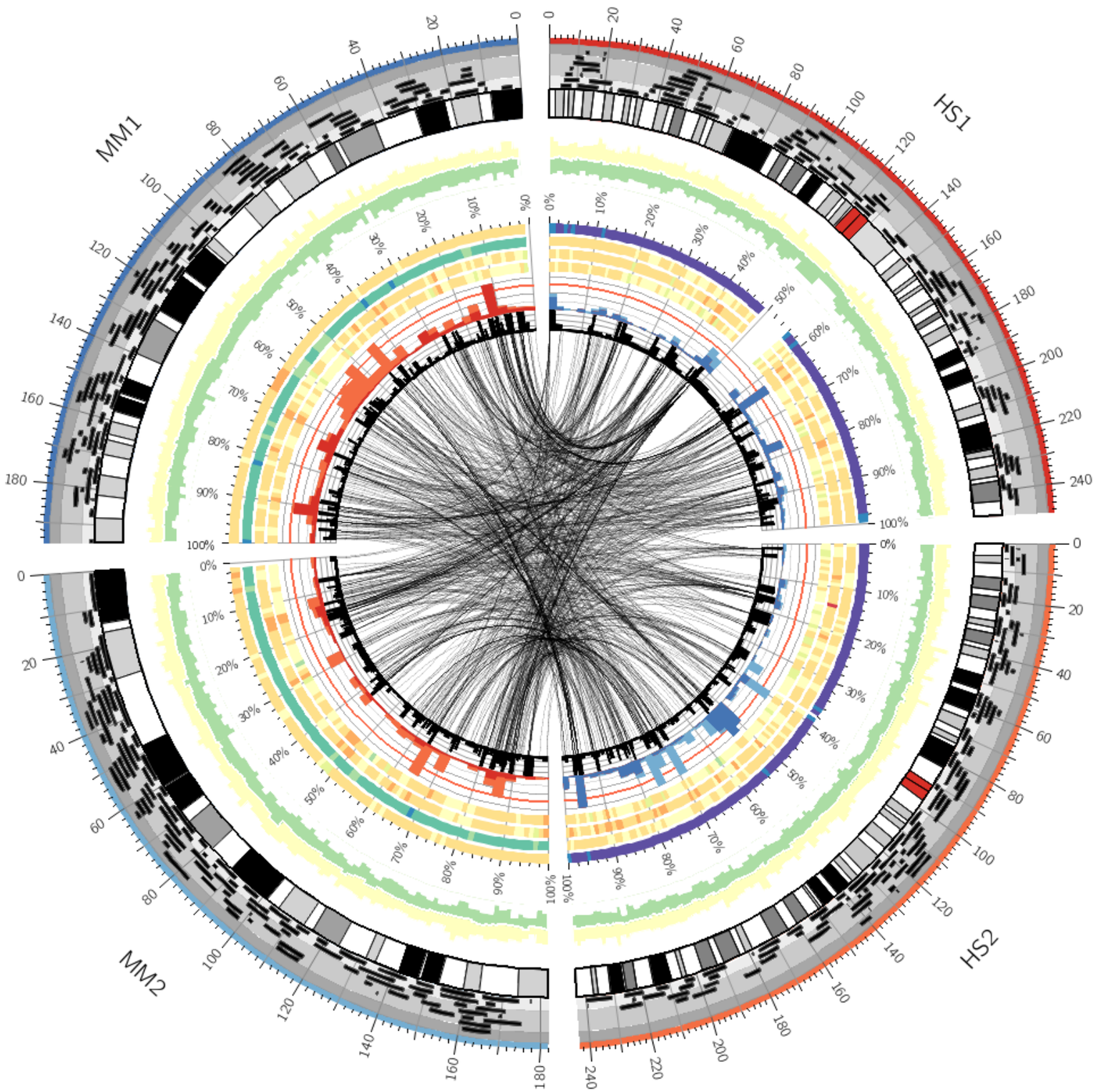



```
<plot>

...

<axes>
<axis>
color     = grey_a4
spacing   = 0.25r
thickness = 1
</axis>
<axis>
color     = grey_a1
spacing   = 0.5r
thickness = 1
</axis>
<axis>
color     = red
position  = 0.75r
thickness = 2
</axis>
</axes>

...

</plot>
```

tiles, backgrounds & dynamic rules

LESSON 6

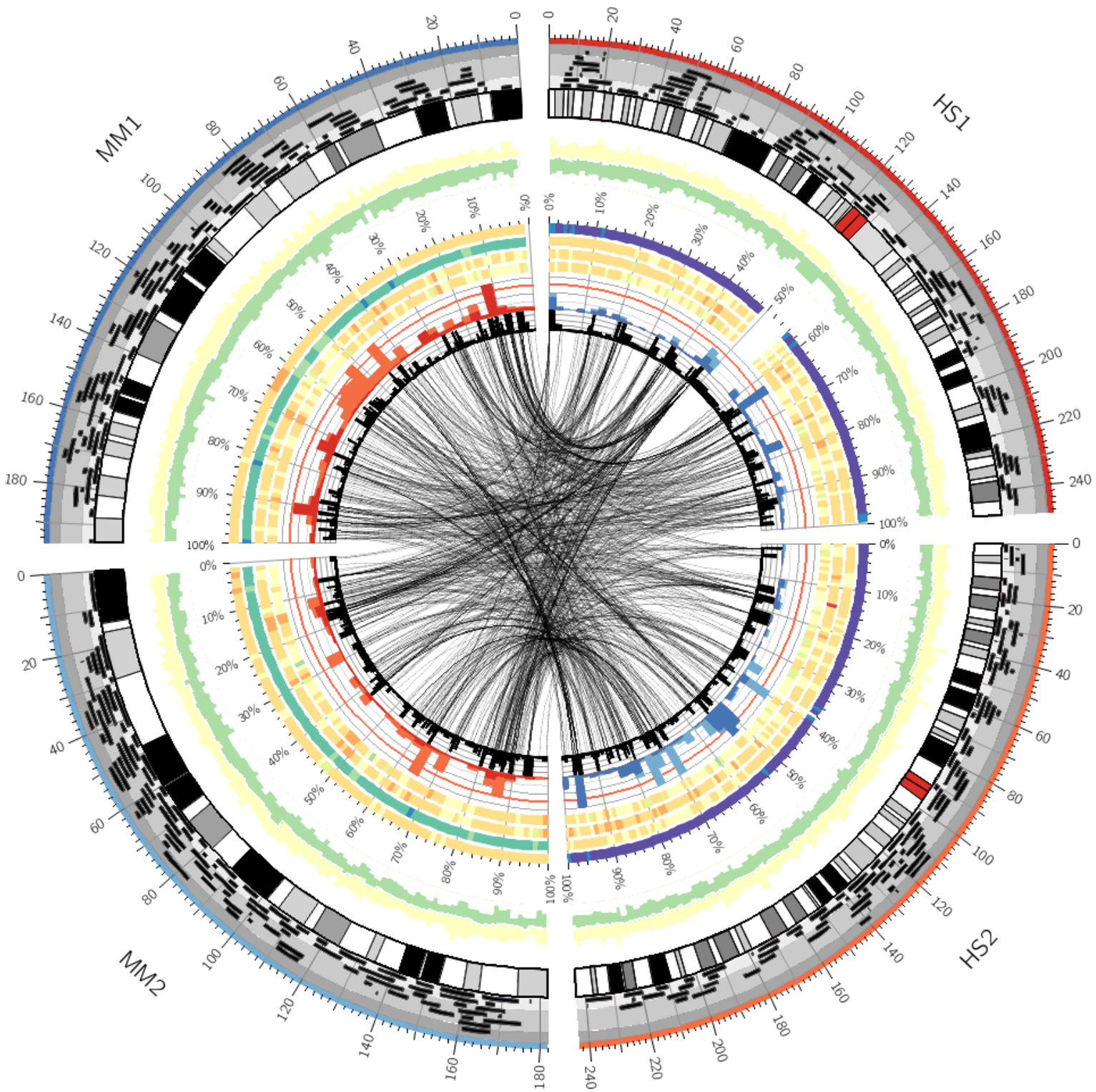
TILES




```
<plot>
type     = tile
file     = ../data/tiles.txt
r0       = 1r+2p
r1       = 1r+40p

layers                = 7
layers_overflow       = hide
layers_overflow_color = red

margin    = 1u
thickness = 3
padding   = 2

orientation = out

color             = black
stroke_thickness  = 1
stroke_color      = vdgrey

...

</plot>
```

.

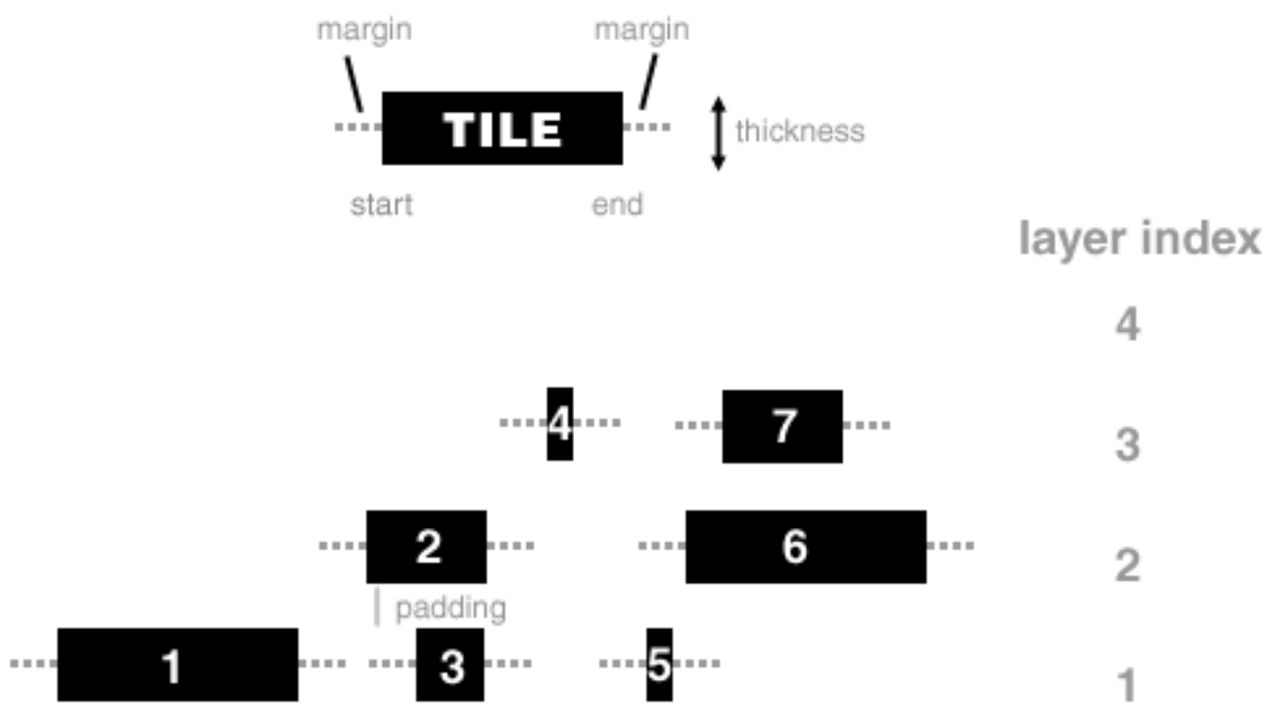
TILES




```
<plot>

...

<backgrounds>
<background>
y0     = 0.75r
color = grey_a1
</background>
<background>
y0     = 0.25r
y1     = 0.75r
color = grey_a3
</background>
<background>
y1     = 0.25r
color = grey_a5
</background>
</backgrounds>

</plot>
```

.

TILE GEOMETRY



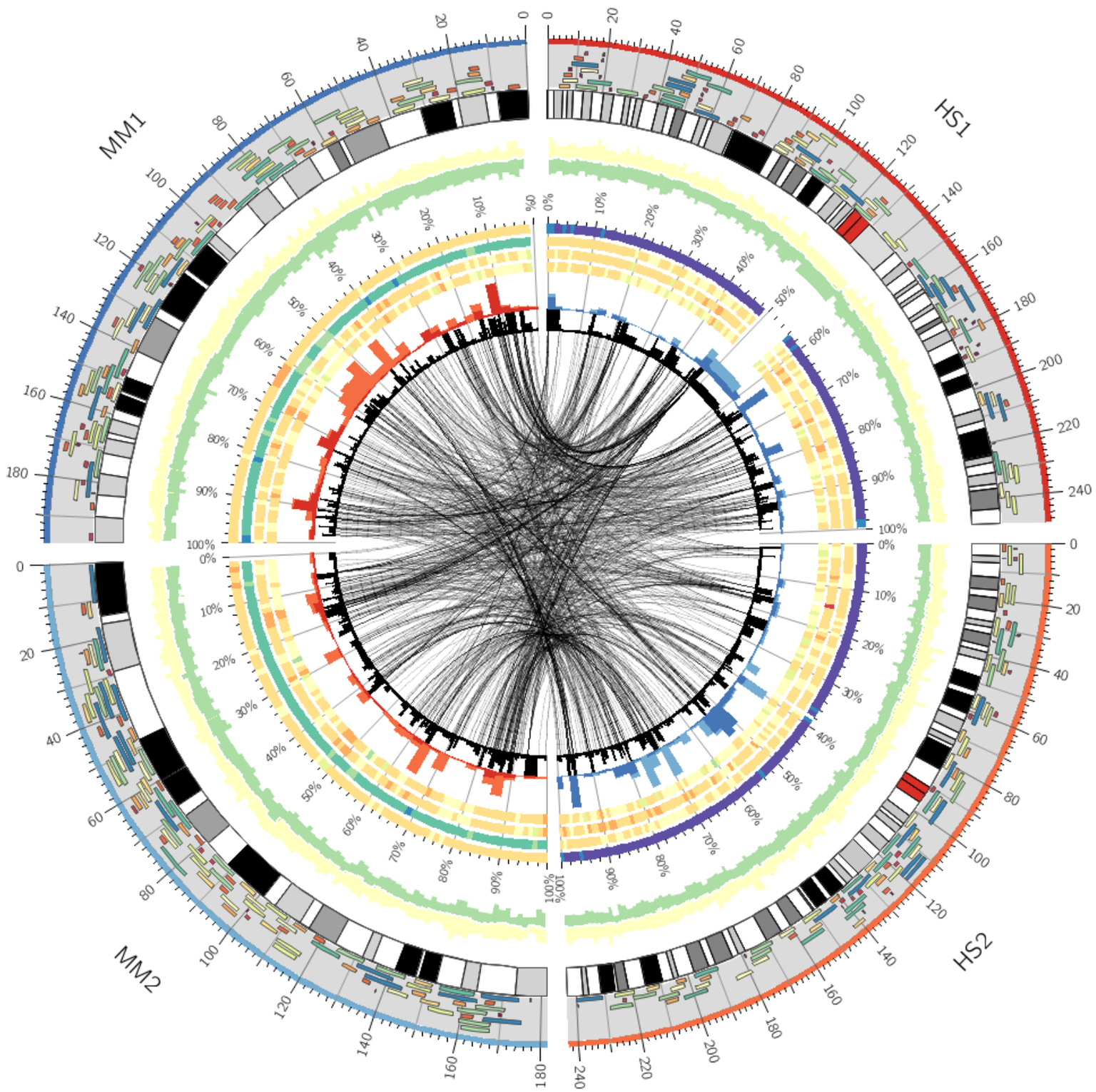
Tiles are placed in layer with smallest index that can accomodate tile's extent without overlap with other tiles in the layer. Tile's extent is defined as the region **[start-margin,end+margin]**. Spacing between layers is defined by **padding**. Relationship between layer index and layer distance from center of circle is defined by tile plot **orientation** (*in*, *out*, or *center*).

orientation

layer index	in	out	center
	1	6	5
	2	5	3
	3	4	1
	4	3	2
	5	2	4
	6	1	6

image center

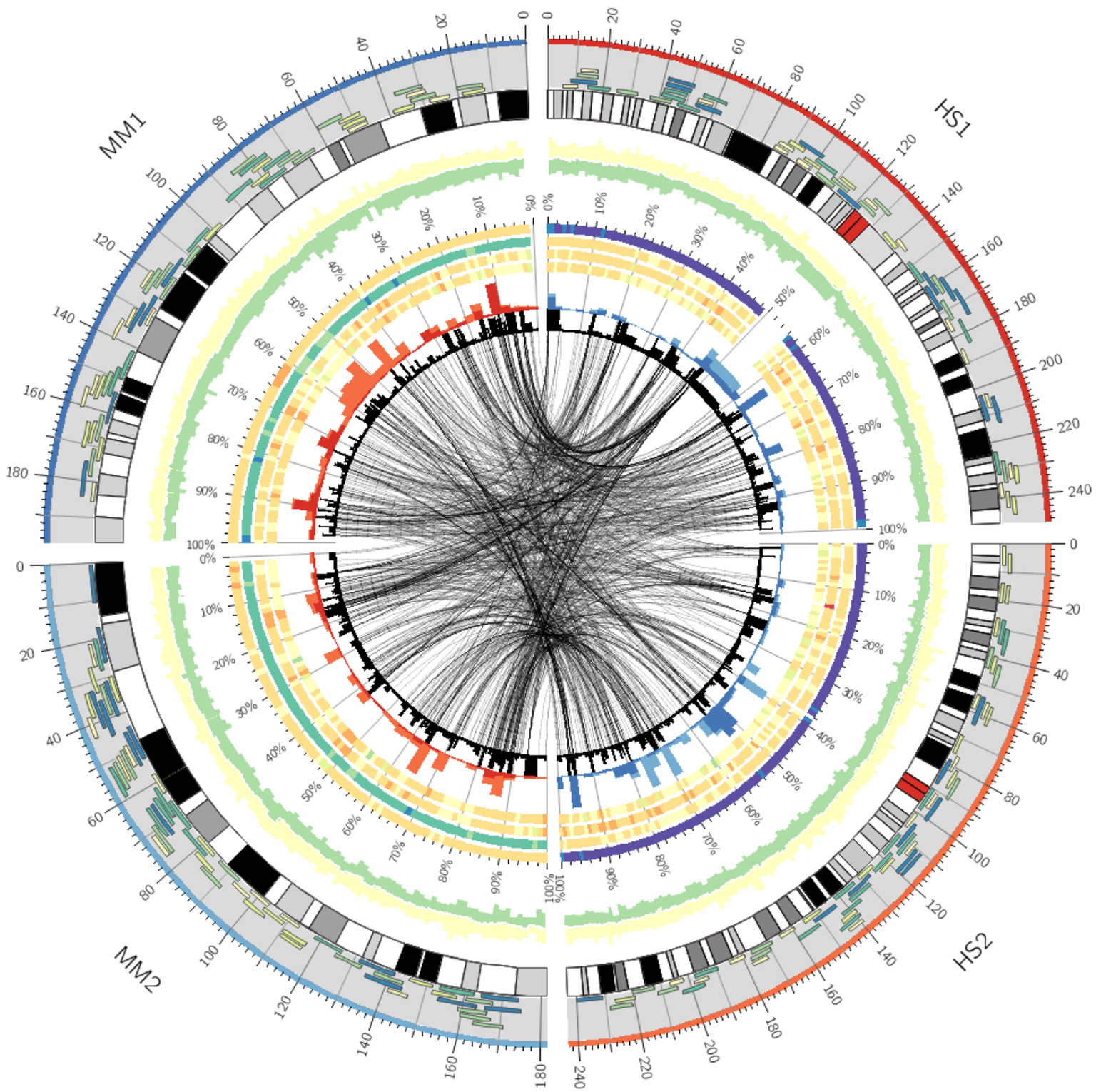
DYNAMIC FORMATTING RULES




```
<plot>

...

<rules>

<rule>
condition  = 1
color      =
 eval(
  sprintf("spectral-11-div-%d",
          remap_int(var(size),0,10e6,1,11)
         )
     )
</rule>

</rules>

</plot>
```

.

DYNAMIC FORMATTING RULES



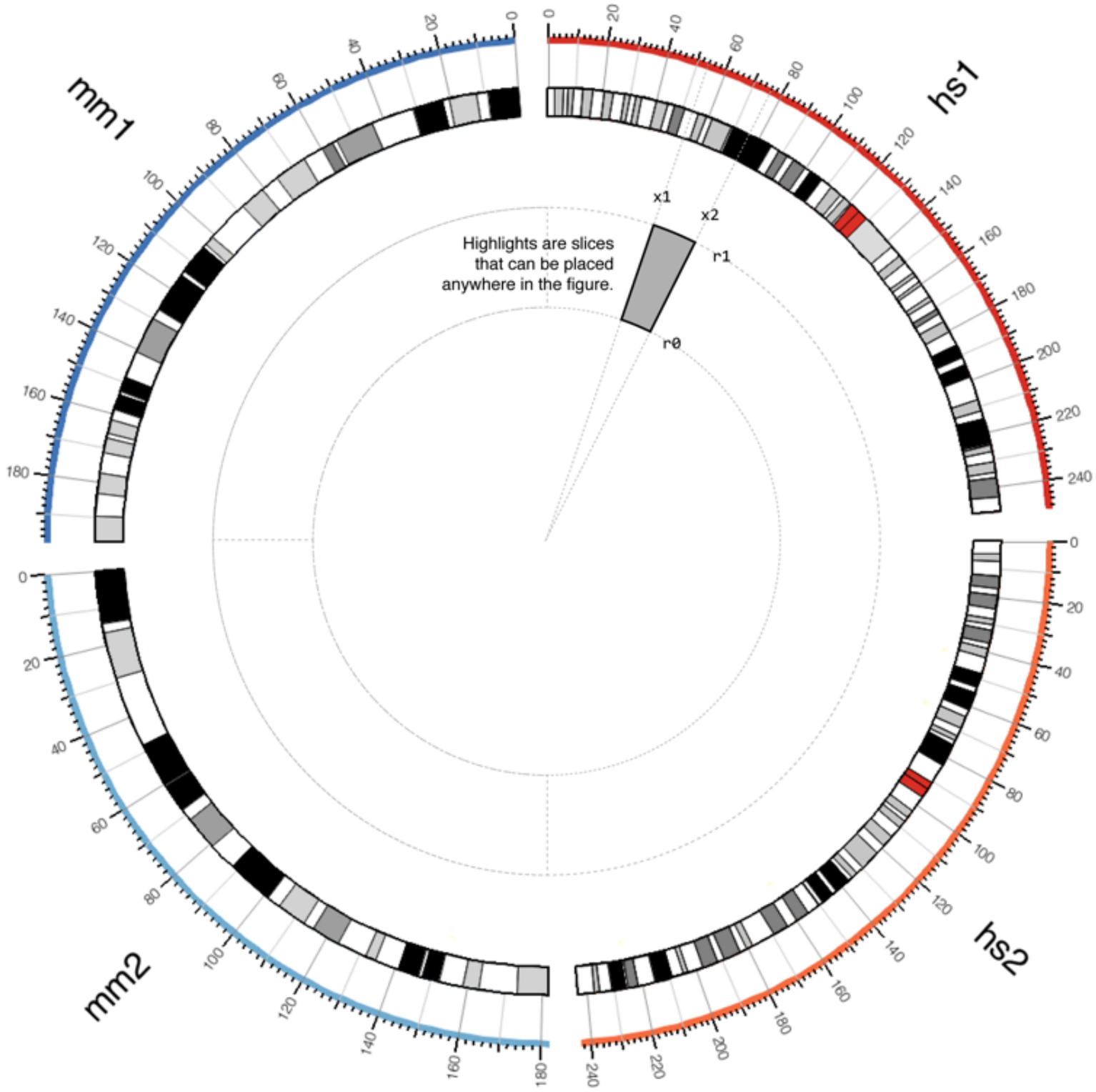

```
<rules>

<rule>
use        = yes
condition  = var(size) < 5e6
show       = no
</rule>

<rule>
condition  = 1
color      =
 eval(
  sprintf("spectral-11-div-%d",
          remap_int(var(size),0,10e6,1,11)
         )
     )
</rule>

</rules>
```

.

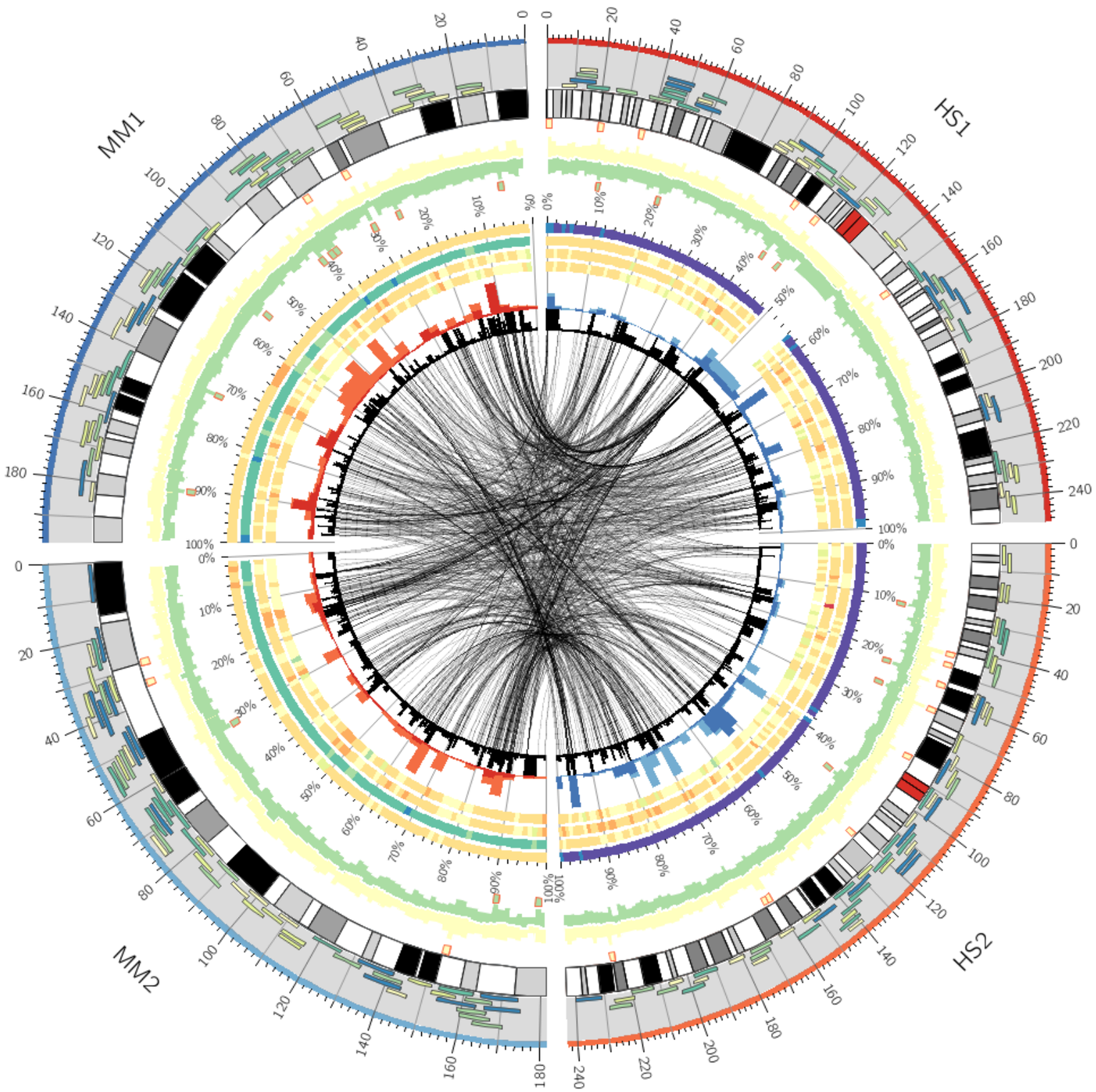
highlights

LESSON 7

HIGHLIGHT GEOMETRY



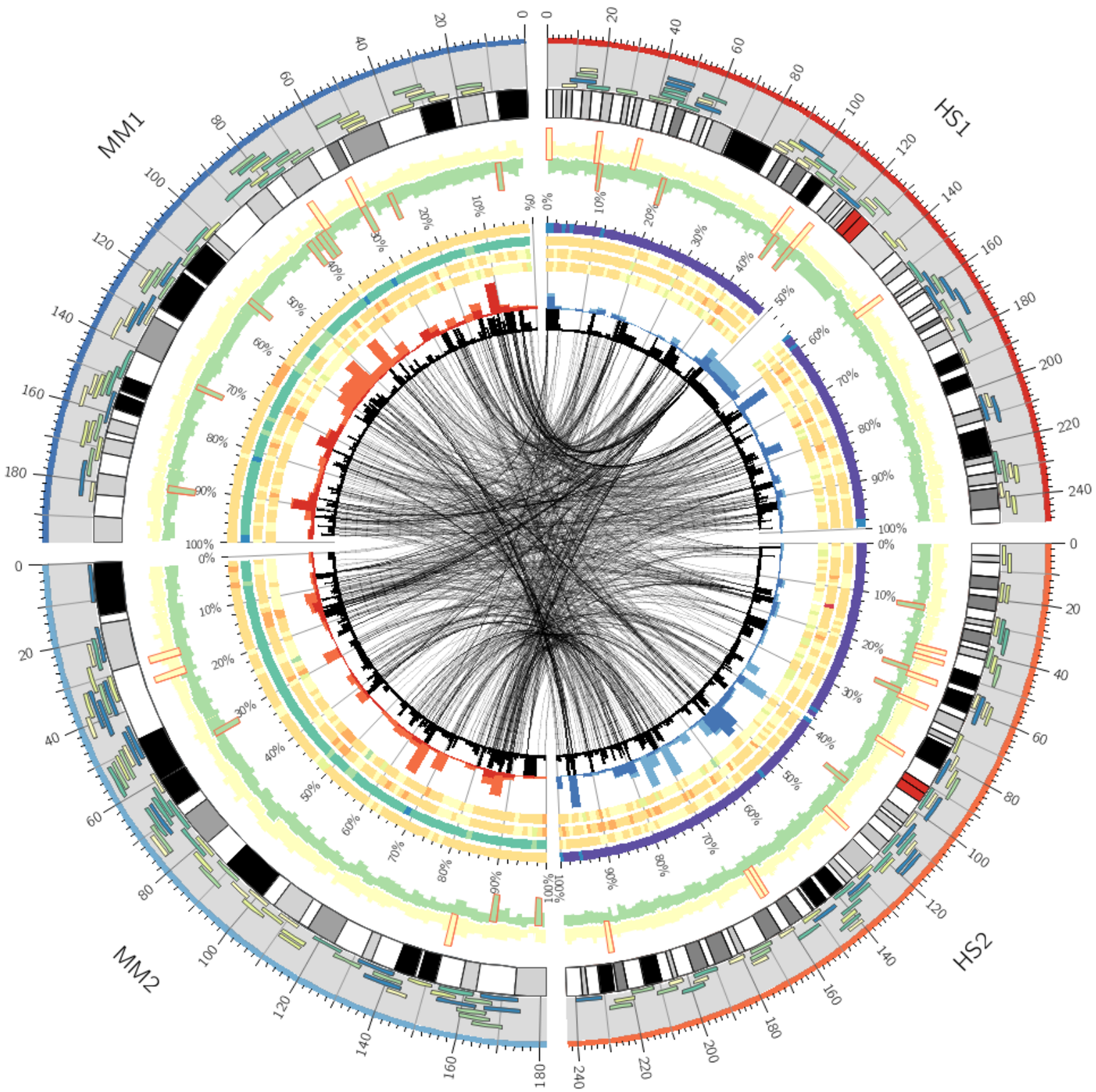
HIGHLIGHTS




```
<plot>
type = highlight
file = ../data/highlight.max.top20.txt

r0   = 0.975r
r1   = 0.995r
#r0   = 0.9r
#r1   = 0.975r
#r0  = dims(ideogram,radius_inner)
#r1  = dims(ideogram,radius_outer)

fill_color        = spectral-5-div-3
stroke_thickness = 1p
stroke_color      = red
z                 = 15
</plot>

<plot>
type = highlight
file = ../data/highlight.min.top20.txt

r0   = 0.835r
r1   = 0.855r
#r0   = 0.835r
#r1   = 0.9r
#r0  = dims(ideogram,radius_inner)
#r1  = dims(ideogram,radius_outer)

fill_color        = spectral-5-div-4
stroke_thickness = 1p
stroke_color      = red
z                 = 15
</plot>
```

.

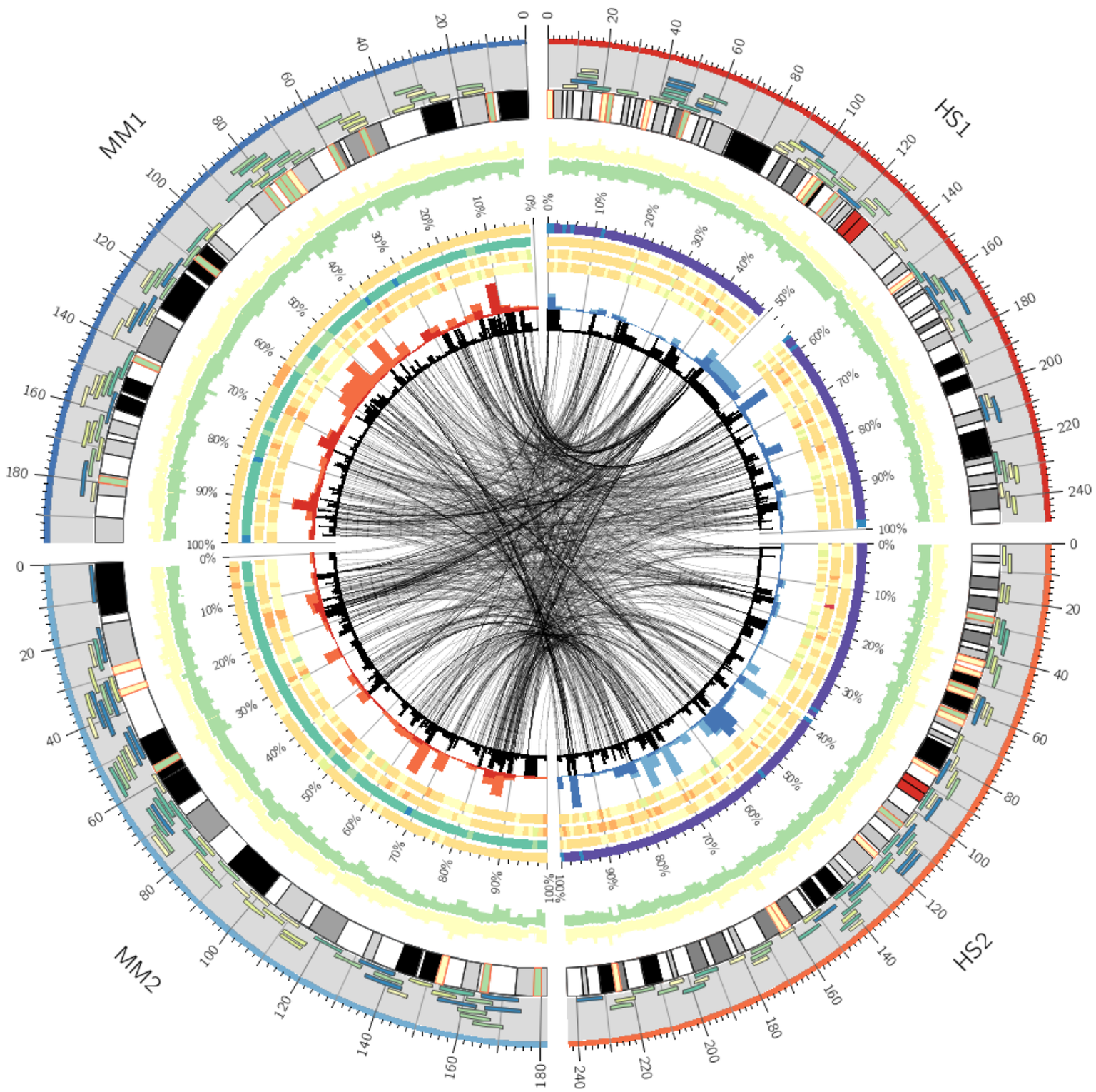
HIGHLIGHTS




```
<plot>
type = highlight
file = ../data/highlight.max.top20.txt

#r0   = 0.975r
#r1   = 0.995r
r0   = 0.9r
r1   = 0.975r
#r0  = dims(ideogram,radius_inner)
#r1  = dims(ideogram,radius_outer)

#fill_color       = spectral-5-div-3
stroke_thickness = 1p
stroke_color     = red
z                = 15
</plot>

<plot>
type = highlight
file = ../data/highlight.min.top20.txt

#r0   = 0.835r
#r1   = 0.855r
r0   = 0.835r
r1   = 0.9r
#r0  = dims(ideogram,radius_inner)
#r1  = dims(ideogram,radius_outer)

#fill_color       = spectral-5-div-4
stroke_thickness = 1p
stroke_color     = red
z                = 15
</plot>
```

.

HIGHLIGHTS



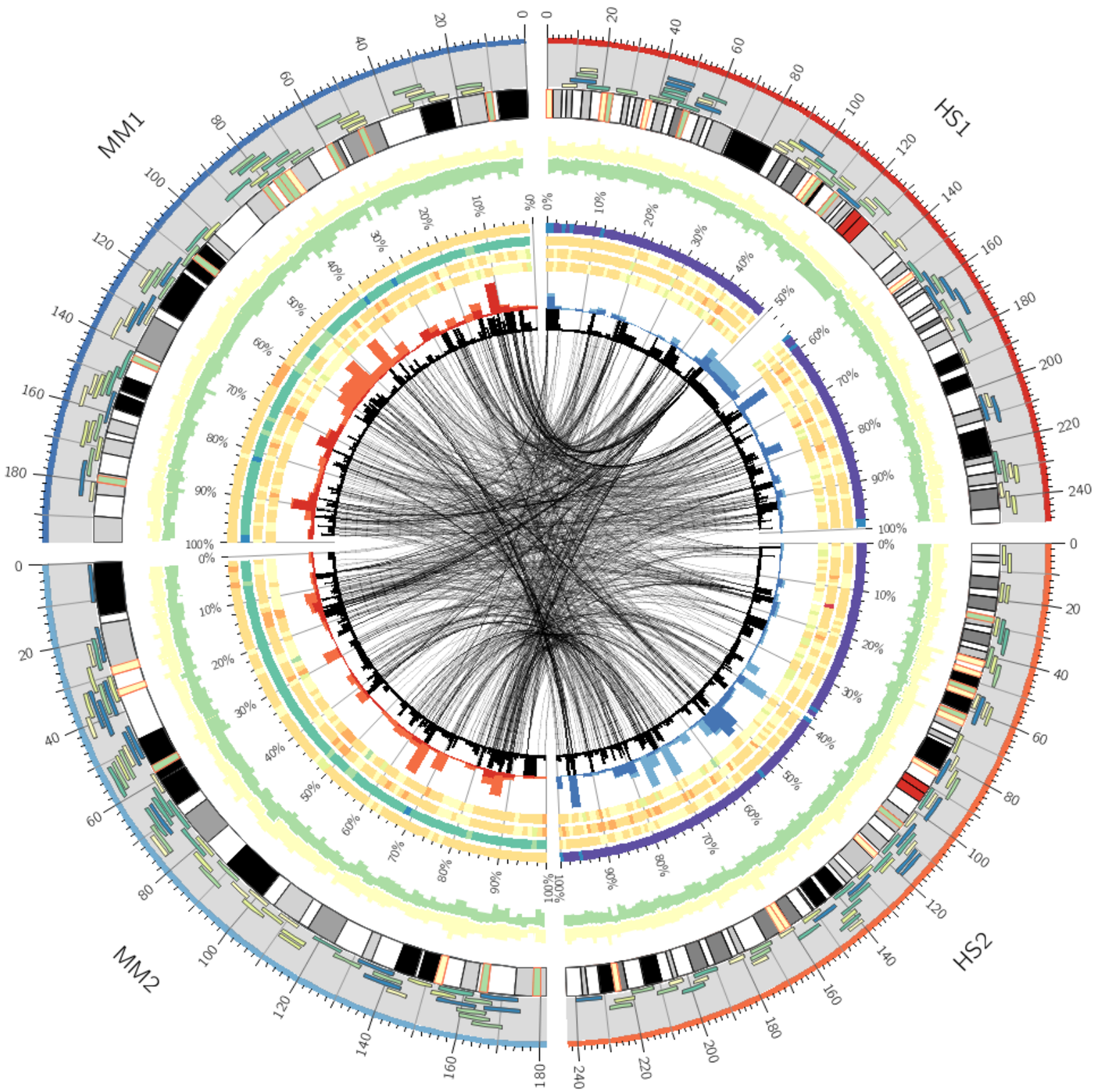

```
<plot>
type = highlight
file = ../data/highlight.max.top20.txt

#r0   = 0.975r
#r1   = 0.995r
#r0   = 0.9r
#r1   = 0.975r
r0  = dims(ideogram,radius_inner)
r1  = dims(ideogram,radius_outer)

fill_color        = spectral-5-div-3
stroke_thickness  = 1p
stroke_color      = red
z                 = 15
</plot>

<plot>
type = highlight
file = ../data/highlight.min.top20.txt

#r0   = 0.835r
#r1   = 0.855r
#r0   = 0.835r
#r1   = 0.9r
r0  = dims(ideogram,radius_inner)
r1  = dims(ideogram,radius_outer)

fill_color        = spectral-5-div-4
stroke_thickness  = 1p
stroke_color      = red
z                 = 15
</plot>
```

.

formatting links with dynamic rules

LESSON 8

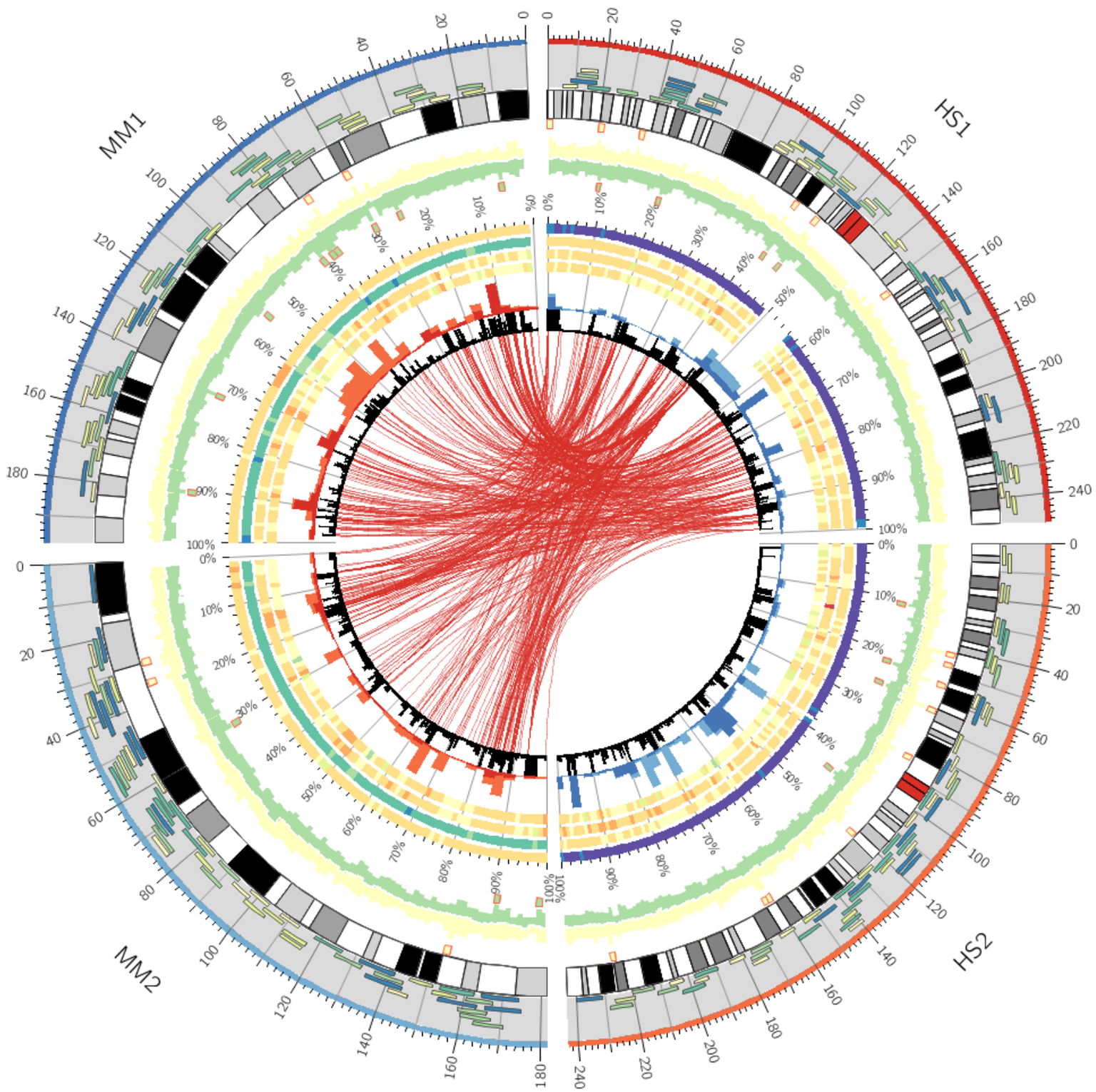
RULES FOR LINKS




```
<link chain>
file          = ../data/links.txt
bezier_radius = 0r
radius        = 0.5r
thickness     = 1p
color         = black_a5
</link>
```

.

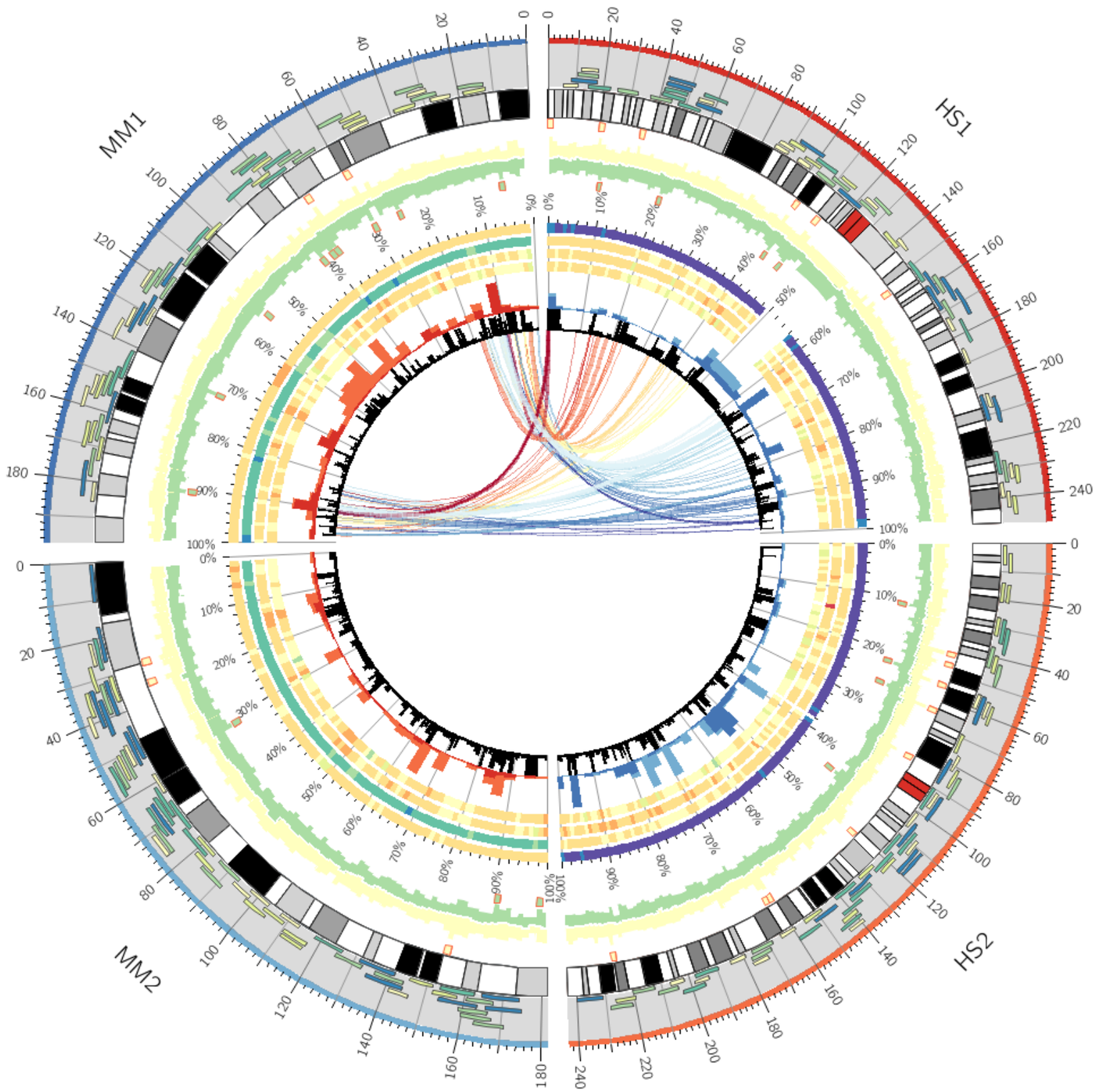
RULES FOR LINKS




```
<rules>

<rule>
condition   = on(hs1)
color       = rdylbu-11-div-2_a3
</rule>

<rule>
condition  = 1
show       = no
</rule>

</rules>
```

.

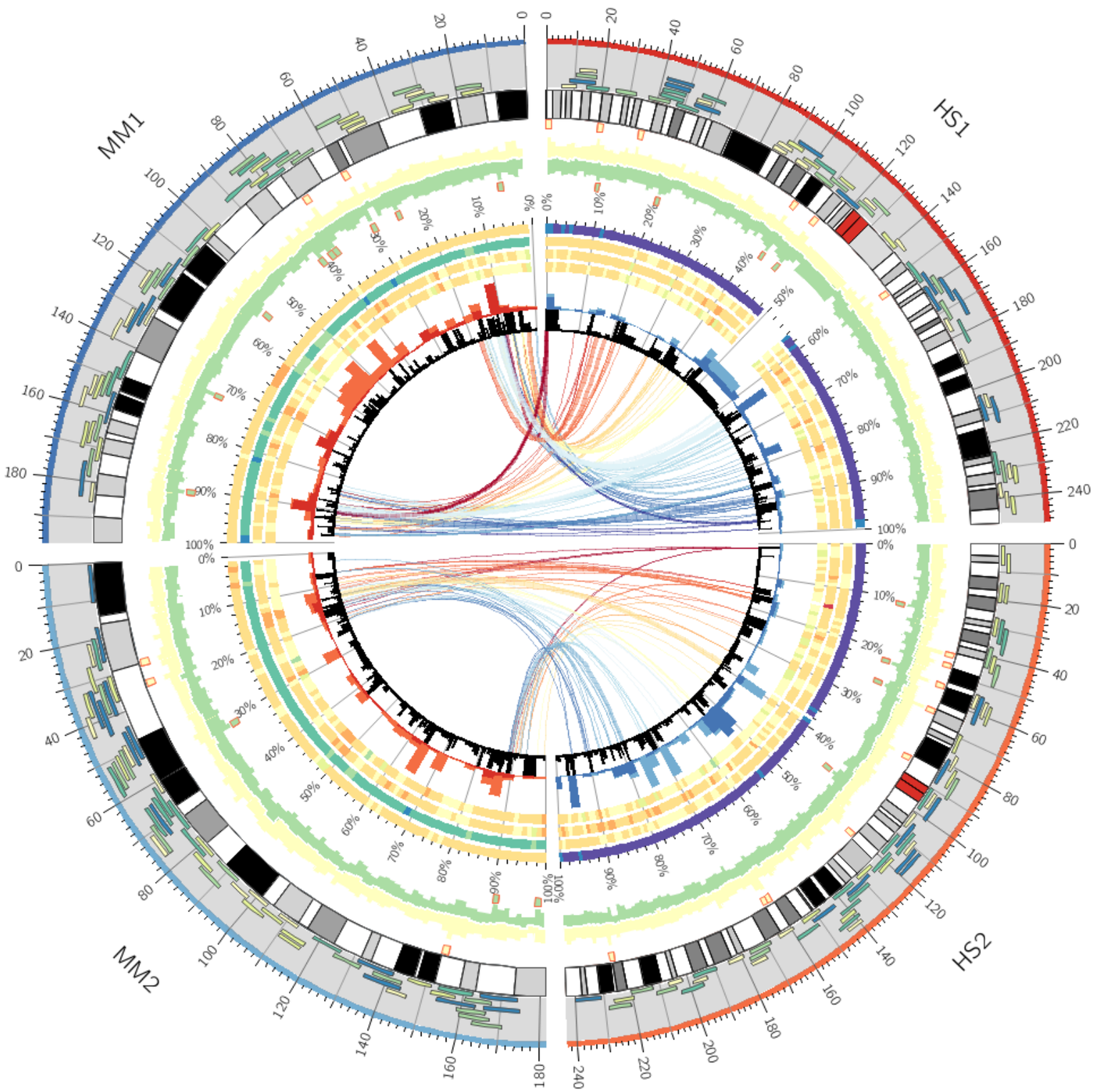
RULES FOR LINKS




```
<rule>

# multiple conditions evaluated with AND

condition    = between(hs1,mm1)
condition    =
 var(start2) < 40Mb || var(start2) > 160Mb

thickness    = eval(
  remap_round(var(size1),0,50000,1,5)
                    )

z            = eval(
  remap_round(var(size1),0,50000,1,5)
                    )

color        = eval(
  sprintf("rdylbu-11-div-%d_a3",
  remap_round(var(start1),0,250e6,1,11)
        )
                    )

</rule>
```

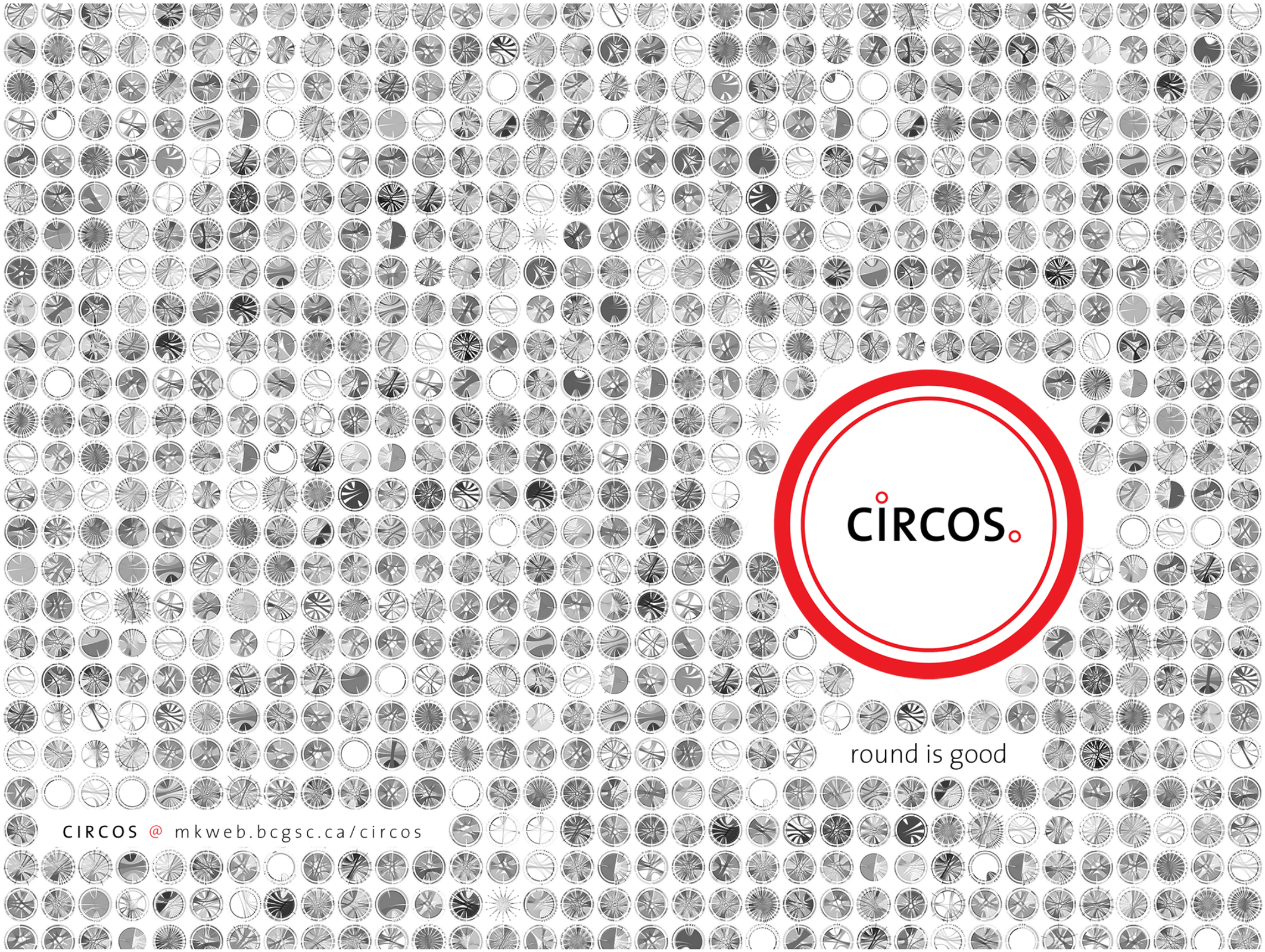
.

RULES FOR LINKS




```
<rule>

# multiple conditions evaluated with AND

condition    =
 between(hs1,mm1) || between(hs2,mm2)
condition    =
 var(start2) < 40Mb || var(start2) > 160Mb

thickness    = eval(
  remap_round(var(size1),0,50000,1,5)
                    )

z            = eval(
  remap_round(var(size1),0,50000,1,5)
                    )

color        = eval(
  sprintf("rdylbu-11-div-%d_a3",
  remap_round(var(start1),0,250e6,1,11)
          )
                    )

</rule>
```

.


CIRCOS.
round is good
CIRCOS @ mkweb.bcgsc.ca/circos