

drawing data – one genome, one sample

SESSION 6

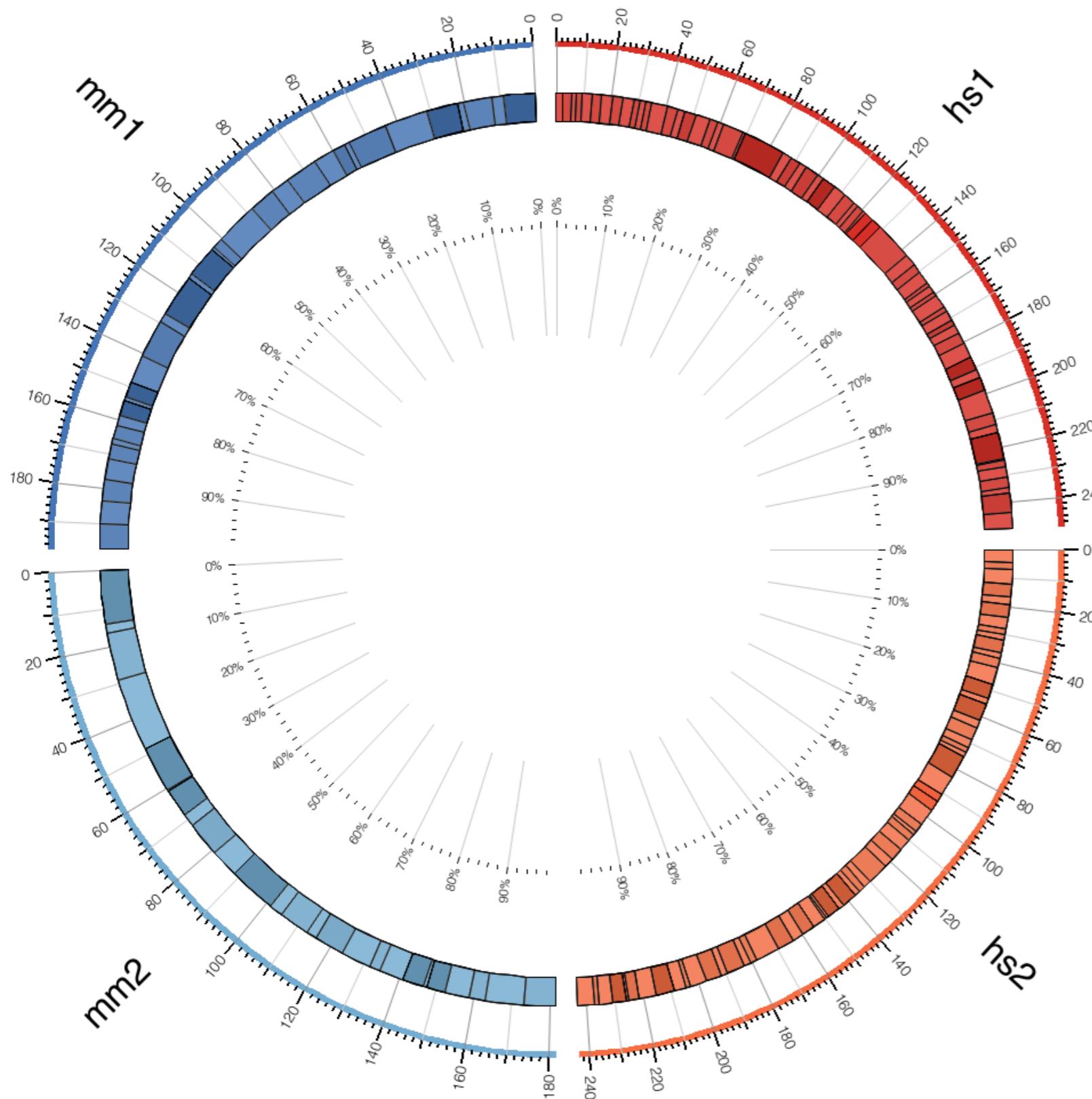
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EMBO PRACTICAL COURSE:
BIOINFORMATICS GENOME ANALYSES

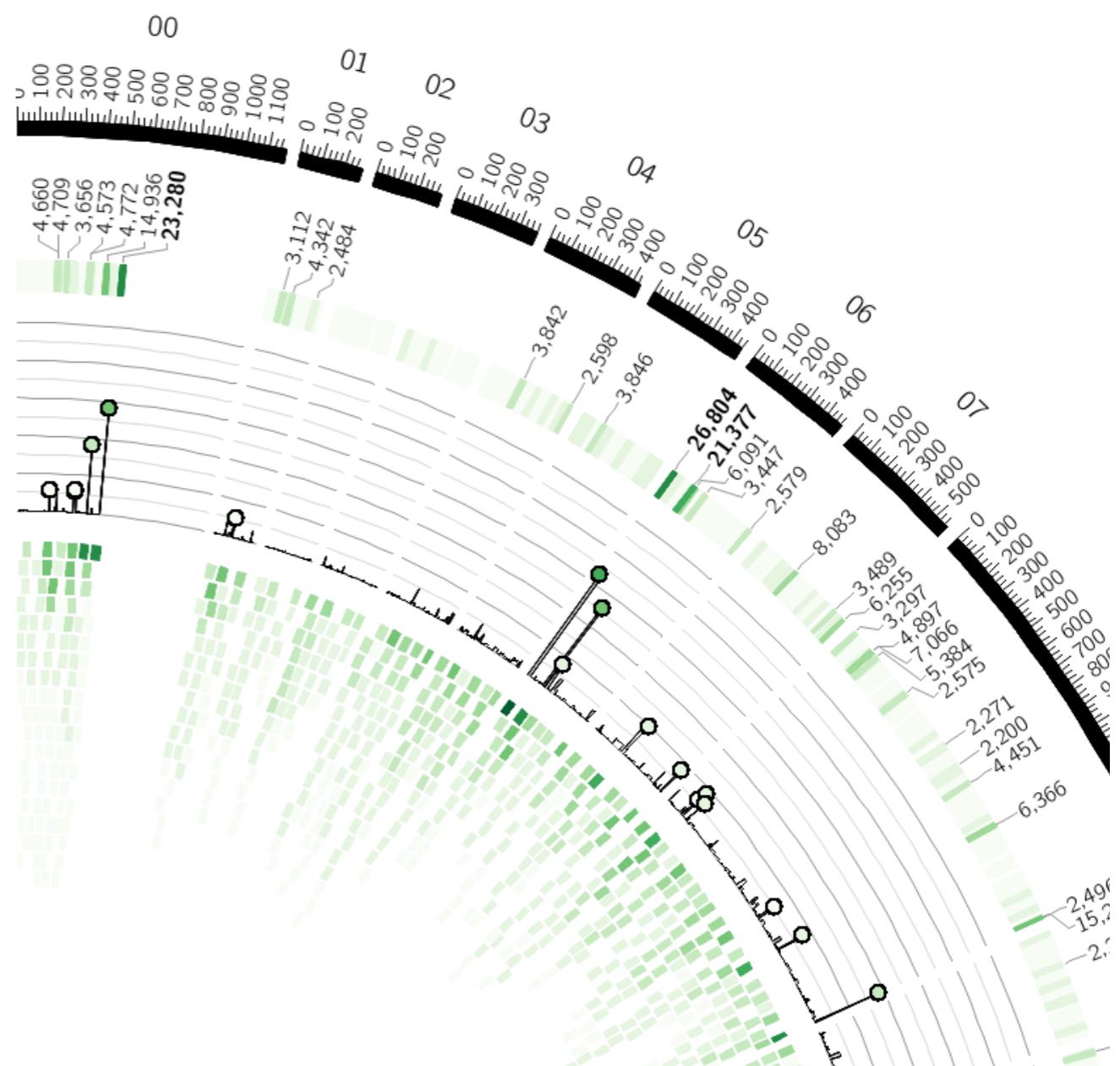
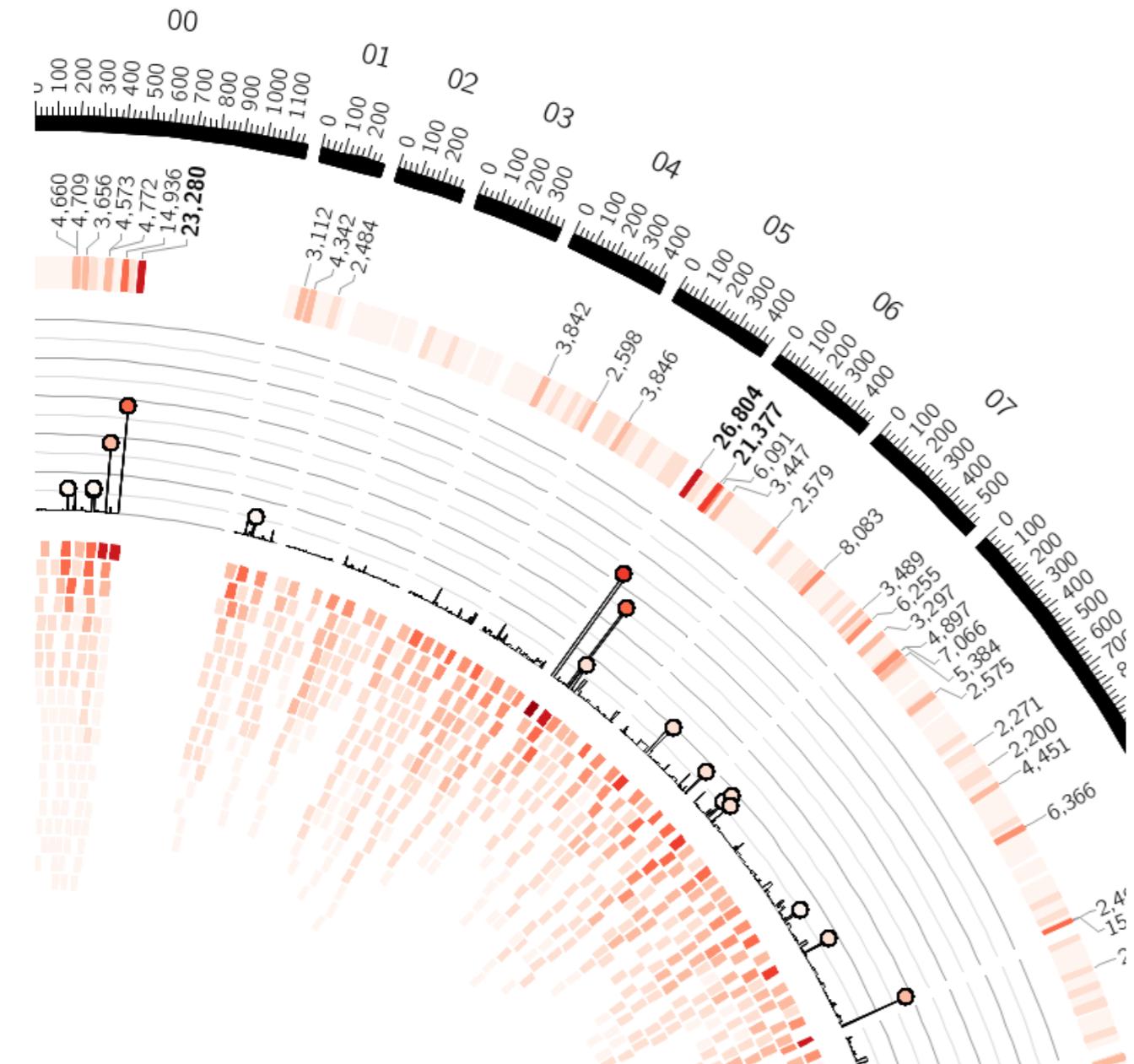
Centre for Research & Technology - Hellas, Thessalonica, Greece
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SESSION FINAL IMAGE



drawing and spacing ideograms
relative ideogram spacing
changing ideogram scale
ideogram selection
ideogram order
drawing ideogram regions
chromosome breaks
ordering ideogram regions
cytogenetic bands
drawing multiple genomes
ideogram progression and orientation
relative and absolute ticks

This is the image you will create during this session. It contains chrs 1 & 2 from human and mouse genomes. Each chromosome occupies 1/4 of the figure.



input files

GFF, EXPRESSION, ORTHOLOGS

```
# all original files are
> cd 6/data/orig
> ls
Lmex_Lmaj_orthologs_toCircos
TriTrypDB-8.0_LmajorFriedlin.gff
TriTrypDB-8.0_LmexicanaMHOMGT2001U1103.gff
rawCounts.txt

> cat rawCounts.txt
id AH063 AH064 AH065 AH066
LmxM.01.0010 28 89 60 181
LmxM.01.0020 56 91 123 138
LmxM.01.0030 76 189 180 208
LmxM.01.0040 60 219 298 410
...
.

> cat Lmex_Lmaj_orthologs_toCircos
LmxM.01.0010 LmjF01.0010
LmxM.01.0020 LmjF01.0020
LmxM.01.0030 LmjF01.0030 LmjF13.1610
LmxM.01.0040 LmjF01.0040
LmxM.01.0050 LmjF01.0050 LmjF31.3130
LmxM.01.0060 LmjF01.0060
.
.
```

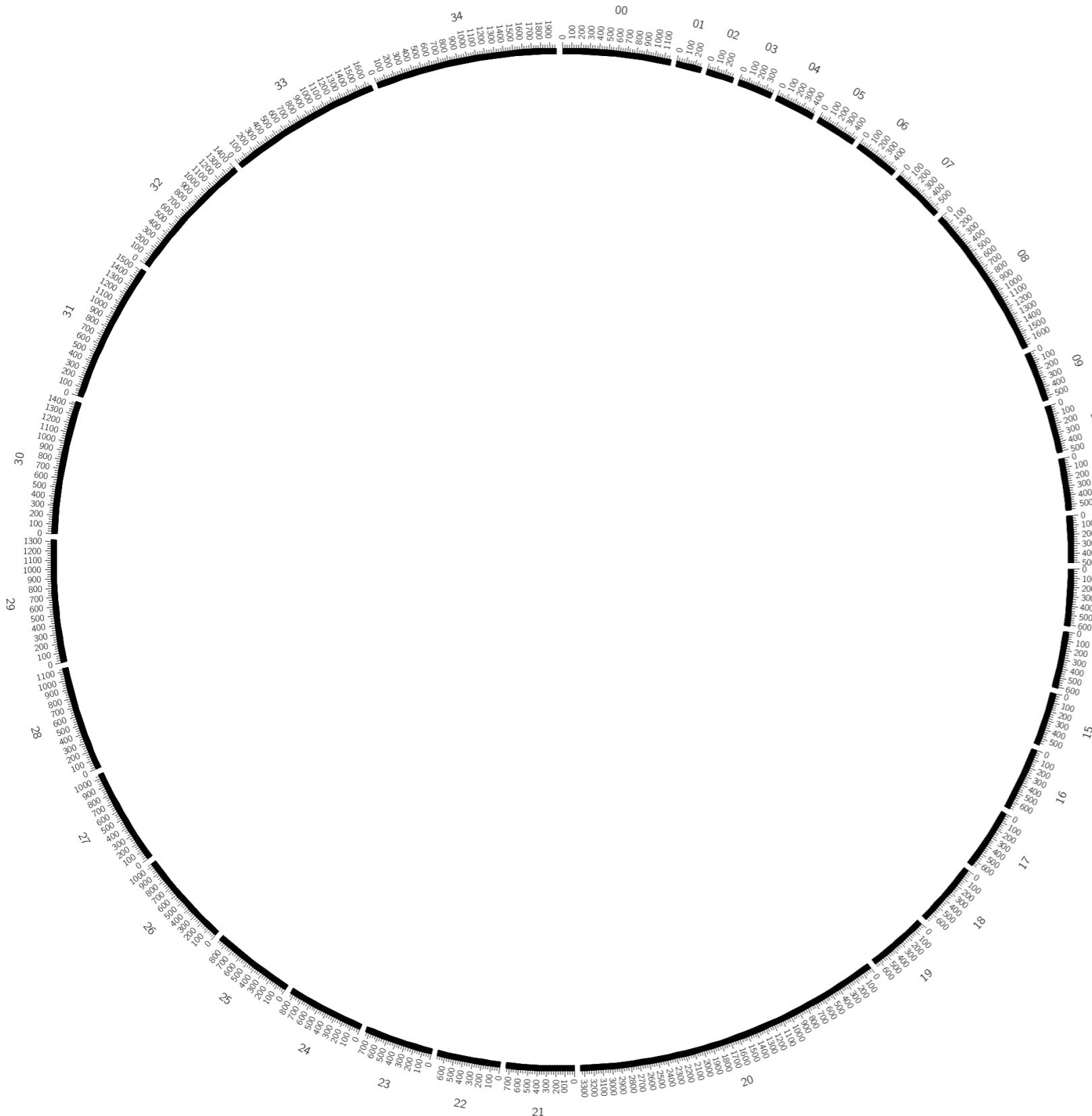
CIRCOS INPUT FILES

```
# all Circos input data files are
> cd 6/data
> ls
lf.karyotype.txt
lm.karyotype.txt
lm.exp.ah063.txt
...
# these were created with make.data.files
#
# look at this script on your own time and understand
# how the parsing was done
```

**configuration files
creating images
ideogram spacing
debugging**

LESSON 1

CONFIGURATION FILE



6/1/etc/circos.conf

karyotype = ../data/lm.karyotype.txt
chromosomes_units = 1000

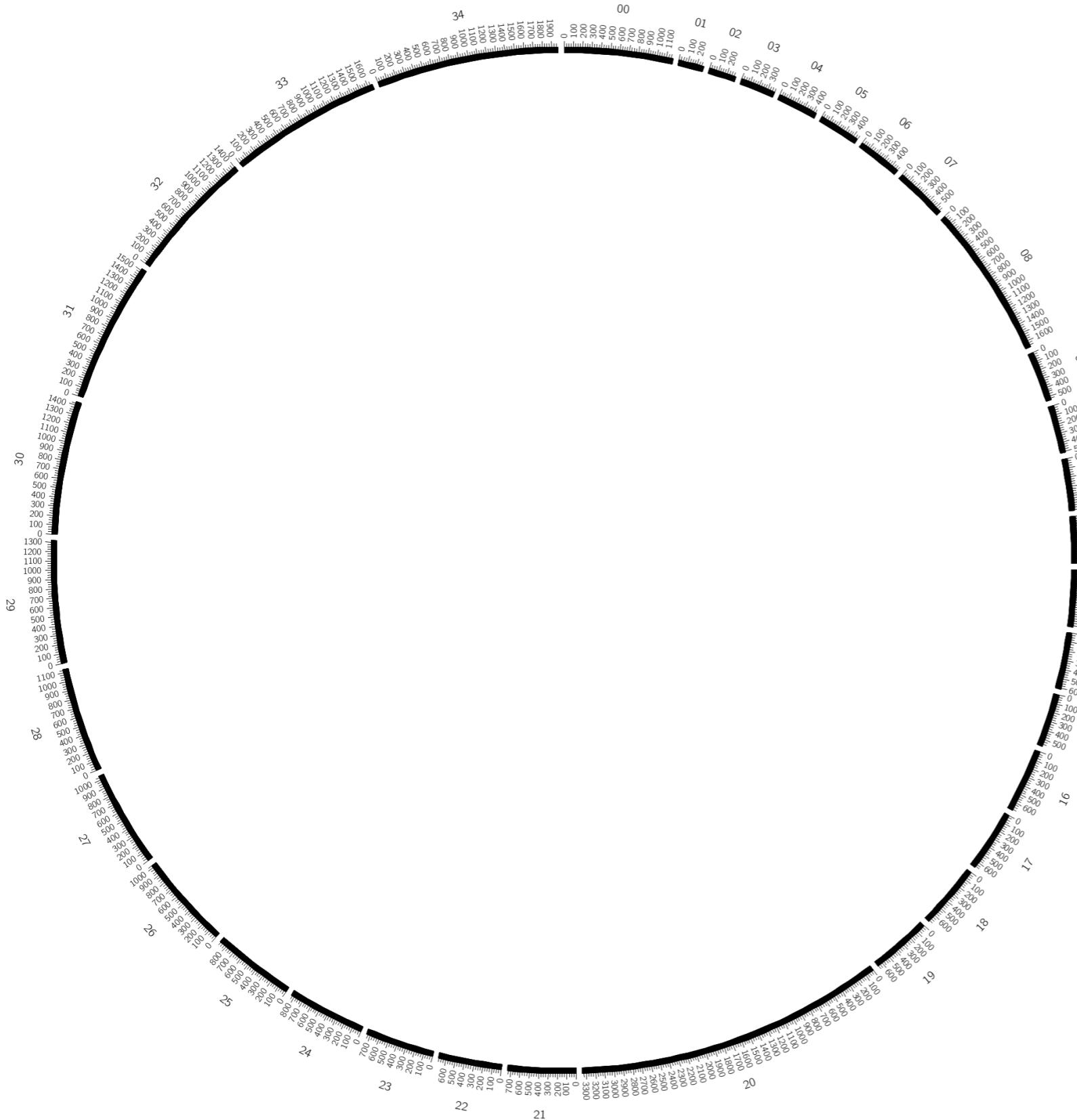
Position and size of ideograms
<<include ideogram.conf>>

Ticks and tick labels
<<include ticks.conf>>

Image size, location
<<include ../etc/image.conf>>

General parameters like colors, fonts,
patterns and system settings.
<<include etc/colors_fonts_patterns.conf>>
<<include etc/housekeeping.conf>>

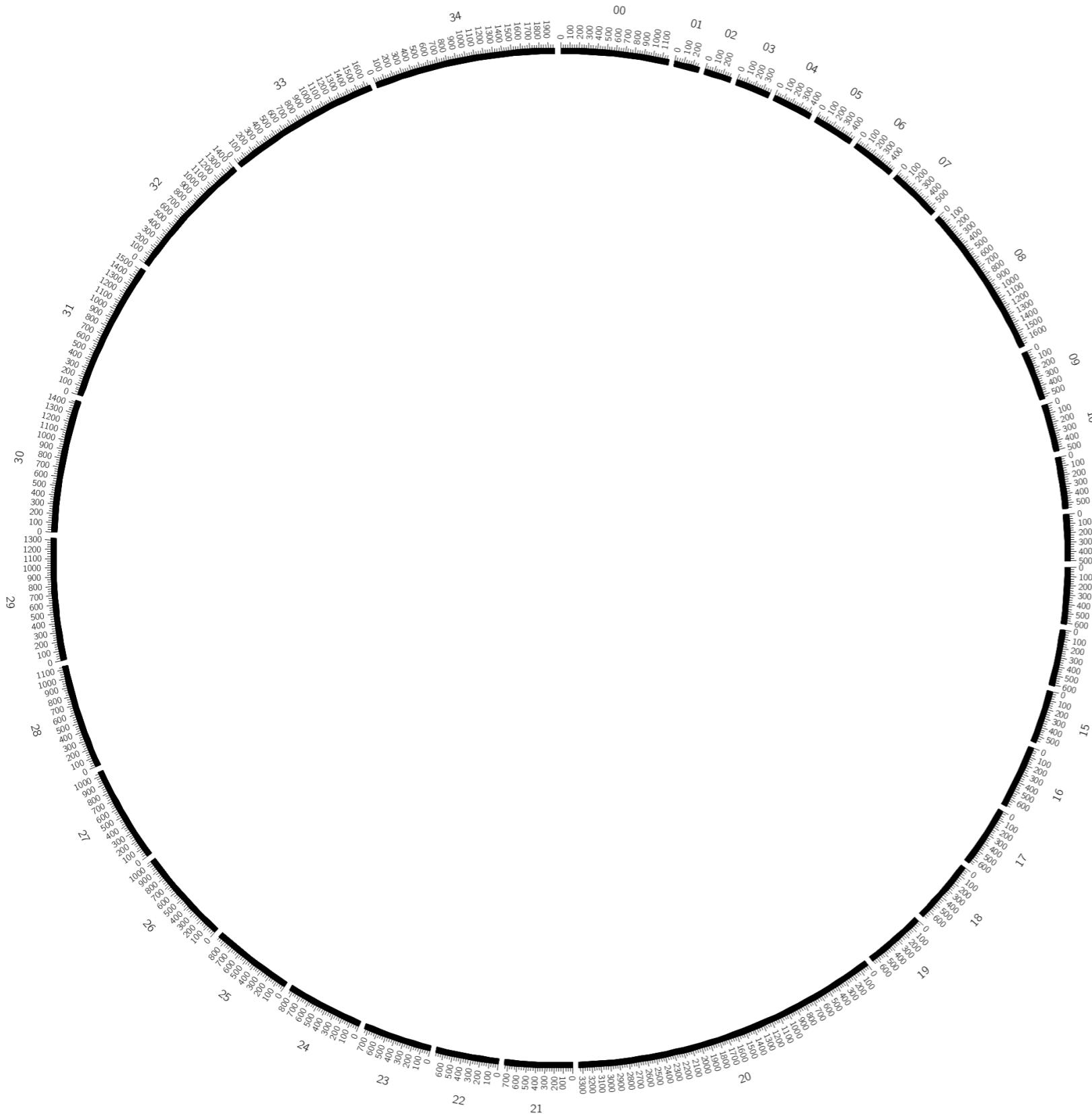
KARYOTYPE FILE



../data/lm.karyotype.txt

```
chr - LmxM.00 00 0 1171052 black
chr - LmxM.01 01 0 273291 black
chr - LmxM.02 02 0 298030 black
chr - LmxM.03 03 0 375930 black
chr - LmxM.04 04 0 438817 black
chr - LmxM.05 05 0 451064 black
chr - LmxM.06 06 0 479586 black
chr - LmxM.07 07 0 568535 black
chr - LmxM.08 08 0 1671993 black
chr - LmxM.09 09 0 543865 black
...
chr - LmxM.25 25 0 883937 black
chr - LmxM.26 26 0 1028550 black
chr - LmxM.27 27 0 1044075 black
chr - LmxM.28 28 0 1137555 black
chr - LmxM.29 29 0 1322285 black
chr - LmxM.30 30 0 1439542 black
chr - LmxM.31 31 0 1524016 black
chr - LmxM.32 32 0 1407111 black
chr - LmxM.33 33 0 1649823 black
chr - LmxM.34 34 0 1968239 black
```

RELATIVE SPACING



```
# 6/etc/ideogram.conf
```

```
<ideogram>
```

```
<spacing>
```

```
default = 0.002r
```

```
#default = 200u
```

```
#<pairwise LmxM.00 LmxM.34>
```

```
#spacing = 5r
```

```
#</pairwise>
```

```
#<pairwise LmxM.00>
```

```
#spacing = 5r
```

```
#</pairwise>
```

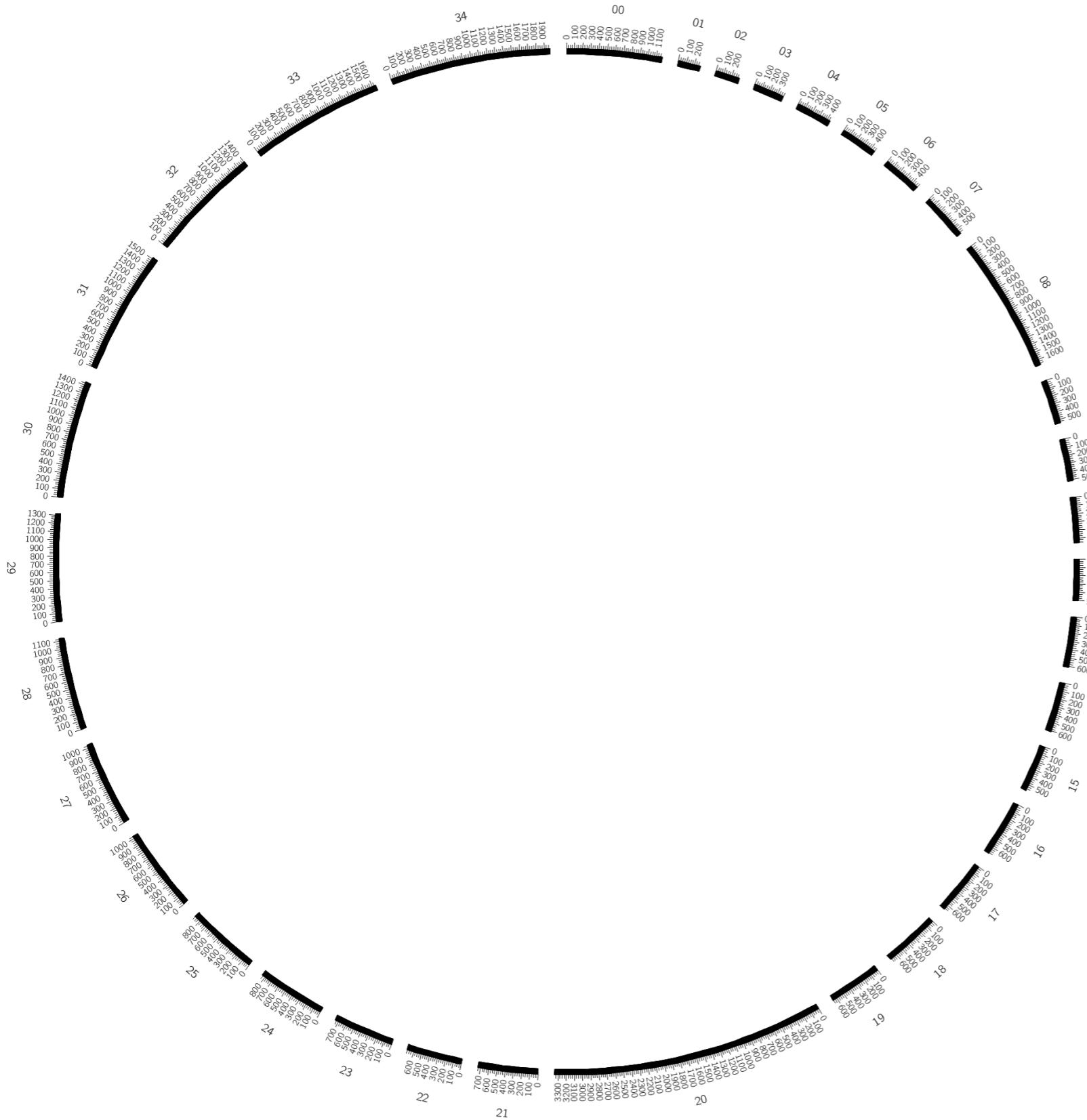
```
</spacing>
```

```
<<include ideogram.position.conf>>
```

```
<<include ideogram.label.conf>>
```

```
</ideogram>
```

ABSOLUTE SPACING



```
# 6/etc/ideogram.conf
```

```
<ideogram>
```

```
<spacing>
```

```
#default = 0.002r
```

```
default = 200u
```

```
#<pairwise LmxM.00 LmxM.34>
```

```
#spacing = 5r
```

```
#</pairwise>
```

```
#<pairwise LmxM.00>
```

```
#spacing = 5r
```

```
#</pairwise>
```

```
</spacing>
```

```
<<include ideogram.position.conf>>
```

```
<<include ideogram.label.conf>>
```

```
</ideogram>
```

ERRORS

```
$VAR1 = {  
    default => [  
        '0.002r',  
        '200u'  
    ]  
};
```

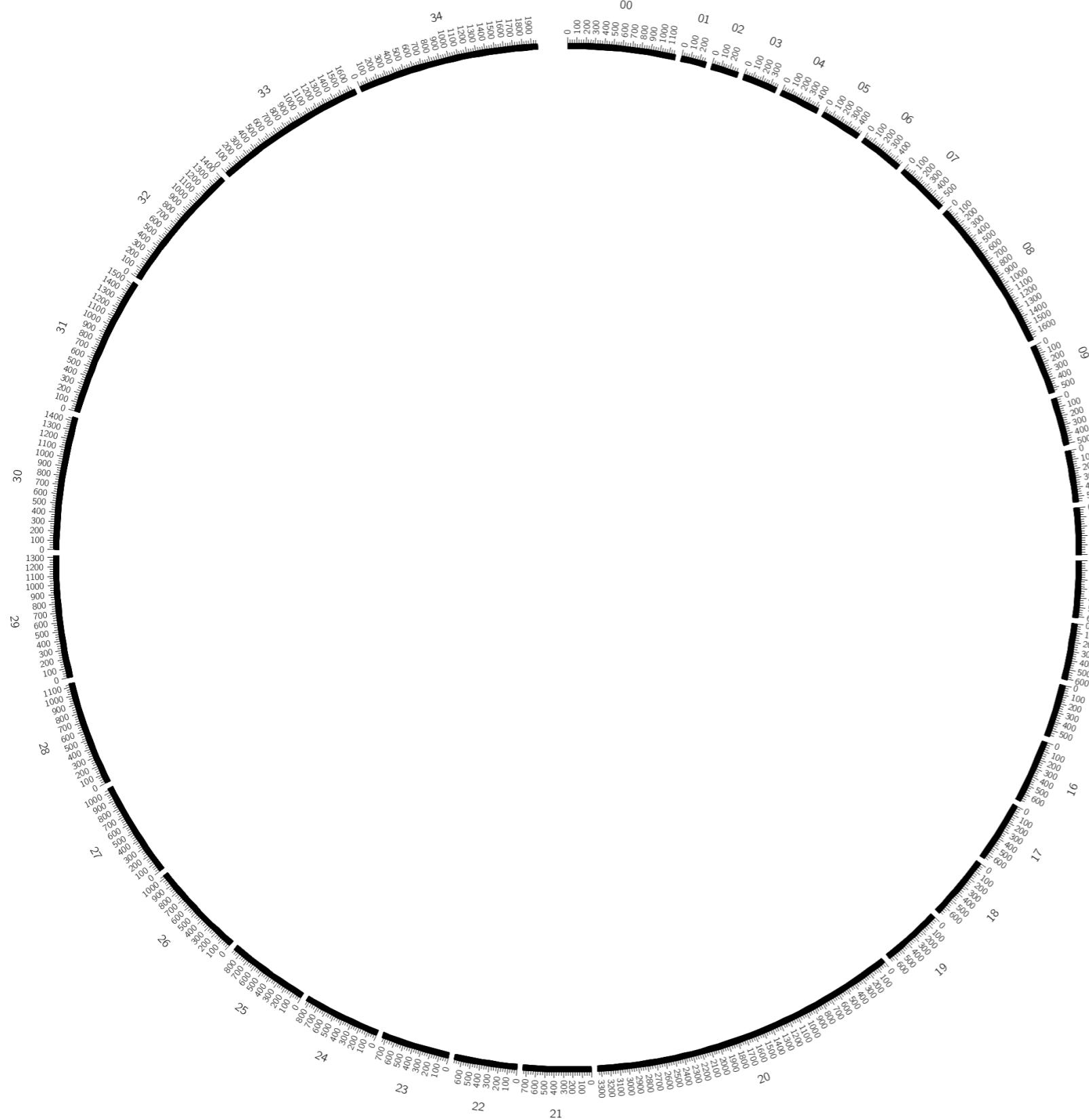
*** CIRCOS ERROR ***

CONFIGURATION FILE ERROR

Configuration parameter [default] in parent block [spacing] has been defined more than once in the block shown above, and has been interpreted as a list. This is not allowed. Did you forget to comment out an old value of the parameter?

```
# 6/1/etc/ideogram.conf  
  
<ideogram>  
  
<spacing>  
  
    default = 0.002r  
  
    default = 200u  
  
#<pairwise LmxM.00 LmxM.34>  
#spacing = 5r  
#</pairwise>  
  
#<pairwise LmxM.00>  
#spacing = 5r  
#</pairwise>  
  
</spacing>  
  
<<include ideogram.position.conf>>  
<<include ideogram.label.conf>>  
  
</ideogram>
```

PAIRWISE SPACING



```
# 6/etc/ideogram.conf
```

```
<ideogram>
```

```
<spacing>
```

```
default = 0.002r
```

```
#default = 200u
```

```
<pairwise LmxM.00 LmxM.34>
```

```
spacing = 5r
```

```
</pairwise>
```

```
#<pairwise LmxM.00>
```

```
#spacing = 5r
```

```
#</pairwise>
```

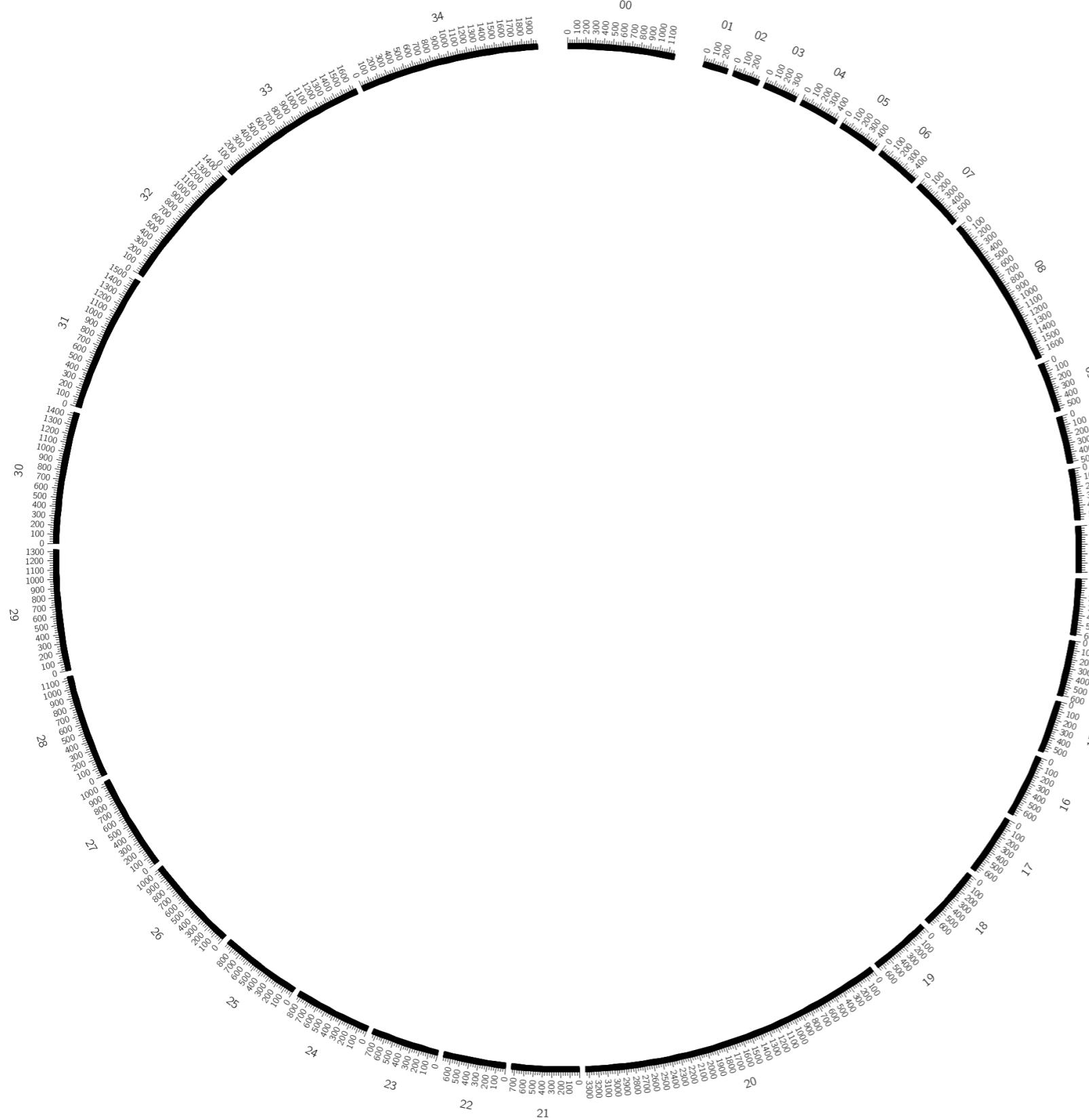
```
</spacing>
```

```
<<include ideogram.position.conf>>
```

```
<<include ideogram.label.conf>>
```

```
</ideogram>
```

PAIRWISE SPACING



```
# 6/etc/ideogram.conf
```

```
<ideogram>
```

```
<spacing>
```

```
default = 0.002r
```

```
#default = 200u
```

```
#<pairwise LmxM.00 LmxM.34>
```

```
spacing = 5r
```

```
#</pairwise>
```

```
<pairwise LmxM.00>
```

```
spacing = 5r
```

```
</pairwise>
```

```
</spacing>
```

```
<<include ideogram.position.conf>>
```

```
<<include ideogram.label.conf>>
```

```
</ideogram>
```

ERRORS

CONFIGURATION FILE ERROR

Error parsing the configuration file. The Config::General module reported the error

Config::General: Block "<ideogram>" has no EndBlock statement (level: 2, chunk 3593)!

```
# 6/1/etc/ideogram.conf

<ideogram>

<spacing>
    default = 0.002r
    default = 200u

#<pairwise LmxM.00 LmxM.34>
#spacing = 5r
#</pairwise>

<pairwise LmxM.00>
    spacing = 5r
#</pairwise>

</spacing>

<<include ideogram.position.conf>>
<<include ideogram.label.conf>>

</ideogram>
```

ERRORS

*** CIRCOS ERROR ***

Cannot read file [../../../../../data/
lm.karyotype.txt.missing] for reading
karyotype. (error No such file or directory)

6/1/etc/circos.conf

karyotype = ../../data/lm.karyotype.txt.missing

DEBUGGING

```
> circos -debug
```

```
...  
debuggroup io 0.32s trying /home/martink/work/conference/tunis/session/1/1/etc/../../../../data/  
lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/conference/tunis/session/1/1/etc/../../../../etc/../../../../data/  
lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/conference/tunis/session/1/1/etc/../../../../data/../../../../data/  
lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/etc/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/data/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/..etc/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/..data/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.32s trying /home/martink/work/circos svn/bin/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.34s trying /home/martink/work/circos svn/bin/../../../../etc/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.34s trying /home/martink/work/circos svn/bin/../../../../data/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.34s trying /home/martink/work/circos svn/bin/../../../../data/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.34s trying /home/martink/work/circos svn/bin/../../../../etc/../../../../data/lm.karyotype.txt.missing  
debuggroup io 0.34s trying /home/martink/work/circos svn/bin/../../../../data/../../../../data/lm.karyotype.txt.missing
```

*** CIRCOS ERROR ***

Cannot read file [../../../../data/lm.karyotype.txt.missing] for reading
karyotype. (error No such file or directory)

DEBUGGING

```
# fix the karyotype file name in circos.conf back to original (lm.karyotype.txt) and then run
> circos -debug_group karyotype
...
debuggroup karyotype 0.28s got cytogenetic information for 35 chromosomes
debuggroup karyotype 0.28s chromosome ranges LmxM.00 display 1 region_display 0-1171052 region_explicit_reject -
debuggroup karyotype 0.28s chromosome ranges LmxM.01 display 1 region_display 0-273291 region_explicit_reject -
debuggroup karyotype 0.28s chromosome ranges LmxM.02 display 1 region_display 0-298030 region_explicit_reject -
debuggroup karyotype 0.28s chromosome ranges LmxM.03 display 1 region_display 0-375930 region_explicit_reject -
debuggroup karyotype 0.28s chromosome ranges LmxM.04 display 1 region_display 0-438817 region_explicit_reject -
debuggroup karyotype 0.28s chromosome ranges LmxM.05 display 1 region_display 0-451064 region_explicit_reject -
...
debuggroup karyotype 1.83s ideogram LmxM.28 scale 1.000000 idx 28 base_range 0 1137555 angle_range 155.805 167.725
debuggroup karyotype 1.86s ideogram LmxM.29 scale 1.000000 idx 29 base_range 0 1322285 angle_range 168.398 182.253
debuggroup karyotype 1.91s ideogram LmxM.30 scale 1.000000 idx 30 base_range 0 1439542 angle_range 182.926 198.010
debuggroup karyotype 1.95s ideogram LmxM.31 scale 1.000000 idx 31 base_range 0 1524016 angle_range 198.683 214.653
debuggroup karyotype 2.00s ideogram LmxM.32 scale 1.000000 idx 32 base_range 0 1407111 angle_range 215.325 230.070
debuggroup karyotype 2.05s ideogram LmxM.33 scale 1.000000 idx 33 base_range 0 1649823 angle_range 230.743 248.030
debuggroup karyotype 2.10s ideogram LmxM.34 scale 1.000000 idx 34 base_range 0 1968239 angle_range 248.703 269.327
```

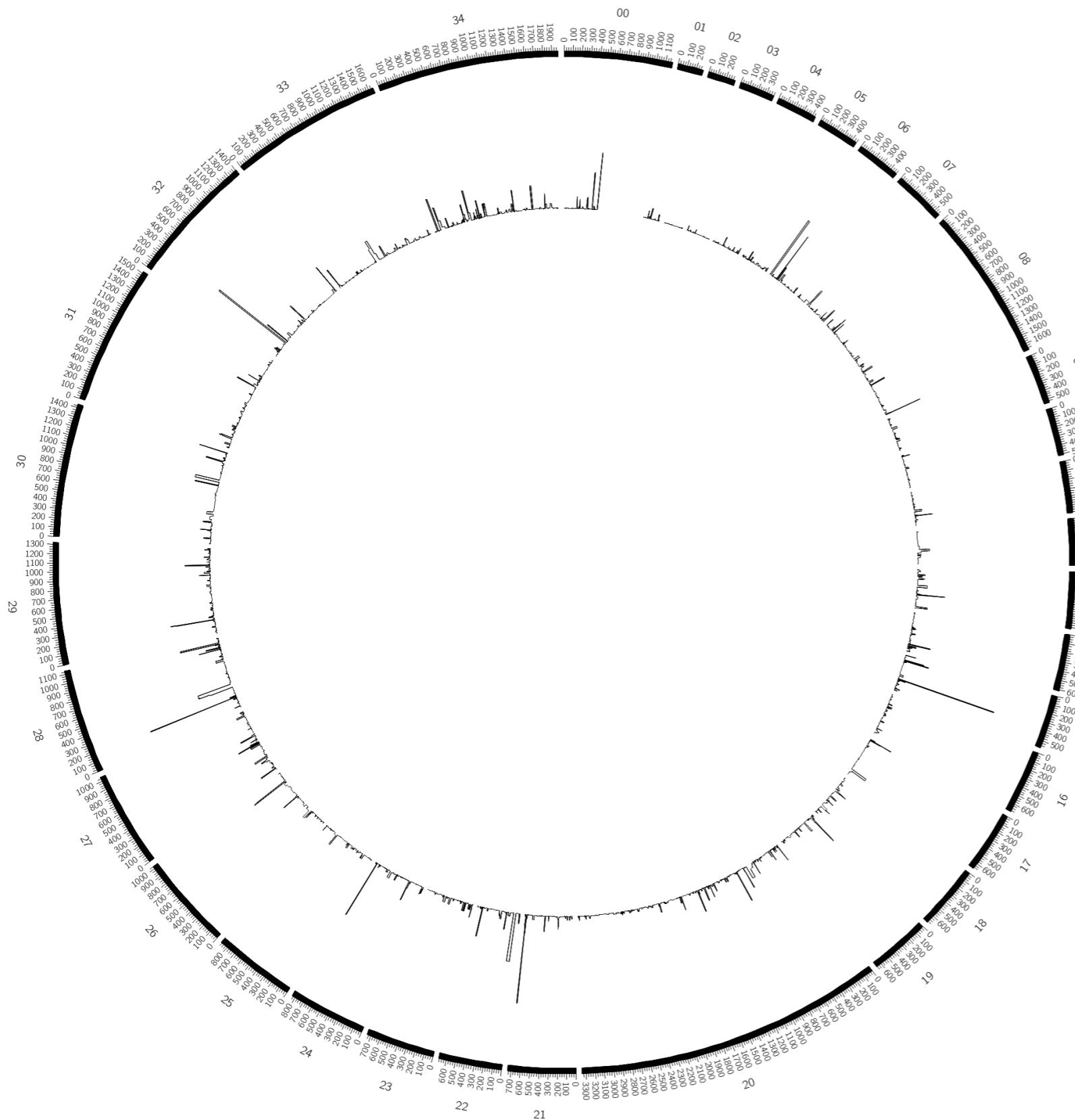
DEBUGGING

```
> circos -debug_group _all
...
debuggroup color 11.24s fetch black 0
debuggroup summary,output 11.24s generating output
debuggroup summary,output 11.59s created PNG image ./circos.png (331 kb) ### vs 2.60s with no debug
debuggroup timer 11.59s report circos 11.446 s
debuggroup timer 11.59s report color 2.890 s
debuggroup timer 11.59s report colorcache 0.005 s
debuggroup timer 11.59s report colordefinitions 0.509 s
debuggroup timer 11.59s report colorfetch 0.028 s
debuggroup timer 11.59s report colorlists 0.009 s
debuggroup timer 11.59s report colorlookups 0.016 s
debuggroup timer 11.59s report colortransparency 2.258 s
debuggroup timer 11.59s report graphic_png_polygon 0.033 s
debuggroup timer 11.59s report graphic_slice 0.059 s
debuggroup timer 11.59s report graphic_slice_polygon_coord 0.023 s
debuggroup timer 11.59s report graphic_slice_preprocess 0.002 s
debuggroup timer 11.59s report highlights 0.000 s
debuggroup timer 11.59s report ideograms_draw 1.743 s
debuggroup timer 11.59s report ideograms_processing 0.022 s
debuggroup timer 11.59s report ideograms_ticks_draw 1.612 s
debuggroup timer 11.59s report ideograms_zoom 0.018 s
debuggroup timer 11.59s report karyotype 0.009 s
debuggroup timer 11.59s report parameter_seek 0.212 s
debuggroup timer 11.59s report unitconvert 0.004 s
debuggroup timer 11.59s report unitconvert_decision 0.000 s
debuggroup timer 11.59s report unitconvert_delegate 0.003 s
debuggroup timer 11.59s report unitparse 0.020 s
```

histograms axis grids macros track defaults

LESSON 2

HISTOGRAM



```
# 6/2/etc/circos.conf
```

```
datadir = ../data  
karyotype = conf(datadir)/lm.karyotype.txt
```

```
<plots>
```

```
<plot>
```

```
type = histogram  
r1 = 0.9r  
r0 = 0.7r  
file = conf(datadir)/lm.exp.ah063.txt
```

```
<axes>
```

```
show = no
```

```
<axis>
```

```
color = vlgrey  
spacing = 0.1r
```

```
<axis>
```

```
color = grey  
spacing = 0.2r
```

```
</axis>
```

```
</axes>
```

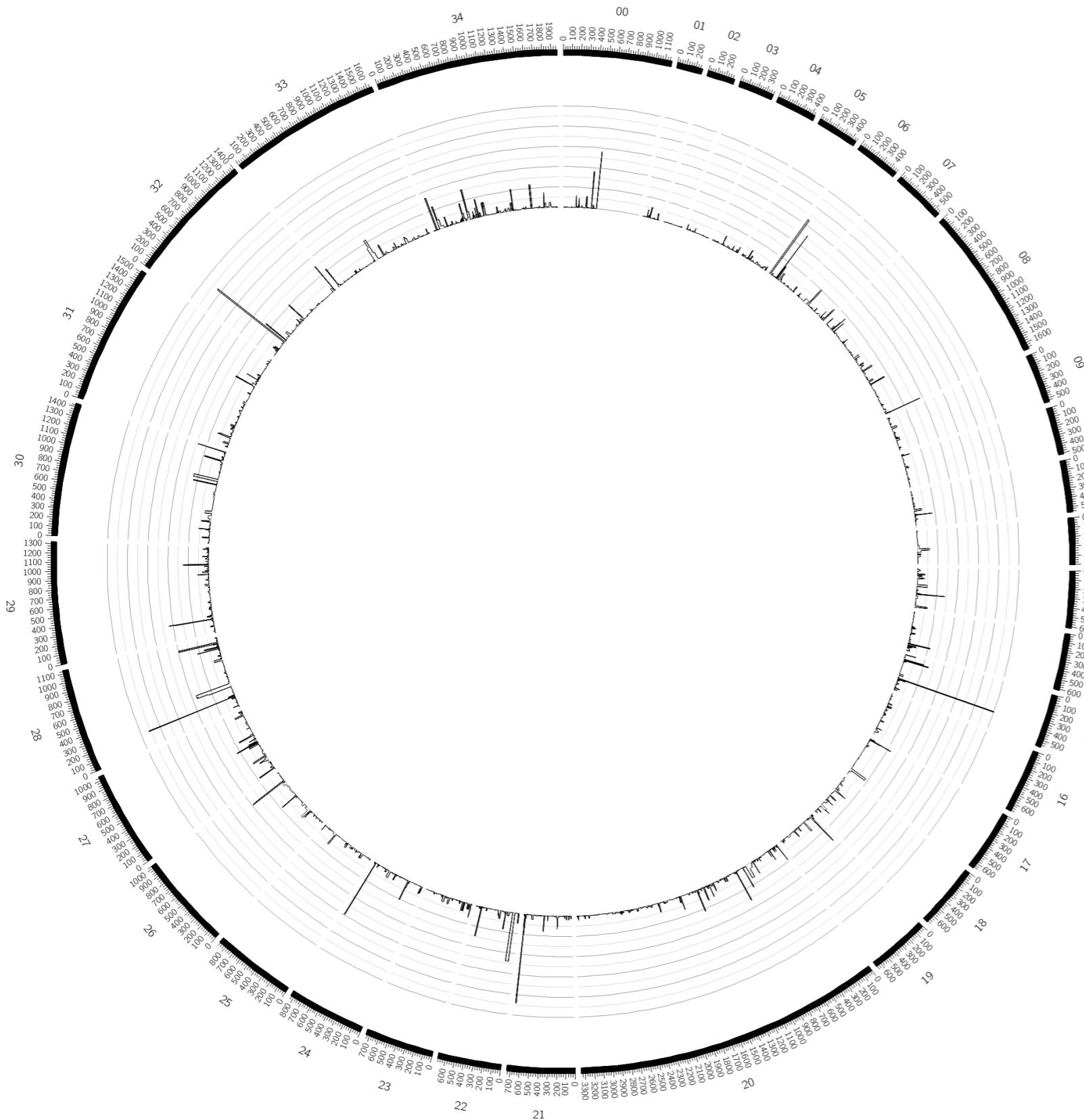
```
</plot>
```

```
</plots>
```

DATA FILE—COMMON FORMAT FOR ALL TRACKS

```
> cat ../data/lm.exp.ah063.txt
LmxM.01 9205 11223 76 gene=LmxM.01.0030
LmxM.01 14846 16843 64 gene=LmxM.01.0050
LmxM.01 27727 28314 72 gene=LmxM.01.0110
LmxM.01 35671 35919 199 gene=LmxM.01.0140
LmxM.01 39931 41277 11 gene=LmxM.01.0170
LmxM.01 42656 44968 3 gene=LmxM.01.0180
LmxM.01 55167 56171 24 gene=LmxM.01.0220
LmxM.01 60622 63405 174 gene=LmxM.01.0240
LmxM.01 69317 69640 3112 gene=LmxM.01.0270
LmxM.01 71022 72266 1 gene=LmxM.01.0280
...
LmxM.20 2586432 2587862 8 gene=LmxM.36.6830
LmxM.20 2598669 2599529 20 gene=LmxM.36.6880
LmxM.20 2601937 2605857 9 gene=LmxM.36.6890
LmxM.20 2610225 2611838 841 gene=LmxM.36.6910
LmxM.20 2614286 2616169 91 gene=LmxM.36.6930
LmxM.20 2617872 2619293 436 gene=LmxM.36.6940
LmxM.20 2620565 2621755 6 gene=LmxM.36.6950
LmxM.20 2625783 2627975 167 gene=LmxM.36.6980
LmxM.20 2629995 2630834 52 gene=LmxM.36.6990
LmxM.20 2631386 2631760 1398 gene=LmxM.36.6995
```

AXIS GRID



```
# 6/2/etc/circos.conf
```

```
datadir = ../data  
karyotype = conf(datadir)/lm.karyotype.txt
```

```
<plots>
```

```
<plot>
```

```
type = histogram  
r1 = 0.9r  
r0 = 0.7r  
file = conf(datadir)/lm.exp.ah063.txt
```

```
<axes>
```

```
show = yes
```

```
<axis>
```

```
color = vlgrey  
spacing = 0.1r
```

```
<axis>
```

```
color = grey  
spacing = 0.2r
```

```
</axis>
```

```
</axes>
```

```
</plot>
```

```
</plots>
```

PARAMETER MACROS—CONF()

```
fill_color = blue                                # globally define data directory

# conf(fill_color) refers to blue

stroke_color = conf(fill_color)

# same as

stroke_color = blue

      = ../data
karyotype    = conf(datadir)/lm.karyotype.txt

<plots>

<plot>
type        = histogram
r1          = 0.9r
r0          = 0.7r
file        = conf(datadir)/lm.exp.ah063.txt
...
...

# globally define species name

species     = lm
karyotype   = conf(datadir)/conf(species).karyotype.txt
```

SHOWING CONFIGURATION TREE

```
> circos -cdump plots
$CONFplots1 = {
    plot => {
        axes => {
            axis => [
                {
                    color => 'vlgrey',
                    spacing => '0.1r'
                },
                {
                    color => 'grey',
                    spacing => '0.2r'
                }
            ],
            show => 1
        },
        file => '../data/lm.exp.ah063.txt',
        r0 => '0.7r',
        r1 => '0.9r',
        type => 'histogram'
    }
};
```

DEFAULT TRACK SETTINGS

```
> cat $CIRCOS/etc/tracks/histogram.conf
color          = black
stroke_thickness = 1
r1             = 0.89r
r0             = 0.8r
orientation     = out

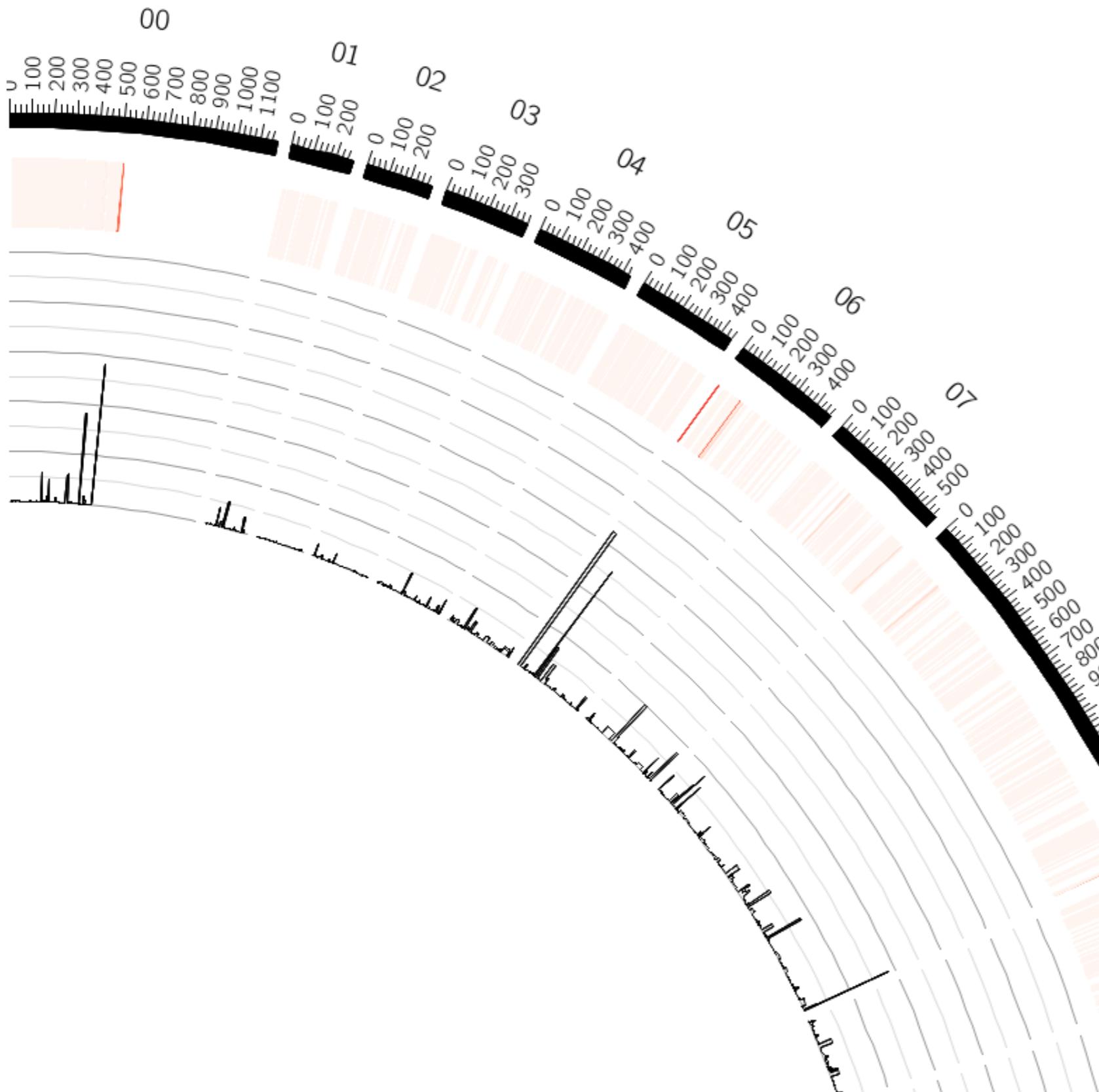
> cat $CIRCOS/etc/tracks/axis.conf
thickness = 1
color      = grey

> ls $CIRCOS/etc/tracks
-rw-r--r-- 1 martink users 220 May 12 09:20 README
-rw-r--r-- 1 martink users  31 Sep 14 17:08 axis.conf
-rw-r--r-- 1 martink users 102 May 12 09:20 connector.conf
-rw-r--r-- 1 martink users 135 May 12 09:20 heatmap.conf
-rw-r--r-- 1 martink users 147 May 12 09:20 highlight.bg.conf
-rw-r--r-- 1 martink users 123 Sep 16 20:27 highlight.conf
-rw-r--r-- 1 martink users 118 Sep 17 18:30 histogram.conf
-rw-r--r-- 1 martink users 120 May 12 09:20 line.conf
-rw-r--r-- 1 martink users 172 May 12 09:20 link.conf
-rw-r--r-- 1 martink users 191 May 12 09:20 scatter.conf
-rw-r--r-- 1 martink users 488 May 12 09:20 text.conf
-rw-r--r-- 1 martink users 256 May 12 09:20 tile.conf
```

**heatmaps
dynamic evaluation
rules
overriding parameters**

LESSON 3

ABSOLUTE IDEOGRAM SCALE



6/3/etc/circos.conf

...

<plot>

type = heatmap

r1 = 0.975r

r0 = 0.92r

file = conf(datadir)/lm.exp.ah063.txt

color = reds-8-seq

#scale_log_base = 0.5

#minsize = 25u

<rules>

use = no

<rule>

condition = 1

z = eval(var(value))

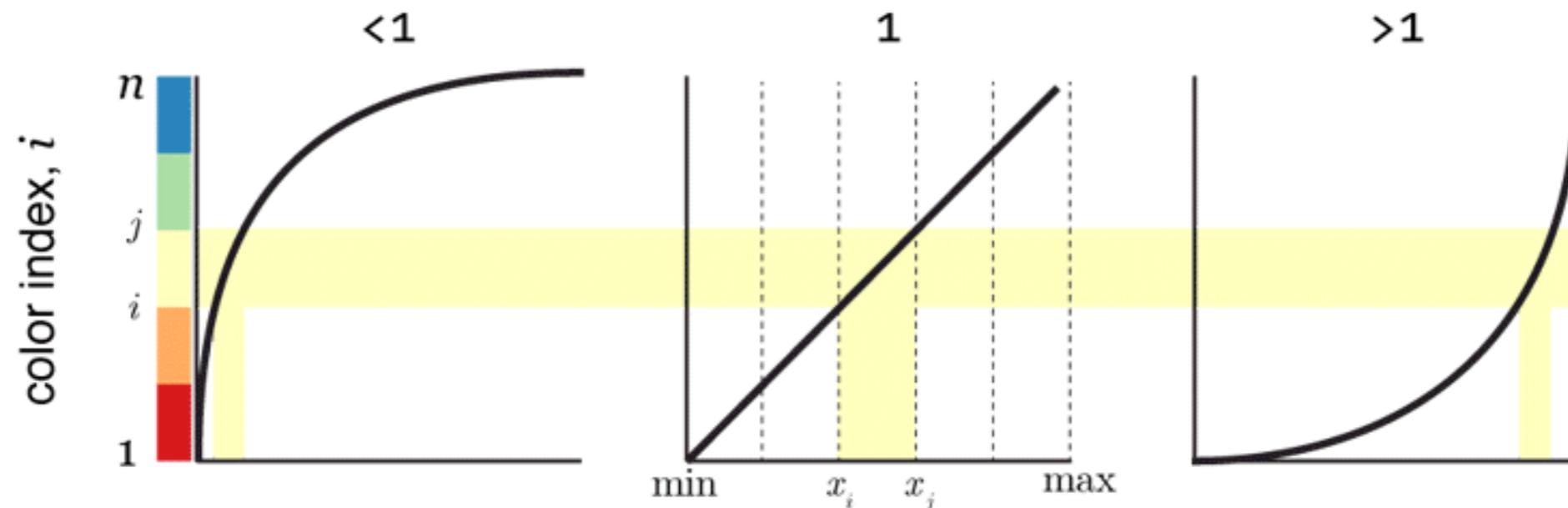
</rule>

</rules>

</plot>

HEATMAP LOG SCALE MAPPING

scale_log_base



$$i : \left[\min + \left(\frac{x_i - \min}{\max - \min} \right)^{\frac{1}{\text{scale_log_base}}}, \min + \left(\frac{x_j - \min}{\max - \min} \right)^{\frac{1}{\text{scale_log_base}}} \right]$$



greater dynamic range
of color for smaller values

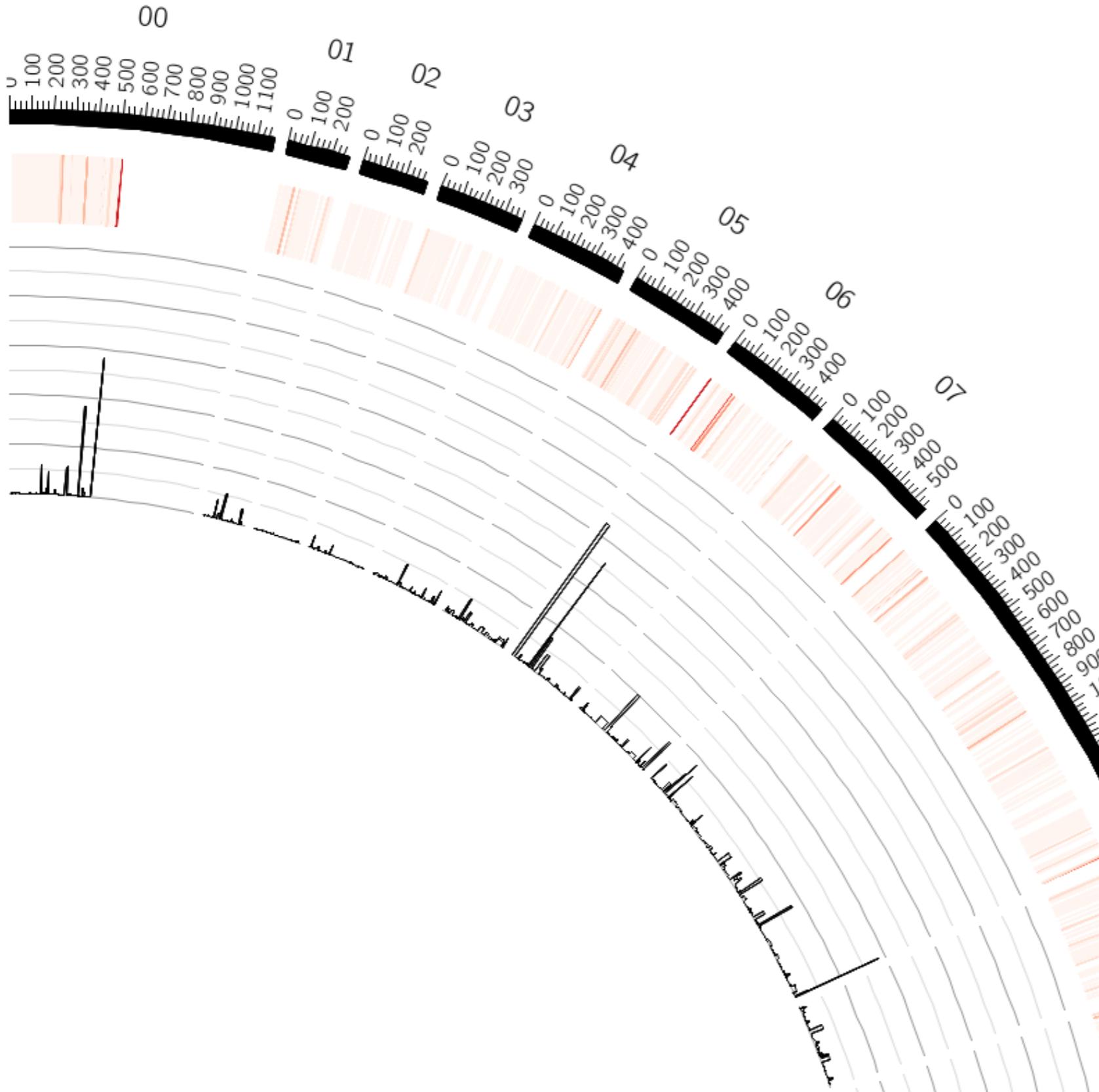


colors uniformly distributed
across range of values



greater dynamic range
of color for larger values

NON-LINEAR COLOR MAPPING



```
# 6/3/etc/circos.conf
```

...

```
<plot>
```

```
type      = heatmap
```

```
r1       = 0.975r
```

```
r0       = 0.92r
```

```
file     = conf(datadir)/lm.exp.ah063.txt
```

```
color    = reds-8-seq
```

```
scale_log_base = 0.5
```

```
#minsize = 25u
```

```
<rules>
```

```
use      = no
```

```
<rule>
```

```
condition = 1
```

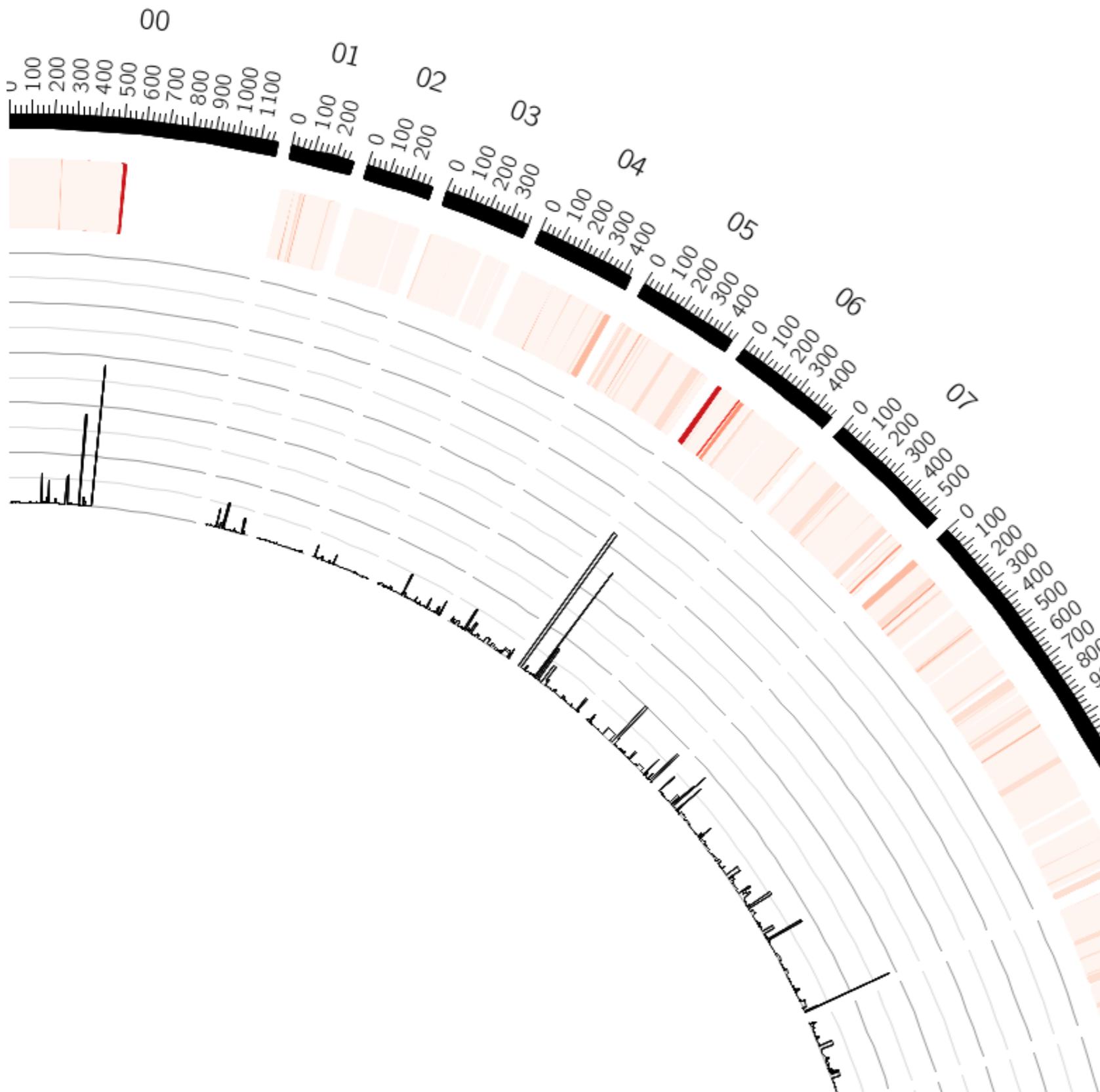
```
z        = eval(var(value))
```

```
</rule>
```

```
</rules>
```

```
</plot>
```

MAKING SMALL INTERVALS VISIBLE WITH MINSIZE



6/3/etc/circos.conf

...

<plot>

type = heatmap

r1 = 0.975r

r0 = 0.92r

file = conf(datadir)/lm.exp.ah063.txt

color = reds-8-seq

scale_log_base = 0.5

minsize = 25u

<rules>

use = no

<rule>

condition = 1

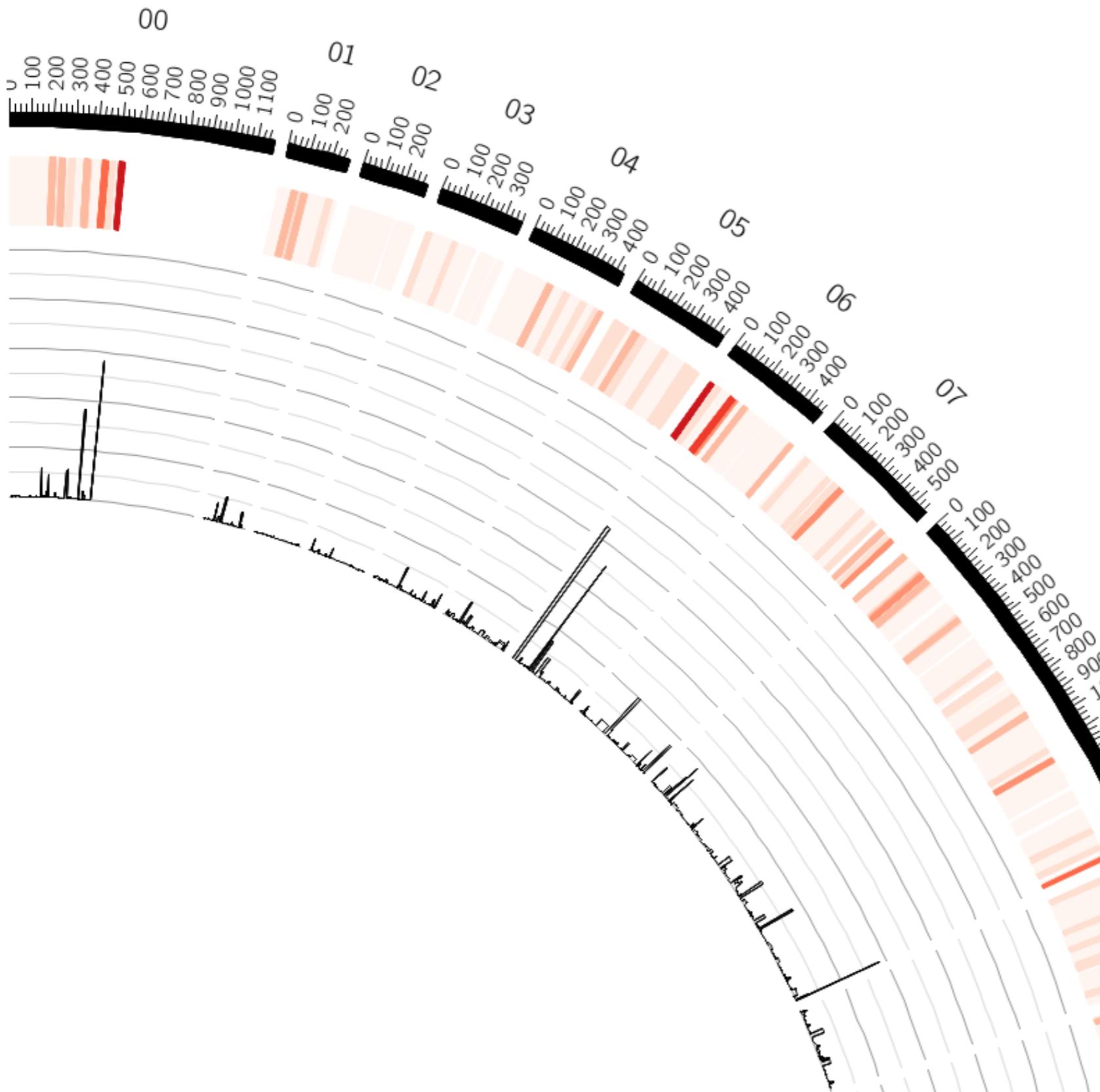
z = eval(var(value))

</rule>

</rules>

</plot>

CHANGING DRAW ORDER—IMPORTANT VALUES ON TOP



6/3/etc/circos.conf

...

<plot>

type = heatmap

r1 = 0.975r

r0 = 0.92r

file = conf(datadir)/lm.exp.ah063.txt

color = reds-8-seq

scale_log_base = 0.5

minsize = 25u

<rules>

use = yes

<rule>

condition = 1

z = eval(var(value))

</rule>

</rules>

</plot>

DYNAMIC PARAMETER EVALUATION—USEFUL IN RULES

Recall that `conf()` gave you access to configuration parameters.

```
color      = blue
fill_color = conf(color)
```

To access properties of data points, use `var()`

e.g. `var(chr)` `var(start)` `var(end)` `var(value)`

```
<rules>
<rule>
condition = 1
z          = eval(var(value))
</rule>
</rules>
```

NOTE

`eval()` is necessary here so that `var(value)` is evaluated as code without `eval()`, the parameter would be the string “`var(value)`”.

PARAMETERS YOU CAN ACCESS WITH VAR()

```
<rules>
<rule>
condition = 1
z          = eval(var(?))
</rule>
</rules>
```

You asked for help in the expression [eval(var(?))].

In this expression the arguments marked with * are available for the var() function.

```
  chr * LmxM.01
  end * 24999
  gene * LmxM.01.0030
    i * 0
  next_value * 64
plot_average * 708.355828220859
  plot_avg * 708.355828220859
  plot_max * 41018
  plot_mean * 708.355828220859
  plot_min * 0
  plot_n * 2934
  plot_sd * 2434.10318623493
plot_stddev * 2434.10318623493
  plot_var * 5924858.32123903
    rev * 0
  start * 0
  value * 76
```

OVERRIDING SYSTEM SETTINGS

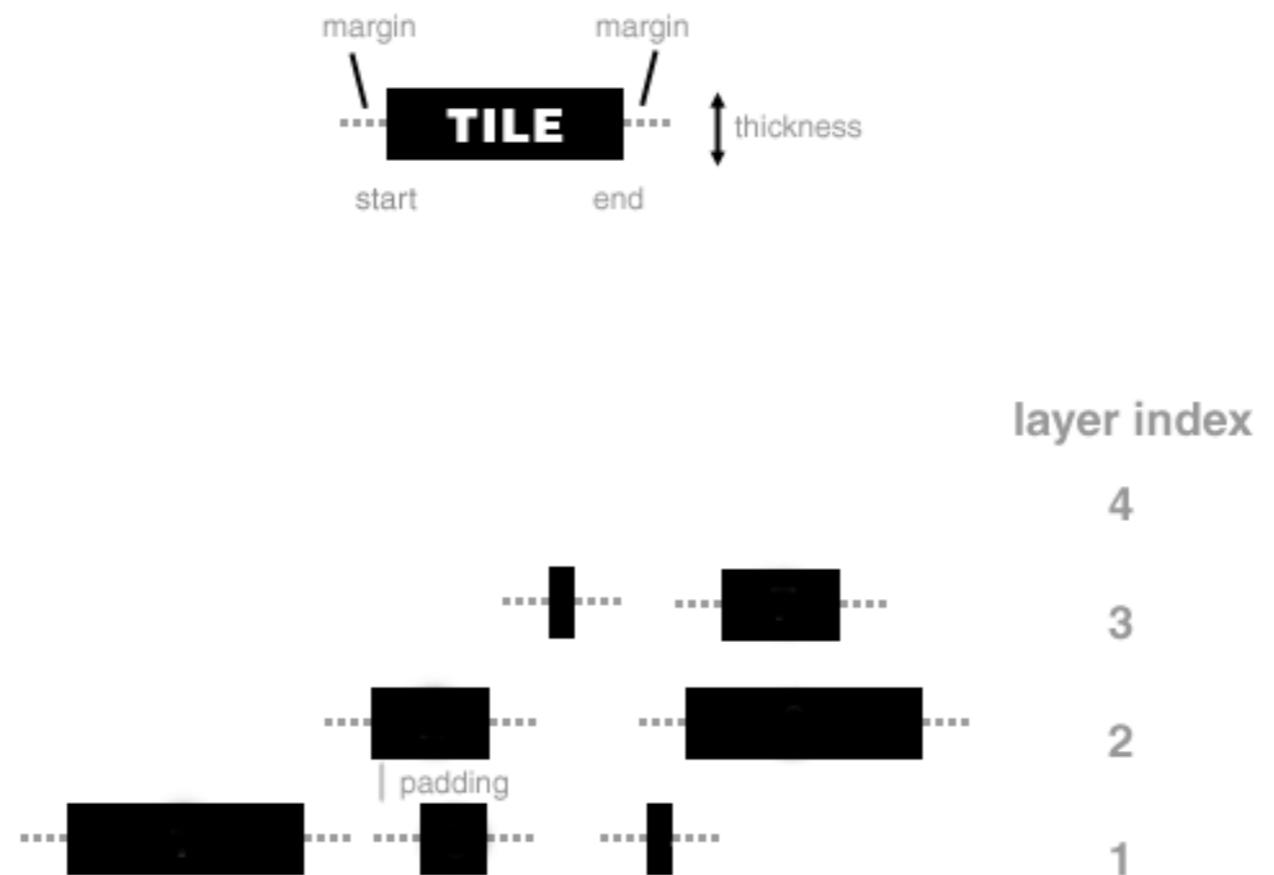
```
> circos
...
WARNING *** Data point of type [heatmap] [1306391-1331390] extended past end of ideogram [LmxM.29 0-1322285].
This data point will be [trimmed].
WARNING *** Data point of type [heatmap] [870143-895142] extended past end of ideogram [LmxM.25 0-883937].
This data point will be [trimmed].
WARNING *** Data point of type [heatmap] [1422772-1447771] extended past end of ideogram [LmxM.30 0-1439542].
This data point will be [trimmed].
WARNING *** Data point of type [heatmap] [1392220-1417219] extended past end of ideogram [LmxM.32 0-1407111].
This data point will be [trimmed].
WARNING *** Data point of type [heatmap] [275301-300300] extended past end of ideogram [LmxM.02 0-298030].
This data point will be [trimmed].
WARNING *** Data point of type [heatmap] [1509054-1534053] extended past end of ideogram [LmxM.31 0-1524016].
This data point will be [trimmed].
...
```

```
# circos.conf
```

```
# imports many parameters, including data_out_of_range=trim,warn
<<include etc/housekeeping.conf>>
# overwrite parameters in current block using * suffix -- here we remove the warn option
data_out_of_range* = trim
```

tiles

LESSON 4



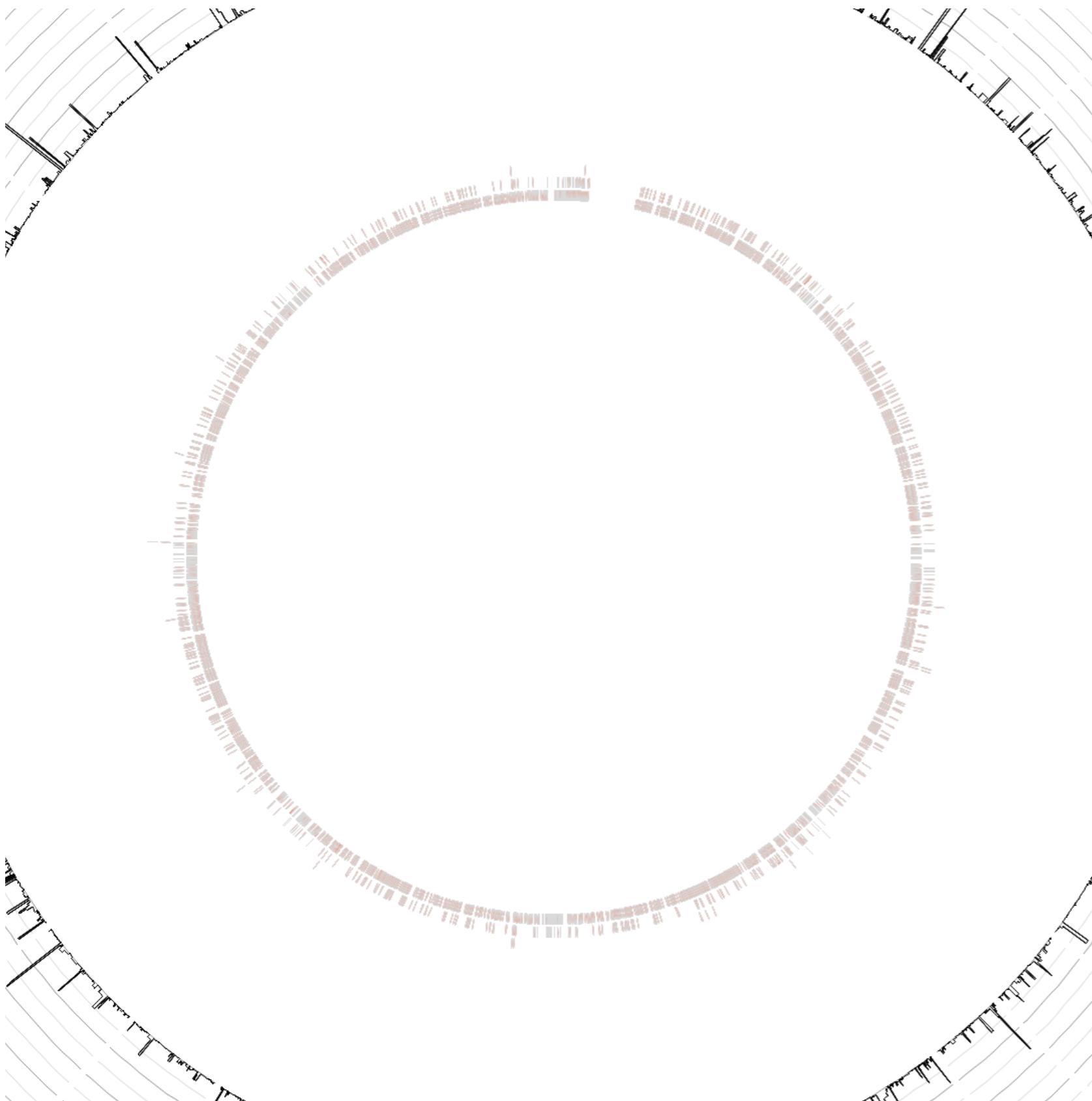
Tiles are placed in layer with smallest index that can accomodate tile's extent without overlap with other tiles in the layer. Tile's extent is defined as the region **[start-margin,end+margin]**. Spacing between layers is defined by **padding**. Relationship between layer index and layer distance from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

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

↓

image center

FILL OF SMALL ELEMENTS MAY BE INVISIBLE



```
# 6/4/etc/circos.conf

<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt

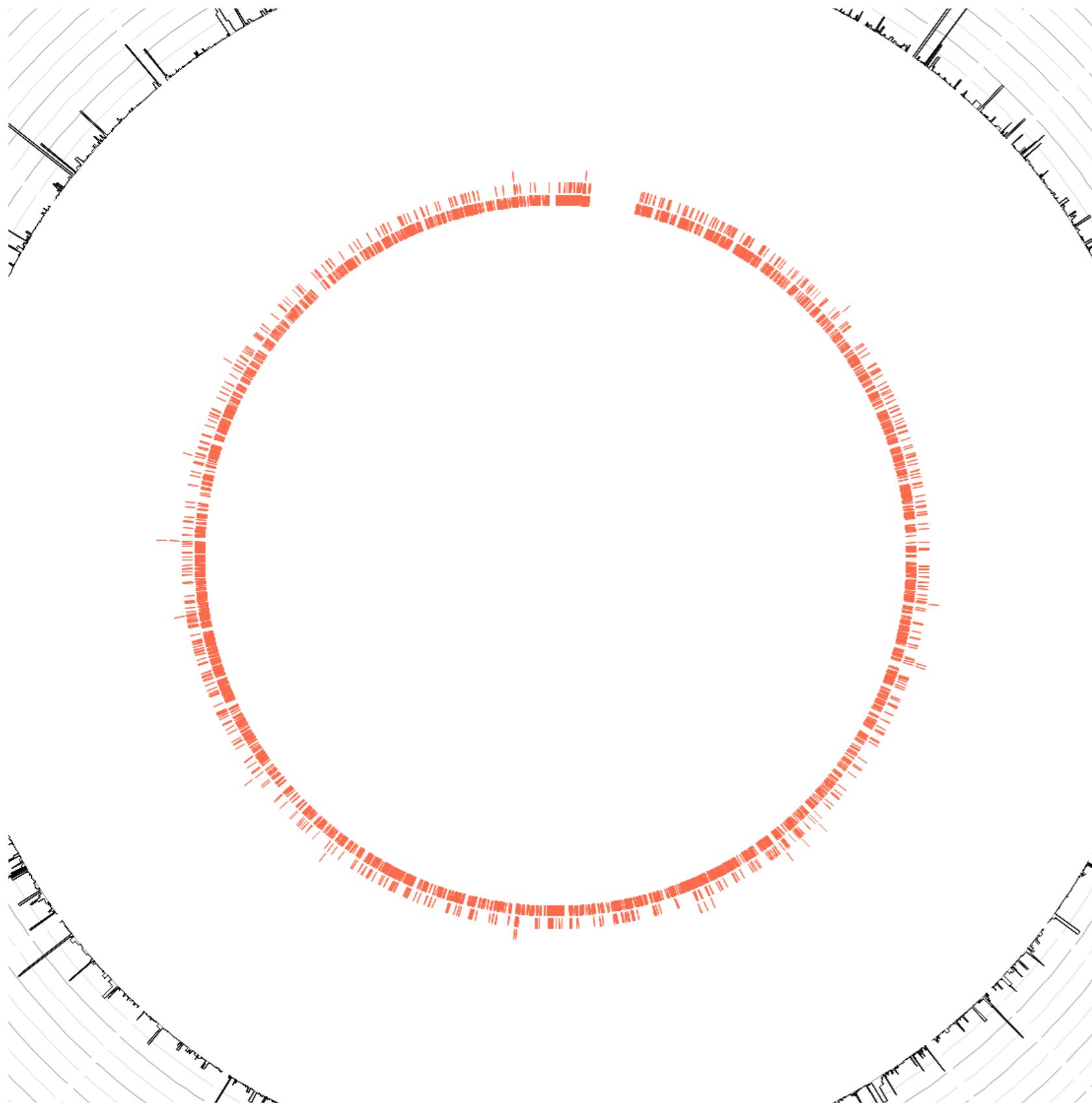
color     = red
#scale_log_base = 0.25
#stroke_thickness = undef

#minsize   = 10u
#thickness = 15
#margin    = 5u

#orientation      = in
#sort           = value
#sort_direction  = desc

</plot>
```

DON'T APPLY STROKE TO SMALL ELEMENTS



6/4/etc/circos.conf

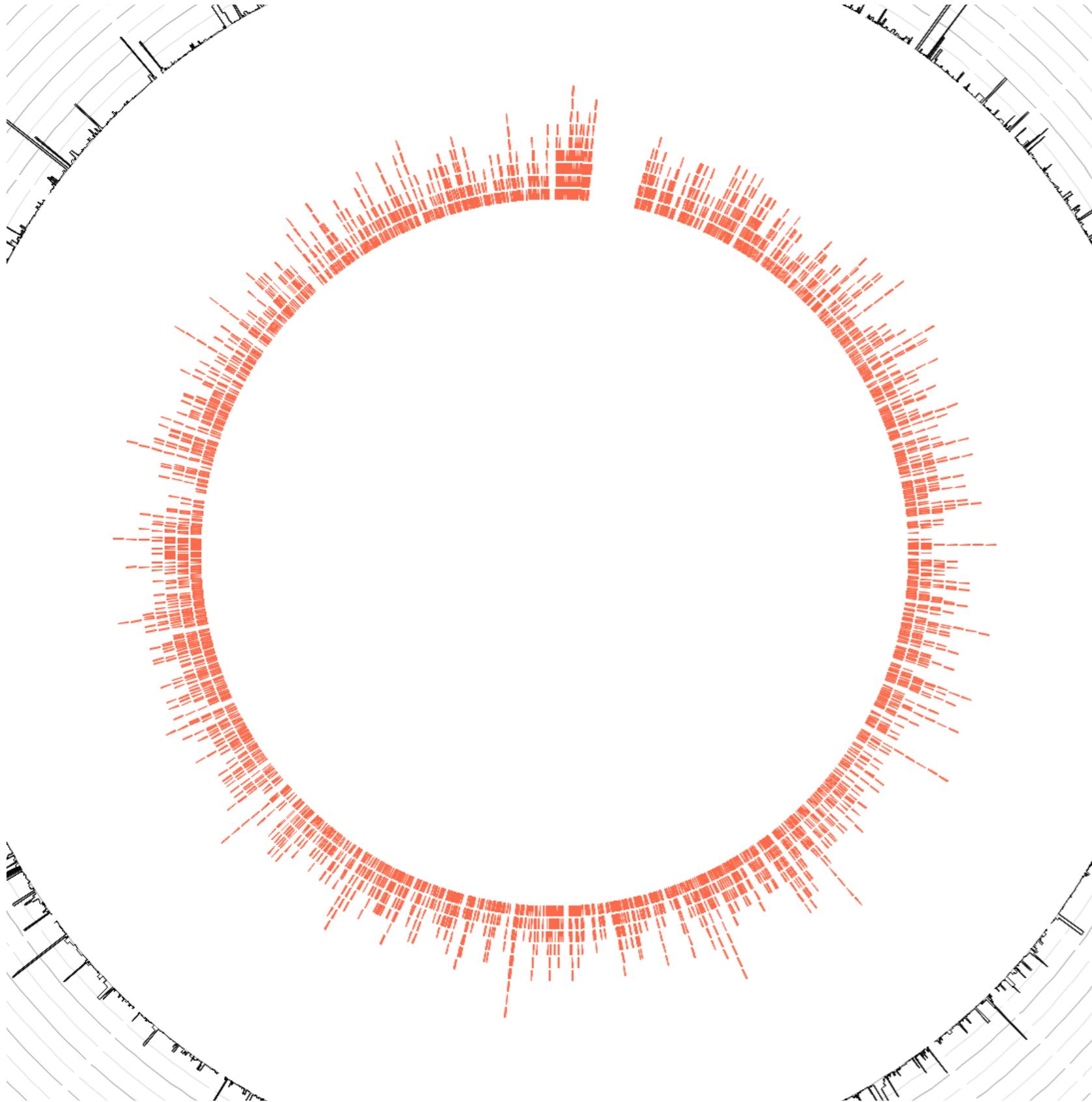
```
<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt
color     = red
#scale_log_base = 0.25
stroke_thickness = undef

#minsize   = 10u
#thickness = 15
#margin    = 5u

#orientation      = in
#sort              = value
#sort_direction   = desc

</plot>
```

ELEMENTS SHOULD BE VISIBLE



```
# 6/4/etc/circos.conf

<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt

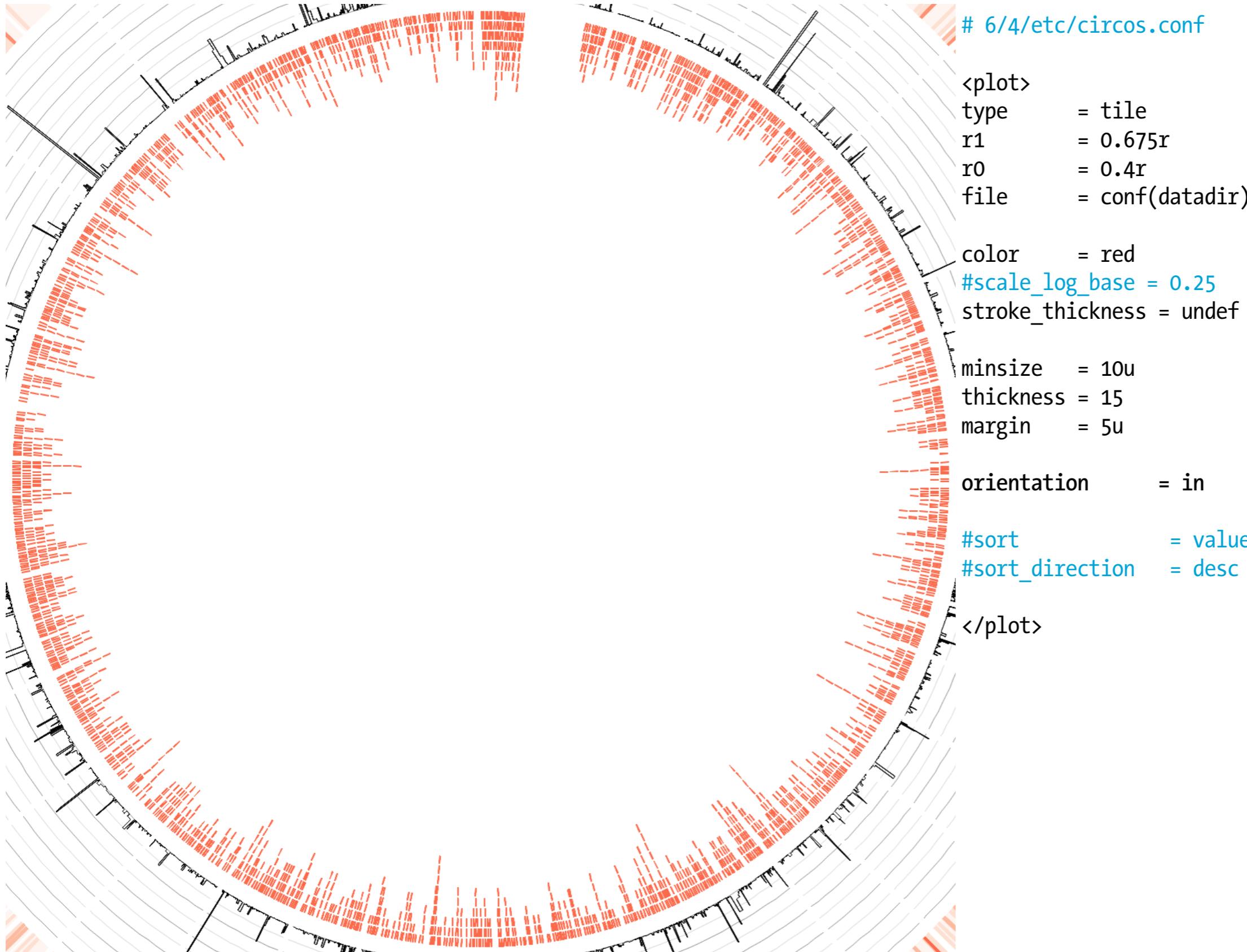
color     = red
#scale_log_base = 0.25
stroke_thickness = undef

minsize   = 10u
thickness = 15
margin    = 5u

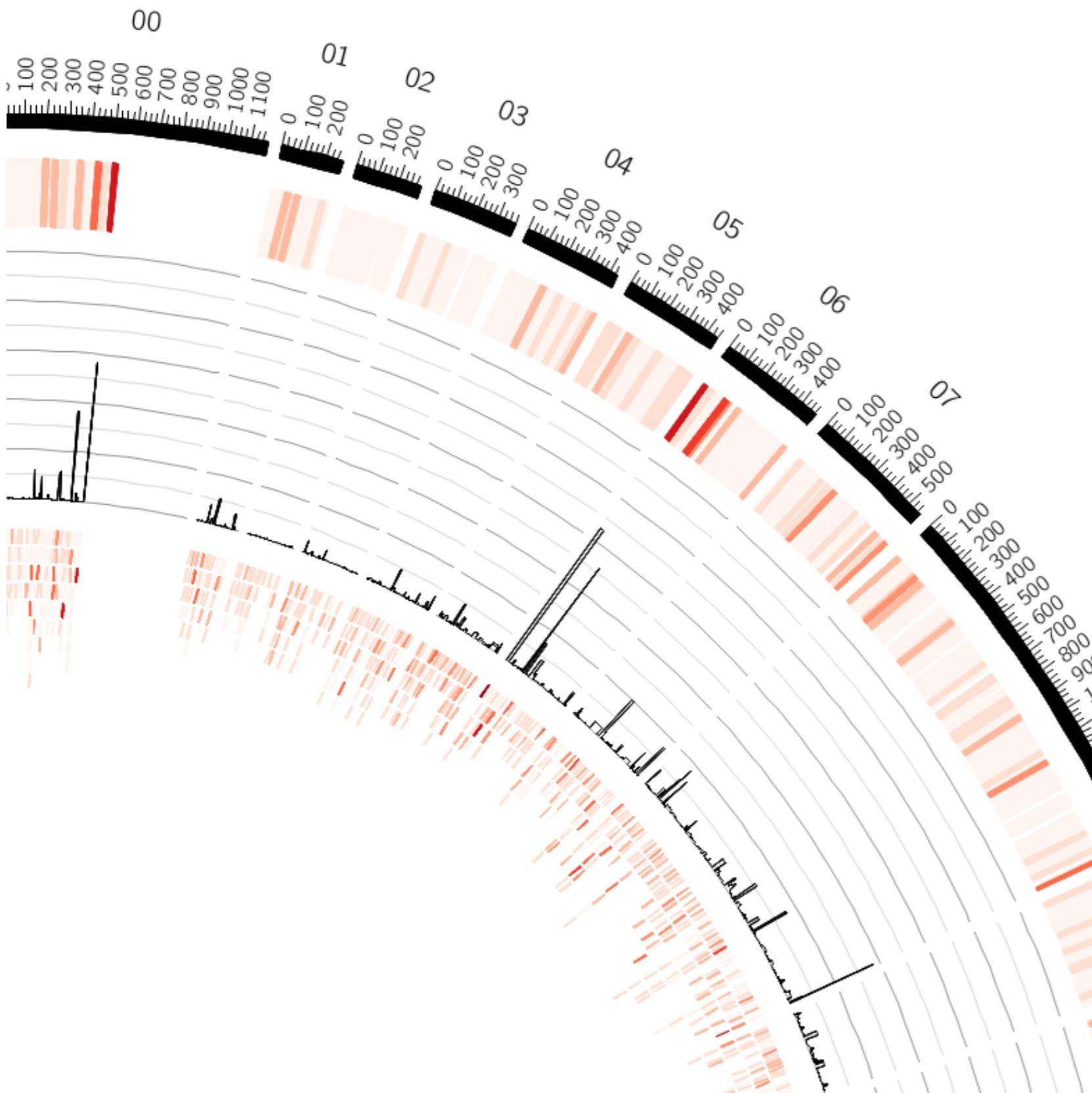
#orientation      = in
#sort             = value
#sort_direction   = desc

</plot>
```

TRACK ORIENTATION



TILE VALUES ENCODED LIKE FOR HEATMAPS



6/4/etc/circos.conf

```
<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt

color     = reds-8-seq
scale_log_base = 0.25
stroke_thickness = undef

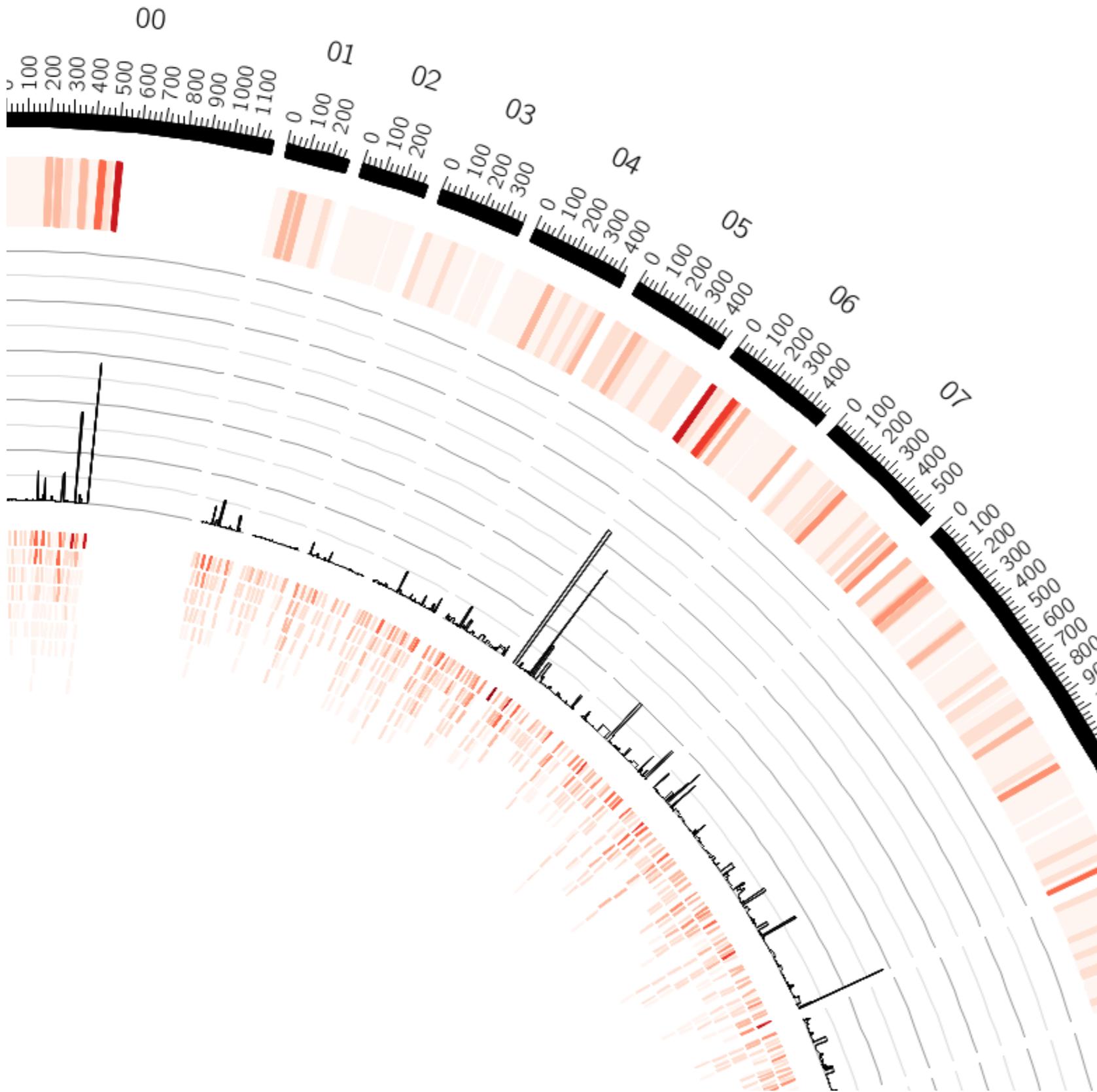
minsize   = 10u
thickness = 15
margin    = 5u

orientation      = in

#sort           = value
#sort_direction = desc

</plot>
```

TILES CAN BE SORTED BY VALUE OR SIZE



6/4/etc/circos.conf

```
<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt
```

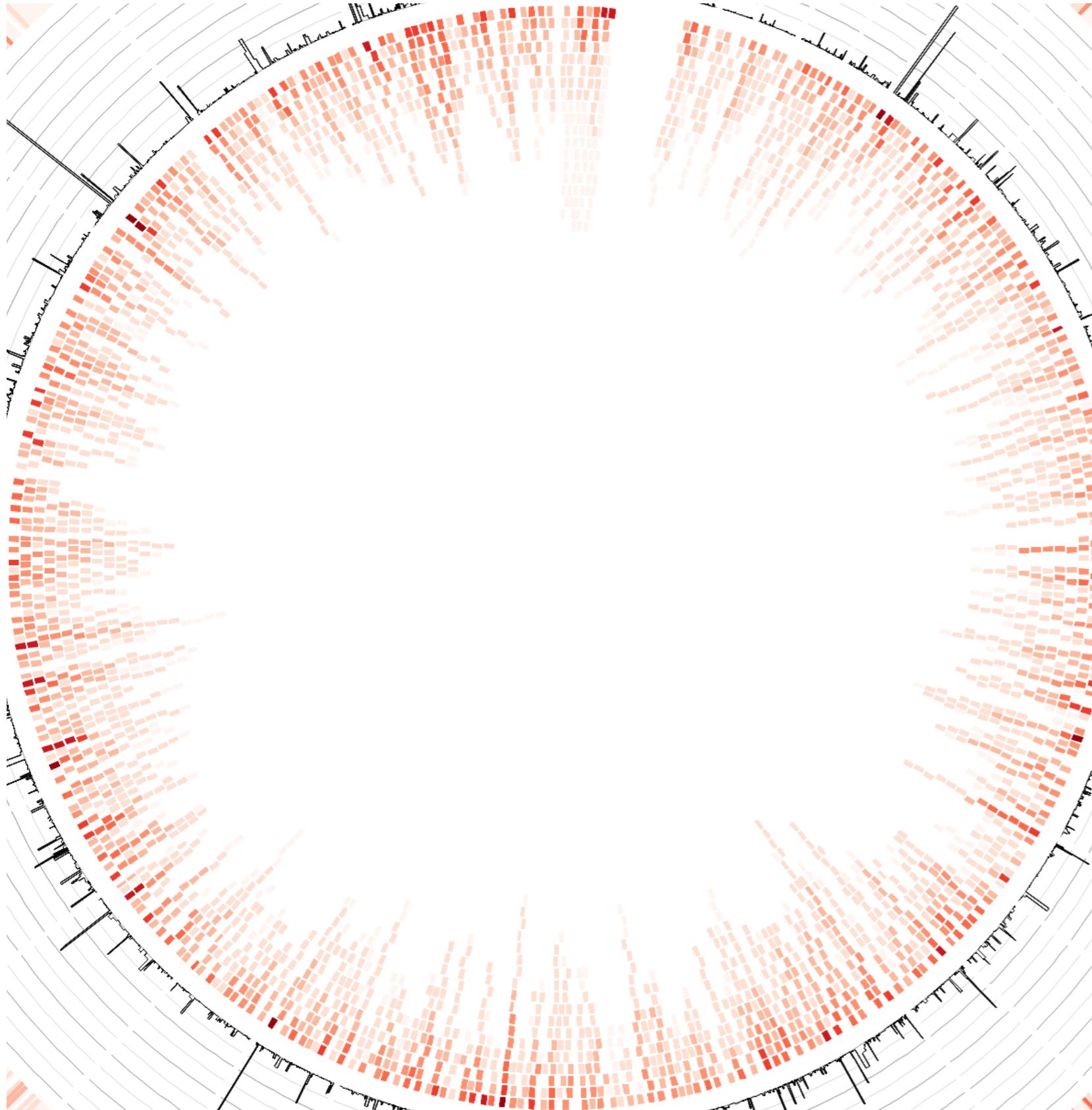
```
color     = reds-8-seq
scale_log_base = 0.25
stroke_thickness = undef
```

```
minsize   = 10u
thickness = 15
margin    = 5u
```

```
orientation      = in
sort             = value
sort_direction   = desc
```

```
</plot>
```

VISIBILITY FIRST, CORRECT SCALE SECOND



6/4/etc/circos.conf

```
<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt

color     = reds-8-seq
scale_log_base = 0.25
stroke_thickness = undef

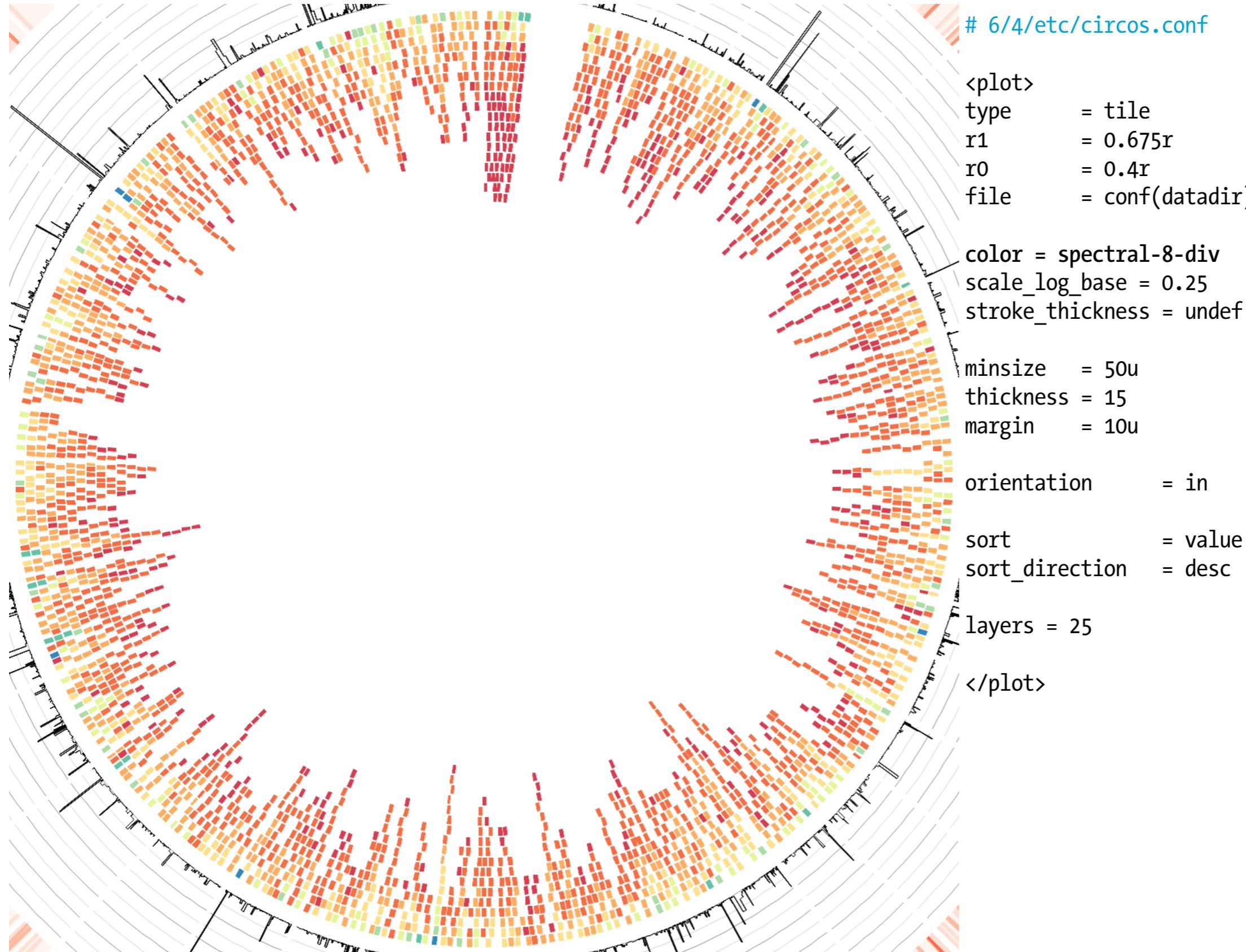
minsize   = 50u
thickness = 15
margin    = 10u

orientation      = in
sort           = value
sort_direction  = desc

layers = 25

</plot>
```

AVOID USING HUE TO ENCODE CONTINUOUS VALUES



6/4/etc/circos.conf

```
<plot>
type      = tile
r1        = 0.675r
r0        = 0.4r
file      = conf(datadir)/lm.exp.ah063.txt

color     = spectral-8-div
scale_log_base = 0.25
stroke_thickness = undef

minsize   = 50u
thickness = 15
margin    = 10u

orientation      = in
sort           = value
sort_direction  = desc

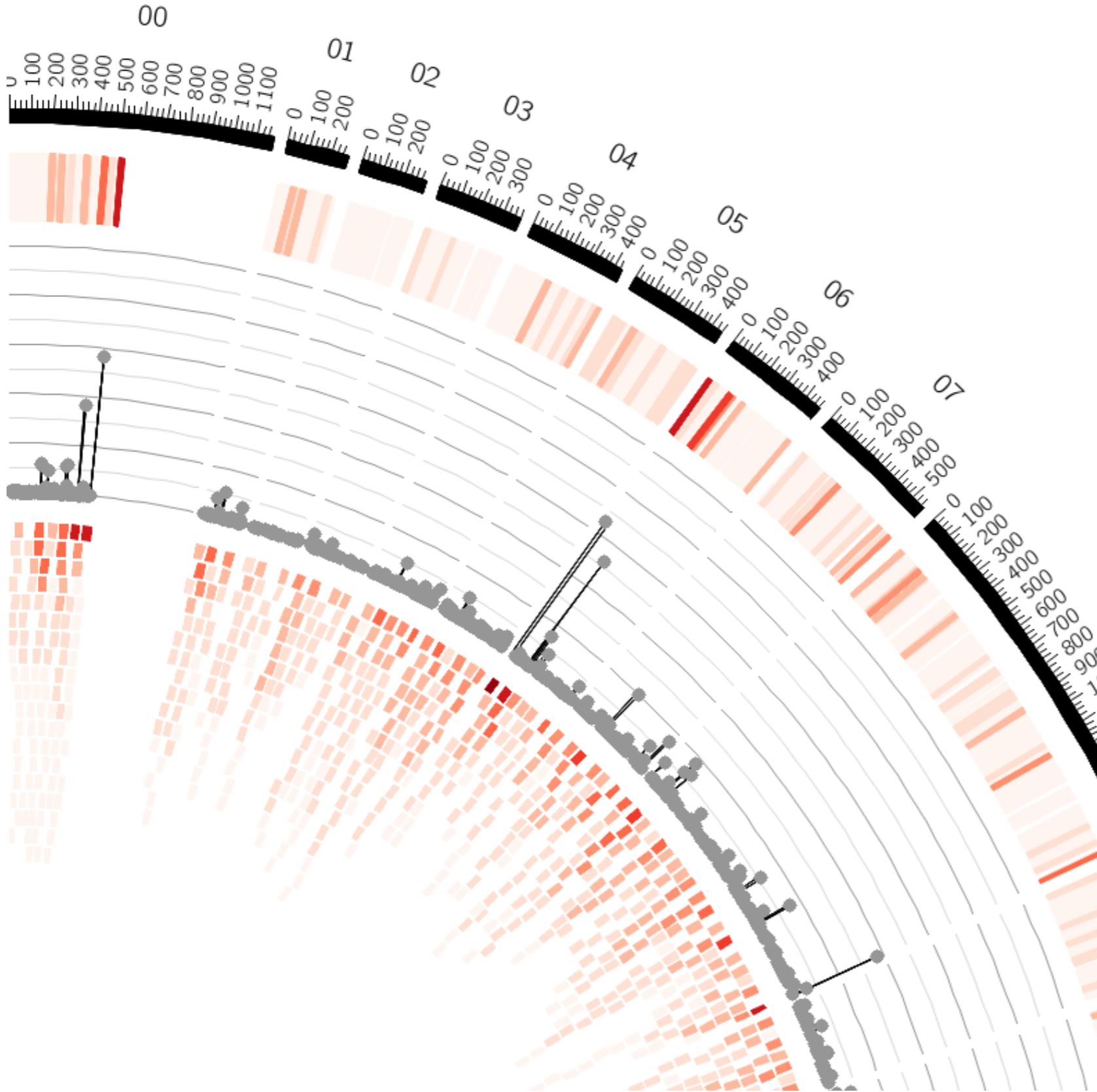
layers = 25

</plot>
```

scatter plots

LESSON 5

SCATTER PLOT



```
# 6/5/etc/circos.conf
```

```
<plot>
```

```
type = scatter
```

```
r1 = 0.9r
```

```
r0 = 0.7r
```

```
file = conf(datadir)/lm.exp.ah063.txt
```

```
#color = reds-8-seq
```

```
#stroke_color = black
```

```
#stroke_thickness = 2
```

```
#glyph_size = 12
```

```
<rules>
```

```
use = no
```

```
<rule>
```

```
condition = var(value) < 0.1*var(plot_max)
```

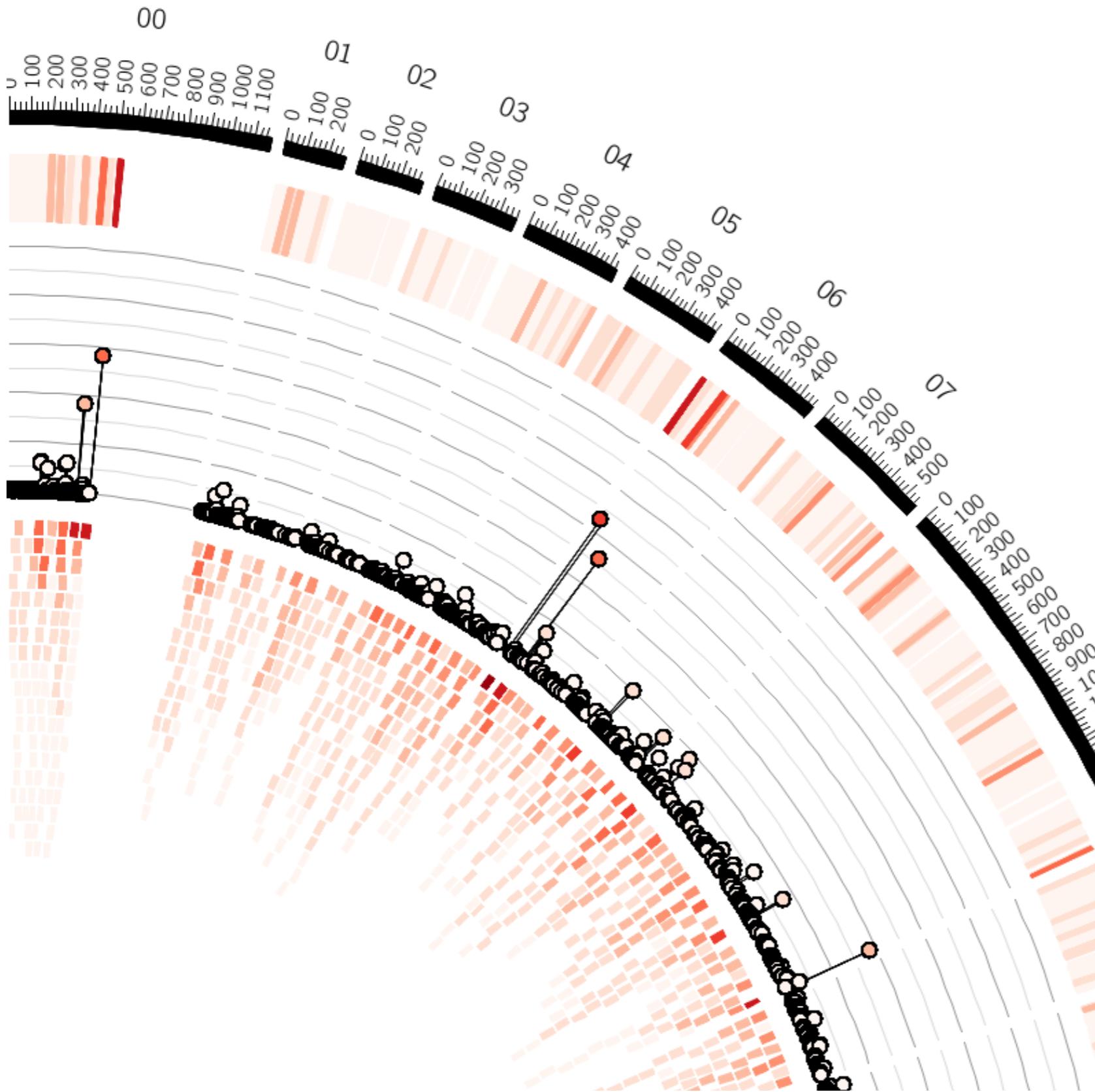
```
glyph_size = 0
```

```
</rule>
```

```
</rules>
```

```
</plot>
```

SCATTER PLOT



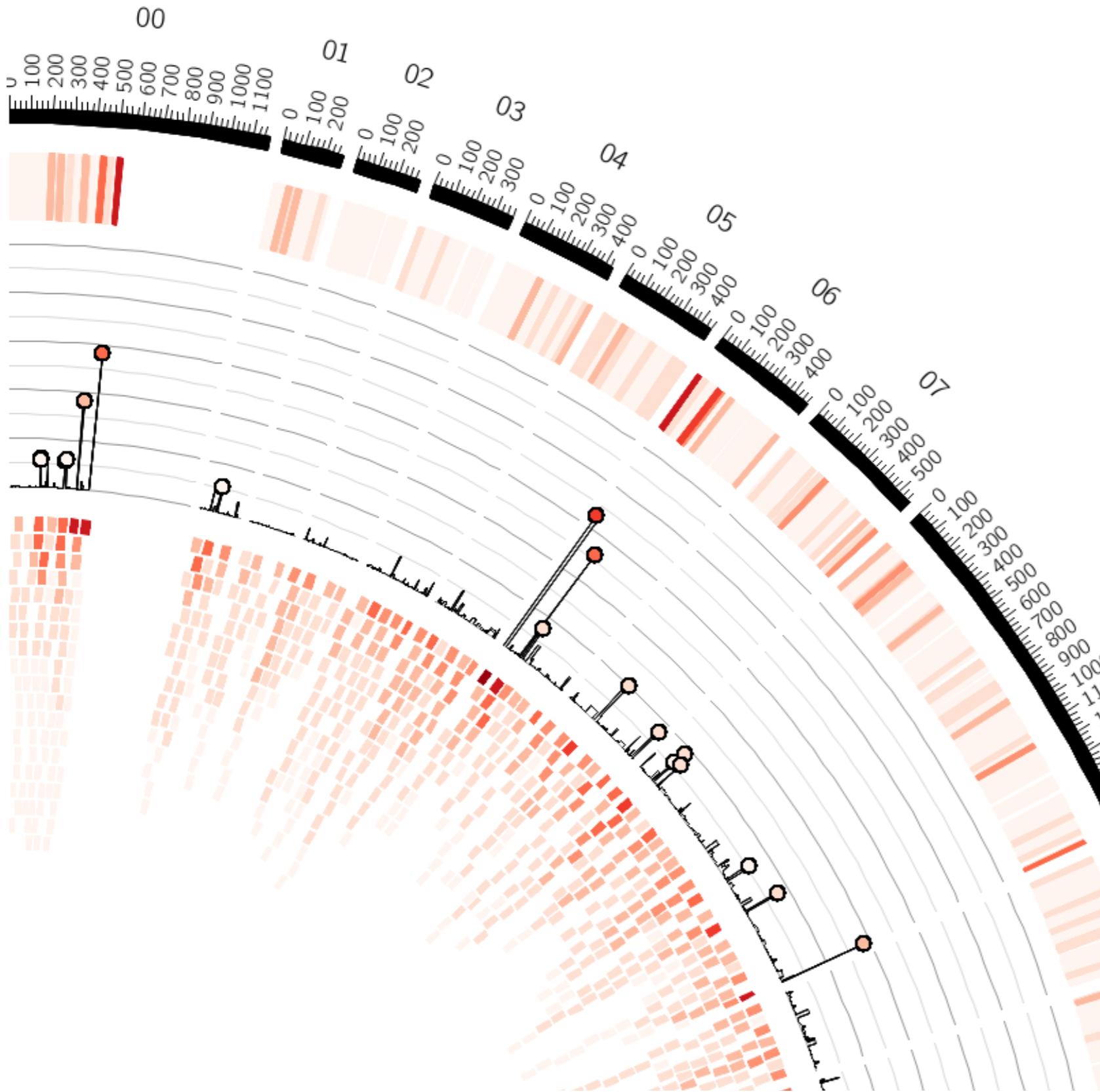
```
# 6/5/etc/circos.conf
```

```
<plot>
type      = scatter
r1        = 0.9r
r0        = 0.7r
file      = conf(datadir)/lm.exp.ah063.txt
```

```
color      = reds-8-seq
stroke_color = black
stroke_thickness = 2
glyph_size   = 12
```

```
<rules>
use      = no
<rule>
condition = var(value) < 0.1*var(plot_max)
glyph_size = 0
</rule>
</rules>
</plot>
```

SCATTER PLOT



```
# 6/5/etc/circos.conf
```

```
<plot>
```

```
type = scatter
```

```
r1 = 0.9r
```

```
r0 = 0.7r
```

```
file = conf(datadir)/lm.exp.ah063.txt
```

```
color = reds-8-seq
```

```
stroke_color = black
```

```
stroke_thickness = 2
```

```
glyph_size = 12
```

```
<rules>
```

```
use = yes
```

```
<rule>
```

```
condition = var(value) < 0.1*var(plot_max)
```

```
glyph_size = 0
```

```
</rule>
```

```
</rules>
```

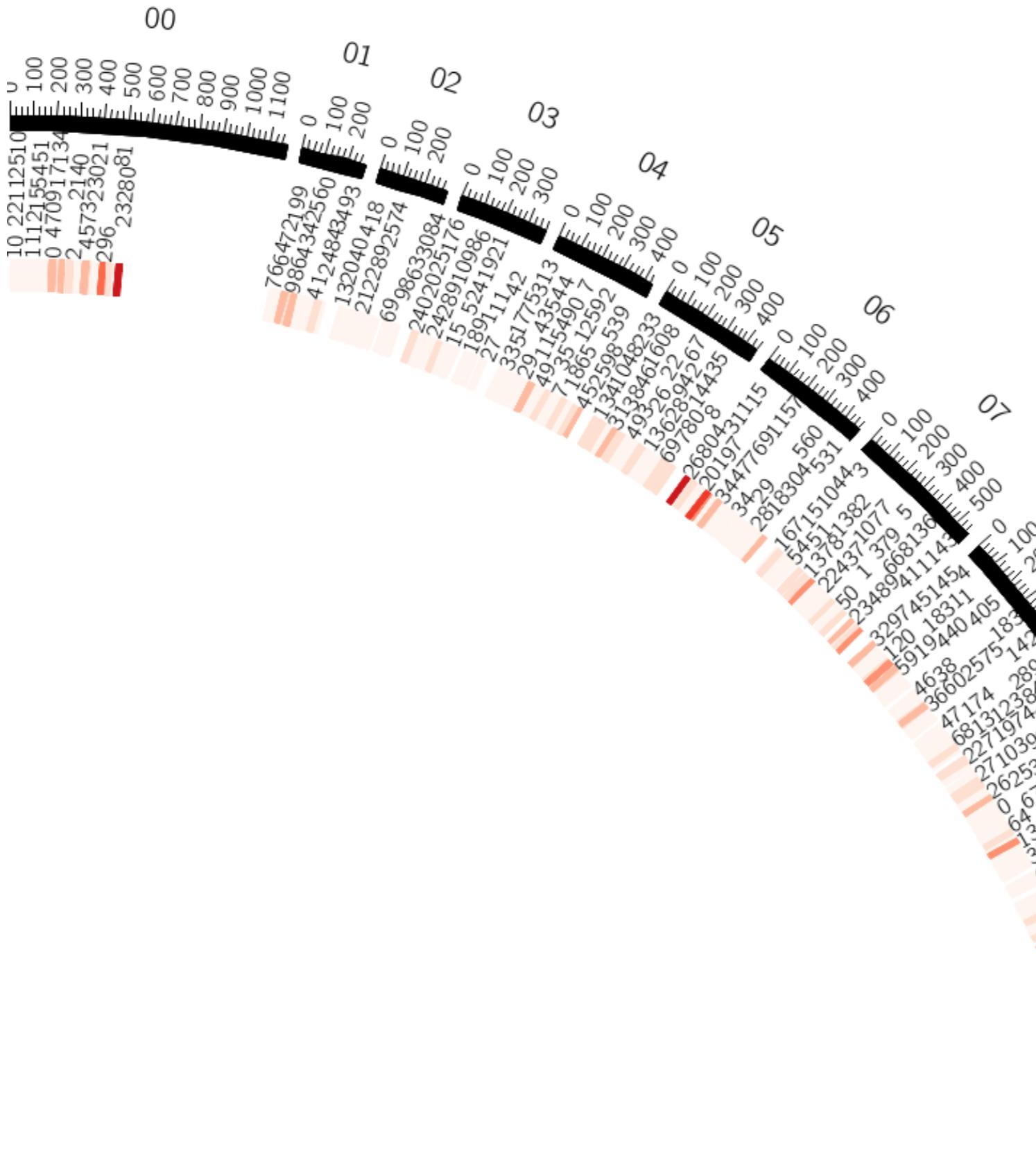
```
</plot>
```

text

parameter inheritance

LESSON 6

TEXT TRACK



```
# 6/6/etc/circos.conf

<plots>
show = no
...
<plot>
show = yes
type = text
r1   = dims(ideogram,radius_inner)
r0   = 0.9r
file = conf(datadir)/lm.exp.ah063.txt

#label_snuggle = yes
#show_links    = yes
#link_color    = grey
#max_snuggle_distance = 3r

<rules>
use = no
<rule>
condition = var(value) < 0.05*var(plot_max)
show      = no
</rule>
<rule>
condition = var(value) > 0.5*var(plot_max)
label_font = bold
flow       = continue
</rule>
<rule>
condition = 1
value     = eval(replace(var(value),qr/\B(?=\d{3})+(?!\\d))/,","))
</rule>
</rules>

</plot>
```

FORMAT RULES—CAN BE USED WITH ANY TRACK

<plot>

must be inside <plot> block (or <link>)

...

<rules>

rule chain is applied to each data point

<rule>

condition =

...

</rule>

<rule> blocks are applied in order of appearance

<rule>

condition =

...

</rule>

the first <rule> block for which condition is TRUE, is applied, changing any data point parameters; all further rule blocks are not tested

<rule>

condition =

...

</rule>

“flow” parameter can control what happens when a rule block condition fails

e.g.

flow = continue

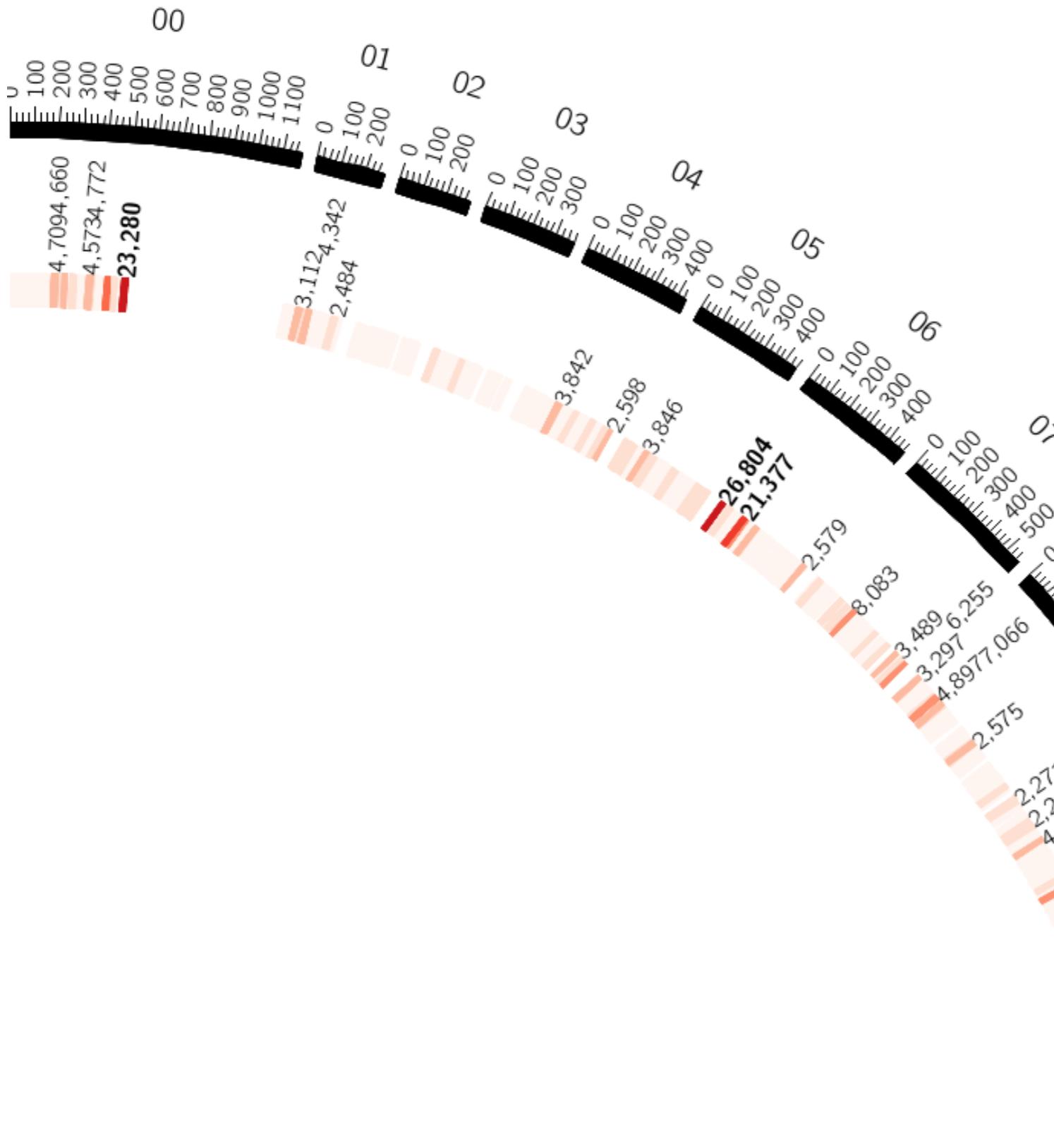
will continue testing subsequent <rule> blocks

...

</rules>

</plot>

TEXT TRACK



```
# 6/6/etc/circos.conf

<plots>
show = no
...
<plot>
show = yes
type = text
r1  = dims(ideogram,radius_inner)
r0  = 0.9r
file = conf(datadir)/lm.exp.ah063.txt

#label_snuggle = yes
#show_links    = yes
#link_color    = grey
#max_snuggle_distance = 3r

<rules>
use = yes
<rule>
condition = var(value) < 0.05*var(plot_max)
show      = no
</rule>
<rule>
condition = var(value) > 0.5*var(plot_max)
label_font = bold
flow       = continue
</rule>
<rule>
condition = 1
value     = eval(replace(var(value),qr/\B(?= (\d{3})+(?! \d))/,",""))
</rule>
</rules>

</plot>
```

TRACK FORMAT RULES

<plot>

...

<rules>

use = yes

<rule>

condition = var(value) < 0.05*var(plot_max)
show = no
</rule>

do not show data points with
value less than 5% of plot max

<rule>

condition = var(value) > 0.5*var(plot_max)
label_font = bold
flow = continue
</rule>

bold font for data points with value >50% max

<rule>

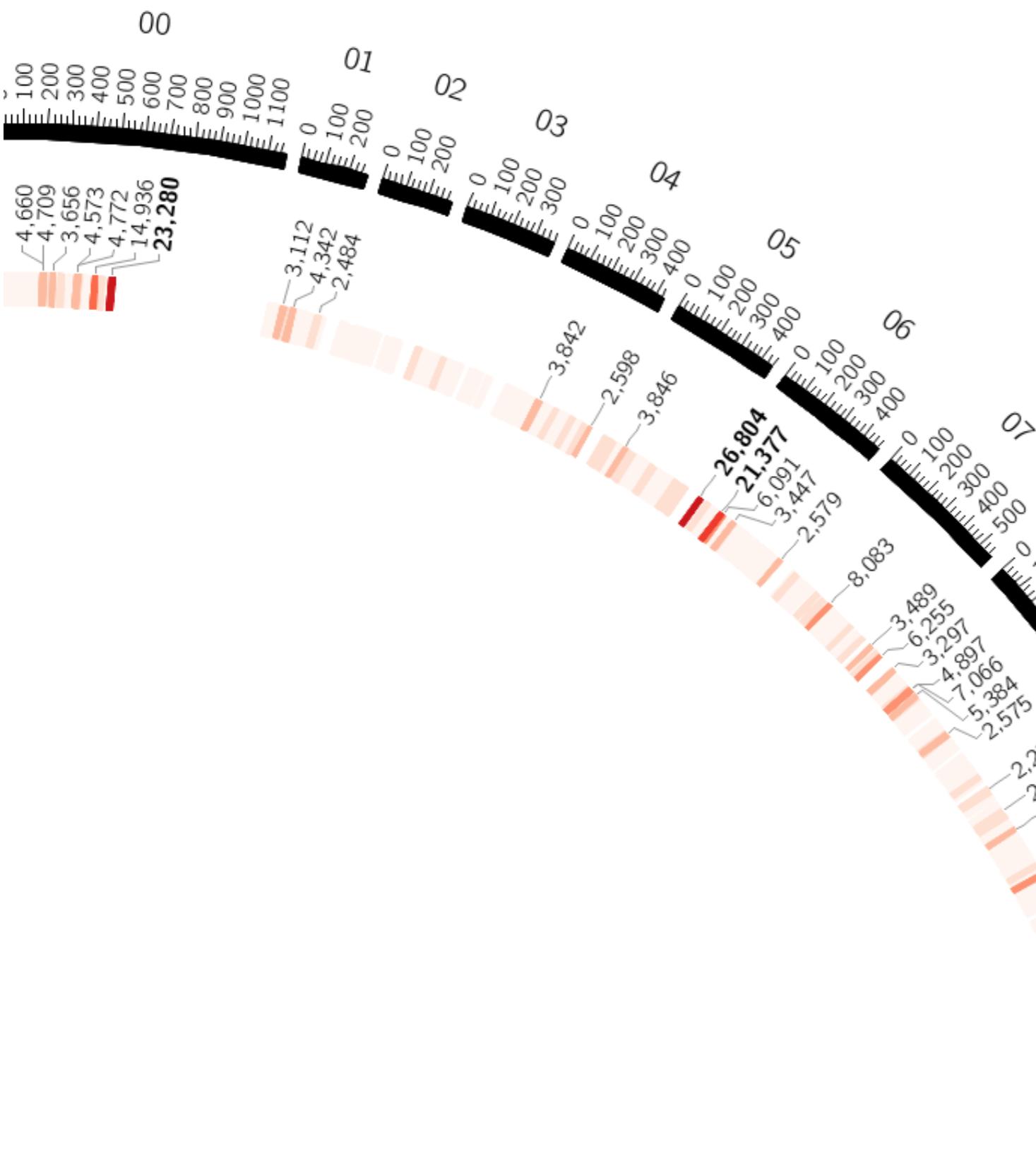
condition = 1
value = eval(replace(var(value),qr/\B(?=(\d{3})+(!\d))/,","))
</rule>

add thousands separator (1000 -> 1,000)

</rules>

</plot>

LABEL SNUGGLING AND CALLOUTS



```
# 6/6/etc/circos.conf

<plots>
show = no
...
<plot>
show = yes
type = text
r1   = dims(ideogram,radius_inner)
r0   = 0.9r
file = conf(datadir)/lm.exp.ah063.txt

label_snuggle = yes
show_links    = yes
link_color    = grey
max_snuggle_distance = 3r

<rules>
use = yes
<rule>
condition = var(value) < 0.05*var(plot_max)
show      = no
</rule>
<rule>
condition = var(value) > 0.5*var(plot_max)
label_font = bold
flow       = continue
</rule>
<rule>
condition = 1
value     = eval(replace(var(value),qr/\B(?=(\d{3})+(?!\\d))/,","))
</rule>
</rules>

</plot>
```

PARAMETER INHERITANCE

<plots>

```
# inherited by all subblocks  
show = no
```

<plot>

...

</plot>

<plot>

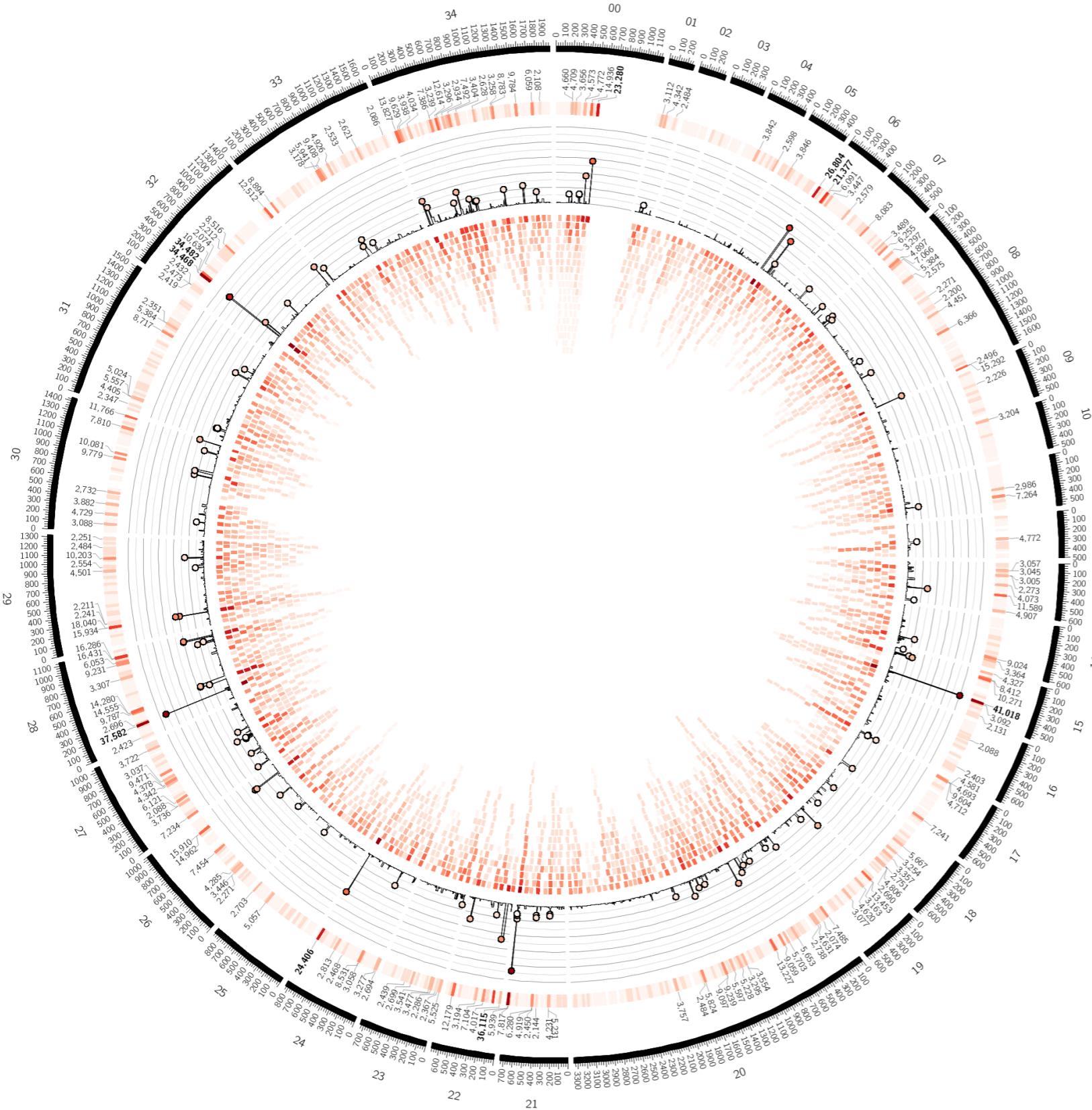
```
show = yes
```

...

</plot>

</plots>

OUR IMAGE SO FAR



6/etc/circos.conf

<plots>
show = yes

• • •

modular configuration

<<include>>

LESSON 7

IMPORTING CONFIGURATION WITH <<INCLUDE>>

```
<plot>
type      = histogram
r1        = 0.85r
r0        = 0.7r
file      =
conf(datadir)/lm.exp.ah063.txt
```

```
<axes>
<axis>
color    = vlgrey
spacing  = 0.1r
</axis>
<axis>
color    = grey
spacing  = 0.2r
</axis>
</axes>

</plot>
```

```
<plot>
type      = histogram
r1        = 0.85r
r0        = 0.7r
file      =
conf(datadir)/lm.exp.ah063.txt
```

```
# path relative to file in which
# <<include>> was used
<<include axes.conf>>
```

```
</plot>
```

```
# etc/axes.conf
<axes>
<axis>
color    = vlgrey
spacing  = 0.1r
</axis>
<axis>
color    = grey
spacing  = 0.2r
</axis>
</axes>
```

IMPORTING CONFIGURATION WITH <<INCLUDE>>

```
<plot>
show = yes
type      = heatmap
r1        = 0.9r
r0        = 0.875r
file      =
    conf(datadir)/lm.exp.ah063.txt
color     = reds-8-seq
scale_log_base = 0.5
minsize   = 25u
```

```
<rules>
<rule>
condition = 1
z          = eval(var(value))
</rule>
</rules>

</plot>
```

```
<plot>
show = yes
type      = heatmap
r1        = 0.9r
r0        = 0.875r
file      =
    conf(datadir)/lm.exp.ah063.txt
color     = reds-8-seq
scale_log_base = 0.5
minsize   = 25u
```

```
<<include rules.heatmap.conf>>
```

```
</plot>
```

```
# etc/rules.heatmap.conf
<rules>
<rule>
condition = 1
z          = eval(var(value))
</rule>
</rules>
```

SETTING PARAMETERS AT COMMAND LINE

```
> circos -param label=gene -cdump :label  
$CONF:label1 = {  
    label => 'gene',  
    show_tick_labels => 1  
};
```

-param NAME:VALUE
sets parameter NAME to VALUE

```
> circos -param label=gene -param label2=foo -cdump :label  
$CONF:label1 = {  
    label => 'gene',  
    label2 => 'foo'  
    show_tick_labels => 1  
};
```

-param BLOCK/NAME:VALUE
sets parameter NAME in BLOCK to VALUE

-cdump
shows the entire configuration tree

-cdump BLOCK
shows configuration for BLOCK

-cdump BLOCK/OTHERBLOCK
shows configuration for a nested blocks

-cdump BLOCK:REGEXP
shows only parameters in BLOCK whose names match REGEXP

-cdump :REGEXP
shows only parameters in the root whose names match REGEXP

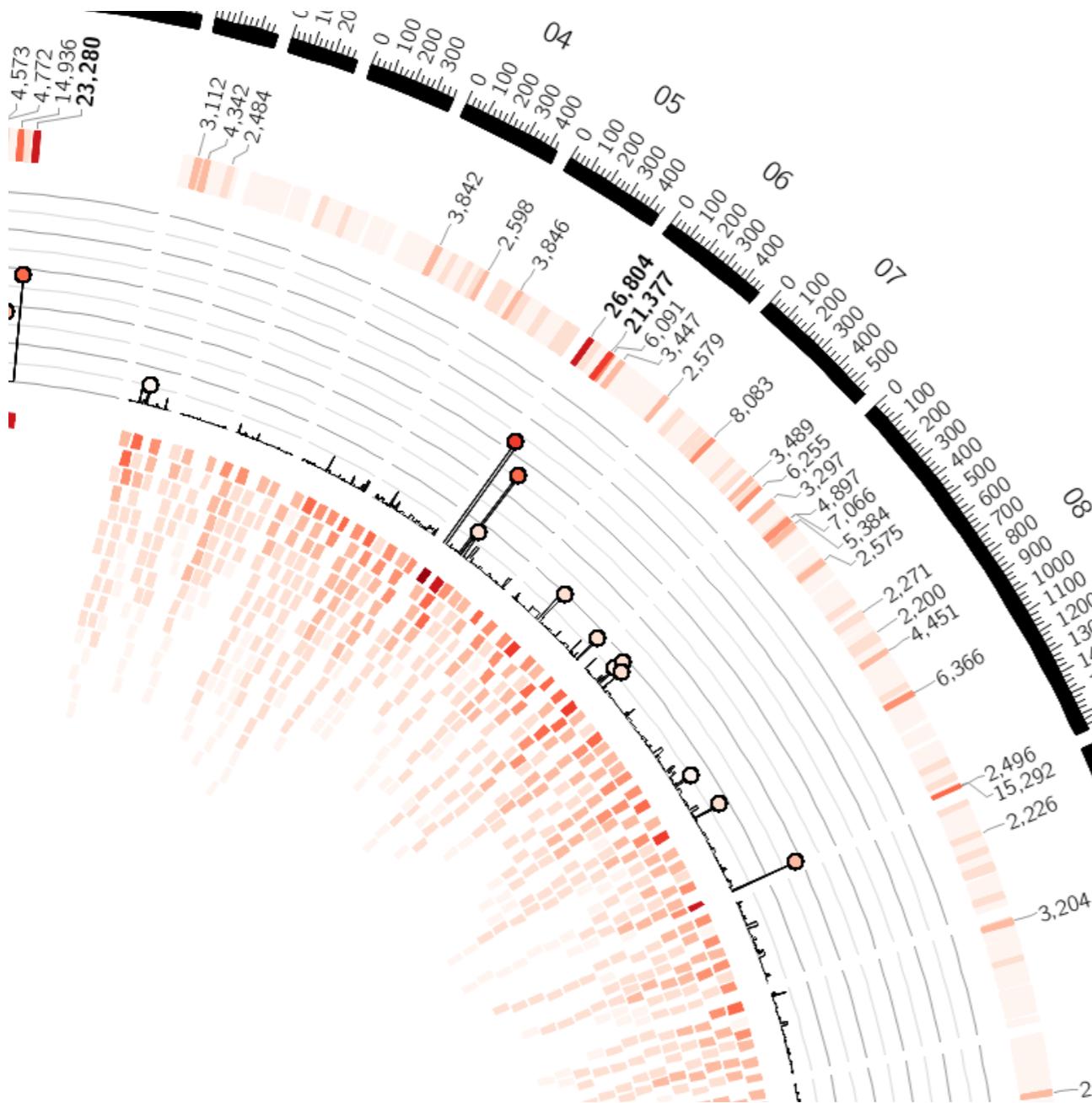
SETTING PARAMETERS AT COMMAND LINE

```
# ./data/lm.exp.ah063.txt
LmxM.01 9205 11223 76 gene=LmxM.01.0030
LmxM.01 14846 16843 64 gene=LmxM.01.0050
LmxM.01 27727 28314 72 gene=LmxM.01.0110
LmxM.01 35671 35919 199 gene=LmxM.01.0140
LmxM.01 39931 41277 11 gene=LmxM.01.0170
...
# etc/rules.text.txt
<rule>
condition = 'conf(label)' eq "gene"
value      = eval( replace(var(gene),qr/LmxM.\d+./,"") )
label_font = eval( var(label_font) eq "bold" ? "bolditalic" : "italic" )
</rule>

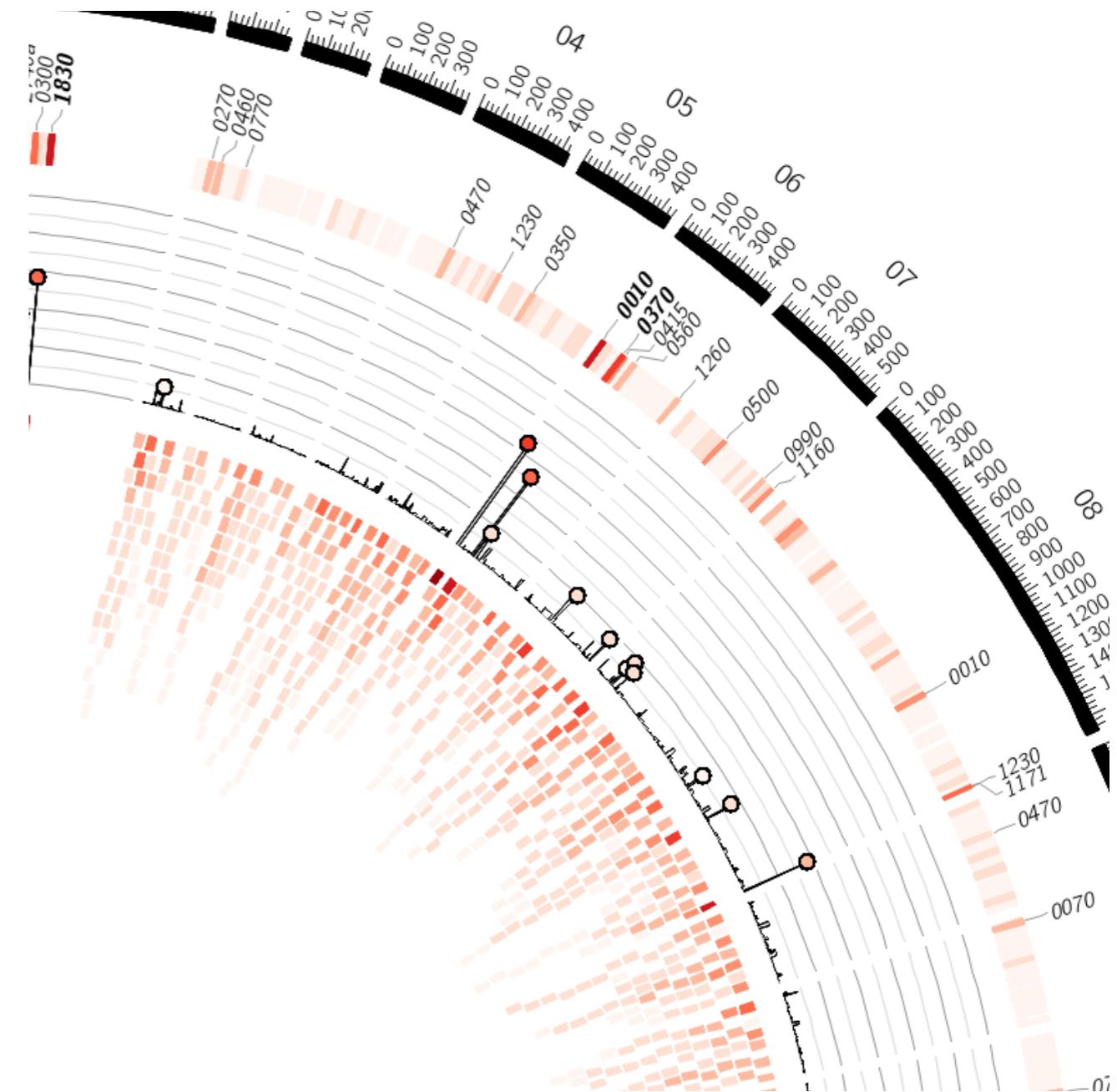
# labels are expression values
# 'label' parameter is not set
> circos

# labels are gene names
> circos -param label=gene
```

SETTING PARAMETERS AT COMMAND LINE



```
> circos
```



```
> circos -param label=gene
```

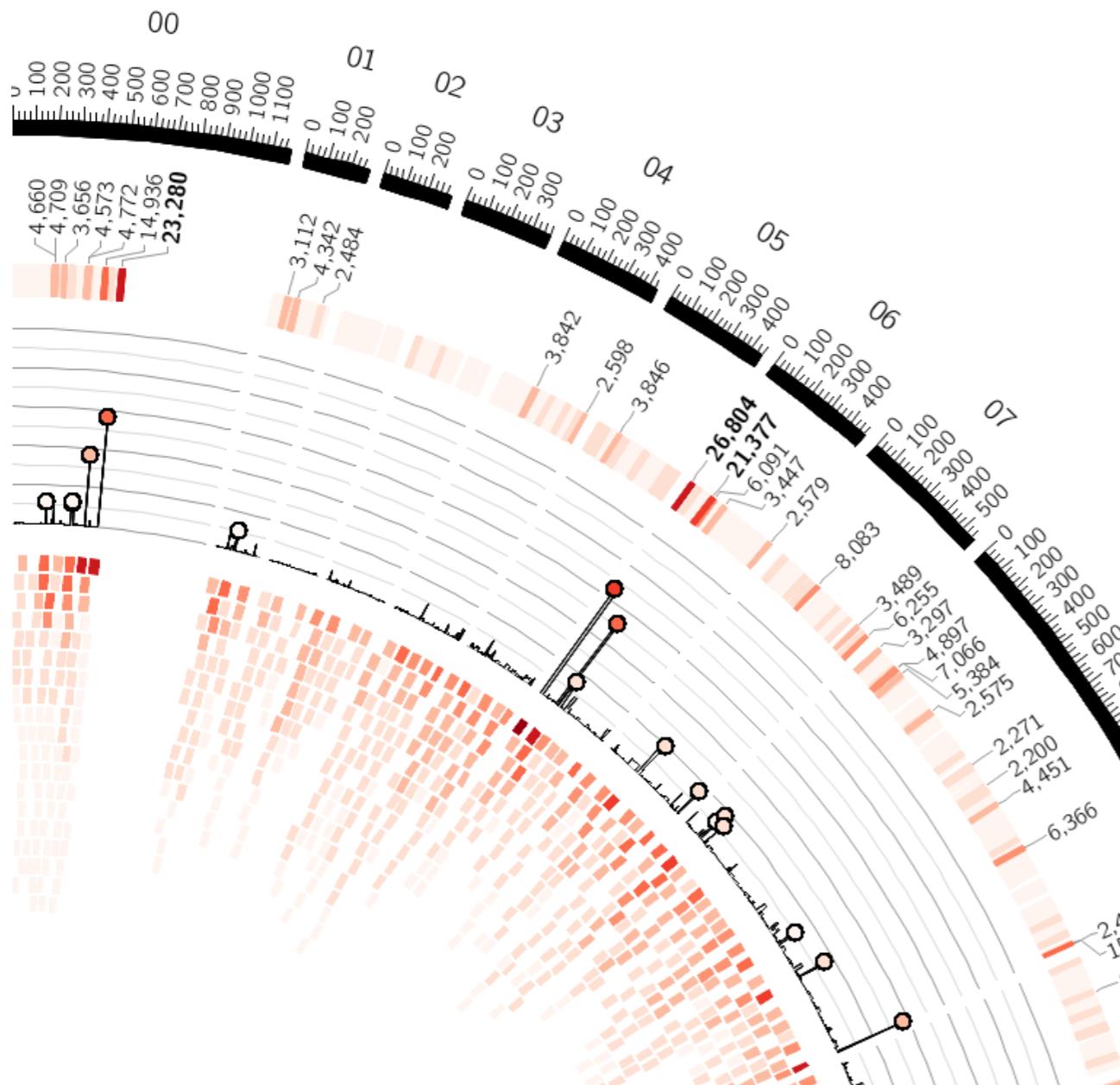
ideogram filtering/cropping, parameter inheritance ideogram color

LESSON 8

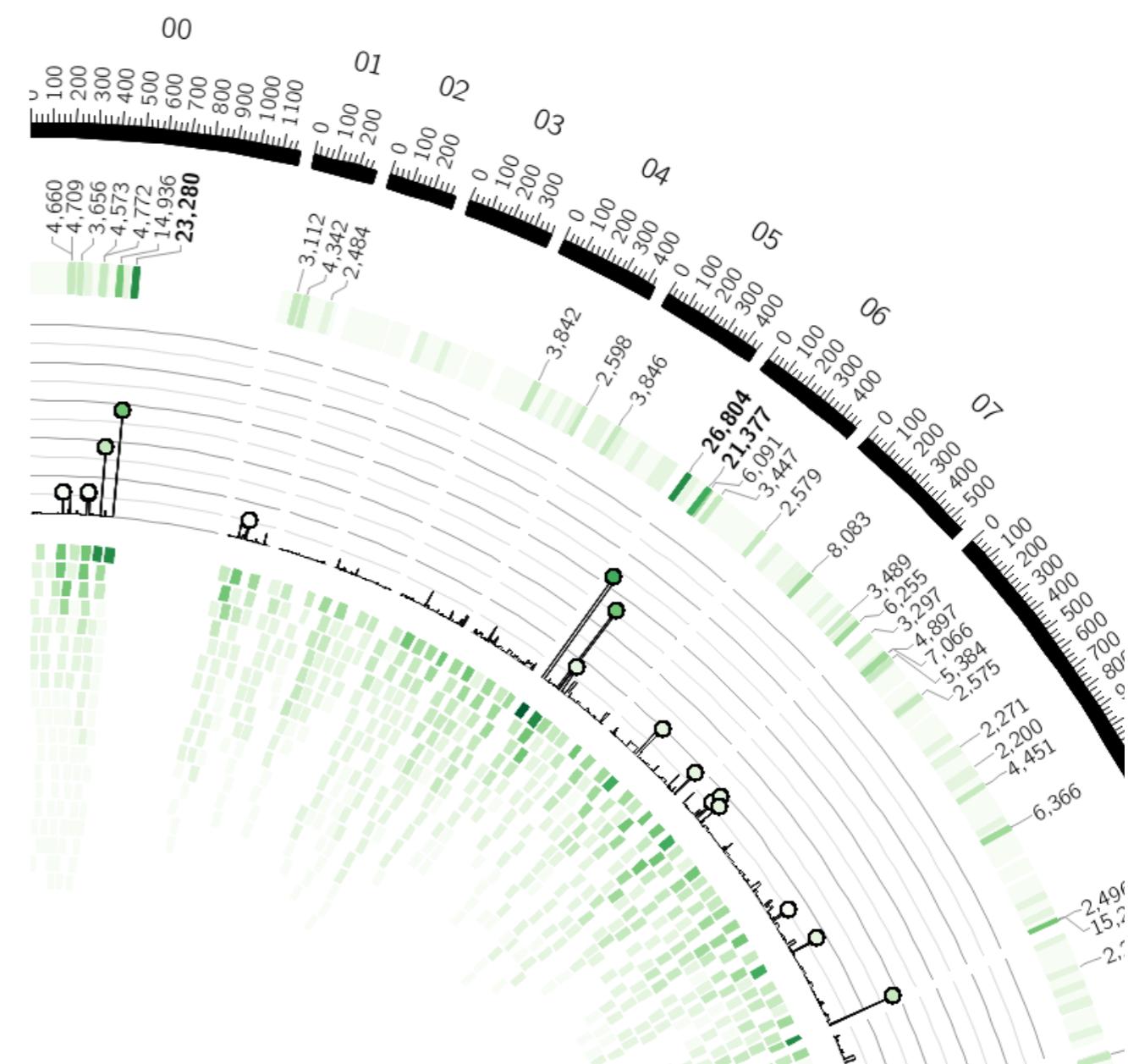
PARAMETER INHERITANCE—CONT'D

```
<plots>  
  
<plot>  
type = histogram  
file = conf(datadir)/lm.exp.ah063.txt  
color = reds-8-seq  
...  
</plot>  
  
<plot>  
type = heatmap  
file = conf(datadir)/lm.exp.ah063.txt  
color = reds-8-seq  
...  
</plot>  
  
<plot>  
type = scatter  
file = conf(datadir)/lm.exp.ah063.txt  
color = reds-8-seq  
...  
</plot>  
  
...  
  
</plots>  
  
<plots>  
  
<plot>  
file = conf(datadir)/lm.exp.ah063.txt  
color = reds-8-seq  
  
<plot>  
type = histogram  
...  
</plot>  
  
<plot>  
type = heatmap  
...  
</plot>  
  
<plot>  
type = scatter  
...  
</plot>  
  
...  
  
</plots>
```

PARAMETER INHERITANCE



```
<plots>  
colors = reds-8-seq  
...
```



```
<plots>  
colors = greens-8-seq  
...
```

PARAMETER INHERITANCE

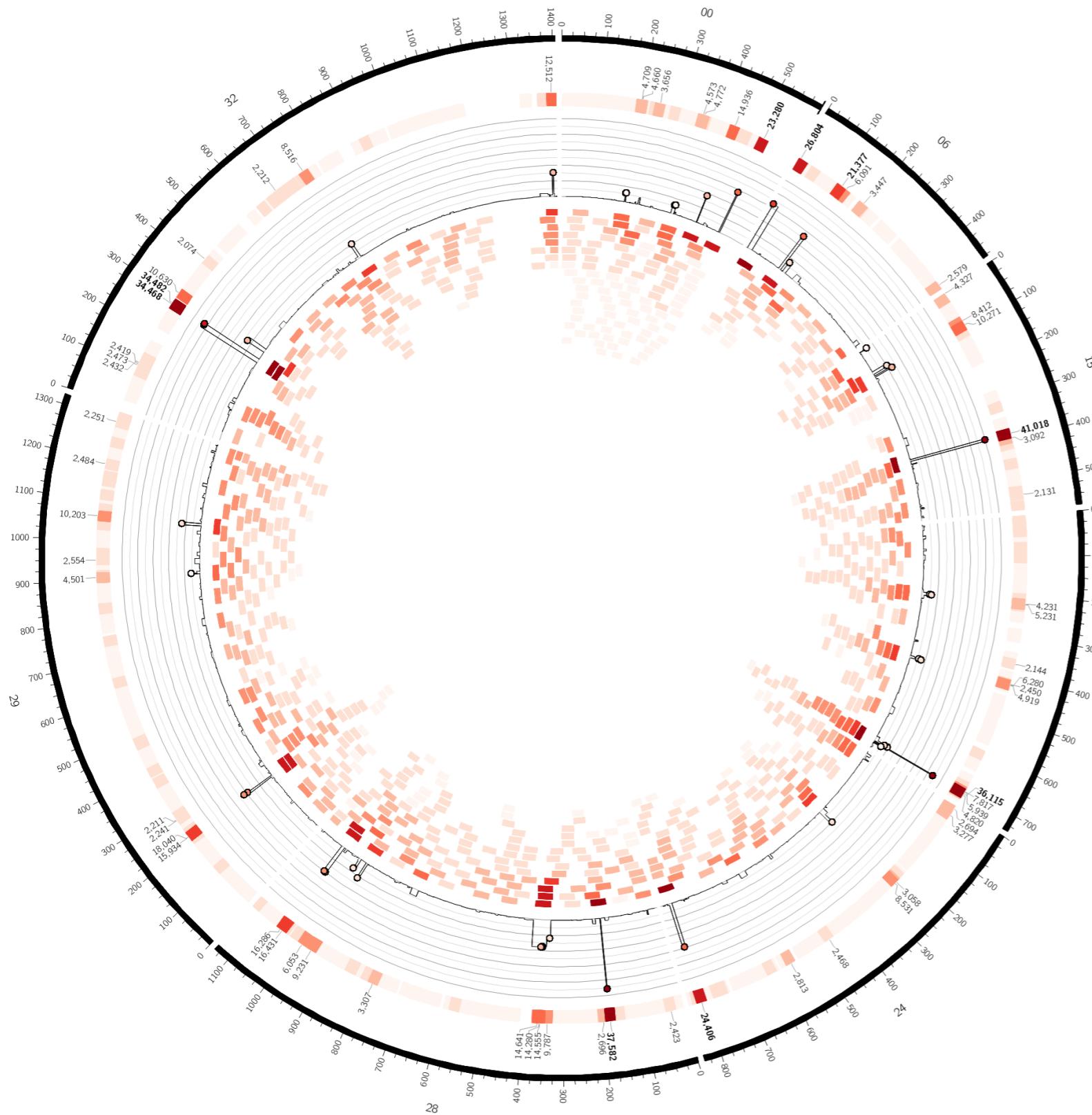
```
scheme = reds  
  
<plots>  
color = reds-8-seq  
  
...  
  
# you can now change the color scheme on  
# the command line  
> circos -param scheme=reds  
> circos -param scheme=greens  
> circos -param scheme=blues
```

FILTERING AND CROPPING IDEOGRAMS

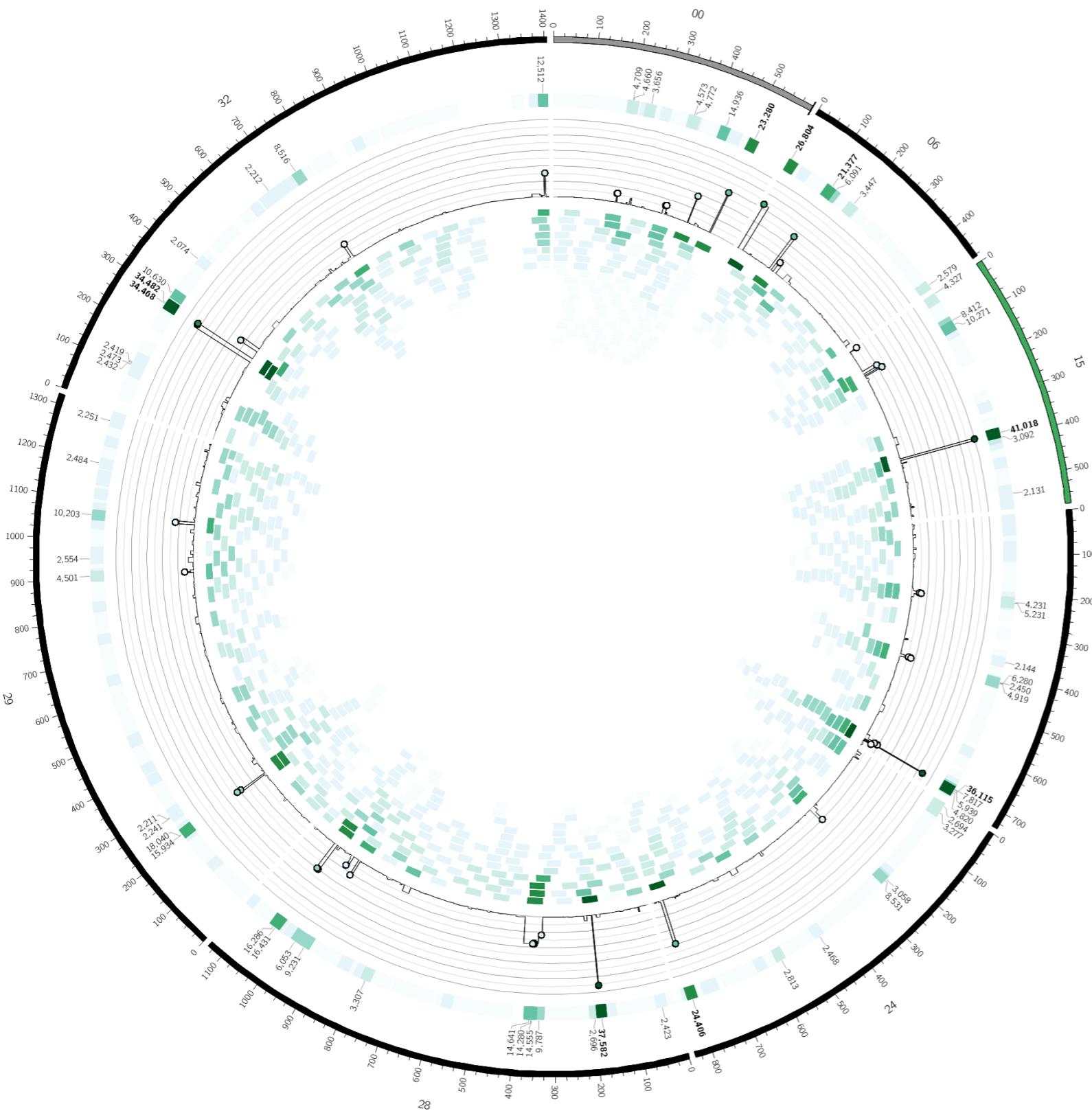
6/8/etc/circos.conf

chromosomes_display_default = no

chromosomes = LmxM.00:0-600;
LmxM.06;
LmxM.15; LmxM.21; LmxM.24;
LmxM.28; LmxM.29; LmxM.32



FILTERING AND CROPPING IDEOGRAMS



6/8/etc/circos.conf

chromosomes_display_default = no

more convenient selection of
ideograms with /REGEXP/

chromosomes = /00/:0-600;
/06/;/15/;/2[1489]/;/32/

chromosomes_color = /00/=grey;/15/=dgreen

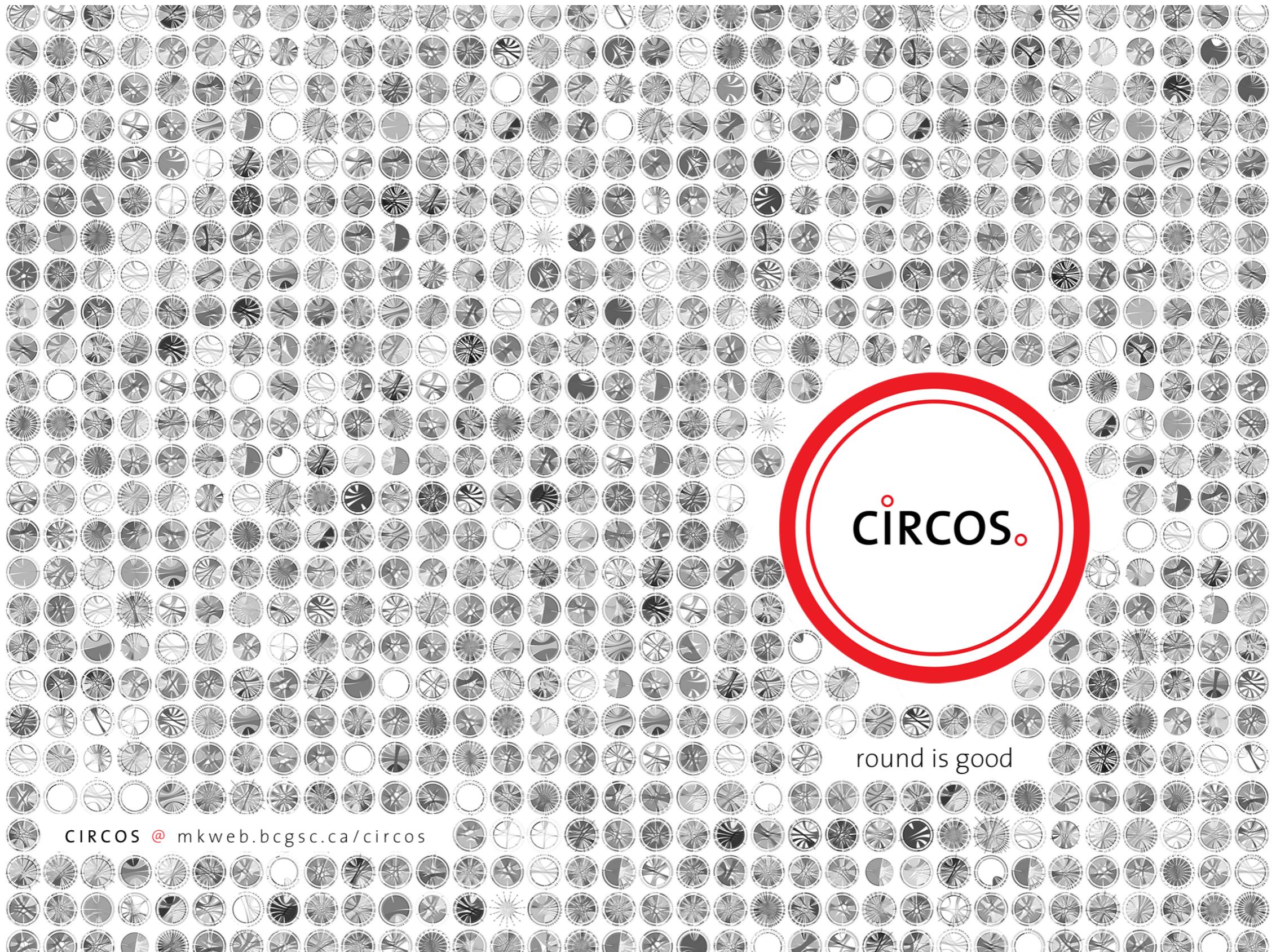
try it with a different color scheme
buggn - blue-green sequential palette
(refer to color handout)

> circos -param scheme=buggn

CIRCOS PLAY TIME



```
# randomize all colors,  
# except black and white  
> circos -random black,white
```



CIRCOS @ mkweb.bcgsc.ca/circos