Intro to R for Biologists
Session 5
Data Visualisation

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INTRO TO R FOR BIOLOGISTS

▶ **Data Visualisation**

  ▶ Plotting continued from Session 4

  ▶ Statistics

  ▶ Problem set from Session 4

  ▶ Heatmaps

  ▶ Colours

  ▶ Q & A

Basic statistics

- Correlations – `cor(), cor.test()`
- T-test (parametric):
o   Unpaired 2-group t-test

`t.test(y~x)` # where y is numeric and x is a binary factor

`t.test(y1,y2)` # where y1 and y2 are numeric

o   Paired 2-group t-test

`t.test(y1,y2, paired=TRUE)` # where y1 & y2 are numeric

- Non-parametric tests:
o   Unpaired 2-group Mann-Whitney U Test

`wilcox.test(y~A)` # where y is numeric and A is A binary factor

`wilcox.test(y,x)` # where y and x are numeric

o   Paired 2-group Wilcoxon Signed Rank Test

`wilcox.test(y1,y2, paired=TRUE)` # where y1 and y2 are numeric

- More than 2 groups - analysis of variance (ANOVA, parametric)

`aov(), anova()`

Adding statistics to the plots

```
library(ggpubr)
```

- Perform the test

```
compare_means(formula,   data,   method   =
   "wilcox.test", paired = FALSE, group.by =
   NULL, ref.group = NULL, ...)
```

*method = "t.test", "anova"

- Or just add the significance levels to the plot

```
stat_compare_means(mapping = NULL,
comparisons = NULL, hide.ns = FALSE, label =
NULL, label.x = NULL, label.y = NULL, ...)
```

Adding statistics to the plots - alternatively

```
library(ggsignif)
stat_signif(mapping = NULL, data = NULL,
position = "identity", na.rm = FALSE,
show.legend = NA, inherit.aes =
TRUE, comparisons = NULL, test =
"wilcox.test", test.args = NULL, annotations
= NULL, map_signif_level = FALSE ...)


map_signif_level = c("***"=0.001, "**"=0.01,
"*"=0.05)
```
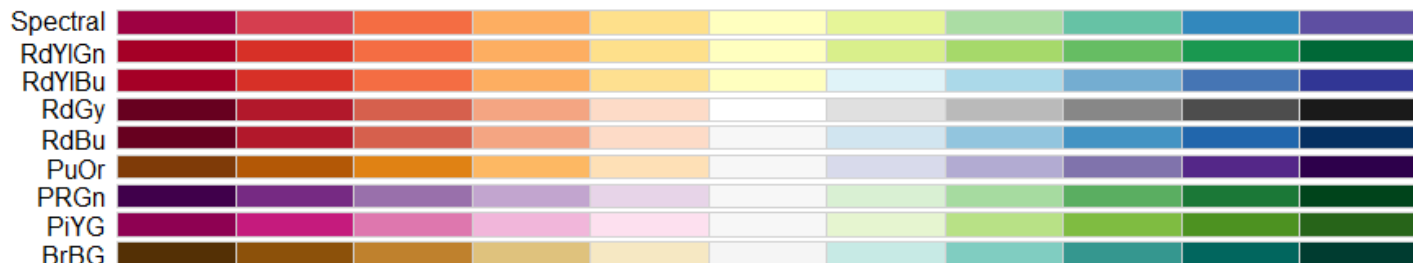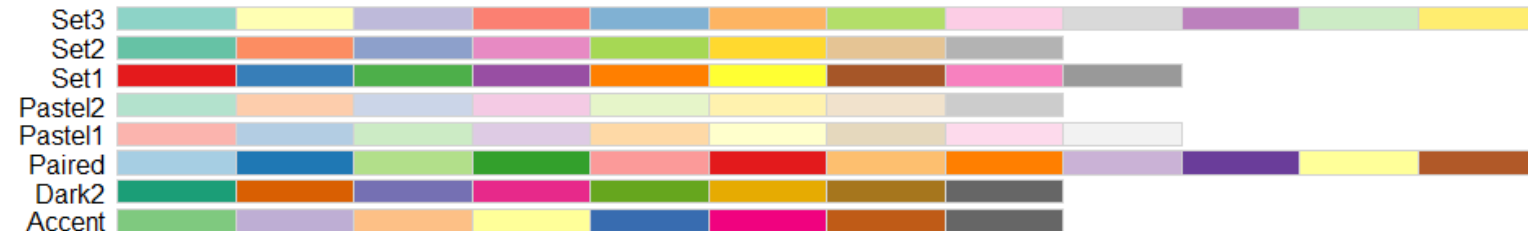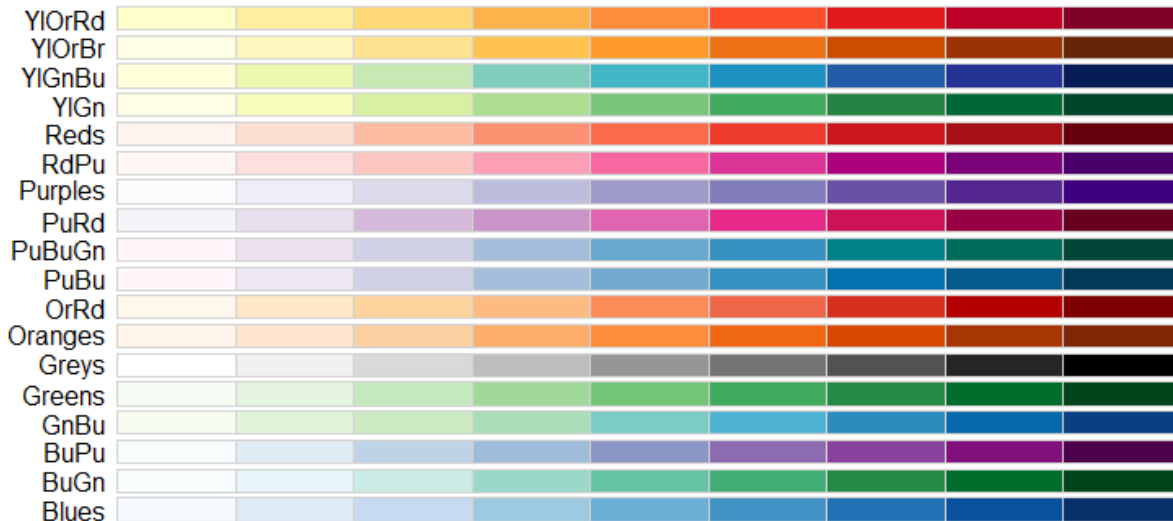
Let's explore practically

Colours in R

- Represented as named colours (e.g. "red", "mediumspringgreen") or hexadecimal code (e.g. "#FF0000FF", "#00FA9AFF")

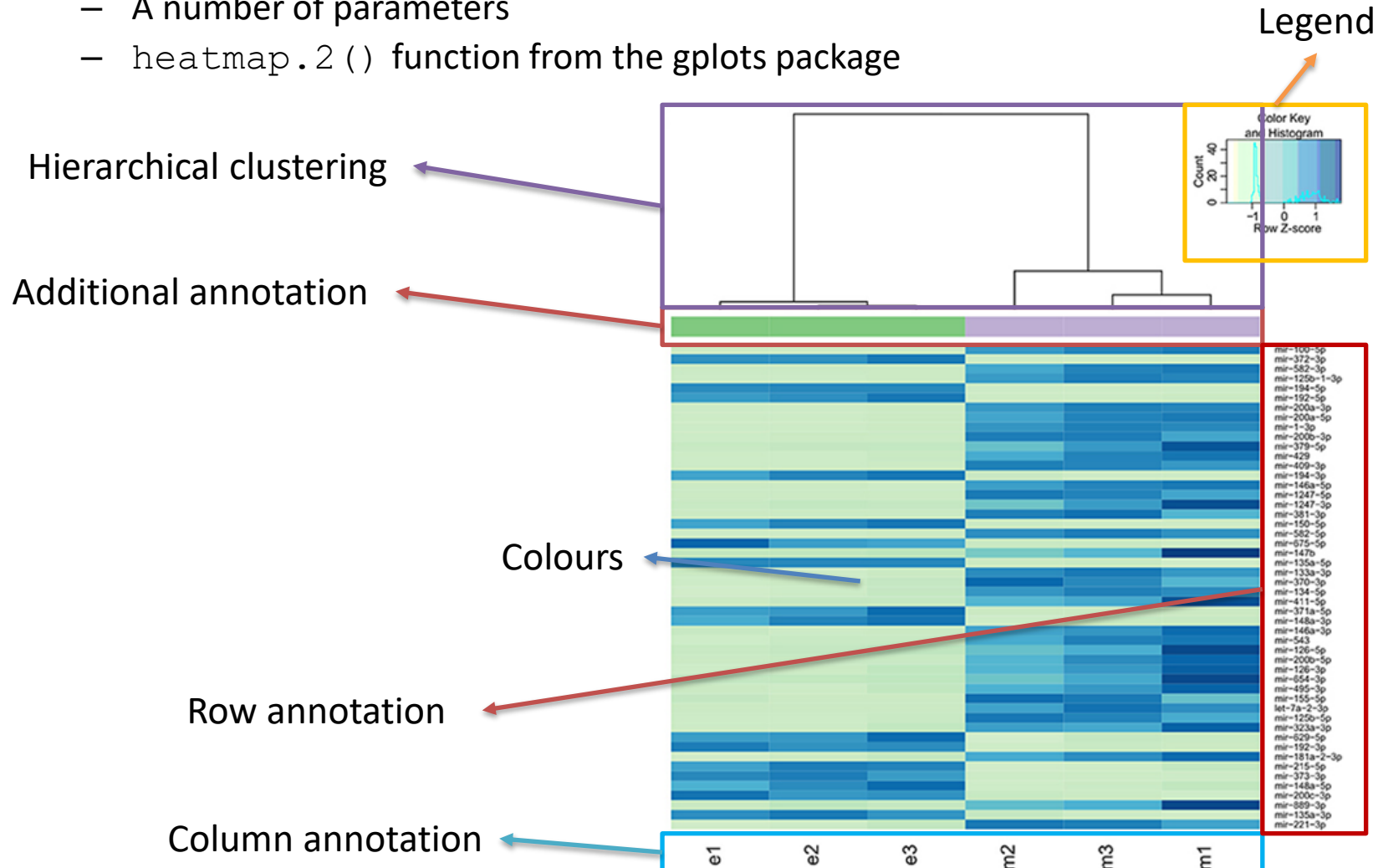|									
white	aliceblue	antiquewhite	antiquewhite1	antiquewhite2	antiquewhite3	antiquewhite4	aquamarine	aquamarine1	aquamarine2
aquamarine3	aquamarine4	azure	azure1	azure2	azure3	azure4	beige	bisque	bisque1
bisque2	bisque3	bisque4	blanchedalmond	blue	blue1	blue2	blue3	blue4	blueviolet
brown	brown1	brown2	brown3	brown4	burlywood	burlywood1	burlywood2	burlywood3	burlywood4
cadetblue	cadetblue1	cadetblue2	cadetblue3	cadetblue4	chartreuse	chartreuse1	chartreuse2	chartreuse3	chartreuse4
chocolate	chocolate1	chocolate2	chocolate3	chocolate4	coral	coral1	coral2	coral3	coral4
cornflowerblue	cornsilk	cornsilk1	cornsilk2	cornsilk3	cornsilk4	cyan	cyan1	cyan2	cyan3
cyan4	darkblue	darkcyan	darkgoldenrod	darkgoldenrod1	darkgoldenrod2	darkgoldenrod3	darkgoldenrod4	darkgray	darkgreen
darkgrey	darkkhaki	darkmagenta	darkolivegreen	darkolivegreen1	darkolivegreen2	darkolivegreen3	darkolivegreen4	darkorange	darkorange1
darkorange2	darkorange3	darkorange4	darkorchid	darkorchid1	darkorchid2	darkorchid3	darkorchid4	darkred	darksalmon
darkseagreen	darkseagreen1	darkseagreen2	darkseagreen3	darkseagreen4	darkslateblue	darkslategray	darkslategray1	darkslategray2	darkslategray3
darkslategray4	darkslategrey	darkturquoise	darkviolet	deeppink	deeppink1	deeppink2	deeppink3	deeppink4	deepskyblue
deepskyblue1	deepskyblue2	deepskyblue3	deepskyblue4	dimgray	dimgrey	dodgerblue	dodgerblue1	dodgerblue2	dodgerblue3
dodgerblue4	firebrick	firebrick1	firebrick2	firebrick3	firebrick4	floralwhite	forestgreen	gainsboro	ghostwhite
gold	gold1	gold2	gold3	gold4	goldenrod	goldenrod1	goldenrod2	goldenrod3	goldenrod4
gray	gray0	gray1	gray2	gray3	gray4	gray5	gray6	gray7	gray8
gray9	gray10	gray11	gray12	gray13	gray14	gray15	gray16	gray17	gray18
gray19	gray20	gray21	gray22	gray23	gray24	gray25	gray26	gray27	gray28
gray29	gray30	gray31	gray32	gray33	gray34	gray35	gray36	gray37	gray38
gray39	gray40	gray41	gray42	gray43	gray44	gray45	gray46	gray47	gray48
gray49	gray50	gray51	gray52	gray53	gray54	gray55	gray56	gray57	gray58
gray59	gray60	gray61	gray62	gray63	gray64	gray65	gray66	gray67	gray68
gray69	gray70	gray71	gray72	gray73	gray74	gray75	gray76	gray77	gray78
gray79	gray80	gray81	gray82	gray83	gray84	gray85	gray86	gray87	gray88
gray89	gray90	gray91	gray92	gray93	gray94	gray95	gray96	gray97	gray98
gray99	gray100	green	green1	green2	green3	green4	greenyellow	grey	grey0
grey1	grey2	grey3	grey4	grey5	grey6	grey7	grey8	grey9	grey10
grey11	grey12	grey13	grey14	grey15	grey16	grey17	grey18	grey19	grey20
grey21	grey22	grey23	grey24	grey25	grey26	grey27	grey28	grey29	grey30
grey31	grey32	grey33	grey34	grey35	grey36	grey37	grey38	grey39	grey40
grey41	grey42	grey43	grey44	grey45	grey46	grey47	grey48	grey49	grey50
grey51	grey52	grey53	grey54	grey55	grey56	grey57	grey58	grey59	grey60
grey61	grey62	grey63	grey64	grey65	grey66	grey67	grey68	grey69	grey70
grey71	grey72	grey73	grey74	grey75	grey76	grey77	grey78	grey79	grey80
grey81	grey82	grey83	grey84	grey85	grey86	grey87	grey88	grey89	grey90
grey91	grey92	grey93	grey94	grey95	grey96	grey97	grey98	grey99	grey100
honeydew	honeydew1	honeydew2	honeydew3	honeydew4	hotpink	hotpink1	hotpink2	hotpink3	hotpink4
indianred	indianred1	indianred2	indianred3	indianred4	ivory	ivory1	ivory2	ivory3	ivory4
khaki	khaki1	khaki2	khaki3	khaki4	lavender	lavenderblush	lavenderblush1	lavenderblush2	lavenderblush3
lavenderblush4	lawngreen	lemonchiffon	lemonchiffon1	lemonchiffon2	lemonchiffon3	lemonchiffon4	lightblue	lightblue1	lightblue2
lightblue3	lightblue4	lightcoral	lightcyan	lightcyan1	lightcyan2	lightcyan3	lightgoldenrod	lightgoldenrod1	lightgoldenrod2
lightgoldenrod3	lightgoldenrod4	lightgoldenrodyellow	lightgray	lightgreen	lightgrey	lightpink	lightpink1	lightpink2	lightpink3
lightpink4	lightsalmon	lightsalmon1	lightsalmon2	lightsalmon3	lightsalmon4	lightseagreen	lightskyblue	lightskyblue1	lightskyblue2
lightskyblue3	lightskyblue4	lightslateblue	lightslategray	lightslategrey	lightsteelblue	lightsteelblue1	lightsteelblue2	lightsteelblue3	lightsteelblue4
lightyellow	lightyellow1	lightyellow2	lightyellow3	lightyellow4	limegreen	linen	magenta	magenta1	magenta2
magenta3	magenta4	maroon	maroon1	maroon2	maroon3	maroon4	mediumaquamarine	mediumblue	mediumorchid
mediumorchid1	mediumorchid2	mediumorchid3	mediumorchid4	mediumpurple	mediumpurple1	mediumpurple2	mediumpurple3	mediumpurple4	mediumseagreen
mediumslateblue	mediumspringgreen	mediumturquoise	mediumvioletred	midnightblue	mintcream	mistyrose	mistyrose1	mistyrose2	mistyrose3
mistyrose4	moccasin	navajowhite	navajowhite1	navajowhite2	navajowhite3	navajowhite4	navy	navyblue	oldlace
olivedrab	olivedrab1	olivedrab2	olivedrab3	olivedrab4	orange	orange1	orange2	orange3	orange4
orangered	orangered1	orangered2	orangered3	orangered4	orchid	orchid1	orchid2	orchid3	orchid4
palegoldenrod	palegreen	palegreen1	palegreen2	palegreen3	palegreen4	paleturquoise	paleturquoise1	paleturquoise2	paleturquoise3
paleturquoise4	palevioletred	palevioletred1	palevioletred2	palevioletred3	palevioletred4	papayawhip	peachpuff	peachpuff1	peachpuff2
peachpuff3	peachpuff4	peru	pink	pink1	pink2	pink3	pink4	plum	plum1
plum2	plum3	plum4	powderblue	purple	purple1	purple2	purple3	purple4	red
red1	red2	red3	red4	rosybrown	rosybrown1	rosybrown2	rosybrown3	rosybrown4	royalblue
royalblue1	royalblue2	royalblue3	royalblue4	saddlebrown	salmon	salmon1	salmon2	salmon3	salmon4
sandybrown	seagreen	seagreen1	seagreen2	seagreen3	seagreen4	seashell	seashell1	seashell2	seashell3
seashell4	sienna	sienna1	sienna2	sienna3	sienna4	skyblue	skyblue1	skyblue2	skyblue3
skyblue4	slateblue	slateblue1	slateblue2	slateblue3	slateblue4	slategray	slategray1	slategray2	slategray3
slategray4	slategrey	snow	snow1	snow2	snow3	snow4	springgreen	springgreen1	springgreen2
springgreen3	springgreen4	steelblue	steelblue1	steelblue2	steelblue3	steelblue4	tan	tan1	tan2
tan3	tan4	thistle	thistle1	thistle2	thistle3	thistle4	tomato	tomato1	tomato2
tomato3	tomato4	turquoise	turquoise1	turquoise2	turquoise3	turquoise4	violet	violetred	violetred1
violetred2	violetred3	violetred4	wheat	wheat1	wheat2	wheat3	wheat4	whitesmoke	yellow
yellow1	yellow2	yellow3	yellow4	yellowgreen					

Colours in R

- Palettes – a set of colours that can be used together
- RColorBrewer package
  - Sequential
  - Qualitative
  - Diverging
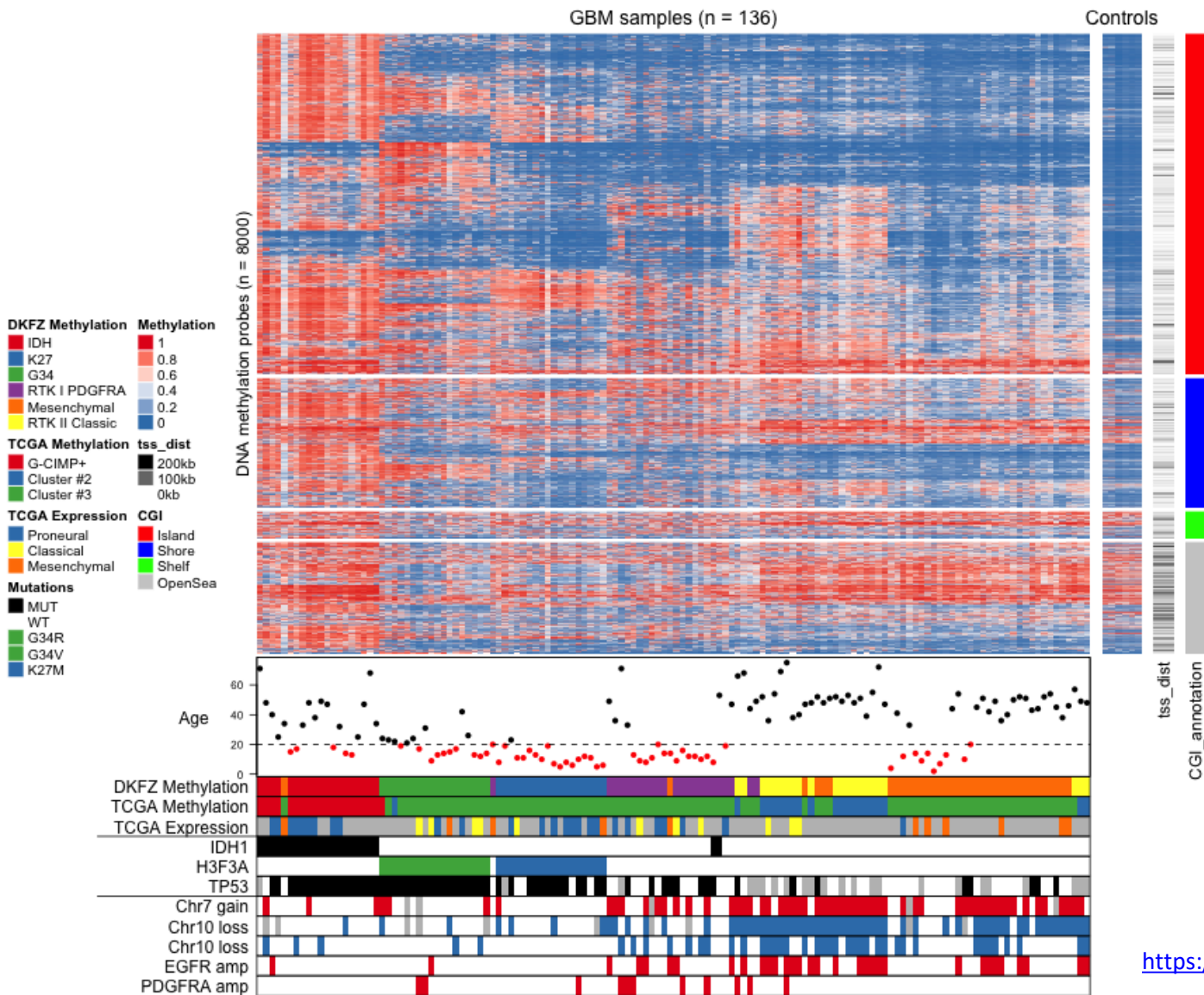- https://github.com/Emil Hvitfeldt/r-color-palettes for a huge list of palettes and the packages they come in

Heatmaps

- Useful for displaying multidimensional data
  - A number of parameters
  - `heatmap.2()` function from the gplots package

Legend

Hierarchical clustering

Additional annotation

Colours

Row annotation

Column annotation

A lot of information can be conveyed!

- A more complicated example with the Complex Heatmap package

Let's explore practically

Let's explore practically

Address the tasks in breakout rooms!

Useful references

- https://github.com/EmilHvitfeldt/r-color-palettes - a huge list of R palettes

- https://colorbrewer2.org/ - RColorBrewer package based on this tool by Cynthia Brewer

- https://jokergoo.github.io/ComplexHeatmap-reference/book/ - R package to produce Complex Heatmaps