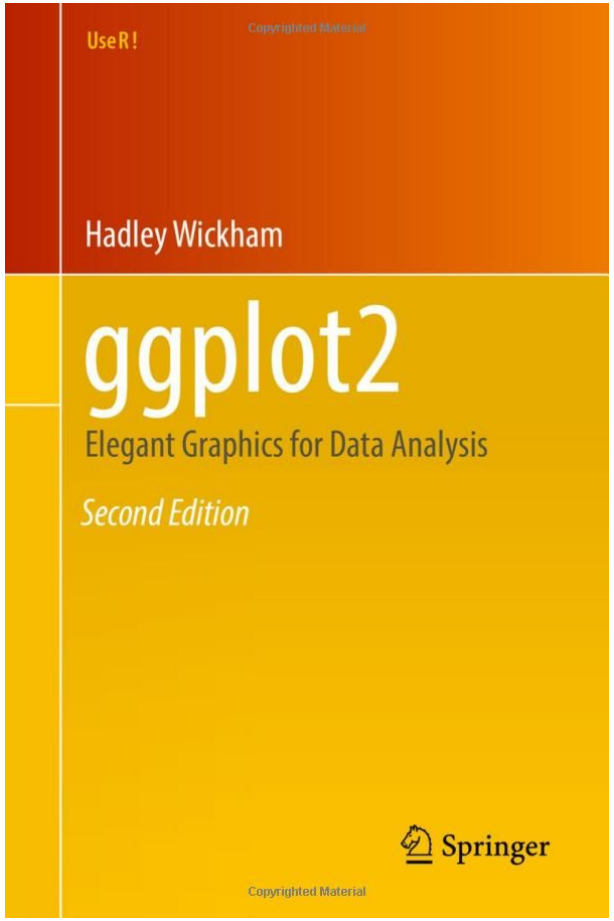
Trực quan hóa dữ liệu bằng ngôn ngữ lập trình R

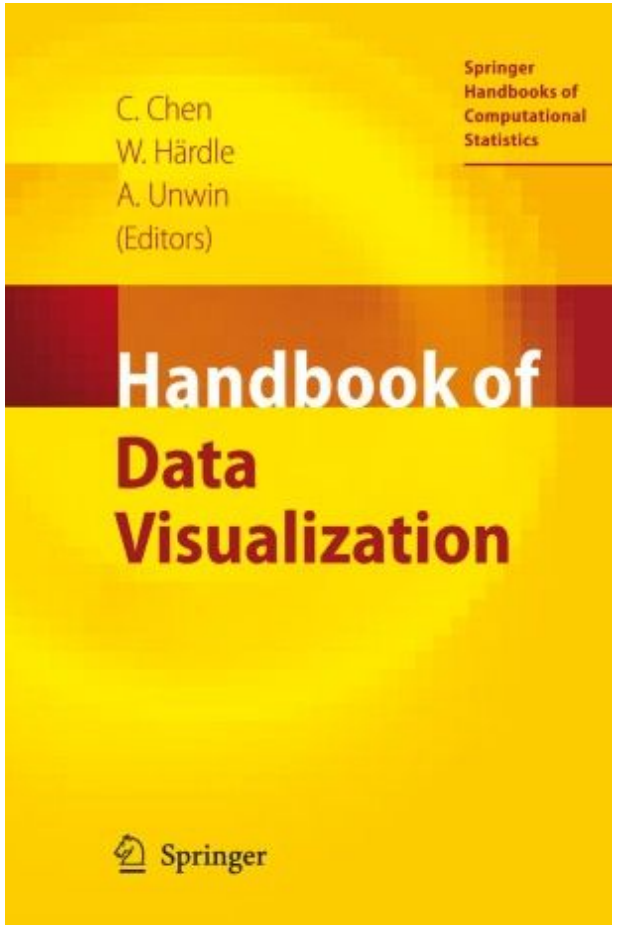
TS. Lưu Phúc Lợi,
Trưởng Phòng Nghiên cứu khoa học, Viện Ariha
Bệnh viện Thống Nhất

Jan 11, 2026

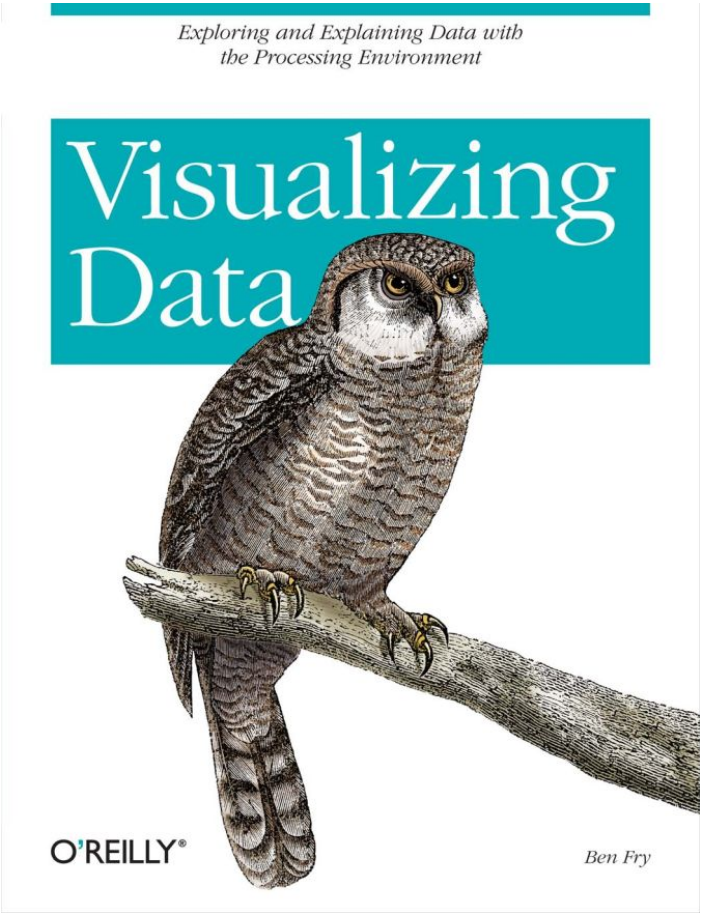
Books, slides, exercises and solutions to exercises



https://ggplot2-book.org/index.html
(GGP)



https://link.springer.com/book/10.1007/978-3-540-33037-0
(HDV)



https://www.iaacblog.com/programs/books-about-data-visualization/
(VD)

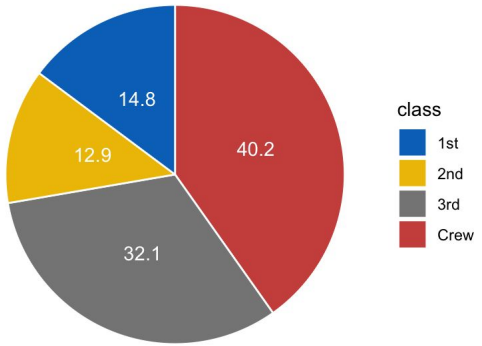
Roadmap of today lecture

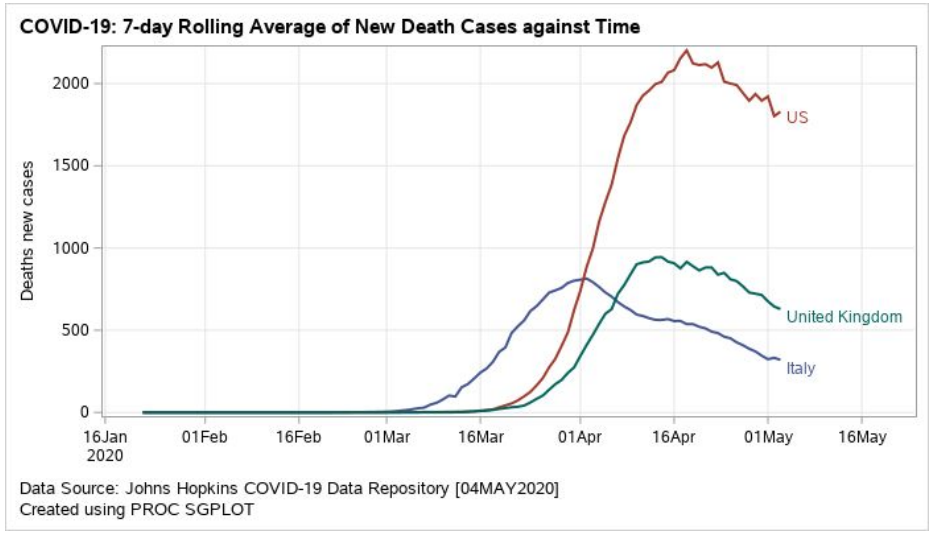
- Overview of basic plots
- Types of plots
- Visualizing Images in pathology
- Why Do We Visualize Data?
- Student Projects

Basic Plots

1. Table
2. Bar/pie/waterfall plot
3. Boxplot
4. Histogram/density/violin
5. Variant of boxplot/histogram/density/violin/cloud
6. Parallel plot and its variants
7. Heatmap
8. Dendrogram
9. Venn diagram
10. Upset plot
11. Forest plot
12. Survival plot
13. Volcano and MA plot
14. Scatter plot
15. Dot plot
16. Time series plot
17. Spatial/ Map/Location plot
18. Hexabin/contour plot
19. ROC curve
20. RMSE
21. Circos plot
22. Hexanbin plot
23. Maths plot
24. Radar plot

Pie + Bar + Water Fall + Time plot





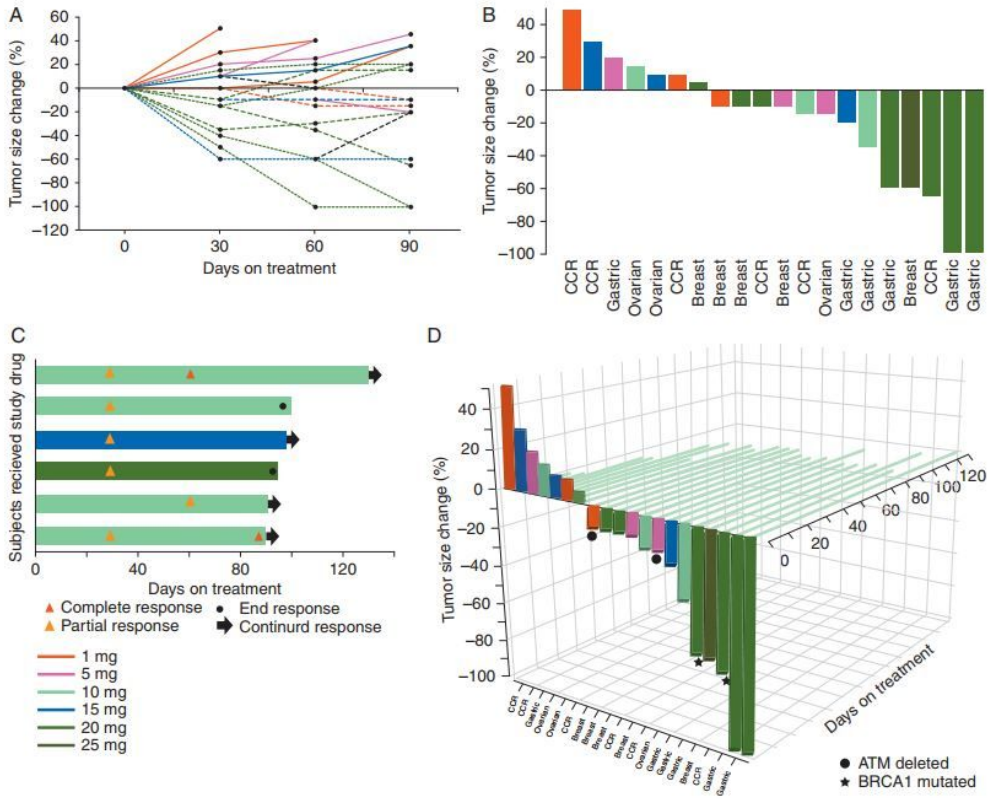


Figure 1 (A) Spider plot, (B) classical (2D) waterfall plot, (C) swimmer plot and (D) 3D waterfall plot.

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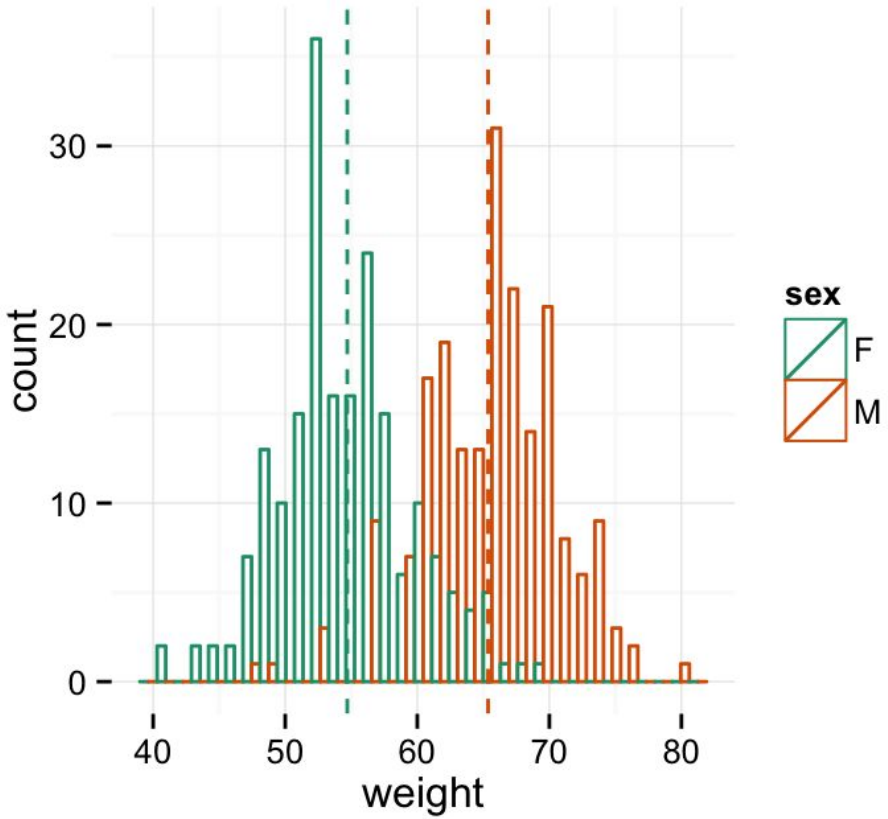
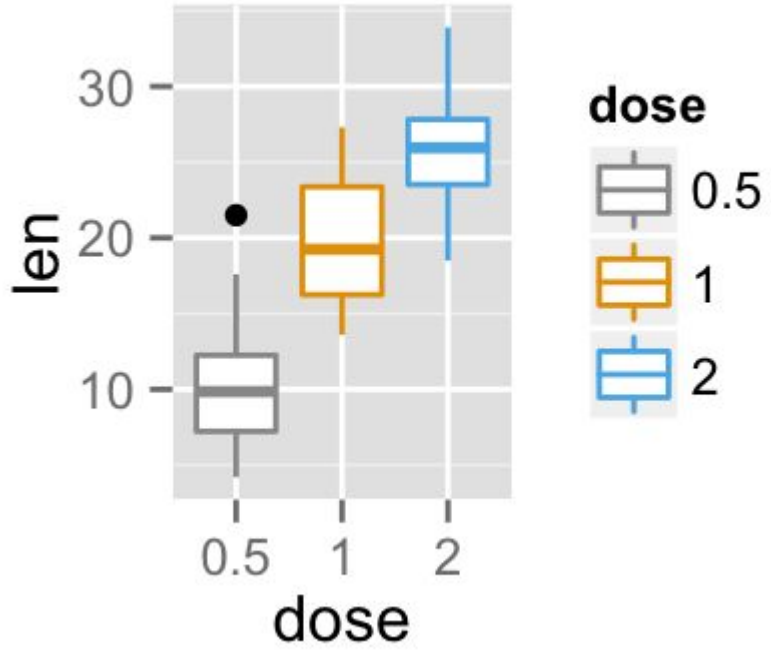
10.1093/annonc/mdw656

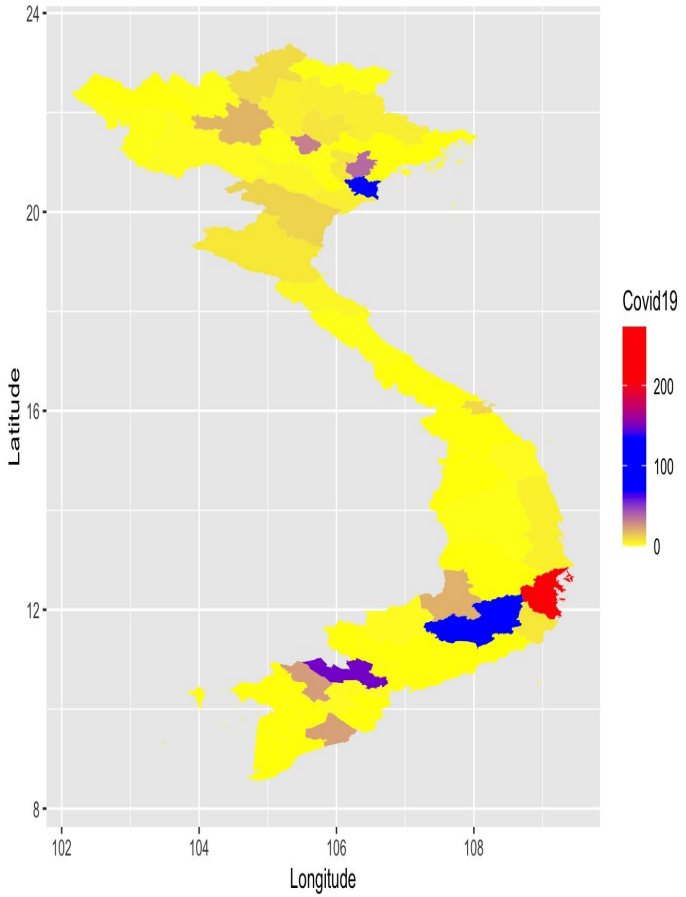
Boxplot and Histogram

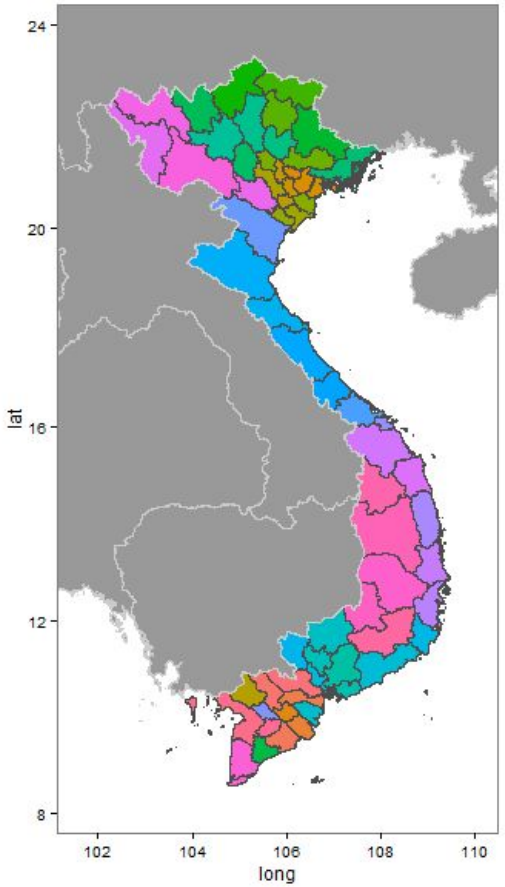




10.1093/annonc/mdw656

Map and location plots

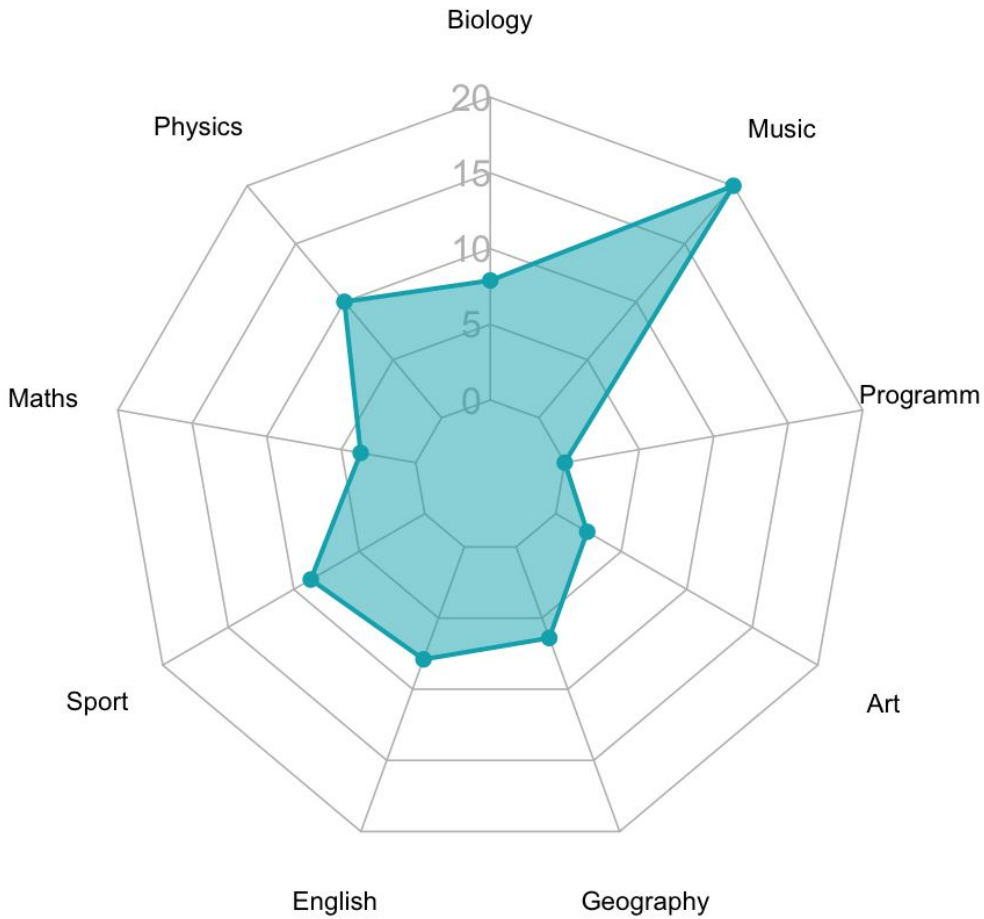




https://rpubs.com/nguyet/647153

https://stackoverflow.com/questions/26914616/r-how-to-add-border-countries-to-a-country-spatialpolygons-map

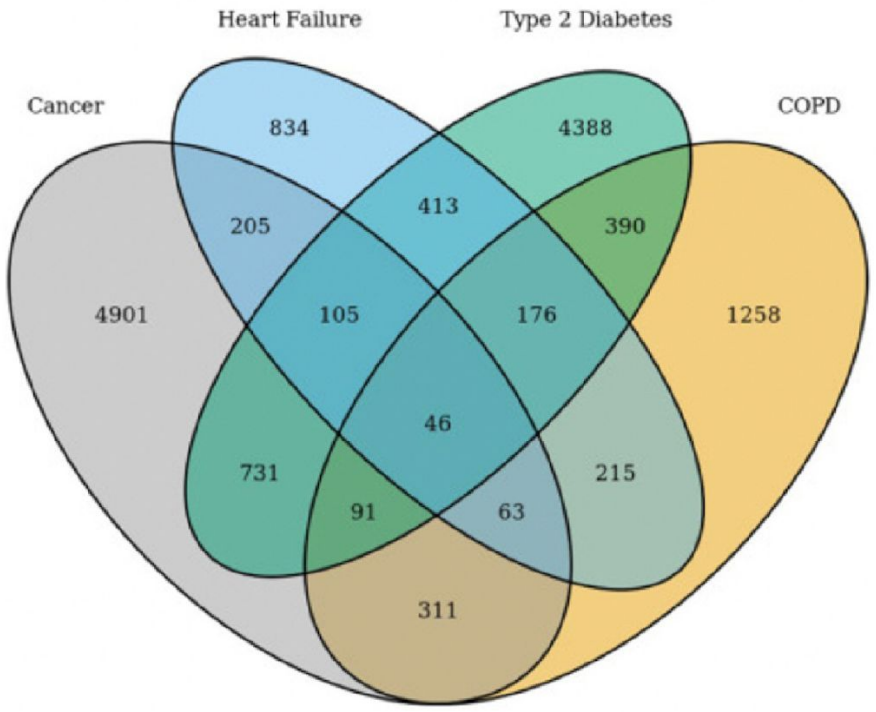
Radar plot



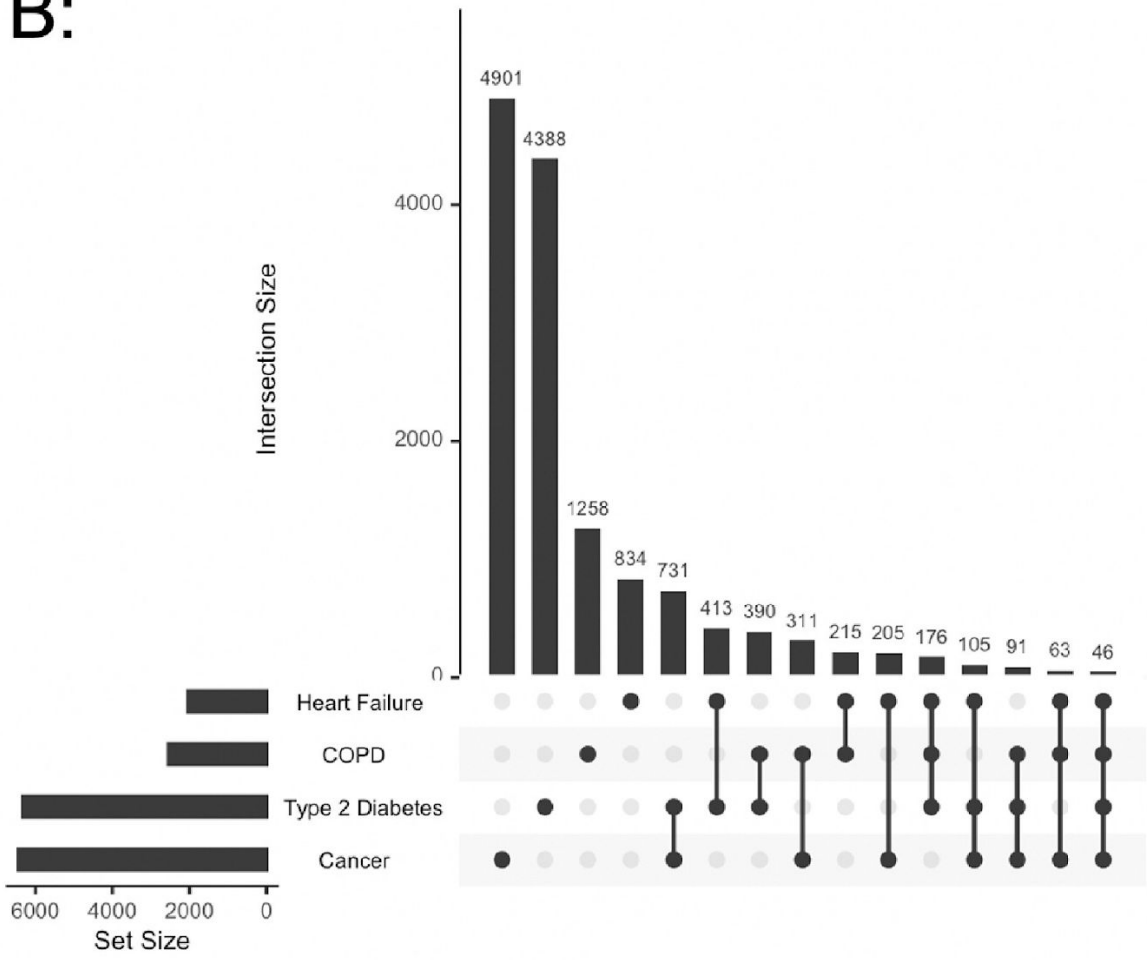
https://www.datanovia.com/en/blog/beautiful-radar-chart-in-r-using-fmsb-and-ggplot-packages/

Ven Diagram and Upset plot

A:

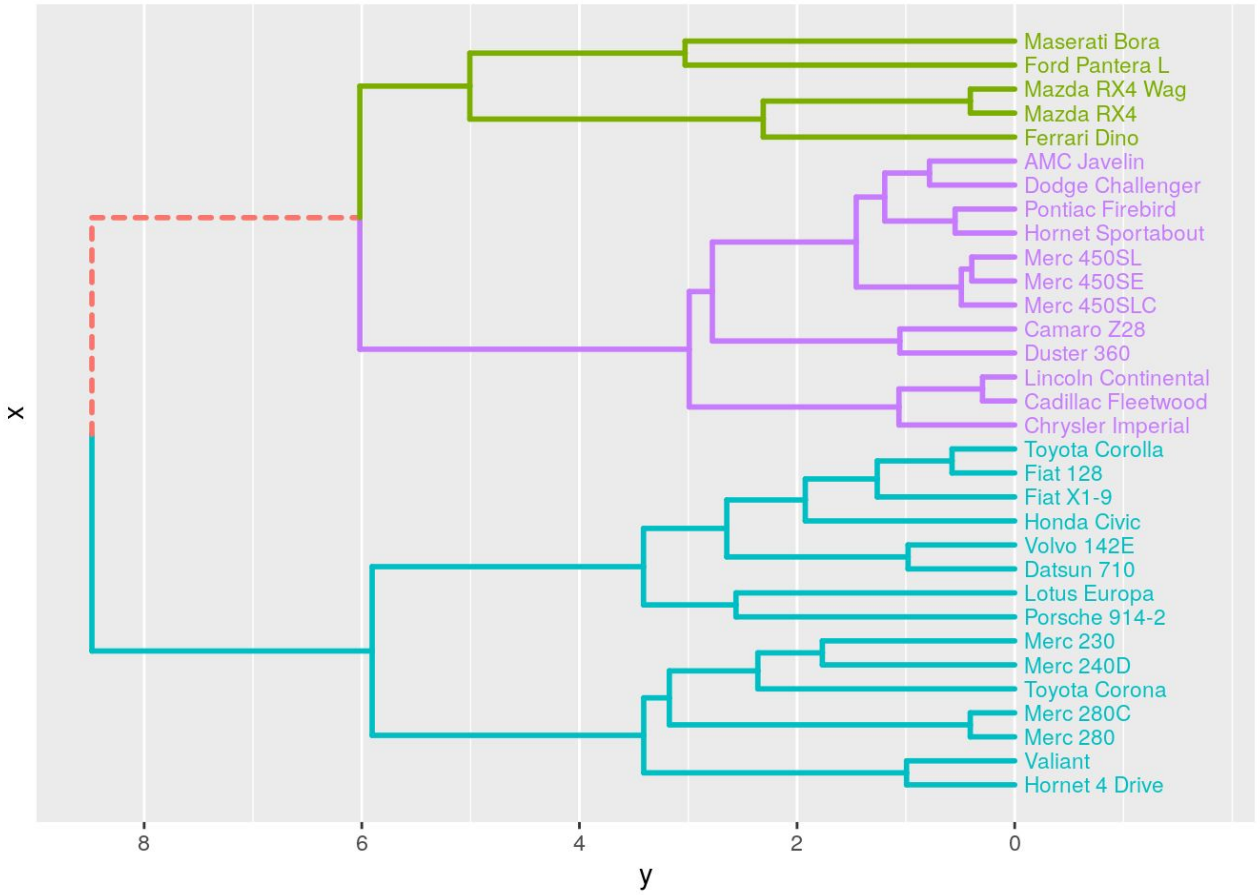


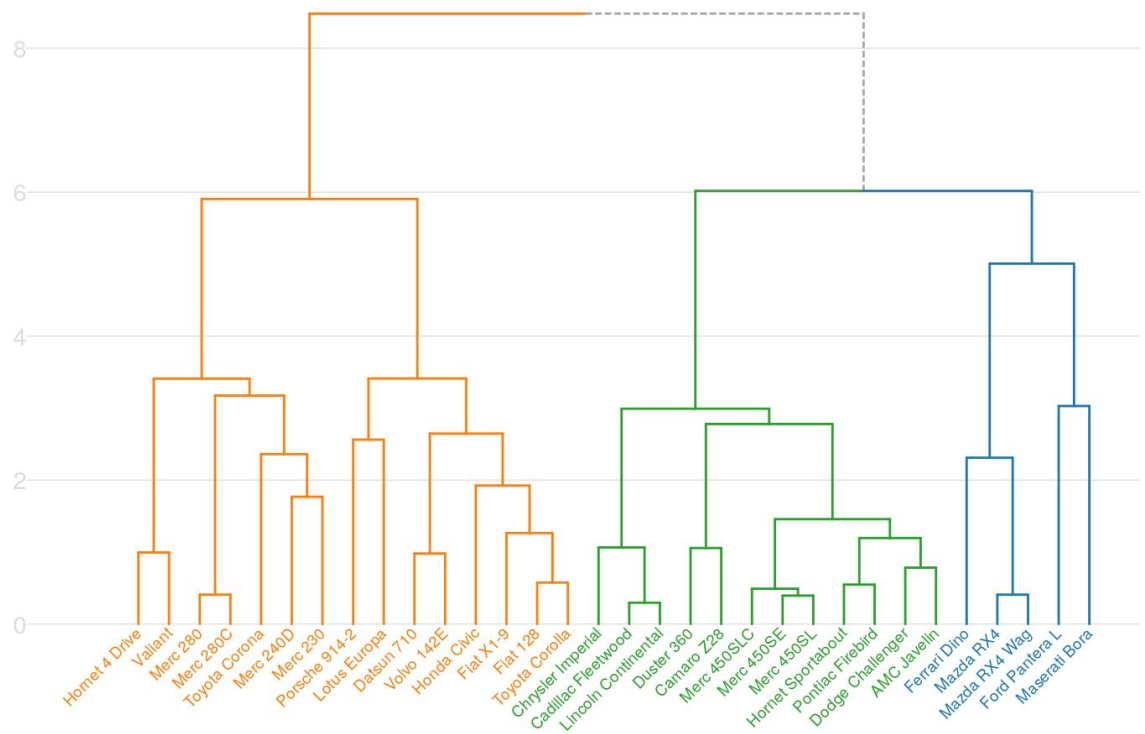
B:



https://www.jpsmjournal.com/article/S0885-3924(22)01010-7/fulltext

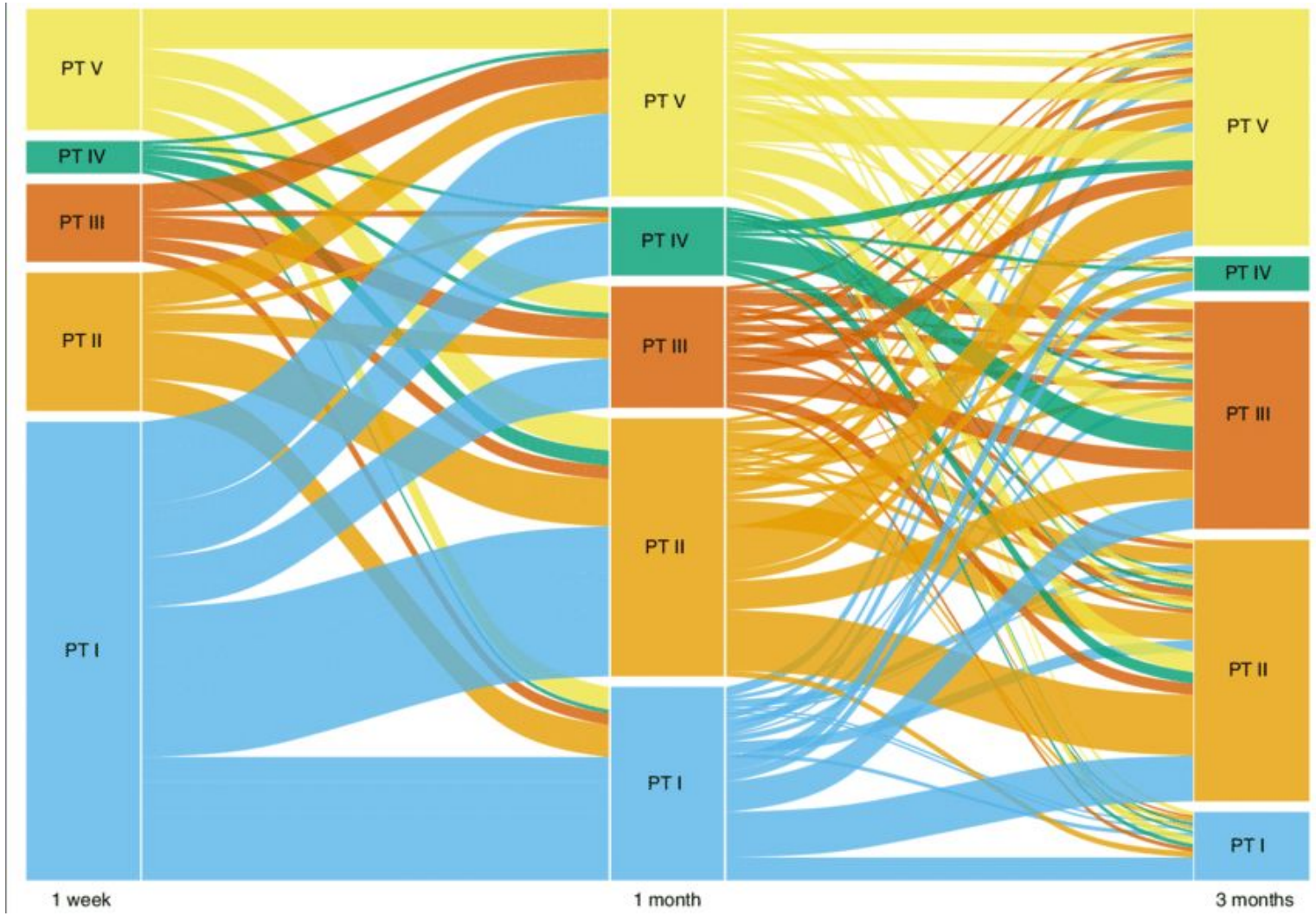
Dendrogram





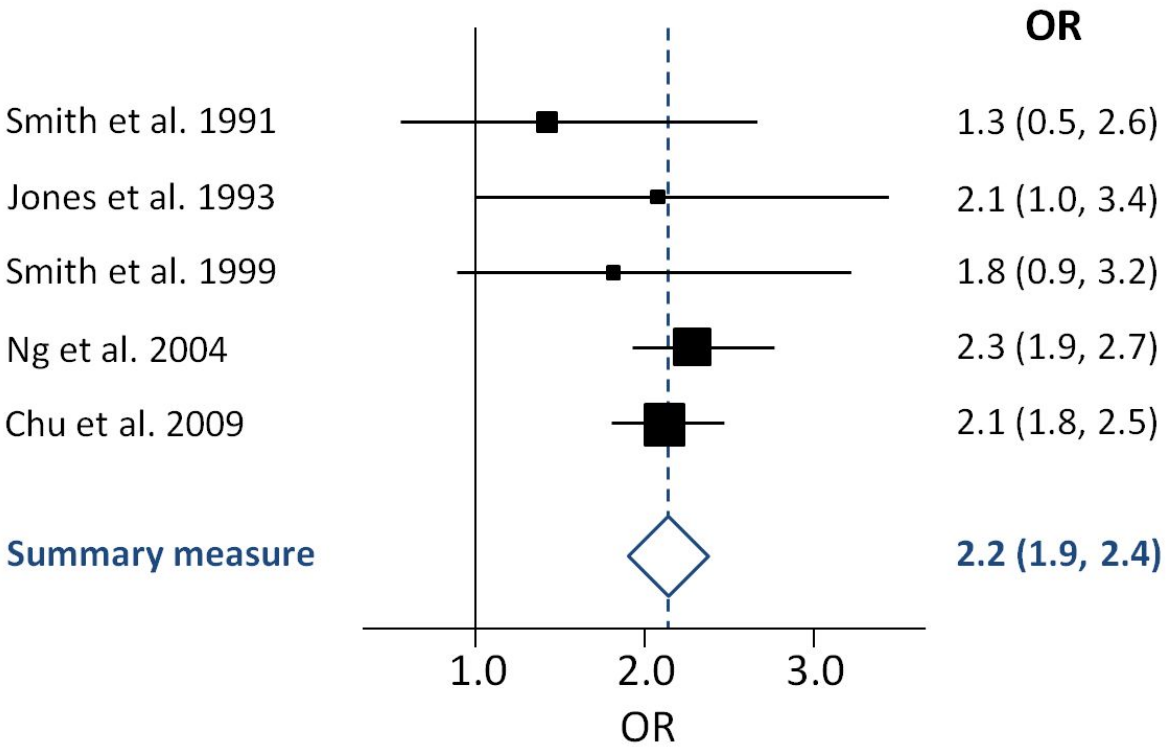
https://atrebas.github.io/post/2019-06-08-lightweight-dendrograms/

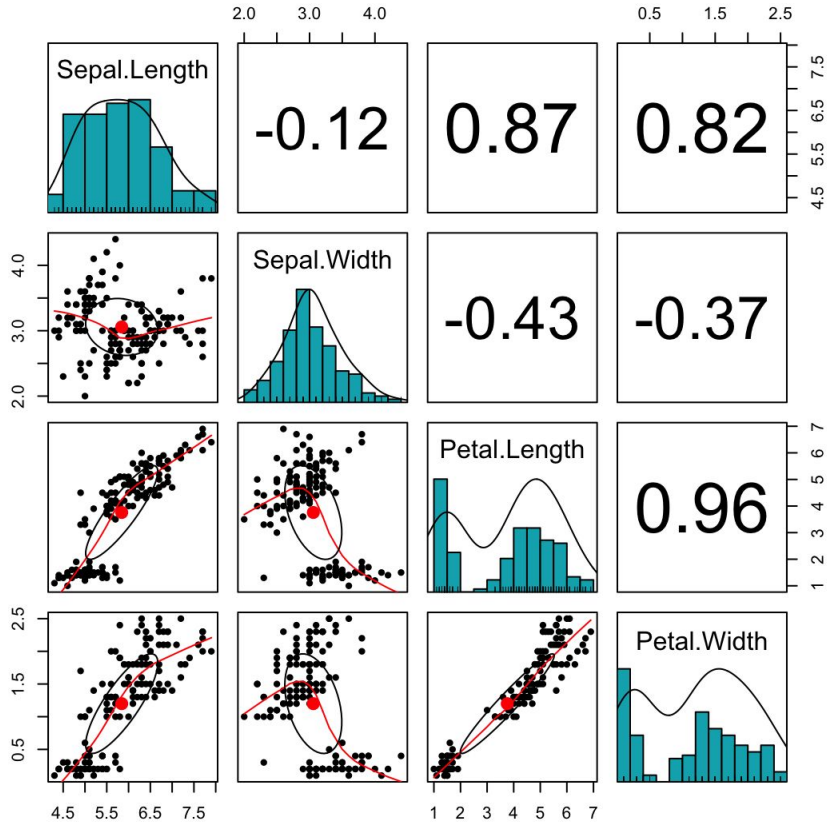
Alluvial Plot



https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-016-0215-9

Forest plot vs matrix plot

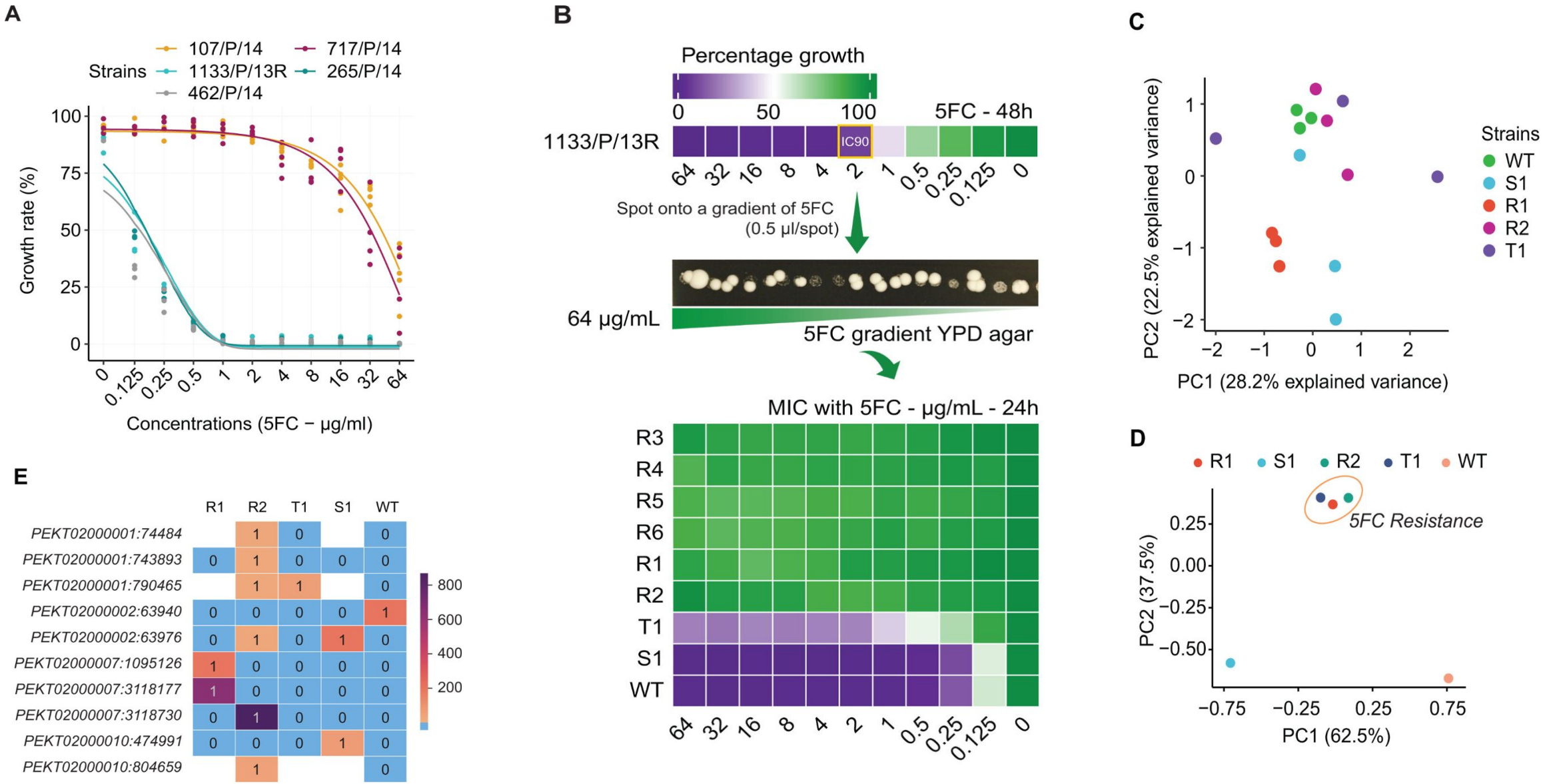




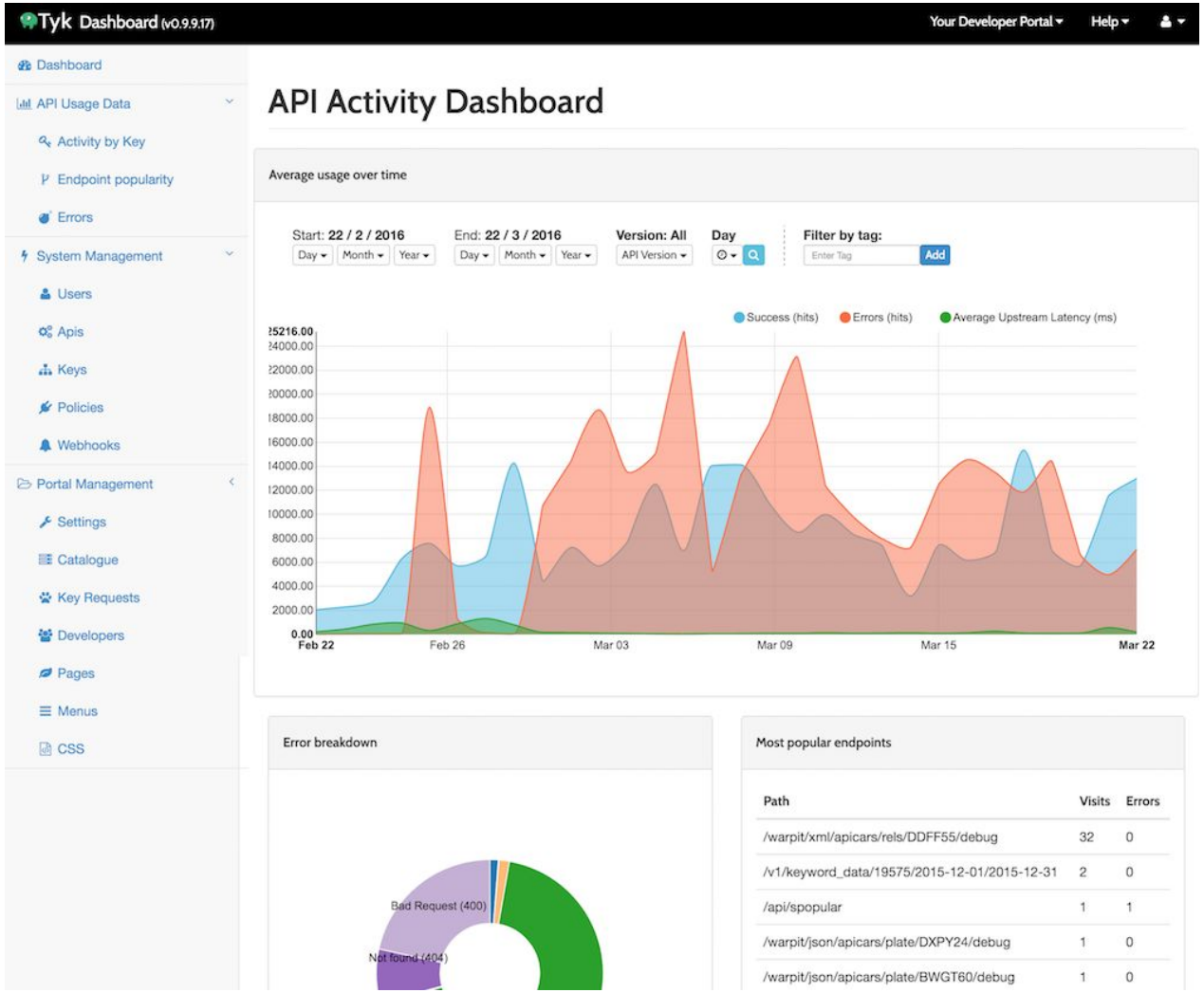
https://en.wikipedia.org/wiki/Forest_plot

http://www.sthda.com/english/wiki/scatter-plot-matrices-r-base-graphs

In vitro evolution of 5FC resistance in *C. auris*

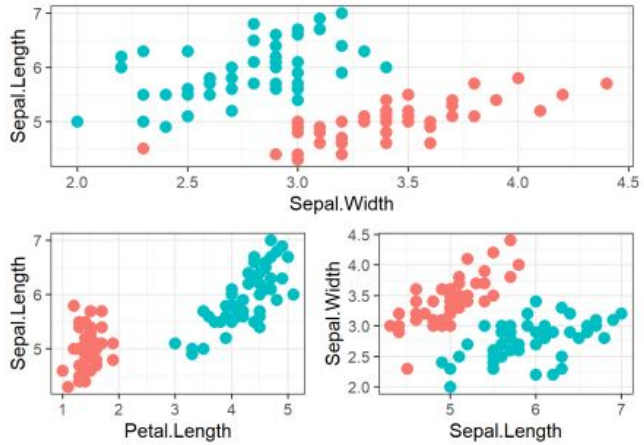


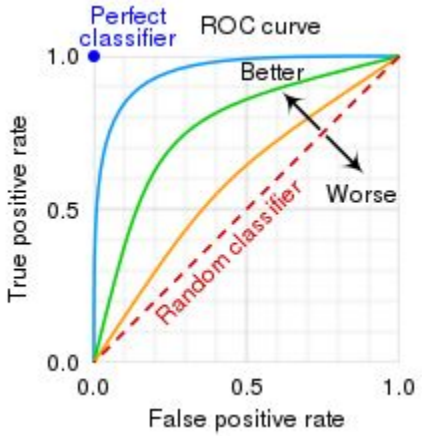
Dashboard with Tyk/Tableau

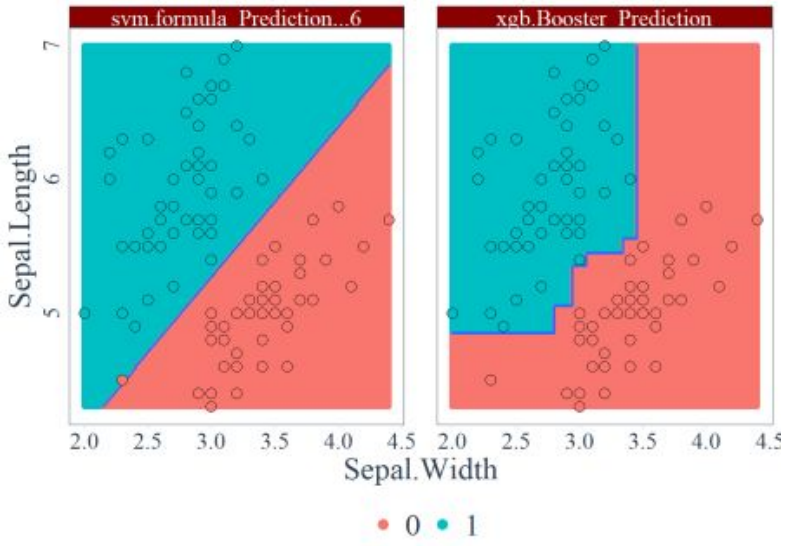


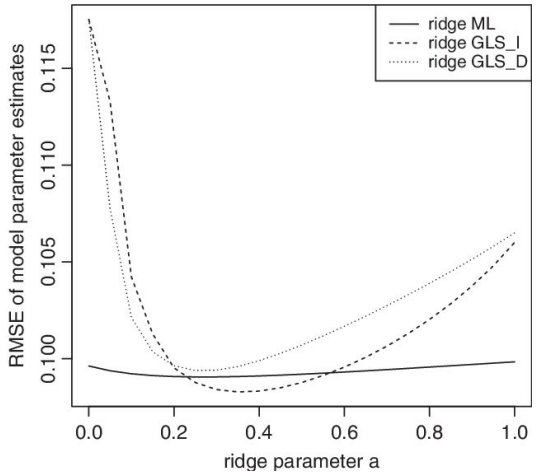
https://www.youtube.com/watch?v=BmInbeEkDPs&list=PLjCJtqjjSdAf9_xJzdaakpGKGBO8rGs-c&index=9

Data visualization for machine learning

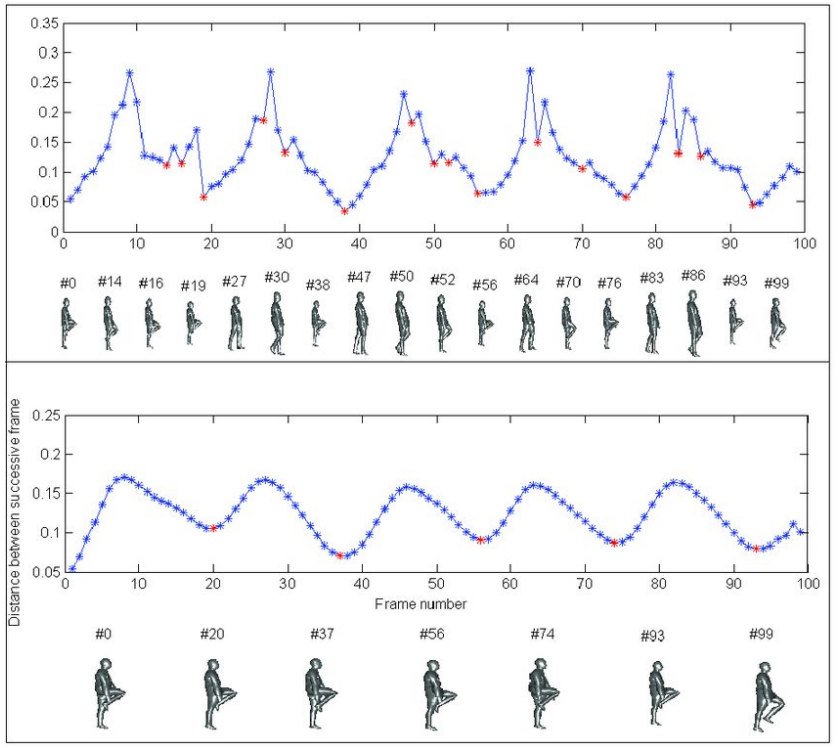






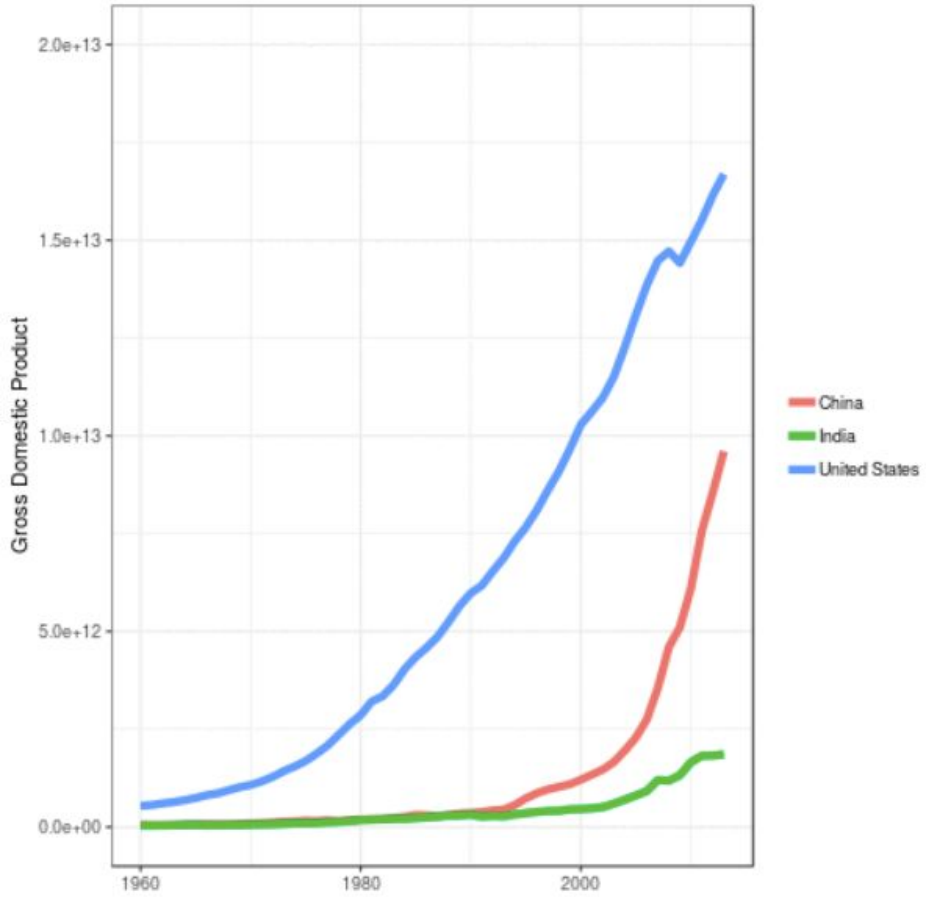


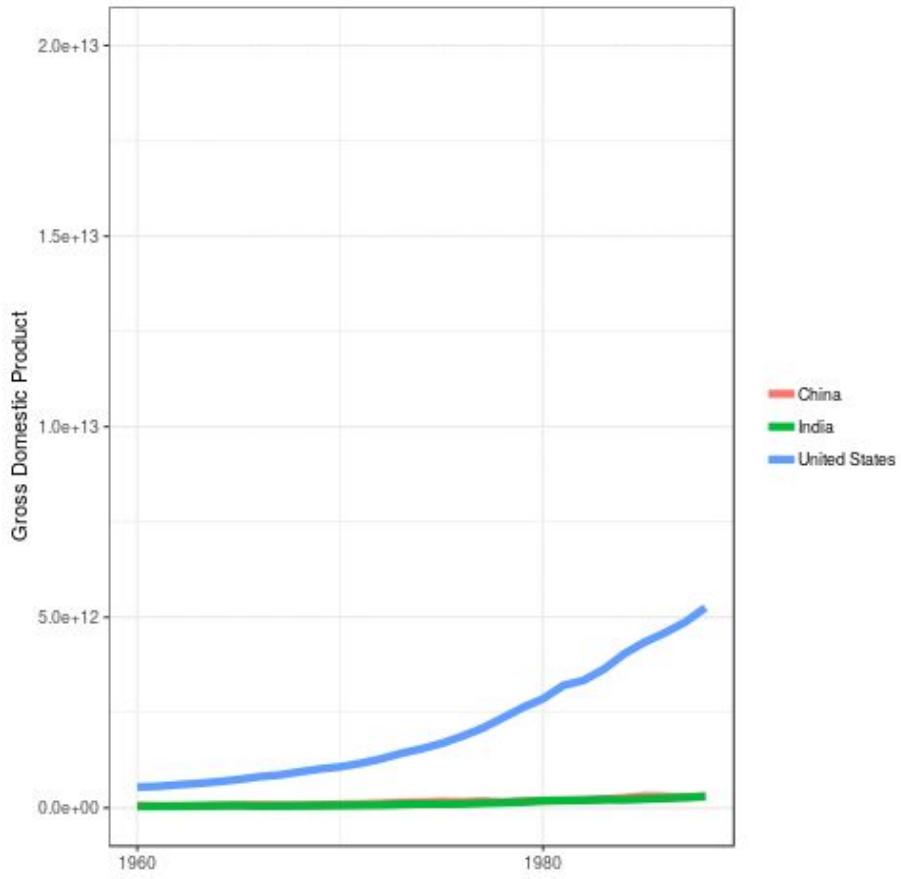
10.1080/10705511.2015.1077335



Speed curve smoothing: (top) speed curve before smoothing, (bottom) speed curve after smoothing. https://hal.archives-ouvertes.fr/tel-01094740/file/RimSlamaThesis2014.pdf

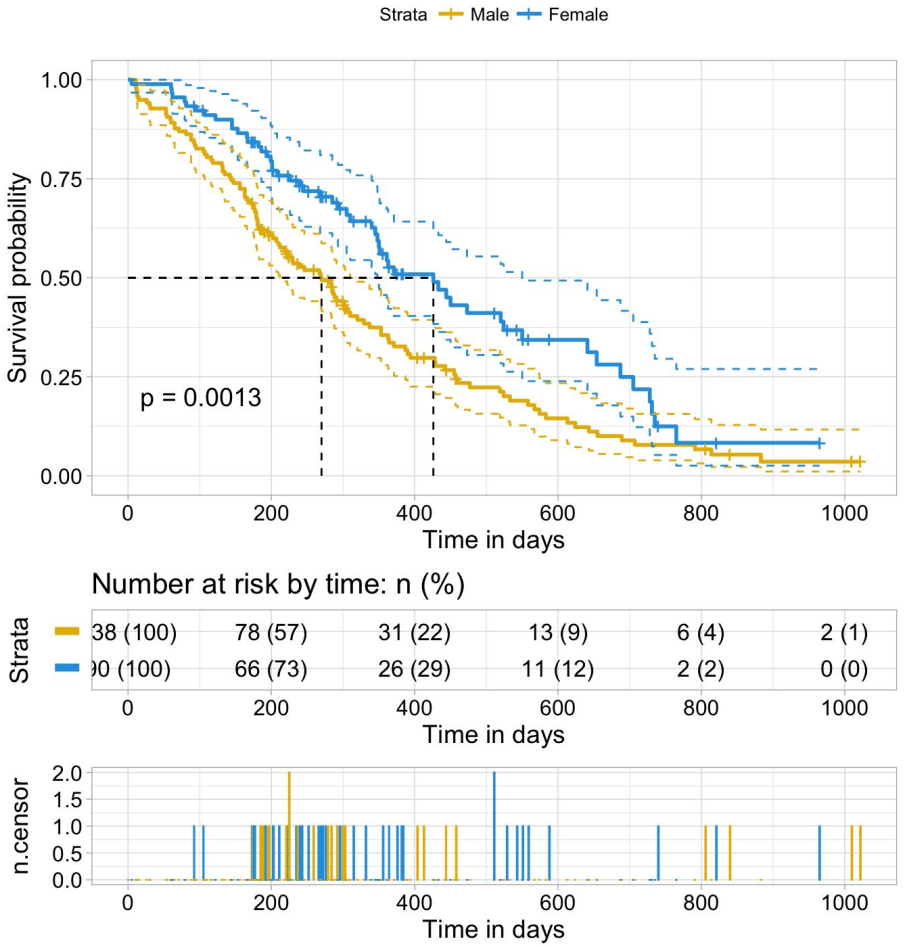
Amination plot





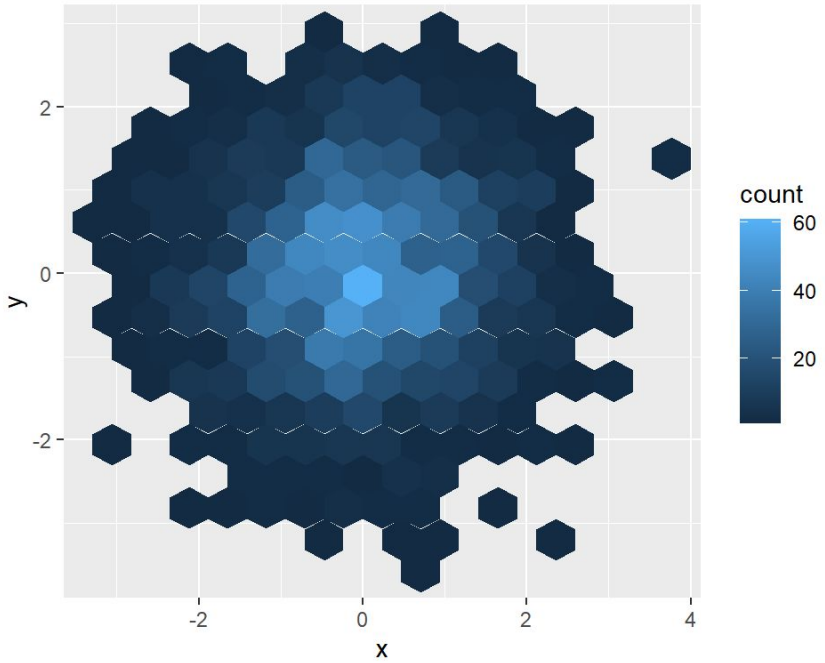
https://www.datanovia.com/en/blog/gganimate-how-to-create-plots-with-beautiful-animation-in-r/

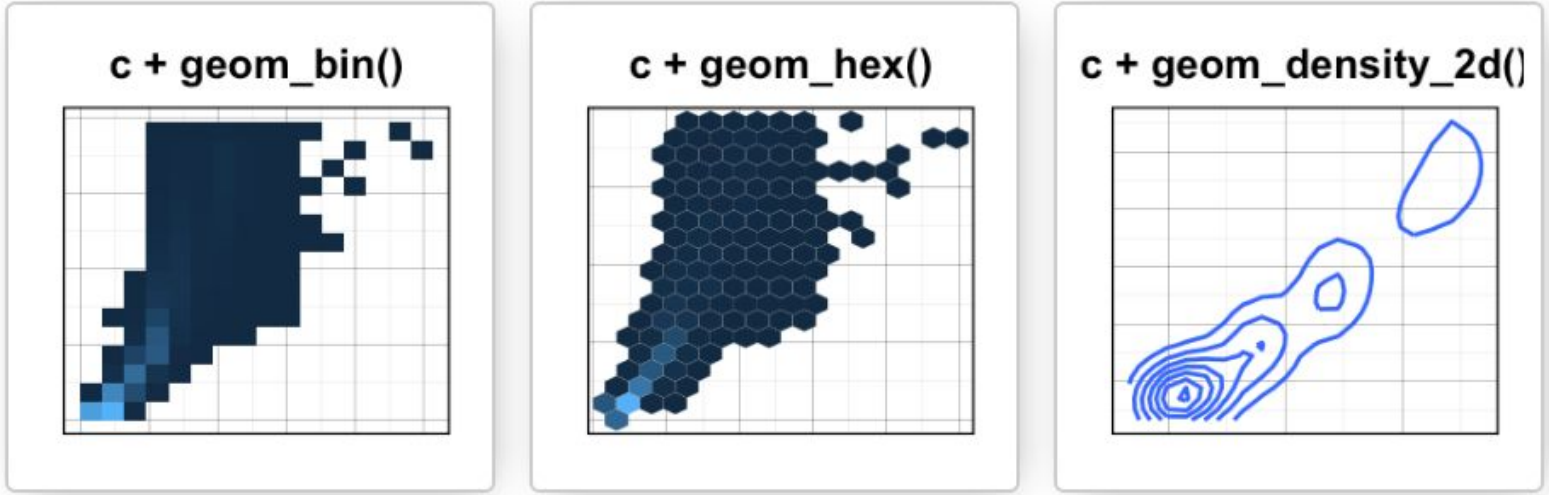
Survival plot (Kaplan-Meier Curve)

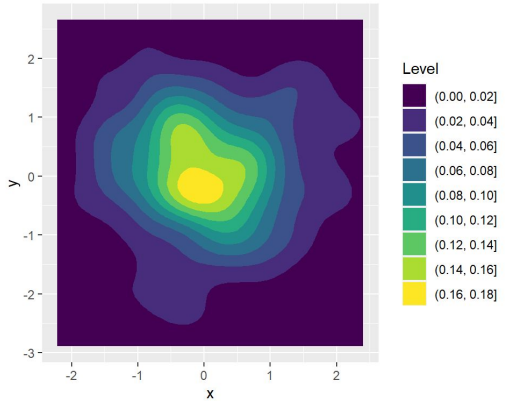


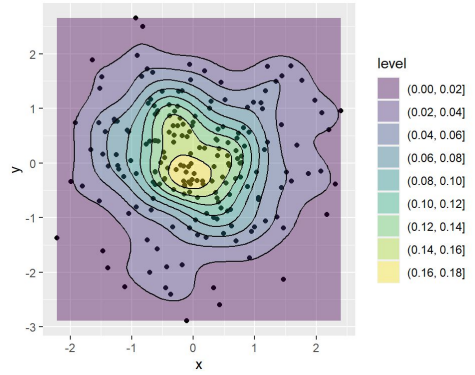
http://www.sthda.com/english/wiki/survival-analysis-basics

Binning and contour plot





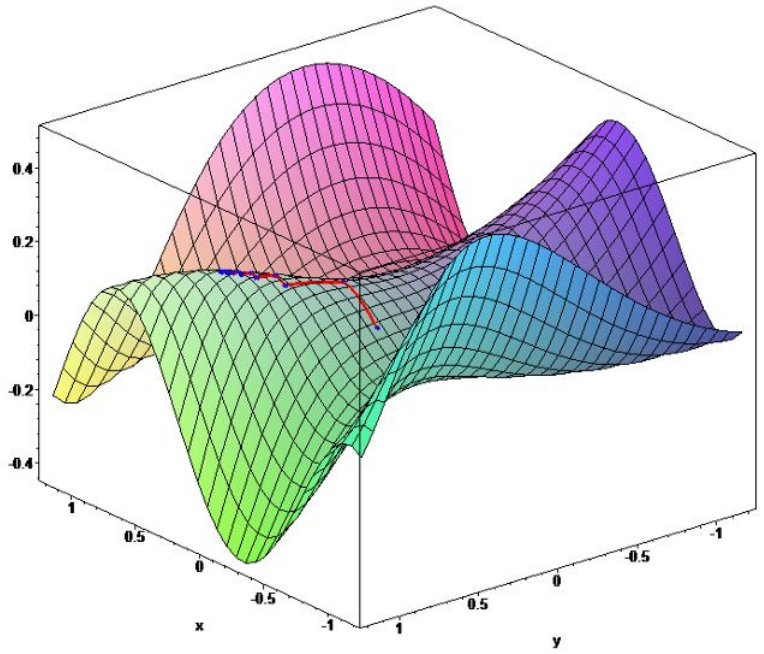


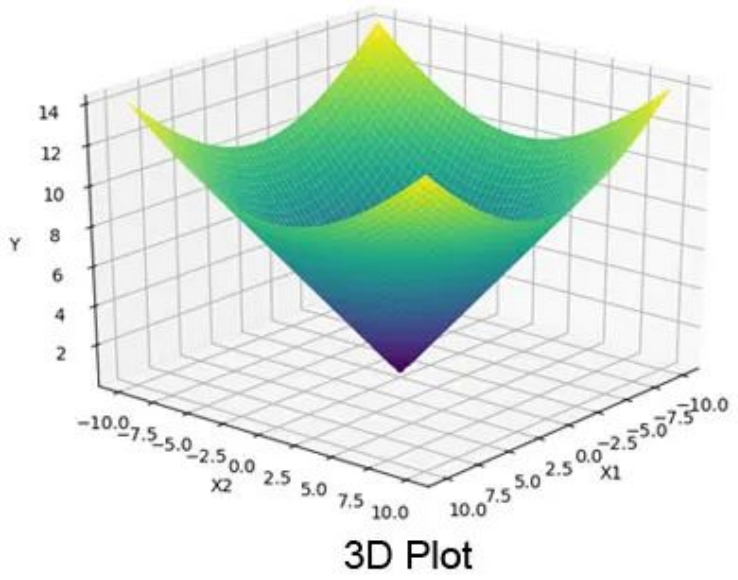


https://r-charts.com/correlation/hexbin-chart-ggplot2/

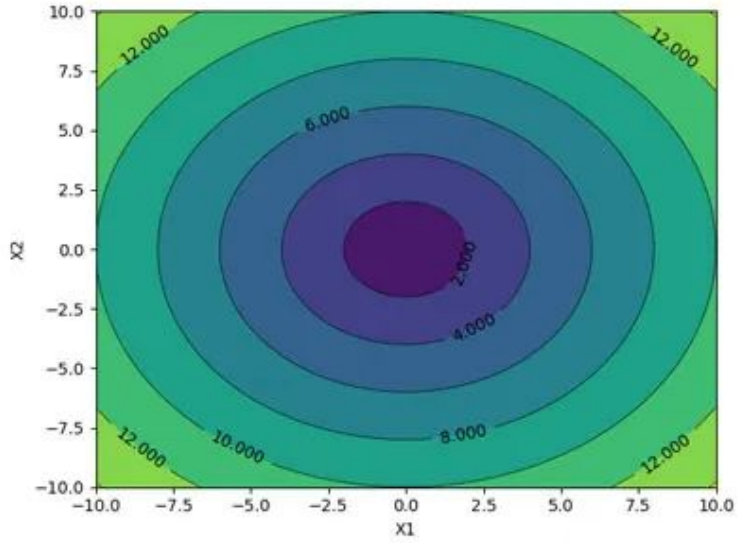
https://r-charts.com/correlation/contour-plot-ggplot2/
https://vincenzocoia.com/post/contour_plots/

3D contour plot for Gradient Descent





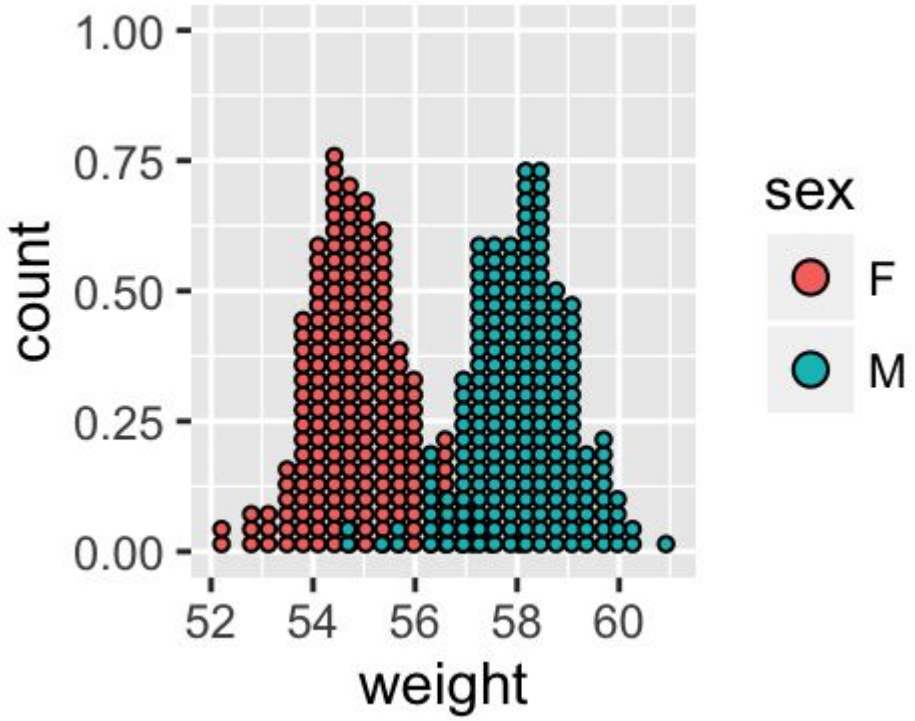
3D Plot

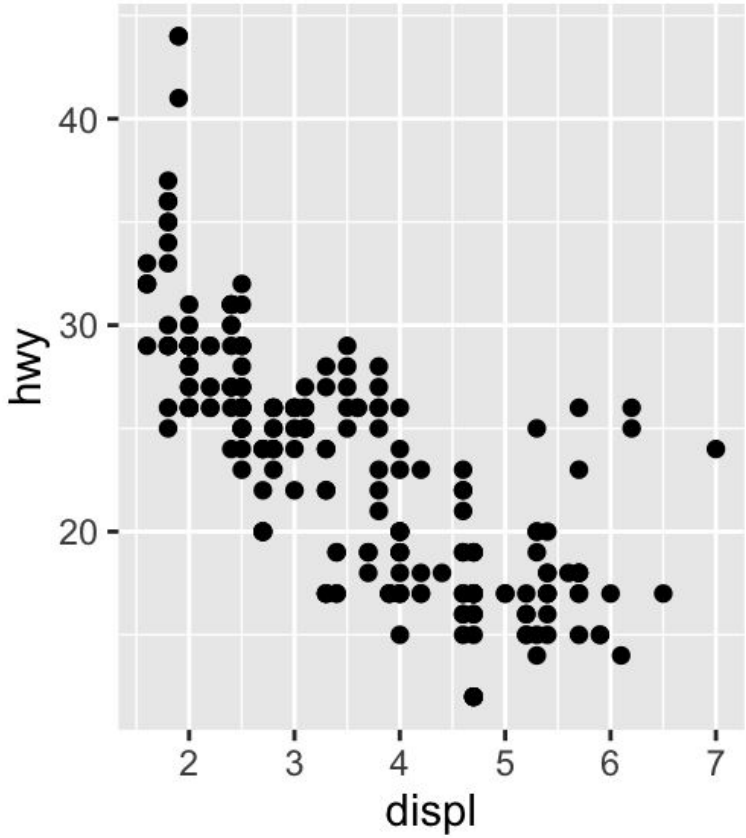


Contour Plot

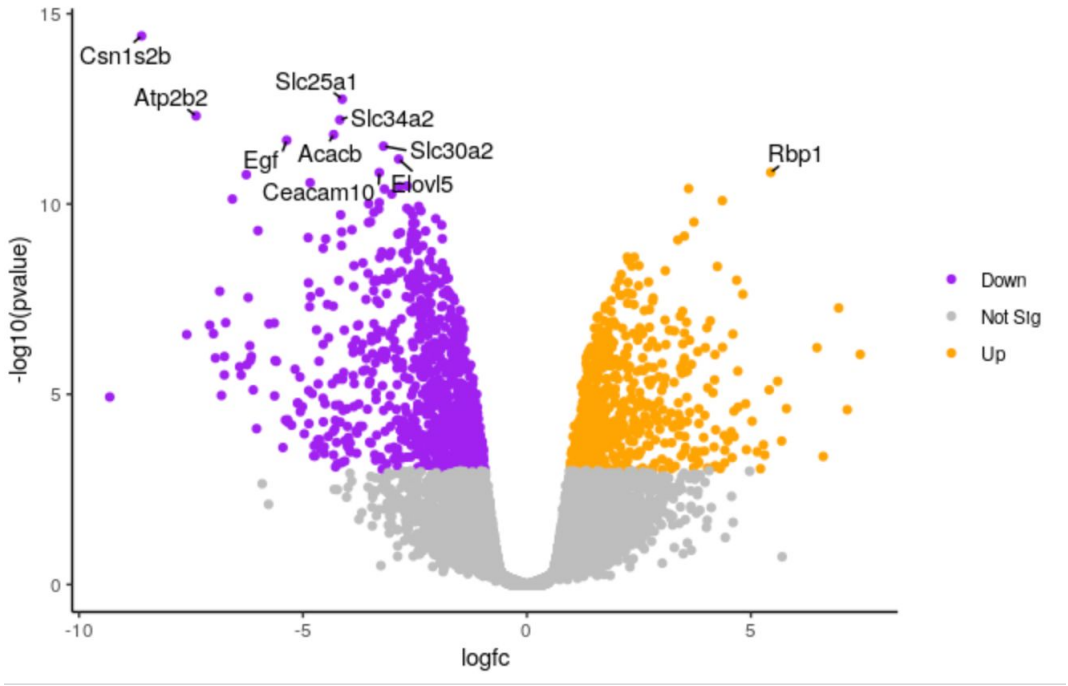
https://medium.com/@jackyfeng530/machine-learning-gradient-descent-8681c40d27c3
http://www.adeveloperdiary.com/data-science/how-to-visualize-gradient-descent-using-contour-plot-in-python/

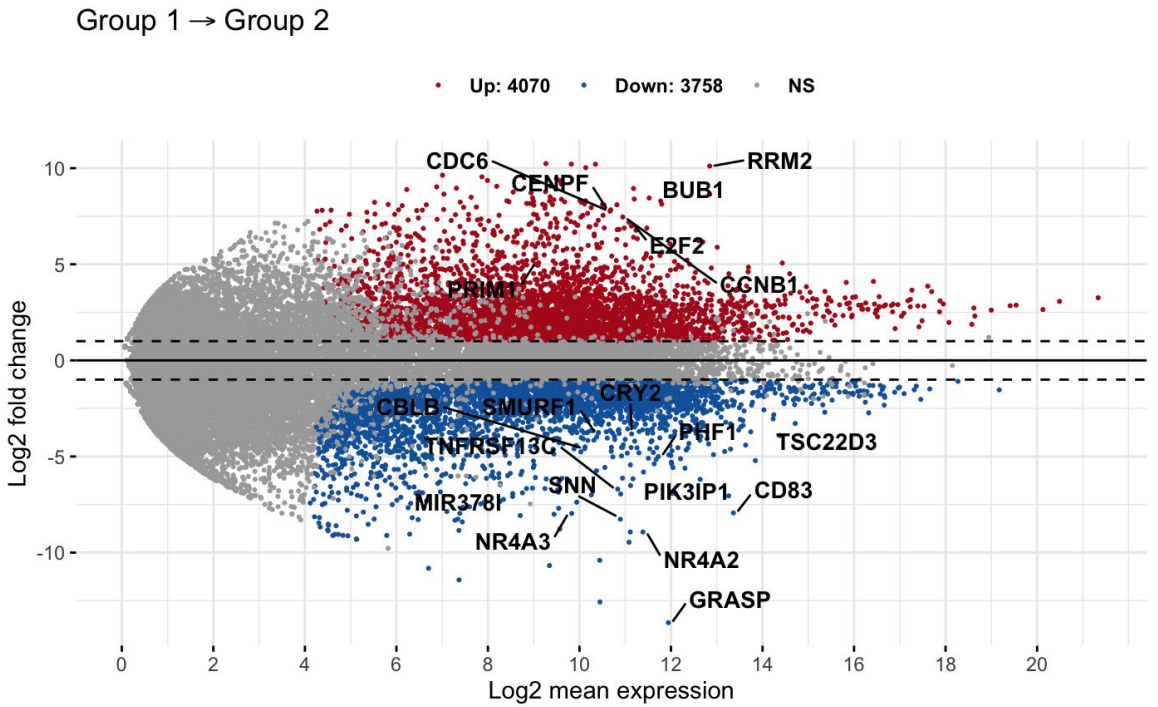
Dotplot and jitter plot





Volcano vs MA (Bland–Altman) plot



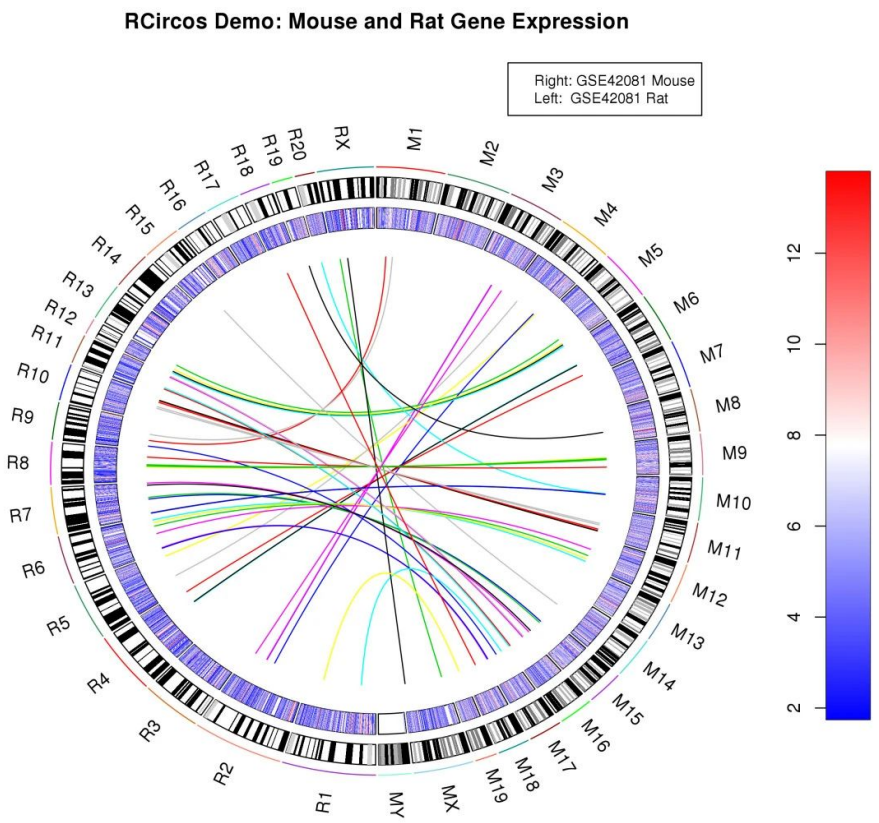


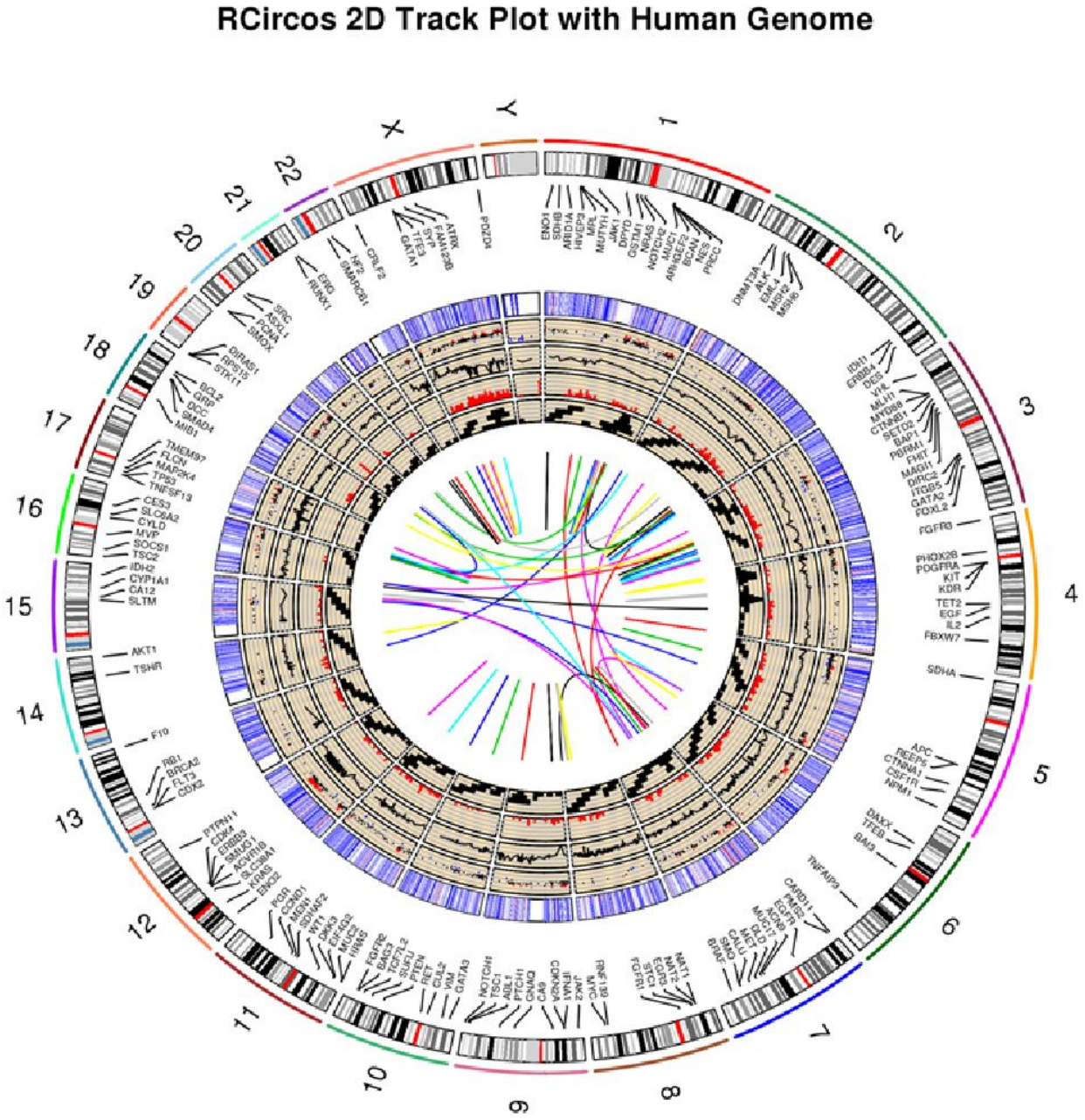
http://onetipperday.sterding.com/2012/11/t-test-volcano-plot.html

https://biocorecrg.github.io/CRG_RIntroduction/volcano-plots.html

https://rpkgs.datanovia.com/ggpubr/reference/ggmaplot.html

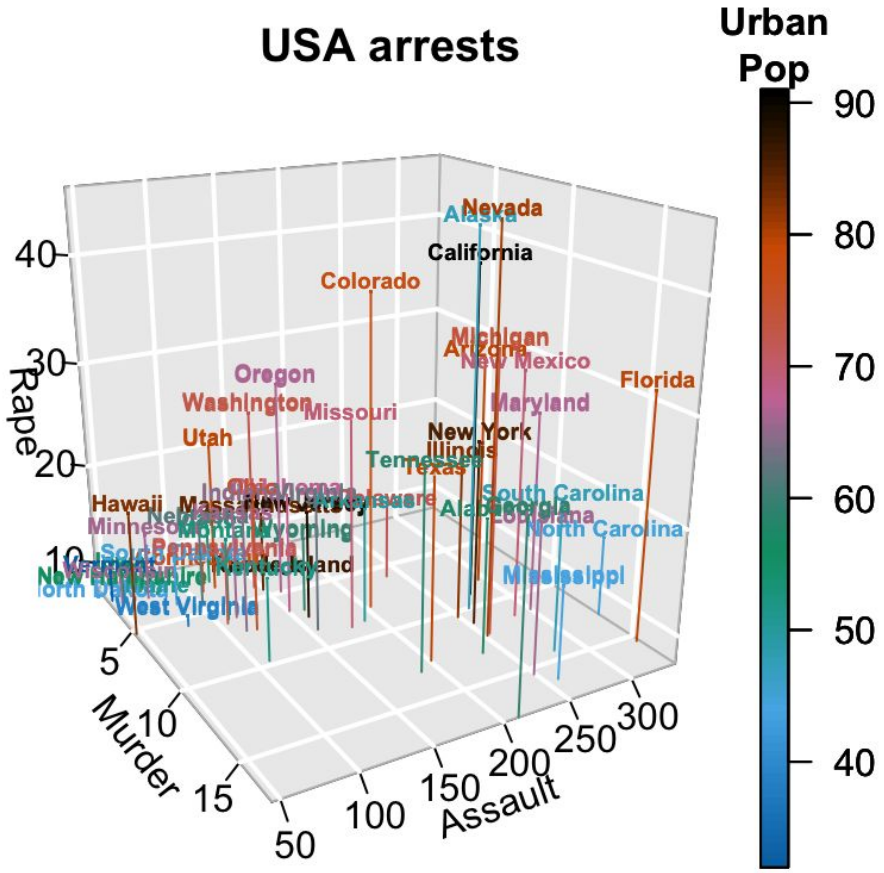
Circos plot

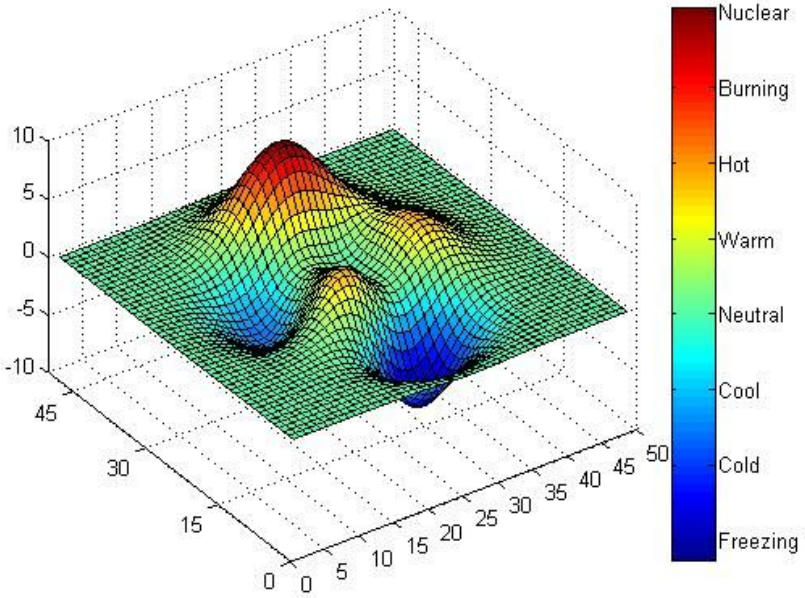




https://bmcbioinformatics.biomedcentral.com/articles/10.1186/1471-2105-14-244

3D plot





http://www.sthda.com/english/wiki/impressive-package-for-3d-and-4d-graph-r-software-and-data-visualization
https://stackoverflow.com/questions/43330727/how-to-plot-three-dimension-data-or-four-dimension-data-to-filled-contour-plot-o

Linked Views for Visual Exploration

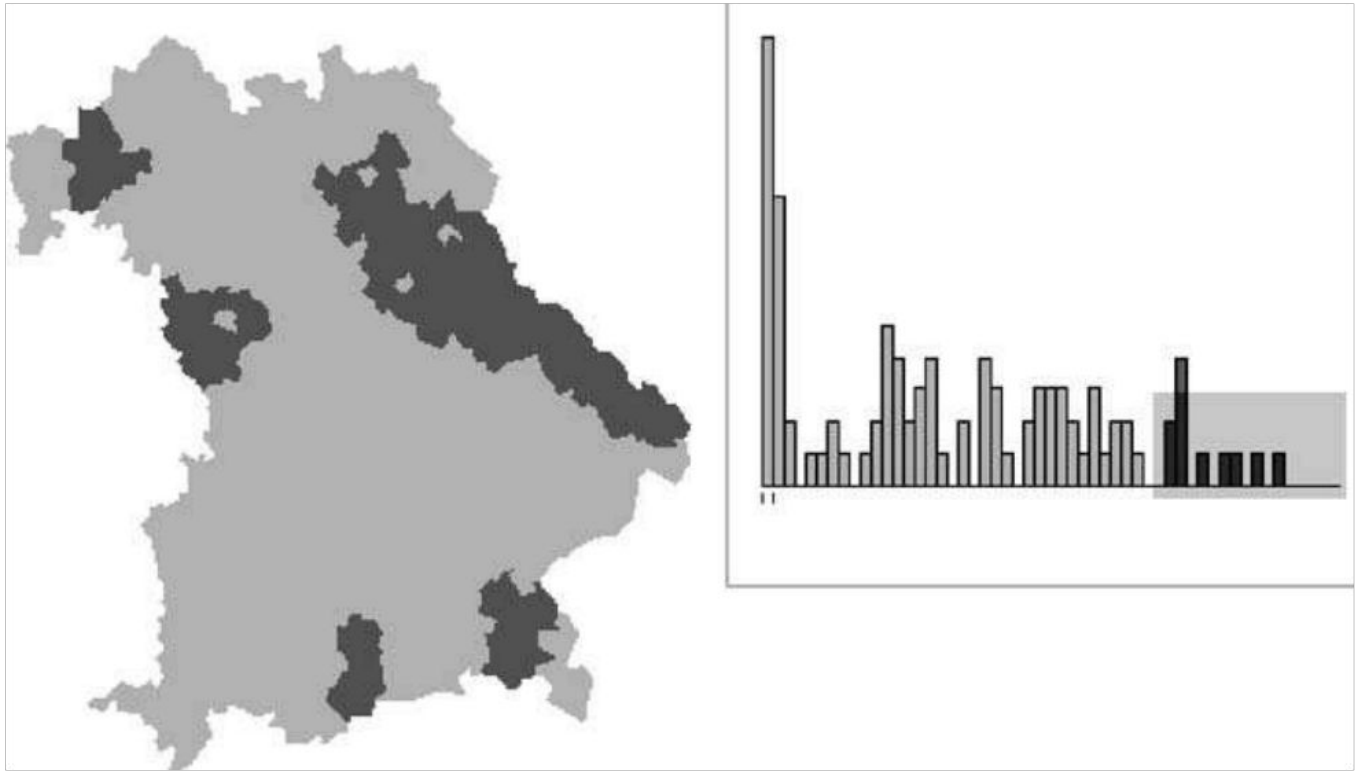


Figure 8.3. Land usage on the county level in Bavaria. Highlighted are those counties with a high percentage of forestry

Linked Views for Visual Exploration

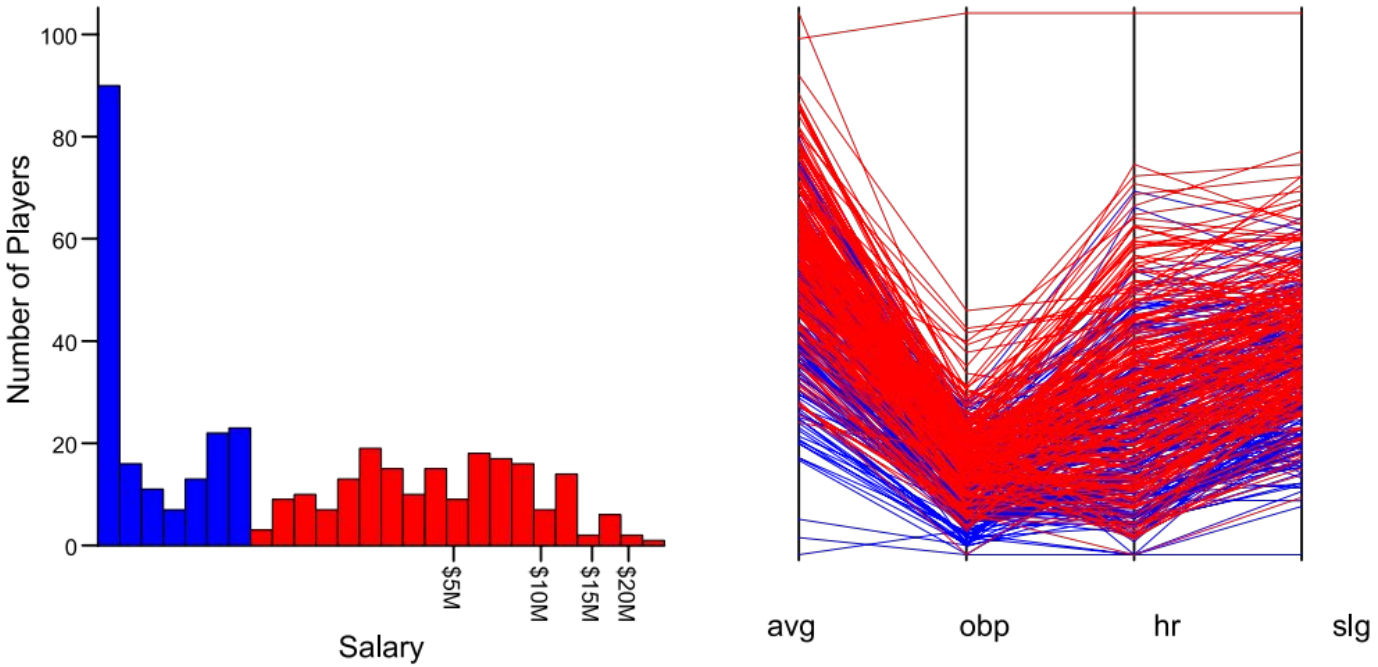
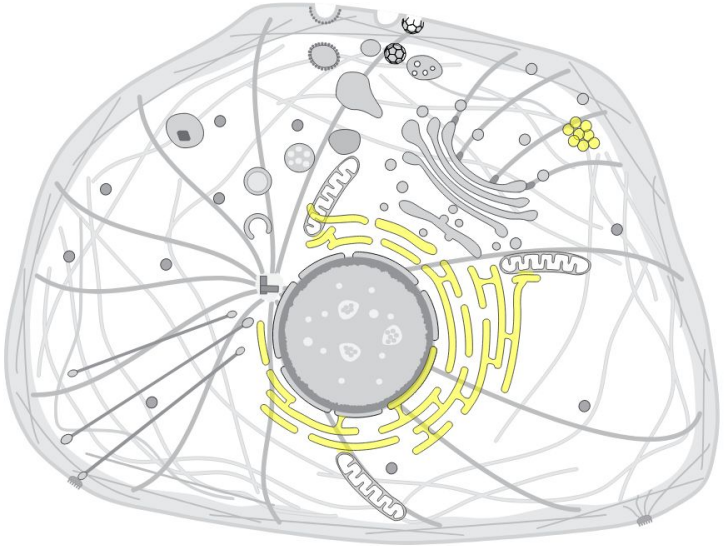
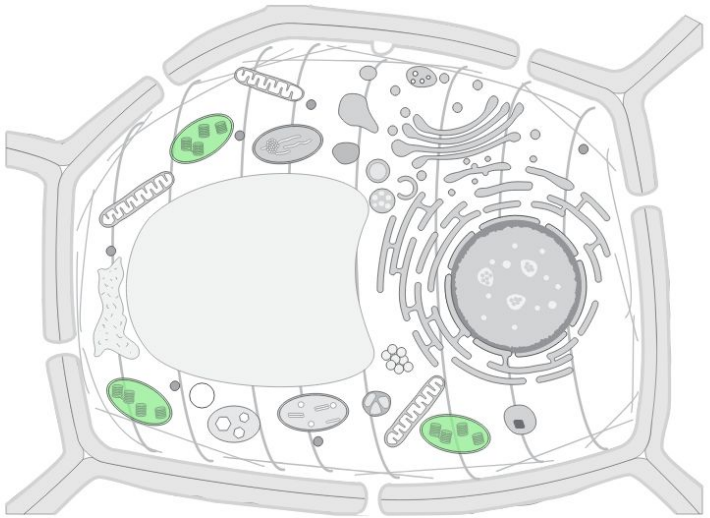
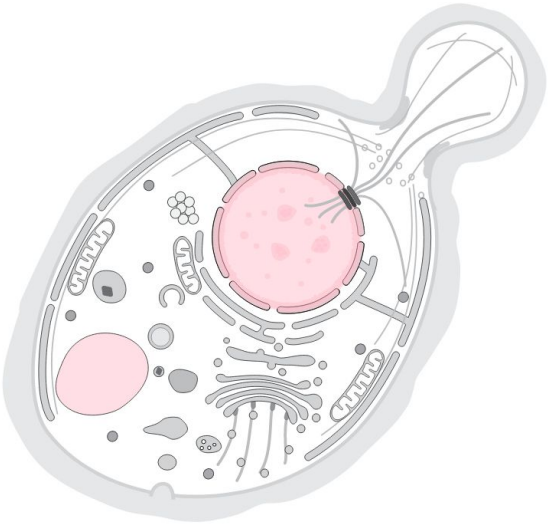


Figure 9.5. Faceting and parallel coordinates. For the 2004 season, the *left view* shows a histogram of salary on a log scale. Players earning over $1,000,000 were selected and are shown in the linked *parallel coordinates plot* as *dashed line*. The parallel coordinates view shows four major measures of performance: batting average, on-base percentage, home-run rate, and slugging average

Draw Cell

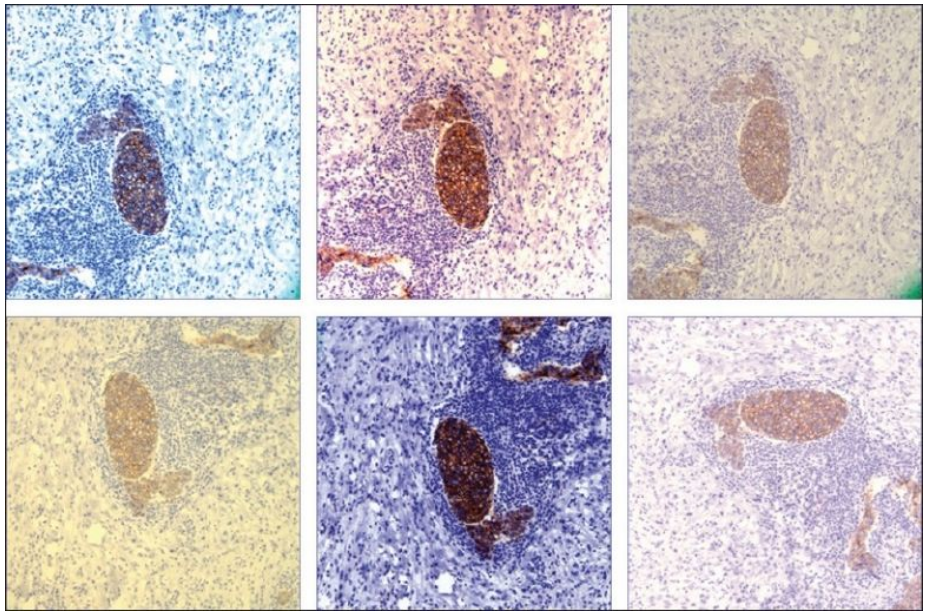






https://github.com/svalvaro/drawCell

Visualizing Images in pathology

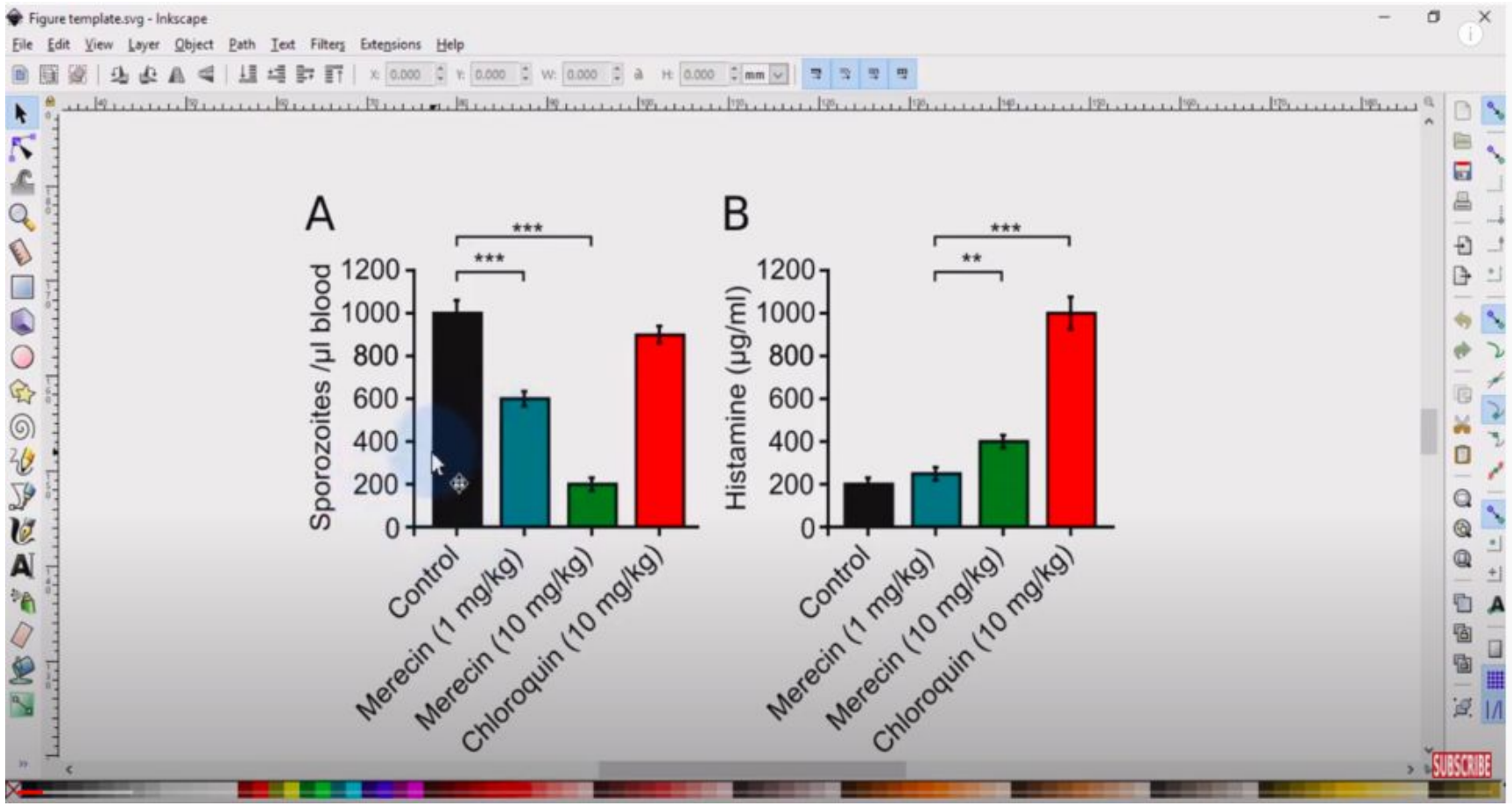


Different digital images of the same region on a glass slide photographed at the same magnification by six different pathologists, each using similar microscopes and the same attached digital cameras (HER-2/neu immunohistochemical stain)

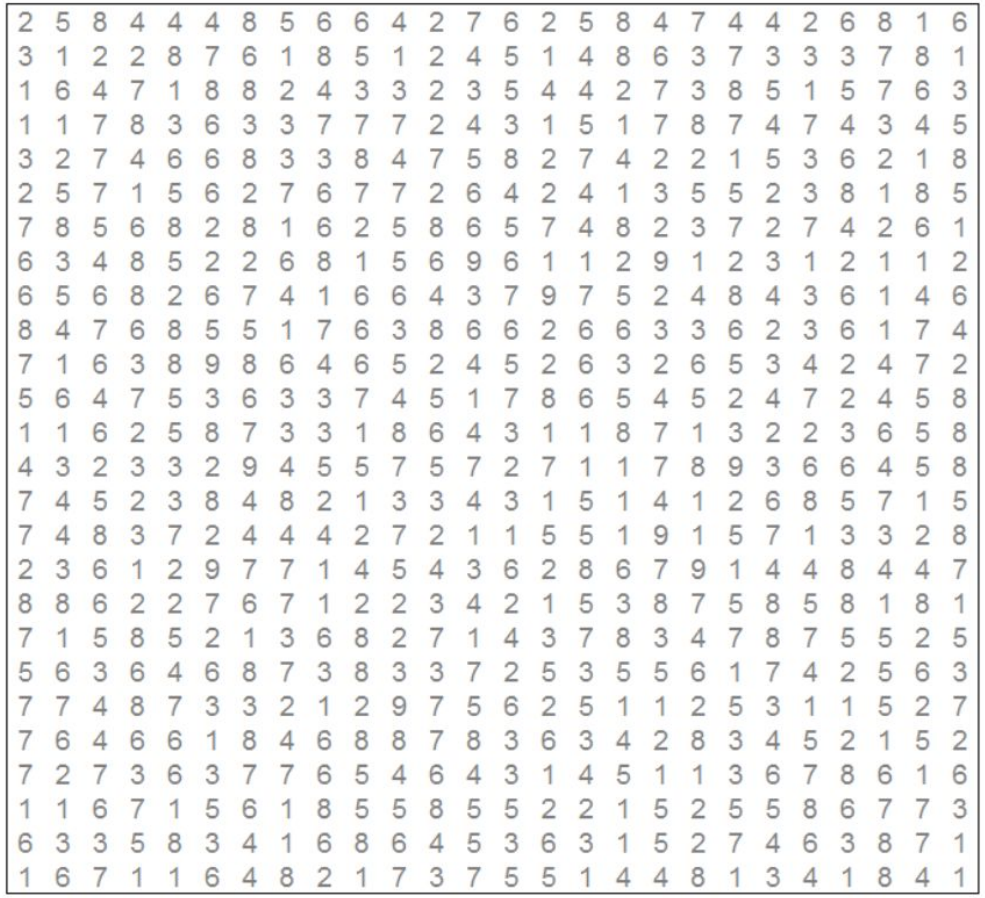
Whole slide images help create a “virtual multiheaded microscope” that supports interactive education (Image courtesy of BioImagene)

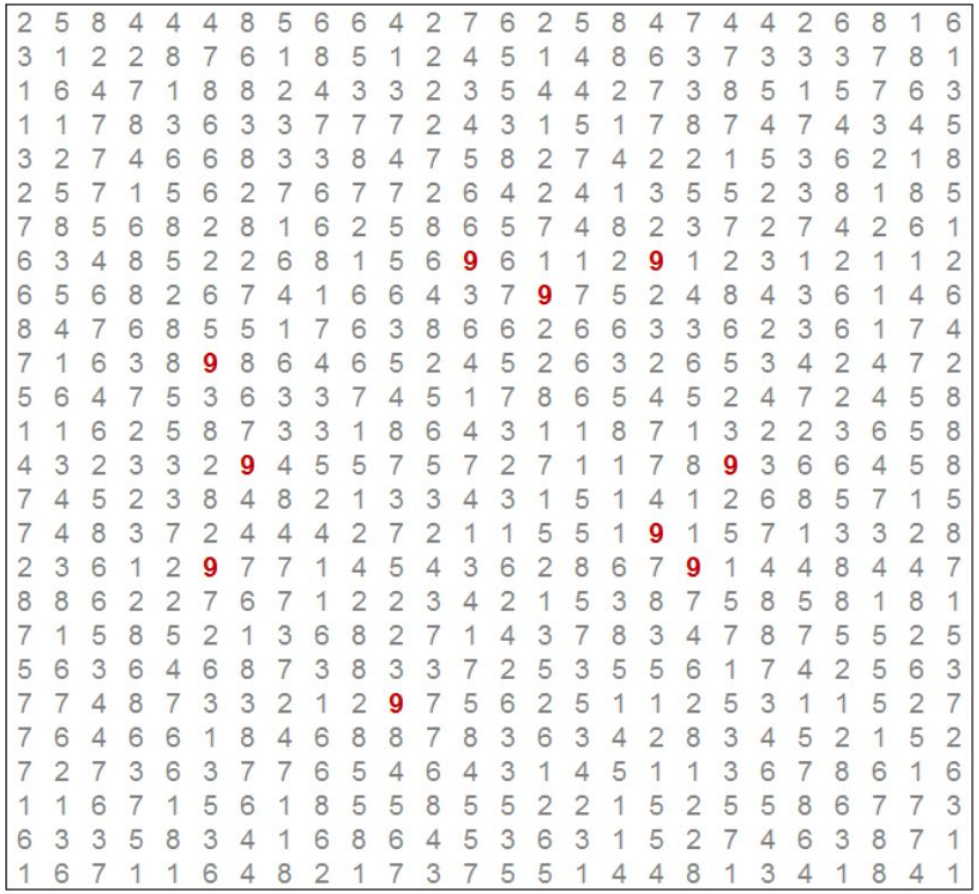
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2941968/

Inkscape for scientists: Making a data figure for a publication



Why Do We Visualize Data?





Why Do We Visualize Data?

TABLE 1.1 Table with four groups of numbers: What do they tell you?

Group A		Group B		Group C		Group D	
x	y	x	y	x	y	x	y
10.00	8.04	10.00	9.14	10.00	7.46	8.00	6.58
8.00	6.95	8.00	8.14	8.00	6.77	8.00	5.76
13.00	7.58	13.00	8.74	13.00	12.74	8.00	7.71
9.00	8.81	9.00	8.77	9.00	7.11	8.00	8.84
11.00	8.33	11.00	9.26	11.00	7.81	8.00	8.47
14.00	9.96	14.00	8.10	14.00	8.84	8.00	7.04
6.00	7.24	6.00	6.13	6.00	6.08	8.00	5.25
4.00	4.26	4.00	3.10	4.00	5.39	19.00	12.50
12.00	10.84	12.00	9.13	12.00	8.15	8.00	5.56
7.00	4.82	7.00	7.26	7.00	6.42	8.00	7.91
5.00	5.68	5.00	4.74	5.00	5.73	8.00	6.89

Explore Data

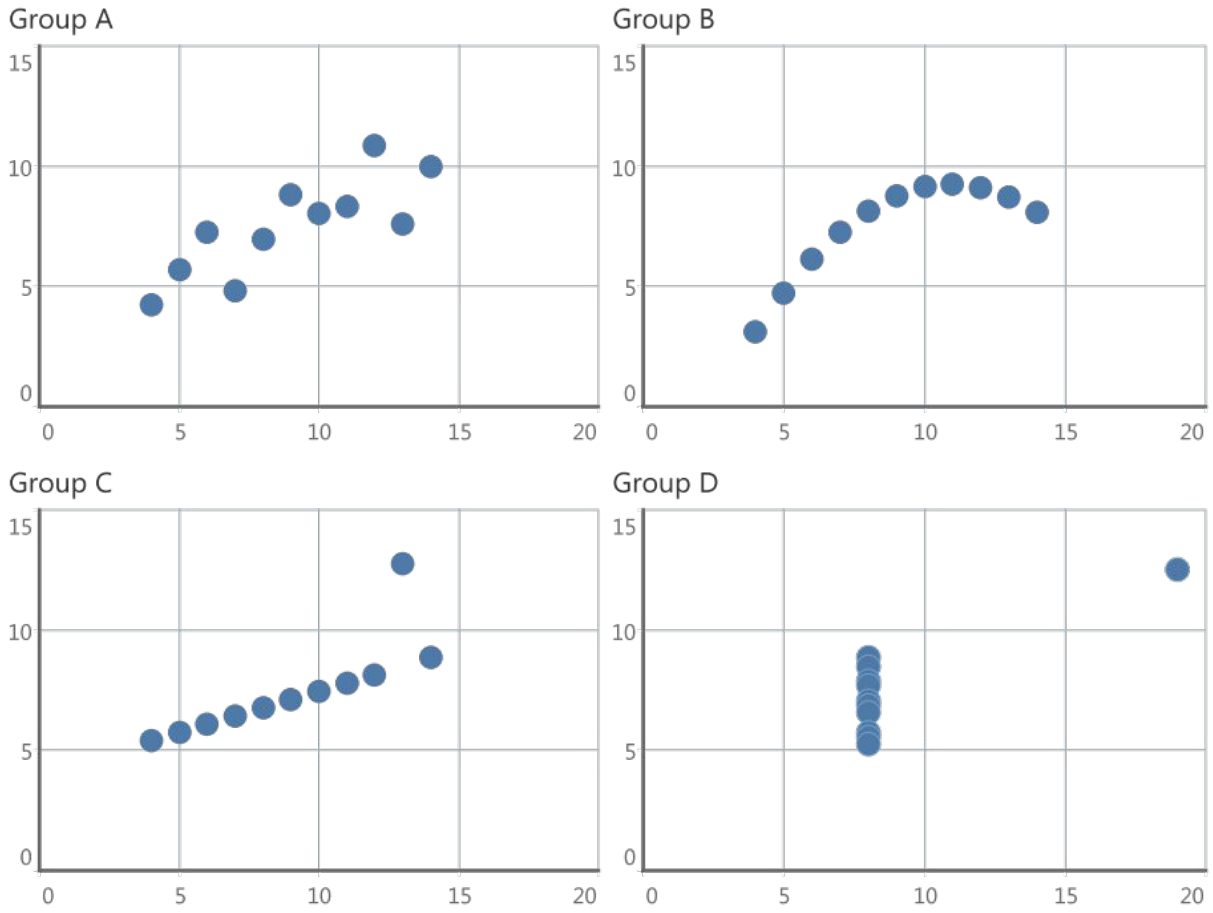


FIGURE 1.1 Now can you see a difference in the four groups?

"Anscombe's Quartet"—in the paper "Graphs in Statistical Analysis" in 1973.

Discover the trends of data

TABLE 1.2 What are the trends in sales?

Category	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4
Furniture	$463,988	$352,779	$338,169	$317,735	$320,875	$287,934	$319,537	$324,319
Office Supplies	$232,558	$290,055	$265,083	$246,946	$219,514	$202,412	$198,268	$279,679
Technology	$563,866	$244,045	$432,299	$461,616	$285,527	$353,237	$338,360	$420,018
Category	**2015 Q1**	**2015 Q2**	**2015 Q3**	**2015 Q4**	**2016 Q1**	**2016 Q2**	**2016 Q3**	**2016 Q4**
Furniture	$307,028	$273,836	$290,886	$397,912	$337,299	$245,445	$286,972	$313,878
Office Supplies	$207,363	$183,631	$191,405	$217,950	$241,281	$286,548	$217,198	$272,870
Technology	$333,002	$291,116	$356,243	$386,445	$386,387	$397,201	$359,656	$375,229

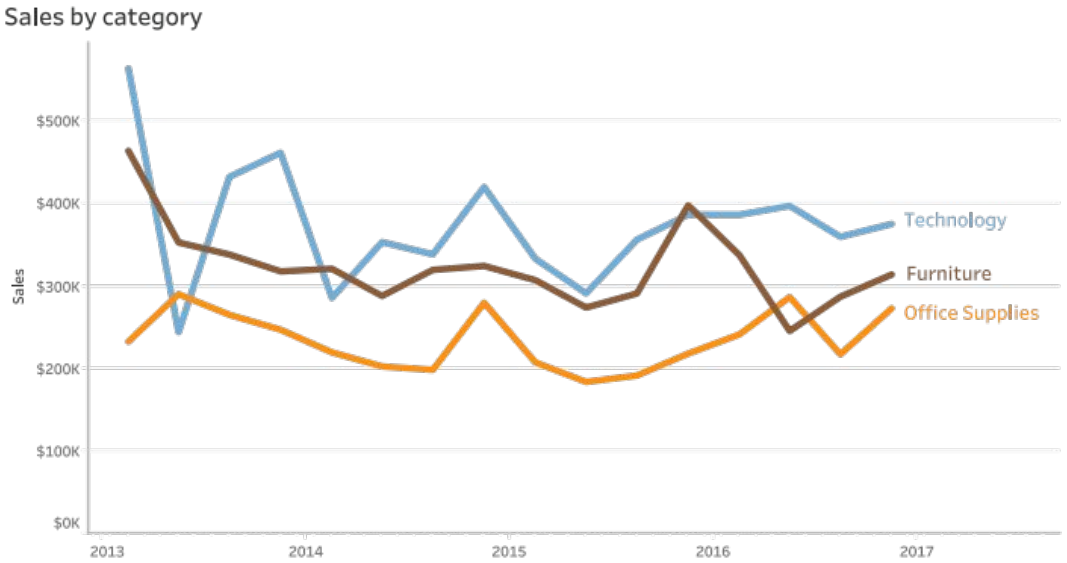
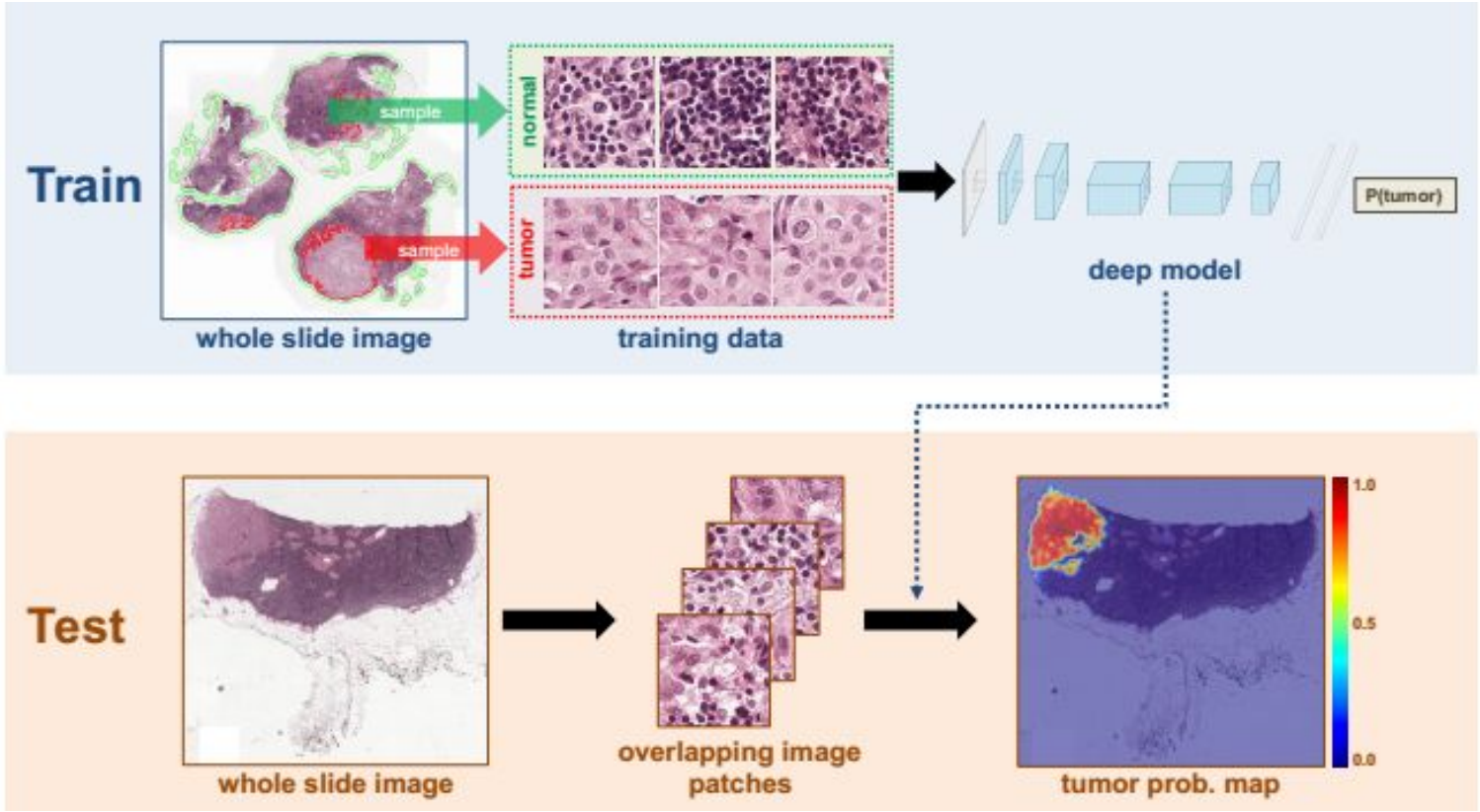
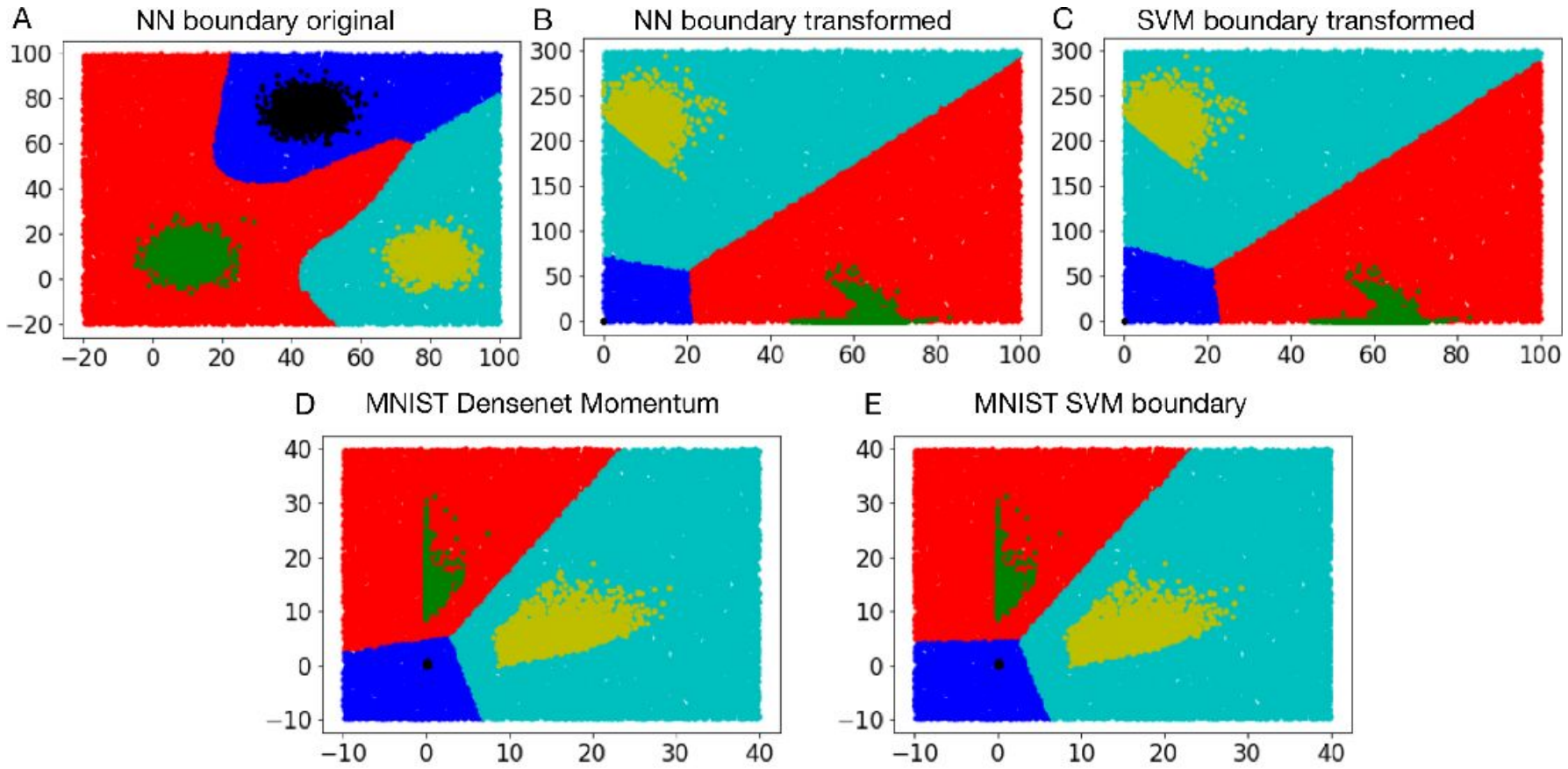


FIGURE 1.2 Now can you see the trends?

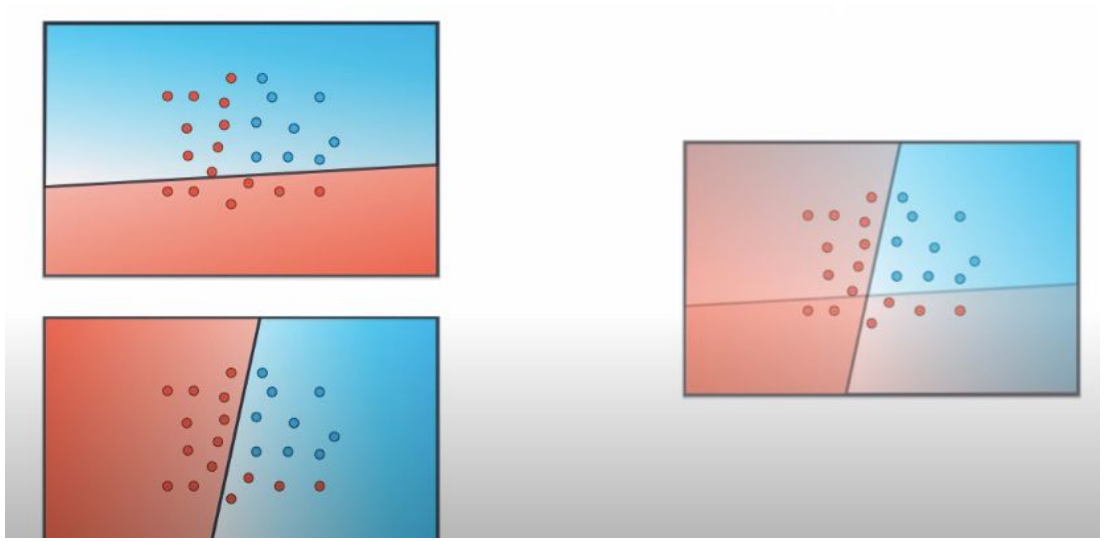
Neural network Interpretable

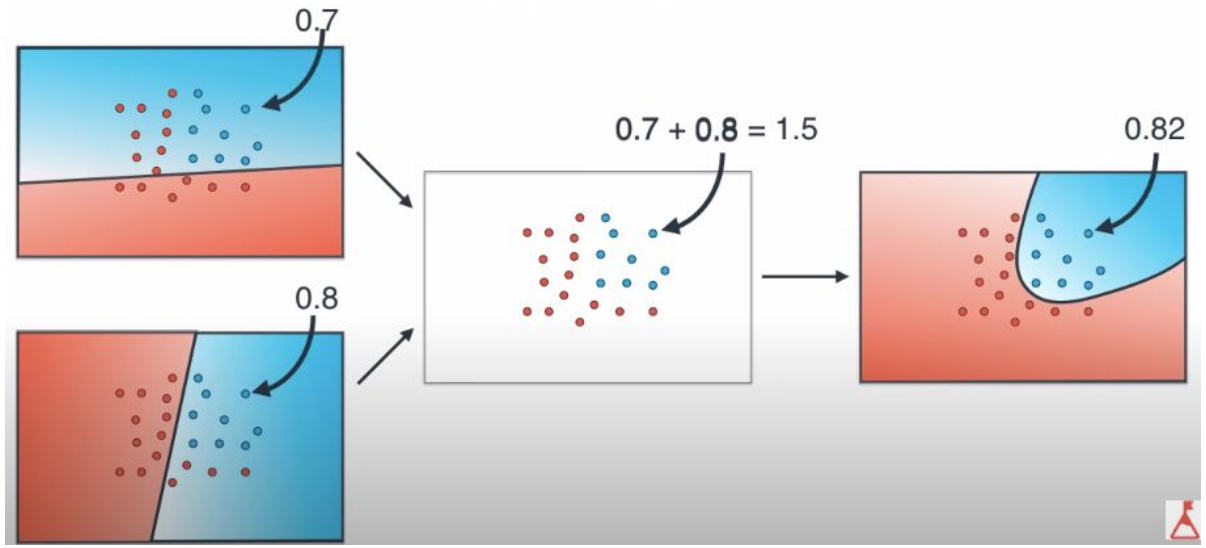


Neural network Interpretable



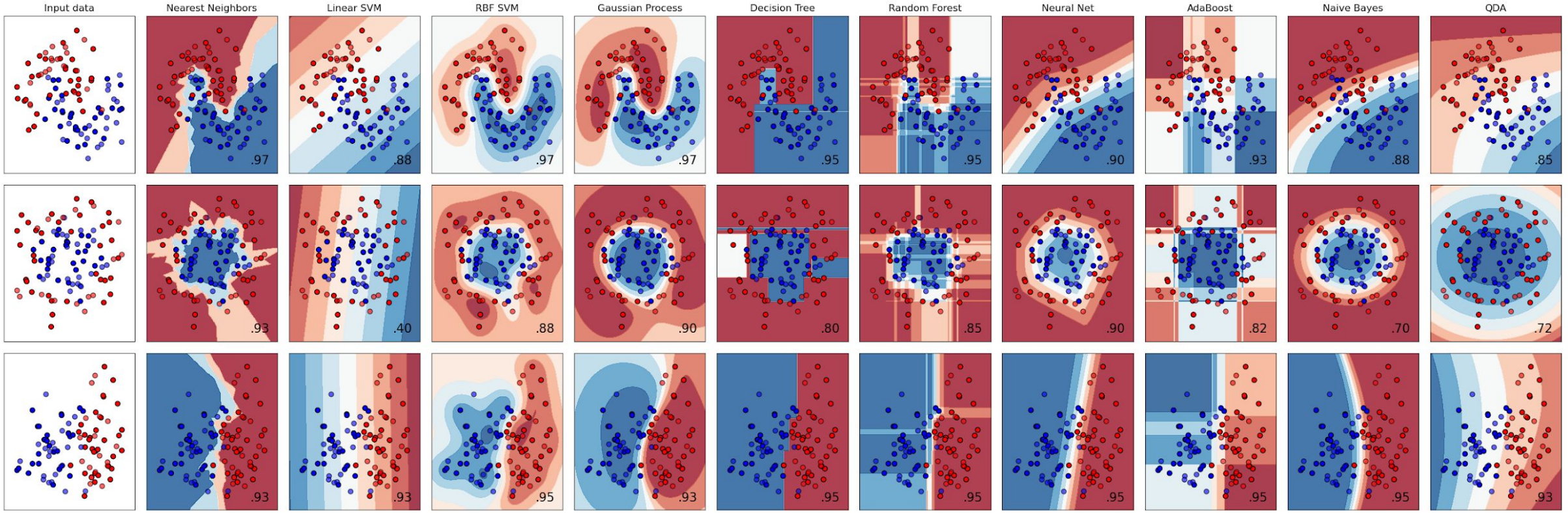
Neural network Interpretable





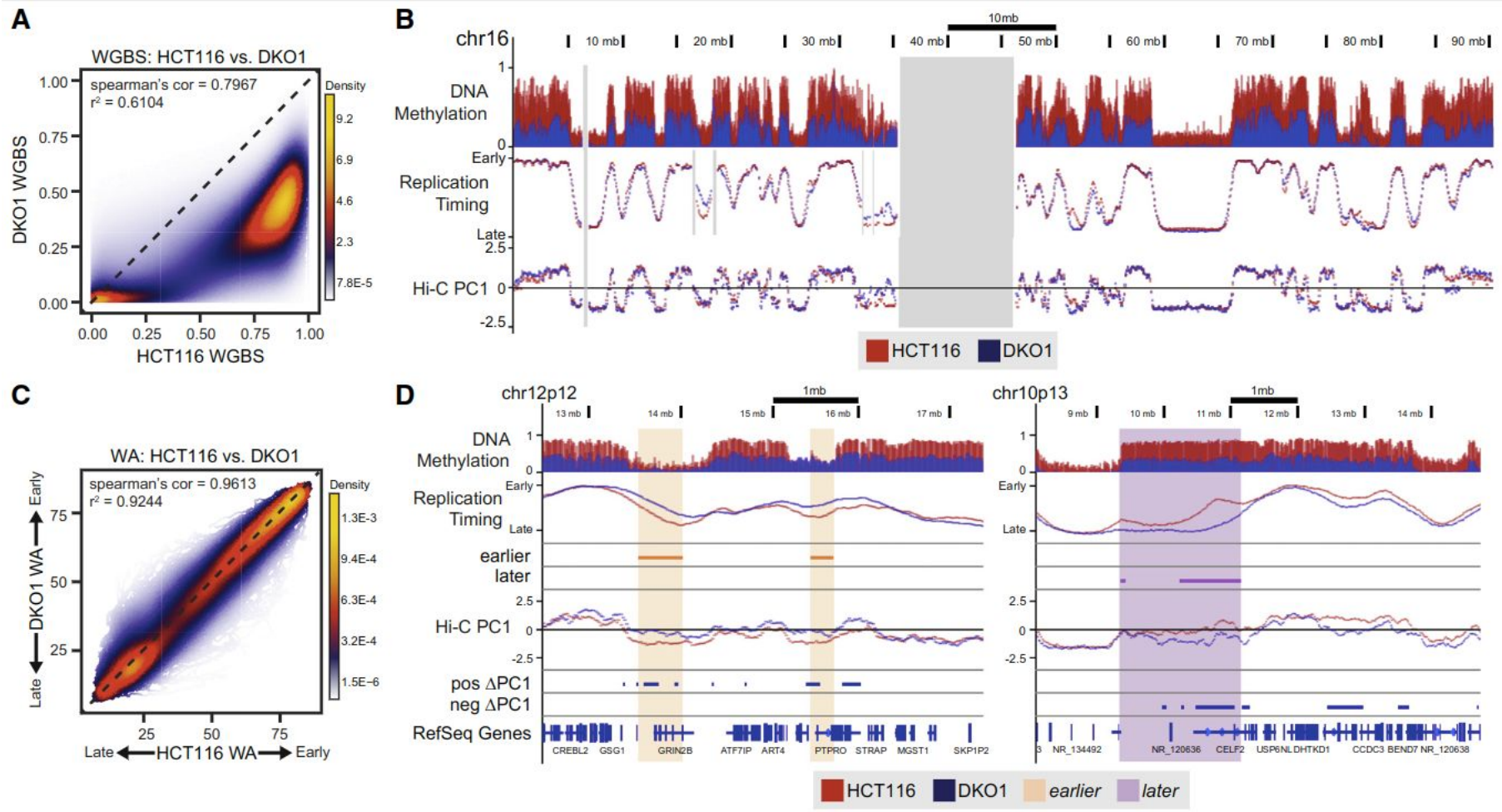
https://www.youtube.com/watch?v=BR9h47Jtqyw

Decision Boundary



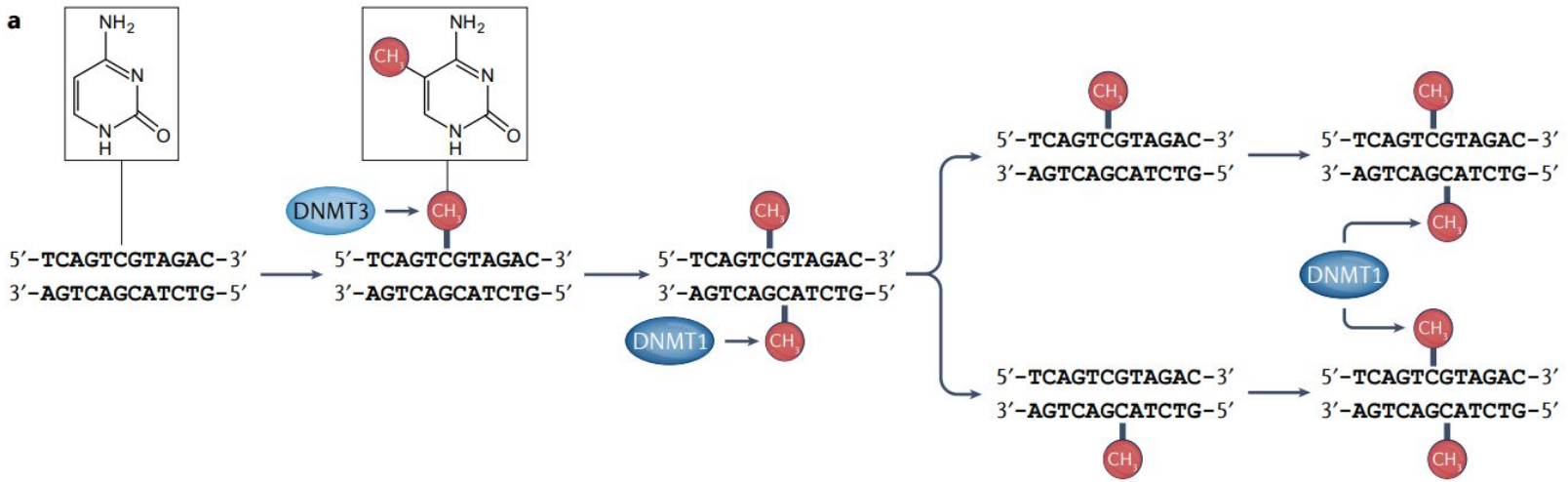
https://scikit-learn.org/stable/auto_examples/classification/plot_classifier_comparison.html

Presenting a hypothesis



10.1016/j.celrep.2021.109722

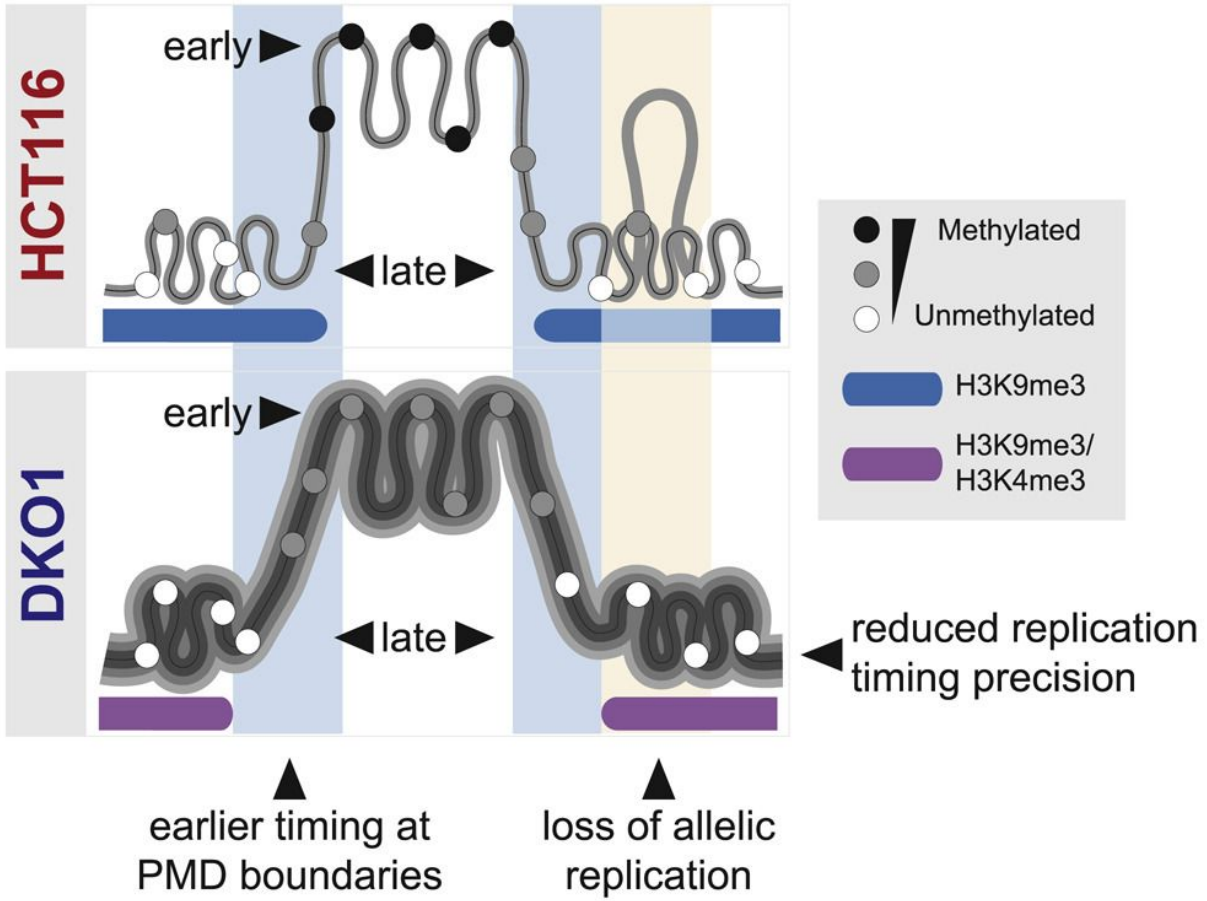
Summary scientific facts



CTCF, CCCTC binding factor; HP1, heterochromatin protein 1; MeCP2, methyl-CpG-binding protein 2.

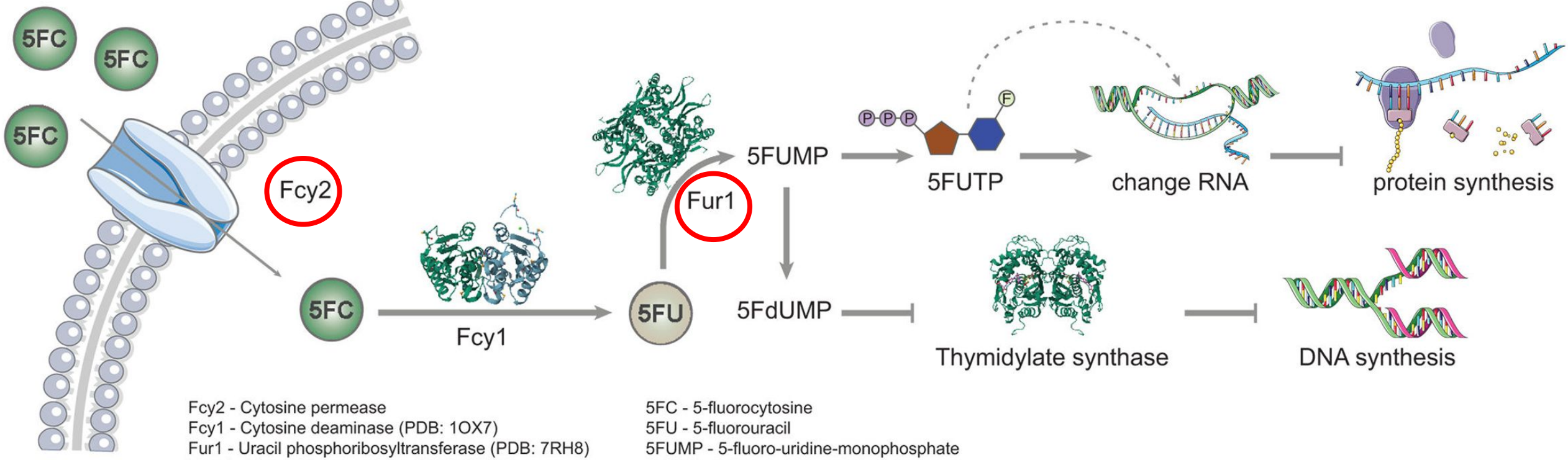
https://doi.org/10.1038/s41576-021-00438-5

Graphical abstract



10.1016/j.celrep.2021.109722

Rapid *in vitro* evolution of flucytosine resistance in *Candida auris*



Fcy2 - Cytosine permease
Fcy1 - Cytosine deaminase (PDB: 1OX7)
Fur1 - Uracil phosphoribosyltransferase (PDB: 7RH8)
Tmp1 - Thymidylate synthase (PDB: 2AAZ)

5FC - 5-fluorocytosine
5FU - 5-fluorouracil
5FUMP - 5-fluoro-uridine-monophosphate
5FUTP - 5-fluoro-uridine-triphosphate
5FdUMP - 5-fluoro-deoxy-uridine-monophosphate

Reference

- Data visualization
  - https://www.youtube.com/watch?v=3X3cjEqaPro&list=PLZo40sVmw_4My97tv62aDITkOxOaJup7X&index=1
  - https://www.youtube.com/watch?v=Khj94kaJjWo&list=PLg91P4KVeUZbg28jiPq_qTgTCf6xQya-e

    (https://sas.uwaterloo.ca/~rwoldfor/courses/DataVisualization/Slides/2020/)
  - https://curran.github.io/dataviz-course-archive/
- Machine learning visualization
  - https://goodekat.github.io/presentations/2020-isugg-iml/slides.html#1
  - https://medium.com/analytics-vidhya/awesome-machine-learning-visualizations-5208f1617ec5

Thank you for your listening
Q & A