Graphical Report: Wheat

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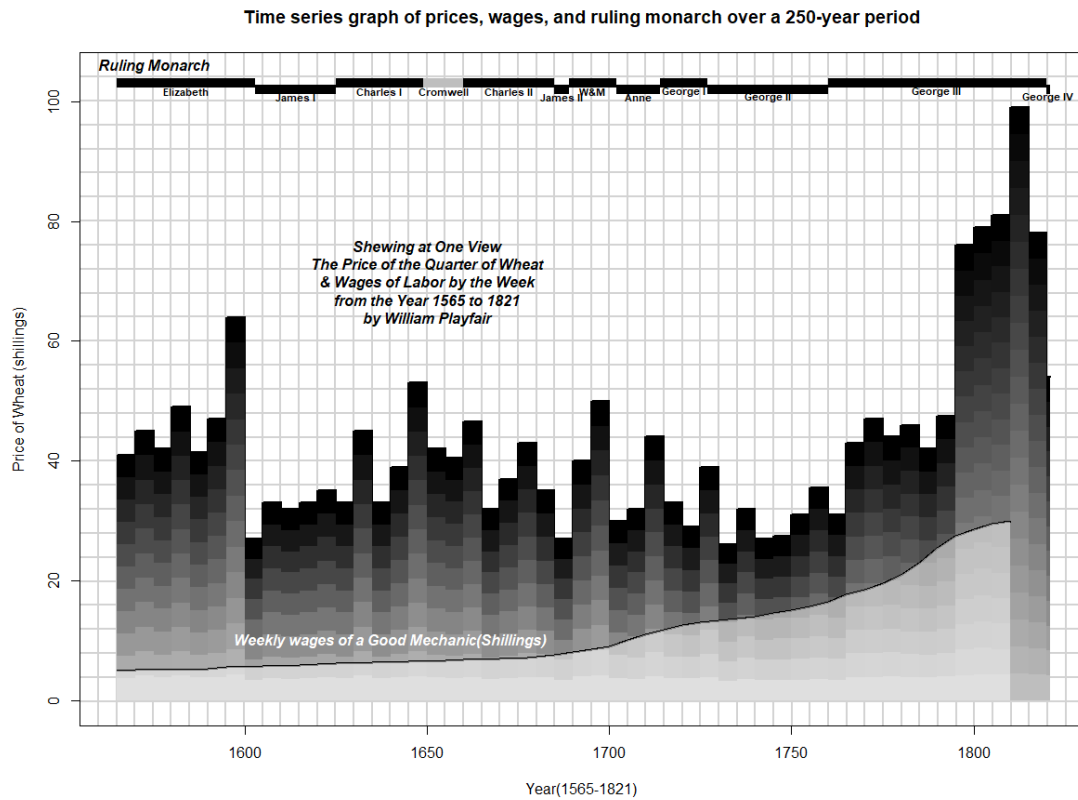
Time series graph of prices, wages, and ruling monarch over a 250-year period

Fig 1. Time series graph of prices, wages, and ruling monarch over a 250-year period

I   INTRODUCTION

William Playfair published a graph (Figure 2) containing three parallel time series, including the price of a quarter of wheat, weekly wages of a good mechanic, and the ruling British monarch over 250 years in 1822. His visualisation is regarded as a milestone in the field of infographics because it is the first known bar graph [1]. Although it has been proven to be a graphical failure due to the separate scales, it is still a great work worth learning. Figure 1 is a visualisation reproduced by me. And this report will describe the details, the method and the reason why choosing that method of re-working this classical graph.
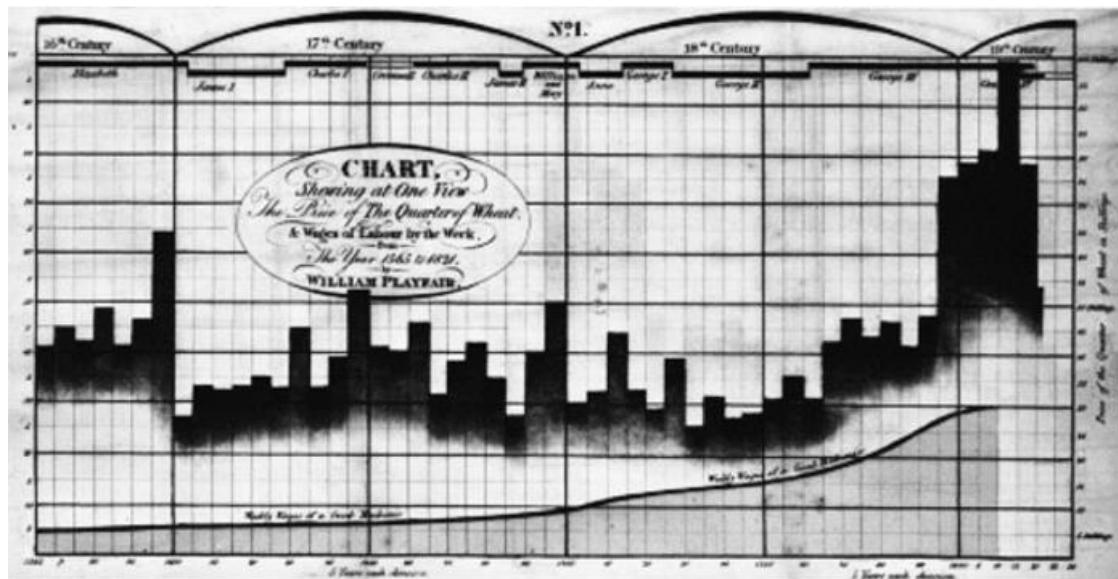

Fig 2. William Playfair's 1821 time series graph of prices, wages, and ruling monarch over a 250-year period. [2]

II   PRICE OF WHEAT

What Playfair wanted to research was the correlation between the price of wheat and the weekly wages of workers. In this section, a trend of the price of the wheat over time needed to be drawn.

First of all, in order to allow the audience to see the value in this graph more clearly, it is necessary to draw the grid lines of the entire coordinate system. For example, with grid lines, it is obvious that the price of wheat in the first year (1565) is 41 shillings. But in practice, when coding in R, the first problem encountered was to align the grid lines and coordinate scales. After repeatedly trying to modify the parameters of *xlim*, *ylim*, and *grid()*, all the grid lines are aligned with the coordinate scale.

Then, what needs to be done is to draw the histogram. Because the data of wheat price is not continuous and updated every five years, a relatively smooth histogram will be more appropriate to represent. The histogram can also help compare the gap with weekly wages of workers. In the process of implementation, I divided this goal into two steps. The first step is to draw the line chart in stair steps [3], and the second step is to

fill with the gradient colour. Figure 3 is a graph from R package HistData [3], which only contains the line but no filling. Drawing a line chart is very simple, just use *plot()* and modify the parameter *type=s*. However, I was once again in difficulty when filling the colour. The entire histogram cannot be filled together, so I need to use a for loop to fill each column separately. Also, it is hard to fill the grey-black gradient colour. I started using the function *polygon()*, but I found that the parameter *col* was unable to be a gradient. Finally, I used function *gradient.rect()*, which can fill a rectangle with a gradient colour but cannot modify the transparency.

III   WEEKLY WAGES

In this section, a curve of weekly wages of a good mechanic over 250 years can be obtained. Since the weekly wage changes are small, a smooth curve can basically be acquired in a line graph. Unlike Figure 3, I changed the area of the shade to the bottom of the curve instead of above the curve.

After getting a smooth curve by function *line()*, the question is how to shade the part below the curve with colour grey. In the R language, the function *polygon()* provides the method. However, the attribute *Wages* in dataset *Wheat* has NA so that calling the function directly does not get the desired result like Figure 1. So, I pre-processed the data by removing the NA and then set the parameter of the colour to change transparency. Finally, the shape in Figure 1 has been obtained.
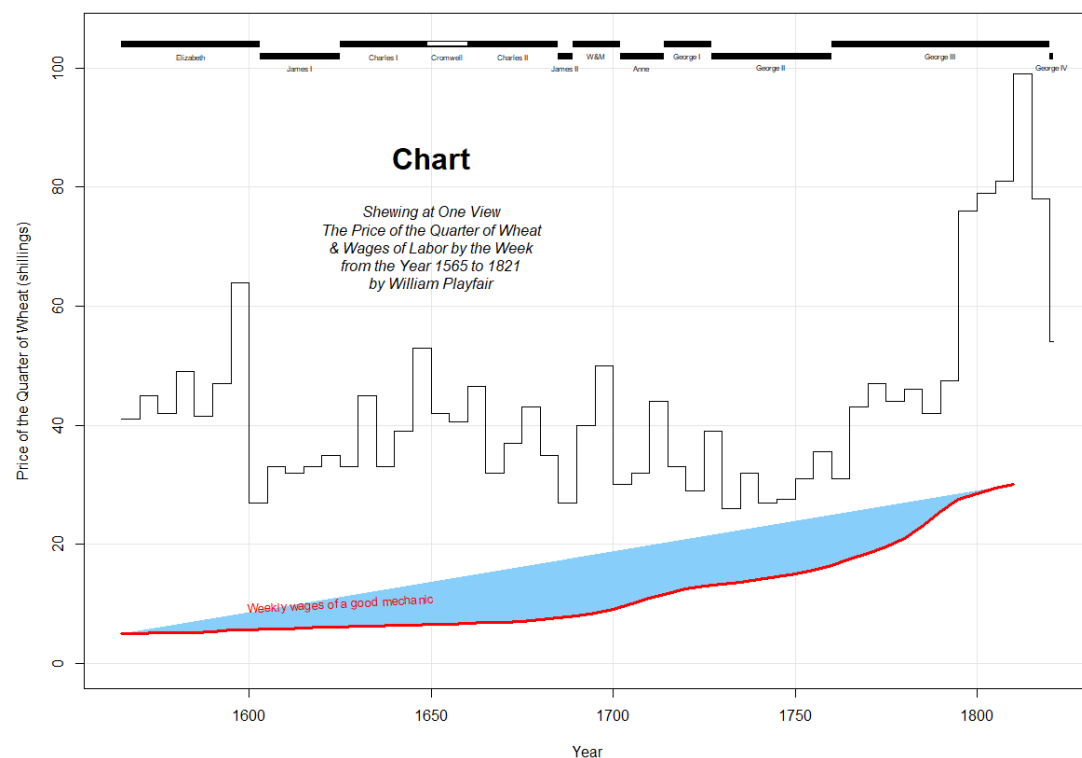

Fig 3. Graph provided by R package

IV   RULING MONARCH

Ruling monarch is another way of expressing time. Because during that era, people

were more accustomed to using the monarchs to mark time. Compared with the year, they may be more familiar with the monarchs. Also, there may exist a relationship between the ruling monarch and the price of wheat.

It is appropriate to use lines to represent time, so the function *segments()* can be used to represent the timeline of each monarchy. What's more, the attribute *Commonwealth* are marked with grey to indicate the difference. Here, I referred to the code and figure in the HistData package [3] to implement my reproduction. After that, a clear view of the period of the ruling monarch is shown in the graph.

V   CONCLUSION

Although I did not solve the problem of inconsistent scale, I still feel that my emulation of the original is clear. The annotation is very clear with white font in the black area, drawing histograms from 0 can more clearly compare the difference between the price of the wheat and the weekly wage of mechanics (comparing the area between the curve and the histogram).

In summary, I learnt a lot about visualisation through this coursework. In order to understand the data and the visualisation, I searched the historical background, only to know that the basic graphics that we take for granted such as the line graph, the bar chart, and the pie chart were not existing in the beginning. Most of them were invented by William Playfair. So, we should face this subject with a more open mind. Perhaps we can also find very good ways to visualise things in the real world. On the other hand, my ability to visualise with R language has also been enhanced. Especially the use of function *polygon()*, *segments()*, *gradient.rect()*, I also enjoy the process of getting the visualisation I want step by step.

REFERENCE

[1] Friendly, M. & Denis, D. (2005). The early origins and development of the scatterplot Journal of the History of the Behavioral Sciences, 41, 103-130.

[2] Playfair, W. (1821). Letter on our Agricultural Distresses, Their Causes and Remedies. London: W. Sams, 1821

[3] Michael Friendly (2018). HistData: Data Sets from the History of Statistics and Data Visualization. R package version 0.8-4. https://CRAN.R-project.org/package=HistData

APPENDIX

```r
1.  library(HistData)
2.  library(plotrix)
3.
4.  data(Wheat)
5.  data(Wheat.monarchs)
6.
7.  Wheat1 <- na.omit(Wheat)
8.
9.  # Plot wheat price and years in line(stair steps)
10. plot(Wheat$Year, Wheat$Wheat, type="s", lwd=2,
11.     ylim=c(0,104), xlim=c(1565,1820),
12.     xlab="Year(1565-1821)",
13.     ylab="Price of Wheat (shillings)",
14.     main="Time series graph of prices, wages, and ruling monarch over a 250-year period",
15.     panel.first = grid(55,28,lty = 1,lwd = 2))
16. text(1650, 70,
17.     paste("Shewing at One View",
18.         "The Price of the Quarter of Wheat",
19.         "& Wages of Labor by the Week",
20.         "from the Year 1565 to 1821",
21.         "by William Playfair",
22.         sep="\n"), font=4)
23. for (i in 1:nrow(Wheat)){
24.   gradient.rect(Wheat$Year[i],0,Wheat$Year[i+1],Wheat$Wheat[i],
25.         col=smoothColors("grey",(Wheat$Wheat[i]-0)/5,"black"),
26.         gradient="y",border=NA)
27. }
28.
29. # Plot wages and years in line
30. lines(Wheat$Year, Wheat$Wages, lwd=2,col="white")
31. text(1640,10, "Weekly wages of a Good Mechanic(Shillings)", cex=1, font=4,col="white")
32. polygon(c(1565,Wheat1$Year,1810),c(0,Wheat1$Wages,0), border =NA, col = rgb(1,1,1,0.5))
33.
34. # Plot monarchs on the top
35. p <- ifelse((!seq_along(Wheat.monarchs$start) %% 2) & !Wheat.monarchs$commonwealth, 102,
    103)
36. segments(Wheat.monarchs$start, p, Wheat.monarchs$end, p,
37.     col = ifelse(Wheat.monarchs$commonwealth, "grey", "black"),
38.     lwd = 10, lend=1)
39. text((Wheat.monarchs$start+Wheat.monarchs$end)/2, p-
    1.2, Wheat.monarchs$name, cex=0.7,font=2)
40. text(1575,106,"Ruling Monarch",cex=1,font=4)
```