

VISUAL ANALYTICS INTRODUCTION TO R TUTORIAL 1

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DATA ANALYSIS

Challenge

BIBLIOMETRICS

Study of measuring and analysing science, technology and innovation

BIBLIOMETRICS

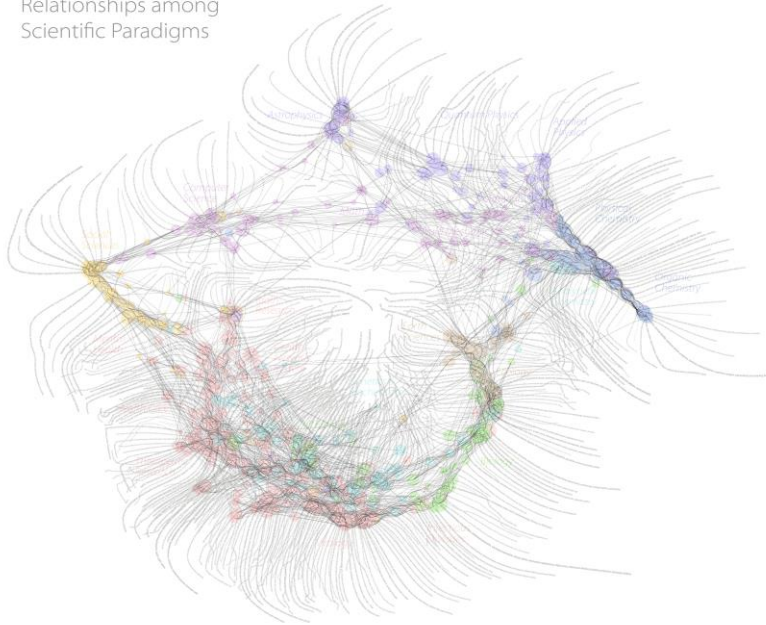
the application of mathematical and statistical methods to books and other media of communication (Pritchard, 1969)

Scientometrics: the science of measuring and analyzing science

WHY?

to understand science

Relationships among
Scientific Paradigms



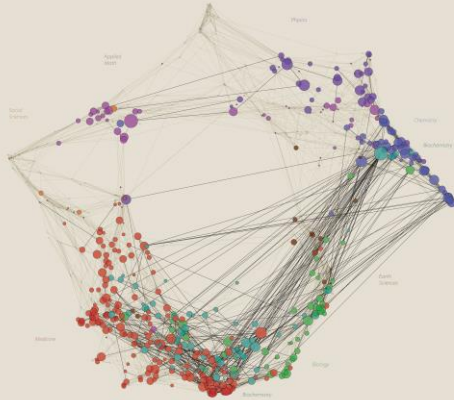
<http://wbpaley.com/brad/mapOfScience/>

THE SCIENTIFIC PARADIGMS THAT SUPPORT PATENT GENERATION

The network diagram draws attention to the areas of science that support patents. Each node (circle) represents a specific publication in a specific scientific field or paradigm. There are 73 nodes in all, distributed in six of the structure of the largest paradigms. The nodes are connected by lines representing relationships. Many patents come out of paradigms in fields that are not directly related to the paradigm. For example, the paradigm of "Chemistry" includes those that concern physical and chemical properties (15), Chemistry (20), and have the following properties of a "Chemical" (10). Areas of study include Earth Science and Biology (10), as well as the fields of Biotechnology (10), Chemistry (10), and Chemistry (10).
 Reference: [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99] [100] [101] [102] [103] [104] [105] [106] [107] [108] [109] [110] [111] [112] [113] [114] [115] [116] [117] [118] [119] [120] [121] [122] [123] [124] [125] [126] [127] [128] [129] [130] [131] [132] [133] [134] [135] [136] [137] [138] [139] [140] [141] [142] [143] [144] [145] [146] [147] [148] [149] [150] [151] [152] [153] [154] [155] [156] [157] [158] [159] [160] [161] [162] [163] [164] [165] [166] [167] [168] [169] [170] [171] [172] [173] [174] [175] [176] [177] [178] [179] [180] [181] [182] 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The size of each colored node represents the number of patents that build from that area of science. Nodes are color-coded by paradigm. There is a small collection of nodes in the computer science (CS) paradigm, a larger number of nodes in the medicine (M) paradigm, and a very large number of nodes in the earth science (ES) paradigm. There are relatively few patents coming from the social sciences (SS) paradigm (CS, ES, M).

The edges (lines between nodes) represent papers that explore multiple scientific paradigms. The thick edges are those where patents are more likely to be found. The nodes are color-coded by paradigm. There are a particularly large number of thick edges between areas of Science that build from the social sciences (SS) paradigm and the area of Science (CS) paradigm.



Drilling Down for Additional Insights

Paradigm 365

A paradigm in computer science has been pulled out of the diagram. A sub-network showing relationships between this paradigm and other areas of science. The nodes are color-coded by paradigm. The edges are color-coded by paradigm. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



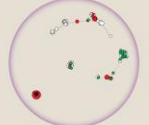
Paradigm 725

One of the largest and most important paradigms in biology has been pulled out of the diagram in order to show its relationships to other areas of science. The nodes are color-coded by paradigm. The edges are color-coded by paradigm. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



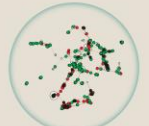
Research Communities within Paradigm 365

There are 30 unique research communities within Paradigm 365 that are further grouped into four research areas. The size of each node represents the amount of research in the area. The color represents the paradigm where the research is most highly visible. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



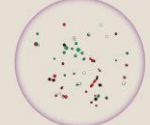
Research Communities within Paradigm 725

There are 400 unique research communities within Paradigm 725. The nodes are color-coded by paradigm. The edges are color-coded by paradigm. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



Author Communities within Paradigm 365

The size of each node represents the amount of research that the author has published in this paradigm. The color represents the paradigm where the research is most highly visible. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



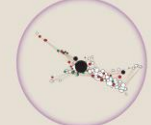
Author Communities within Paradigm 725

The size of each node represents the amount of research that the author has published in this paradigm. The color represents the paradigm where the research is most highly visible. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



Themes within Paradigm 365

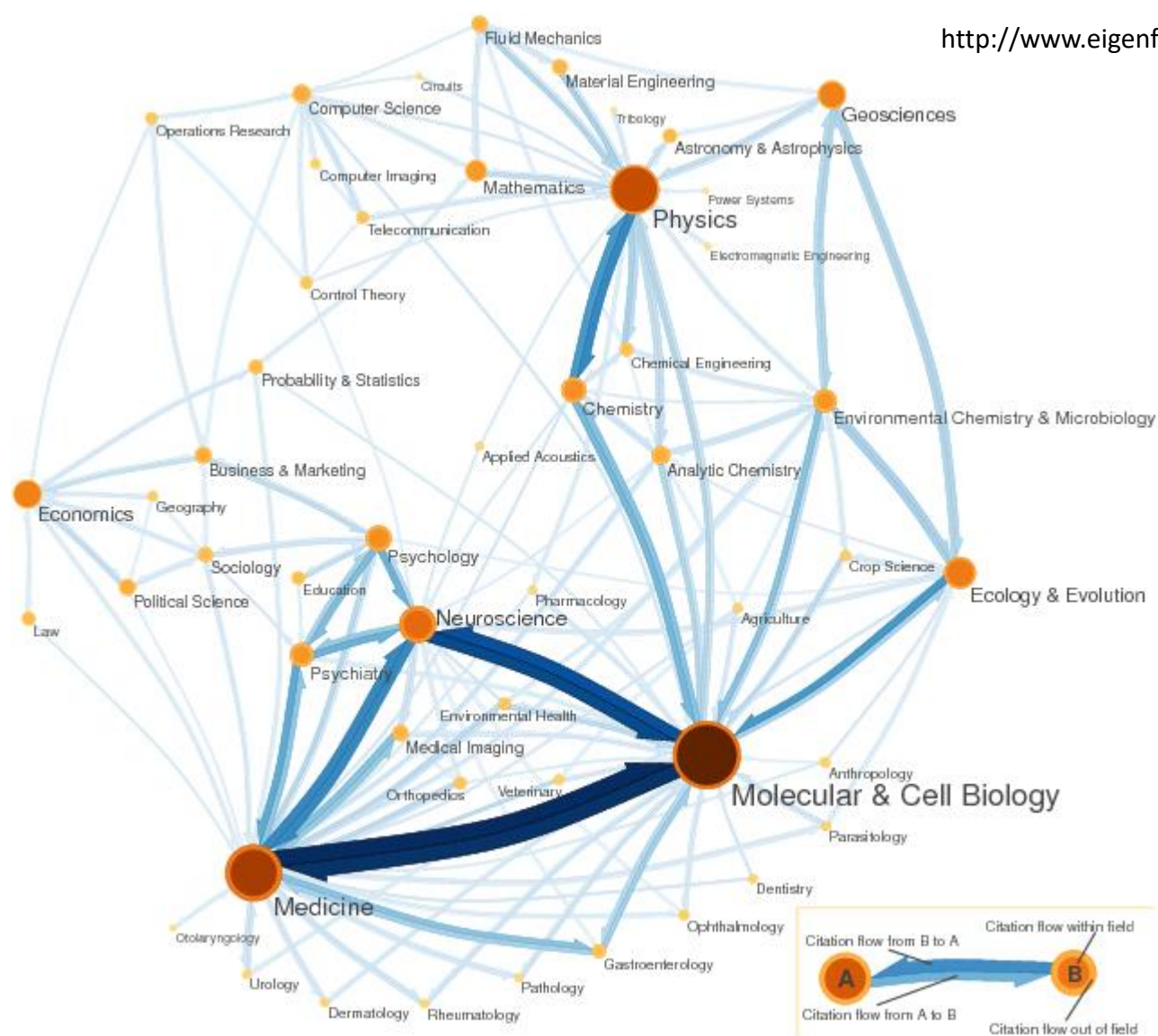
Another way to gain insights into this paradigm is to cluster the research into 100 scientific publications. The color represents the paradigm where the research is most highly visible. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.



Themes within Paradigm 725

The 400 unique research communities within Paradigm 725 can be grouped into 100 scientific publications. The color represents the paradigm where the research is most highly visible. The nodes are color-coded by paradigm. The edges are color-coded by paradigm.





WHY?

- to understand science
- to manage science / research
 - ranking of scholarly output of researchers / institutions
 - identifying the centers of excellence

WHY IMPORTANT?

- Globalization of research
- Availability of large databases
- Increased research output → need for awareness
- Quickly evolving research fields

HOW WILL WE ANALYZE SCIENCE?

- through the study of scientific publications
- in the domains of **Visual Analytics** and **Visualization**
- by using exploratory analysis **using visual analytics techniques** (& some statistics)

SCIENTIFIC PUBLICATIONS

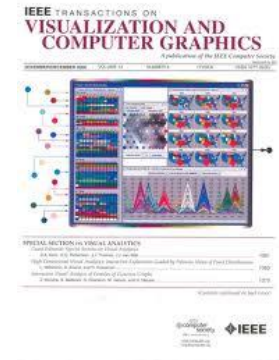
Why are they there?

1. Sharing scientific results/methods/processes
2. To show research performance
3. To allow validation of findings
4. To gain prestige and recognition

PUBLICATION VENUES

Conferences vs. Journals

- journals typical publication venues in most sciences
- in computer science (some) conference publications are highly regarded (with acceptance rates $<25\%$)



RESEARCH QUESTIONS

- Simple & boring
 - Numbers of papers at IEEE VIS 2015
- Boring
 - Numbers of papers by P. Isenberg in 2015
- Interesting (unfortunately not simple)
 - In the domain of visual analytics growing or shrinking?
 - Are visual analytics and visualization the same community?
 - Are research interests of specific researchers changing?
 - What are new research trends in visual analytics?
 - To which university should I go to do a PhD in visual analytics?
 - Who are good reviewers for a certain topic?
 - Who should be in the program committee of VAST / VIS 2017?
 - How does a change in affiliation impact a researcher's interests?
 - Is there a relation between affiliation and citations?
 - Are there gender biases in the domains of visualization? How do they compare to computer science in general?

Exploring the Placement and Design of Word-Scale Visualizations

Pascal Goffin, Wesley Willett, Jean-Daniel Fekete *Senior Member, IEEE* and Petra Isenberg

Abstract—We present an exploration and a design space that characterize the usage and placement of word-scale visualizations within text documents. Word-scale visualizations are a more general version of sparklines—small, word-sized data graphics that allow meta-information to be visually presented in-line with document text. In accordance with Edward Tufte’s definition, sparklines are traditionally placed directly before or after words in the text. We describe alternative placements that permit a wider range of word-scale graphics and more flexible integration with text layouts. These alternative placements include positioning visualizations between lines, within additional vertical and horizontal space in the document, and as interactive overlays on top of the text. Each strategy changes the dimensions of the space available to display the visualizations, as well as the degree to which the text must be adjusted or reflowed to accommodate them. We provide an illustrated design space of placement options for word-scale visualizations and identify six important variables that control the placement of the graphics and the level of disruption of the source text. We also contribute a quantitative analysis that highlights the effect of different placements on readability and text disruption. Finally, we use this analysis to propose guidelines to support the design and placement of word-scale visualizations.

Index Terms—Information visualization, text visualization, sparklines, glyphs, design space, word-scale visualizations

1 INTRODUCTION

Small high-resolution data graphics, included alongside words or word sequences in text documents, can often communicate information that could not be succinctly conveyed by the text itself. Examples include small stock charts embedded next to the name of a company, game statistics next to the name of a soccer team, or weather trends next to the name of a city. Traditionally, most of these “word-scale visualizations” have consisted of small line charts and bar charts and been placed in-line with text. Edward Tufte terms these word-scale visualizations “sparklines” [30], and provides some guidelines for their visual design. However, Tufte provides little guidance for placing word-scale visualizations with respect to text, suggesting only that they be placed in a “relevant context”—usually just after the word that they complement. However, the space of design and placement options for word-scale visualizations is actually quite large, and the consequences of placement decisions, in particular, are not well-understood.

In this paper, we provide design considerations for placing word-scale visualizations associated with words or word sequences (what we refer to as “entities”) in a document. Our work is motivated by a close collaboration on digital note-taking with historians in the digital humanities. When visiting an archive, the historians we work with regularly take detailed notes on their findings. In these notes, they specifically tag entities such as the people, locations, or dates that occur in their document sources. The goal of tagging these entities is to help historians build an understanding of how entities relate to one another, where else the same entities appear in their notes, and what kinds of metadata are associated with them. Embedding this information using word-scale visualizations is a promising approach, because these small visualizations can add additional information in-context without distracting attention from the primary reading task.

In prior work, sparklines have typically been placed before or after the word they are related to. However, this is often not possible for the kinds of notes taken by our historians—e.g. when adding information to scanned documents and other immutable texts. Placing word-scale visualizations in-line with text may also be undesirable in other situations, as it requires reflowing the text and restricts the visu-

alization’s maximum height to that of the font—making visualizations hard to read when small font sizes were chosen. In-line visualizations can also disrupt sentences, making the text more difficult to read.

To better understand the options available for integrating word-scale visualizations in text documents, we outline a design space of possible placements relative to the text. In doing so, we relax some aspects of Tufte’s original sparkline definition, imposing less restrictive size requirements and allowing the small visualizations to extend beyond strictly “word-sized.” Also, while Tufte did not restrict sparklines to specific visual encodings, the term “sparkline” does inherently suggest a “line-based” data encoding such as a line chart. In contrast, we specifically allow a variety of encodings, including geographical maps, heat maps, pie charts, and more complex visualizations and, thus, chose the term “word-scale visualizations.” We also formalize the notion of an *entity*—a concrete piece of text with associated metadata that can be encoded in a word-scale visualization. This explicit connection between an entity and a word-scale visualization directly affects the options for placing the visualization, and allows us to formally characterize the spatial relationship between text and graphic.

We begin our discussion by reviewing related work on small-scale and text visualizations. Then, in Section 3 we introduce the design space, its focus, and dimensions. Section 4 details several placement options and discusses trade-offs between word-scale visualization placement options. In Section 5 we discuss three examples that demonstrate the importance of the association between word-scale visualization and entity for the purpose of layout and interaction. Finally, in Section 6 we provide an in-depth analysis that examines how various placement options affect word-scale visualization placement in real documents. Based on this analysis, we provide recommendations that can help designers choose the right word-scale visualization given their own constraints.

2 RELATED WORK

Our work relates closely to four research areas: (a) the use of sparklines and the design of word-scale visualizations (b) the integration of meta-data within text documents, (c) research on labeling in visualization, and (d) the readability of texts and visualizations.

2.1 Sparklines and Small-Scale Visualizations

According to Tufte [30] sparklines are “small, intense, simple, word-sized graphics with typographic resolution” that can be included anywhere a word or number can be—e.g. in a sentence, table, headline, map, spreadsheet or graphic. Tufte presents several examples of these embeddings. One example shows sparklines embedded in-line with text in order to provide metadata for a single word, for example glucose measurements next to the word glucose. In another, sparklines

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BUT FIRST WE NEED TO LEARN THE TOOLS

An introduction to R

INSTALLATION

Visual Analytics...

#software [Add a topic](#)

#software

You created this channel on October 11th. This is the very beginning of the [#software](#) channel. Purpose: *software related to this class* ([edit](#))

[+ Add an app](#) [Invite others to this channel](#)

Wednesday, October 11th

Petra Isenberg 9:50 PM
joined [#software](#).

Petra Isenberg 9:50 PM
set the channel purpose: software related to this class

Petra Isenberg 9:59 PM
Pinned
shared this post

Software to Install for the Course
Last edited 1 day ago

For Lecture 1:
R:
<https://www.r-project.org/>

Petra Isenberg 9:59 PM
 The software needed for tutorials and assignments in this course

Martina 10:53 PM
joined [#software](#) along with 7 others. new messages

The screenshot shows the RStudio interface. The console pane on the left contains the following text:

```
R version 3.1.1 (2014-07-10) -- "Sock it to Me"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[workspace loaded from ~/.RData]

Loading required package: RCurl
Loading required package: bitops
> |
```

A red arrow points from the bottom of the console to the text box below. The environment pane on the right shows "Global Environment" and "Environment is empty". The viewer pane on the right shows the documentation for the `html_text` function, with the title "Extract attributes, text and tag name from html." and a description "Extract attributes, text and tag name from html."

R is an interpreted language. Type code here and have it executed

The screenshot displays the RStudio interface with three main panels. The left panel is the console, showing R version information and user commands. The top right panel is the workspace, displaying active objects A and B. The bottom right panel is the files tab, showing a file explorer view of the current workspace.

Console Output:

```
R version 3.0.0 (2013-04-03) -- "Masked Marvel"
Copyright (C) 2013 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> getwd()
[1] "H:/MyData/RFiles"
> 5*5
[1] 25
> A <- matrix(c(1,2,3,4,5,6,7,8), nrow=4, ncol=2)
> A
  [,1] [,2]
[1,]  1   5
[2,]  2   6
[3,]  3   7
[4,]  4   8
> B <- matrix(c(1,2,3,4,5,6,7,8), nrow=4, ncol=2, byrow=TRUE)
> B
  [,1] [,2]
[1,]  1   2
[2,]  3   4
[3,]  5   6
[4,]  7   8
>
```

Workspace:

Data	Size
A	4x2 double matrix
B	4x2 double matrix

Files:

Name	Size	Modified
..		
.Rhistory	34 bytes	Aug 23, 2013, 1:26 PM

The **workspace** tab shows all the active objects (see next slide). The **history** tab shows a list of commands used so far.

The **files** tab shows all the files and folders in your default workspace as if you were on a PC/Mac window. The **plots** tab will show all your graphs. The **packages** tab will list a series of packages or add-ons needed to run certain processes. For additional info see the **help** tab

The **console** is where you can type commands and see output

HELLO WORLD

Type into your console

```
> print("Hello world!")
```

output:

```
[1] "Hello world!"
```

QUICK R TUTORIALS

Let's get you to work:

```
> install.packages("swirl")  
  
> library(swirl)  
> install_from_swirl("R Programming")  
> swirl()
```

Choose "R Programming"

If you are new to R complete the following lessons:

1, 2, 4, 7

If you are already a proficient R user pick a lesson that interests you

- | when you are at the R prompt (>): |
- Typing skip() allows you to skip the current question. |
- Typing play() lets you experiment with R on your own; swirl | will ignore what you do... |
- UNTIL you type nxt() which will regain swirl's attention. |
- Typing bye() causes swirl to exit. Your progress will be | saved. |
- Typing main() returns you to swirl's main menu. |
- Typing info() displays these options again.