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Advanced quantitative text analysis (2022W)

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Contents

Day	Session 1	Session 2
1	Text as data	Text representation
2	Feature Engineering	Data collection
3	Dictionaries	Supervised machine learning
4	Unsupervised machine learning	Multilingual Text Analysis
5	Advanced methods	Wrap-up

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Introduction

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About us

Petro Tolochko

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- Research focus: Text complexity, social networks
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- Research focus: Multilingual automated text analysis
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Your turn :)

- Name
- Affiliation? Background?
- Experience with content analysis and R
- What are the expectations and wishes for the workshop and the workshop leaders?

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Course objectives

- Getting to know (basic) procedures of automated text analysis
- Insight into practical challenges
- Critical reflection on the method and its results
- Inspiration for your own projects

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Course philosophie

Topics are covered with

- Lecture style input
- Guided coded session
- Coding challenge

Interrupt us, ask all kinds of questions

Work on your own data, code ,and projects

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Course assessment

Participation in class (20%)

Final paper: application of one or several automated text analysis methods on a topic related to the PhD thesis or a topic of free choice (80%)

- Contents: short motivation, analysis (commented code), description and interpretation of results (about 10 pages)
- Format: R Markdown
- Deadline: January 31st, 2023

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Receive feedback on your projects

Very informal opportunity to talk about your text analysis use case and (initial) design (plan)

- Research question, Data, Methods, Current struggles

And to receive some feedback (no grades, points, etc. just free brainstorming opportunity)

Can also be useful to get initial feedback for your final paper in this course.

When: Friday

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Course repository

https://github.com/fabiennelind/text-as-data-in-R

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Today

9:45-10:40	Input: Orga & Intro
10:40-10:50	Coffee Break
10:50-11:45	Coding: R Basics
11:45-12:45	Lunch
12:45-13:40	Input: Text Representation
13:40-13:50	Coffee Break
13:50-14:45	Coding

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Text as Data

Day 1 Session 1

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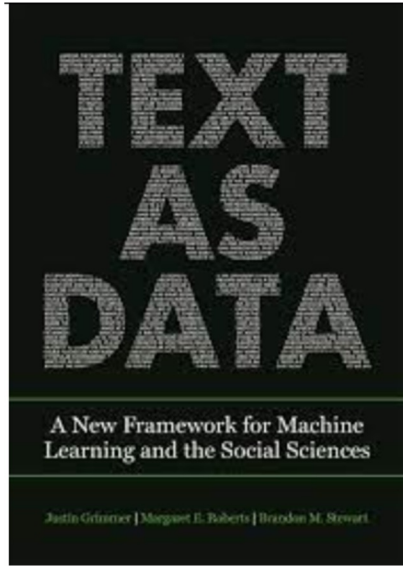
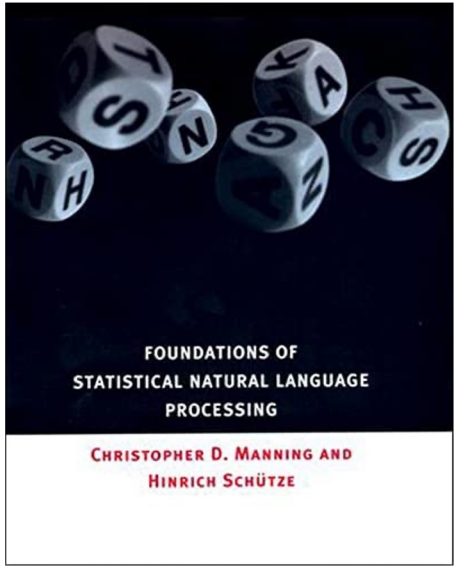
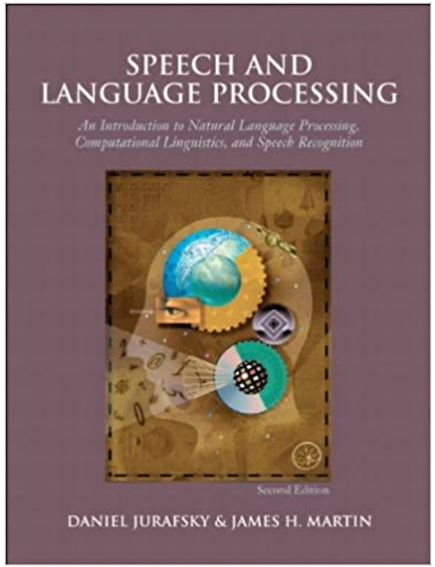
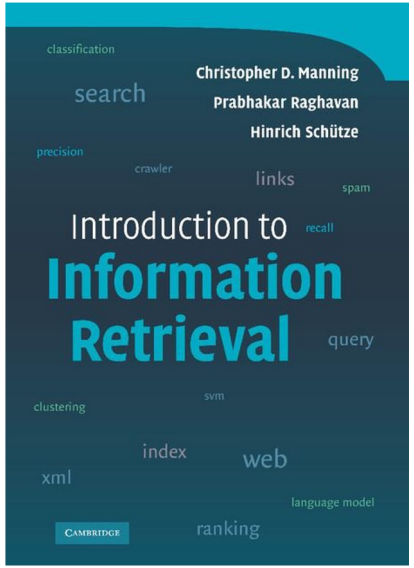
Resources









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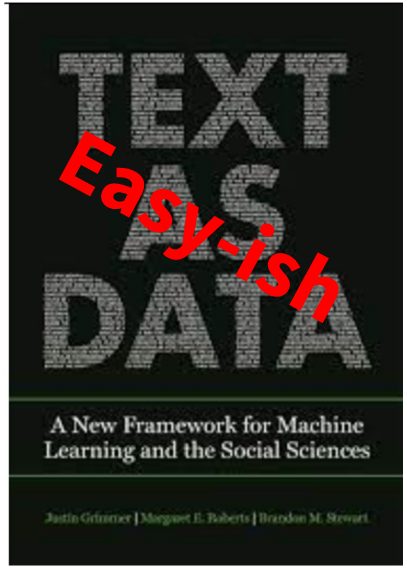
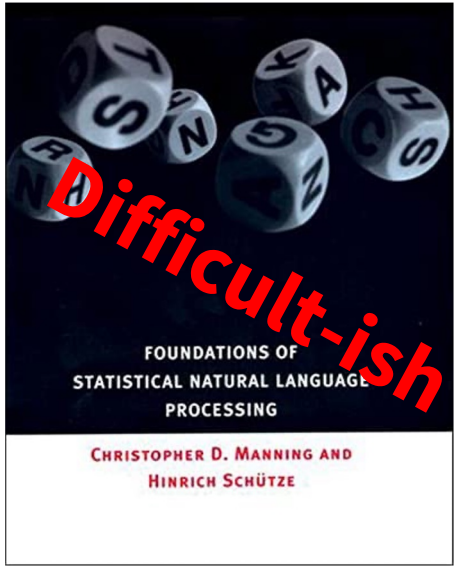
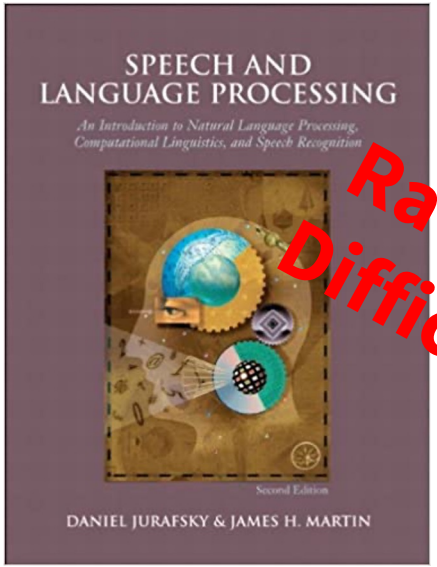
Resources



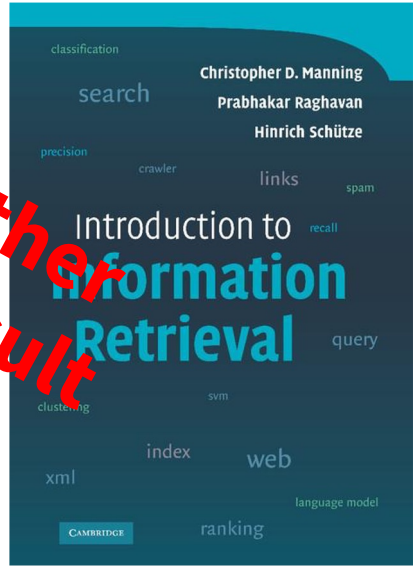
Easy-ish



Difficult-ish



Rather Difficult



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Motivations to analyse text

- Huge volumes of digital available information
- Traces of social behaviour
- Measure contents of texts
- Explain, understand, predict feelings, attitudes and behaviour of individuals, groups, societies

Barberá & Steinert-Threlkeld, 2020

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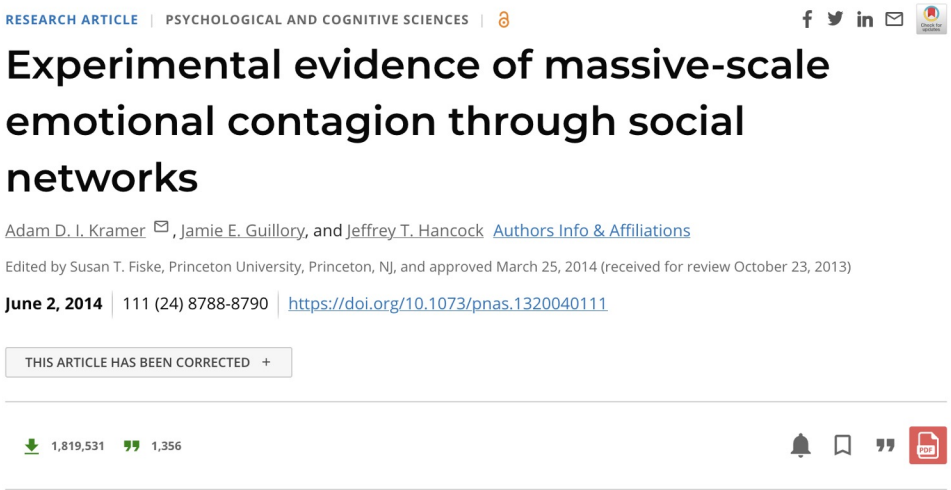
Field experiments



RESEARCH ARTICLE | PSYCHOLOGICAL AND COGNITIVE SCIENCES |

Experimental evidence of massive-scale emotional contagion through social networks

Adam D. I. Kramer, Jamie E. Guillory, and Jeffrey T. Hancock Authors Info & Affiliations

Edited by Susan T. Fiske, Princeton University, Princeton, NJ, and approved March 25, 2014 (received for review October 23, 2013)

June 2, 2014 | 111 (24) 8788-8790 | https://doi.org/10.1073/pnas.1320040111

THIS ARTICLE HAS BEEN CORRECTED +

1,819,531 1,356

Significance

We show, via a massive (N = 689,003) experiment on Facebook, that emotional states can be transferred to others via emotional contagion, leading people to experience the same emotions without their awareness. We provide experimental evidence that emotional contagion occurs without direct interaction between people (exposure to a friend expressing an emotion is sufficient), and in the complete absence of nonverbal cues.

Effects of social media communication

New Media & Society
OnlineFirst

https://doi-org.uaccess.univie.ac.at/10.1177/14614448221088970

Article

The relationship between humanitarian NGO communication and user engagement on Twitter

Daniela Dimitrova [1], Tobias Heidenreich [2], and Teodor Antonio Georgiev[3]

Abstract

One of the few actors whose mission is to provide support and advocacy for refugee communities with limited access to information and services are humanitarian non-governmental organizations (NGOs). This study examines the narratives produced by the leading humanitarian NGOs on one of the most popular social media platforms today—namely, Twitter. The study investigates which narratives are most popular among global NGOs and whether the way they frame the refugee issue is related to Twitter engagement. The findings contribute to scholarship on online communication and user engagement, and also inform humanitarian NGO practices and policy discussions regarding media and migration.

Keywords

Message framing, migration, NGO communication, refugees, Twitter, user engagement

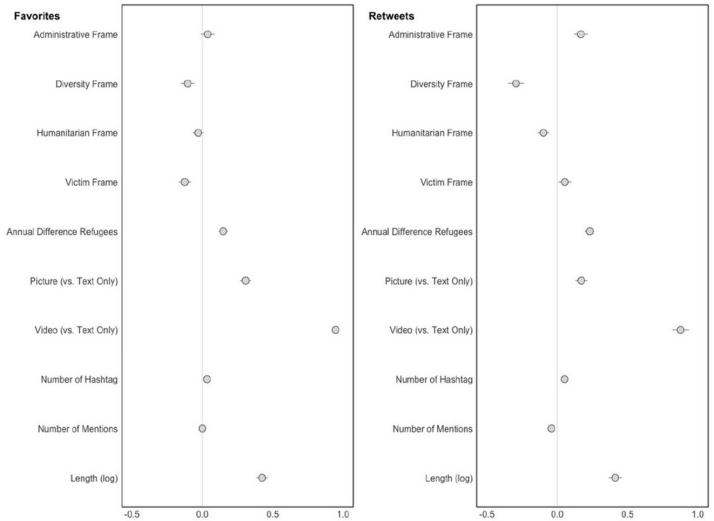


Figure 2. Estimated posterior fixed-effects parameters.
Note. Estimated posterior fixed-effects parameters for the models considering the number of favorites (left) and retweets (right). Thin lines represent 95% confidence intervals (CIs).

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Polarization

2012 Presidential Election

2013 Super Bowl

Dark red = conservative
dark blue = liberal

Barbera et al., 2015, Fig. 3

For a systematic lit review see also: Kubin & von Sikorski 2021

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Policy diffusion

AJPS AMERICAN JOURNAL of POLITICAL SCIENCE

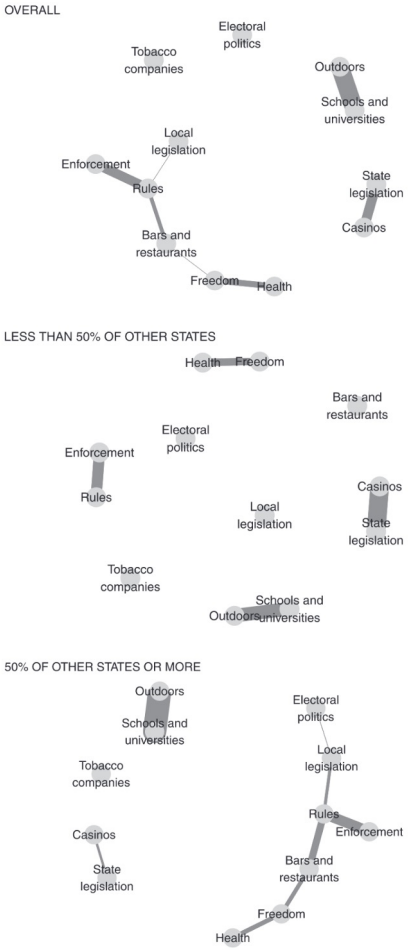
Policy Diffusion: The Issue-Definition Stage

Fabrizio Gilardi University of Zurich
Charles R. Shipan University of Michigan
Bruno Wüest Forschungsstelle sotomo

Abstract: *We put forward a new approach to studying issue definition within the context of policy diffusion. Most studies of policy diffusion—which is the process by which policymaking in one government affects policymaking in other governments—have focused on policy adoptions. We shift the focus to an important but neglected aspect of this process: the issue-definition stage. We use topic models to estimate how policies are framed during this stage and how these frames are predicted by prior policy adoptions. Focusing on smoking restriction in U.S. states, our analysis draws upon an original data set of over 52,000 paragraphs from newspapers covering 49 states between 1996 and 2013. We find that frames regarding the policy's concrete implications are predicted by prior adoptions in other states, whereas frames regarding its normative justifications are not. Our approach and findings open the way for a new perspective to studying policy diffusion in many different areas.*

Verification Materials: The data and materials required to verify the computational reproducibility of the results, procedures, and analyses in this article are available on the *American Journal of Political Science* Dataverse within the Harvard Dataverse Network, at https://doi.org/10.7910/DVN/QEMNP1.

FIGURE 3 Topic Correlations



Note: Topic correlations over all paragraphs (top panel) and as a function of low (center panel) or high values (bottom panel) of the share of prior policy adoptions within a state's diffusion network.

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Motivations to analyse text automatically

- Impossible to read all texts for large corpora

https://www.mittelbayerische.de/junge-leser/klasse-informiert-nachrichten/warum-wir-heute-zeitung-lesen-koennen-24440-art1260807.html

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Purpose of obtaining measures for a large number of documents

- Filter options
  - If measurements are available for a large number of data, other filtering options are possible. E.g.; linkage studies combination with media usage data
- Evidence-based policy making
  - Making the opinion of populations visible, holding politicians accountable

González-Bailón, 2013

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The end of manual coding?

- Augmenting not replacing (Grimmer & Steward, 2013)
- Human input for quality control: select, monitor, and test on the level of data, inputs, process, outputs

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Some major challenges when working with large corpora

Big data, big bias?

The end of theory?

Generalizing from online to offline behavior

Ethical concerns (Guess, 2021)

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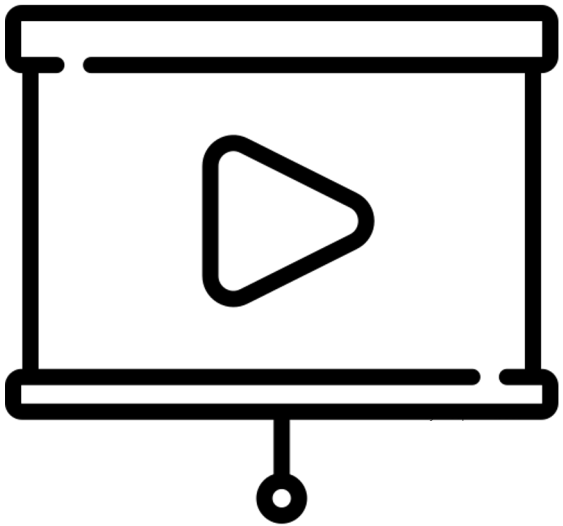
Your (initial) text analysis project idea



by Freepik - Flaticon

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Motivations to use R and RStudio

- Free
- Open source
- Large number of packages, still growing (Nov 2022: 18834 packages on CRAN)
- Large variety of packages: scraping, cleaning, analysis, data visualisation, network analysis, etc.
- Great online support ressources
- A full programming language and thus a good start to pick up other programming languages

RStudio is now Posit, our mission continues

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Exercise in R

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Text Representation

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What is text?

- Data
- *Unstructured*
- *Multidimensional (Highly)*

In general, difficult to work with (if you're not human)

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From Text to Structure

- We need to “structure” the text before we perform analyses
- Different ways to ***represent*** text so that computers “understand”
- Different ways to ***model*** text so that both (we and computer) “understand”
    - Different research questions
    - Different ways to think about what text is

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Document-Term Matrix

$$X = \begin{bmatrix} 1 & 1 & \dots & 0 \\ 2 & 1 & \dots & 0 \\ \dots & \dots & \dots & \\ 2 & 0 & \dots & 3 \end{bmatrix}$$

X = N * K matrix
N = number of ***documents***
K = number of ***terms***/***features***

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Example

Corpus (Collection of texts)

Document 1: “John loves ice-cream”
Document 2: “John loves oranges”
Document 3: “Marry hates ice-cream”

N? K?

	Terms					
Docs	icecream	john	loves	oranges	hates	marry
1	1	1	1	0	0	0
2	0	1	1	1	0	0
3	1	0	0	0	1	1

N = 3
K = 6

X = 3 * 6 matrix

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Types & Tokens

Types: unique words in a text

Tokens: all words in the text

Types and tokens in our example corpus?

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Types & Tokens

Types: unique words in a text

Tokens: all words in the text

Types and tokens in our example corpus?

6 types (unique words) / *9 tokens* (total length of the corpus)

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Bag-of-Words representation

Representation of text as a bag of words

- Collection of words
- Ordering is unimportant
- Each text is represented as a ***count*** of word contained in it

	Terms					
Docs	icecream	john	loves	oranges	hates	marry
1	1	1	1	0	0	0
2	0	1	1	1	0	0
3	1	0	0	0	1	1

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Multinomial Model of Language

You can think of a text as a draw from a Multinomial distribution

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Binomial

$$\binom{n}{k} p^k (1-p)^{n-k}$$

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Binomial

n = number of events
k = number of successes

$$\binom{n}{k} p^k (1-p)^{n-k}$$

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Multinomial

$$\frac{n!}{x_1!...x_k!}p_1^{x_1}...p_k^{x_k}$$

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Multinomial

$$\frac{n!}{x_1!...x_k!}p_1^{x_1}...p_k^{x_k}$$

n = text length
k = size of vocabulary
p = probability of a word

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Example Texts

Text_1 = "banana banana banana banana chocolate"

Text_3 = "chocolate chocolate chocolate banana fudge"

Text_2 = "banana banana"

Text_4 = "icecream icecream fudge ice-cream"

Text_5 = "fudge fudge fudge"

Text_6 = "ice-cream ice-cream fudge fudge"

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Example Texts

Text_1 = "banana banana banana banana chocolate"

Text_3 = "chocolate chocolate chocolate banana fudge"

Text_2 = "banana banana"

John

Text_4 = "icecream icecream fudge ice-cream"

Text_5 = "fudge fudge fudge"

Text_6 = "ice-cream ice-cream fudge fudge"

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Example Texts

Text_1 = "banana banana banana banana chocolate"
Text_3 = "chocolate chocolate chocolate banana fudge"
Text_2 = "banana banana"

John

Text_4 = "icecream icecream fudge ice-cream"
Text_5 = "fudge fudge fudge"
Text_6 = "ice-cream ice-cream fudge fudge"

Marry

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Document-Term Matrix

banana	chocolate	fudge	icecream
4	1	0	0
2	0	0	0
1	3	1	0
0	0	1	3
0	0	3	0
0	0	2	2

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Document-Term Matrix

banana	chocolate	fudge	icecream
7	4	1	0

John rates

banana	chocolate	fudge	icecream
1	3	7	5

Marry rates

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John Language Model

Document-Term Matrix

banana	chocolate	fudge	icecream
7	4	1	0

John rates

banana	chocolate	fudge	icecream
1	3	7	5

Marry rates

Marry Language Model

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New Texts

new_text_1 = "ice-cream fudge fudge"

new_text_2 = "chocolate chocolate banana banana"

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New Texts

new_text_1 = "ice-cream fudge fudge"

new_text_2 = "chocolate chocolate banana banana"

What's the probability that they have been generated by John or Marry?

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New Texts

banana	chocolate	fudge	icecream
0	0	2	1
2	2	0	0

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Probability Spoken by John

new_text_1 = "ice-cream fudge fudge"

$$Pr(b = 0, ch = 0, f = 2, i = 1) = \frac{3!}{0!0!2!1!} 0.583^0 \times 0.333^0 \times 0.08^2 \times 0^1 = 0$$

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Probability Spoken by John

new_text_2 = "chocolate chocolate banana banana"

$$Pr(b = 2, ch = 2, f = 0, i = 0) = \frac{4!}{2!2!0!0!} 0.583^2 \times 0.333^2 \times 0.08^0 \times 0^0 = 0.23$$

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Probability Spoken by Marry

new_text_1 = "ice-cream fudge fudge"

P = 0.18

new_text_2 = "chocolate chocolate banana banana"

P = 0.0008

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Vector Space Representation

Representation of texts as ***vectors*** in a multidimensional ***space***

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Multidimensional?

- Position on a map:
  - **X** = Longitude **Y** = Latitude
- Position in a real world:
  - **X** = Longitude **Y** = Latitude **Z** = Height
- Point in time and space
  - **X** = Longitude **Y** = Latitude **Z** = Height **T** = Time

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Multidimensional?

Number of dimensions is the ***number of data points*** needed to describe an object in space

- ***Coordinates*** in the context of ***geographical position***
- ***Words*** in the context of position of text within a ***linguistic space***

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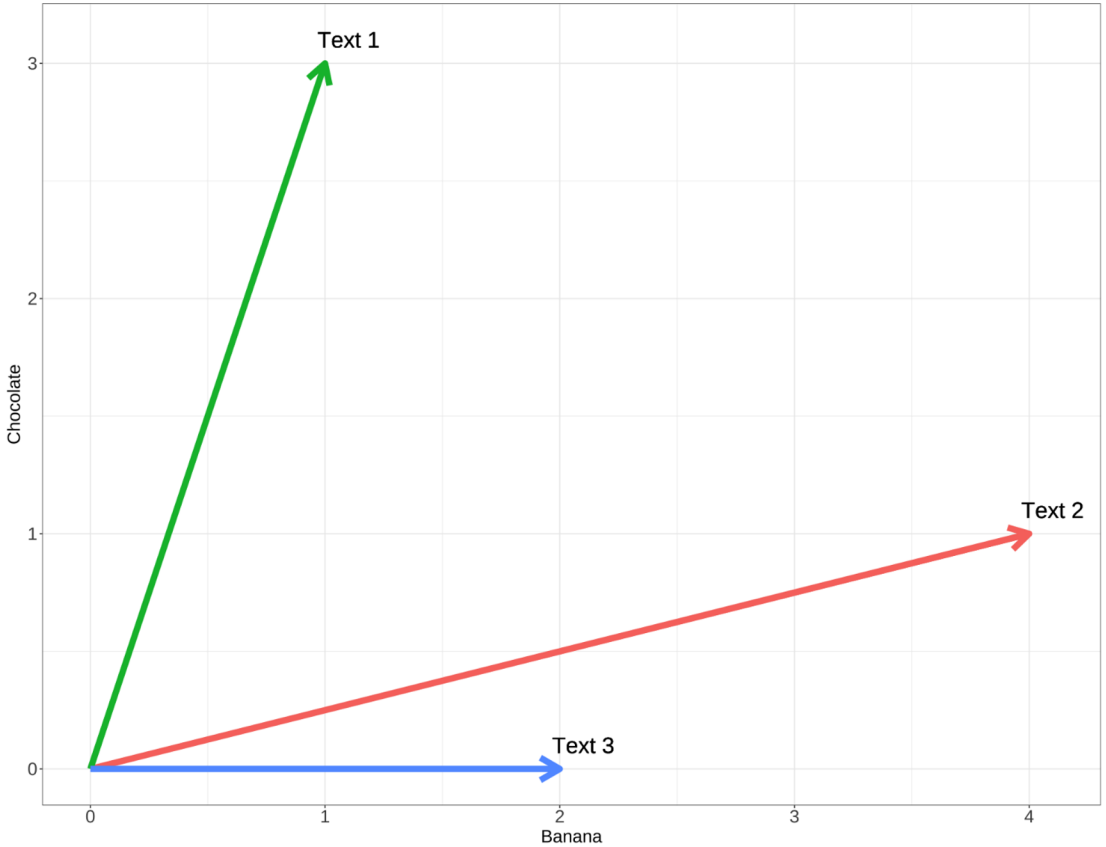
Two-dimensional space

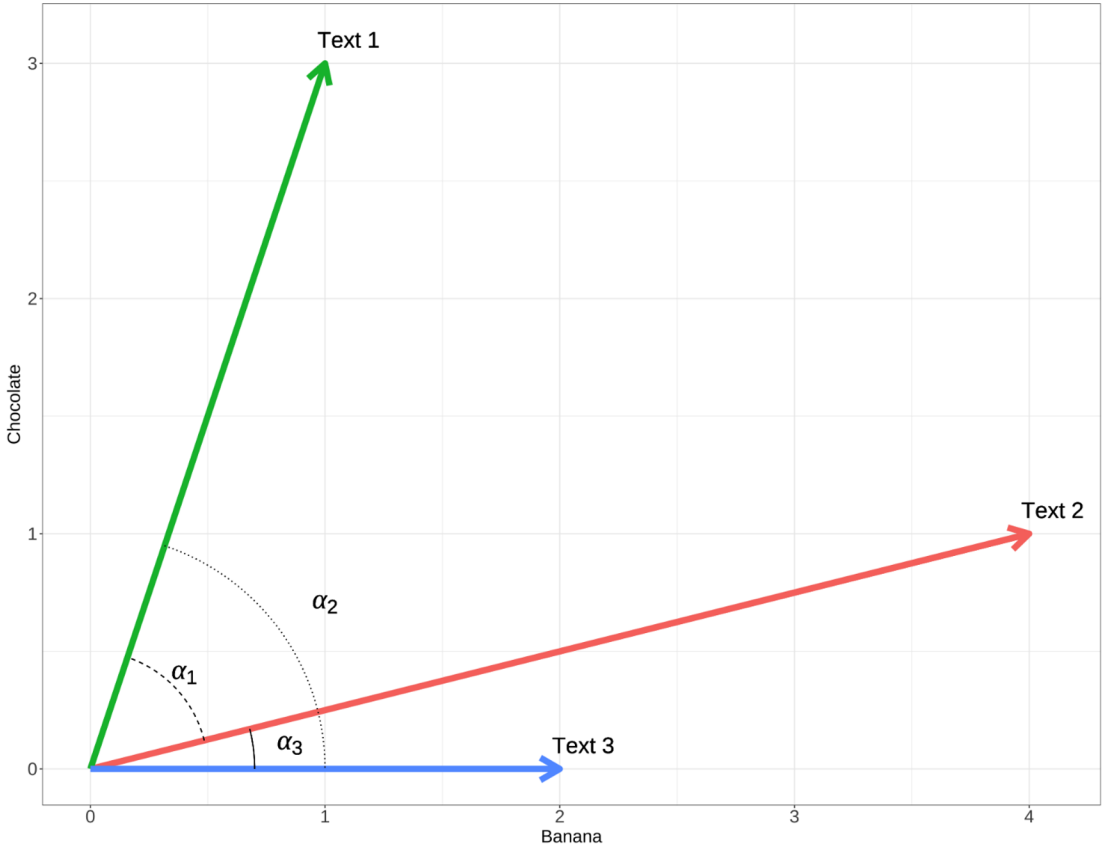
vocabulary = {“banana”, “chocolate”}

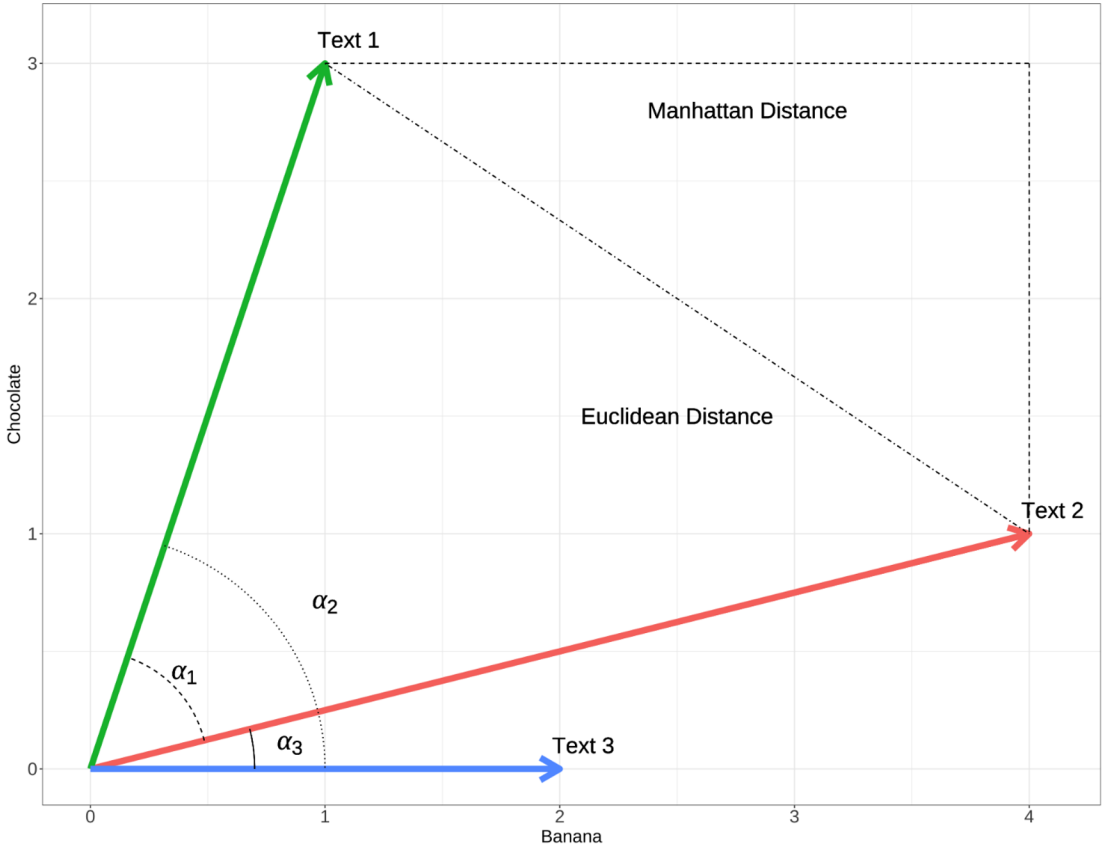
Text 1 = “chocolate, chocolate, chocolate, banana”

Text 2 = “banana, banana, banana, banana, chocolate”

Text 3 = “banana, banana”


Text 1
Text 2
Text 3
Chocolate
Banana
0
1
2
3
4


Text 1
Text 2
Text 3
α_1
α_2
α_3
Chocolate
Banana
0
1
2
3
4


Text 1
Manhattan Distance
Euclidean Distance
Text 2
α_2
α_1
α_3
Text 3
Chocolate
Banana
0
1
2
3
4

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Multidimensional?

Estimated ~1,022,000 words in English language

~ 1,022,000-dimensional space


[adult swim]

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Same math, though

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Distributional Hypothesis / Word Embeddings

The new thing kids do…

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Distributional Hypothesis / Word Embeddings

The new thing kids do… at least since ‘57…

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Distributional Hypothesis / Word Embeddings

- In most cases, the meaning of a word is its use (Wittgenstein, 1953)
- Distributional hypothesis: difference of meaning correlates with difference of distribution (Harris, 1954)
- A word is characterized by the company it keeps (Firth, 1957)
- Words which are similar in meaning occur in similar contexts (Rubenstein & Goodenough, 1965)
- Words with similar meanings will occur with similar neighbors if enough text material is available (Schütze & Pedersen, 1995)

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Distributional Hypothesis / Word Embeddings

Each word is *embedded* in an n-dimensional vector space (typically, 300 dimensions)

Neural network that “learns” the context of a word by looking at the words *around* it

Word2Vec (Mikolov, 2013) – one of the most famous methodologies

```
[ 0.20778 , -2.4151  ,  0.36605 ,  2.0139  , -0.23752 , -3.1952  ,
 -0.2952  ,  1.2272  , -3.4129  , -0.54969 ,  0.32634 , -1.0813  ,
  0.55626 ,  1.5195  ,  0.97797 , -3.1816  , -0.37207 , -0.86093 ,
  2.1509  , -4.0845  ,  0.035405,  3.5702  , -0.79413 , -1.7025  ,
 -1.6371  , -3.198   , -1.9387  ,  0.91166 ,  0.85409 ,  1.8039  ,
 -1.103   , -2.5274  ,  1.6365  , -0.82082 ,  1.0278  , -1.705   ,
  1.5511  , -0.95633 , -1.4702  , -1.865   , -0.19324 , -0.49123 ,
  2.2361  ,  2.2119  ,  3.6654  ,  1.7943  , -0.20601 ,  1.5483  ,
 -1.3964  , -0.50819 ,  2.1288  , -2.332   ,  1.3539  , -2.1917  ,
  1.8923  ,  0.28472 ,  0.54285 ,  1.2309  ,  0.26027 ,  1.9542  ,
  1.1739  , -0.40348 ,  3.2028  ,  0.75381 , -2.7179  , -1.3587  ,
 -1.1965  , -2.0923  ,  2.2855  , -0.3058  , -0.63174 ,  0.70083 ,
  0.16899 ,  1.2325  ,  0.97006 , -0.23356 , -2.094   , -1.737   ,
  3.6075  , -1.511   , -0.9135  ,  0.53878 ,  0.49268 ,  0.44751 ,
  0.6315  ,  1.4963  ,  4.1725  ,  2.1961  , -1.2409  ,  0.4214  ,
  2.9678  ,  1.841   ,  3.0133  , -4.4652  ,  0.96521 , -0.29787 ,
  4.3386  , -1.2527  , -1.7734  , -3.5637  , -0.20035 , -3.3013  ,
  0.99951 , -0.92888 , -0.94594 ,  1.5124  , -3.9385  ,  2.7935  ,
 -3.1042  ,  3.3382  ,  0.54513 , -0.37663 ,  2.5151  ,  0.51468 ,
 -0.88907 ,  1.011   ,  3.4705  , -3.6037  ,  1.3702  ,  2.3468  ,
  1.6674  ,  1.3904  , -2.8112  ,  2.237   , -1.0344  , -0.57164 ,
  1.0641  , -1.6919  ,  1.958   , -0.78305 ,  0.14741 ,  0.51083 ,
  1.8278  , -0.69638 ,  0.90548 ,  0.62282 , -1.8315  , -2.8587  ,
  0.48424 , -2.0527  , -0.53808 , -2.3472  ,  1.0354  , -1.8257  ,
 -0.3892  , -0.24943 ,  0.8651  , -1.5195  ,  1.2166  , -2.698   ,
 -0.96698 ,  2.2175  , -0.16089 , -0.49677 , -0.19646 ,  1.3284  ,
  4.0824  ,  1.3919  ,  0.80669 , -1.0316  , -0.28056 , -1.8632  ,
  0.47716 , -0.53628 ,  1.3853  , -2.1755  , -0.2354  ,  2.4933  ,
 -0.87255 ,  1.4493  , -0.10778 , -0.44159 ,  1.3462  ,  4.4211  ,
 -1.8385  ,  0.3985  ,  0.47637 , -0.60074 ,  3.3583  , -0.15006 ,
 -0.40495 ,  2.7225  , -1.6297  ,  0.86797 , -4.1445  , -2.7793  ,
  1.1535  , -0.011691,  0.9792  , -1.0141  ,  0.80134 ,  0.43642 ,
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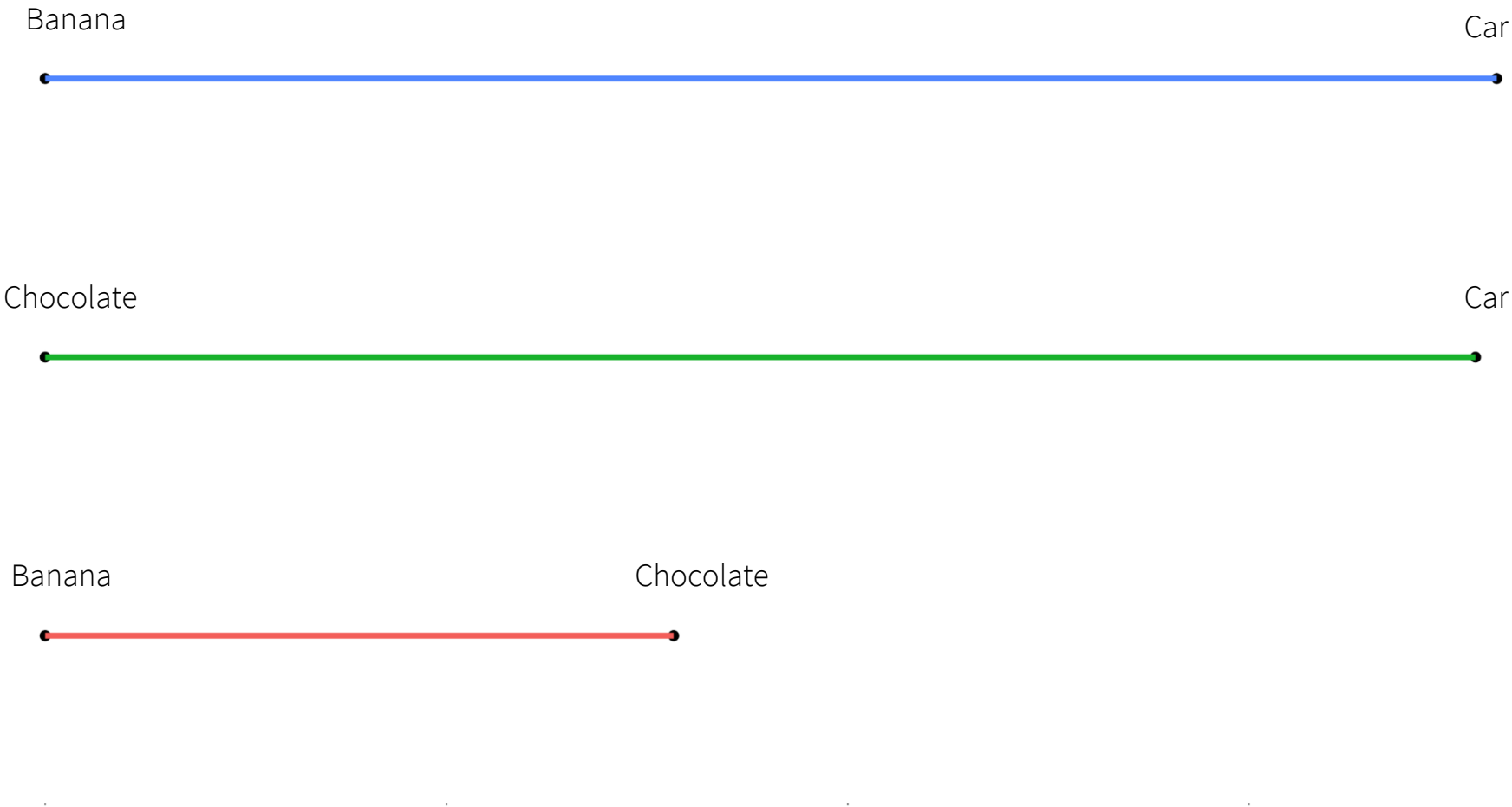
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More on text representation later in the week