Multifactorial Exploratory Approaches: multiple correspondence analysis

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Multifactorial Exploratory Approaches

multiple correspondence analysis

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outline

MCA

Because MCA is an extension of CA, its inner workings are very similar. For this reason, they are not repeated here.

nominal data

As pointed out yesterday, MCA takes as input a table of nominal data.

Table 1: A sample input table for MCA (Desagulier 2017, p. 36)

corpus file	mode	genre	exact match	intensifier	syntax	adjective
KBF.xml	spoken	conv	*a quite ferocious mess*	quite	preadjectival	*ferocious*
AT1.xml	written	biography	*quite a flirty person*	quite	predeterminer	*flirty*
A7F.xml	written	misc	*a rather anonymous name*	rather	preadjectival	*anonymous*
ECD.xml	written	commerce	*a rather precarious foothold*	rather	preadjectival	*precarious*
B2E.xml	written	biography	*quite a restless night*	quite	predeterminer	*restless*
AM4.xml	written	misc	*a rather different turn*	rather	preadjectival	*different*
F85.xml	spoken	unclassified	*a rather younger age*	rather	preadjectival	*younger*
J3X.xml	spoken	unclassified	*quite a long time*	quite	predeterminer	*long*
KBK.xml	spoken	conv	*quite a leading light*	quite	predeterminer	*leading*

beware of inertia

For MCA to yield manageable results, it is best if

- the table is of reasonable size (not too many columns)
- each variable does not break down into too many categories

Otherwise, the contribution of each dimension to ϕ^2 is small, and a large number of dimensions must be inspected(which kind of defeats the purpose)

beware of inertia

There are no hard and fast rules for knowing when there are too many dimensions to inspect.
However, when the eigenvalue that corresponds to a dimension is low, we know that the dimension is of little interest (the chances are that the data points will be close to the intersection of the axes in the summary plot).

how men and women swear in the BNC-XML

Schmid (2003) provides an analysis of sex differences in the 10M-word spoken section of the British National Corpus (BNC). Schmid shows that women use certain swear-words more than men, although swear-words which tend to have a perceived 'strong' effect are more frequent in male speech. Schmid's study is based on two subcorpora, which are both sampled from the spoken section of the BNC. The subcorpora amount to 8,173,608 words.

how men and women swear in the BNC-XML

The contributions are not equally shared among men and women since for every 100 word spoken by women, 151 are spoken by men. To calculate the distinctive lexical preferences of men and women, while taking the lack of balance in the contributions into account, Schmid's measures rely on the difference coefficient.

how men and women swear in the BNC-XML

This formula is based on normalized frequencies per million words. Its score ranges from -1 (if a word occurs more frequently in women's utterances) to 1 (if a word occurs more frequently in male speech). Absolute frequencies are used to calculate the significance level of the differences using the hypergeometrical approximation of the binomial distribution. With respect to swear-words, Schmid's conclusion is that both men and women swear, but men tend to use stronger swear-words than women.

how men and women swear in the BNC-XML

Schmid's study is repeated here in order to explore the distribution of swear-words with respect to gender in the BNC-XML. The goal is to see if:

- men swear more than women;
- some swear-words are preferred by men or women;
- the gender-distribution of swear-words is correlated with other variables: age and social class.

The data file for this case study is `swearwords_bnc.txt`.

how men and women swear in the BNC-XML

The code for the extraction was partly contributed by Mathilde Léger, a third-year student at Paris 8 University, as part of her end-of-term project.
Unlike Schmid, and following Rayson et al. (1997), the data are extracted from the demographic component of the BNC-XML, which consists of spontaneous interactive discourse. The swear-words are: *bloody*, *damn*, *fuck*, *fucked*, *fucker*, *fucking*, *gosh*, and *shit*.
Two exploratory variables are included: age and social class.

how men and women swear in the BNC-XML

```
> # clear R's memory
> rm(list=ls(all=TRUE))
> #load FactoMineR
> library(FactoMineR)
> # load the data (choose swearwords_bnc.txt)
> df <- read.table(file=file.choose(), header=TRUE, sep="\t")
```

how men and women swear in the BNC-XML

The data set contains 293,289 swear-words. These words are described by three categorical variables (nominal data):

- gender (2 levels: male and female)
- age (6 levels: Ag0, Ag1, Ag2, Ag3, Ag4, Ag5)
- social class (4 levels: AB, C1, C2, DE)

how men and women swear in the BNC-XML

Age breaks down into 6 groups:

- `Ag0`: respondent age between 0 and 14;
- `Ag1`: respondent age between 15 and 24;
- `Ag2`: respondent age between 25 and 34;
- `Ag3`: respondent age between 35 and 44;
- `Ag4`: respondent age between 45 and 59;
- `Ag5`: respondent age is 60+.

Social classes are divided into 4 groups:

- `AB`: higher management: administrative or professional.
- `C1`: lower management: supervisory or clerical;
- `C2`: skilled manual;
- `DE`: semi-skilled or unskilled.

how men and women swear in the BNC-XML

It is advisable to keep an eye on the number of levels for each variable and see if any can be kept to a minimum to guarantee that inertia will not drop.

```
> str(df)
'data.frame': 293289 obs. of  4 variables:
 $ word     : Factor w/ 8 levels "bloody","damn",..: 2 2 7 7 7 2 7 2 7 7 ...
 $ gender   : Factor w/ 2 levels "f","m": 2 2 2 2 2 2 2 2 2 2 ...
 $ age      : Factor w/ 6 levels "Ag0","Ag1","Ag2",..: 6 6 6 6 6 6 6 6 6 6 ...
 $ soc_class: Factor w/ 4 levels "AB","C1","C2",..: 1 1 1 1 1 1 1 1 1 1 ...
> table(df$word)

 bloody    damn    fuck  fucked  fucker fucking    gosh    shit
 146203   32294    9219      11     467   23487   60678   20930
```

how men and women swear in the BNC-XML

We can group *fuck*, *fucking*, *fucked*, and *fucker* into a single factor: *f*-words. With `gsub()`, we replace each word with the single tag `f-words`.

```
> df$word <- gsub("fuck|fucking|fucker|fucked", "f-words", df$word, ignore.case=TRUE)
> table(df$word)

 bloody    damn f-words    gosh    shit
 146203   32294   33184   60678   20930
```

We convert `df$word` back to a factor. The number of levels has been reduced to five.

```
> df$word <- as.factor(df$word)
```

How men and women swear in the BNC-XML

As in CA, we can declare some variables as active and some other variables as supplementary/illustrative in MCA. We declare the variables corresponding to swear words and gender as active, and the variables age and social class as supplementary/illustrative.
Running a MCA involves the following steps:

- determining how many dimensions there are to inspect;
- interpreting the MCA graph.

How men and women swear in the BNC-XML

We run the MCA with the `MCA()` function. We declare age and `soc_class` as supplementary (`quali.sup=c(3,4)`). We do not plot the graph yet (`graph=FALSE`).

```
> mca.object <- MCA(df, quali.sup=c(3,4), graph=FALSE)
```

Again, the `eig` object allows us to see how many dimensions there are to inspect.

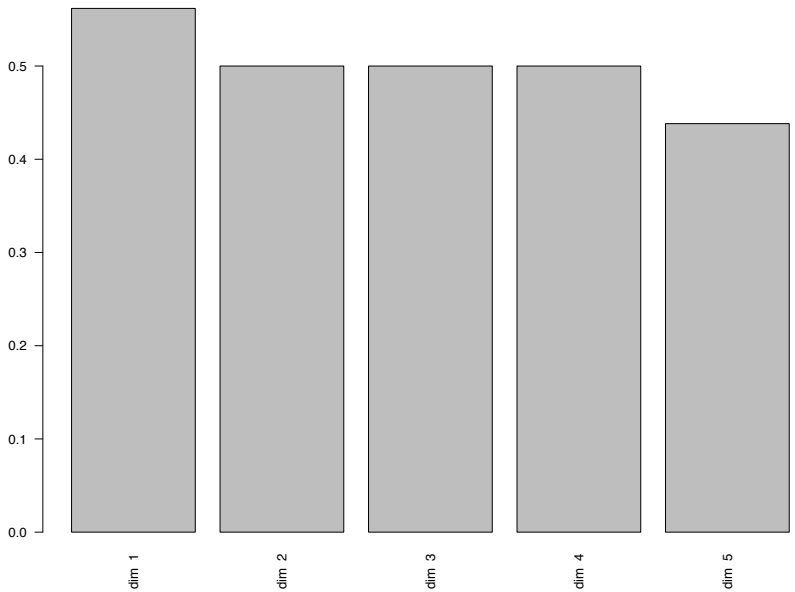
```
> round(mca.object$eig, 2)
      eigenvalue percentage of variance cumulative percentage of variance
dim 1       0.56                 22.47                              22.47
dim 2       0.50                 20.00                              42.47
dim 3       0.50                 20.00                              62.47
dim 4       0.50                 20.00                              82.47
dim 5       0.44                 17.53                             100.00
```

How men and women swear in the BNC-XML

The number of dimensions is rather large and the first two dimensions account for only 42.47% of ϕ^2. To inspect a significant share of ϕ^2, e.g. 80%, we would have to inspect at least 4 dimensions. This issue is common in MCA. The eigenvalues can be vizualized by means of a scree plot. It is obtained as follows.

```
> barplot(mca.object$eig[,1],
+         names.arg=paste("dim ", 1:nrow(mca.object$eig)), las=2)
```

How men and women swear in the BNC-XML



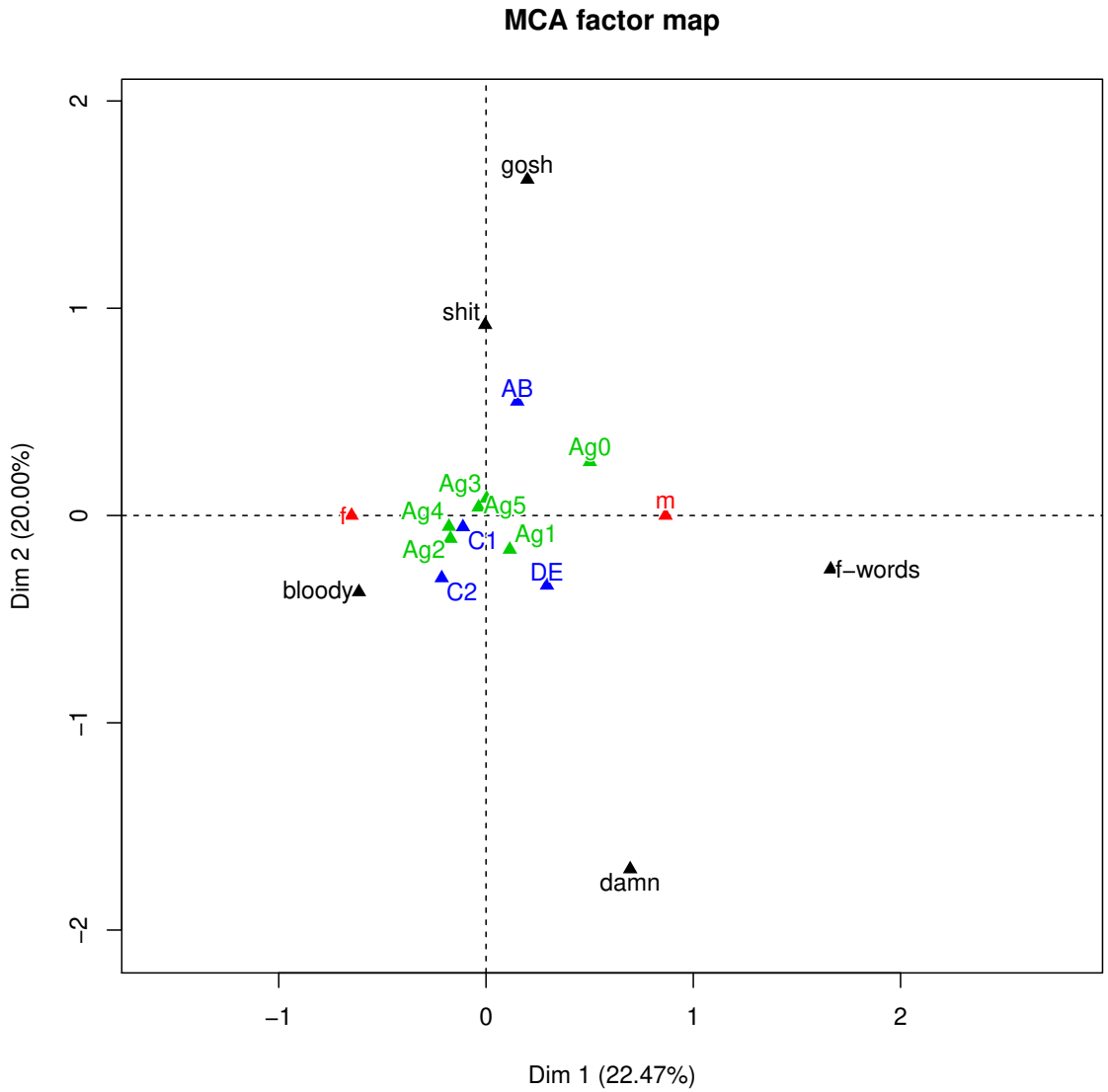
Ideally, we would want to see a sharp decrease after the first few dimensions, and we would want these first few dimensions to account for as much share of ϕ^2 as possible. Here, no sharp decrease is observed.

How men and women swear in the BNC-XML

The MCA map is plotted with the `plot.MCA()` function. Each category is the color of its variable (`habillage="quali"`). The title is removed (`title=""`).

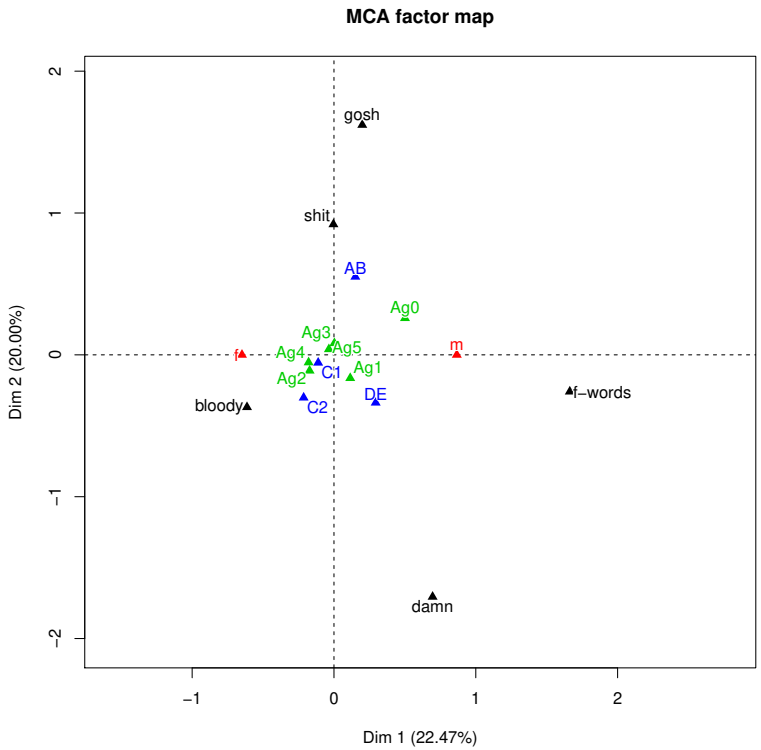
```
> plot.MCA(mca.object,
+          invisible="ind",
+          autoLab="yes",
+          shadowtext=TRUE,
+          habillage="quali",
+          title="")
```

How men and women swear in the BNC-XML



How men and women swear in the BNC-XML

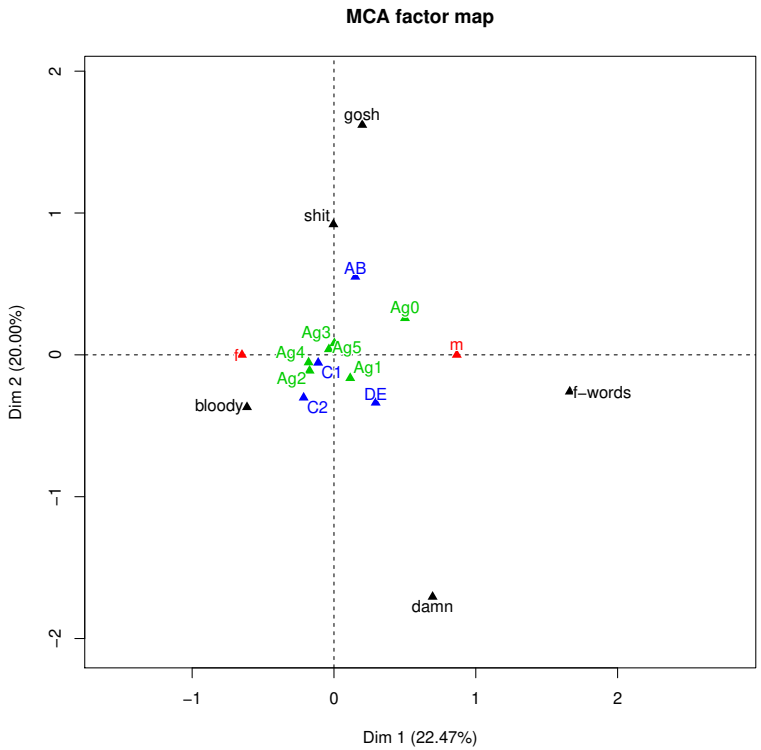
dim 1



Strikingly, the most explicit swear words (*f*-words) cluster in the right-most part of the plot. These are used mostly by men. Female speakers tend to prefer a softer swear word: *bloody*.

How men and women swear in the BNC-XML

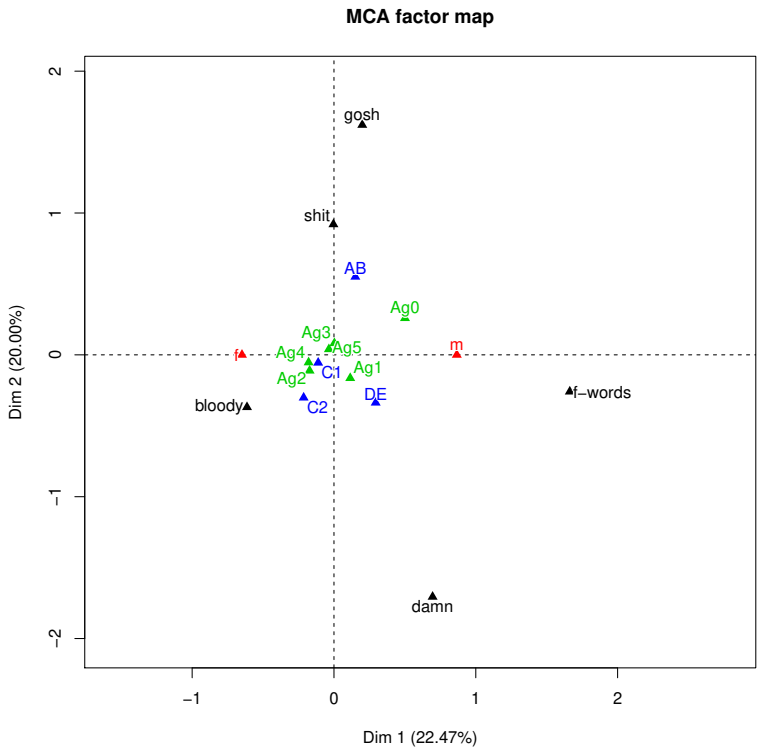
dim 2



Words in the upper part (*gosh* and *shit*) are used primarily by upper-class speakers. *F*-words, *bloody*, and *damn* are used by lower social categories. Age groups are positioned close to the intersection of the axes. This is a sign that the first two dimensions bring little or no information about them.

How men and women swear in the BNC-XML

dim 1 + dim 2



we observe 3 distinct clusters:

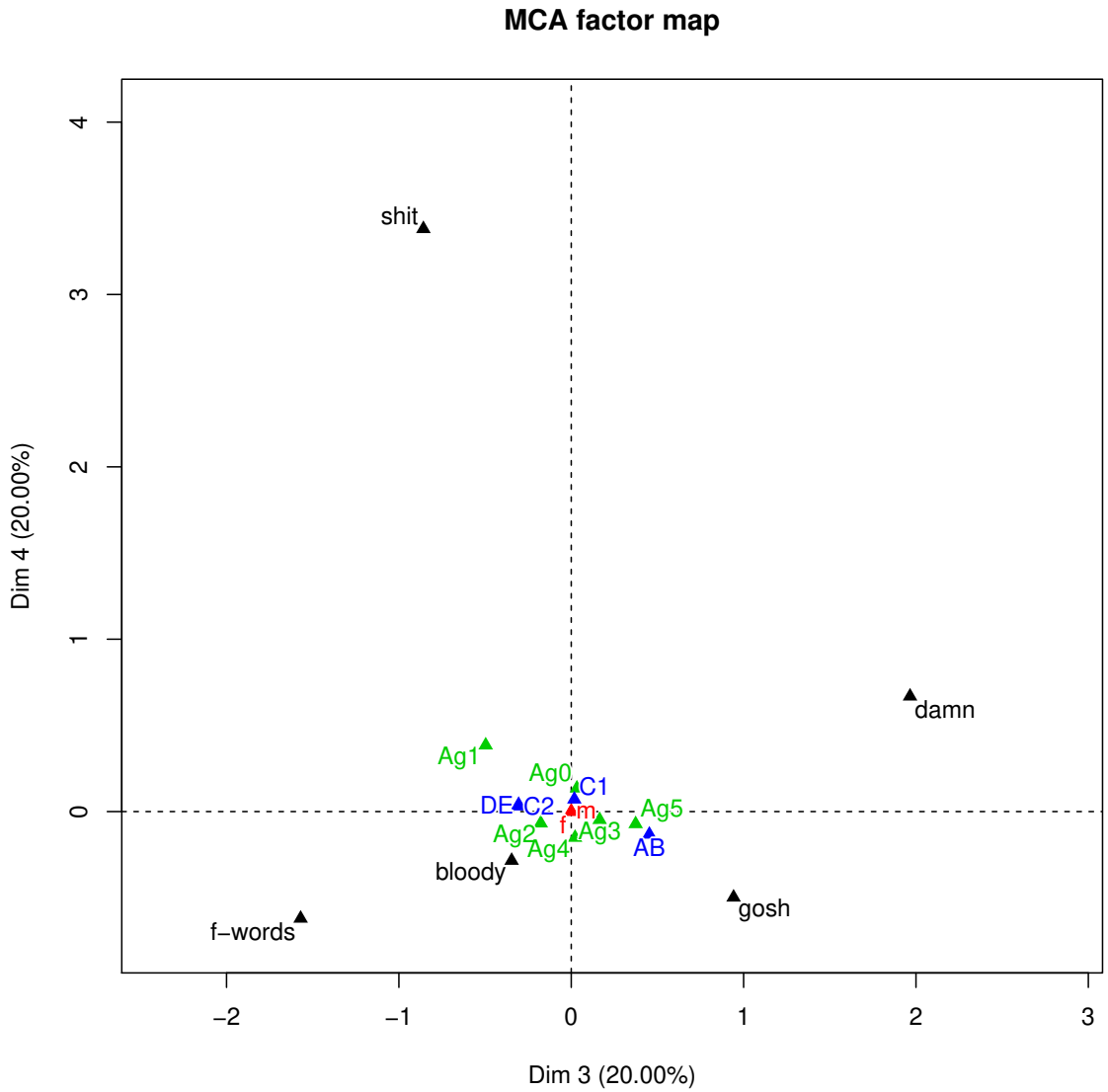
- cluster 1 (upper-right corner) *gosh* and *shit*, used by male and female upper class speakers;
- cluster 2 (lower-left corner) *bloody*, used by female middle-class speakers;
- cluster 3 (lower-right corner) *f*-words and *damn*, used by male lower-class speakers.

How men and women swear in the BNC-XML

A divide exists between male (`m`, right) and female (`f`, left) speakers. However, as the combined eigenvalues indicate, we should be wary of making final conclusions based on the sole inspection of the first two dimensions. The relevance of age groups becomes more relevant if dimensions 3 and 4 are inspected together

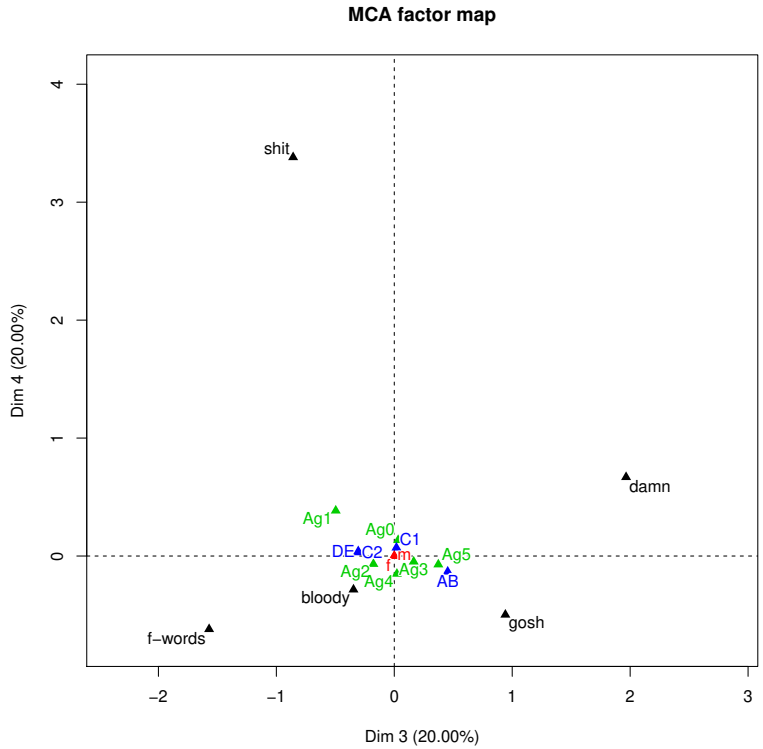
```
> plot.MCA(mca.object,
+          axes=c(3,4),
+          invisible="ind",
+          autoLab="yes",
+          shadowtext=TRUE,
+          habillage="quali",
+          title="")
```

How men and women swear in the BNC-XML



How men and women swear in the BNC-XML

dim 3 + dim 4

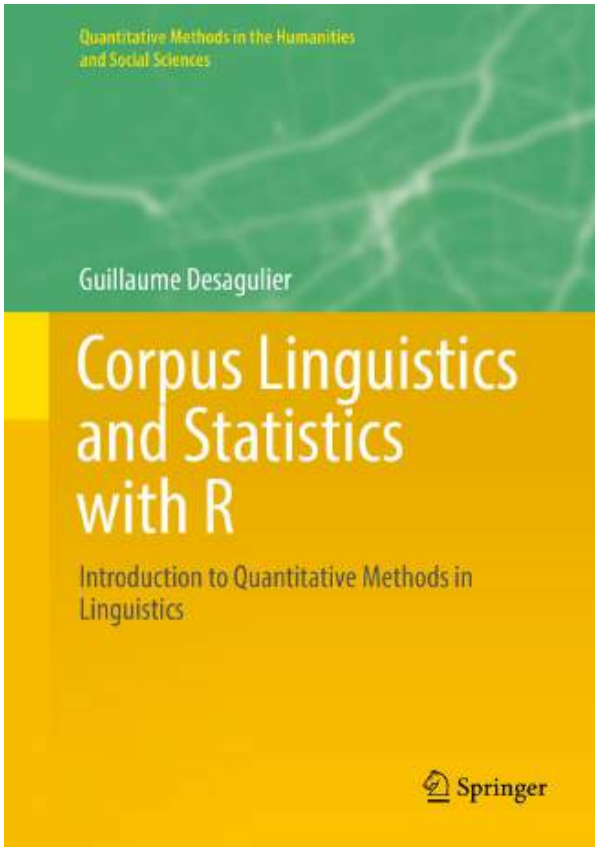


- the male/female distinction disappears
- a divide is observed between *f*-words and *bloody* (left), used mostly by younger and middle-aged speakers, and *gosh* and *damn* (right), used mostly by upper-class speakers from age groups 3 and 5.
- the most striking feature is the outstanding position of *shit* in the upper-left corner.

Practical Handbook of Corpus Linguistics

Guillaume Desagulier (to appear). "Multifactorial exploratory approaches." In: *Practical Handbook of Corpus Linguistics*. Ed. by Magali Paquot and Stefan Thomas Gries. New York: Springer

Corpus Linguistics and Statistics with R



Section 10.5 – (Desagulier 2017)

Bibliography I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