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Multifactorial Exploratory Approaches exploratory factor analysis

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outline	introduction	principles	case study	References

outline

1 introduction





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EFA				

EFA has been made popular in linguistics by Biber's studies on register variation (Biber 1991, 1995).

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FFA				

- EFA is designed to identify patterns of joint variation in a number of observed variables.
- although close to PCA, EFA differs with respect to the following: the number of relevant components, which are called factors, is not determined automatically. It must be chosen before we run the analysis.

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EFA				

- EFA looks for variables that are highly correlated with a group of other variables. These intercorrelated variables are assumed to measure one underlying variable. This variable, which is not directly observed, but inferred, is latent. It is known as a factor.
- one added value of EFA is that "an error term is added to the model in order to do justice to the possibility that there is noise in the data" (Baayen 2008, p. 127).

- the same data set serves as input for EFA: inclusion_FrWaC.txt
- In base R, we run EFA with factanal()

- based on PCA, we are tempted to specify 3 factors
- unfortunately, this is not going to work because 3 factors are too many for 5 variables in the kind of EFA that factanal() performs.

why?

A χ^2 test reports whether the specified number of factors is sufficient. If the *p*-value is smaller than 0.05, more factors are needed. If it is greater than 0.05, no more factors are needed. The test reports that the χ^2 statistic is 12,667.73 on 1 degree of freedom and that the p-value is 0. Although a third factor is required, we have no choice but stick to 2 factors. This means that we should be careful when we interpret the results.

> # clear R's memory
> rm(list=1s(all=TRUE))
> # load the data (inclusion_FrWaC.txt)
> data <- read.table(file=file.choose(), header=TRUE, row.names=1, sep="\t")</pre>

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inc	lusion in Fre	ench			
	> fa.object <- fac > fa.object	ctanal(data, fac	ctors=2)		
	Call: factanal(x = data,	, factors = 2)			
	Uniquenesses: centre coeur mili 0.655 0.436 0.8	ieu parmi sei 349 0.005 0.00	.n 05		
	Loadings: Factor1 Fac centre 0.587	ctor2			
	coeur 0.750 milieu 0.389 parmi -0.147 0.	. 987			
	sein -0.740 -0. Fac	.669 ctor1 Factor2			
	SS loadings 1	1.626 1.424			
	Cumulative Var (0.325 0.285 0.325 0.610			

Test of the hypothesis that 2 factors are sufficient. The chi square statistic is 12667.73 on 1 degree of freedom. The p-value is 0 $\,$

The output displays:

- uniqueness (unexplained variation)
- factor loadings (the loadings that are too close to zero are not displayed)
- the proportions of variance explained by the factors
- the χ^2 test

factor loadings:

- the higher the loading the more relevant the variable is in explaining the dimensionality of the factor
- Au milieu de, au centre de, and au cœur de define the first factor
- Parmi defines the second factor.
- it seems that *au sein de* defines both.

The proportions of variance explained by the factors

- = eigenvalues
- a factor is considered worth keeping if the corresponding SS loading (i.e. the sum of squared loadings) is greater than 1
- 2 factors are retained because both have eigenvalues over 1. Factor 1 accounts for 32.5% of the variance. Factor 2 account for 28.5% of the variance. Both factors account for 66.9% of the variance.

Graphic output:

- rotation a procedure meant to clarify the relationship between variables and factors. As its name indicates, it rotates the factors to align them better with the variables.
- varimax rotation: the factor axes are rotated in such a way that they are still perpendicular to each other
- promax rotation: the factor axes are rotated in an oblique way.
- with promax, the resulting model provides a closer fit to the data than with varimax.

Plotting the loadings of the prepositions on the two factors with varimax rotation:

> loadings <- loadings(fa.object)</pre> > plot(loadings, type="n", xlim=c(-1,1)) > text(loadings, rownames(loadings))

For promax rotation, set rotation to promax:

```
> fa.object2 <- factanal(data, factors=2, rotation="promax")</pre>
> loadings2 <- loadings(fa.object2)
> plot(loadings2, type="n", xlim=c(-1,1))
> text(loadings2, rownames(loadings2))
```

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Plotting the loadings of the prepositions on the two factors with varimax rotation:



Figure 1: loadings with varimax rotation

Figure 2: with promax rotation

summary

The distinctive profiles we obtain with EFA are similar to those we obtained with PCA. The only major difference is the proximity of *au milieu de* with *au centre de* and *au cœur de*. This may be due to the fact that only two factors are retained in the analysis. As far as this data set is concerned, PCA is clearly a better alternative, all the more so as individuals are not taken into account in the graphic output of this kind of EFA.

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Bibliography I

- Baayen, R Harald (2008). Analyzing linguistic data: A practical introduction to statistics using R. Cambridge University Press.
- Biber, Douglas (1991). Variation across speech and writing. Cambridge University Press.
- (1995). Dimensions of register variation: A cross-linguistic comparison. Cambridge University Press.
- Desagulier, Guillaume (to appear). "Multifactorial exploratory approaches." In: Practical Handbook of Corpus Linguistics. Ed. by Magali Paquot and Stefan Thomas Gries. New York: Springer.