

Interpretation of EFA and factor rotation

DIMENSIONALITY REDUCTION IN R



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Steps to perform EFA

- Check for data factorability
- Extract factors
- Choose the "right" number of factors to retain
- **Rotate factors**
- **Interpret the results**

Factor rotation in EFA

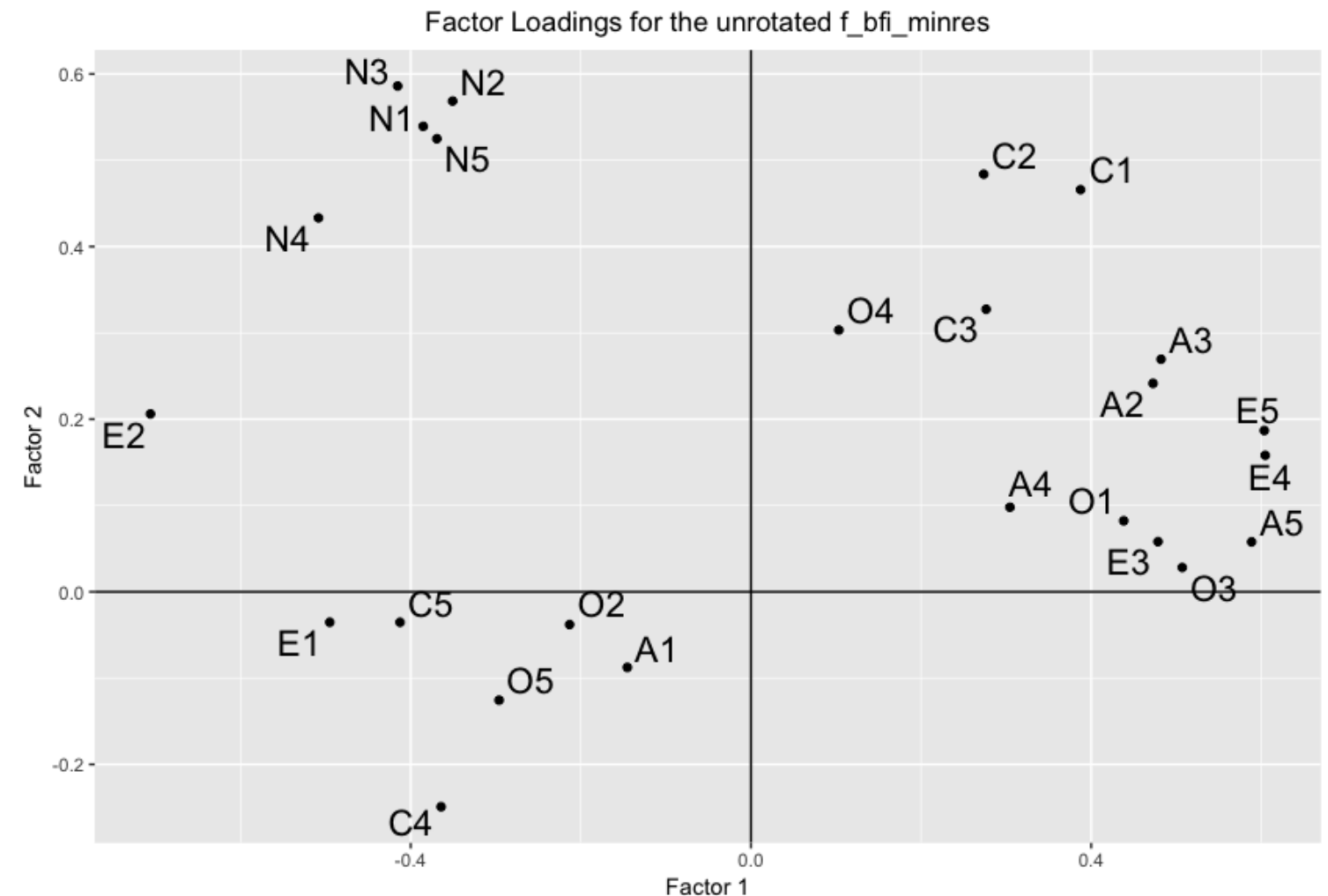
Why further rotate the factors?

- To ease interpretation
- **Orthogonal** methods
 - Quartimax
 - Equimax
 - **Varimax**
- **Oblique** methods
 - Direct Oblimin
 - Promax

Plotting unrotated factor loadings

5 putative factors behind the 25 self report items:

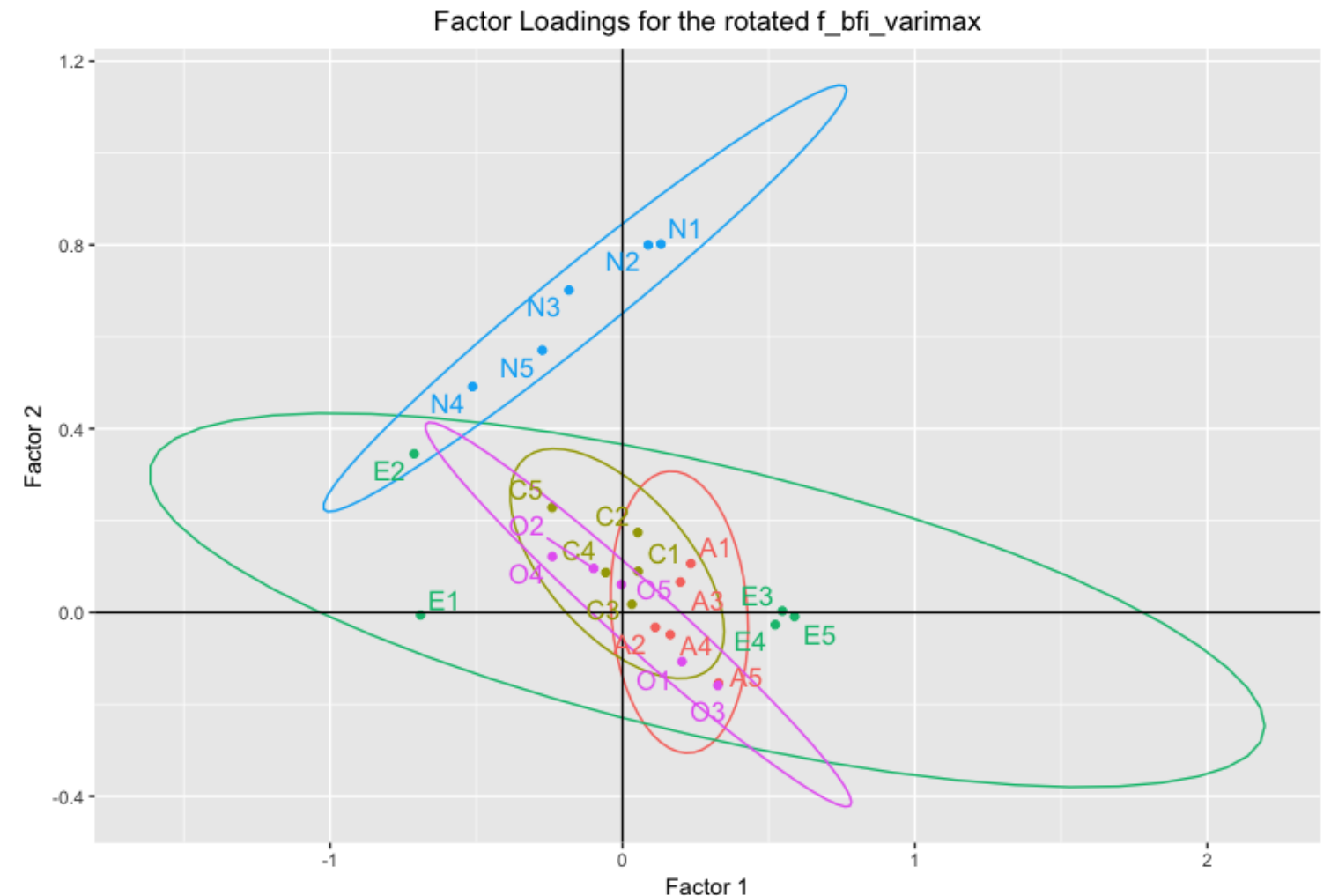
- **A**greeableness (A1,A2,A3,A4,A5)
- **C**onscientiousness (C1,C2,C3,C4,C5)
- **E**xtraversion (E1,E2,E3,E4,E5)
- **N**euroticism (N1,N2,N3,N4,N5)
- **O**penness (O1,O2,O3,O4,O5)



Rotating with varimax

```
# Applying varimax.  
f_bfi_varimax <- fa(bfi_c,  
  fm = "minres",  
  nfactors = 5,  
  rotate = "varimax")
```

- **E1:** "Don't talk a lot"
- **E2:** "Find it difficult to approach others"
- **E3:** "Know how to captivate people"
- **E4:** "Make friends easily"
- **E5:** "Take charge"



Let's practice!

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Interpretation of EFA and path diagrams

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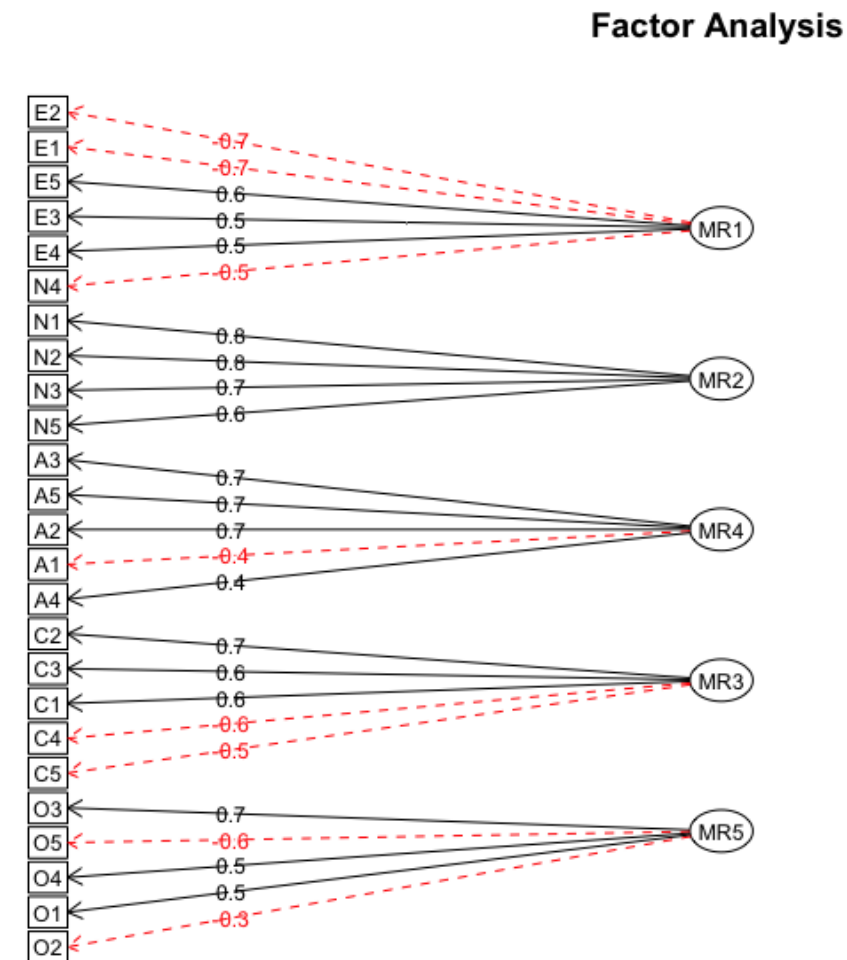
Interpretation: a crucial part of EFA

```
library(psych)
```

```
# Creating the path diagram.
```

```
fa.diagram(f_bfi_varimax)
```

- Agreeableness (A1,A2,A3,A4,A5)
- Conscientiousness (C1,C2,C3,C4,C5)
- Extraversion (E1,E2,E3,E4,E5)
- Neuroticism (N1,N2,N3,N4,N5)
- Openness (O1,O2,O3,O4,O5)



Interpretation: a crucial part of EFA

```
# Checking out factor loadings.  
print(f_bfi_varimax$loadings, cut=0)
```

```
Loadings:  
  MR1  MR2  MR4  MR3  MR5  
A1 0.234 0.106 -0.422 -0.072 -0.092  
A2 0.112 -0.032 0.653 0.190 0.113  
A3 0.198 0.066 0.744 0.051 0.169  
A4 0.163 -0.048 0.413 0.137 -0.142  
A5 0.328 -0.154 0.692 -0.009 0.115  
C1 0.054 0.089 0.140 0.634 0.287  
C2 0.052 0.174 0.114 0.690 0.050  
C3 0.032 0.018 0.076 0.642 0.016  
C4 -0.058 0.087 -0.090 -0.559 -0.159  
C5 -0.241 0.228 -0.040 -0.459 0.014  
E1 -0.691 -0.006 -0.066 -0.084 -0.017  
E2 -0.713 0.345 -0.138 -0.133 -0.025  
E3 0.546 0.003 0.157 -0.008 0.221  
E4 0.522 -0.027 0.416 0.167 0.048  
E5 0.588 -0.009 0.148 0.308 0.159  
N1 0.131 0.802 -0.150 -0.074 -0.133  
N2 0.088 0.800 -0.151 -0.038 -0.008  
N3 -0.183 0.701 0.005 0.037 -0.087  
N4 -0.513 0.491 -0.006 0.004 0.034  
N5 -0.274 0.571 0.059 0.096 -0.082  
O1 0.203 -0.107 0.148 0.076 0.535  
O2 -0.099 0.096 0.144 -0.191 -0.330  
O3 0.326 -0.159 0.034 0.062 0.680  
O4 -0.240 0.122 0.169 0.105 0.548  
O5 -0.004 0.061 -0.074 -0.077 -0.636  
  
SS loadings  MR1  MR2  MR4  MR3  MR5  
Proportion Var 0.113 0.107 0.089 0.084 0.075  
Cumulative Var 0.113 0.220 0.309 0.393 0.467
```

Let's practice!

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EFA: case study

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The Short Dark Triad

- A dataset that resulted from measuring the 3 *dark* personality traits:
 - machiavellianism (a manipulative behaviour),
 - narcissism (excessive self-admiration), and
 - psychopathy (lack of empathy)

(Interactive version of the test: <https://openpsychometrics.org/tests/SD3/>)

The SD3 dataset

```
sdt_test <- read.csv("SD3.csv", sep = "\t")  
dim(sdt_test)
```

```
18192    29
```

```
head(sdt_test)
```

	M1	M2	M3	M4	M5	M6	M7	M8	M9	N1	N2	N3	N4	N5	N6	N7	N8	N9	P1	P2	P3	P4	P5	P6	P7	P8	P9	country	source
1	4	4	4	4	4	4	4	3	4	2	4	2	3	4	4	2	3	4	3	4	3	2	4	4	4	4	4	GB	1
2	2	1	5	2	2	1	2	2	3	1	5	1	1	5	5	1	5	2	1	1	1	5	4	1	5	3	2	US	1
3	3	3	3	5	1	1	5	5	3	2	5	1	1	1	5	1	5	5	3	5	3	1	3	1	2	3	1	US	1
4	5	5	4	5	5	5	5	5	5	5	1	5	5	5	1	5	1	5	5	1	5	2	5	5	5	1	5	GB	3
5	4	4	2	5	5	5	4	1	4	3	4	3	1	5	4	3	2	5	4	5	3	1	4	3	5	4	1	GB	3
6	4	2	2	4	2	3	5	2	2	2	5	2	2	2	4	1	3	5	3	5	4	4	2	2	1	1	5	IT	1

EFA: The steps

- Check for data factorability
- Extract factors
- Choose the "right" number of factors to retain
- Rotate factors
- Interpret the results

Let's practice!

DIMENSIONALITY REDUCTION IN R

Overview of the course

DIMENSIONALITY REDUCTION IN R



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Dimensionality Reduction: the bigger picture

Biggest challenge of handling high-dimensional data:

- data interpretability
- remove noise and keep a reduced, interpretable representation

PCA and N-NMF

PCA

- **mathematically-sound** method
- suitable for **continuous data**

N-NMF

- **computationally efficient** (suitable for images and big data manipulation)
- suitable for data with **positive entries**

EFA

EFA

- **exploratory** method
- suitable for **ordinal data**
- discovering underlying latent constructs

Common steps in practicing dimensionality reduction

- Factor/Component/Dimension extraction
- Decision on the number of Factor/Component/Dimension to retain
 - parsimonious representation
 - least information loss
 - most interpretable representation
- Use visual aid for interpretation (e.g. biplot)

Where to go from here? My two cents..

- Deepen your freshly-acquired R knowledge
 - FactoMiner , factoextra , NMF , psych , ...
- Test alternative packages for performing these methods
 - stats , ade4 , amap , ca , MASS
- Extend your theoretical knowledge on commonly used notions:
 - eigenvalues, eigenvectors, orthogonality (for starters)
- Explore more dimensionality reduction methods

Good luck!

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