UNIVERSITÄT LEIPZIG

erc European Research Council

Semantics in Space: Probabilistic semantic maps and Multidimensional Scaling

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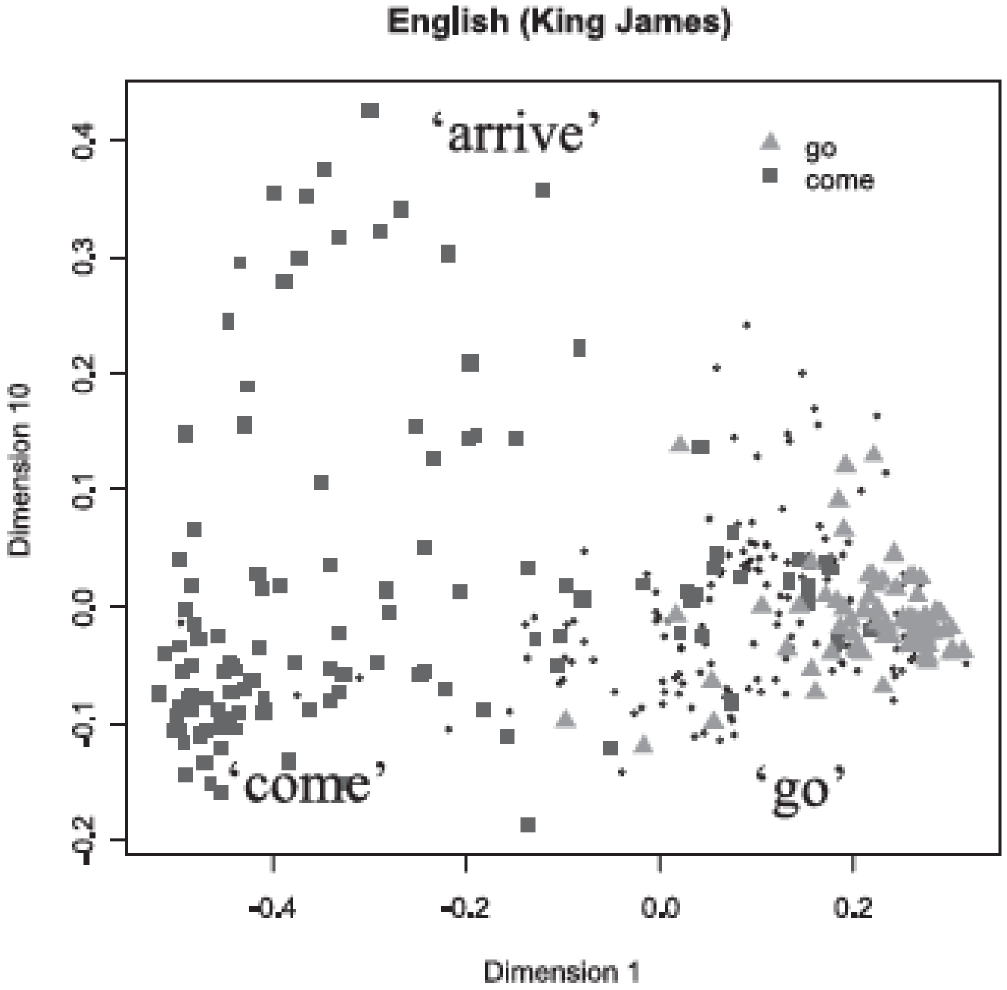
Probabilistic semantic maps

- Instead of dictionary information (as in CLiCs), probabilistic semantic maps are often based on parallel corpora.
- The main unit is a specific context in a parallel corpus (e.g. sentence from the New Testament translated into many languages), not a concept.
- The relationships between contexts are represented as distances in MDS, not links.
- The distances between contexts are determined by the similarity between the translations in the language sample.

Wälchli & Cysouw (2012): motion verbs



Algorithm for MDS: Step 1

1. Collect the data (fictitious example)

	Lang1	Lang2	Lang3	Lang4	Lang5
Sit1	bla	qu	da	nina	haha
Sit2	bla	qu	da	nana	hihi
Sit3	bla	qa	ta	nina	hehe

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Comparative concepts (cf. Haspelmath 2010)

Algorithm for MDS: Step 2

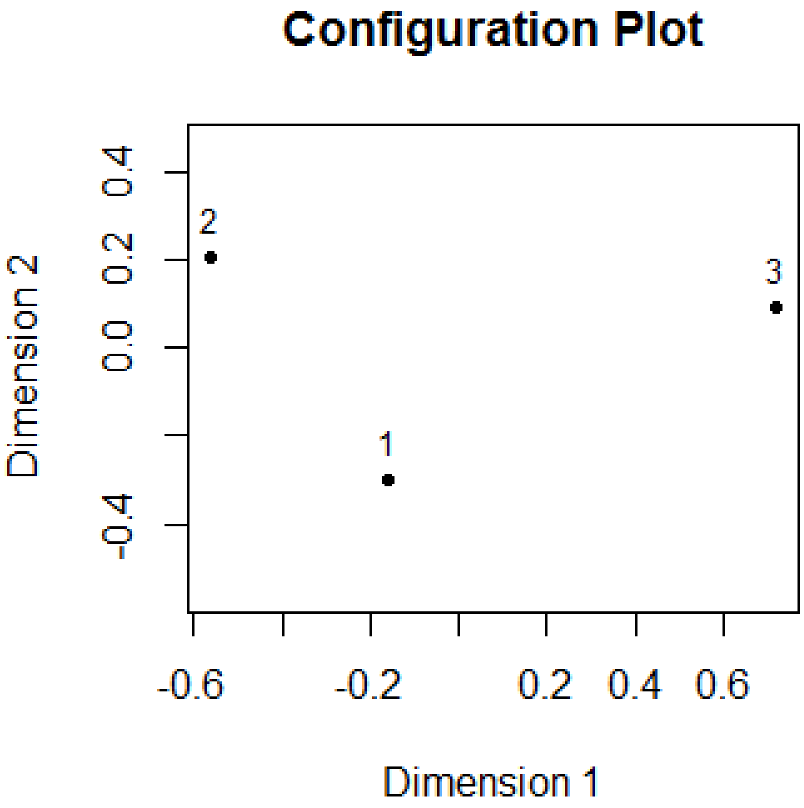
2. Compute the distances between the situations (rows) = the proportion of dissimilar values.

	Lang1	Lang2	Lang3	Lang4	Lang5
Sit1	bla	qu	da	nina	haha
Sit2	bla	qu	da	nana	hihi
Sit3	bla	qa	ta	nina	hehe

D (1,2) = 2/5 = 0.4
D (1,3) = 3/5 = 0.6
D (2,3) = 4/5 = 0.8

Algorithm for MDS: Step 3

3. Perform MDS



Interpretation

- The closer two points on the map, the more overlapping constructions they share across the languages.
- Following the isomorphism principle (same function => same form), the corresponding functions/meanings/situations are more semantically similar if more authors of the doculects chose identical constructions to represent these functions/meaning/situations.

Case study

Analytic causatives in European languages

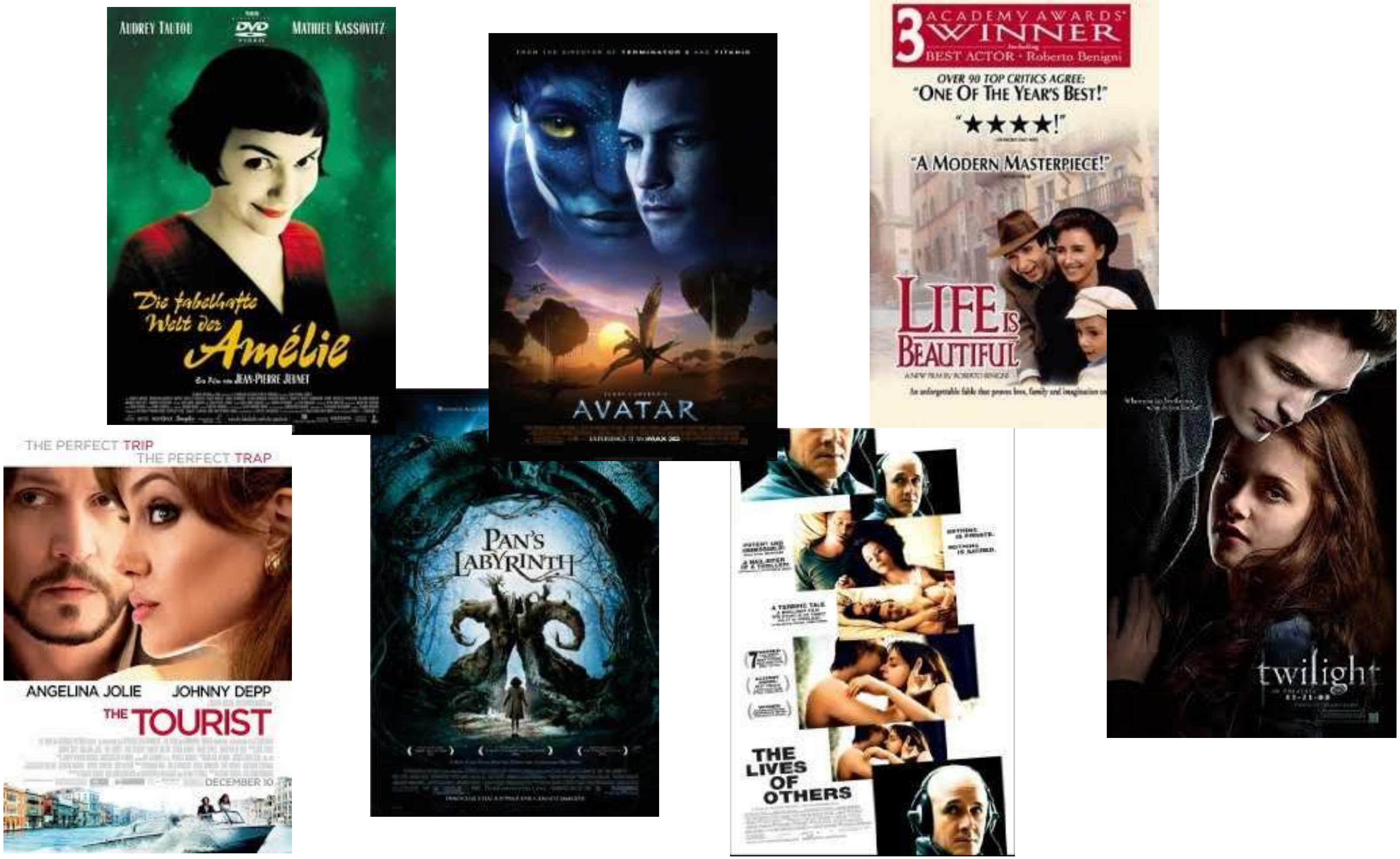
Languages

- Indo-European
    - Germanic
        - Dutch, English, German, Norwegian, Swedish
    - Romance
        - French, Italian, Portuguese, Romanian, Spanish
    - Slavic
        - Bulgarian, Czech, Polish, Russian, Slovene
- Uralic
    - Finnic
        - Estonian, Finnish
    - Ugric
        - Hungarian

Analytic Causatives: Examples

- English:
  - *make* + Vinf, *let* + Vinf, *have* + Vinf, *cause* + *to-Vinf*
- German:
  - *lassen* + Vinf
- Dutch:
  - *laten* + Vinf, *doen* + Vinf
- Russian: *zastavljat*' "force" + Vinf, *davat*' "give" + Vinf
- French:
  - *faire* + Vinf, *laisser* + Vinf
- Romanian:
  - *face* + *să* + Vsubj, *lasă* + *să* + Vsubj

Films for case study



Data set

- Alignment: Jörg Tiedemann’s software subalign
- All contexts with of ACs in 18 languages
- Dataset: 72 contexts, in which at least 6 languages have an AC

Examples

- Situation (row) A

  ENG: And we make them do it… ...or we kill them. make

  ITA: E glielo facciamo fare ... o lo uccidiamo. fare

  CZE: Donutíme je to udělat, nebo je zabijeme. donutit

- Situation (row) B

  ENG: Pick up someone my height and build and make them believe it is me. make

  ITA: Individua una della mia corporatura e fa credere loro che sia io. fare

  CZE: Vyber někoho, kdo je mi podobný a přesvědč je, že jsem to já. NA

Data frame causatives

```
> str(causatives)
'data.frame':     72 obs. of  20 variables:
 $ Film: Factor w/ 8 levels "Amelie","Avatar",..:
1 1 1 1 1 1 1 1 1 1 ...
 $ Text: Factor w/ 72 levels "...and won't let the
tree thrive.",..: 20 47 48 50 62 25 5 6 54 7 ...
 $ FRA : Factor w/ 6 levels
"autoriser","faire",..: 2 2 4 NA 2 4 4 4 4 2 ...
 $ ENG : Factor w/ 6 levels "allow","force",..: 4
NA 5 6 4 5 5 5 NA 6 ...
 $ GER : Factor w/ 3 levels
"bringen","erlauben",..: 3 3 3 3 3 3 3 NA 3 3 ...
[output omitted]
```

Data frame causatives

```
> head(causatives[,3:10])
      FRA  ENG    GER   SPA   DUT  SWE      ITA    POR
1   faire have lassen  <NA>  <NA> <NA>     fare   <NA>
2   faire <NA> lassen hacer  <NA> <NA>     fare   <NA>
3 laisser  let lassen dejar laten lata     fare   <NA>
4    <NA> make lassen  <NA>  doen   fa     <NA>   <NA>
5   faire have lassen  <NA> laten <NA>     <NA>   <NA>
6 laisser  let lassen dejar laten lata lasciare deixar
```

Gower distances

```
> library(cluster)
> causatives.dist <- daisy(causatives[, 3:20])
> summary(causatives.dist)

2556 dissimilarities, summarized :
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0000  0.1429  0.6000  0.5415  0.9091  1.0000       1
Metric :  mixed ;  Types = N, N, N, N, N, N, N, N, N, N,
N, N, N, N, N, N, N, N
Number of objects : 72
```

Understanding Gower distances

```
> causatives.dist[1:3]
[1] 0.0 0.6 0.5
> causatives[1:2, 3:20]
 FRA  ENG    GER   SPA  DUT  SWE  ITA  POR  ROM  POL
1 faire have lassen  <NA> <NA> <NA> fare <NA> <NA> <NA>
2 faire <NA> lassen hacer <NA> <NA> fare <NA> face <NA>
 SLO  CZE  RUS  BUL   EST     FIN  HUN  NOR
1 dati  dat <NA> <NA> <NA>   <NA> <NA> <NA>
2 <NA> <NA> <NA> <NA> panema <NA> <NA>  la
```

D (1, 2) = 0/3 = 0

Exercise

- Compute manually the Gower distance between observations 71 and 72.

Solution

```
> causatives[71:72, 3:20]
     FRA  ENG  GER   SPA   DUT  SWE  ITA     POR  ROM
71 faire  get <NA> hacer laten <NA> fare   fazer face
72 faire <NA> <NA> hacer  <NA> <NA> fare obrigar face
    POL  SLO    CZE        RUS      BUL    EST   FIN
71 <NA> <NA> nechat zastavljat nakarvam panema saada
72 <NA> <NA>   <NA>       <NA>     <NA> panema  <NA>
    HUN  NOR
71 <NA> <NA>
72 <NA> <NA>
```

$$D\ (71, 72) = 1/6 \approx 0.167$$

Fitting MDS

```
> library(smacof)
```

Fitting a two-dimensional metric MDS (default):

```
> causatives.mds <- mds(causatives.dist)
```

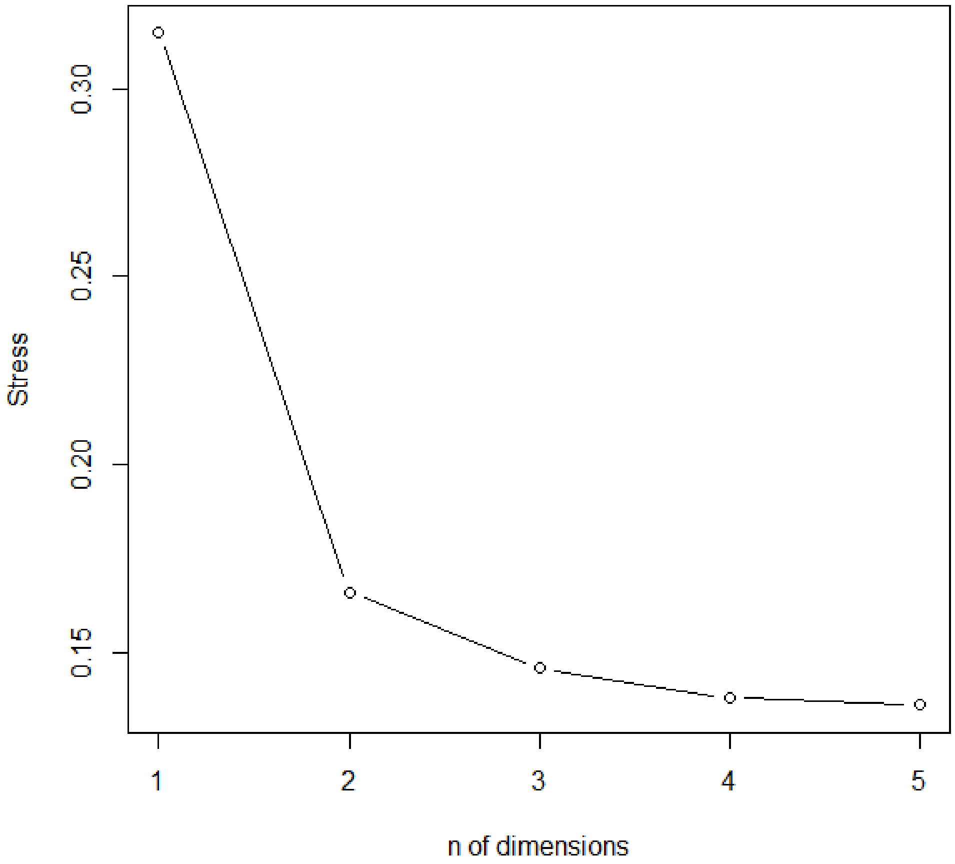
How good is the 2D solution?

```
> causatives.mds$stress
[1] 0.166 #relatively OK
> d1 <- mds(causatives.dist, ndim = 1)$stress
> d2 <- mds(causatives.dist, ndim = 2)$stress
> d3 <- mds(causatives.dist, ndim = 3)$stress
> d4 <- mds(causatives.dist, ndim = 4)$stress
> d5 <- mds(causatives.dist, ndim = 5)$stress
```

Make a scree plot:

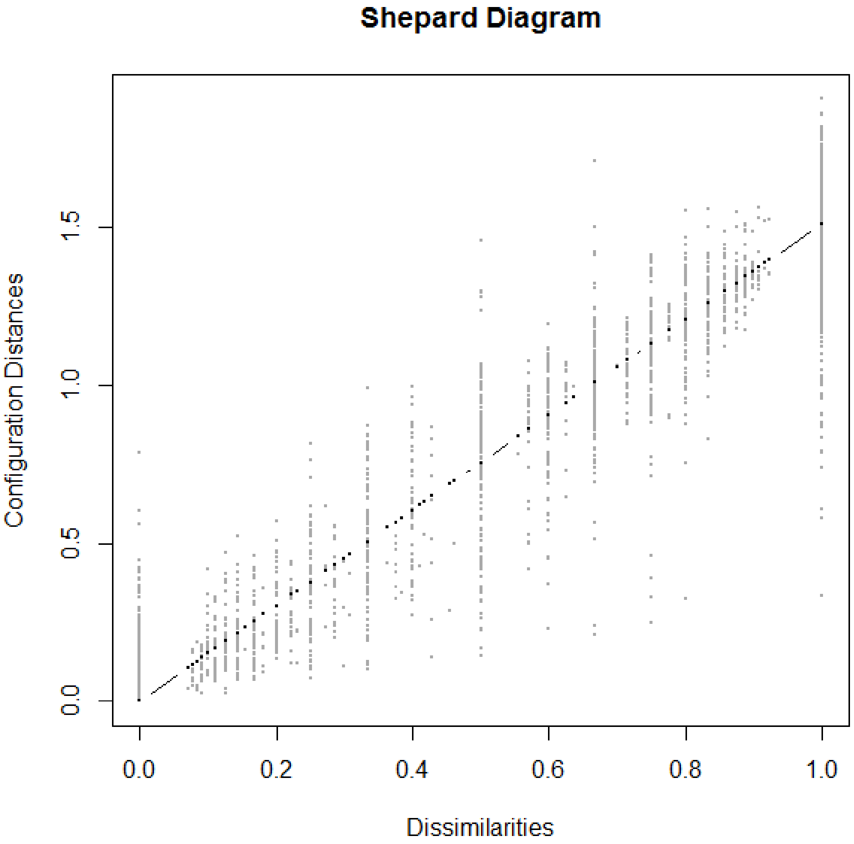
```
> plot(1:5, c(d1, d2, d3, d4, d5), type = "b",
xlab = "n of dimensions", ylab = "Stress")
```

Watch the ‘elbow’



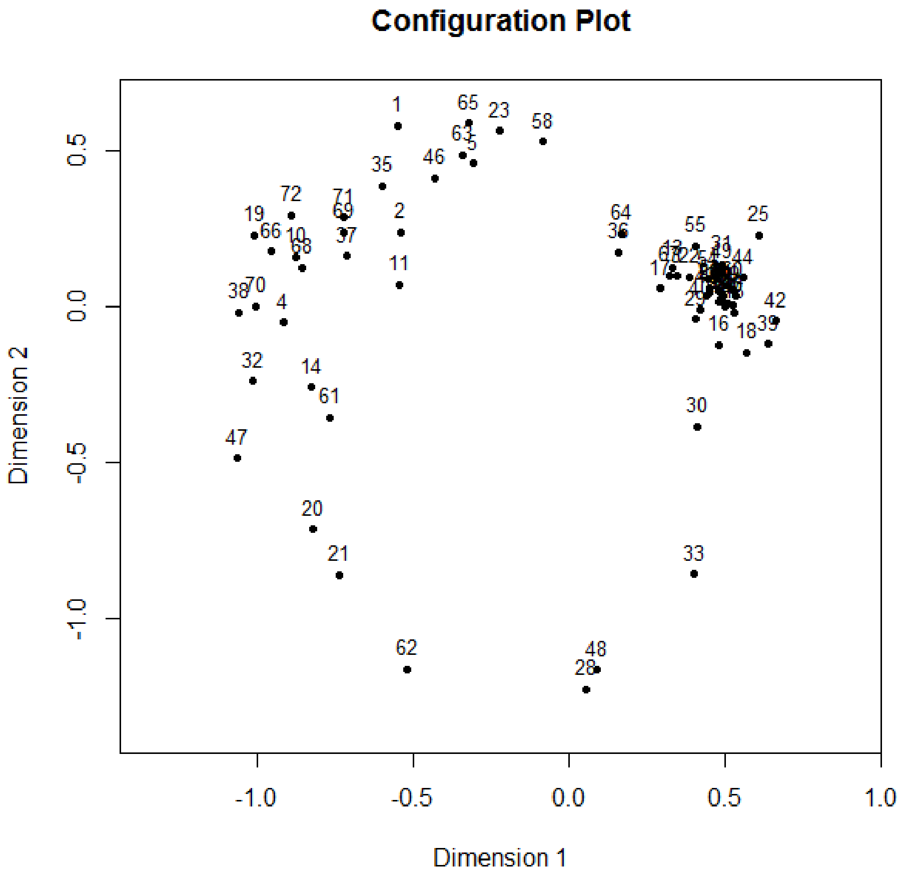
Stress and individual distances

```
> plot(causatives.mds,
"Shepard")
```



Interpreting the solution

```
> plot(causatives.mds,
"conf")
```



Exploring the contexts: bubbles

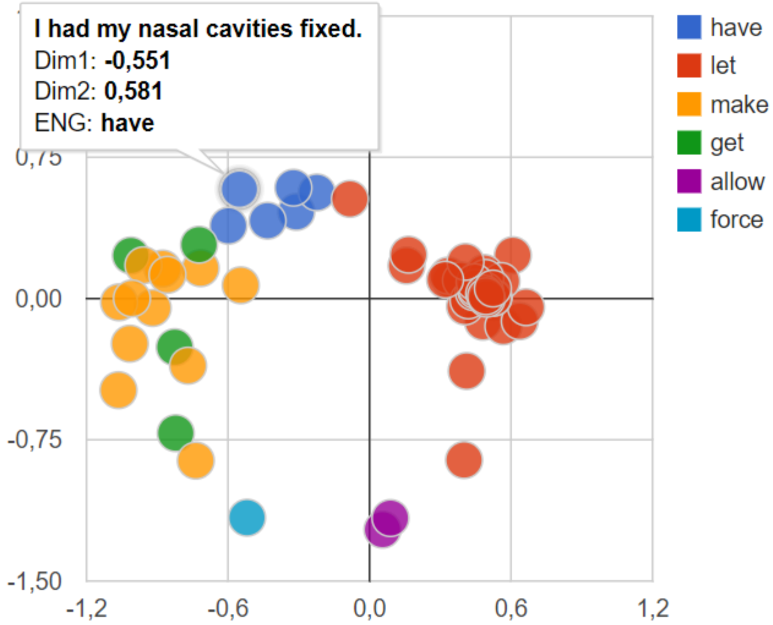
```
> library(googleVis)
```

```
> text.df <- data.frame(Text = causatives$Text,
Dim1 = causatives.mds$conf[, 1], Dim2 =
causatives.mds$conf[, 2], ENG = causatives$ENG)
```

```
> bubbles <- gvisBubbleChart(text.df, idvar =
"Text", xvar = "Dim1", yvar = "Dim2", colorvar =
"ENG", options = list(sizeAxis = '{maxSize:
10}', vAxis = '{minValue:-0.8, maxValue:0.8}',
height = 500, width = 500,
bubble="{textStyle:{color: 'none'}}"))
```

```
> plot(bubbles)
```

Bubble chart

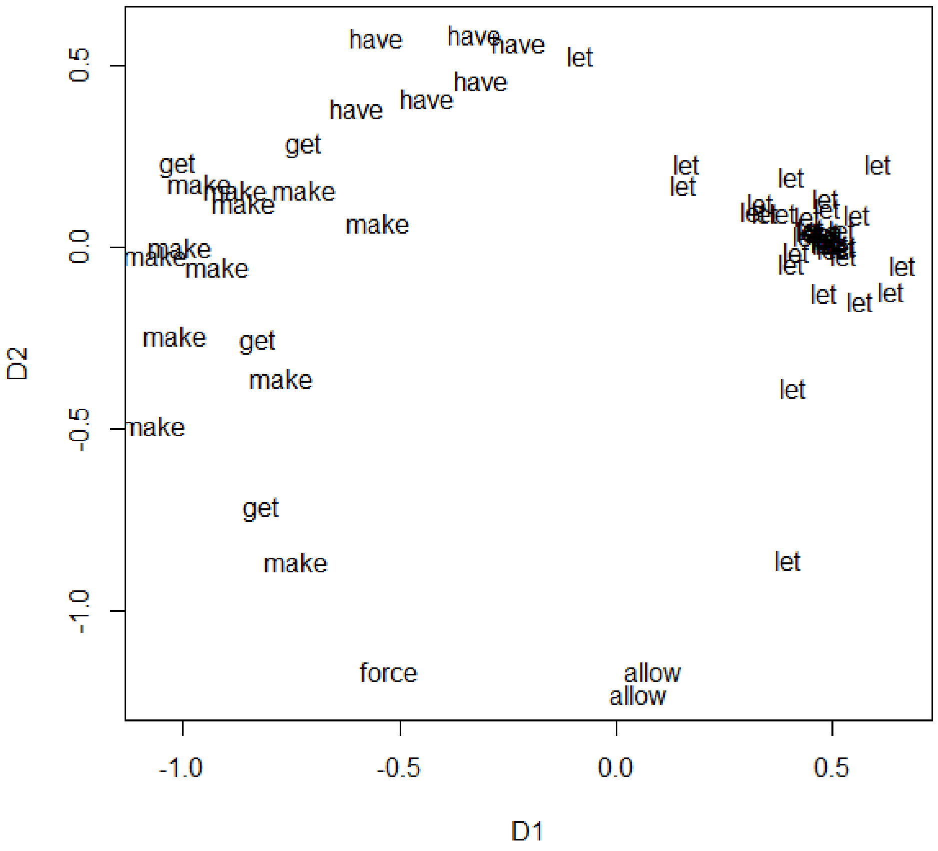


I had my nasal cavities fixed.
Dim1: **-0,551**
Dim2: **0,581**
ENG: **have**

Data: text.df • Chart ID: BubbleChartID1d6472c66b06 • googleVis-0.6.2
R version 3.4.0 (2017-04-21) • Google Terms of Use • Documentation and Data Policy

Exploring form-meaning mapping

```
> plot(causatives.mds$conf,
type = "n")

> text(causatives.mds$conf,
labels = causatives$ENG)
```



“Make” in Romance

- Let us compare the semantics of cognate causal auxiliaries in Romance:
  - FRA faire
  - ITA fare
  - POR fazer
  - ROM (a) face
  - SPA hacer
- Are there semantic differences?
- For theoretical background, see Levshina (2015).

ITA fare vs. ROM (a) face

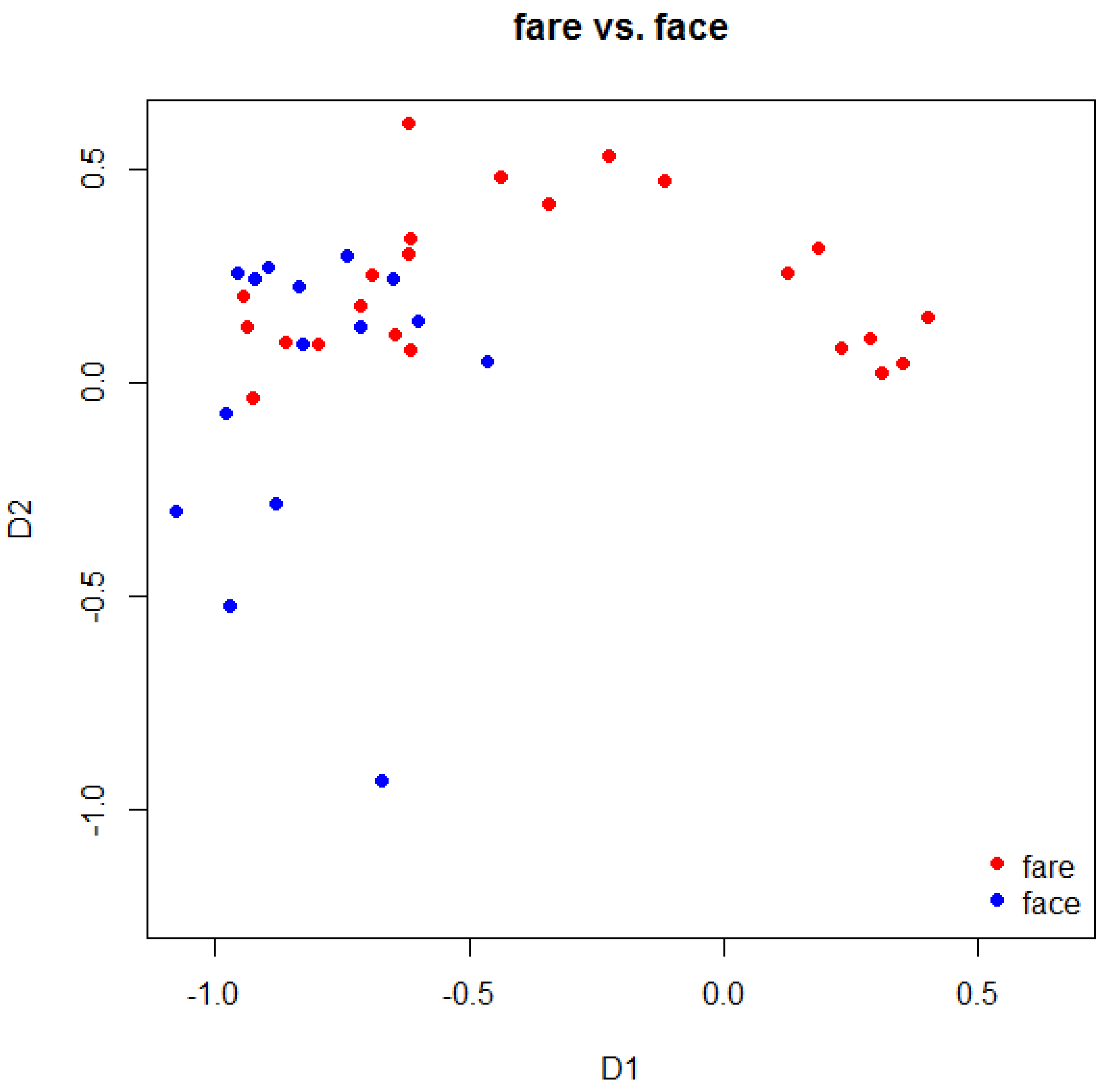
```
> plot(causatives.mds$conf, type = "n", main =
"fare vs. face")
```

Add some jitter to avoid overplotting:

```
> points(jitter(causatives.mds$conf[causatives$ROM
== "face",], amount = 0.1), col = "blue", pch =
16)
```

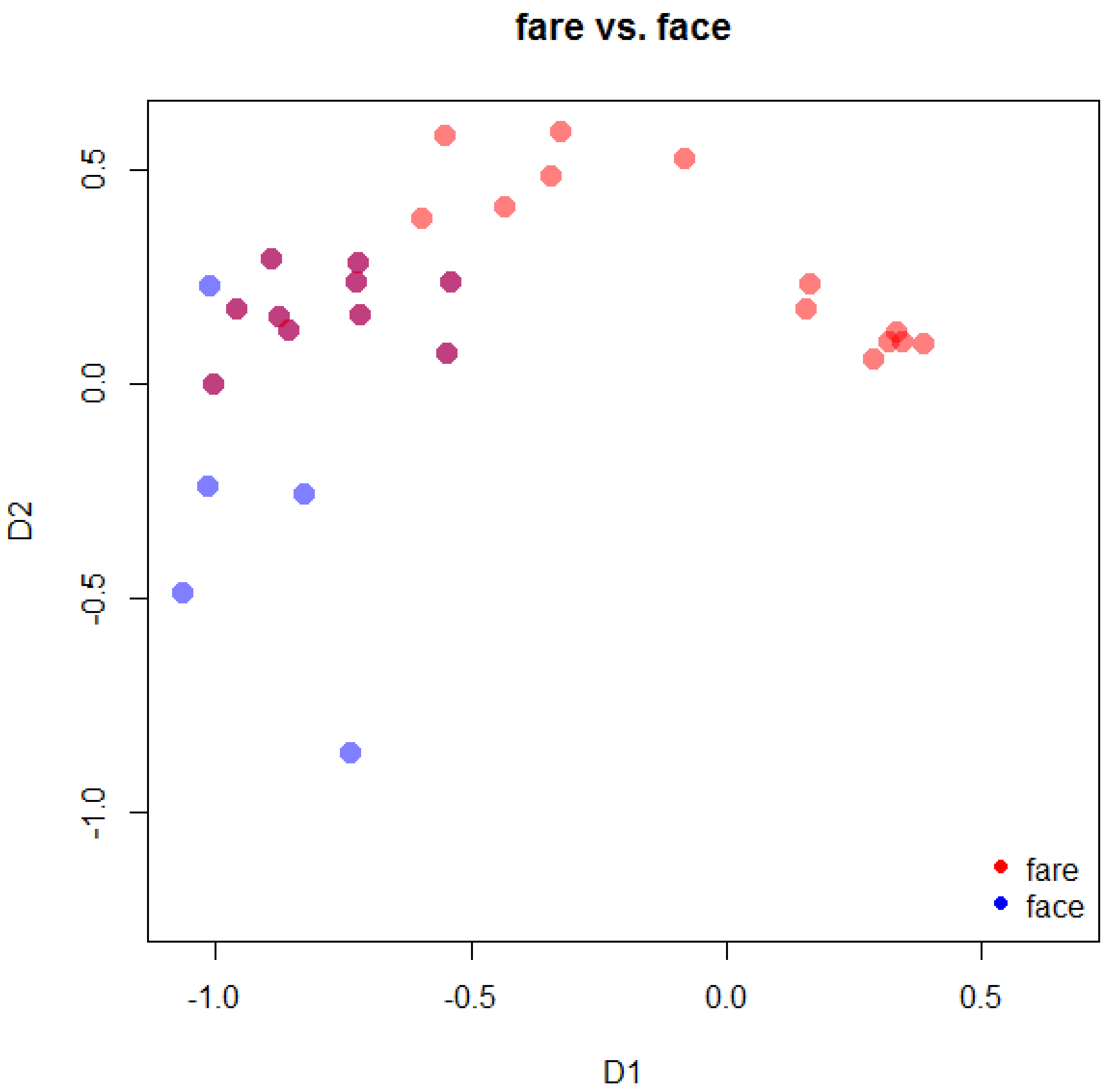
```
> points(jitter(causatives.mds$conf[causatives$ITA
== "fare",], amount = 0.1), col = "red", pch = 16)
```

```
> legend("bottomright", legend = c("fare",
"face"), col = c("red", "blue"), pch = 16, bty =
"n")
```


fare vs. face
D2
0.5
0.0
-0.5
-1.0
D1
-1.0
-0.5
0.0
0.5
● fare
● face

Transparent colours

```
> library(grDevices)

> plot(causatives.mds$conf, type = "n", main =
"fare vs. face")

> points(causatives.mds$conf[causatives$ROM ==
"face",], col = adjustcolor("blue", alpha.f =
0.5), pch = 16, cex = 1.5)

> points(causatives.mds$conf[causatives$ITA ==
"fare",], col = adjustcolor("red", alpha.f = 0.5),
pch = 16, cex = 1.5)

> legend("bottomright", legend = c("fare",
"face"), col = c("red", "blue"), pch = 16, bty =
"n")
```


fare vs. face
D2
0.5
0.0
-0.5
-1.0
D1
-1.0
-0.5
0.0
0.5
● fare
● face

Exercise

- Create similar plots for English let and German lassen.
- How can you interpret the difference semantically?

Kriging: preparation

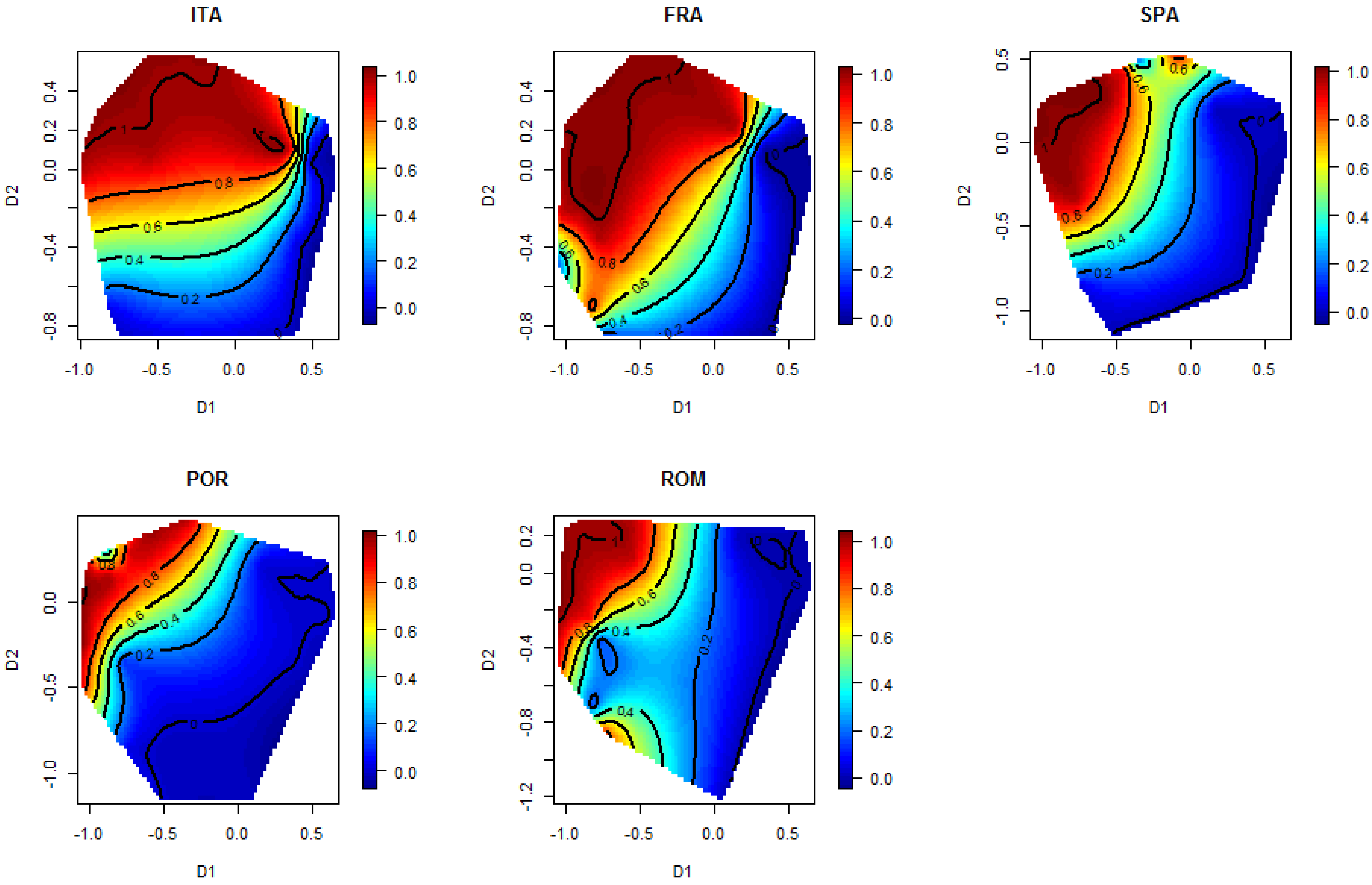
```
> y.ita <- ifelse(causatives$ITA == "fare", 1, 0)
> y.fra <- ifelse(causatives$FRA == "faire", 1, 0)
> y.spa <- ifelse(causatives$SPA == "hacer", 1, 0)
> y.por <- ifelse(causatives$POR == "fazer", 1, 0)
> y.rom <- ifelse(causatives$ROM == "face", 1, 0)
```

Kriging

```
> Krig.rom <- Krig(causatives.mds$conf, y.rom,
lambda = 0.05) #try different lambda values

> Krig.ita <- Krig(causatives.mds$conf, y.ita,
lambda = 0.05)

> Krig.fra <- Krig(causatives.mds$conf, y.fra,
lambda = 0.05)

> Krig.spa <- Krig(causatives.mds$conf, y.spa,
lambda = 0.05)

> Krig.por <- Krig(causatives.mds$conf, y.por,
lambda = 0.05)
```

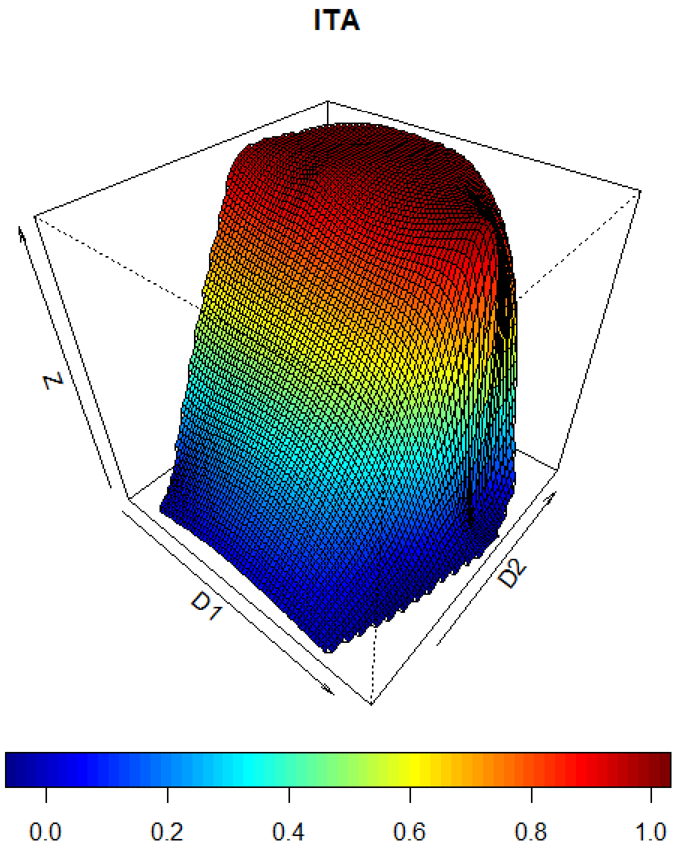
Fitted surface plots

```
> surface(Krig.ita, main = "ITA")
> surface(Krig.fra, main = "FRA")
> surface(Krig.spa, main = "SPA")
> surface(Krig.por, main = "POR")
> surface(Krig.rom, main = "ROM")
```


ITA
FRA
SPA
POR
ROM
D1
D2
-1.0
-0.5
0.0
0.5
0.4
0.2
0.0
-0.4
-0.8
-1.2
-1.0
1.0
0.8
0.6
0.4
0.2
0.0
1
0.8
0.6
0.4
0.2
0

Perspective plot

```
> surface(Krig.ita,
main = "ITA", type =
"p", theta = 40, phi
= 40)
```



Romance causatives: conclusion

- The Italian causative verb fare is the most semantically bleached with regard to the distinction between letting and marking, and the Romanian face is the least bleached.
- The other languages are in-between.
- A scale of grammaticalization:
  - ITA > FRA > SPA > POR > ROM
- This is reflected in the different levels of syntactic integration of the auxiliary and the second predicate:
  - The Italian *fare* and French *faire* are normally followed immediately by an infinitive (VV)
  - Portuguese *fazer* and Spanish *hacer* are often used in the pattern V + NP + V
  - Romanian *a face* is followed by the complementizer *să* and a subjunctive clause (finite).

Exercise

- Perform Kriging for the letting constructions in English (let), German (lassen), Dutch (laten), Swedish (lata), Norwegian (la)
- What are your conclusions?

References

- Haspelmath, M. (2010) Comparative concepts and descriptive categories in cross-linguistic studies. *Language* 86(3). 663-687
- Levshina, N. (2015) European analytic causatives as a comparative concept. Evidence from a parallel corpus of film subtitles. *Folia Linguistica* 49(2). 487-520.
- Wälchli, B. & Cysouw, M. (2012). Lexical typology through similarity semantics: Toward a semantic map of motion verbs. *Linguistics* 50(3). 671–710.