UNIVERSITÄT LEIPZIG

European Research Council

Multidimensional Scaling and token-based semantic maps

Natalia Levshina ©2017

Corpus Linguistics Summer School

Birmingham, July 2017

Outline

1. Semantic maps in linguistic research

2. Multidimensional Scaling

3. Case study: analytic causatives in European languages

Semantic maps

- Represent a convenient tool for comparison of semantic and pragmatic functions across languages
- Are based on different kinds of data: grammars and typological databases, parallel corpora and experimental data

Main types of semantic maps

	Connectivity (links between objects)	**Proximity (distances between objects)**
Type-based (pre-determined functions; frequencies do NOT count)	Manual/Automatic	Automatic
Token-based (corpus exemplars; frequencies COUNT)	?	Automatic

Types of semantic maps

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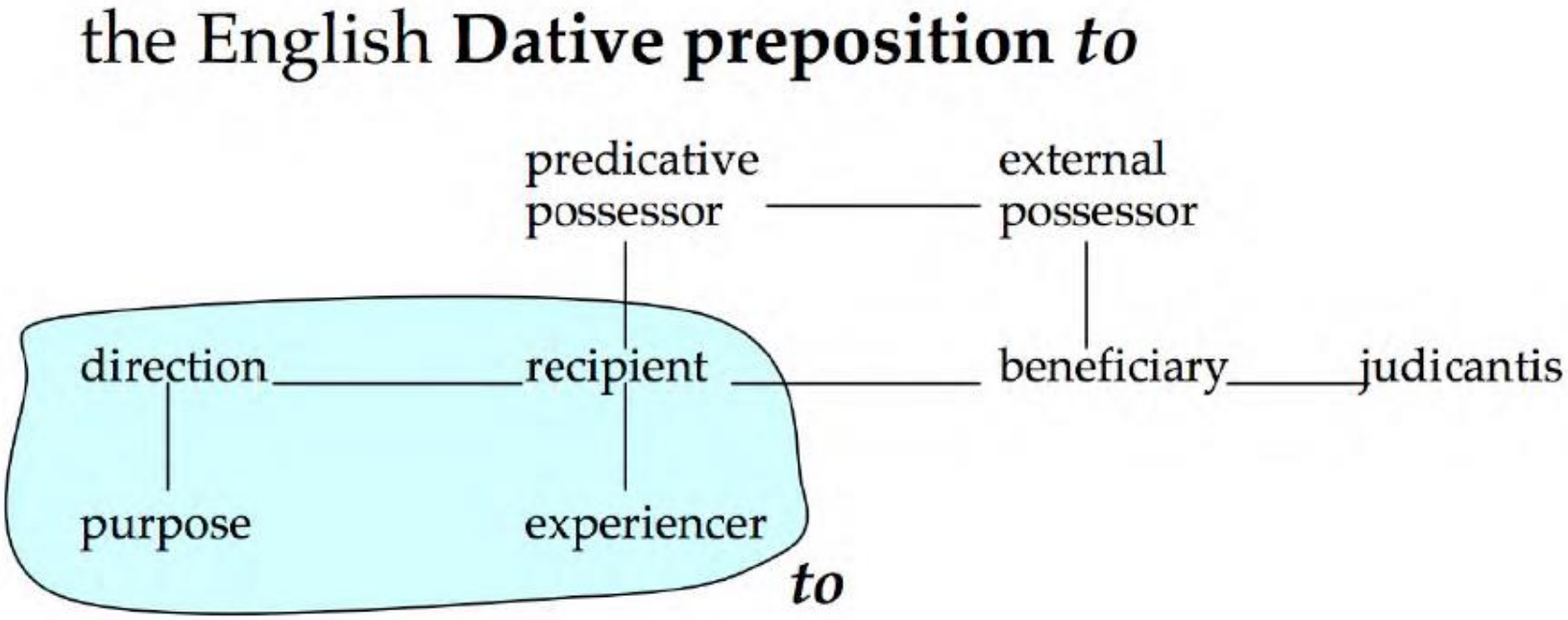
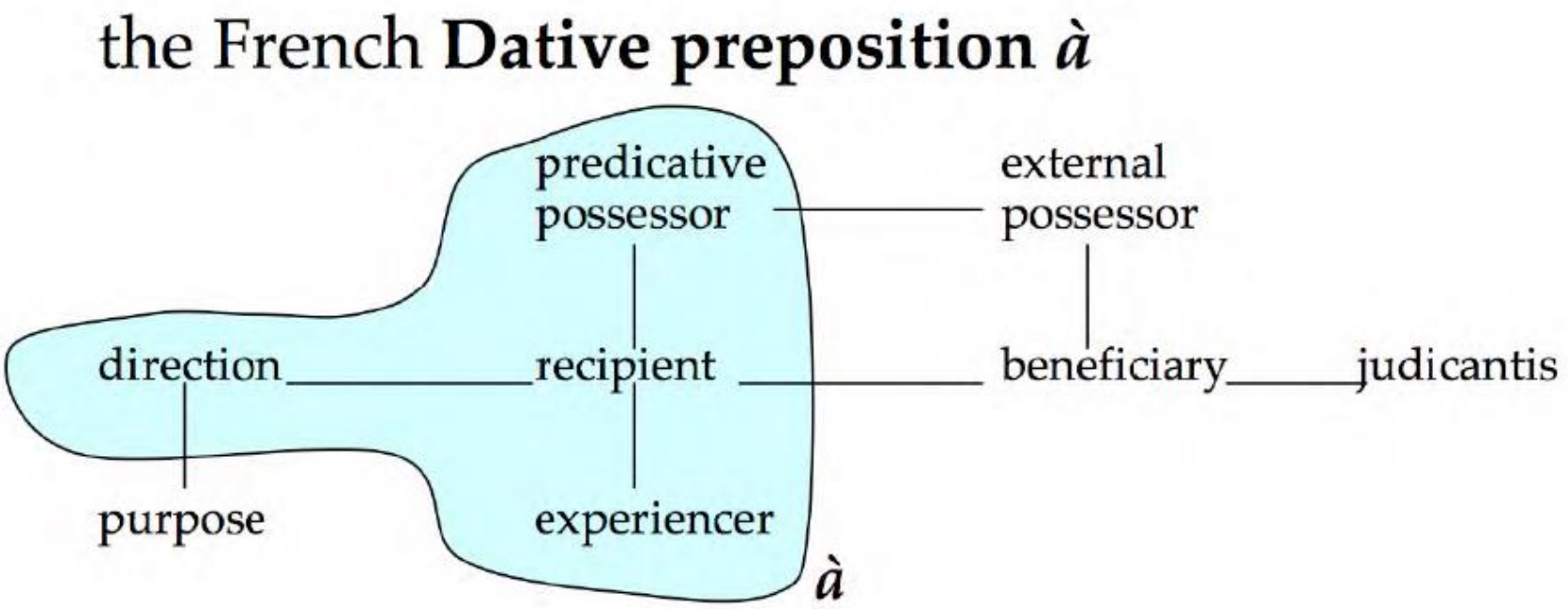
Traditional maps

- non-directional
- directional

Haspelmath 2003: Datives



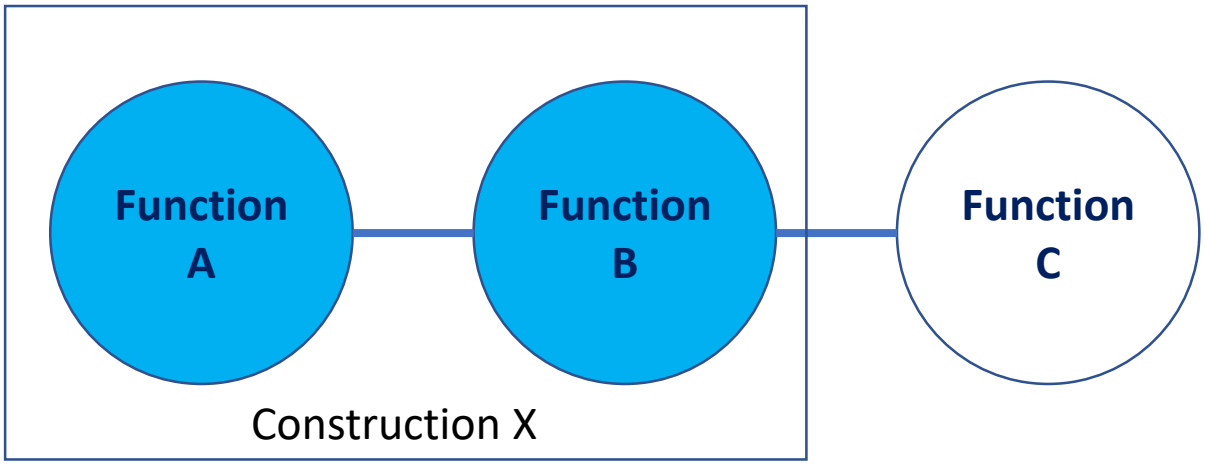
Haspelmath 2003: Datives



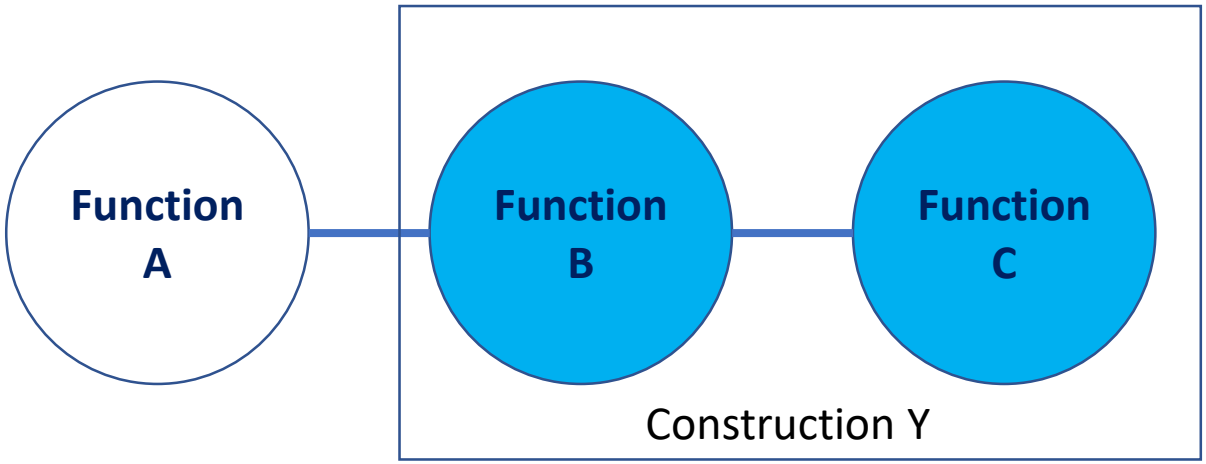
Main principles

- Nodes: A function is put on a map when there's at least one pair of languages which differ wrt. this function (Haspelmath 2003)
- Links: the principle of connectivity (adjacency/contiguity):
  - if a construction has more than one function, they should be connected (see van der Auwera 2013)

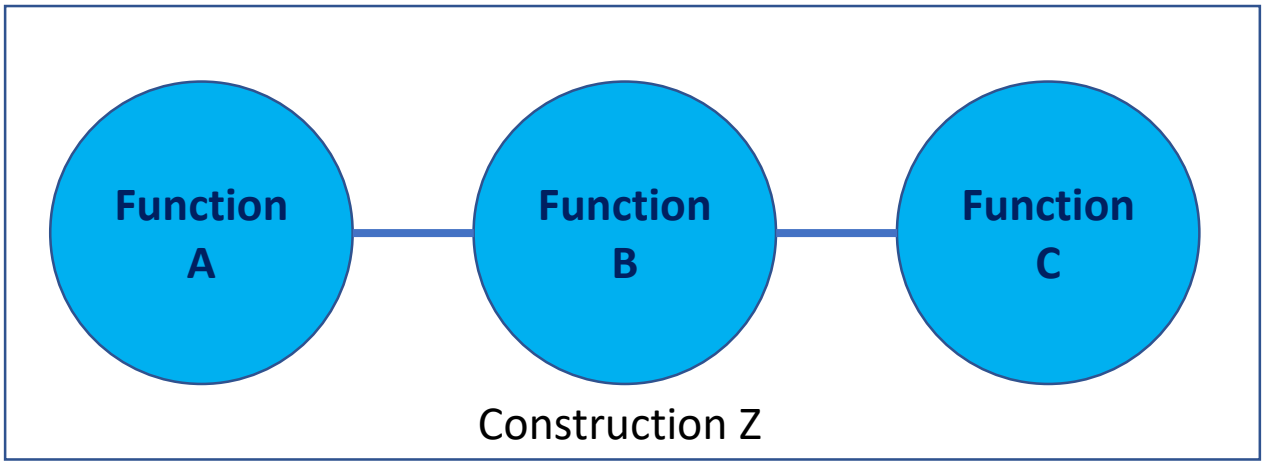
Example 1



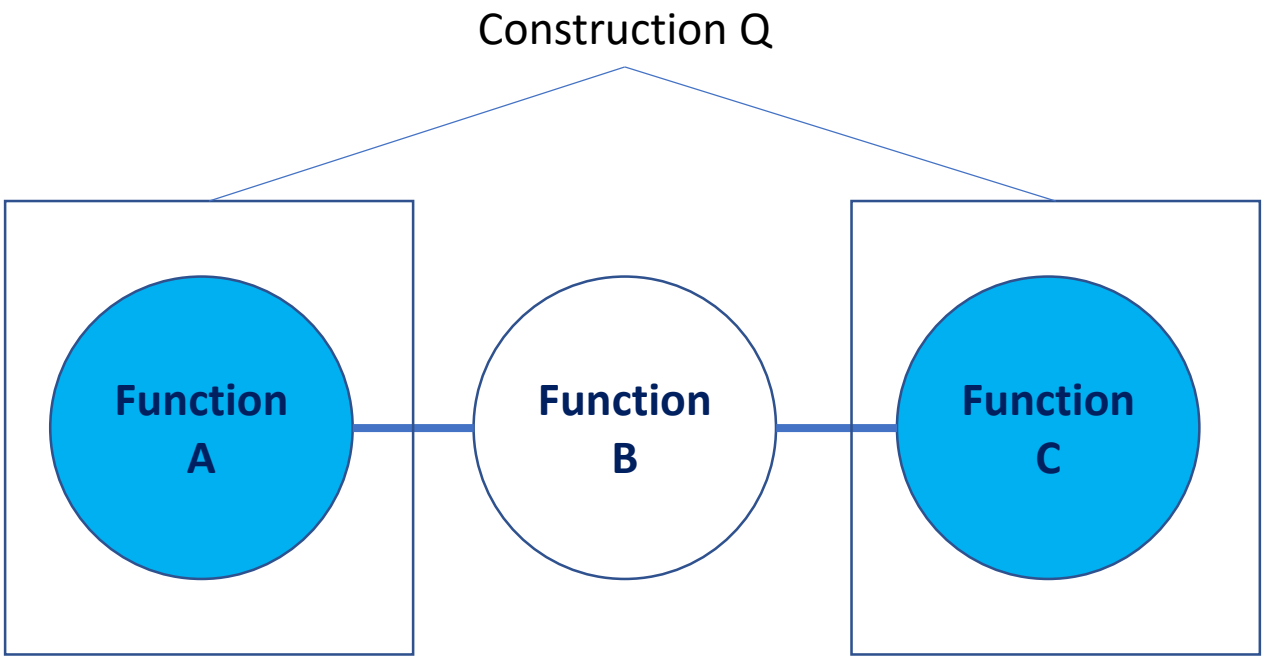
Example 2



Example 3

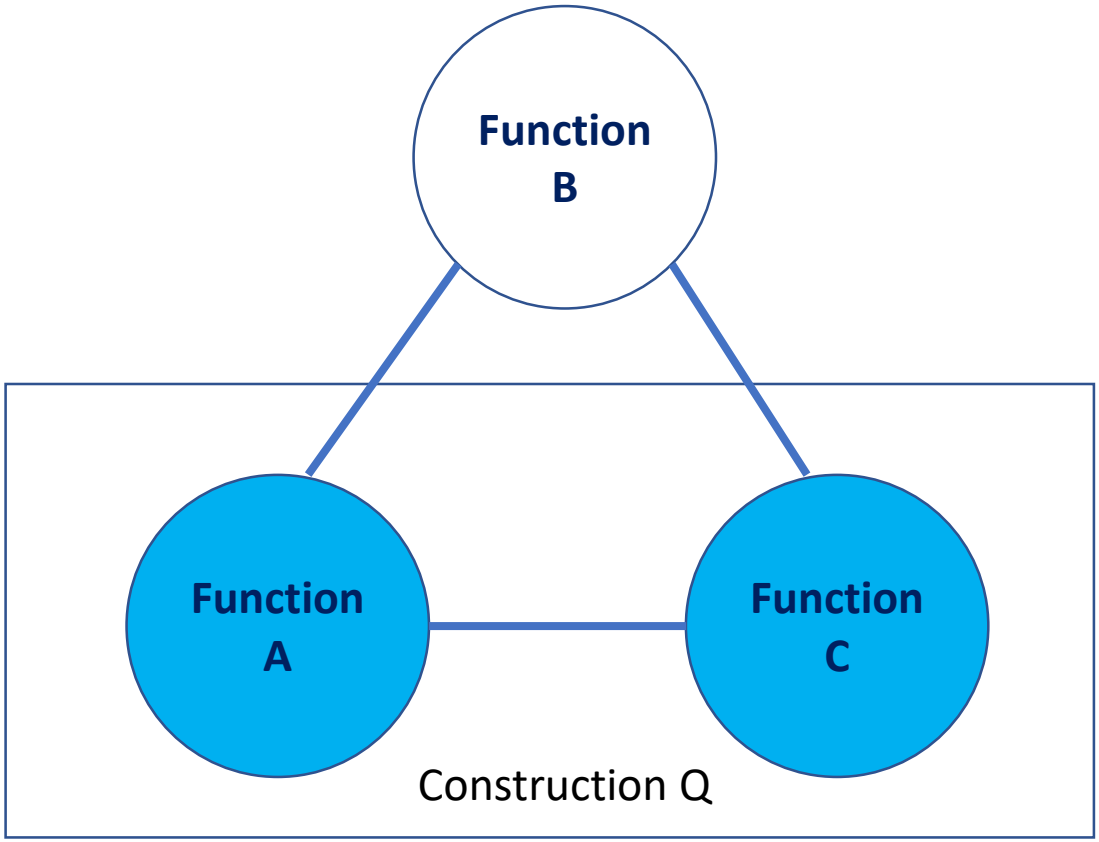


Example 4



Wrong:
the connectivity principle is not observed!

A fix



Traditional maps

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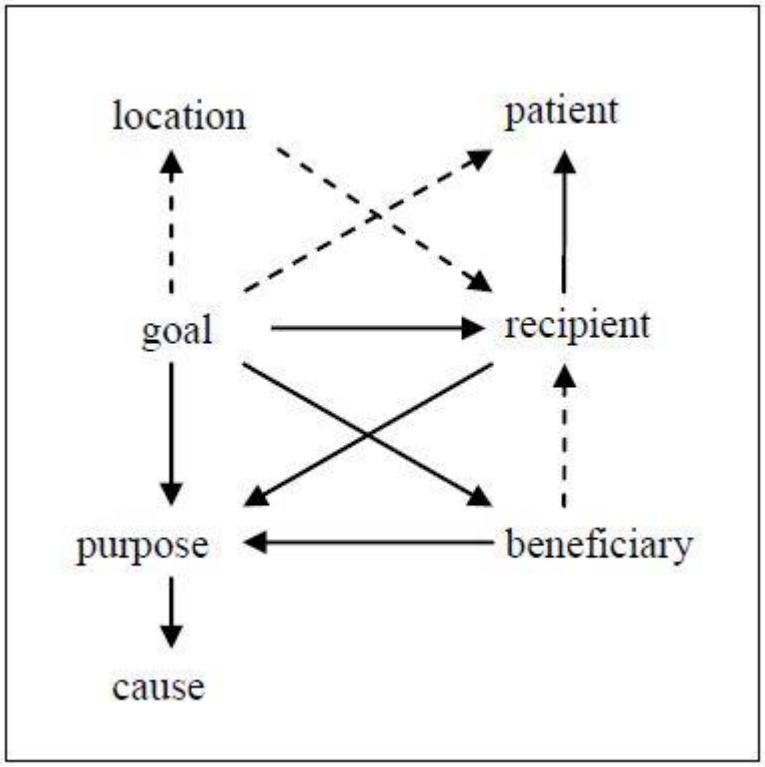
- directional

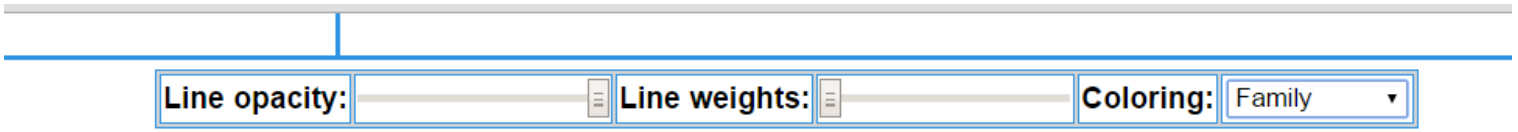
Narrog 2010: Goal-Recipient Domain



Types of semantic maps

	Connectivity (links between objects)	**Proximity (distances between objects)**
Type-based (pre-determined functions, frequencies do NOT count)	Manual/**Automatic**	Automatic
Token-based (corpus exemplars, frequencies COUNT)	?	Automatic

CLICS (List et al. 2014): HAND



85 links for "arm" and "hand":

Language	Family	Form
1. Gawwada	Afro-Asiatic	harɠo
2. Hausa	Afro-Asiatic	hannu
3. Iraqw	Afro-Asiatic	dawa
4. Polci	Afro-Asiatic	aam
5. Tarifit	Afro-Asiatic	fus
6. Azerbaijani, South	Altaic	əл
7. Kumyk	Altaic	къол
8. Oroqen	Altaic	ŋa:la
9. Gurinji	Australian	wartarn
10. Vietnamese	Austro-Asiatic	tay

http://clics.lingpy.org/

Types of semantic maps

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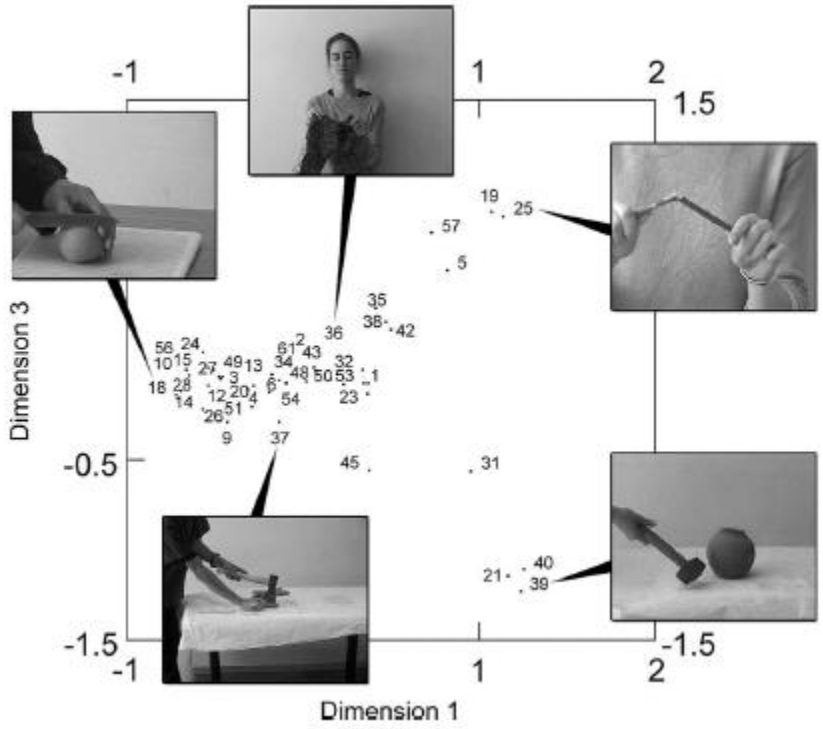
Majid et al. 2008: cutting and breaking



Types of semantic maps

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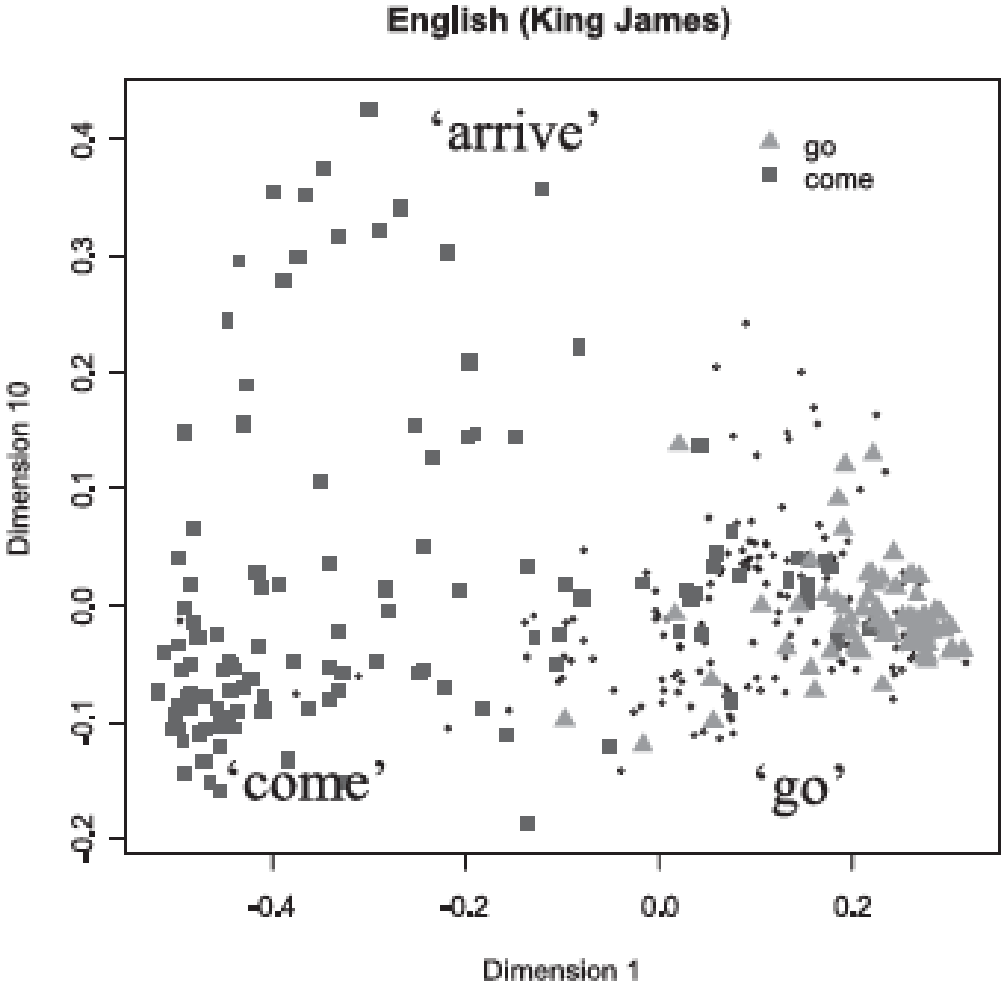
Wälchli & Cysouw (2012): motion verbs



Outline

1. Semantic maps in linguistic research

2. Multidimensional Scaling

3. Case study: analytic causatives in European languages

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

Algorithm for MDS: Step 1

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Comparative concepts (cf. Haspelmath 2010)

Algorithm for MDS: Step 2

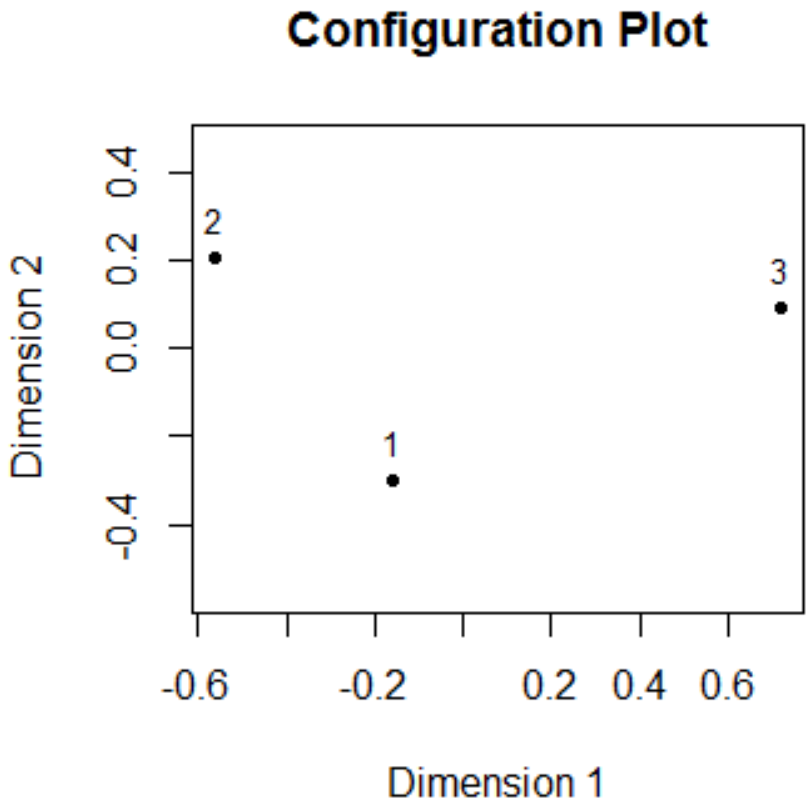
2. Compute the distances between the situations (rows) = the proportion of dissimilar values.

	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



Intepretation

- 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.

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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

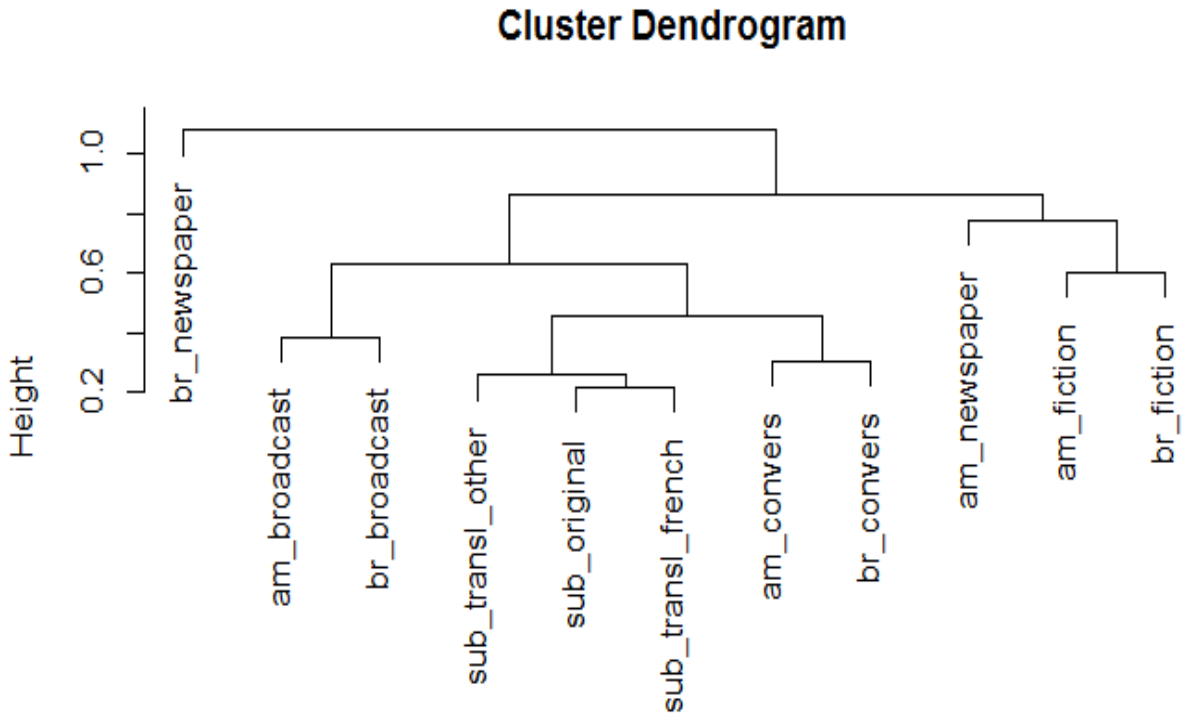
Analytic Causatives: Examples

- 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

ParTy corpus

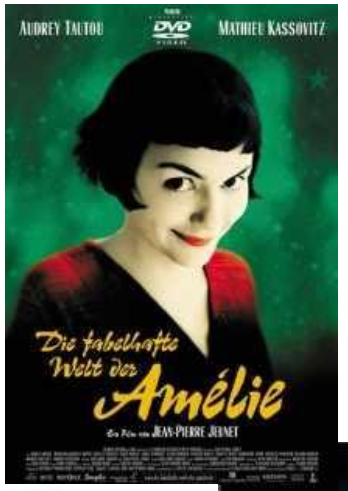
- a Parallel corpus for Typology
- subtitles of films and TED talks
- mostly European languages, but also other major languages (Chinese, Turkish, Indonesian, etc.)
- all languages aligned with English
- downloadable files at www.natalialevshina.com/corpus.html

Why subtitles?



Based on the frequencies of 3-grams (Levshina, In press)

Films for case study



An example of .srt format

…
646
00:51:27,880 --> 00:51:32,920
For always evil will look to
find a foothold in this world.

647
00:51:39,440 --> 00:51:42,603
Not good. Not good at all.

648
00:51:50,040 --> 00:51:51,326
Eww.

649
00:52:06,760 --> 00:52:09,081
Oh, no. Sebastian.

650
00:52:12,800 --> 00:52:13,847
Good gracious.

651
00:52:34,720 --> 00:52:35,767
Come on.
…

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

Task

- Compute 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 ≈ 0.167

Fitting MDS

```
> library(smacof)
```

Fitting a two-dimensional metric MDS (default):

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

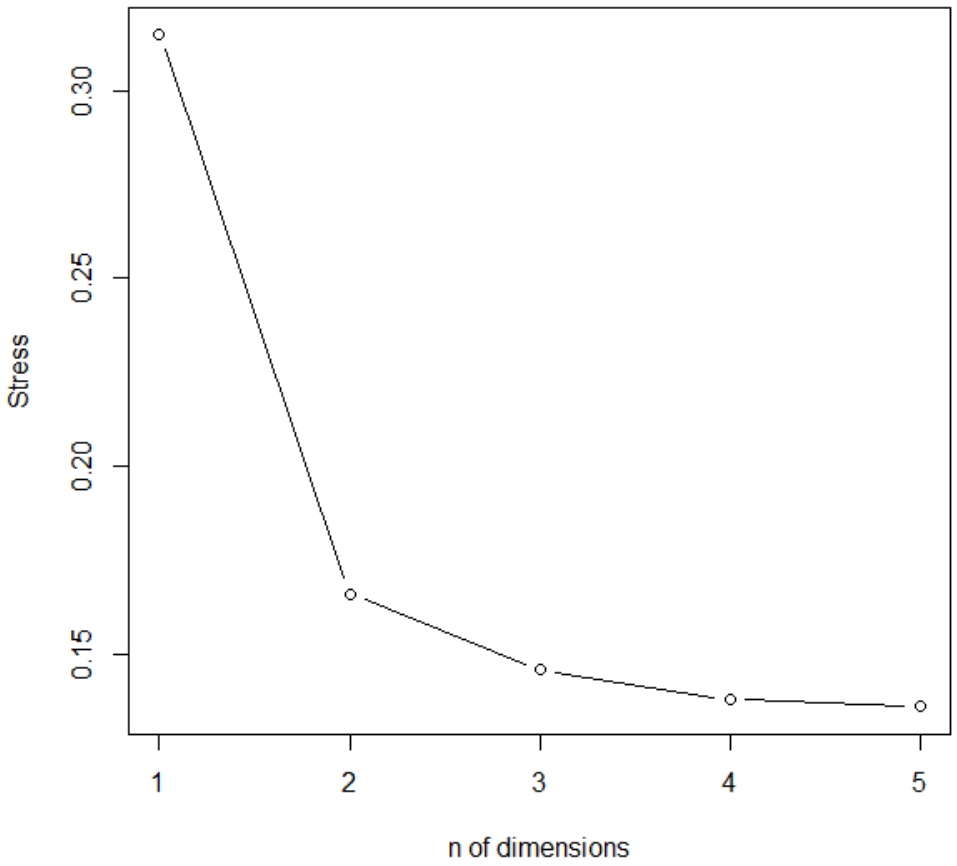
How good is the 2D solution?

```
> 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:

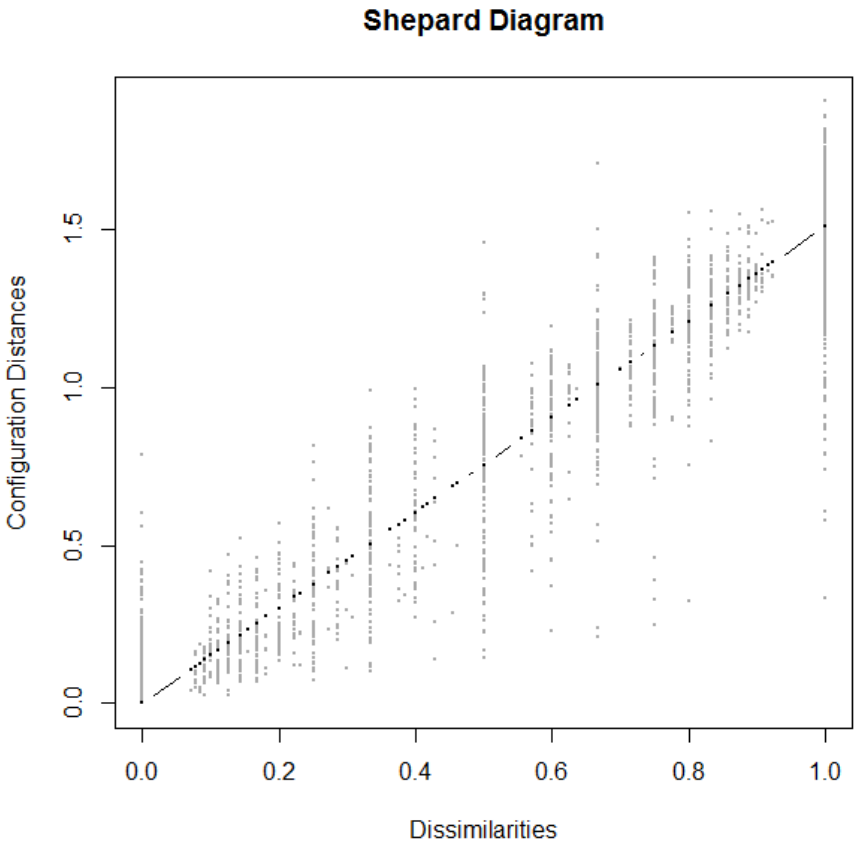
```
> plot(1:5, c(d1, d2, d3, d4, d5), type = "b",
xlab = "n of dimensions", ylab = "Stress")
```

Watch the ‘elbow’



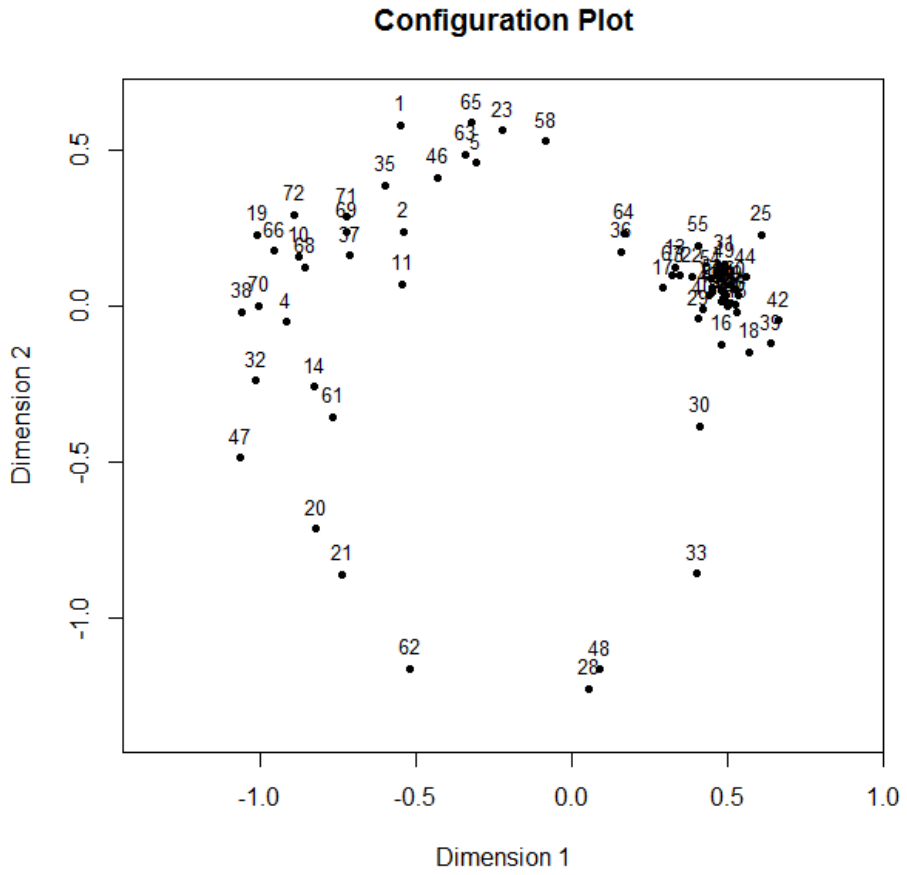
Stress and individual distances

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



Interpreting the solution

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



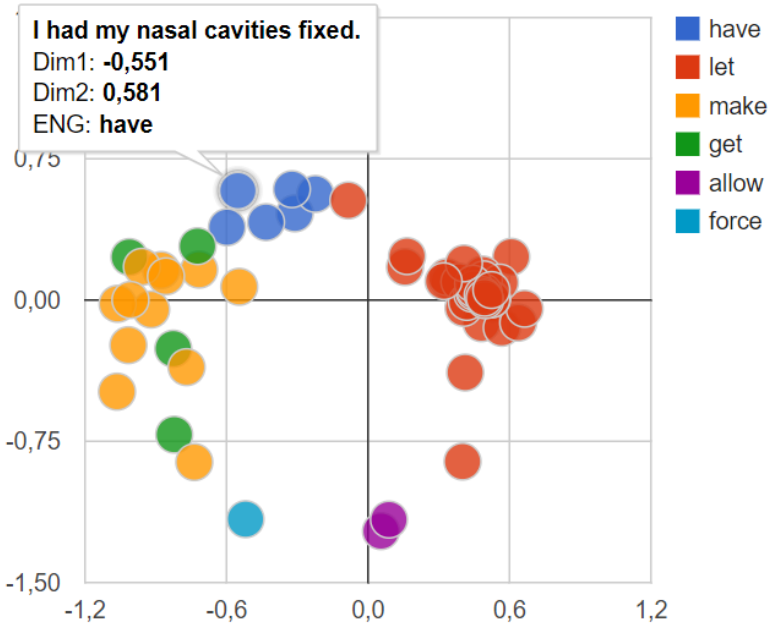
Exploring the contexts: bubbles

```
> 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

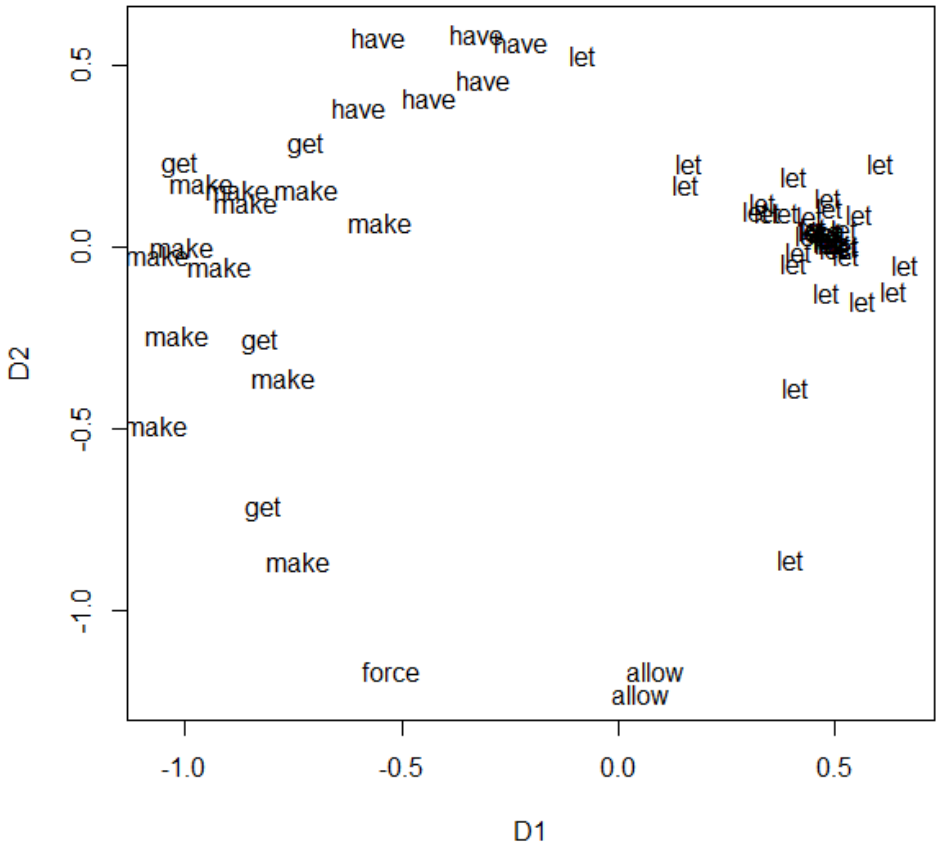


Data: text.df • Chart ID: BubbleChartID1d6472c66b06 • googleVis-0.6.2
R version 3.4.0 (2017-04-21) • Google Terms of Use • Documentation and Data Policy

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

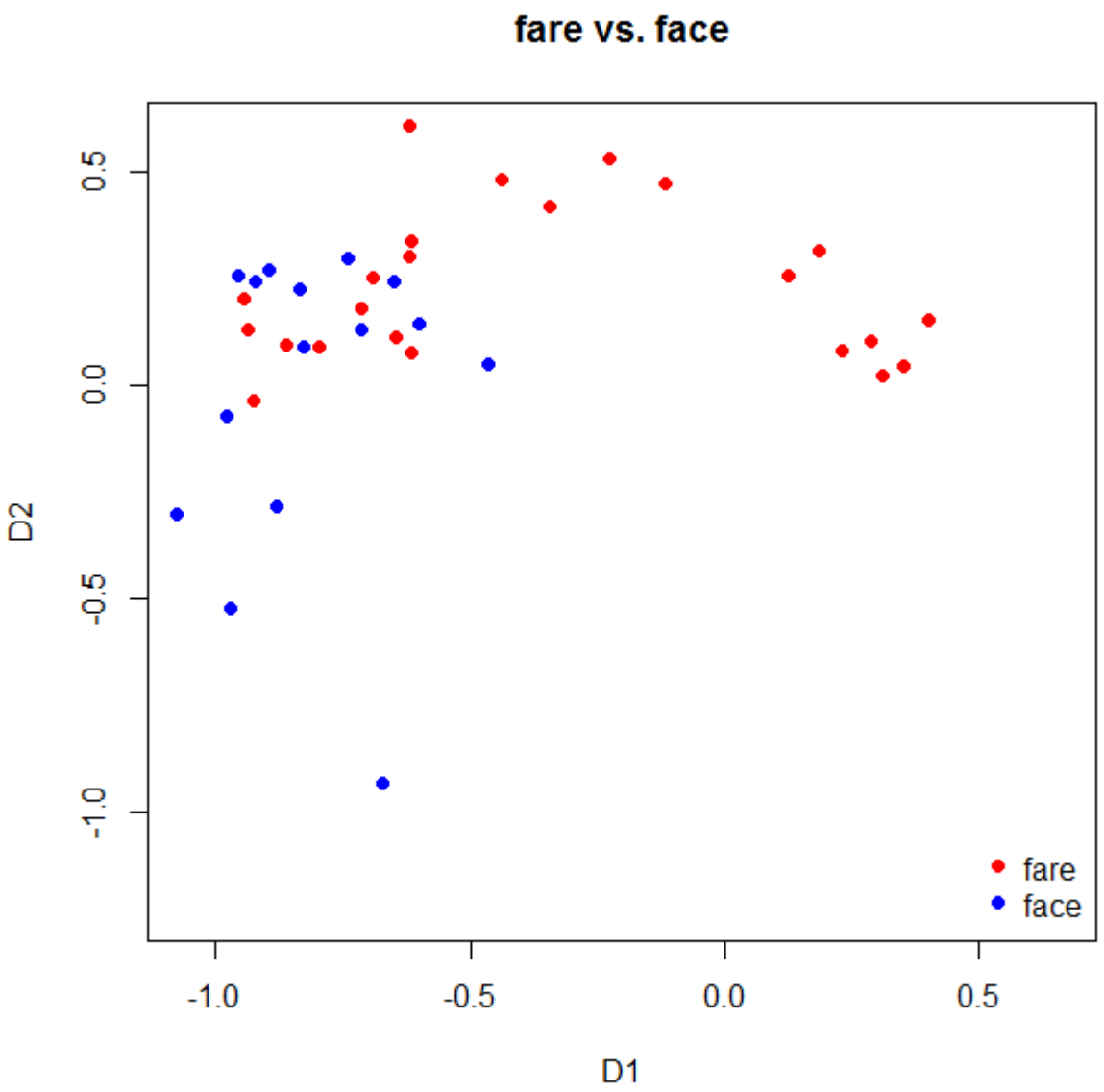
```
> plot(causatives.mds$conf, type = "n", main =
"fare vs. face")
```

Add some jitter to avoid overplotting:

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

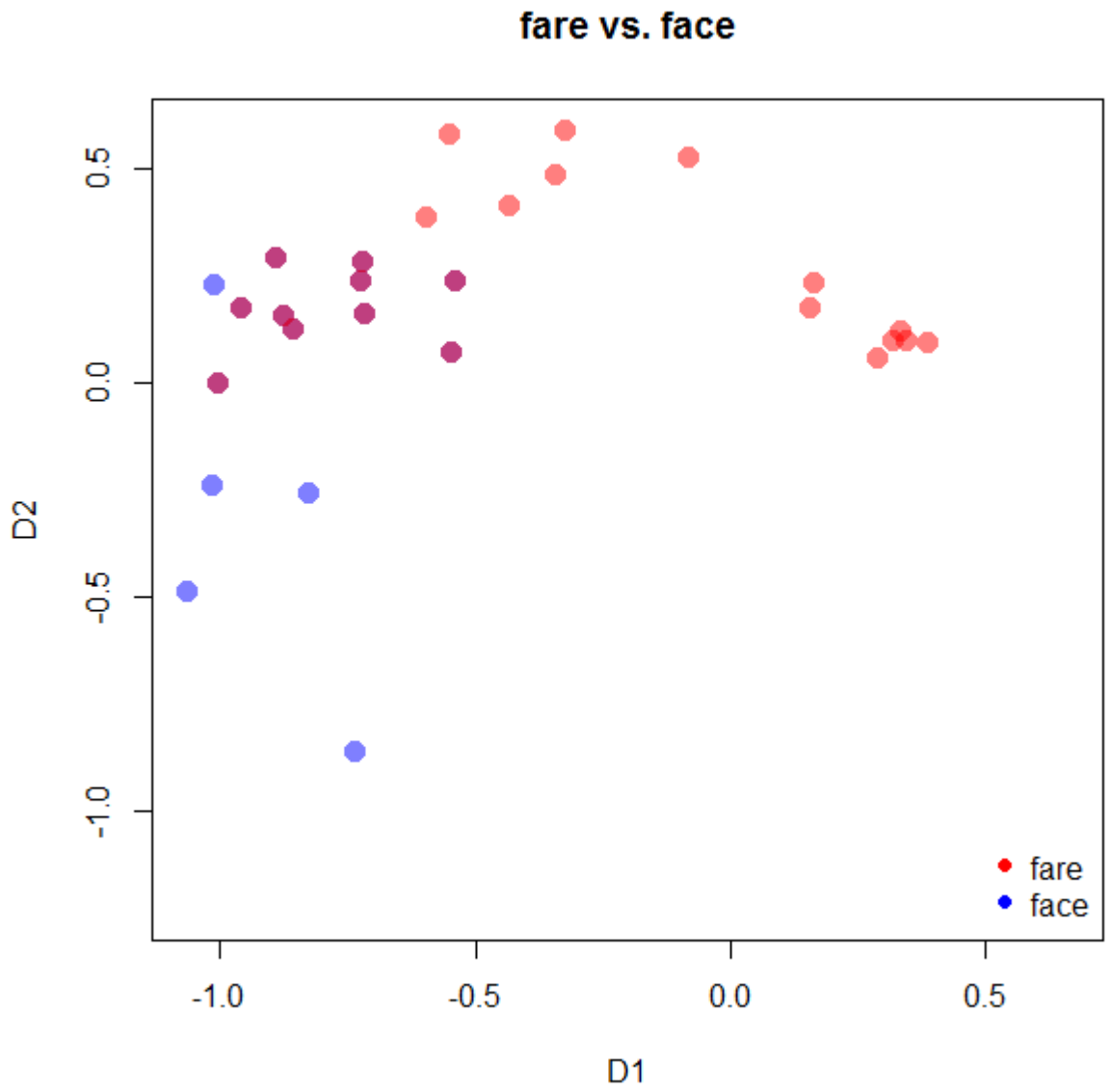
```
> points(jitter(causatives.mds$conf[causatives$ITA
== "fare",], amount = 0.1), col = "red", pch = 16)
```

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


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

Kriging: preparation

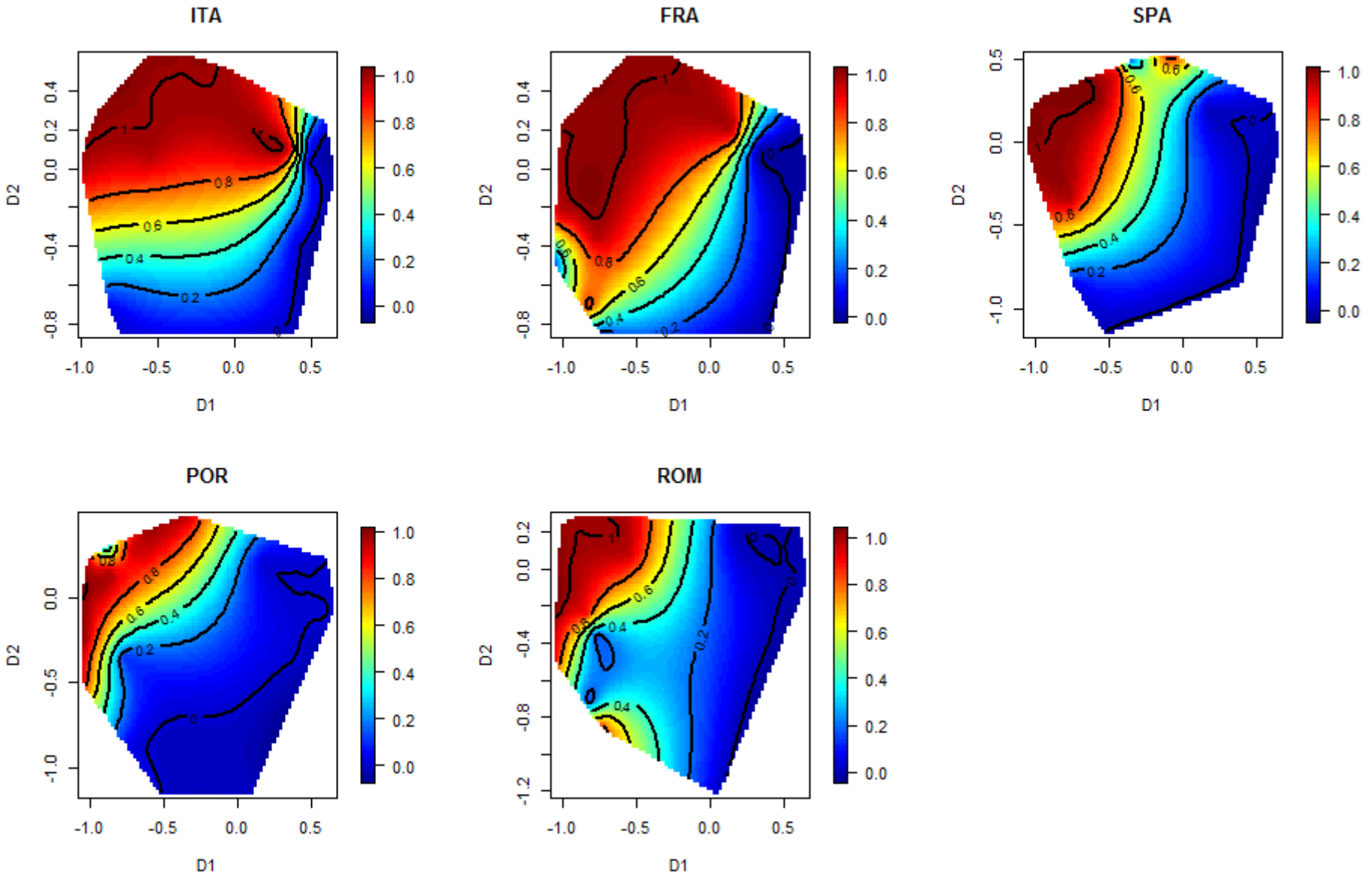
```
> y.ita <- ifelse(causatives$ITA == "fare", 1, 0)
> y.fra <- ifelse(causatives$FRA == "faire", 1, 0)
> y.spa <- ifelse(causatives$SPA == "hacer", 1, 0)
> y.por <- ifelse(causatives$POR == "fazer", 1, 0)
> y.rom <- ifelse(causatives$ROM == "face", 1, 0)
```

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)
```

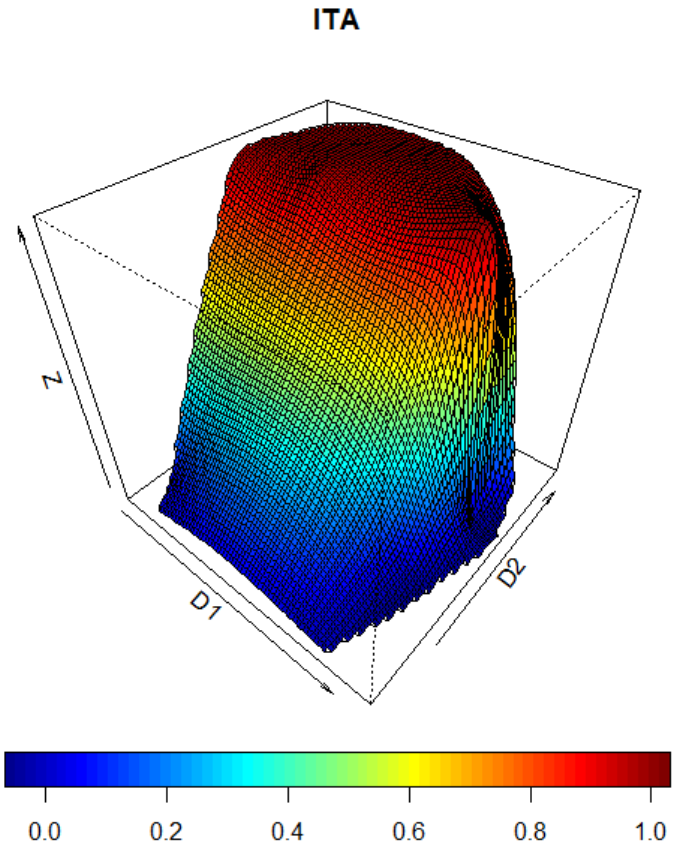
Fitted surface plots

```
> 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

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 similar analyses for the Germanic verbs of letting
  - DUT laten
  - ENG let
  - GER lassen
  - SWE låta (represented as lata)
  - NOR la
- Are there differences in grammaticalization and semantic bleaching?

References

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