Interactive Graphs with Stata

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Presentation

Aims

The aims of this presentation are:

- To show *network coincidence analysis*, which is a statistical framework to study concurrence of events.
- To present `coin`, an ado program that is able to perform this analysis.
- To show interactive graphs with Stata with the command `netcoin`.
- As an example, an analysis of people in the picture albums of an eminent character in the early 20^{th} century will be presented.
- This kind of representations can also be applied to
  - Social media analysis.
  - Content analysis of media and textbooks.
  - Multiresponse, glm and sem analysis in questionnaires.
  - Historical representation of eminent figures.

Coincidence analysis

Definition

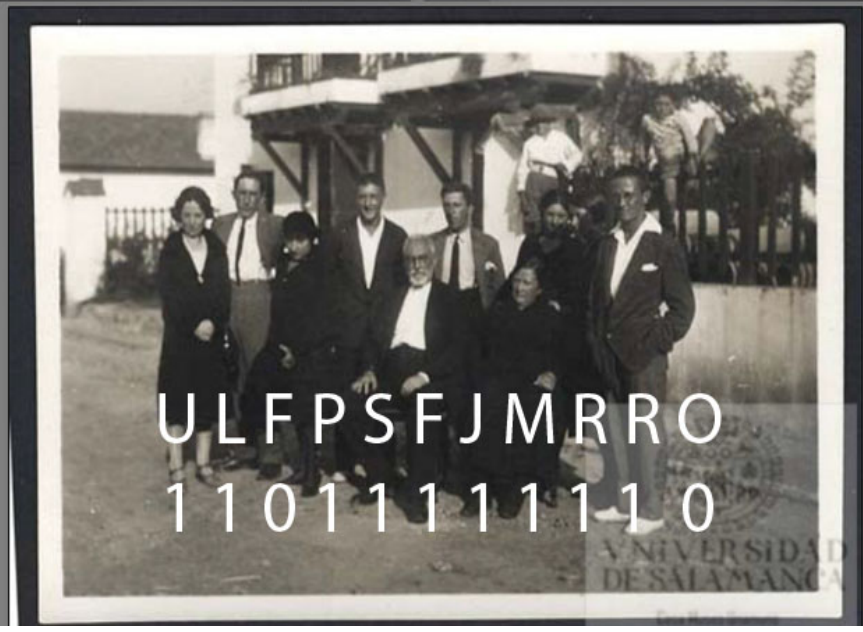
- Coincidence analysis is a set of techniques whose object is to detect which people, subjects, objects, attributes or events tend to appear at the same time in different delimited spaces.
- These delimited spaces are called n scenarios, and are considered as units of analysis (i).
- In each scenario a number of J events X_j may occur (1) or may not (0) occur.
- We call incidence matrix ($\mathbf{X}$) an $n \times J$ matrix composed by 0 and 1, according to the incidence or not of every event X_j.
- In order to make comparative analysis of coincidences, these scenarios may be classified in H sets

An example of incidences matrix

Meeting the people

An example of incidences matrix

Coding the people



Input of the analyses

Incidences matrix (appearance or not appearance of 8 events in 4 scenarios)

The input of the analysis is a $\mathbf{X}$ matrix constructed with i rows representing scenarios, and the j columns representing events:

$$\mathbf{X} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \end{bmatrix}$$

Coincidences matrix

Definition

- From the incidence matrix ($\mathbf{X}$), the coincidences matrix ($\mathbf{F}$) can be obtained by

$$\mathbf{F} = \mathbf{X}'\mathbf{X}$$

  - where each element f_{jk} represents the number of scenarios where X_j and X_k are both 1, that is to say, the two events coincide.

- As may be imagined, there are special elements (f_{jj}) in the diagonal, which represent the number of incidences of X_j in the n scenarios.

Example of coincidences matrix

Coincidences matrix (co-appearances in the pictures)

The symmetric **F** matrix is compose by i rows and j columns representing incidences (diagonal) and coincidences of events:

$$\mathbf{F} = \begin{bmatrix}
\mathbf{3} & & & & & & & & & \\
3 & \mathbf{4} & & & & & & & & \\
2 & 2 & \mathbf{2} & & & & & & & \\
3 & 4 & 2 & \mathbf{4} & & & & & & \\
3 & 4 & 2 & 4 & \mathbf{4} & & & & & \\
3 & 4 & 2 & 4 & 4 & \mathbf{4} & & & & \\
3 & 4 & 2 & 4 & 4 & 4 & \mathbf{4} & & & \\
3 & 4 & 2 & 4 & 4 & 4 & 4 & \mathbf{4} & & \\
3 & 4 & 2 & 4 & 4 & 4 & 4 & 4 & \mathbf{4} & \\
1 & 2 & 0 & 2 & 2 & 2 & 2 & 2 & 2 & \mathbf{2} \\
1 & 2 & 1 & 2 & 2 & 2 & 2 & 2 & 2 & 1 & \mathbf{2}
\end{bmatrix}$$

3 grades of coincidence

Mere and probable events

- Two events (X_j and X_k) are defined as 1) **merely** coincident if they occur in the same scenario at least once:

$$[\exists_i (x_{ij} = 1 \wedge x_{ik} = 1)] \vee f_{jk} \geq 1$$

- Additionally, two events (X_j and X_k) are defined as 2) **conditionally** coincident if they occur more frequently than if they are independent:

$$f_{jk} > \frac{f_{jj} f_{kk}}{n}$$

3 grades of coincidence (cont.)

Statistically probable events

- And two events are 3) **statistically conditional** if the joint frequency of their events meets one of the following inequalities:

$$\begin{aligned} \mathrm{P}(r_{jk} \leq 0) &< c \\ \mathrm{P}(\theta_{jk} \leq 1) &< c \\ \mathrm{P}(\mathrm{p}(X_j) - \mathrm{p}(X_j|X_k) \leq 0) &< c \end{aligned}$$

  - where r_{jk} is the Haberman residual, θ_{jk} is the odd ratio, and the third equation represents a one tailed Fisher exact test. Furthermore, c is the selected level of significance, normally 0.05)

- Haberman residuals (r_{jk}) with normal distribution may be used to assess statistically conditional events:

$$r_{jk} = \frac{f_{jk} - \frac{f_{jj} f_{kk}}{n}}{\sqrt{\frac{f_{jj} f_{kk} (n - f_{jj})(n - f_{kk})}{n^3}}}$$

Graph

Definition

- "A graph $\mathcal{G}$ consist of two sets of information: a set of Nodes (events), $\mathcal{N} = \{n_1, n_2, ..., n_g\}$, and a set of lines (adjacencies), $\mathcal{L} = \{l_1, l_2, ..., l_L\}$ between pair of nodes ". (Wasserman and Faust 1994).

Adjacencies

Elaboration of the adjacency matrices

- From the residual matrix, an adjacency $J \times J$ matrix $\mathbf{A}$ may be elaborated with all the elements equal to 0, but 1 in the case where r_{jk} is significantly below the level c.

$$\mathbf{A}[j,k] = 1 \Leftrightarrow [\mathrm{P}(r_{jk} \leq 0) < c] \wedge j \neq k$$

- By extension, other adjacency matrices can be elaborated following
  - The mere coincidence criterion

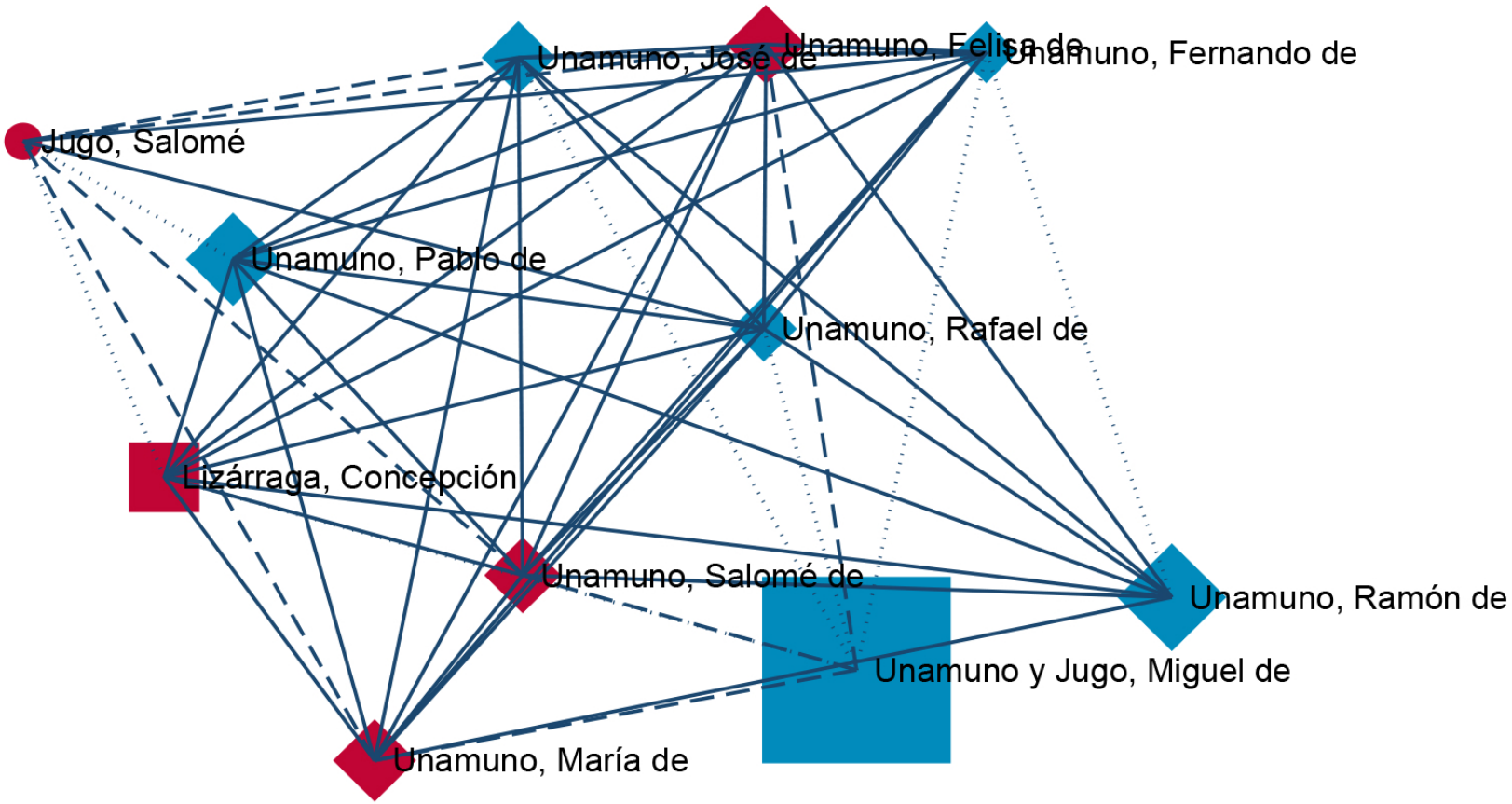
$$\mathbf{A}[j,k] = 1 \Leftrightarrow f_{jk} \geq 1$$

  - Or the conditional coincidence criterion

$$\mathbf{A}[j,k] = 1 \Leftrightarrow [\mathrm{P}(r_{jk} \leq 0) < 0.5] \wedge j \neq k$$

Graph representation

Fruchterman-Reingold layout



Fruchterman-Reingold coordinates

Social network programs

Stata program

- Stata has no tools for SNA.
- However, some advanced users have begun to write some routines. I wish to highlight the following works from which I have obtained insights:
  - Corten (2010) wrote a routine to visualize social networks [`netplot`].
  - Mihura (2012) created routines (SGL) to calculate networks centrality measures, including two Stata commands [`netsis` and `netsummarize`].
  - Afterwards, White (2013) presented a suite [`network`] of Stata programs for meta-analysis which includes the network graphs of Anna Chaimani in the UK. users group meeting.
  - And Grund (2013-2018, forthcoming) have presented a collection of programs to plot and analyze social networks [`nwcommands`].

coin

What is it?

- `coin` is an ado program in its development phase, which is capable of performing coincidence analysis.
- Its input is a dataset with scenarios as rows and events as columns.
- Its outputs are:
  - Different matrices (frequencies, percentages, residuals (3), distances, adjacencies and edges).
  - Several bar graphs, network graphs (circle, mds, pca, ca, biplot) and dendrograms (single, average, waverage, complete, wards, median, centroid).
  - Measures of centrality (degree, closeness, betweenness, information) (eigenvector and power)
  - Options to export to excel and .csv files.
- Its syntax is simple, but flexible. Many options such as output, bonferroni, p value, minimum, special event, graph controls, ...

Command

coin

`coin` *varlist* [*if*] [*in*] [*weight*] [, *options*]

Options can be classified into the following groups:

- **Outputs**: `f`, `g`, `v`, `h`, `e`, `r`, `s`, `n`, `ph`, `o`, `po`, `pf`, `t`, `a`, `d` , `l`, `c`, `all`, `x`, `xy`.
- **Controls**: head(*varlist*), variable(*varname*), ascending, descending, minimum (#), support(#), pvalue(#), levels(# # #), bonferroni, lminimum(#), iterations(#).
- **Plots**
  - Bar: bar, cbar(*varname*)
  - Graph: plot(circle|mds|ca|pca|biplot)
  - Dendrograms: dendrogram(single|complete|average|wards)

Data examples

Coincidences matrix of Unamuno's nuclear family

```
. coin Unamuno-Jugo, f
329 scenarios. 51 probable coincidences amongst 11 events. Density: 0.93. Components: 1.
11 events(n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo
```

Frequencies	Una~o	Liz~a	Fer~o	Pablo	Sal~e	Fel~a	Jose	Maria	Raf~l	Ramon	Jugo
Unamuno y Jugo, Migu~e	176										
Lizárraga, Concepción	12	19									
Unamuno, Fernando de	5	4	7								
Unamuno, Pablo de	9	8	3	17							
Unamuno, Salomé de	9	8	3	7	11						
Unamuno, Felisa de	10	9	2	8	8	12					
Unamuno, José de	7	8	3	8	7	7	10				
Unamuno, María de	10	10	3	10	9	10	8	13			
Unamuno, Rafael de	6	6	3	7	7	7	6	8	8		
Unamuno, Ramon de	5	4	1	5	5	5	4	5	5	23	
Jugo, Salomé	1	1	1	1	1	1	1	1	1	0	5

Data examples

Haberman's residuals matrix of Unamuno's nuclear family

```
. coin Unamuno-Jugo, normalized
329 scenarios. 51 probable coincidences amongst 11 events. Density: 0.93. Components: 1.
11 events(n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo
```

Haberman residuals	Una~o	Liz~a	Fer~o	Pablo	Sal~e	Fel~a	Jose	Maria	Raf~l	Ramon	Jugo
Unamuno y Jugo, Migu~e	18.1										
Lizárraga, Concepción	0.9	18.1									
Unamuno, Fernando de	1.0	5.9	18.1								
Unamuno, Pablo de	-0.0	7.5	4.6	18.1							
Unamuno, Salomé de	1.9	9.7	5.9	8.9	18.1						
Unamuno, Felisa de	2.1	10.5	3.6	9.8	12.4	18.1					
Unamuno, José de	1.1	10.2	6.2	10.9	11.9	11.4	18.1				
Unamuno, María de	1.7	11.2	5.3	11.9	13.5	14.4	12.5	18.1			
Unamuno, Rafael de	1.2	8.5	7.0	10.7	13.4	12.8	12.0	14.1	18.1		
Unamuno, Ramón de	-3.2	2.5	0.8	3.7	5.1	4.8	4.2	4.5	6.2	18.1	
Jugo, Salomé	-1.5	1.4	2.8	1.5	2.1	2.0	2.2	1.9	2.6	-0.6	18.1

Data examples

Adjacency matrix from Haberman's residuals matrix

```
. coin Unamuno-Jugo, adjacencies
329 scenarios. 51 probable coincidences amongst 11 events. Density: 0.93. Components: 1.
11 events(n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo
```

Adjacency matrix	Una~o	Liz~a	Fer~o	Pablo	Sal~e	Fel~a	Jose	Maria	Raf~l	Ramon	Jugo
Unamuno y Jugo, Migu~e	0										
Lizárraga, Concepción	1	0									
Unamuno, Fernando de	1	1	0								
Unamuno, Pablo de	0	1	1	0							
Unamuno, Salomé de	1	1	1	1	0						
Unamuno, Felisa de	1	1	1	1	1	0					
Unamuno, José de	1	1	1	1	1	1	0				
Unamuno, María de	1	1	1	1	1	1	1	0			
Unamuno, Rafael de	1	1	1	1	1	1	1	1	0		
Unamuno, Ramón de	0	1	1	1	1	1	1	1	1	0	
Jugo, Salomé	0	1	1	1	1	1	1	1	1	0	0

Data examples

Adjacency matrix from significant Haberman's residuals matrix

```
. coin Unamuno-Jugo, adjacencies pvalue(.05)
329 scenarios. 44 statistically probable(p<=.05) coincidences. Density: 0.80. Components: 1.
11 events(n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo
```

Adjacency matrix	Una~o	Liz~a	Fer~o	Pablo	Sal~e	Fel~a	Jose	Maria	Raf~l	Ramon	Jugo
Unamuno y Jugo, Migu~e	0										
Lizárraga, Concepción	0	0									
Unamuno, Fernando de	0	1	0								
Unamuno, Pablo de	0	1	1	0							
Unamuno, Salomé de	1	1	1	1	0						
Unamuno, Felisa de	1	1	1	1	1	0					
Unamuno, José de	0	1	1	1	1	1	0				
Unamuno, María de	1	1	1	1	1	1	1	0			
Unamuno, Rafael de	0	1	1	1	1	1	1	1	0		
Unamuno, Ramón de	0	1	0	1	1	1	1	1	1	0	
Jugo, Salomé	0	0	1	0	1	1	1	1	1	0	0

Data examples

Links list

```
. coin Unamuno-Jugo, list key(normalized) lminimum(10)

329 scenarios. 51 probable coincidences amongst 11 events. Density: 0.93. Components: 1.
11 events: Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo

        N Edge
 -------- ---------------------------------------
    14.38 Unamuno, Felisa de <-> Unamuno, María de
    14.12 Unamuno, María de <-> Unamuno, Rafael de
    13.48 Unamuno, Salomé de <-> Unamuno, María de
    13.40 Unamuno, Salomé de <-> Unamuno, Rafael de
    12.81 Unamuno, Felisa de <-> Unamuno, Rafael de
    12.54 Unamuno, José de <-> Unamuno, María de
    12.43 Unamuno, Salomé de <-> Unamuno, Felisa de
    12.00 Unamuno, José de <-> Unamuno, Rafael de
    11.93 Unamuno, Pablo de <-> Unamuno, María de
    11.91 Unamuno, Salomé de <-> Unamuno, José de
    11.37 Unamuno, Felisa de <-> Unamuno, José de
    11.22 Lizárraga, Concepción <-> Unamuno, María de
    10.86 Unamuno, Pablo de <-> Unamuno, José de
    10.65 Unamuno, Pablo de <-> Unamuno, Rafael de
    10.47 Lizárraga, Concepción <-> Unamuno, Felisa de
    10.22 Lizárraga, Concepción <-> Unamuno, José de
```

netcoin

What is it?

- netcoin is a new ado command in its development phase, which is capable of create interactive graphs in html format.
- Its input is a dataset with scenarios as rows and events as columns.
- It can also use another dataset with the characteristics of the events
- Its output is an interactive graph in html format.
- Its syntax is very simple as it uses coin to calculate its statistics.

Command

netcoin

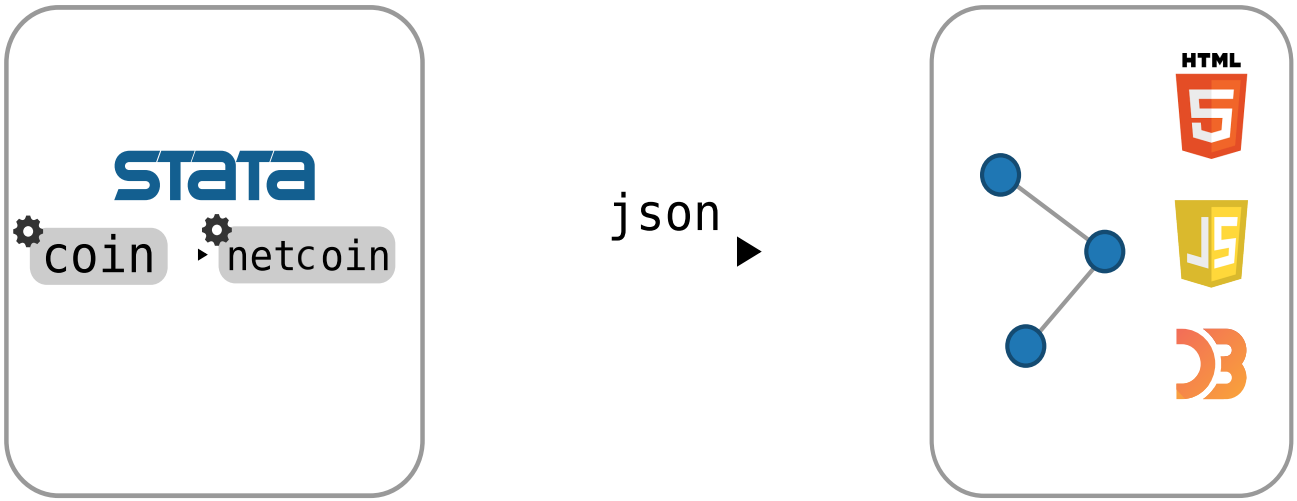
`netcoin` *varlist* [*if*] [*in*] [*weight*] [`using` *filename*] [, *options*]

Options can be classified into the following groups:

- **Controls**: `minimum(#)` `directory(`*dirname*`)` `language(en|es|ca)`
- **Outputs** (only if using): `name(`*varname*`)` `label(`*varname*`)` `size(`*varname*`)` `color(`*varname*`)` `shape(`*varname*`)` `image(`*varname*`)`

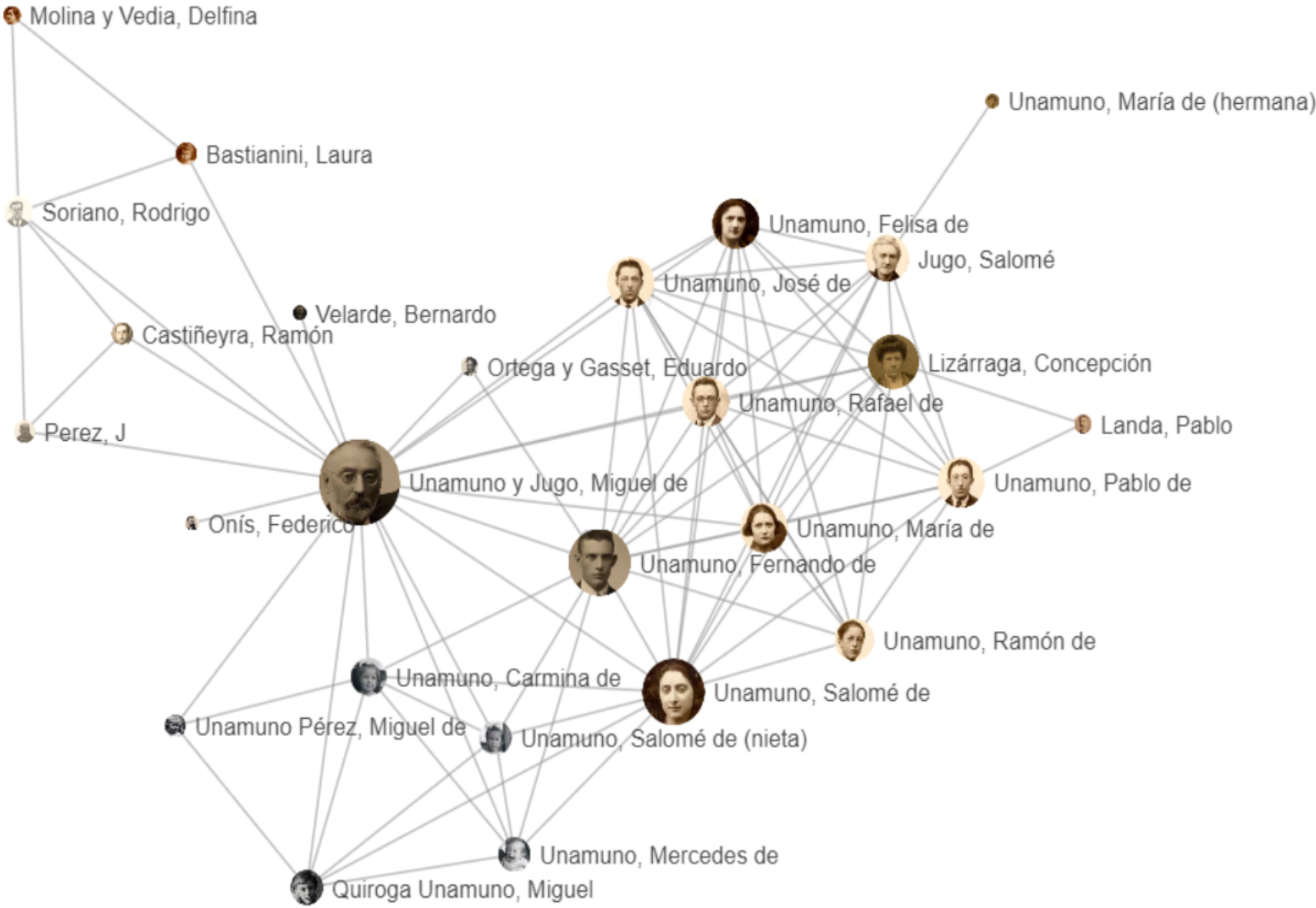
Process

From Stata to D3-JavaScript-html



Output

Network representation of Unamuno's family album



Remarks

About coincidence analysis

- We've proposed a manner of analyzing coincidences mixing different statistical tools.
- We think that the novelty of coincidence analysis is combining several techniques in order to represent data with interactive html graphs.
- This may be useful in analyzing dichotomous variables, but also to represent regressions, structural equation models and other networked graphs.
- We think that this approach could be extensively used with the aid of the `coin`, `precoin`, `netcoin` and other forthcoming programs.

Availability of coin and netcoin

Frame Subtitle

- If you are users of a version superior to the 11.2 of Stata, you can have a free copy of coin by typing:
  - net install coin, from(http://caring.usal.es/coinStata/)
- It is still a beta version, but it works reasonably well and it is being improved. It could be updated as follows:
  - adoupdate, update
- `netcoin` is more difficult to install as it requires to decompress JavaScript files.
- Comments and suggestions will be welcome!!

Last slide

Thanks

¡Gracias por la atención prestada!

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