Interactive Graphs with Stata

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2019 Spanish Stata Users Group meeting

Madrid, 17th October
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 20th 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 ($X$) 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 \( X \) matrix constructed with \( i \) rows representing scenarios, and the \( j \) columns representing events:

\[
X = \begin{bmatrix}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\
0 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0
\end{bmatrix}
\]
• From the incidence matrix ($X$), the coincidences matrix ($F$) can be obtained by

\[ F = X'X \]

• 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 composed by $i$ rows and $j$ columns representing incidences (diagonal) and coincidences of events:

$$F = \begin{bmatrix}
3 & 4 \\
3 & 2 & 2 \\
2 & 4 \\
3 & 4 & 2 & 4 \\
3 & 4 & 2 & 4 & 4 \\
3 & 4 & 2 & 4 & 4 & 4 \\
3 & 4 & 2 & 4 & 4 & 4 & 4 \\
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3 & 4 & 2 & 4 & 4 & 4 & 4 & 4 & 4 \\
1 & 2 & 2 & 2 & 2 & 2 & 2 & 2 & 2 & 2 \\
1 & 2 & 2 & 1 & 2 & 2 & 2 & 2 & 2 & 1 & 2
\end{bmatrix}$$
3 grades of coincidence
Mere and probable events

- Two events \((X_j \text{ and } X_k)\) are defined as 1) **merely** coincident if they occur in the same scenario at least once:
  \[
  \exists i (x_{ij} = 1 \land x_{ik} = 1) \lor f_{jk} \geq 1
  \]

- Additionally, two events \((X_j \text{ and } X_k)\) are defined as 2) **conditionally** coincident if they occur more frequently than if they are independent:
  \[
  f_{jk} > \frac{f_{jj} f_{kk}}{n}
  \]
• And two events are 3) **statistically conditional** if the joint frequency of their events meets one of the following inequalities:

\[
P(r_{jk} \leq 0) < c \\
P(\theta_{jk} \leq 1) < c \\
P(p(X_j) - p(X_j|X_k) \leq 0) < c
\]

• where \( r_{jk} \) is the Haberman residual, \( \theta_{jk} \) 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)
Statistical dependence

Measurement

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

$$r_{jk} = \frac{f_{jk} - \frac{f_{jj}f_{kk}}{n}}{\sqrt{\frac{f_{jj}f_{kk}(n-f_{jj})(n-f_{kk})}{n^3}}}$$
“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 $A$ may be elaborated with all the elements equal to 0, but 1 in the case where $r_{jk}$ is significantly below the level $c$.

$$A[j, k] = 1 \iff [P(r_{jk} \leq 0) < c] \land j \neq k$$

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

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

• Or the conditional coincidence criterion

$$A[j, k] = 1 \iff [P(r_{jk} \leq 0) < 0.5] \land j \neq k$$
Graph representation
Fruchterman-Reingold layout
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, ...
Introduction

NCA Coincidence Types

Graphs

Adjacency Example

Remarks

Final

Command

coin

\texttt{coin \textit{varlist} [ \textit{if} ] [ \textit{in} ] [ \textit{weight} ] [ , \textit{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(\textit{varlist}), variable(\textit{varname}), ascending, descending, minimum (#), support(#), pvalue(#), levels(# # #), bonferroni, lminimum(#), iterations(#).

- **Plots**
  - Bar: bar, cbar(\textit{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
11 events (n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo
```

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### Data examples

#### Haberman’s residuals matrix of Unamuno’s nuclear family

```plaintext
.coin Unamuno-Jugo, normalized
11 events (n>=5): Unamuno Lizarraga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo

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## Data examples

### Adjacency matrix from Haberman’s residuals matrix

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11 events (n>=5): Unamuno Lizarra~aga Fernando Pablo Salome Felisa Jose Maria Rafael Ramon Jugo

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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

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<td>Jugo, Salomé</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
```
. coin Unamuno-Jugo, list key(normalized) lminimum(10)


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.
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)`
Interactive Graphs with Stata

M.E. et al.

Introduction

NCA Coincidence Types Graphs Adjacency Example coin netcoin Remarks

Final

Process

From Stata to D3-JavaScript-html
Output

Network representation of Unamuno’s family album
Remarks
About coincidence analysis

- I’ve proposed a manner of analyzing coincidences mixing different statistical tools.
- I 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.
- I 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

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(https://sociocav.usal.es/me/stata/)`

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 Stata 16.0, Python and the `igraph` module.

Comments and suggestions will be welcome!!
¡Gracias por la atención prestada!
modesto@usal.es