Characterizing social information spreading by using event-synchronization and causality measures

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Campus d'Excel·lència Internacional

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

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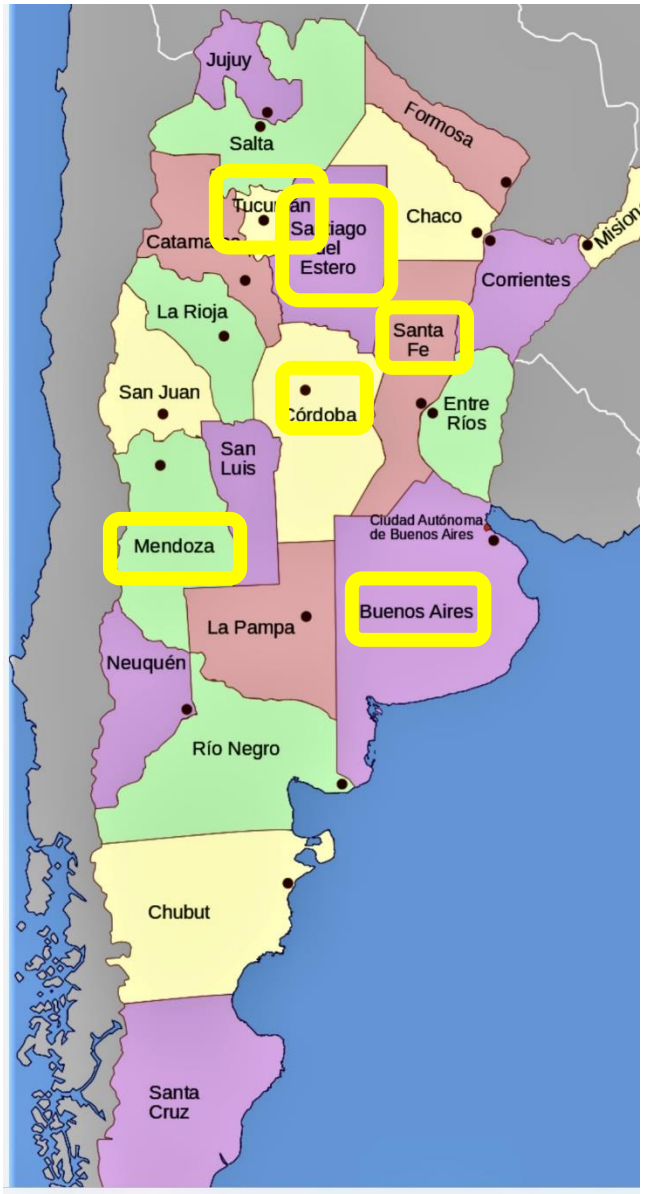
Madrid, June 10, 2026

Diffusion of information in Argentina

- Six observed cities:
  Buenos Aires
  Cordoba
  Tucuman
  Mendoza
  Santa Fe
  Santiago del Estero

- "Output" signals in each city: # of press articles per day in different topics.

- Goal: characterize the information diffusion process using time-series and network analysis.



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Data analyzed

- 28000 news articles published in Argentina in the selected six main cities.
- 4 months (26/05/2022 - 26/09/2022).
- An unsupervised algorithm was used to classify the articles in 20 non-orthogonal topics.

Presentan un proyecto de ley para "garantizar el abastecimiento de combustible líquido"

Política *30 de mayo de 2022* *Por LPTV*

El proyecto impulsado por el legislador Berarducci y acompañado por el bloque del PJS apunta a solucionar una de las crisis que aqueja al sector productivo.

Sergio Berni se cruzó con los transportistas en la autopista La Plata-Buenos Aires y lanzó una advertencia: "Tienen 5 minutos o me llevo los camiones"

"¿Vas a seguir haciendo show?", le preguntó el ministro de Seguridad bonaerense al líder de la protesta, antes de levantar el corte con la Policía; se quejaban por la falta de gasoil

Reunión en Tucumán

Gobernadores del norte reclamaron por la falta de gasoil

Fue durante la 10ª reunión del Consejo de la región Norte Grande. Por parte del Gobierno nacional, Juan Manzur amenazó que caerán "con todo el peso de la ley" sobre quienes alteren los valores del combustible.

S. Pinto, F. Albanese, C. O. Dorso, and P. Balenzuela. *Quantifying time-dependent media agenda and public opinion by topic modeling*. Physica A, 524:614, 2019

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Examples of topics

Alberto Fernandez

Avion Irani

Sergio Massa

Sabag Montiel

Diego Luciani

Silvina Batakis

Cristina Kirchner

Inflacion

Dolar

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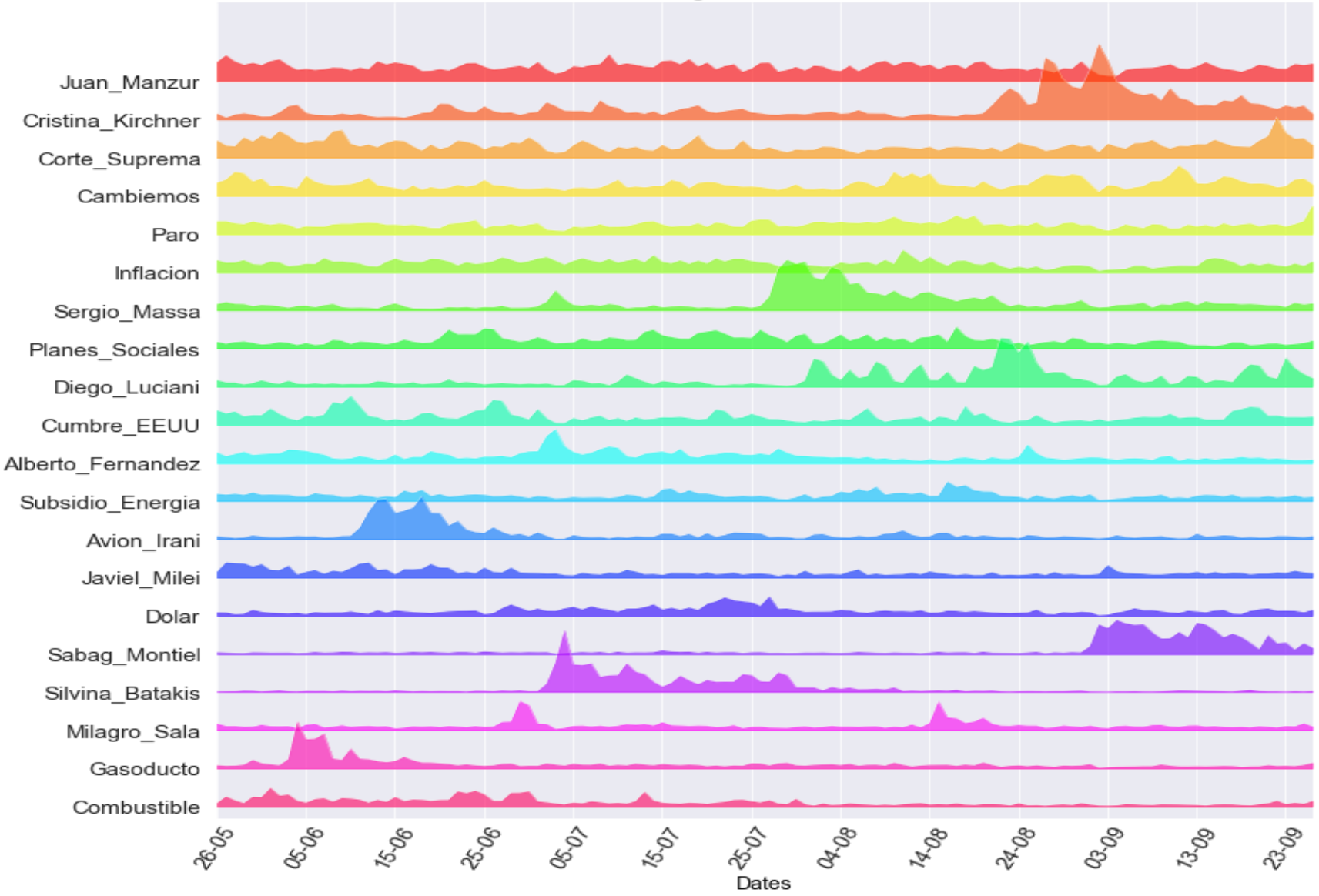
By adding the number of articles per day in the 6 cities, we obtain a time series for each topic.



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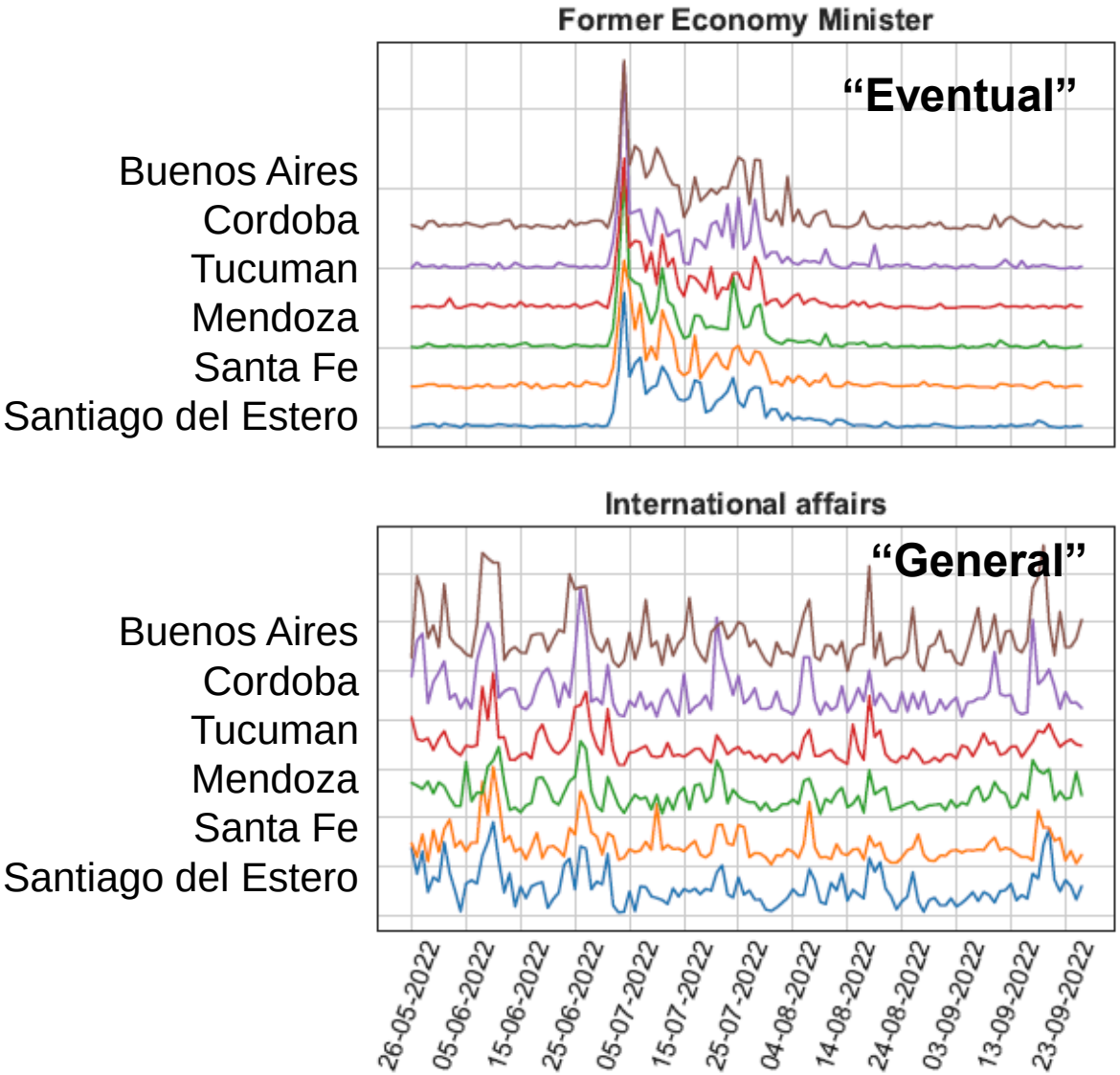
We also have a time series for each topic in each city, with daily resolution.

$x_{n,i}(t)$

n=topic
i = city
t = time



Normalized such that in each city, each day, the total "attention" is 1:

$$\sum_n x_{n,i}(t) = 1$$

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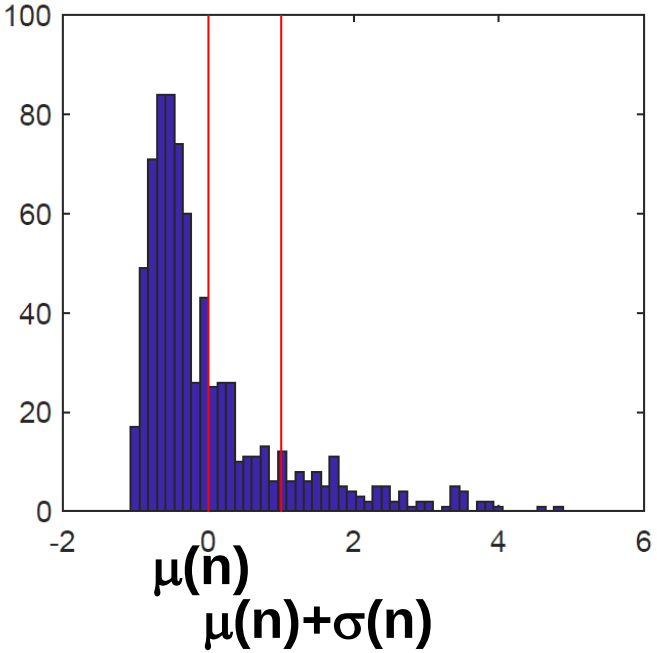
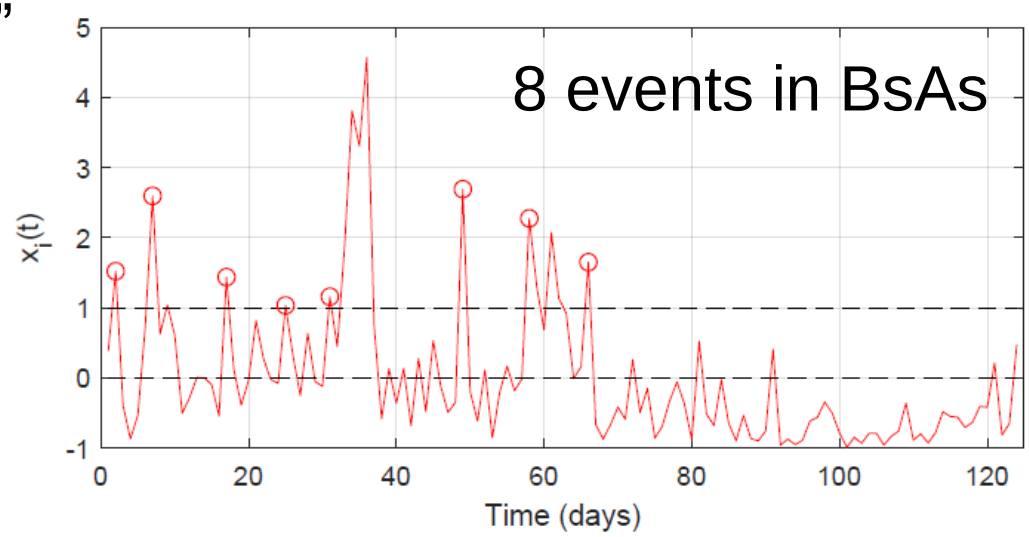
In each time series we define "events" using two thresholds

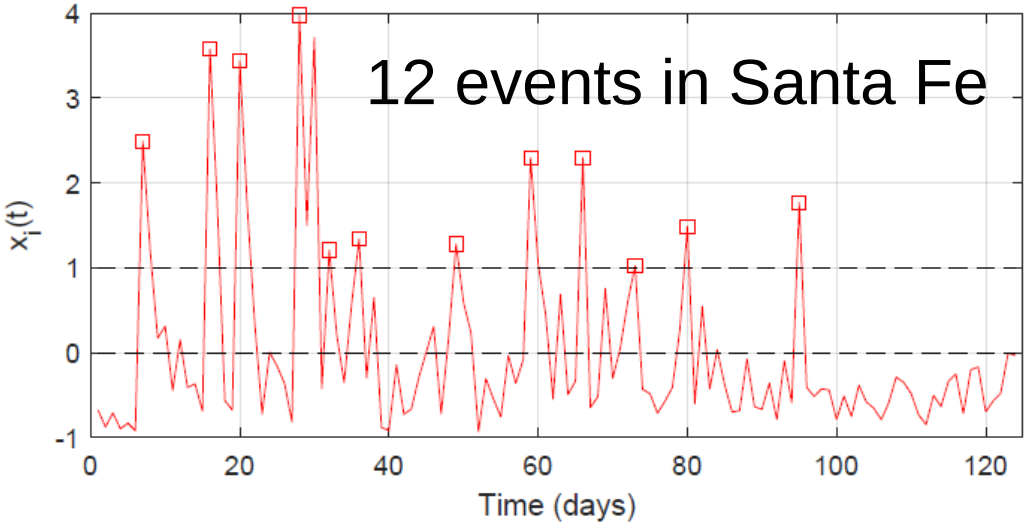
Example: topic "*Combustible*"

Histogram of values
(all cities, all times)



Each time series is normalized to $\mu=0$, $\sigma=1$





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Event synchronization measures

- Count m_x, m_y : number of events in *x(t)* and *y(t)*; $m=[m_x+m_y]/2$
- Count $c^\tau(x|y)$ = number of times an event occurs in *x(t)* shortly after (within an interval of τ days) an event occurs in *y(t).* Idem for $c^\tau(y|x)$. Synchronized events count ½.
- Calculate: $Qs(x,y) = [c^\tau(x|y) + c^\tau(y|x)] / m$

  $Qa(x,y) = [c^\tau(x|y) - c^\tau(y|x)] / m$

$Q_s(x,y) = Q_s(y,x)$ $Q_a(x,y) = - Q_a(y,x)$

$Q_s = 1$: the events are fully synchronized.
$Q_a = 1$: events in *x* always occur before those in *y*.
$Q_a = -1$: events in *x* always occur after those in *y*.

No “causal” information

R. Quian Quiroga, T. Kreuz and P. Grassberger, PRE 66, 041904 (2002).

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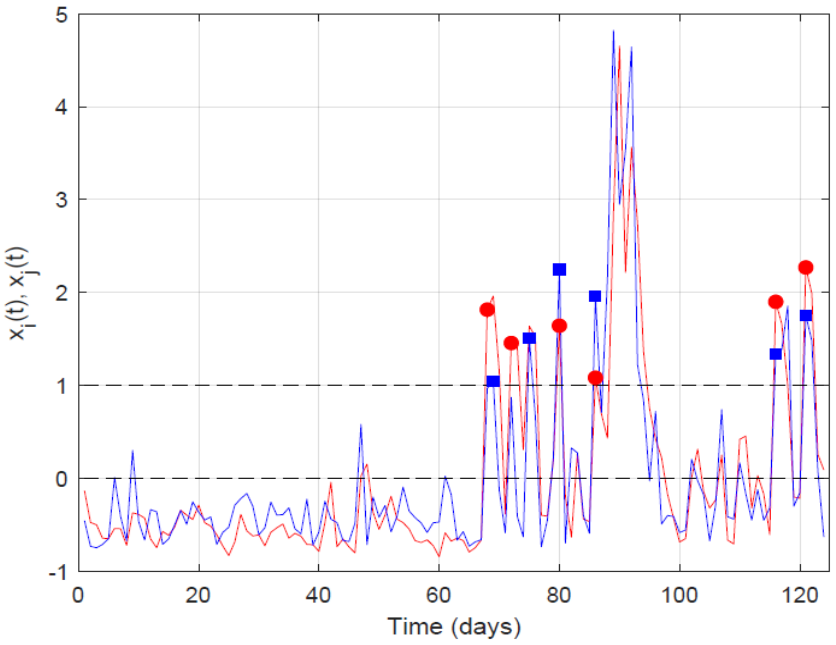
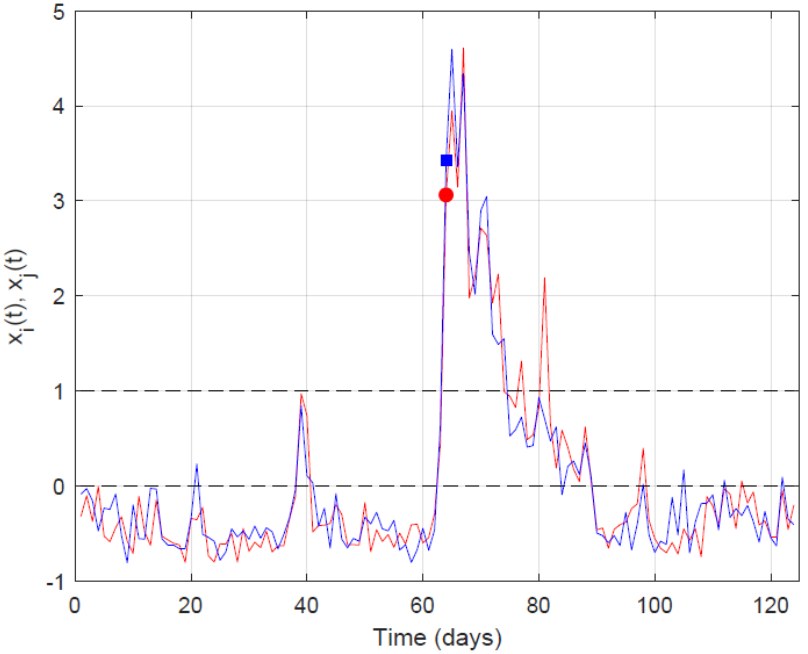
Diego_Luciani
Tucuman – Santiago del Estero



Sergio_Massa
Buenos Aires - Mendoza



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Causal measures: Granger Causality, Transfer entropy and Directionality index

- GC: *X* and *Y* can be described by stationary autoregressive linear models.

- TE: Conditional Mutual Information of *X* and *Y*, given the "past" of one of the variables.

- TE and GC are equivalent if X and Y Gaussian processes.

- DI(i,j) = [F(i,j) - F(j,i)] / [F(i,j) + F(j,i)]
  where F=TE or GC (only values larger than a threshold).
- DI(i,j) = - DI(j,i)

C. W. J. Granger, *Econometrica* 37, 424–438 (1969).
T. Schreiber, Phys. Rev. Lett. 85, 461 (2000).

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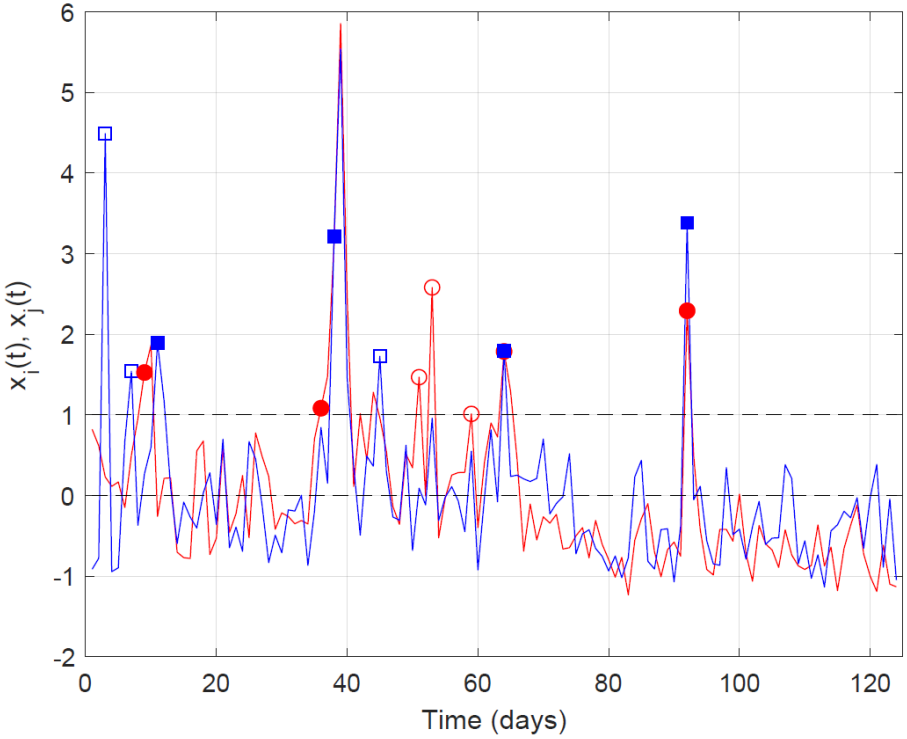
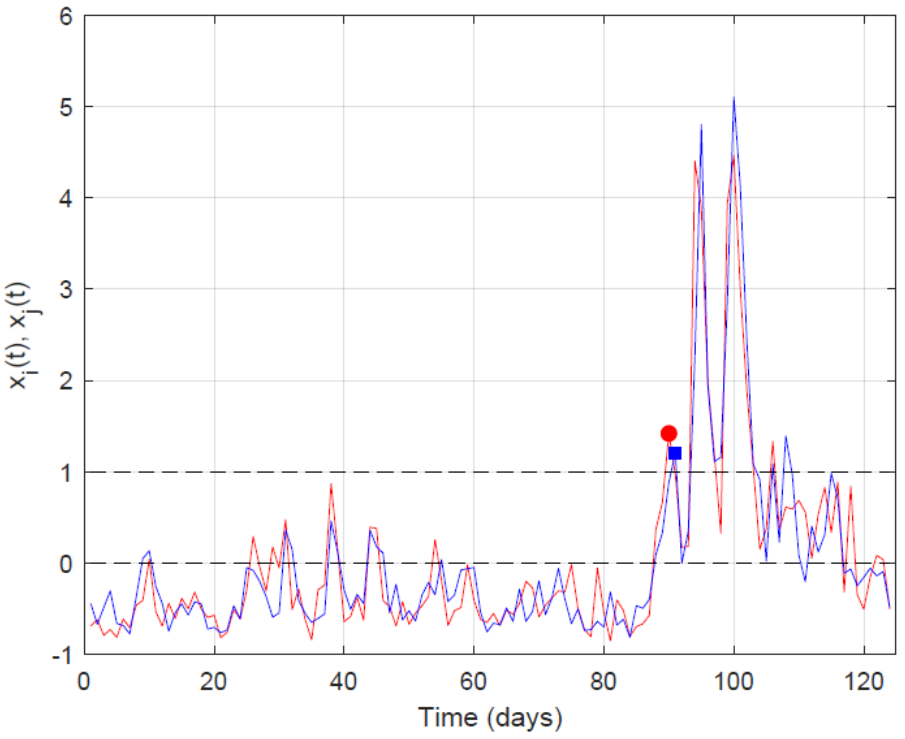
Alberto Fernandez
Cordoba – Santiago del Estero
DI(TE)=1, Qs=0.71, Qa=0.14



Cristina Kirchner
Santiago del Estero – Tucuman
DI(TE)=0, DI(GC)=-0.37, Qs=1, **Qa=1**



L. L. Garcia, G. Tirabassi, C. Masoller, P. Balenzuela, "*Point process analysis of geographical diffusion of news in Argentina*", Chaos 35, 013135 (2025).

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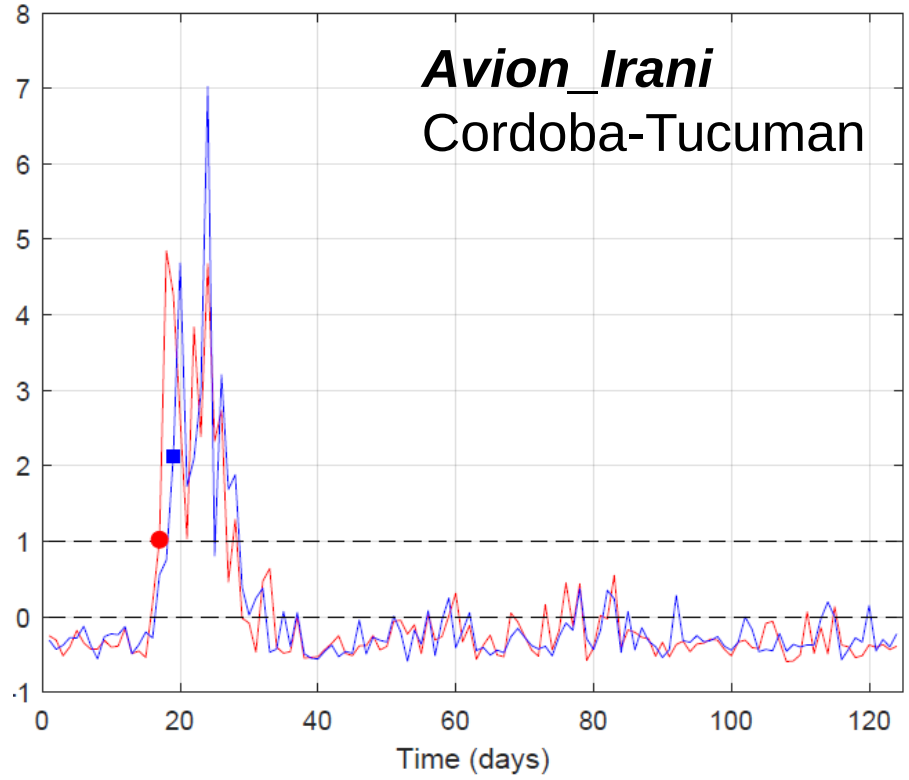

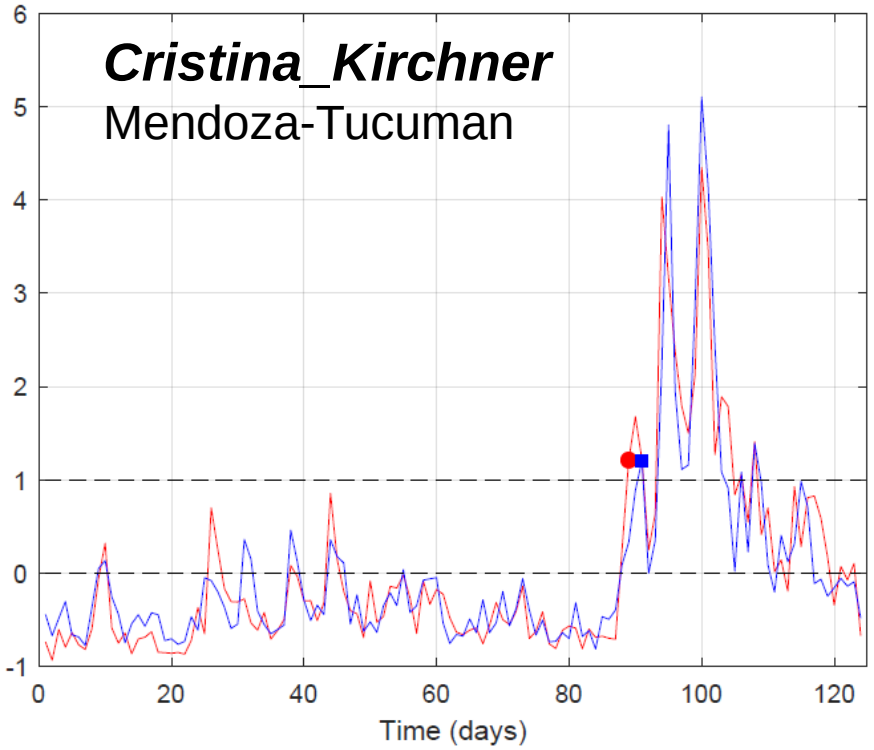

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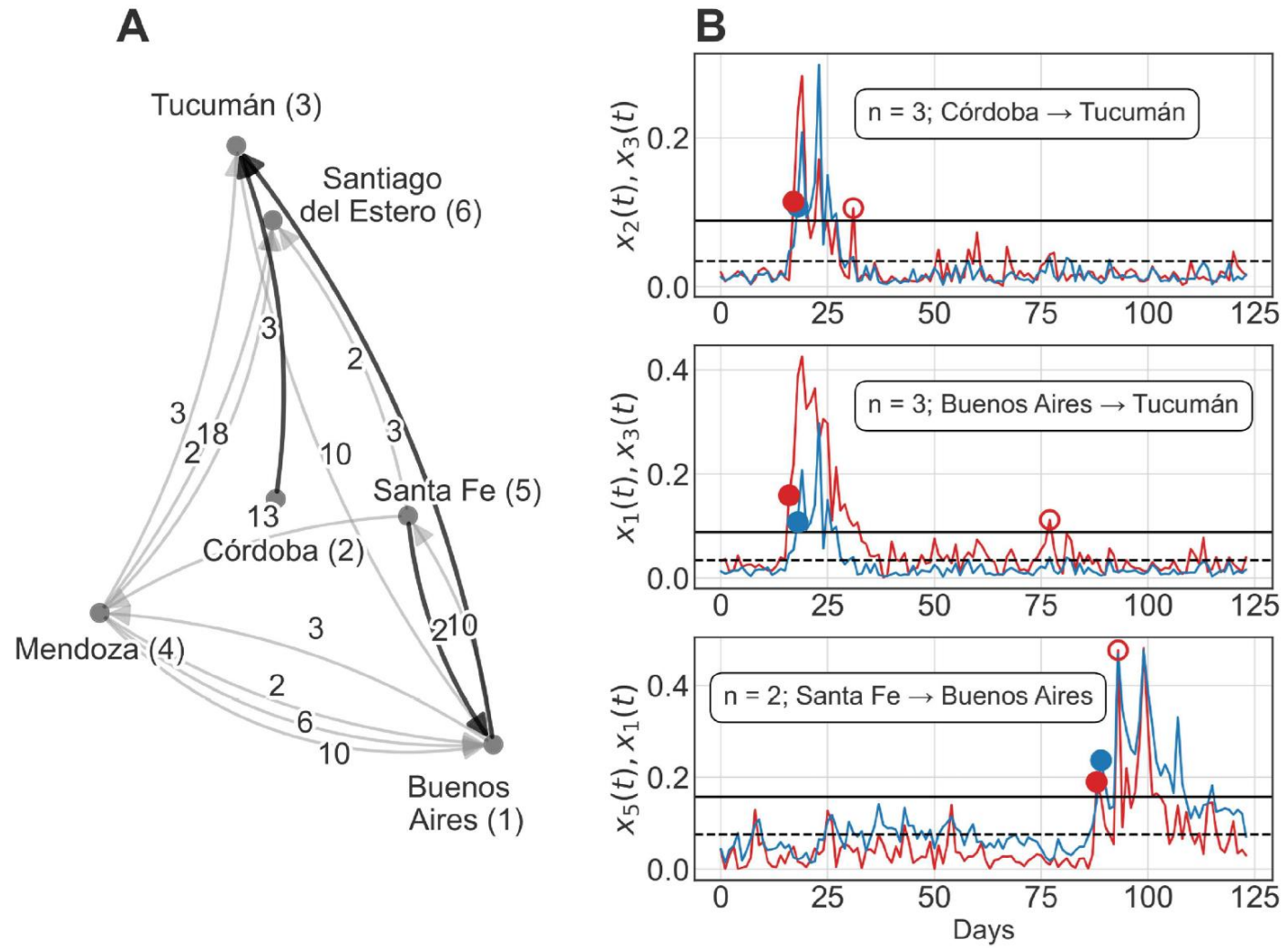
Directed network constructed by selecting the links with |*Qa*| > 0.6 and *Qs* > 0.6



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Conclusions

- The processes of information diffusion in the press is fast, most events are simultaneous $\Rightarrow$ difficult to infer links.
- Raw-data-based measures (CC, MI, GC, TE) not appropriated to see inter-dependencies between events.
- Event-based measures (Q_s, Q_a) work for “eventual” topics.

Thanks to my collaborators.
Thank you for your attention!


L. Garcia


G. Tirabassi


P. Balenzuela

L. L. Garcia, G. Tirabassi, C. Masoller, P. Balenzuela, “*Point process analysis of geographical diffusion of news in Argentina*”, Chaos 35, 013135 (2025).

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