

Bayesian Poisson Tucker Decomposition for Learning the Structure of International Relations

ICML 2016

Aaron Schein

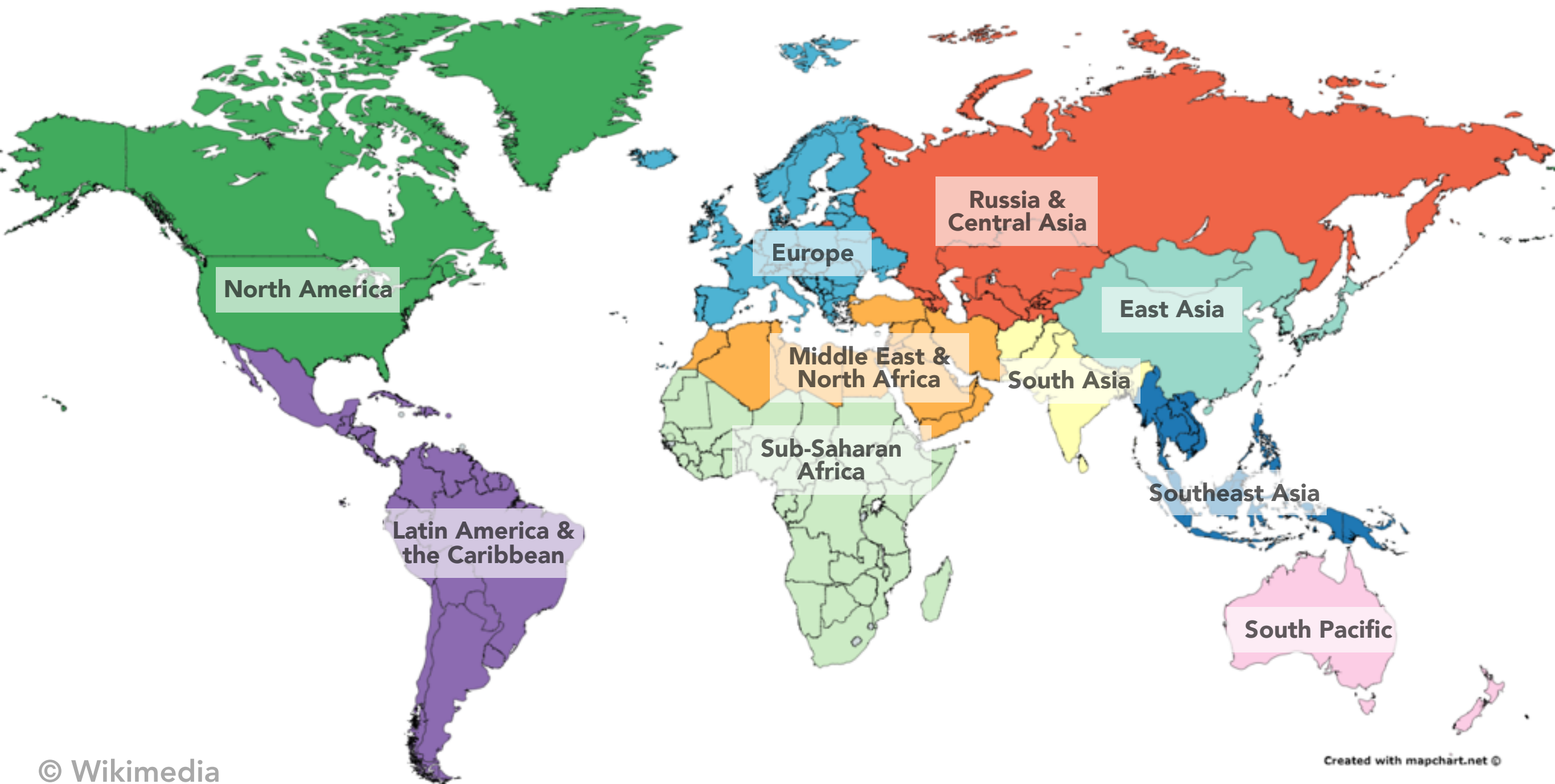
UMass Amherst

With: **Mingyuan Zhou**, **Dave M. Blei** & **Hanna Wallach**
UTexas Austin Columbia Microsoft Research

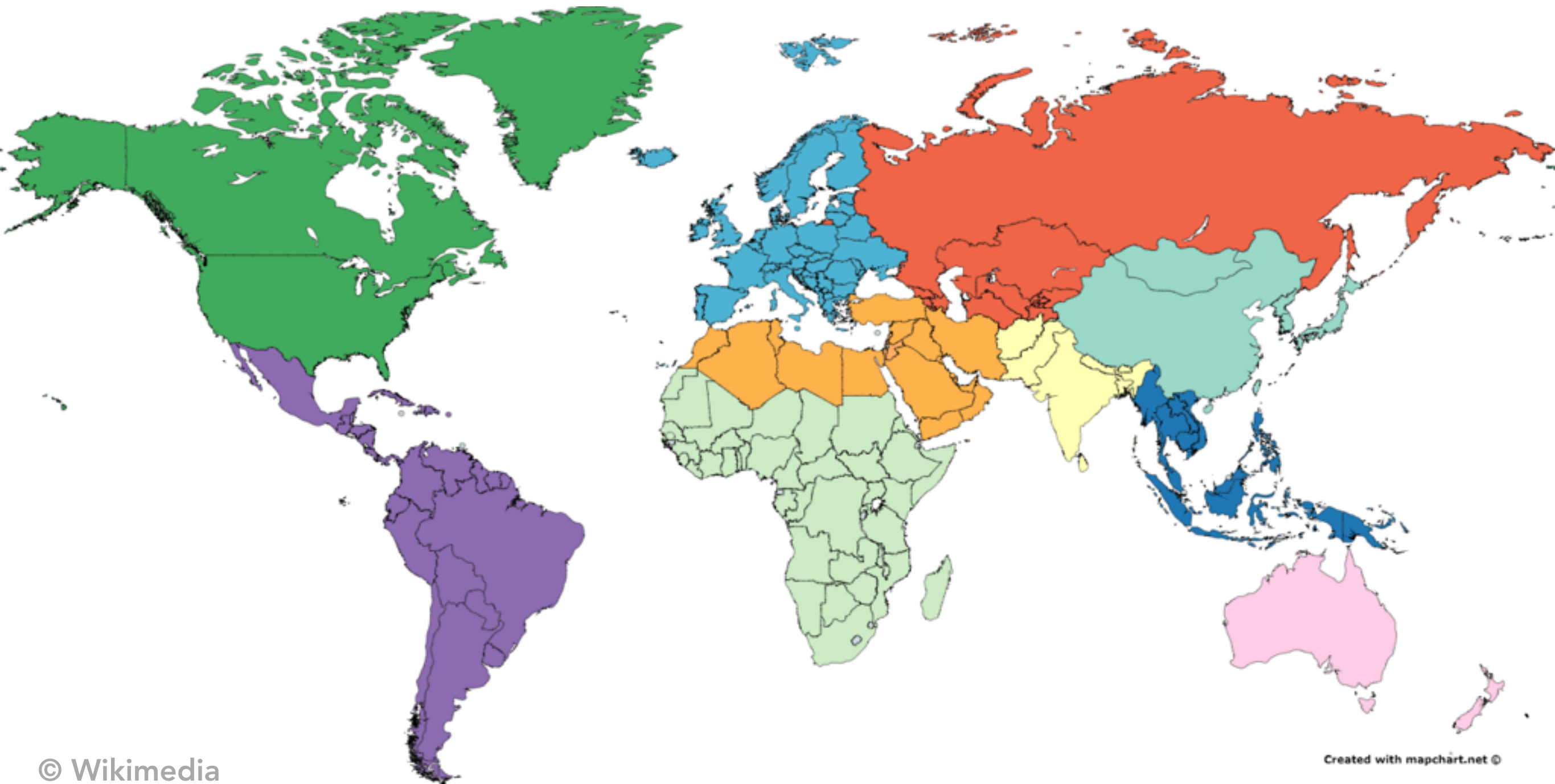
International relations are **multilateral**



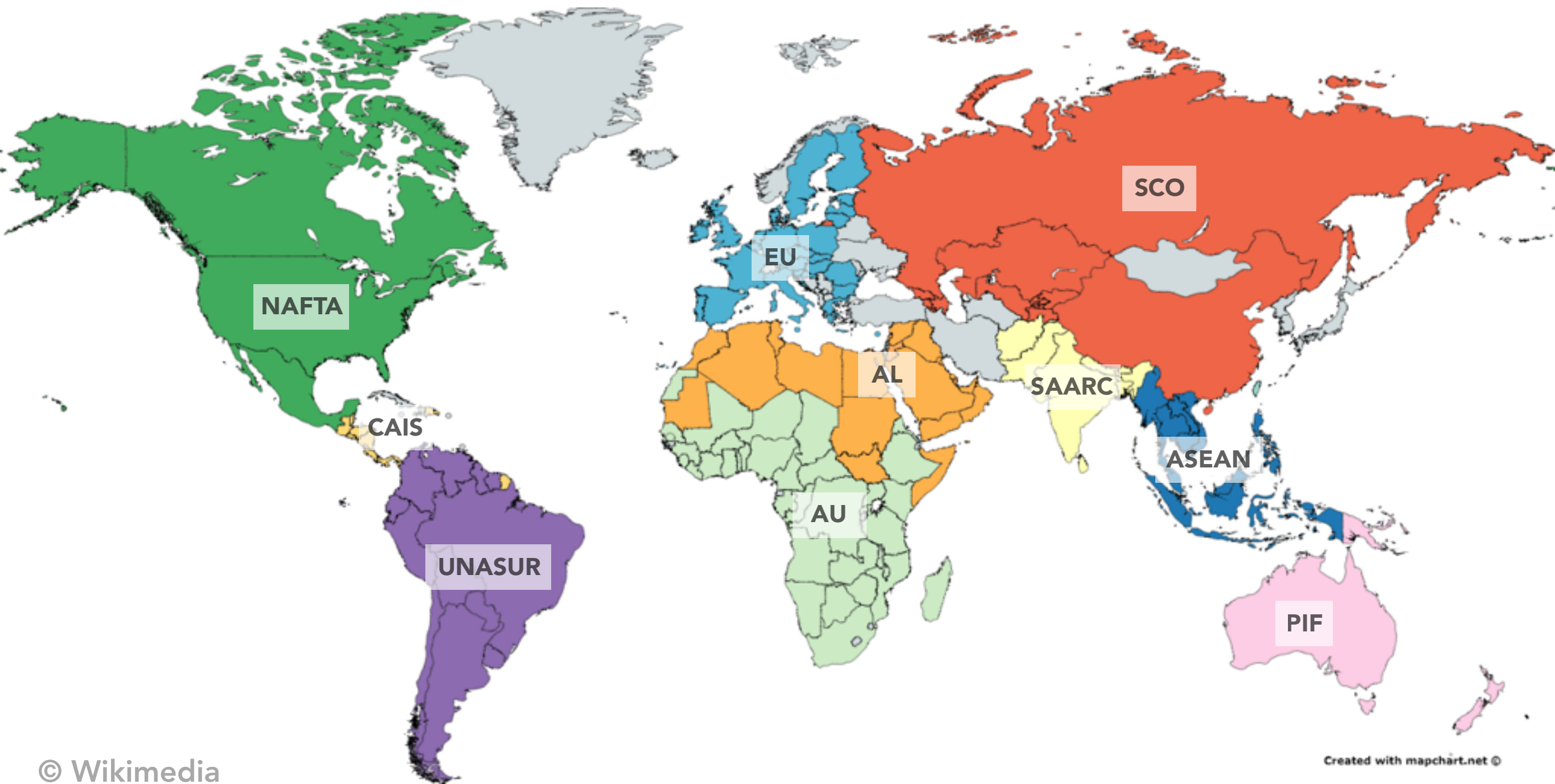
Overlapping communities



Overlapping communities



Overlapping communities



Interaction event data


Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE

Interaction event data

Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE


time t

Interaction event data

Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE


country *i*

Interaction event data

Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE


country j

Interaction event data

Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE


action a

Interaction event data

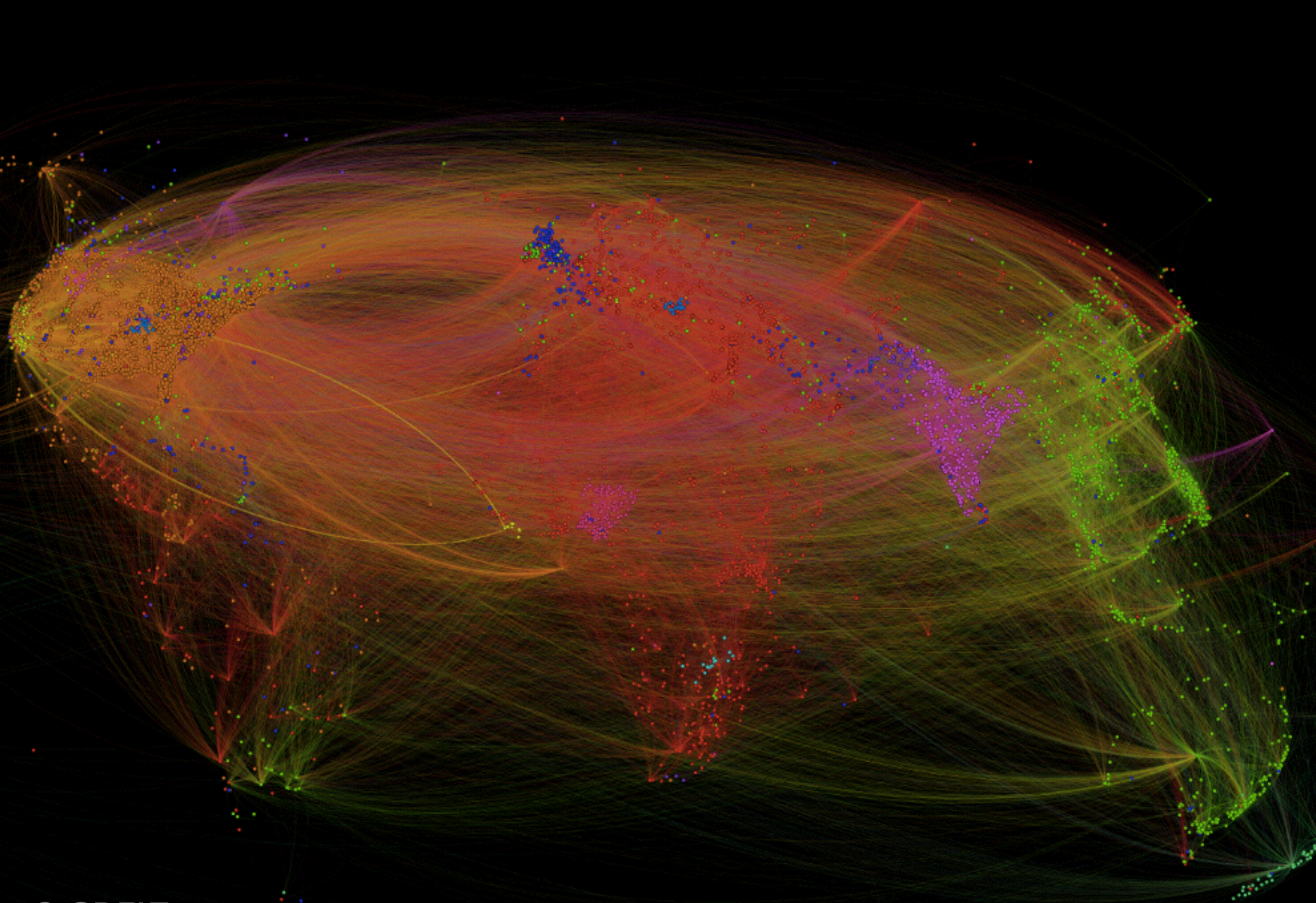
Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION

≈

July 31, 1990: IRAQ INCREASES TROOP LEVELS ON KUWAIT BORDER

Iraq has concentrated nearly 100,000 troops close to the Kuwaiti border, more than triple the number reported a week ago, the Washington Post said in its Tuesday editions.



Interaction event **tokens**

Table 2
WEIS Coding of 1990 Iraq-Kuwait Crisis [Schrodt, '93]

<u>Date</u>	<u>Source</u>	<u>Target</u>	<u>Type of Action</u>
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION

$$e_n = (i \xrightarrow{a} j, t)$$

Interaction event **counts**

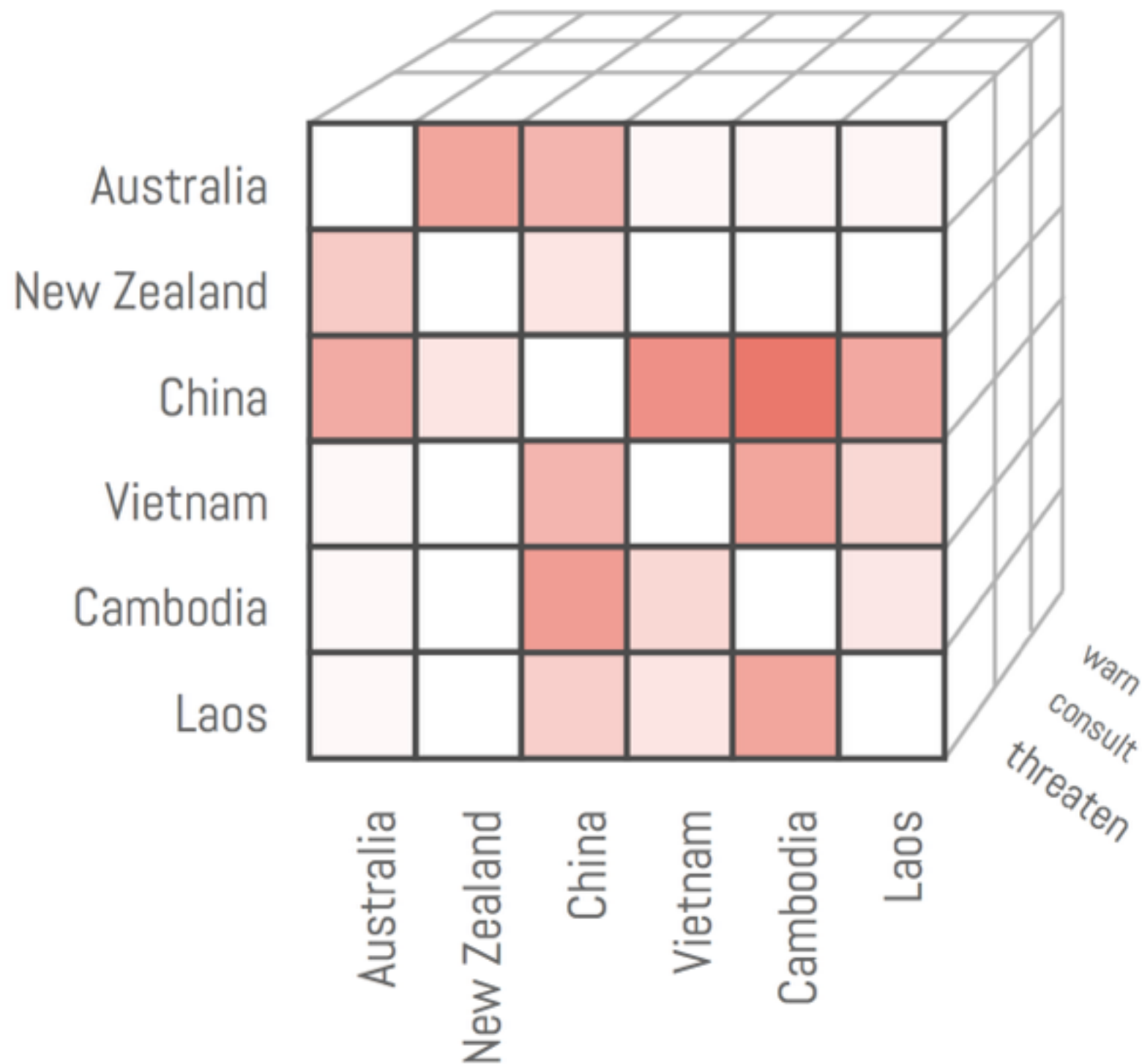
$y_{i \xrightarrow{a} j}^{(t)}$ = “the number of instances that **country i** took **action a** towards **country j** during **time t ”**

Interaction event **counts**

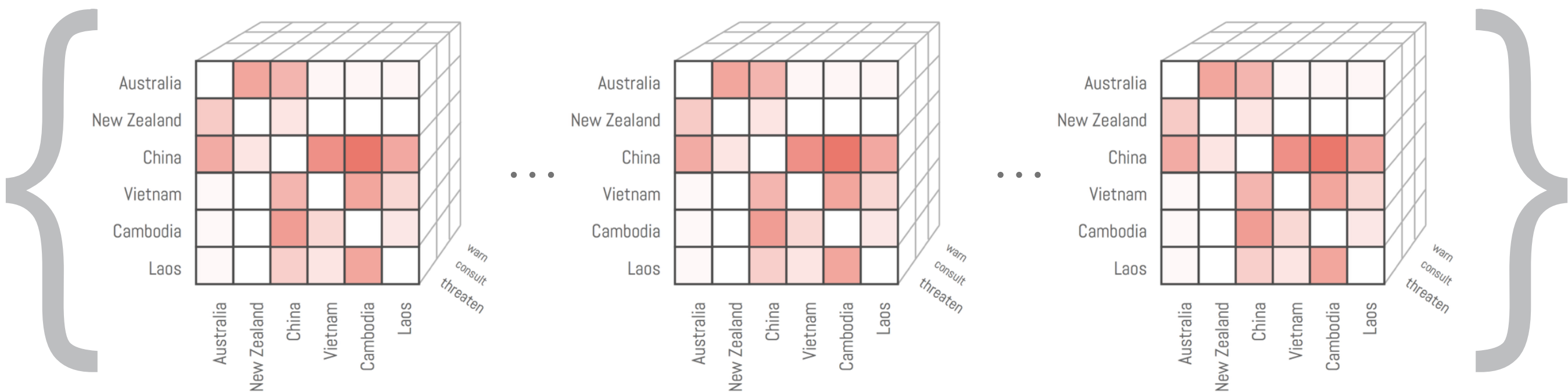
$$y_{i \xrightarrow{a} j}^{(t)} = \sum_{n=1}^N \delta[e_n = (i \xrightarrow{a} j, t)]$$

“the number of instances that **country i** took **action a** towards **country j** during **time t ”**

Interaction event counts

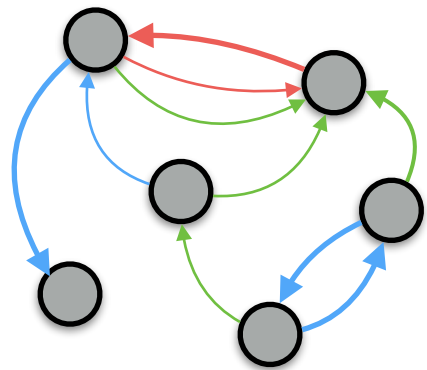


Interaction event counts

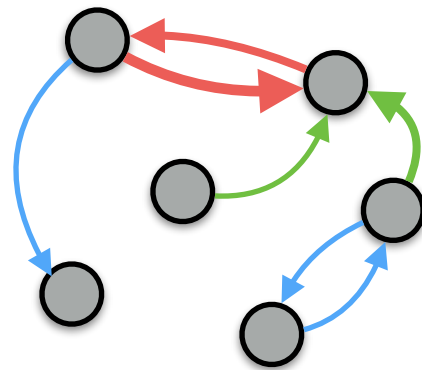


4-dimensional count tensor

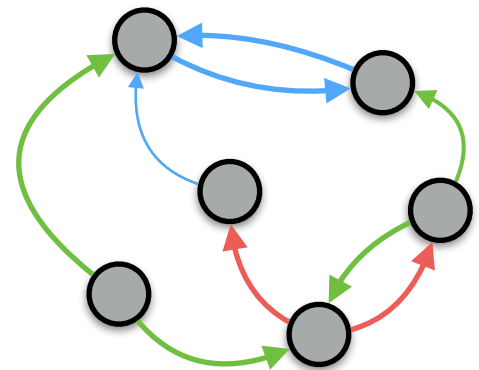
Interaction event **counts**



...



...



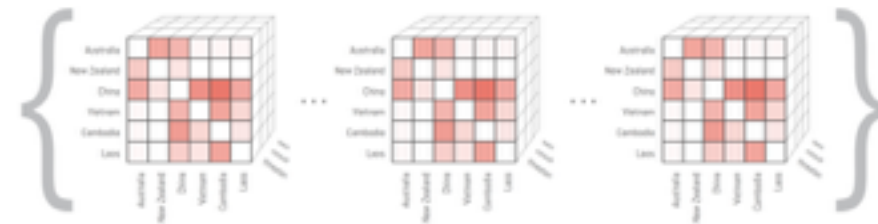
Series of weighted multinetworks

Three representations

tokens

Date	Source	Target	Type of Action
900717	IRQ	KUW	CHARGE
900725	IRQ	EGY	ASSURE
900727	IRQ	KUW	WARN
900731	IRQ	KUW	MOBILIZATION
900801	KUW	IRQ	REFUSE
900802	IRQ	KUW	MILITARY FORCE

count tensor



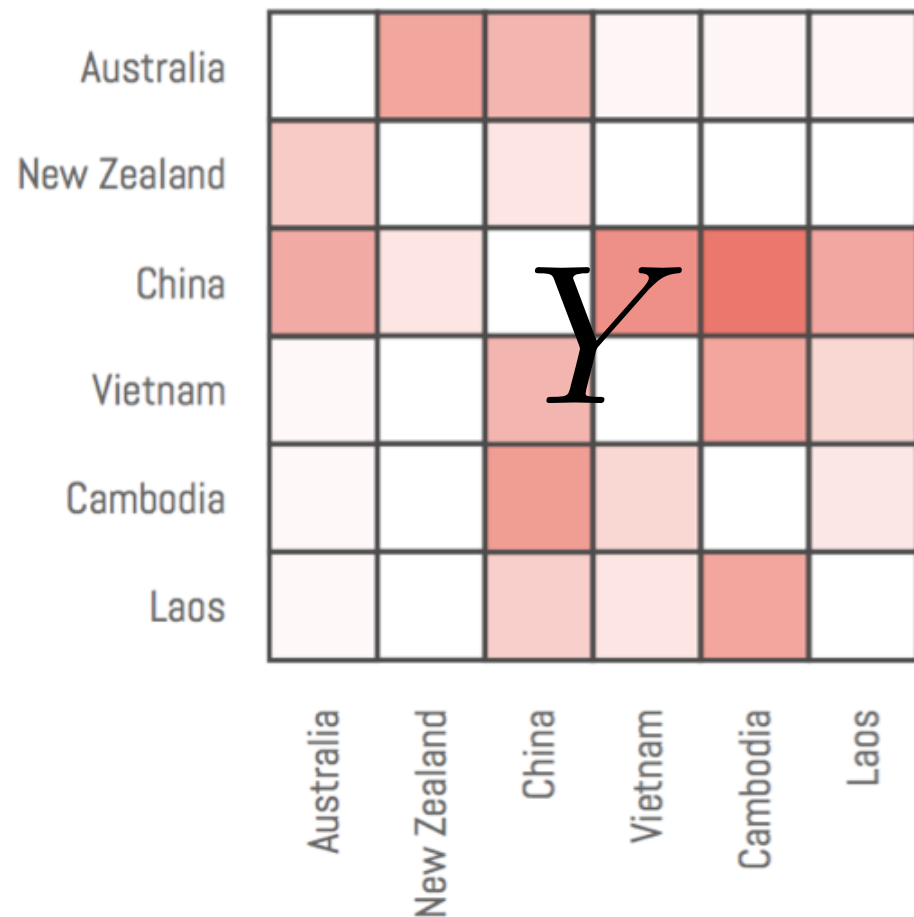
multinetworks



Poisson Tucker decomposition



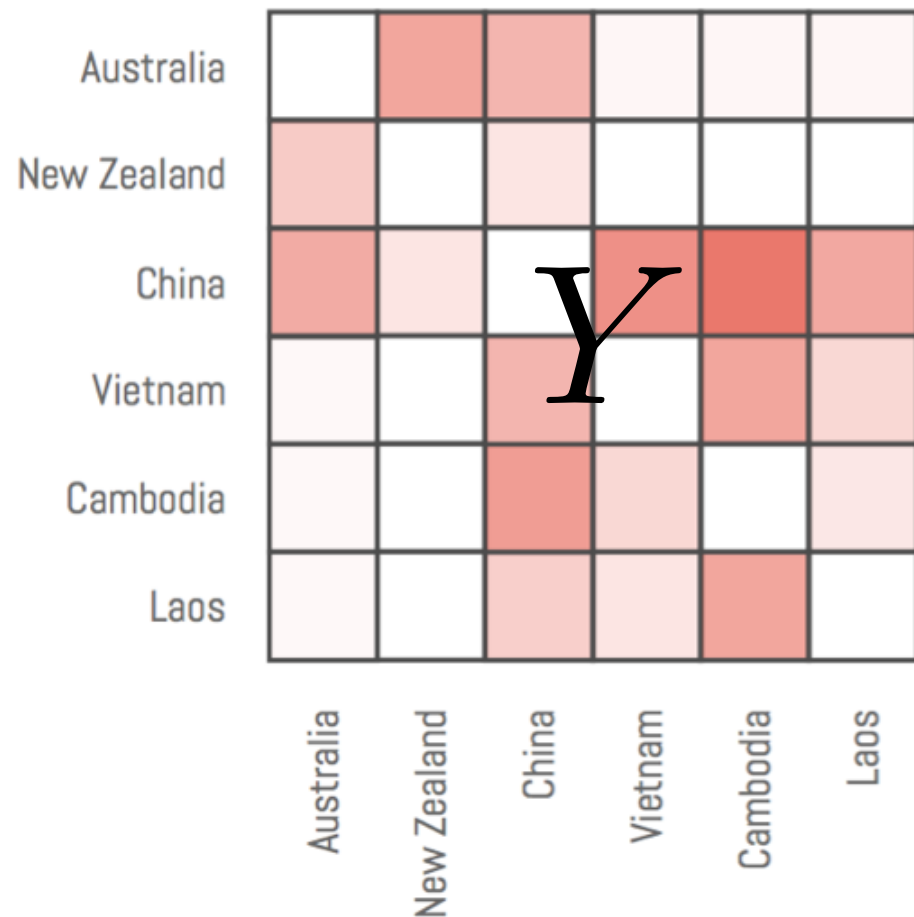
Poisson Tucker decomposition



how much **country i**
participates in **community c**

$$y_{i \rightarrow j} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \theta_{ic} \theta_{jd} \lambda_{c \rightarrow d} \right)$$

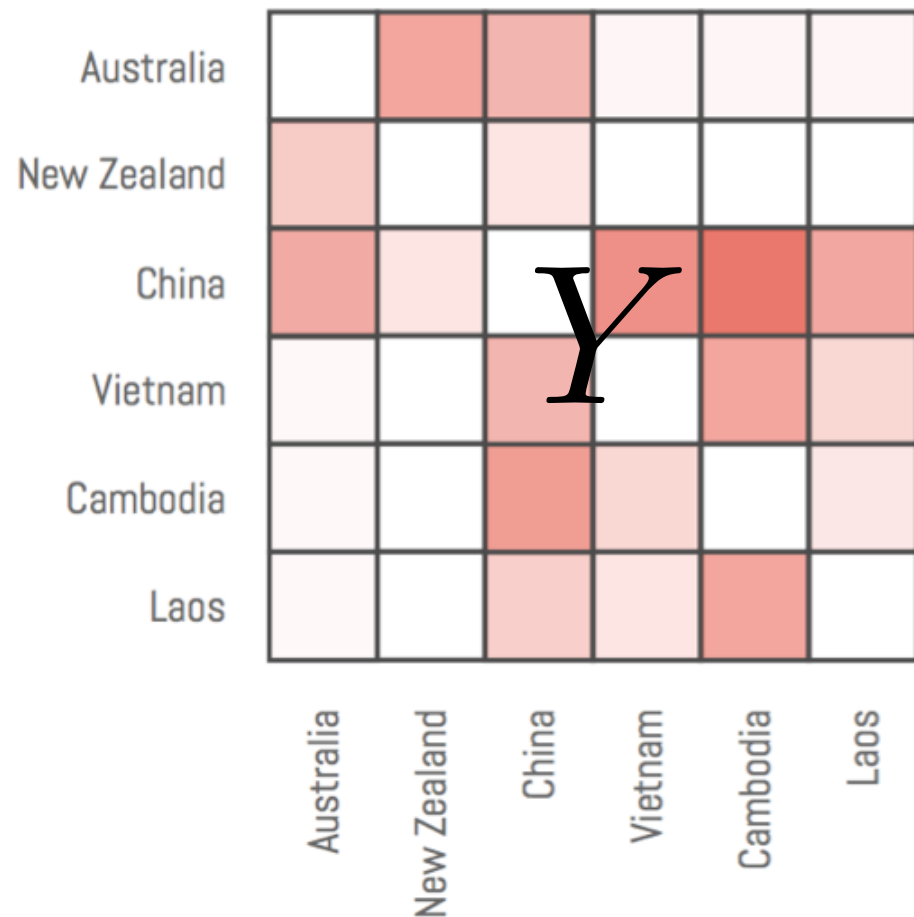
Poisson Tucker decomposition



how much **country j**
participates in **community d**

$$y_{i \rightarrow j} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \theta_{ic} \theta_{jd} \lambda_{c \rightarrow d} \right)$$

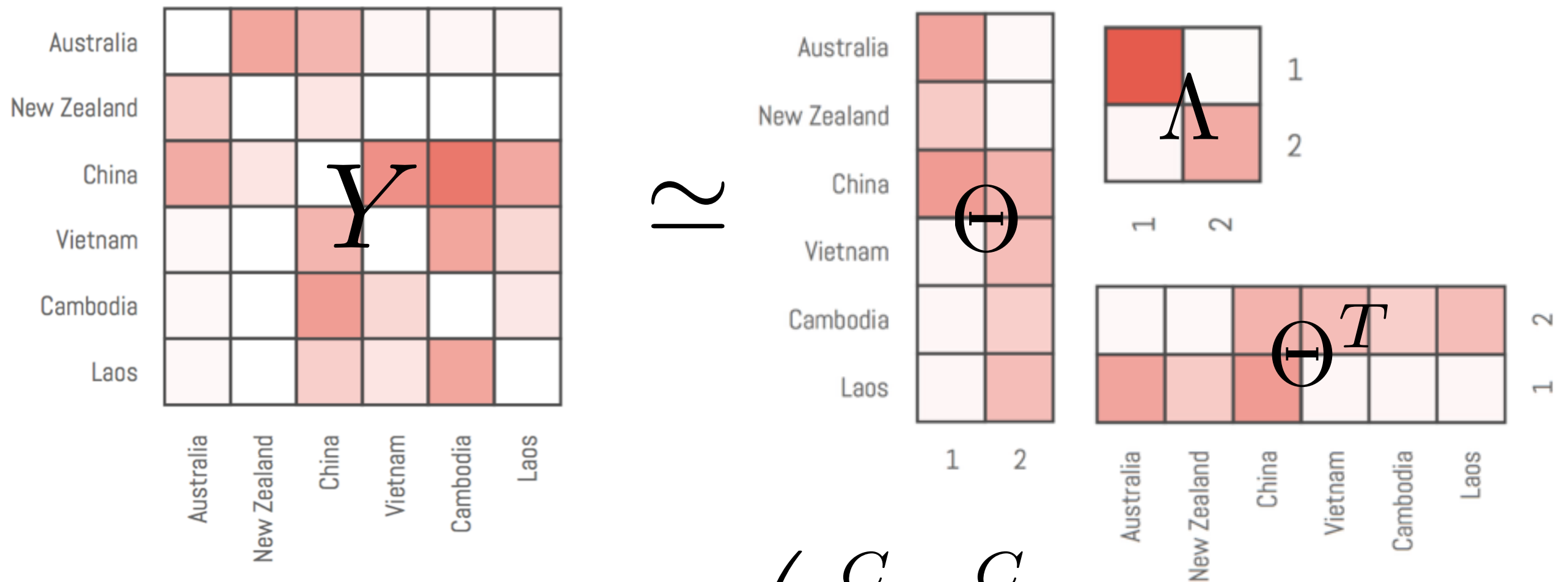
Poisson Tucker decomposition



how much **community c**
acts towards **community d**

$$y_{i \rightarrow j} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \theta_{ic} \theta_{jd} \lambda_{c \rightarrow d} \right)$$

Poisson Tucker decomposition



$$y_{i \rightarrow j} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \theta_{ic} \theta_{jd} \lambda_{c \rightarrow d} \right)$$

Poisson Tucker decomposition



Poisson Tucker decomposition

$$y_{i \xrightarrow{a} j}^{(t)}$$


Poisson Tucker decomposition

how relevant **action a**
is to **topic k**

$$y_{i \xrightarrow{a} j}^{(t)} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \sum_{k=1}^K \sum_{r=1}^R \theta_{ic} \theta_{jd} \phi_{ak} \psi_{tr} \lambda_{c \xrightarrow{k} d}^{(r)} \right)$$



Poisson Tucker decomposition

how well **regime r**
explains to **time t**


$$y_{i \xrightarrow{a} j}^{(t)} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \sum_{k=1}^K \sum_{r=1}^R \theta_{ic} \theta_{jd} \phi_{ak} \psi_{tr} \lambda_{c \xrightarrow{k} d}^{(r)} \right)$$

Poisson Tucker decomposition

how much **community c**
takes actions in **topic k**
towards **community d**
in **regime r**

$$y_{i \xrightarrow{a} j}^{(t)} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \sum_{k=1}^K \sum_{r=1}^R \theta_{ic} \theta_{jd} \phi_{ak} \psi_{tr} \lambda_{c \xrightarrow{k} d}^{(r)} \right)$$


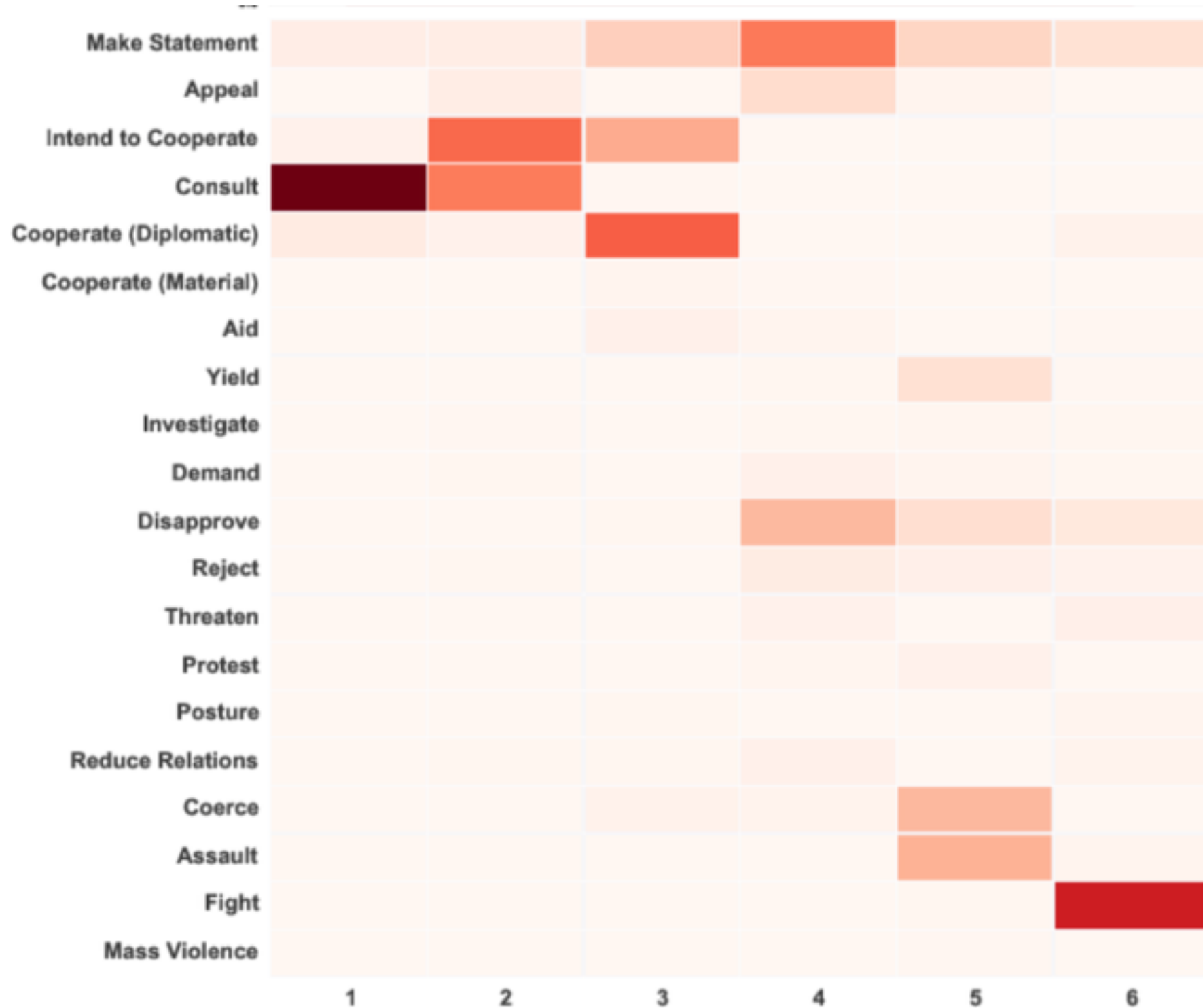
Poisson Tucker decomposition

$$y_{i \xrightarrow{a} j}^{(t)} \sim \text{Pois} \left(\sum_{c=1}^C \sum_{d=1}^C \sum_{k=1}^K \sum_{r=1}^R \theta_{ic} \theta_{jd} \phi_{ak} \psi_{tr} \lambda_{c \xrightarrow{k} d}^{(r)} \right)$$

Poisson Tucker decomposition

$$y_{i \xrightarrow{a} j}^{(t)} \sim \text{Pois} \left(\sum_{c=1}^{\infty} \sum_{d=1}^{\infty} \sum_{k=1}^{\infty} \sum_{r=1}^{\infty} \theta_{ic} \theta_{jd} \phi_{ak} \psi_{tr} \lambda_{c \xrightarrow{k} d}^{(r)} \right)$$

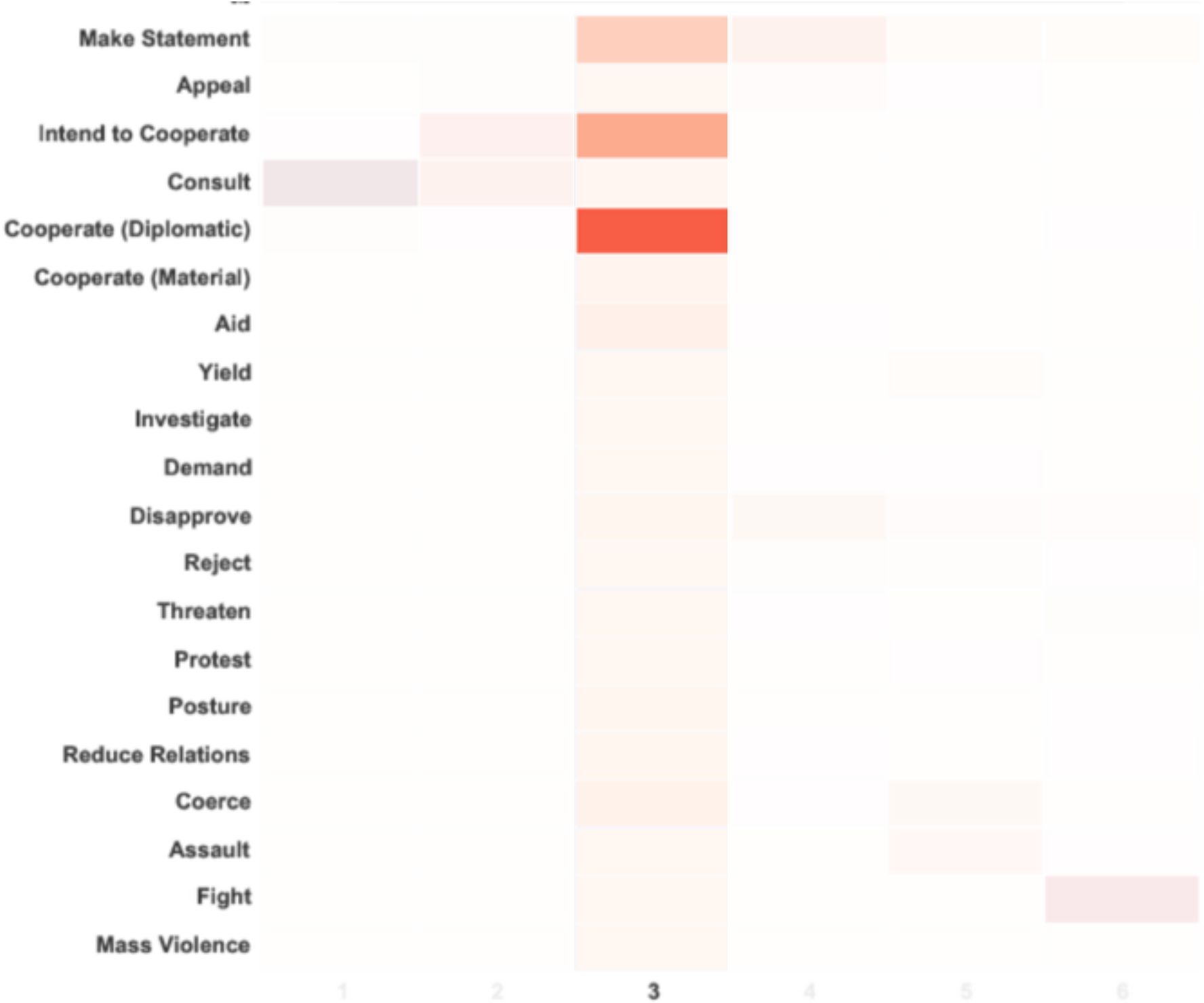
Example results on GDELT (1995-2000)



$$\phi_{ak}$$

topics of actions

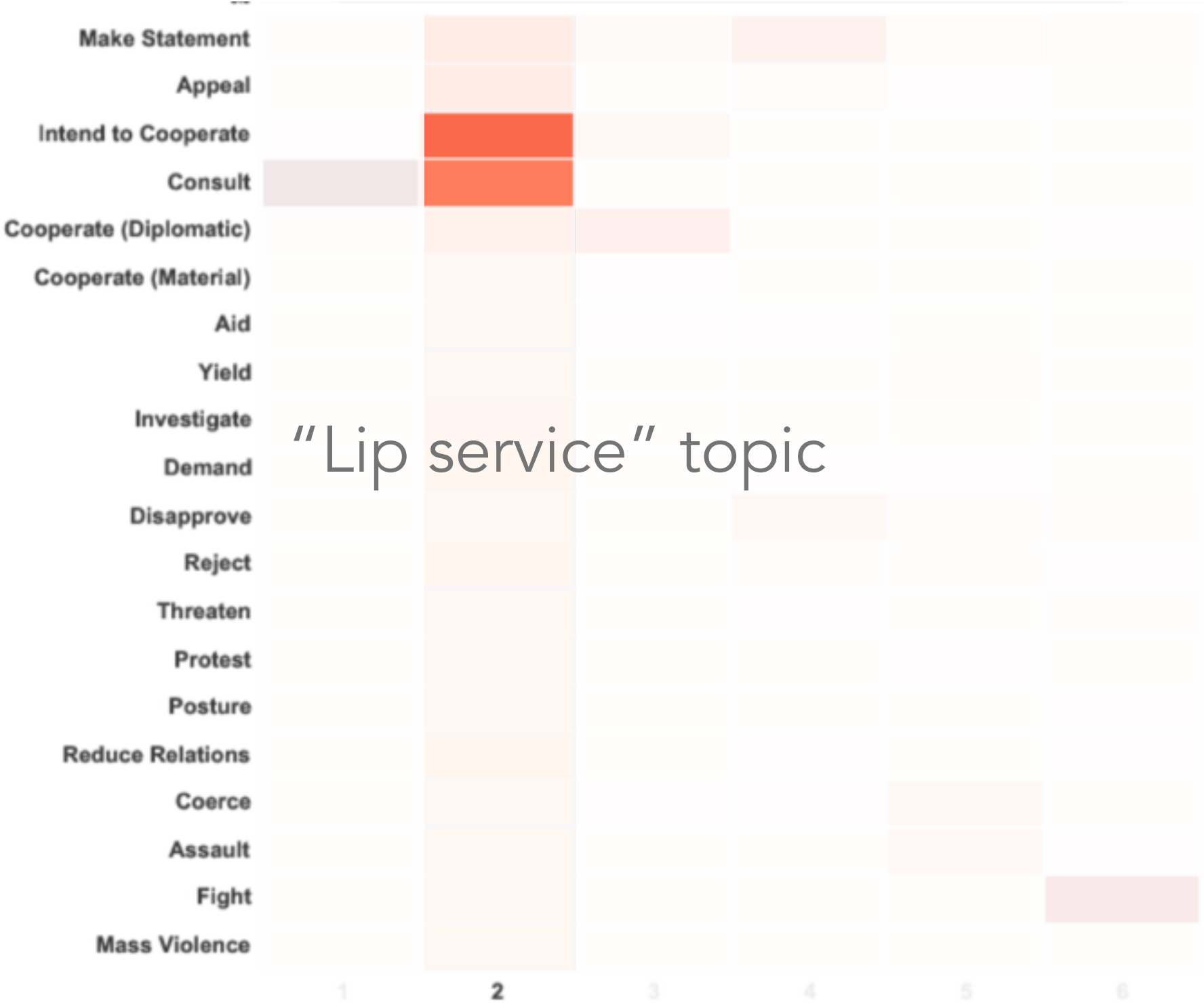
Example results on GDELT (1995-2000)



$$\phi_{ak}$$

topics of actions

Example results on GDELT (1995-2000)

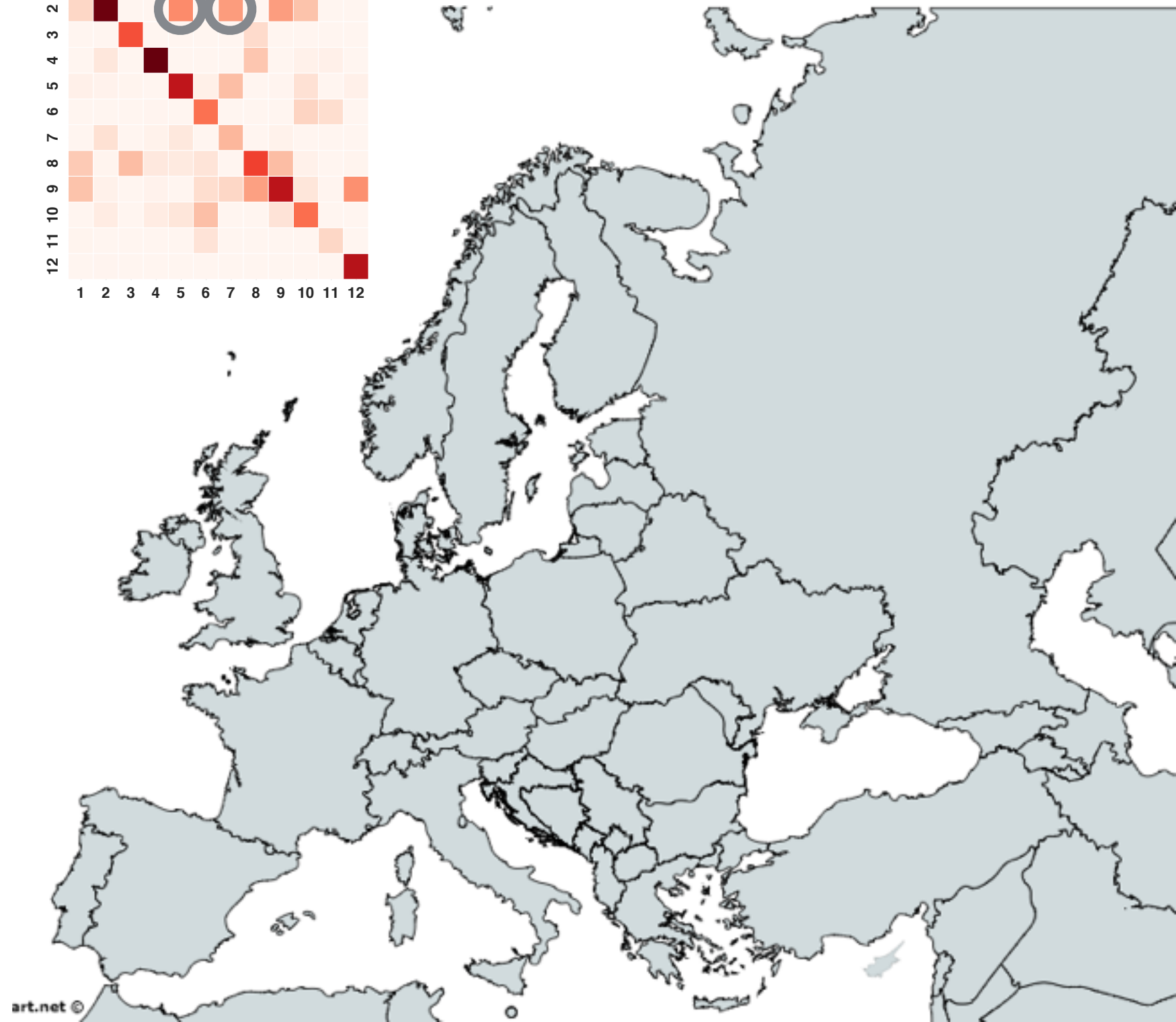
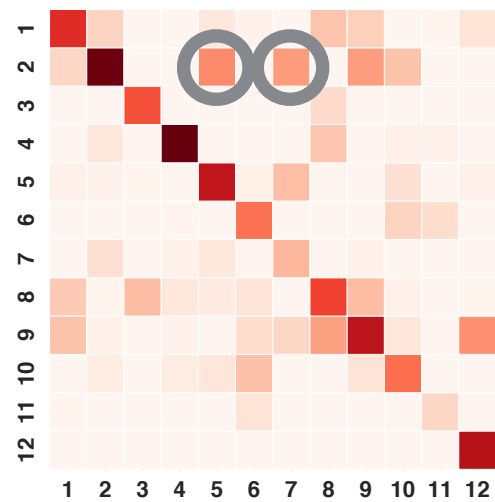
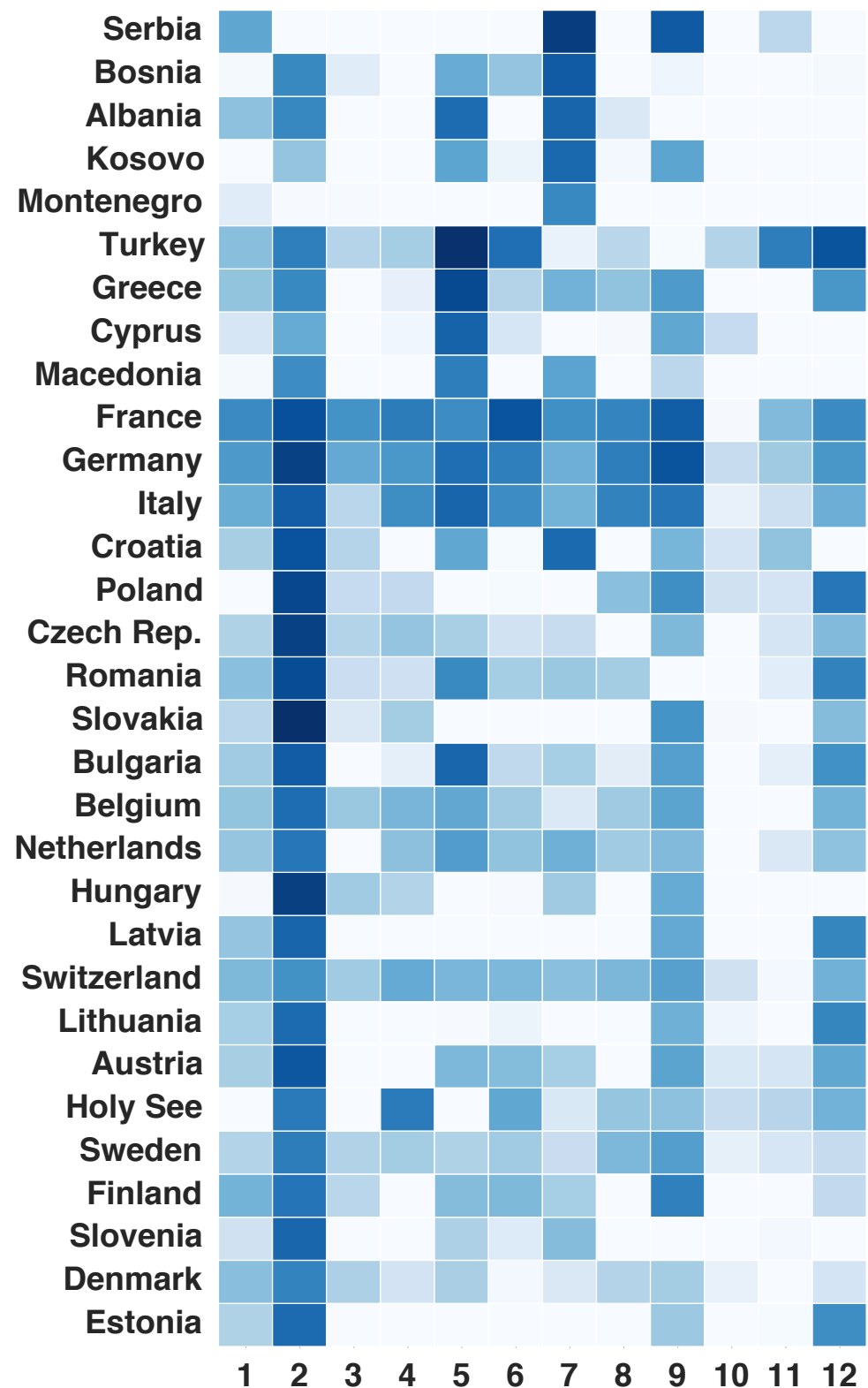


"Lip service" topic

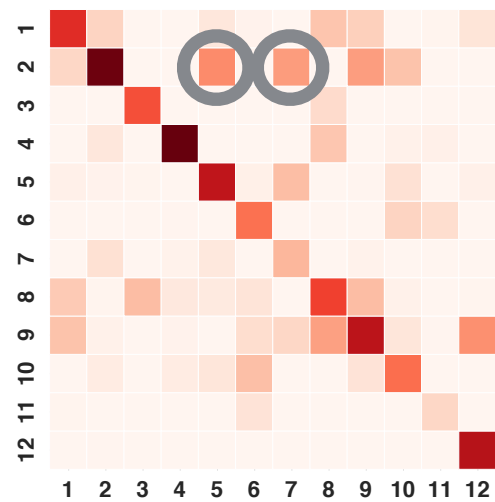
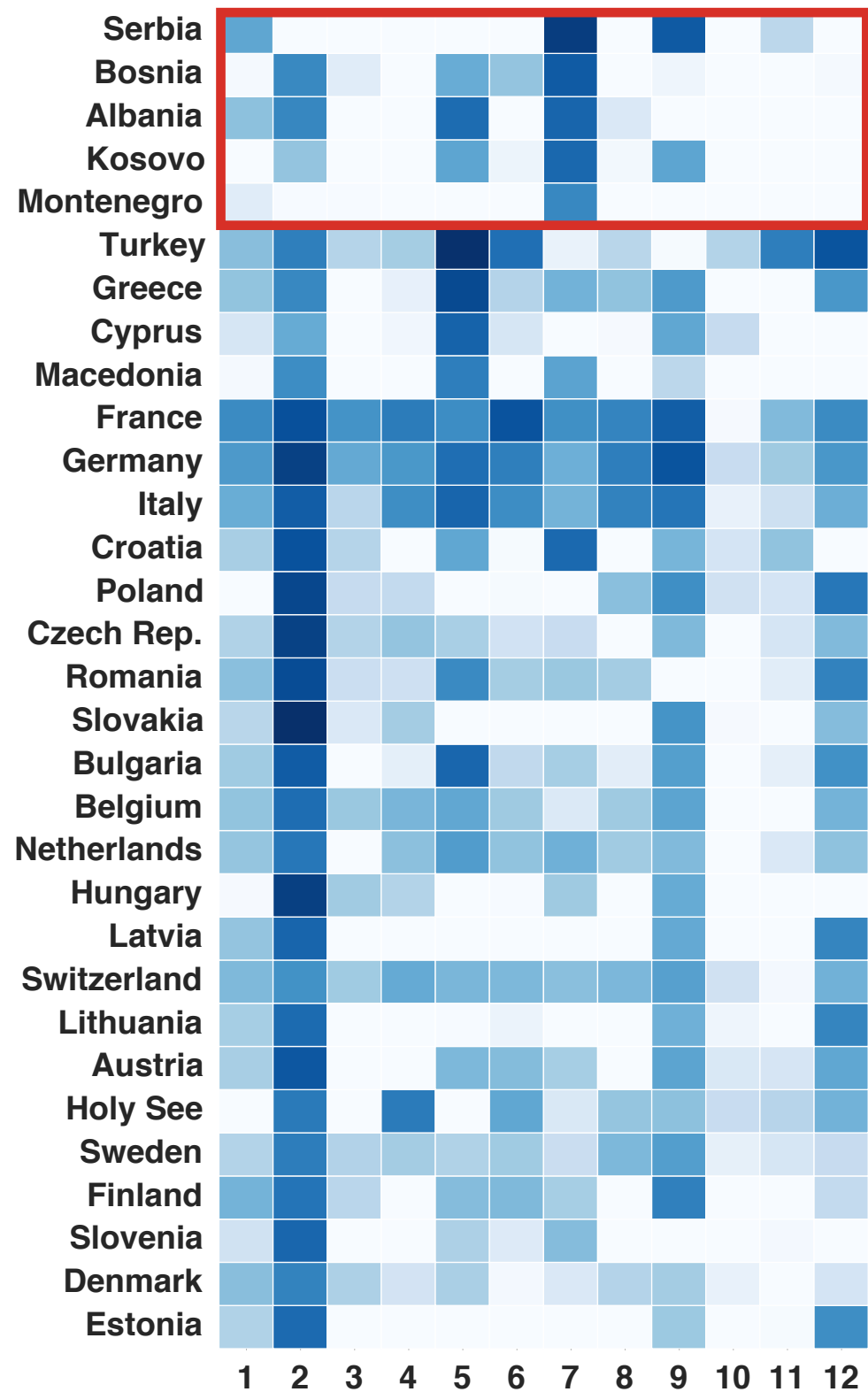
$$\phi_{ak}$$

topics of actions

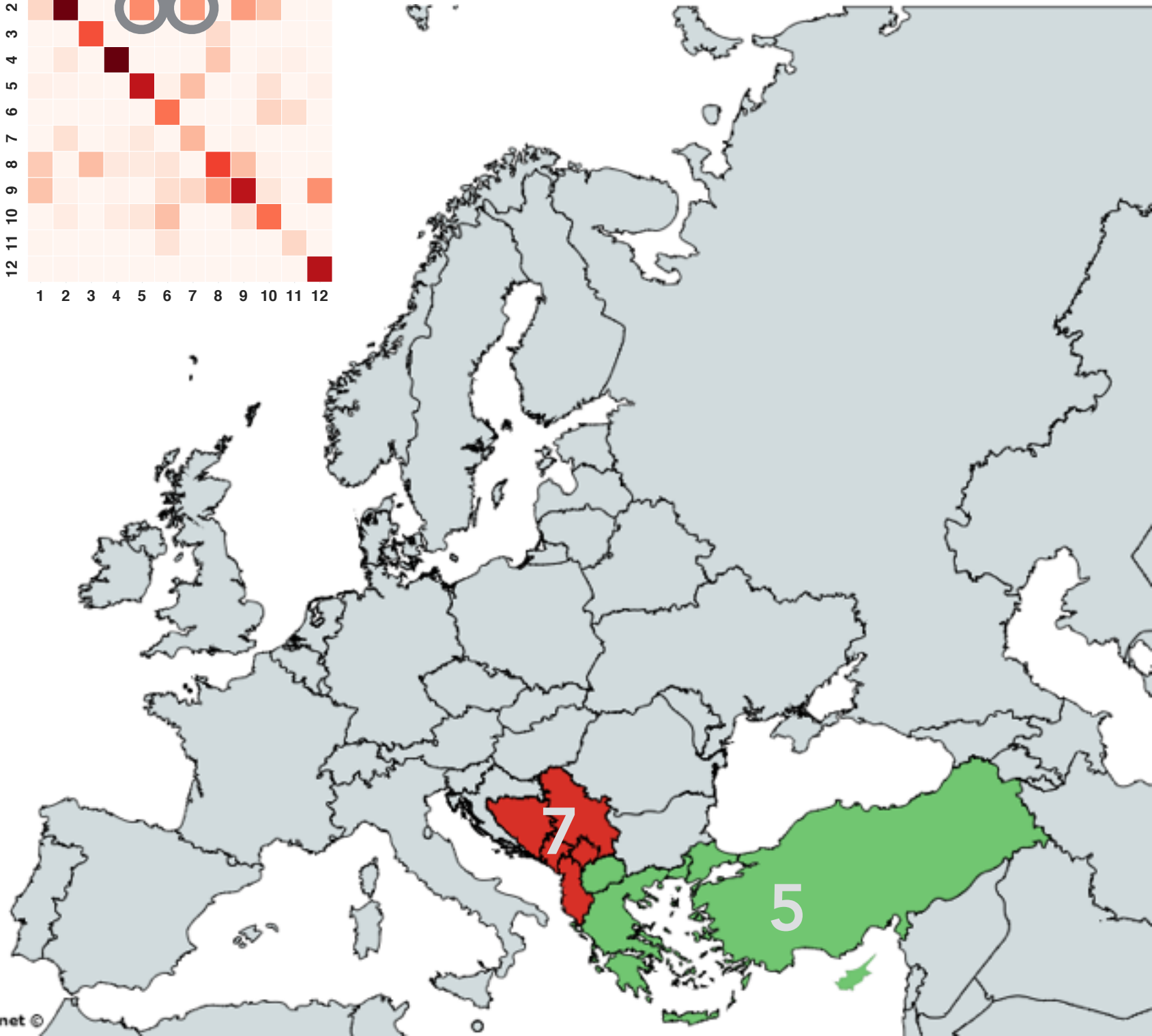
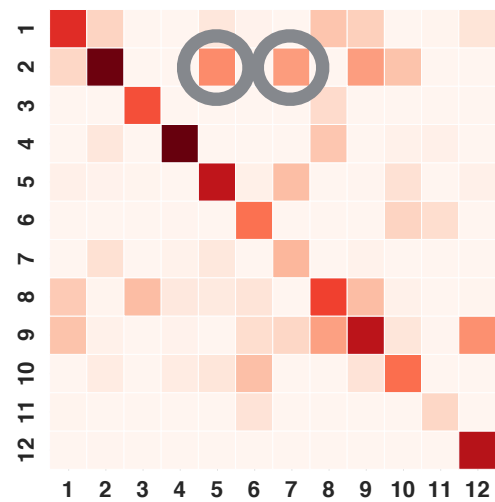
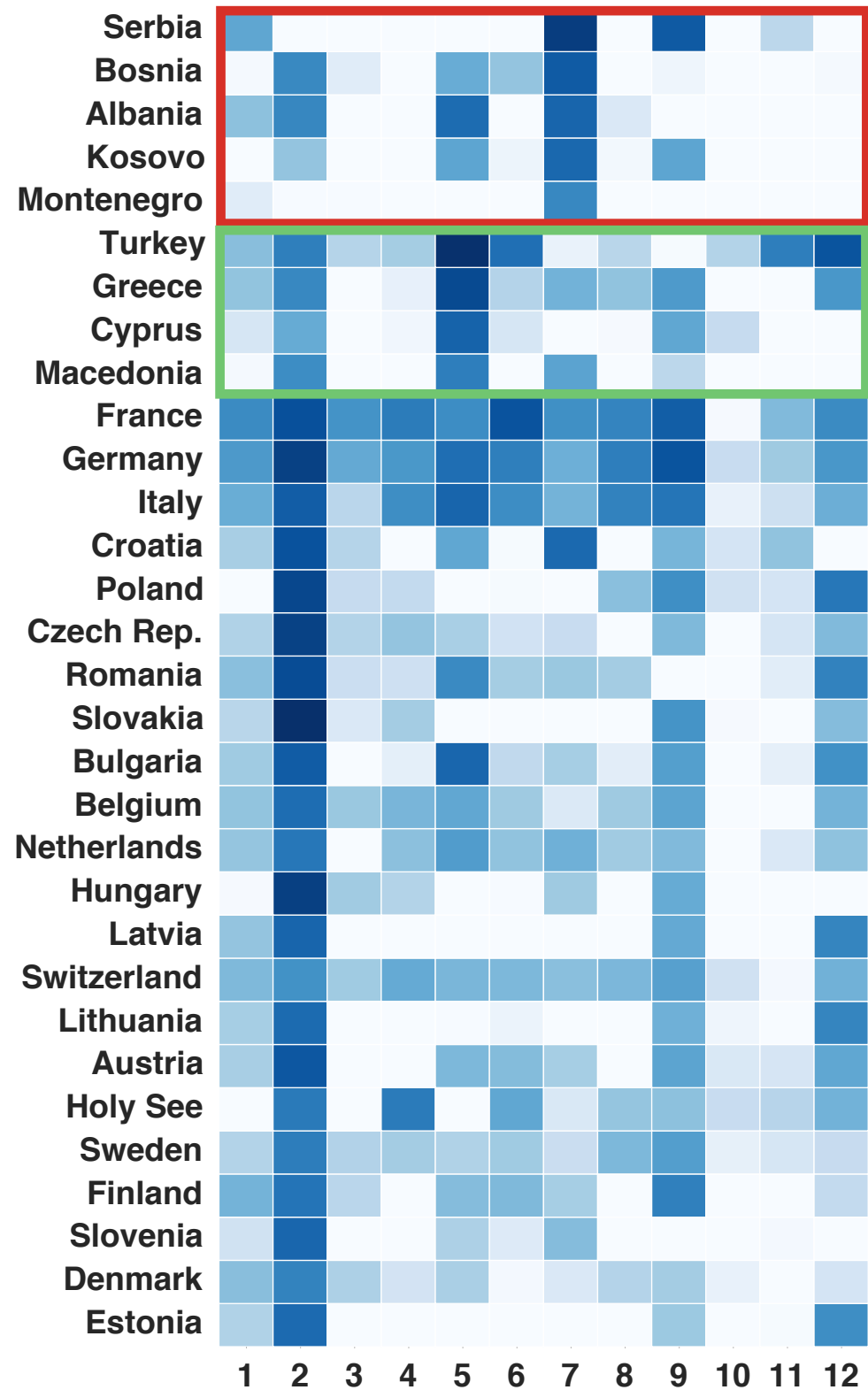
Example results on GDELT (1995-2000)



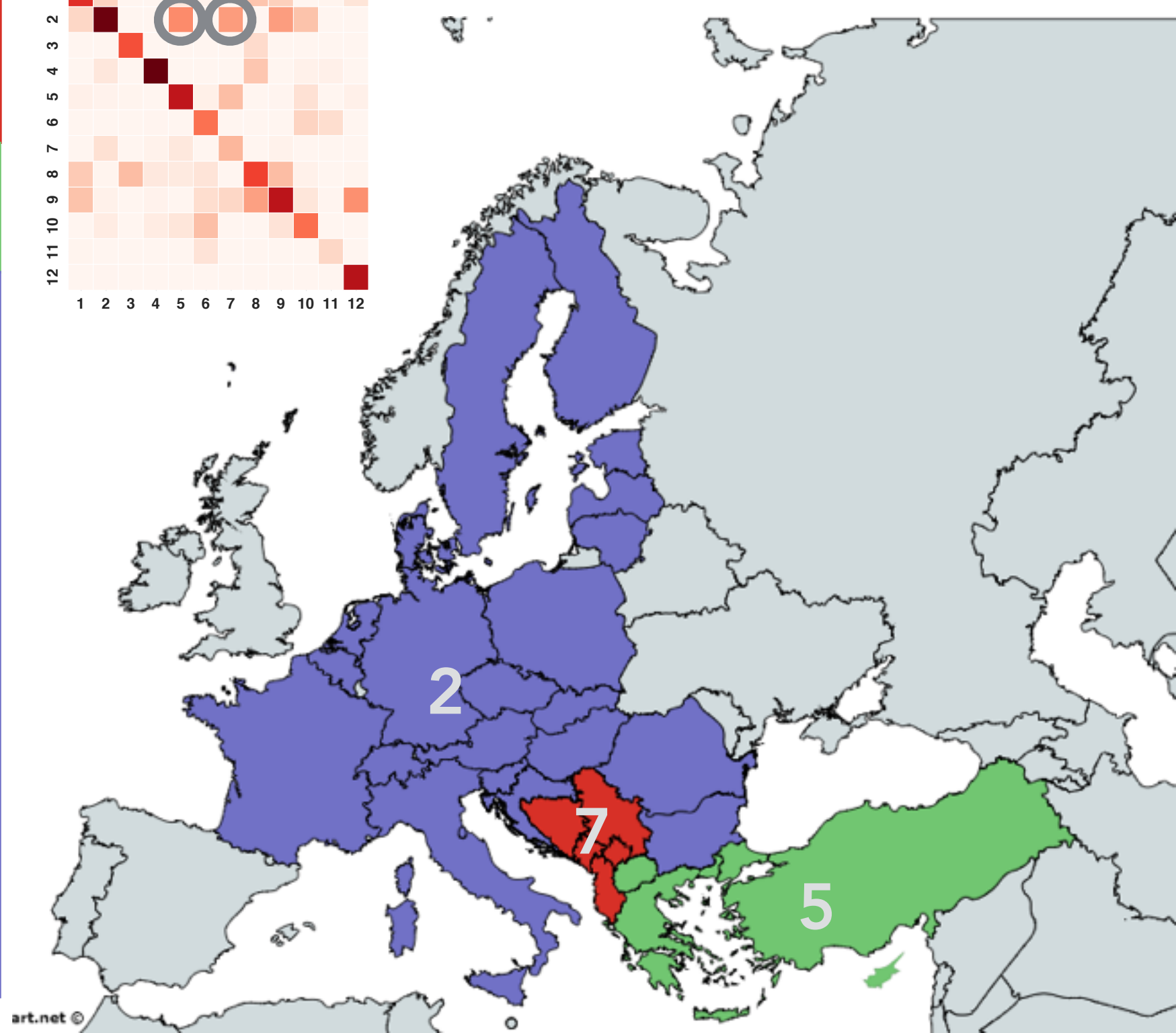
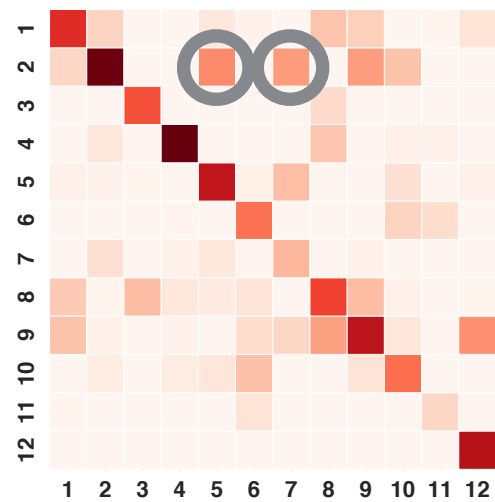
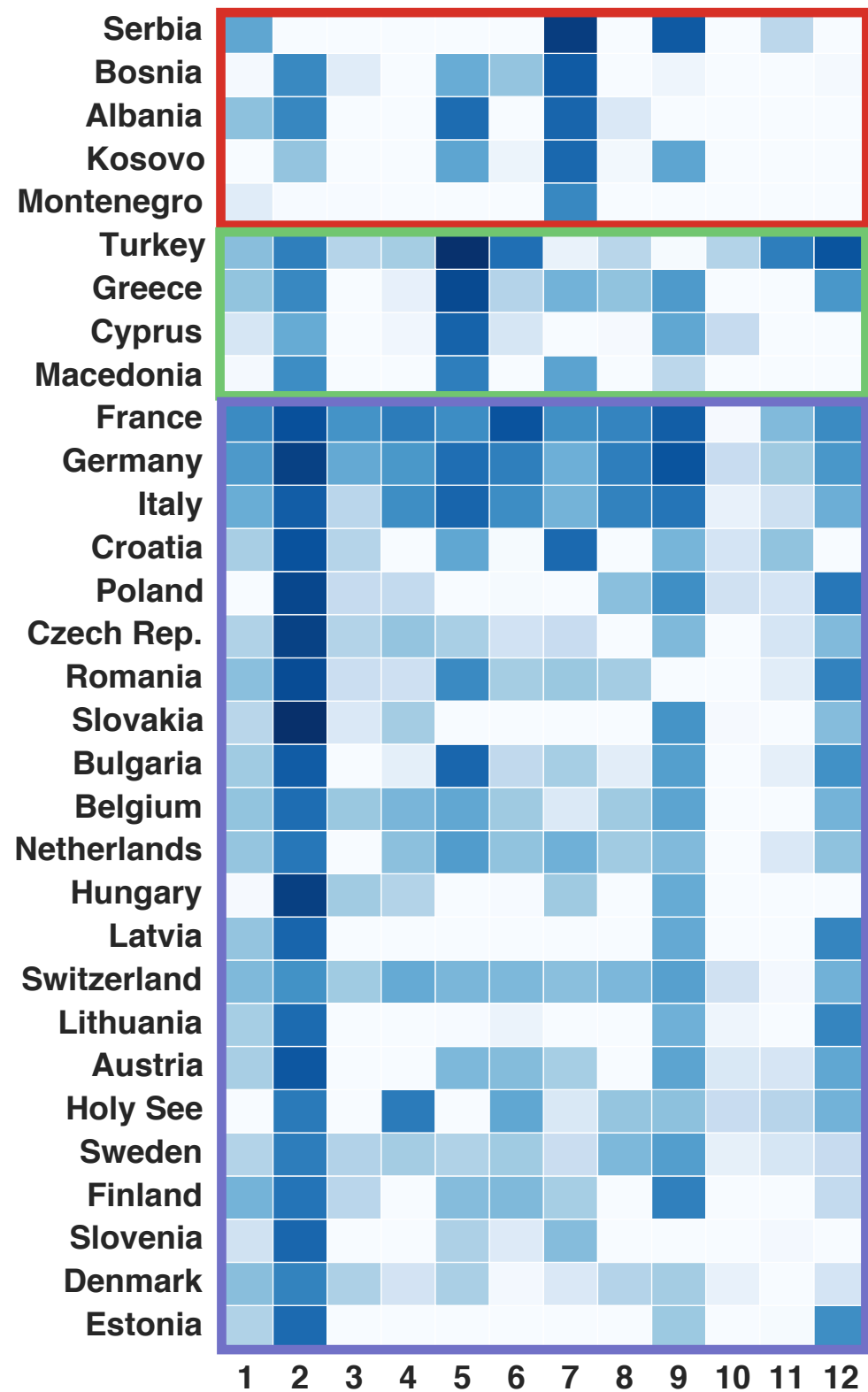
Example results on GDELT (1995-2000)



Example results on GDELT (1995-2000)



Example results on GDELT (1995-2000)



Example results on GDELT (1995-2000)



$$\phi_{ak}$$

topics of actions

Example results on GDELT (1995-2000)



"Protest" topic

$$\phi_{ak}$$

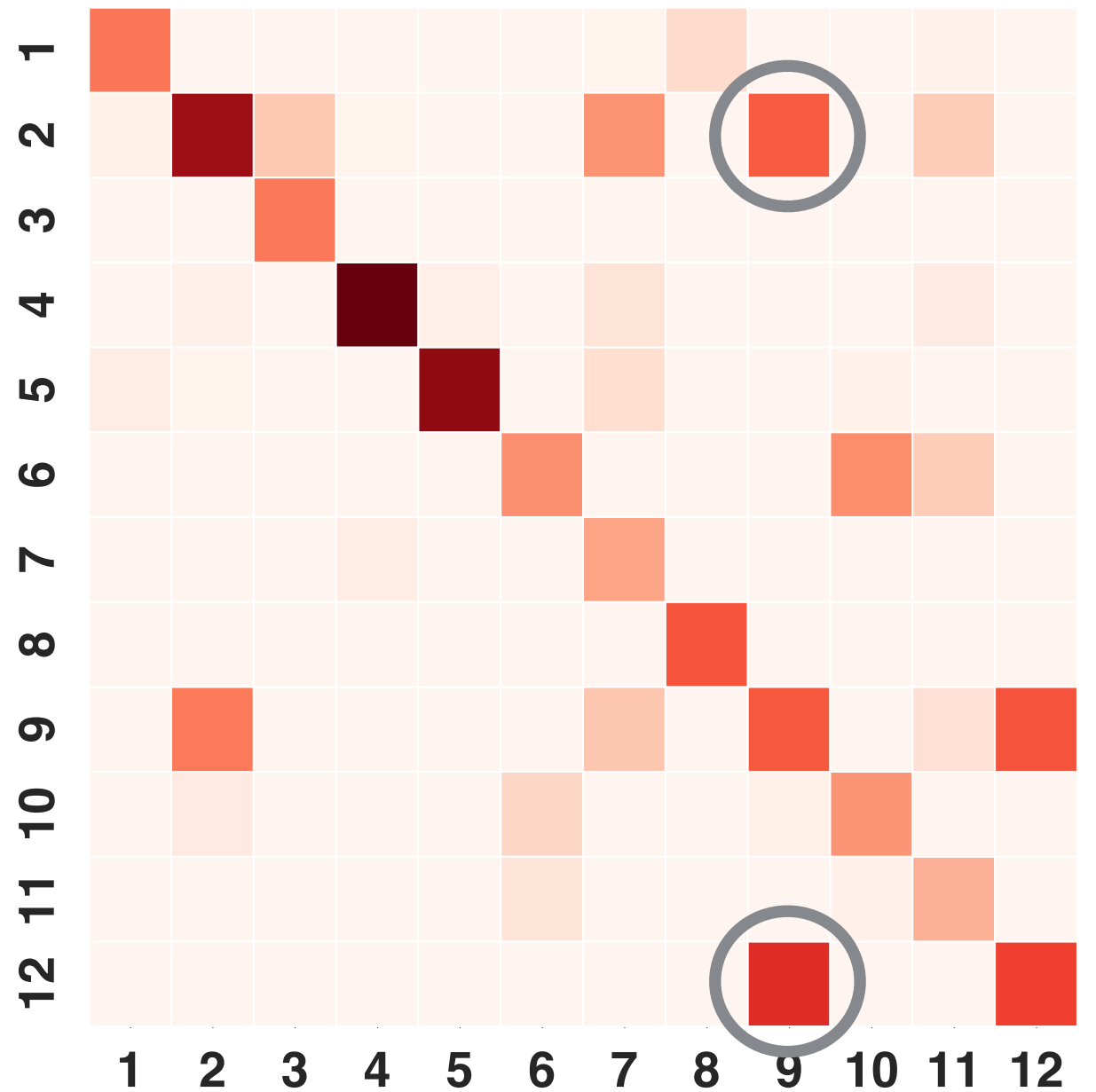
topics of actions

Example results on GDELT (1995-2000)

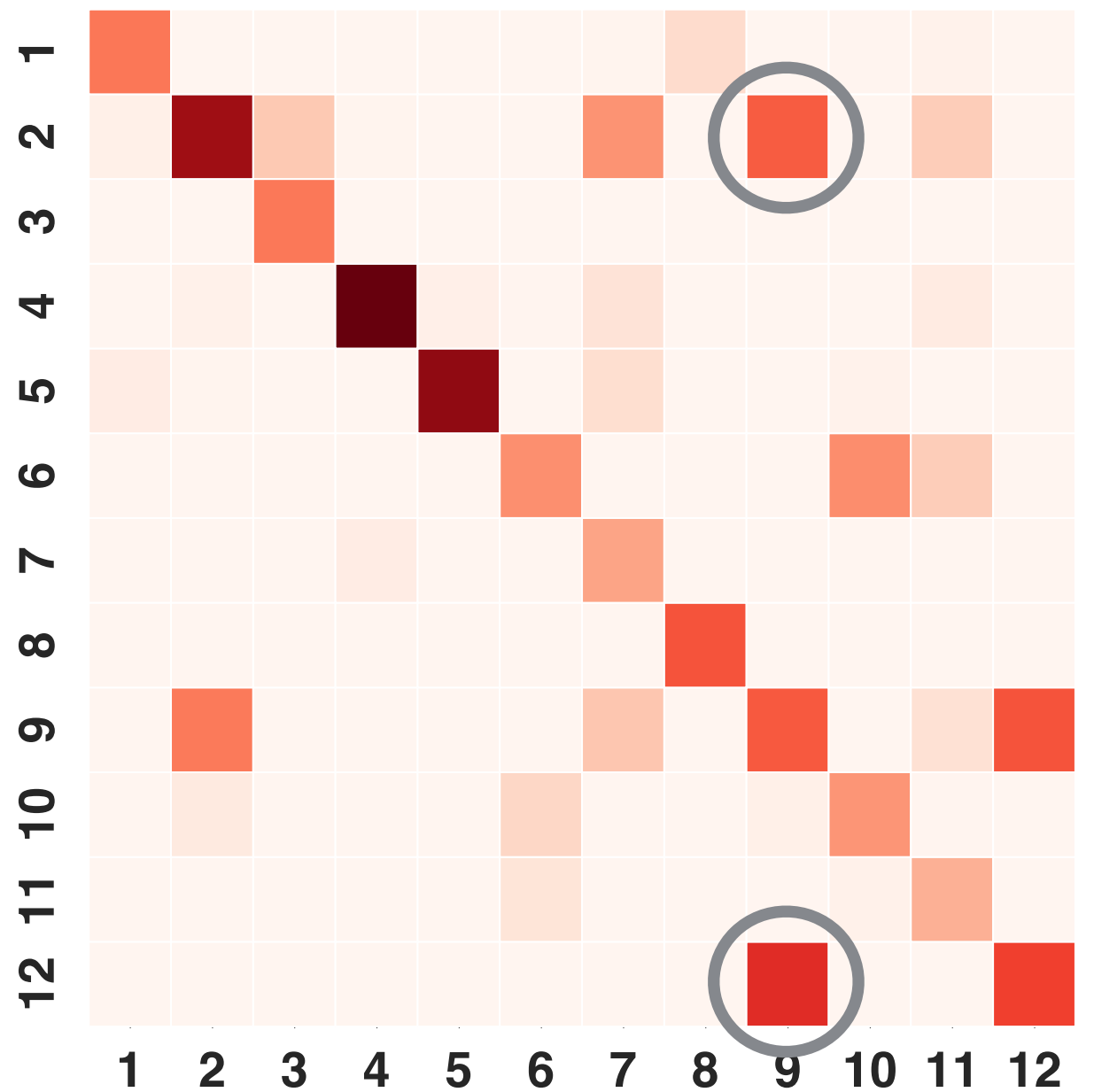
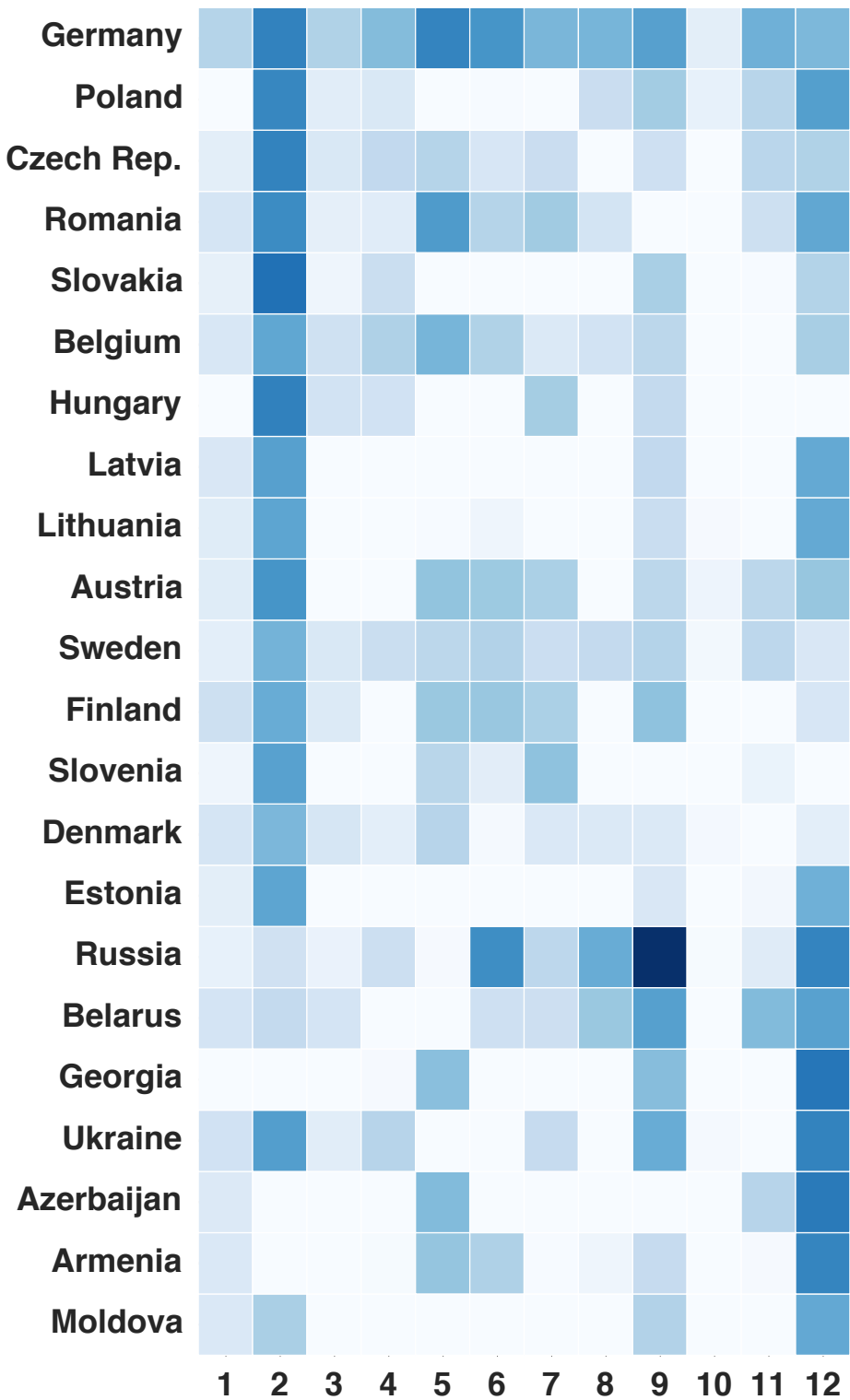
$$\lambda_{c \rightarrow d}^{(r)}$$



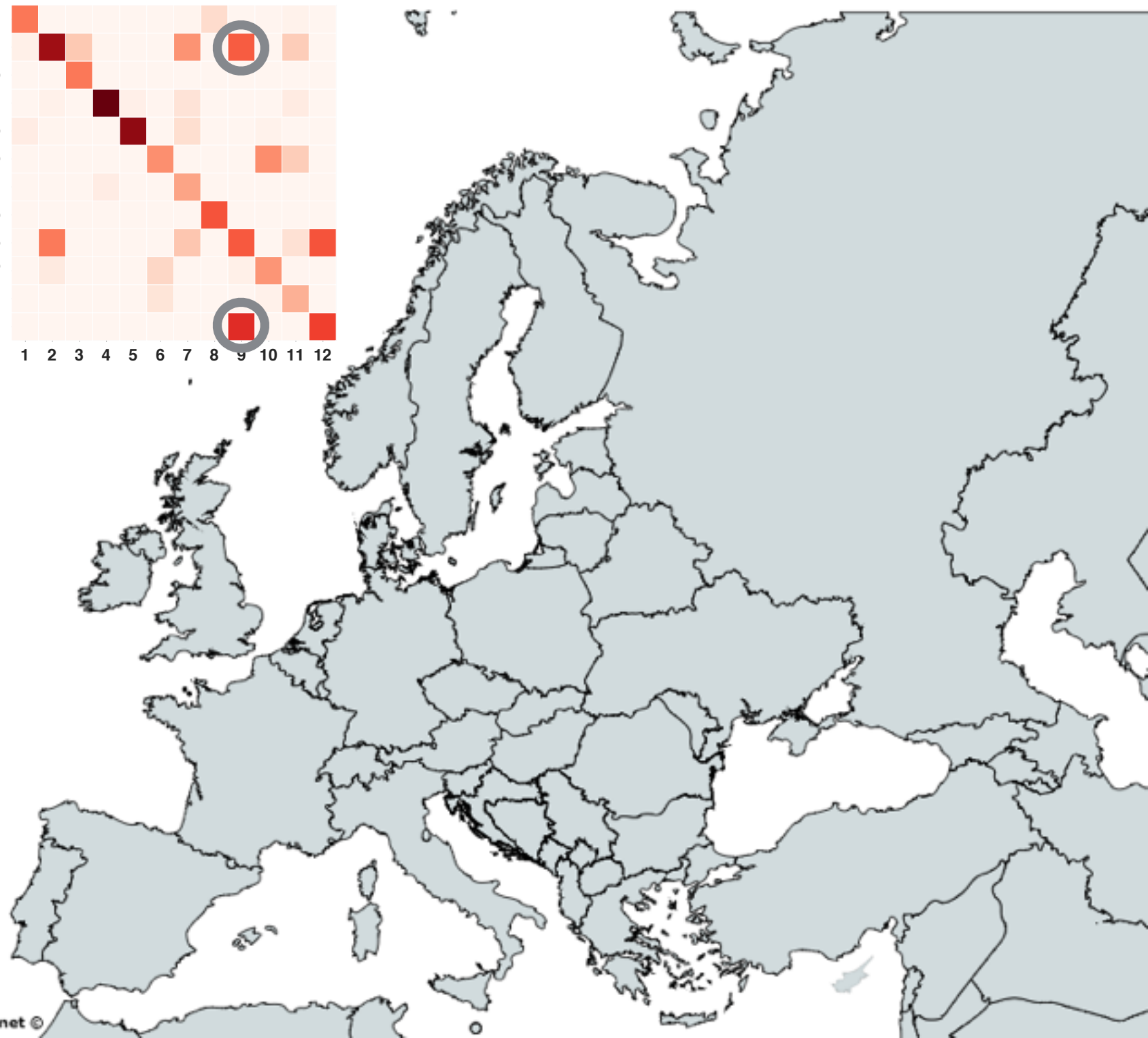
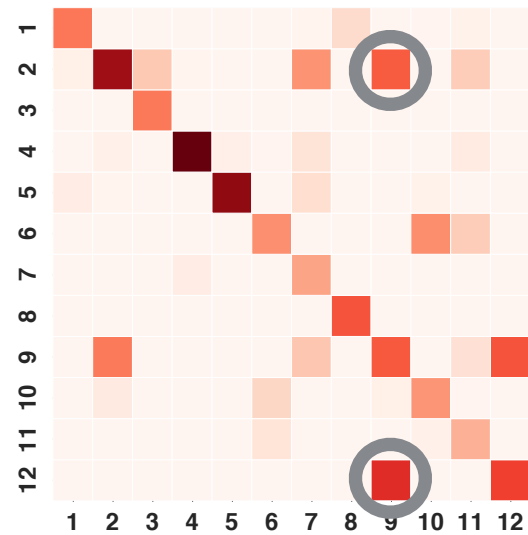
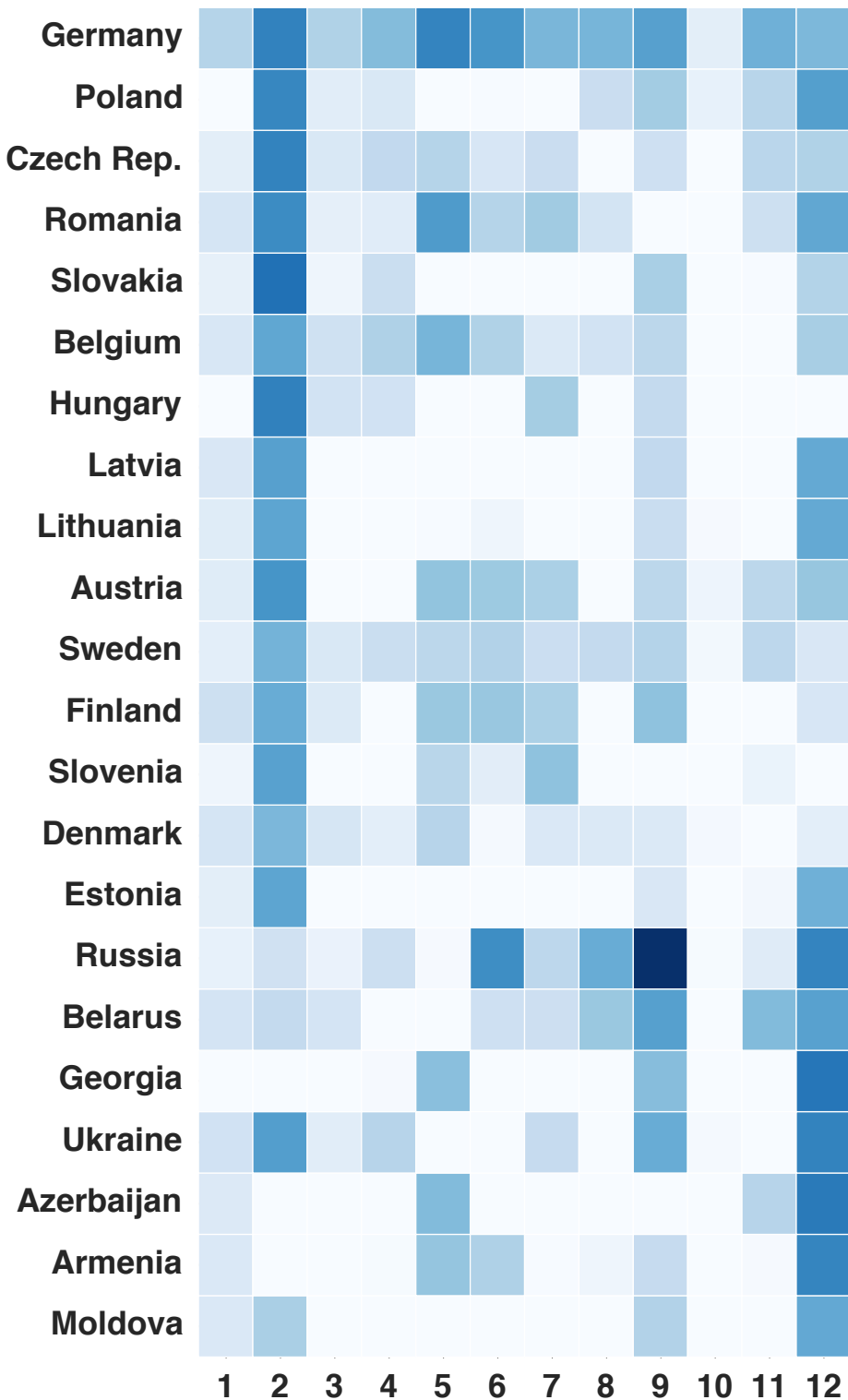
for "Protest" topic k
and top regime r



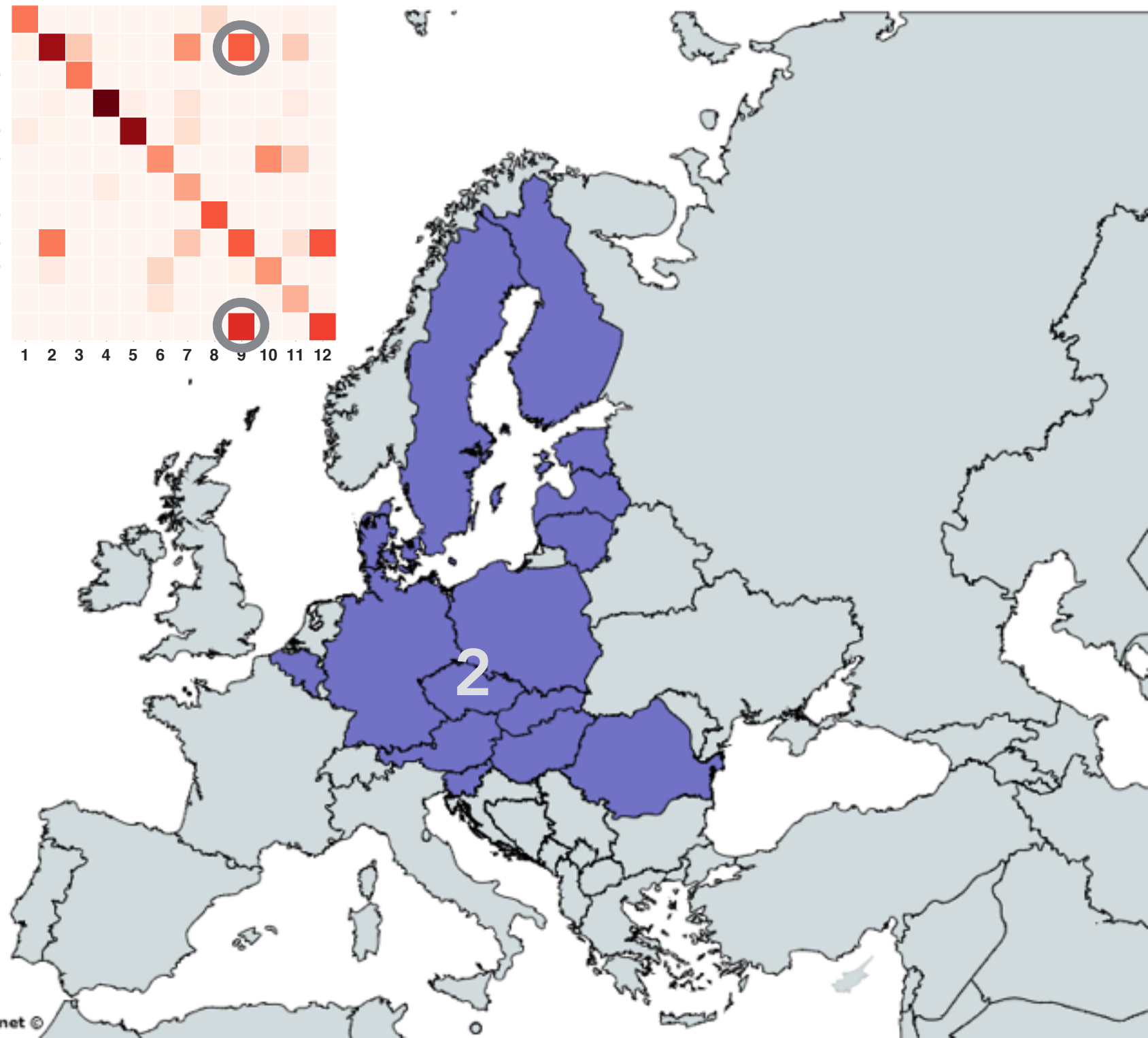
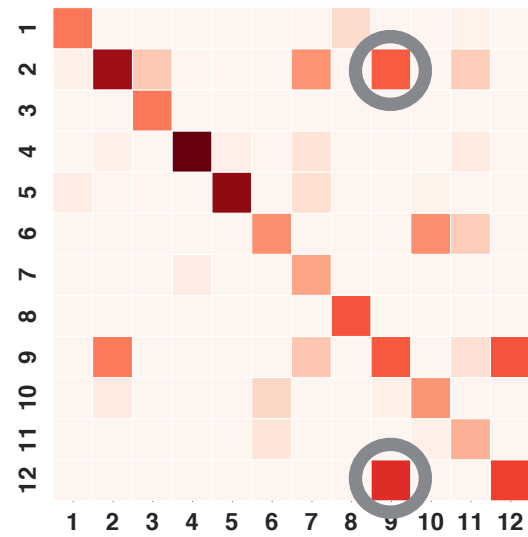
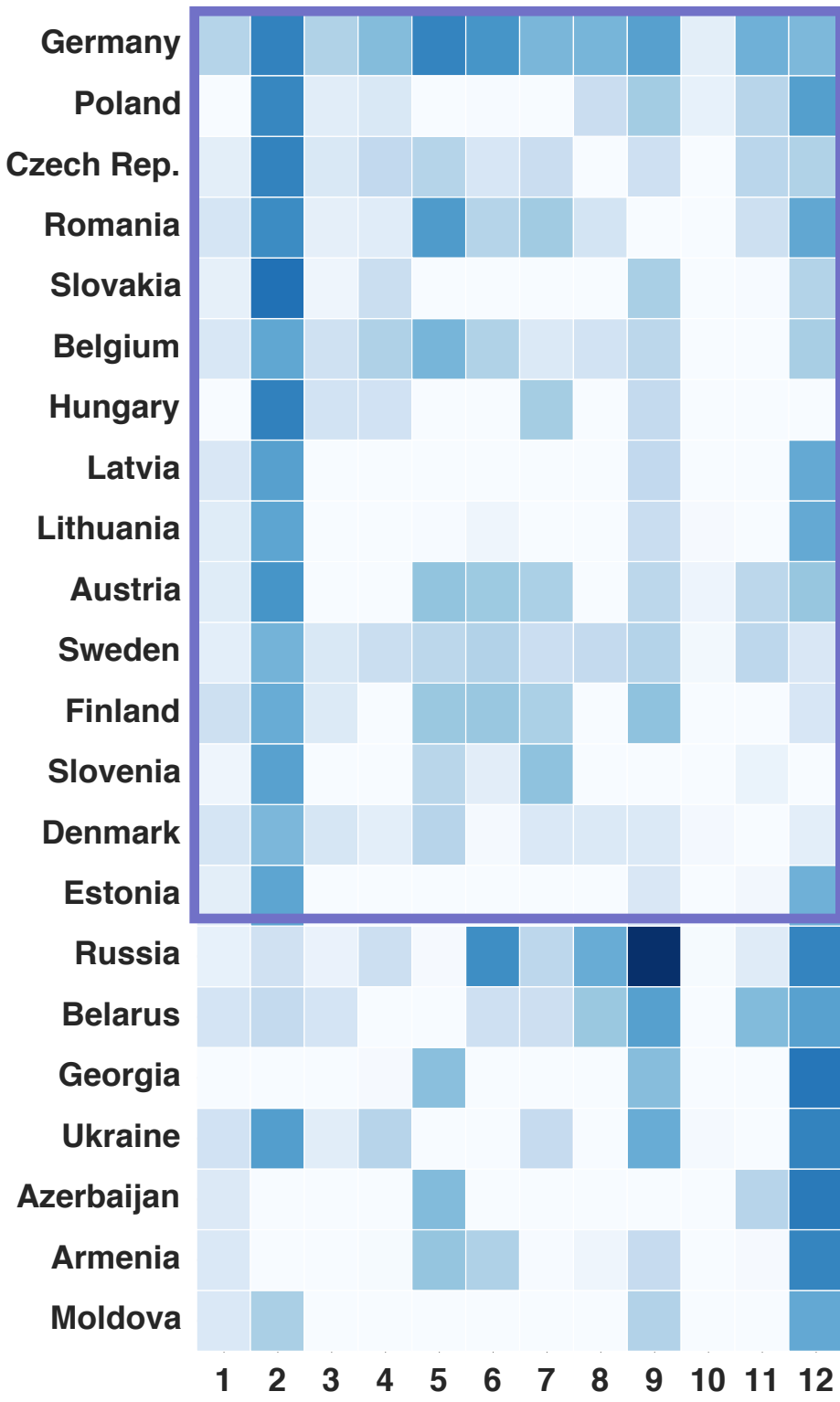
Example results on GDELT (1995-2000)



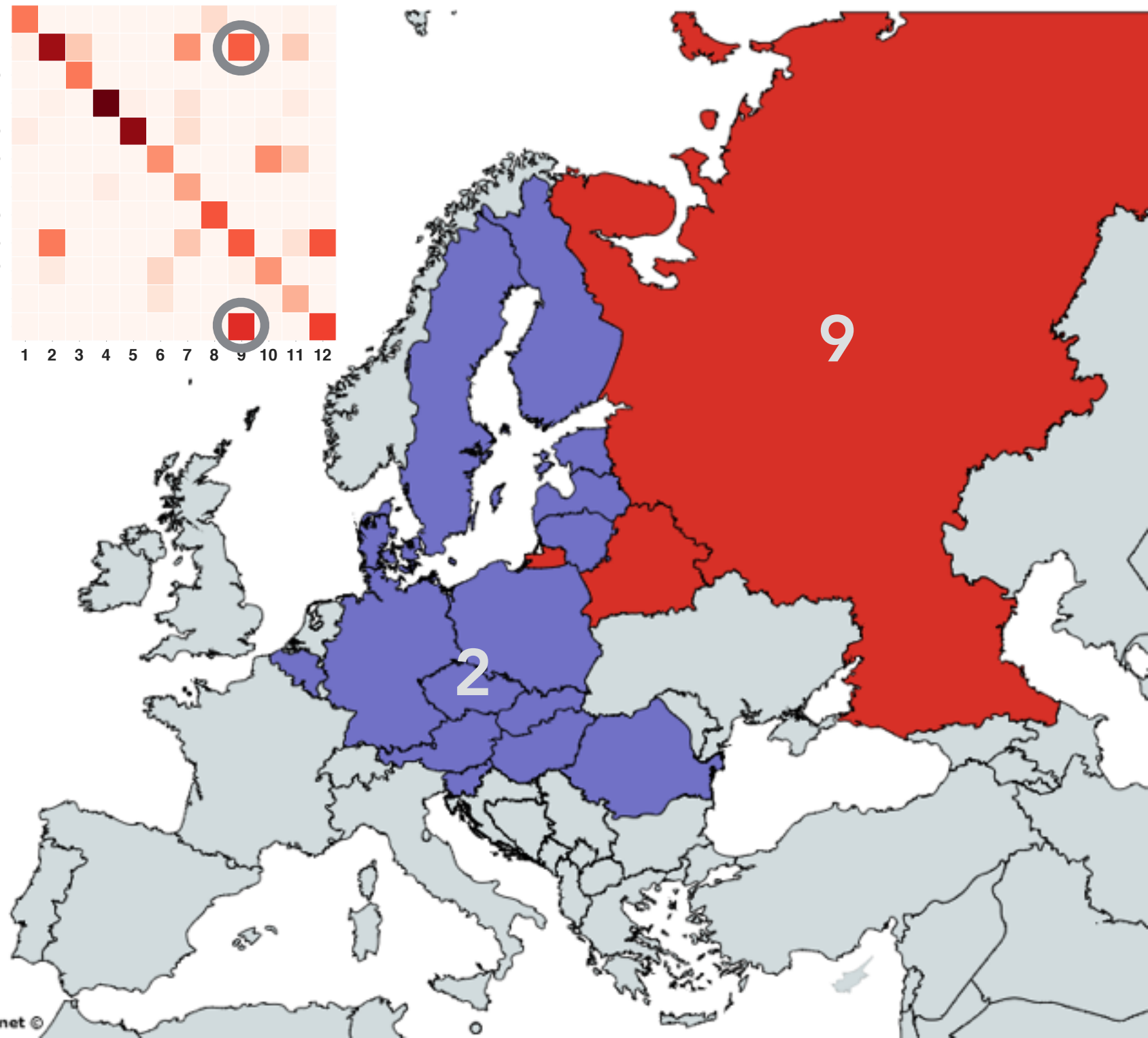
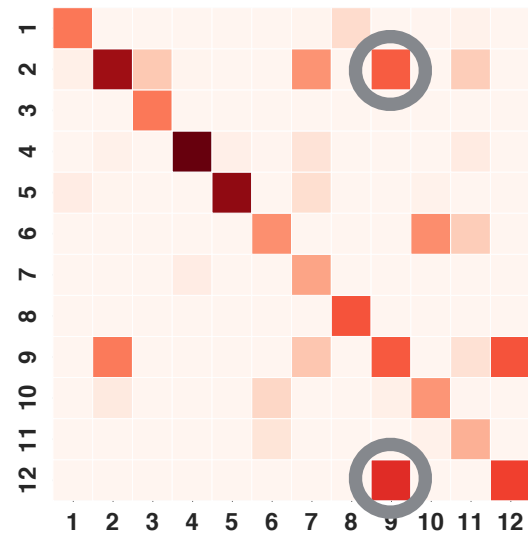
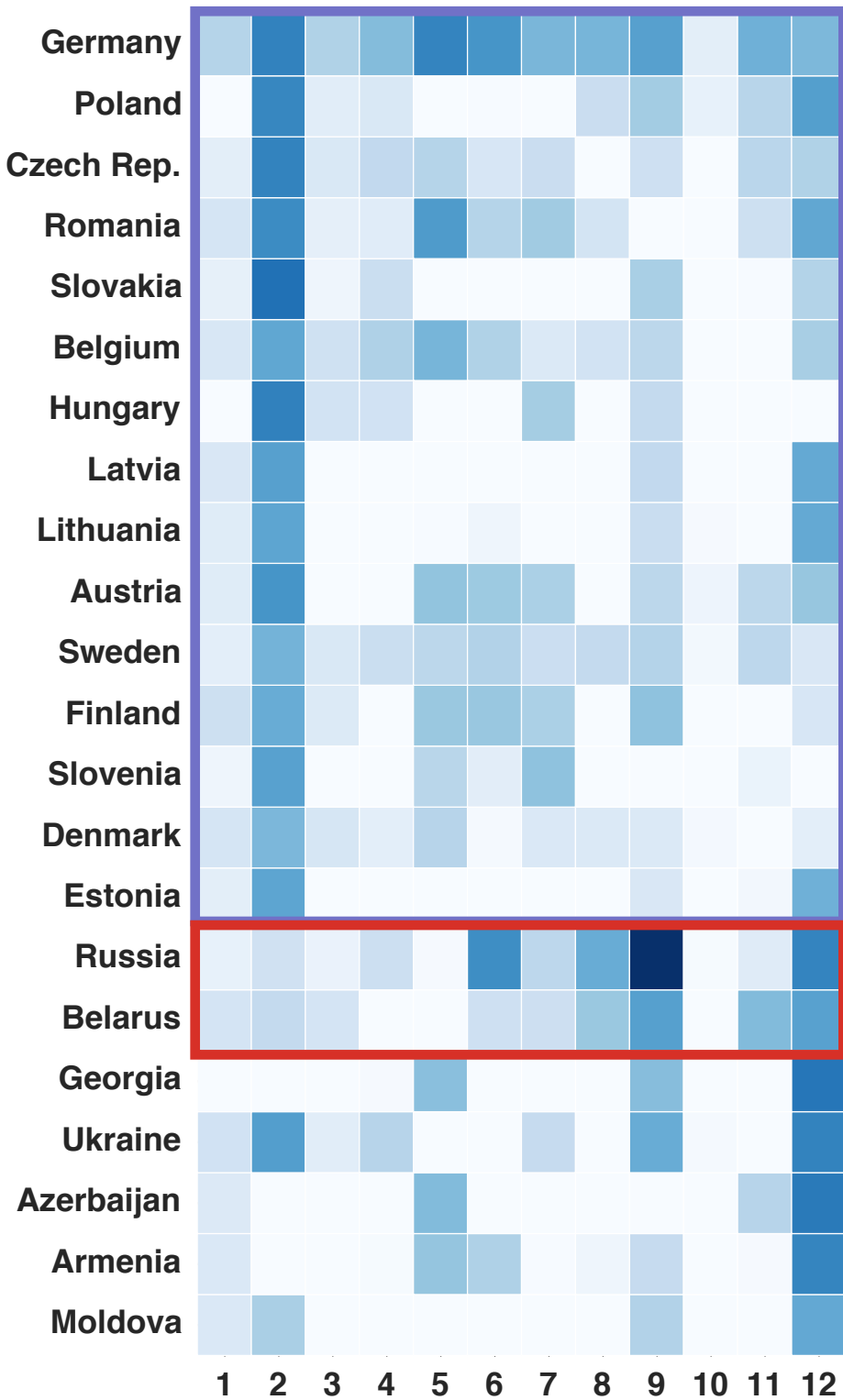
Example results on GDELT (1995-2000)



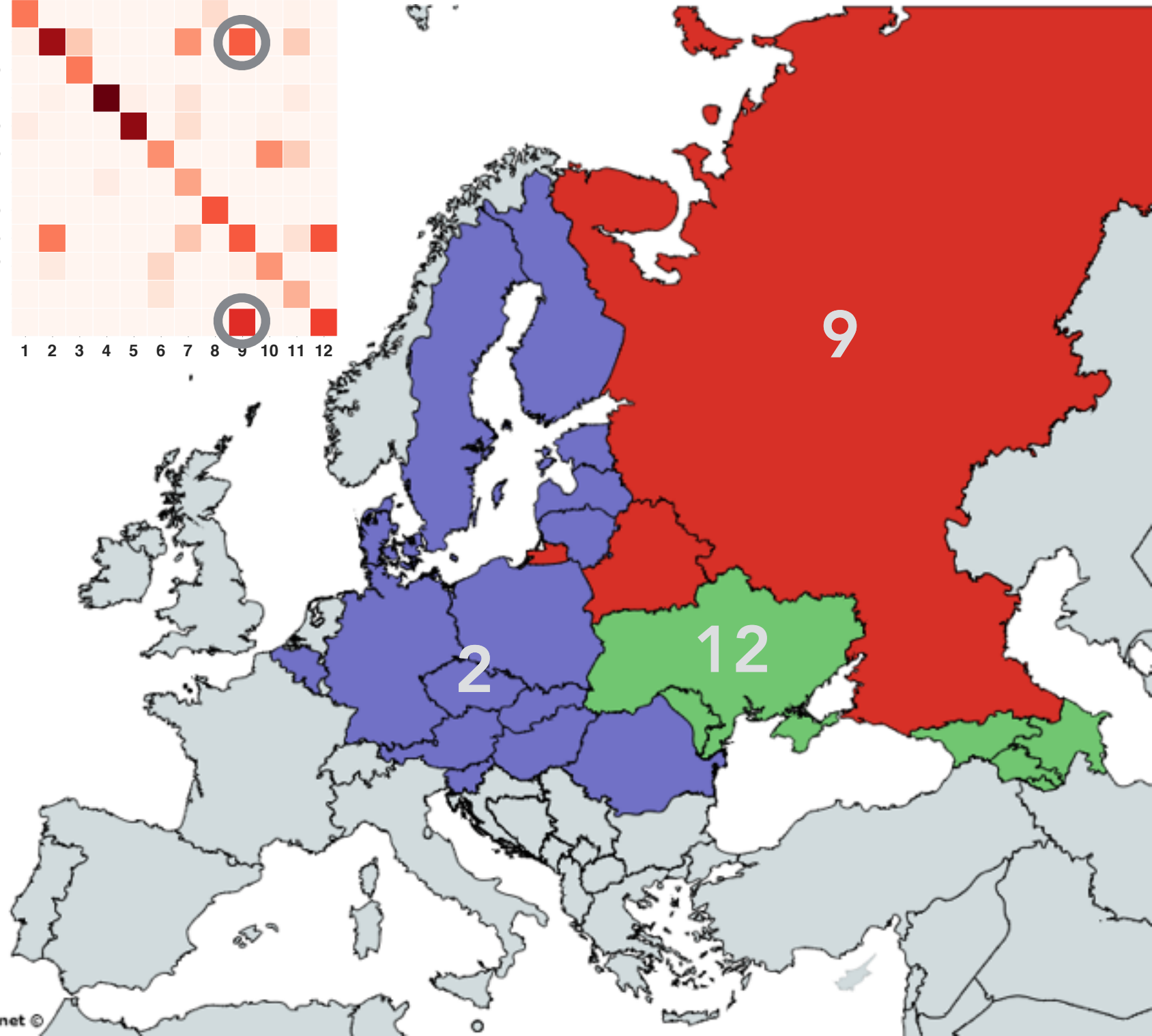
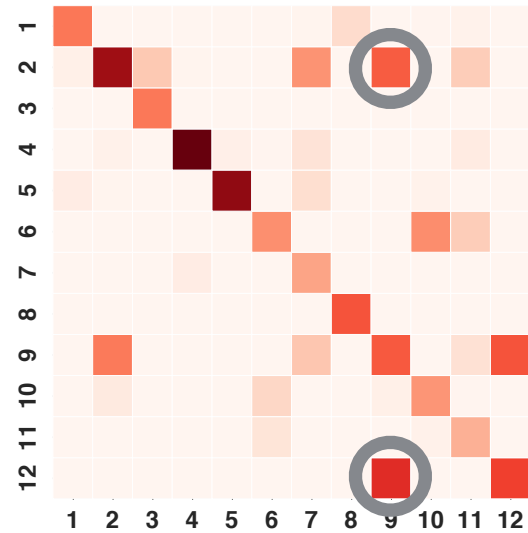
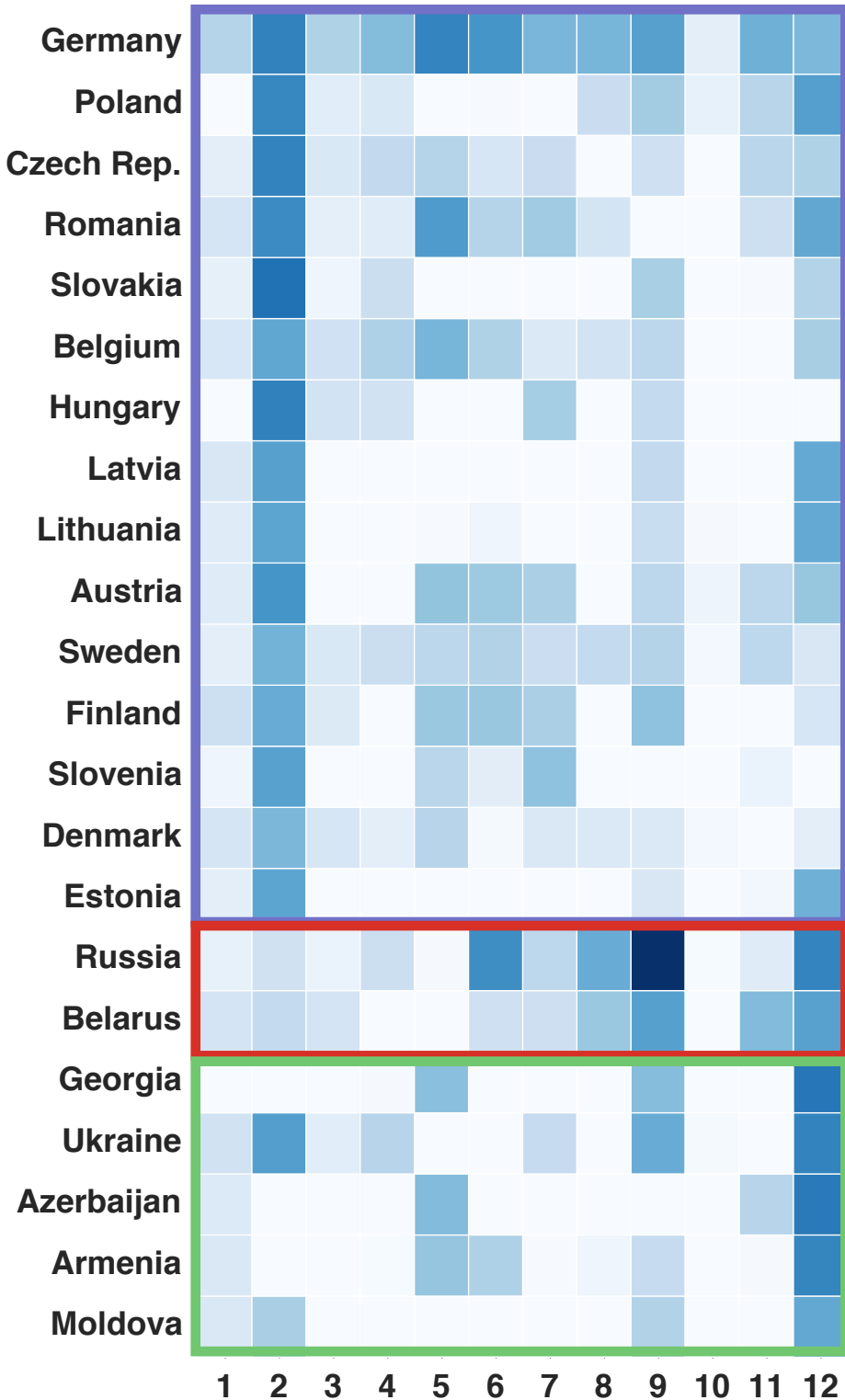
Example results on GDELT (1995-2000)



Example results on GDELT (1995-2000)

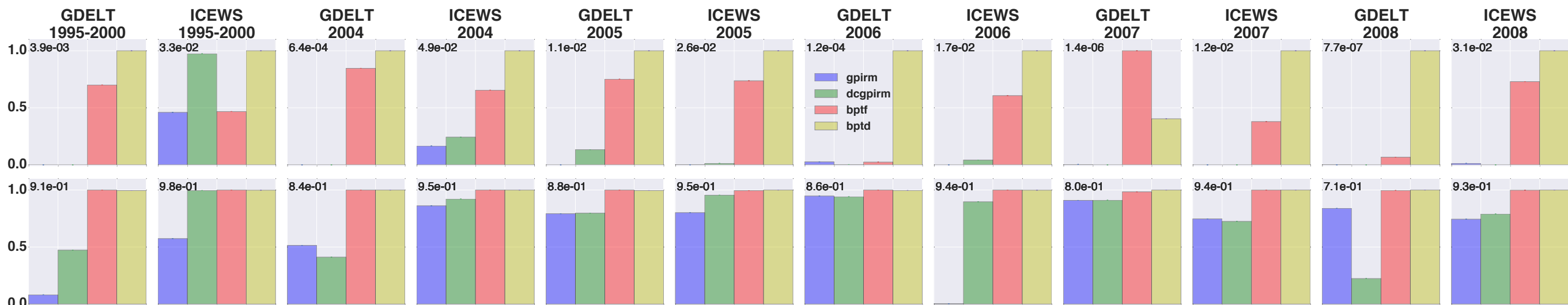


Example results on GDELT (1995-2000)



Prediction

We are yellow. Higher is better.



Merchandise plug



Thanks!