

Membership tables for applications to real data

Supplementary material

September 8, 2025

Countries	Cluster 1	Cluster 2	Crisp Partition
Afghanistan	0.86	0.14	1
Angola	0.96	0.04	1
Bangladesh	0.83	0.17	1
Belarus	0.78	0.22	1
Bolivia	0.98	0.02	1
Brazil	0.96	0.04	1
Cambodia	0.86	0.14	1
Cameroon	0.94	0.06	1
Colombia	0.89	0.11	1
Dominican Republic	0.99	0.01	1
Egypt, Arab Rep.	0.71	0.29	1
Ghana	0.97	0.03	1
Guyana	1.00	0.00	1
Haiti	0.96	0.04	1
Honduras	0.84	0.16	1
Jamaica	1.00	0.00	1
Liberia	0.98	0.02	1
Malawi	0.96	0.04	1
Mexico	0.79	0.21	1
Mongolia	0.95	0.05	1
Myanmar	0.94	0.06	1

Niger	0.96	0.04	1
Nigeria	0.98	0.02	1
Pakistan	0.85	0.15	1
Panama	0.83	0.17	1
Paraguay	0.86	0.14	1
Peru	0.93	0.07	1
Sierra Leone	0.96	0.04	1
South Africa	1.00	0.00	1
Sri Lanka	0.83	0.17	1
Suriname	0.91	0.09	1
Tanzania	0.98	0.02	1
Trinidad and Tobago	0.96	0.04	1
Tunisia	0.89	0.11	1
Türkiye	0.78	0.22	1
Uganda	0.97	0.03	1
Vietnam	0.78	0.22	1
Zambia	0.98	0.02	1
Zimbabwe	0.99	0.01	1
Albania	0.23	0.77	2
Australia	0.05	0.95	2
Austria	0.01	0.99	2
Belgium	0.02	0.98	2
Canada	0.06	0.94	2
Czechia	0.02	0.98	2
Denmark	0.01	0.99	2
Estonia	0.01	0.99	2
Finland	0.01	0.99	2
France	0.06	0.94	2
Georgia	0.06	0.94	2
Germany	0.02	0.98	2
Greece	0.13	0.87	2
Hungary	0.15	0.85	2
Ireland	0.01	0.99	2
Italy	0.08	0.92	2
Japan	0.01	0.99	2
Latvia	0.00	1.00	2
Lithuania	0.02	0.98	2
Luxembourg	0.01	0.99	2

Netherlands	0.03	0.97	2
New Zealand	0.06	0.94	2
North Macedonia	0.06	0.94	2
Norway	0.01	0.99	2
Poland	0.05	0.95	2
Portugal	0.04	0.96	2
Serbia	0.24	0.76	2
Slovak Republic	0.04	0.96	2
Slovenia	0.02	0.98	2
Spain	0.04	0.96	2
Sweden	0.02	0.98	2
Ukraine	0.23	0.77	2
United States	0.27	0.73	2
Algeria	0.66	0.34	Fuzzy
Chile	0.57	0.43	Fuzzy
Costa Rica	0.32	0.68	Fuzzy
El Salvador	0.45	0.55	Fuzzy
Jordan	0.48	0.52	Fuzzy
Uruguay ¹	0.30	0.70	Fuzzy

Table S1: The $\mathbf{U}$ matrix in the application of the FCMd-MSD with $p = 3$, $\gamma = 0.7$ and $C = 2$.

$\gamma = 0.9$	$C = 2$		$C = 3$		
COMUNI	C1	C2	C1	C2	C3
Agrigento	0.00	1.00	0.02	0.96	0.02
Alessandria	0.98	0.02	0.00	0.00	1.00
Ancona	0.02	0.98	0.49	0.39	0.12
Andria	0.00	1.00	0.00	1.00	0.00
Aosta	0.48	0.52	0.02	0.03	0.95
Arezzo	0.99	0.01	1.00	0.00	0.00
Ascoli Piceno	0.00	1.00	0.00	1.00	0.00
Asti	0.04	0.96	0.00	0.01	0.99
Avellino	0.00	1.00	0.00	0.99	0.00

¹Uruguay is included as a fuzzy unit, as its membership degree in the second cluster is rounded up from 0.697.

Bari	0.00	1.00	0.01	0.97	0.01
Barletta	0.00	1.00	0.00	1.00	0.00
Belluno	0.97	0.03	1.00	0.00	0.00
Benevento	0.00	1.00	0.00	1.00	0.00
Bergamo	1.00	0.00	0.00	0.00	1.00
Biella	0.96	0.04	0.00	0.00	1.00
Bologna	1.00	0.00	1.00	0.00	0.00
Bolzano	0.96	0.04	0.80	0.16	0.04
Brescia	1.00	0.00	0.01	0.00	0.99
Brindisi	0.00	1.00	0.08	0.81	0.11
Cagliari	0.00	1.00	0.06	0.78	0.16
Caltanissetta	0.00	1.00	0.00	1.00	0.00
Campobasso	0.00	1.00	0.00	1.00	0.00
Carbonia	0.00	1.00	0.07	0.85	0.08
Caserta	0.00	1.00	0.00	1.00	0.00
Catania	0.00	1.00	0.00	1.00	0.00
Catanzaro	0.03	0.97	0.15	0.75	0.11
Cesena	0.99	0.01	1.00	0.00	0.00
Chieti	0.00	1.00	0.00	1.00	0.00
Como	1.00	0.00	0.00	0.00	1.00
Cosenza	0.00	1.00	0.01	0.98	0.01
Cremona	1.00	0.00	0.01	0.00	0.99
Crotone	0.00	1.00	0.01	0.98	0.01
Cuneo	0.02	0.98	0.02	0.85	0.13
Enna	0.00	1.00	0.00	1.00	0.00
Fermo	0.00	1.00	0.00	0.99	0.00
Ferrara	1.00	0.00	1.00	0.00	0.00
Firenze	1.00	0.00	1.00	0.00	0.00
Foggia	0.00	1.00	0.00	0.99	0.00
Forlì	1.00	0.00	1.00	0.00	0.00
Frosinone	0.00	1.00	0.02	0.96	0.03
Genova	0.72	0.28	0.09	0.04	0.87
Gorizia	0.73	0.27	0.92	0.03	0.05
Grosseto	0.57	0.43	0.40	0.15	0.45
Imperia	0.00	1.00	0.01	0.97	0.02
Isernia	0.00	1.00	0.00	1.00	0.00
La Spezia	0.93	0.07	0.99	0.00	0.00
L'Aquila	0.00	1.00	0.00	1.00	0.00

Latina	0.04	0.96	0.13	0.82	0.06
Lecce	0.09	0.91	0.19	0.55	0.25
Lecco	1.00	0.00	0.00	0.00	1.00
Livorno	1.00	0.00	1.00	0.00	0.00
Lodi	1.00	0.00	0.00	0.00	1.00
Lucca	1.00	0.00	1.00	0.00	0.00
Macerata	0.00	1.00	0.04	0.95	0.01
Mantova	1.00	0.00	0.98	0.00	0.02
Massa	0.99	0.01	0.99	0.01	0.00
Matera	0.00	1.00	0.00	1.00	0.00
Messina	0.00	1.00	0.01	0.96	0.03
Milano	1.00	0.00	0.00	0.00	1.00
Modena	1.00	0.00	1.00	0.00	0.00
Monza	1.00	0.00	0.00	0.00	1.00
Napoli	0.00	1.00	0.00	0.99	0.00
Novara	1.00	0.00	0.00	0.00	1.00
Nuoro	0.01	0.99	0.08	0.83	0.09
Oristano	0.00	1.00	0.01	0.97	0.02
Padova	1.00	0.00	1.00	0.00	0.00
Palermo	0.03	0.97	0.09	0.73	0.18
Parma	0.99	0.01	0.94	0.00	0.06
Pavia	1.00	0.00	0.00	0.00	1.00
Perugia	0.12	0.88	0.39	0.48	0.13
Pesaro	0.23	0.77	0.89	0.10	0.01
Pescara	0.00	1.00	0.00	0.99	0.00
Piacenza	1.00	0.00	0.00	0.00	1.00
Pisa	0.98	0.02	1.00	0.00	0.00
Pistoia	1.00	0.00	1.00	0.00	0.00
Pordenone	1.00	0.00	1.00	0.00	0.00
Potenza	0.00	1.00	0.00	1.00	0.00
Prato	1.00	0.00	1.00	0.00	0.00
Ragusa	0.00	1.00	0.00	1.00	0.00
Ravenna	0.95	0.05	1.00	0.00	0.00
Reggio di Calabria	0.00	1.00	0.00	0.99	0.00
Reggio nell'Emilia	1.00	0.00	1.00	0.00	0.00
Rieti	0.00	1.00	0.00	1.00	0.00
Rimini	0.94	0.06	0.97	0.01	0.02
Roma	0.00	1.00	0.00	0.99	0.01

Rovigo	1.00	0.00	1.00	0.00	0.00
Salerno	0.00	1.00	0.00	1.00	0.00
Sassari	0.01	0.99	0.13	0.71	0.15
Savona	0.00	1.00	0.01	0.90	0.09
Siena	0.85	0.15	1.00	0.00	0.00
Siracusa	0.00	1.00	0.02	0.92	0.06
Sondrio	1.00	0.00	0.00	0.00	1.00
Taranto	0.03	0.97	0.19	0.47	0.34
Teramo	0.00	1.00	0.00	1.00	0.00
Terni	0.00	1.00	0.00	1.00	0.00
Torino	0.48	0.52	0.00	0.00	0.99
Trani	0.00	1.00	0.00	1.00	0.00
Trapani	0.00	1.00	0.03	0.93	0.04
Trento	1.00	0.00	0.97	0.00	0.03
Treviso	1.00	0.00	1.00	0.00	0.00
Trieste	0.54	0.46	0.85	0.08	0.08
Udine	0.97	0.03	0.99	0.00	0.00
Varese	1.00	0.00	0.00	0.00	1.00
Venezia	1.00	0.00	1.00	0.00	0.00
Verbania	1.00	0.00	0.00	0.00	1.00
Vercelli	0.99	0.01	0.00	0.00	1.00
Verona	1.00	0.00	1.00	0.00	0.00
Vibo Valentia	0.00	1.00	0.01	0.98	0.02
Vicenza	1.00	0.00	1.00	0.00	0.00
Viterbo	0.00	1.00	0.00	1.00	0.00

Table S2: The units' membership values in the application of the FCMo-MS C $p = 1$, $\gamma = 0.9$ and $C = 2, 3$.