How the ego perspective shapes the temporal motifs in human face to face interactions

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Who am I?

- Antonio Longa
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01 Network Motifs and Temporal Motifs

NETWORK MOTIFS

- Milo et al. [1]
- **Recurrent** and **statistically significant** sub-graphs of a network

TEMPORAL MOTIFS

- **Two** main **approaches**
 - **Static snapshot** of the temporal network
 - Static motifs from the **aggregated network**
 - Later, introduce temporal dimension [2]

[1] Ron Milo, Shai Shen-Orr, Shalev Itzkovitz, Nadav Kashtan, Dmitri Chklovskii, and Uri Alon. Network motifs: simple building blocks of complex networks. Science, 298(5594):824–827, 2002.

[2] Ashwin Paranjape, Austin R Benson, and Jure Leskovec. Motifs in temporal networks. In Proceedings of the Tenth ACM International Conference on Web Search and Data Mining, pages 601–610, 2017.

O2 Communication Motifs and Related Issues

COMMUNICATION MOTIFS

- Zhao et al. [3]
- Δt-connected temporal graph
- With a frequency greater than a given threshold

RELATED ISSUES

- Ego perspective not considered
- Rely on an isomorphism test \rightarrow high computational cost

[3] Q. Zhao, Y. Tian, Q. He, N. Oliver, R. Jin, and W.-C. Lee, "Communication motifs: a tool to characterize social communications," in Proceedings of the 19th ACM international conference on Information and knowledge management, pp. 1645–1648, 2010.

Egocentric Temporal Motifs







04 Face-to-Face dataset sociopatterns.ord

SOCIOPATTERNS.ORG

- Collaboration formed in 2008 that adopts a data-driven methodology to study social dynamics and human activity.
- Schools, hospital, conferences, workplace etc
- Wearable active Radio Frequency Identification (RFID)

	Nodes	Edges	Avg. degree
High School 11	126	1709	45 ± 32
InVS13	92	750	31 ± 24
LH10	75	1139	34 ± 19











06 Conclusions and future works

CONCLUSIONS

- Novel approach for mining temporal motifs
- ETM are **simpler** (topological level)
- Do not rely on an isomorphism test
- Complexity $\rightarrow O(n \cdot m \cdot d(k) \log d(k)) \approx O(n \cdot m)$

FUTURE WORKS

- Labeled ETM
- ETM distribution
 - Network characterization
 - Loss among networks









THANKS

Does anyone have any questions?

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Algorithm

```
Algorithm 1 Procedure for computing the signature of an ETN graph.
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```
procedure COMPUTEETNS(G_t^k(v))

s \leftarrow []_k

V \leftarrow \bigcup_{i=0}^k V_{t+i}(v)

for u \in V do

if u \neq v then

s_u \leftarrow []

for i = 0, ..., k do

if u \in V_{t+i}(v) then

APPEND(s_u, 1)

else

APPEND(s_u, 0)

APPEND(s, s_u)

s \leftarrow \text{SORT}(s)

return FLATTEN(s)
```

```
Algorithm 2 Procedure for extracting counts of ETN graphs
from a temporal graph.

procedure COUNTETN(\mathcal{G}, \Delta t, k)
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\begin{split} \mathcal{S} &\leftarrow \emptyset \\ G_{t_1,..,t_m} &\leftarrow \text{EXTRACTSNAPSHOTS}(\mathcal{G}, \Delta t) \\ \textbf{for } i = 1,..,m-k \ \textbf{do} \\ \textbf{for } v \in V_{t_i} \ \textbf{do} \\ G_{t_i}^k(v) \leftarrow \text{BUILDETN}(G_{t_i}(v),...,G_{t_{i+k}}(v)) \\ s_{t_i}^k(v) \leftarrow \text{COMPUTEETNS}(G_{t_i}^k(v)) \\ \textbf{if } s_{t_i}^k(v) \in \mathcal{S} \ \textbf{then} \\ &\mathcal{S}[s_{t_i}^k(v)] \leftarrow \mathcal{S}[s_{t_i}^k(v)] + 1 \\ \textbf{else} \\ &\mathcal{S}[s_{t_i}^k(v)] \leftarrow 1 \\ \textbf{return } \mathcal{S} \end{split}
```

