Li Zou
PhD student,
Multimedia computing,
Faculty of Electrical Engineering, Mathematics and Computer Science,
Delft University of Technology
Email: l.zou@tudelt.nl

Research topic: **Model temporal networks**

Alan Hanjalic

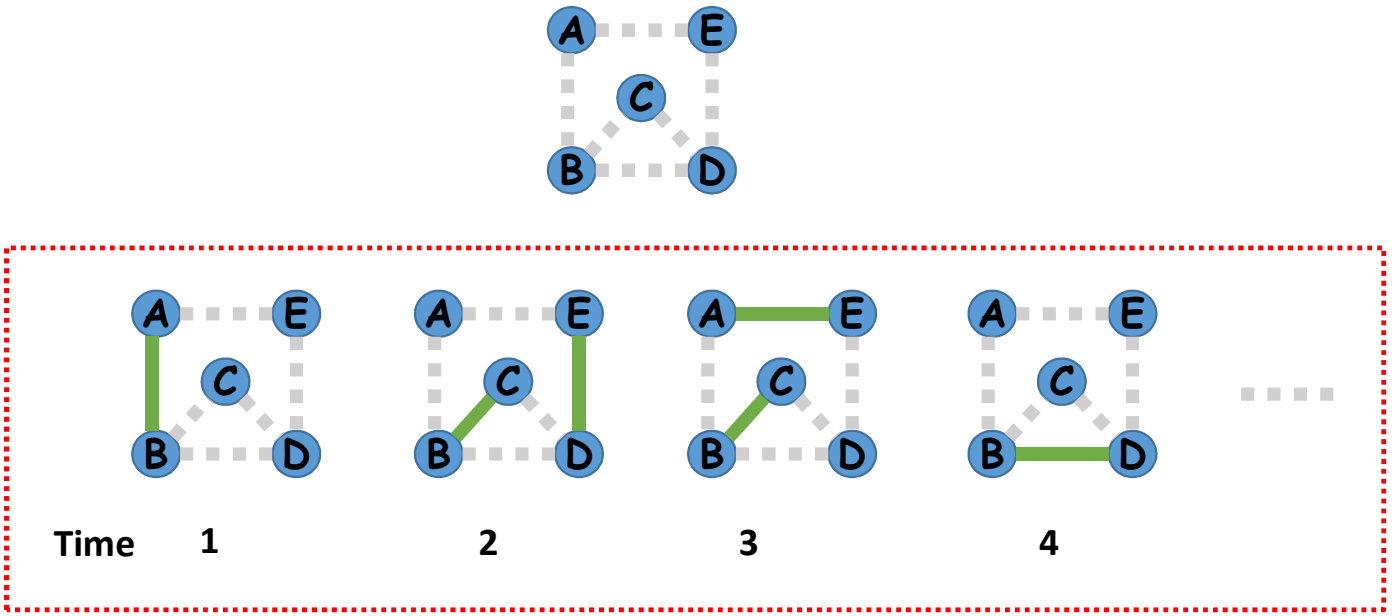
Huijuan Wang

IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING

Temporal Network Prediction and Interpretation

Li Zou, Xiu-Xiu Zhan, Jie Sun, Alan Hanjalic, *Fellow, IEEE*, and Huijuan Wang, *Member, IEEE*

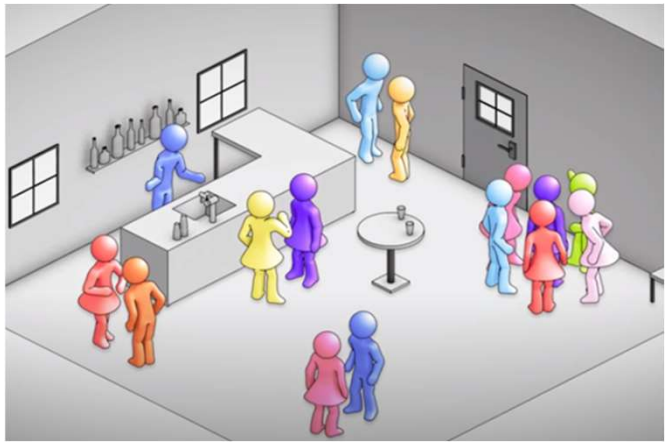
What is temporal networks



Example of temporal networks

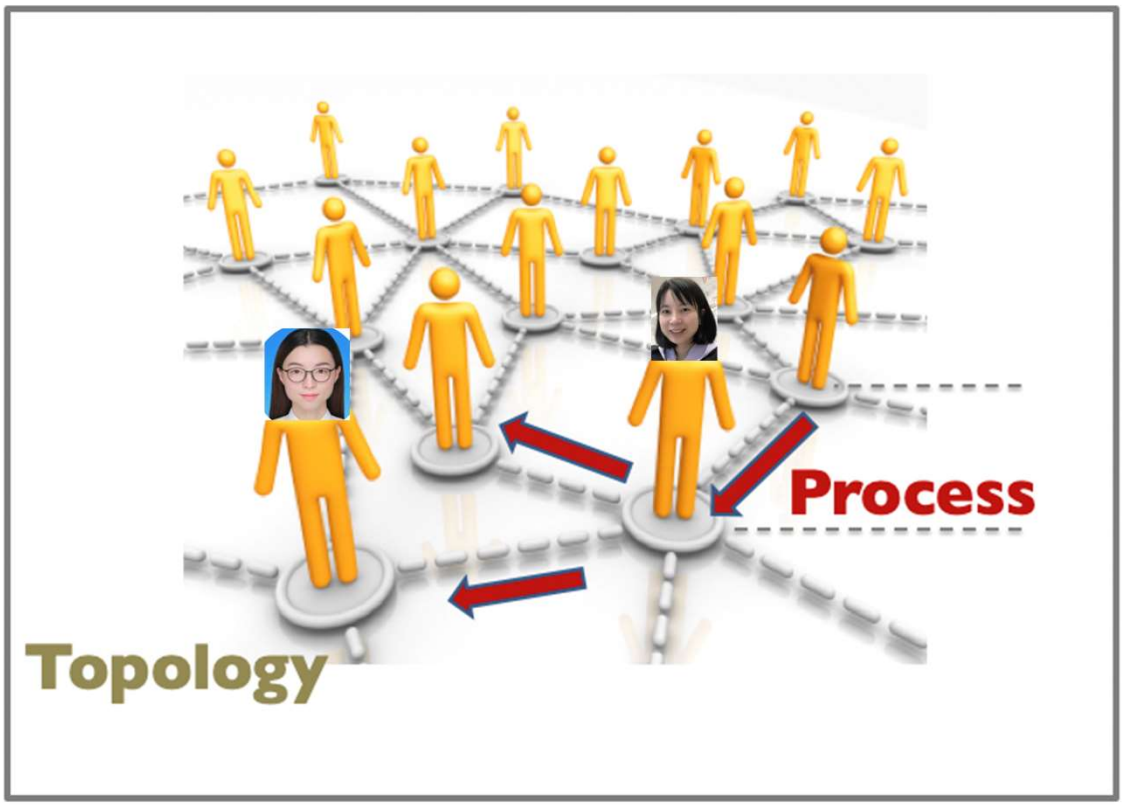
Message networks

Email networks



Physical contact networks

Why temporal networks

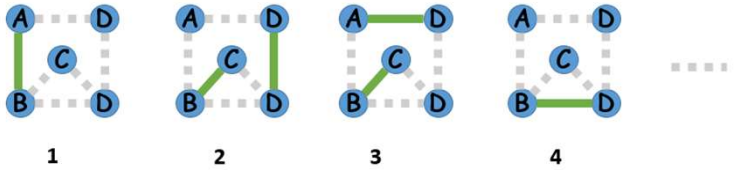


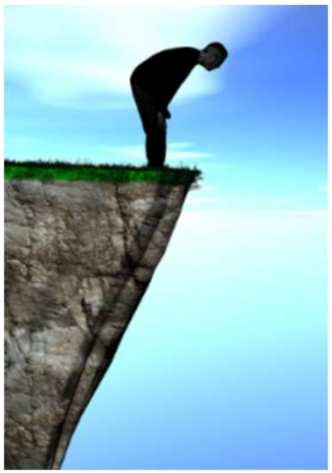
Emergence of contacts

Time ordering of contacts

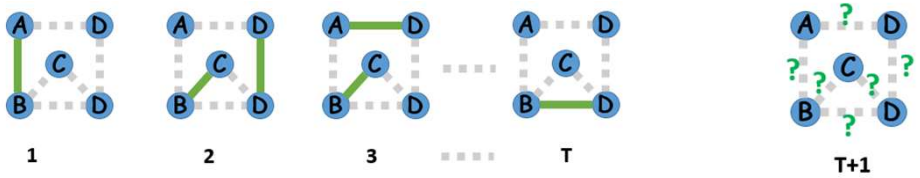
Temporal link prediction

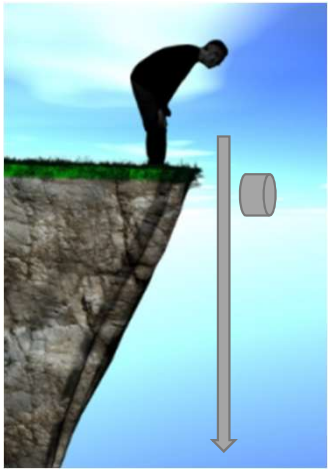
Model temporal networks





Temporal link prediction



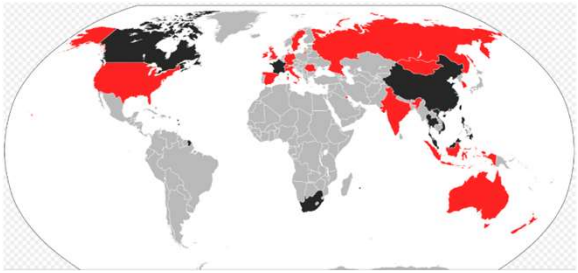


Why Temporal link prediction

- **Methodological reasons:**
  Detect the important feature of the temporal network

- **Commercial reason:**
  Recommendation system

- **Public health reason:**
  Mitigate disease spreading



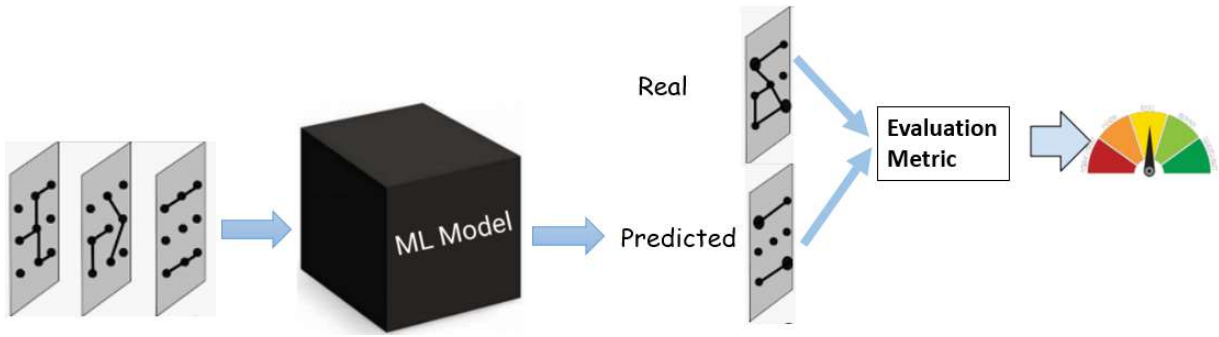
What existing methods do

- Methods generalized by traditional link prediction methods

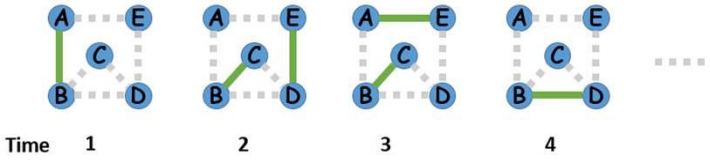
White-box but less accurate

- Machining learning methods

Relatively accurate but black-box



What we do



	link state					
	(A,B)	(A,E)	(B,C)	(B,D)	(C,D)	(D,E)
time \ link id	1	2	3	4	5	6
1	$x_1(1)$	$x_2(1)$	$x_3(1)$	$x_4(1)$	$x_5(1)$	$x_6(1)$
2	$x_1(2)$	$x_2(2)$	$x_3(2)$	$x_4(2)$	$x_5(2)$	$x_6(2)$
3	$x_1(3)$	$x_2(3)$	$x_3(3)$	$x_4(3)$	$x_5(3)$	$x_6(3)$
4	$x_1(4)$	$x_2(4)$	$x_3(4)$	$x_4(4)$	$x_5(4)$	$x_6(4)$
.....	.....					

	link state					
	(A,B)	(A,E)	(B,C)	(B,D)	(C,D)	(D,E)
time \ link id	1	2	3	4	5	6
1	1	0	0	0	0	0
2	0	0	1	0	0	0
3	0	1	1	0	0	0
4	0	0	0	1	0	0
.....	.....					

What we want

Learned model

Link relation

What we assume

$$x_i(t+1) = f_i(x_1(t), x_2(t), ..., x_M(t))$$

What we choose

- Lasso Regression

$$x_i(t+1) = \sum_{j=1}^{M} x_j(t)\beta_{ij} + c_i$$

- Random Forest

What we get

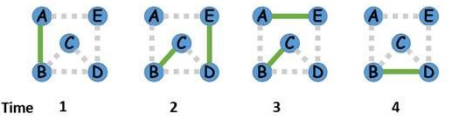
- Learned model

  Prediction

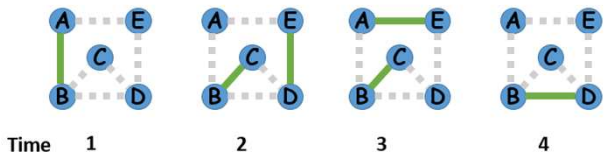
- Link relation coefficient B_{ij}

  Interpretation

Interpretation



Network topology



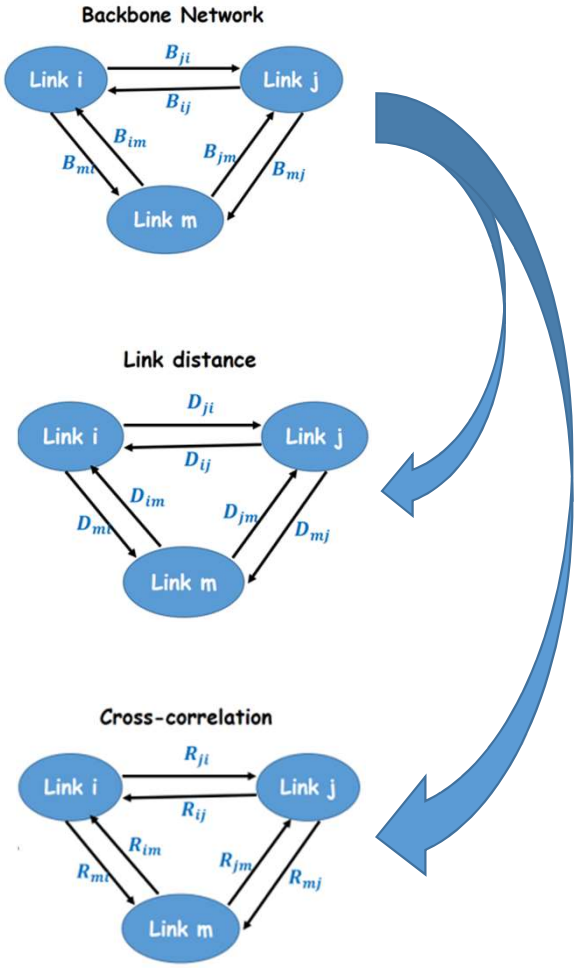
Statistics

time	link id	link state (A,B)	(A,E)	(B,C)	(B,D)	(C,D)	(D,E)
		1	2	3	4	5	6
1		$x_1(1)$	$x_2(1)$	$x_3(1)$	$x_4(1)$	$x_5(1)$	$x_6(1)$
2		$x_1(2)$	$x_2(2)$	$x_3(2)$	$x_4(2)$	$x_5(2)$	$x_6(2)$
3		$x_1(3)$	$x_2(3)$	$x_3(3)$	$x_4(3)$	$x_5(3)$	$x_6(3)$
4		$x_1(4)$	$x_2(4)$	$x_3(4)$	$x_4(4)$	$x_5(4)$	$x_6(4)$
.....							

Link relation B_{ij}

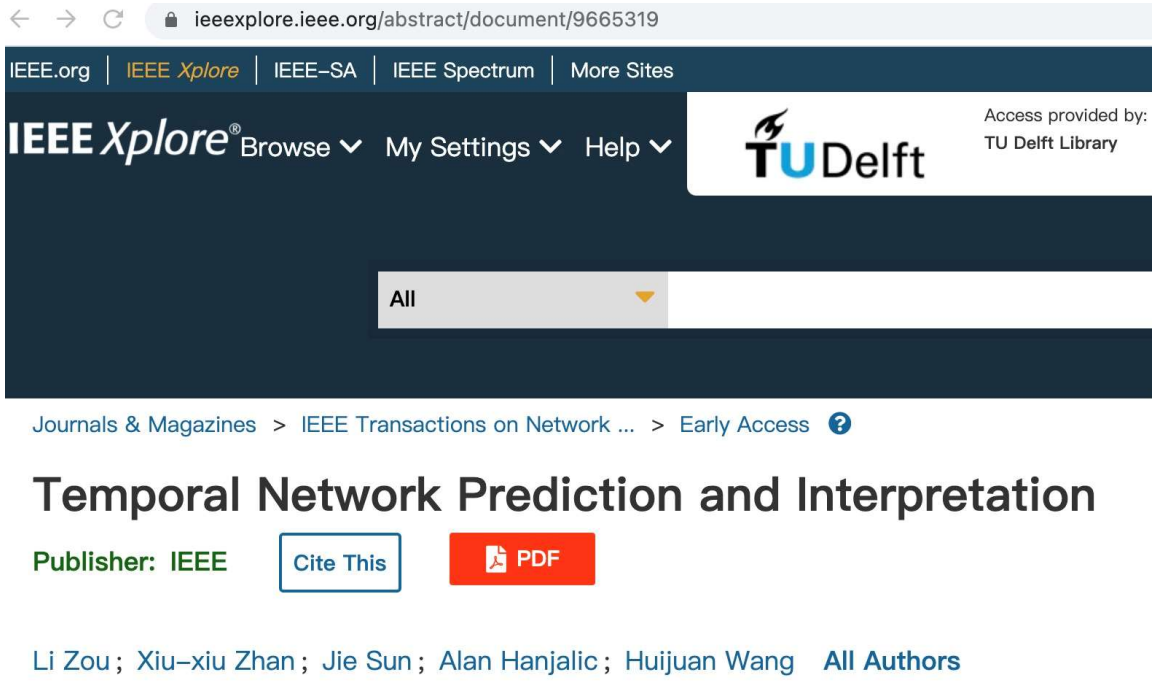
Link distance D_{ij}

Link cross-correlation R_{ij}



Conclusion

- A link's current state is largely determined by **its own activity**;
- A link's current state is also influenced by the activities of **other links**;
- Links tend to influence each other more if they have a **shortest paths** in the aggregated network ;
- Links tend to influence each other more if they are more strongly **correlated in their time series**;
- The **linear regression** assumed by Lasso could be one elementary mechanism to model temporal networks.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Li Zou ; Xiu-xiu Zhan ; Jie Sun ; Alan Hanjalic ; Huijuan Wang All Authors

Further works

Other works

- Long-term prediction for temporal networks
- The memory effect on temporal networks prediction

Next topics:

- Model temporal networks
- Epidemics spreading on temporal networks

TU Delft

Thanks