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Institute

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Are Spatial Graphs Causal DAGs ?

Causal modelling for mappers

London Data Week * GeoMob , July 2024

An aerial photograph of a city, likely New York City, showing a large body of water (Hudson River) on the right, a bridge (George Washington Bridge) in the distance, and a dense urban area with many high-rise buildings. The image is in black and white.

Who I am

- I model stuff.

- Urban planner turned Geographer .

Current work

■ Spatial Causal modeling .

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Urban Analytics Group,

Causal Inference Group.

Quantitative Spatial Science Group,

Center for Multilevel Modelling.



Dr. Levi John Wolf



Prof William Browne



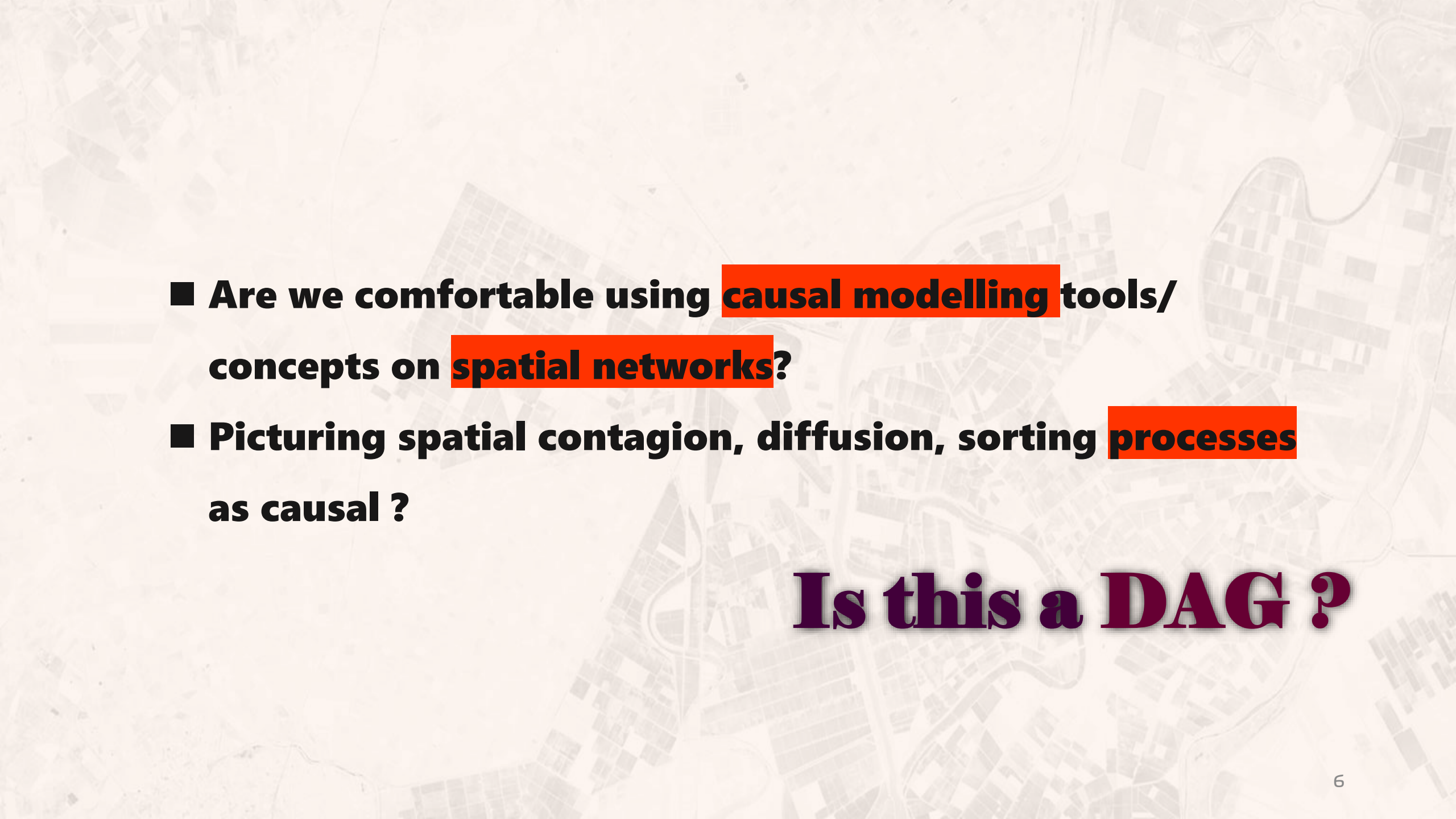
Prof. Emmanouil
Tranos

Types of spatial causal

- Statistical **causal inference** with geographic data.
- **Causal models** of geographical system/ process

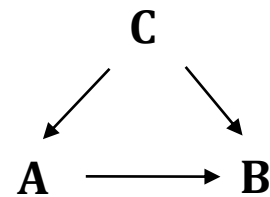
An aerial photograph of a suburban area with a grid-like street pattern, houses, and some green spaces. The image is faded and serves as a background for the text.

Is this a DAG ?

- 
- The background of the slide is a faded, grayscale aerial photograph of a city or town, showing a grid of streets and various building footprints. The image is slightly out of focus, serving as a textured backdrop for the text.
- Are we comfortable using **causal modelling** tools/ concepts on **spatial networks**?
 - Picturing spatial contagion, diffusion, sorting **processes** as causal ?

Is this a DAG ?

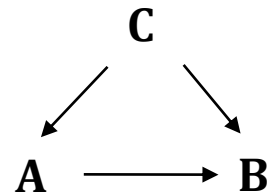
■ **Is this a DAG?**



Directed Acyclic Graph.
Represent a structural
causal relationship,
between the variables.

Has generalised forms.

■ Is this a DAG?

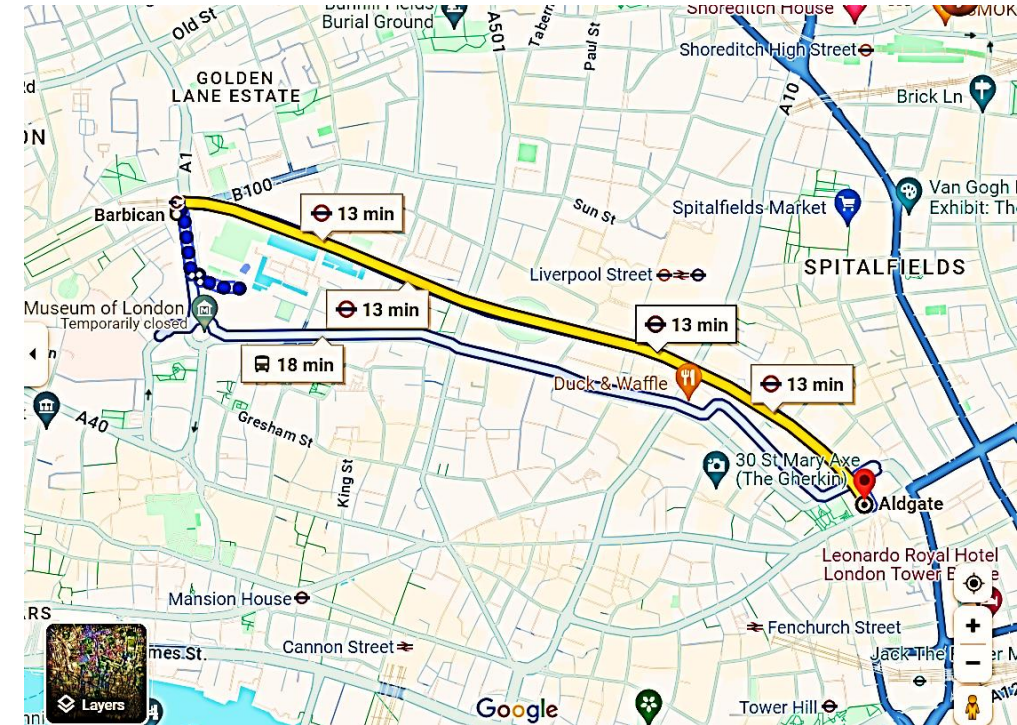
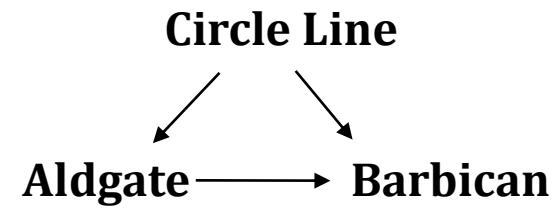


Strictly speaking, today we are talking about **causal diagrams, as maps of causal impact**

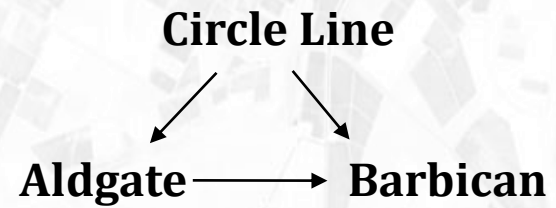
...

What happens when it coincides with **maps of places**.

■ Is this a DAG?



■ Is this a DAG?

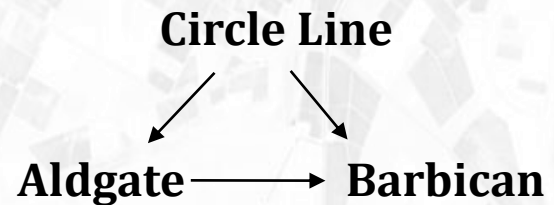


NO?

**Spatial Confounding,
Interference,
Endogeneity,**

...

■ **Is this a DAG?**



NO?

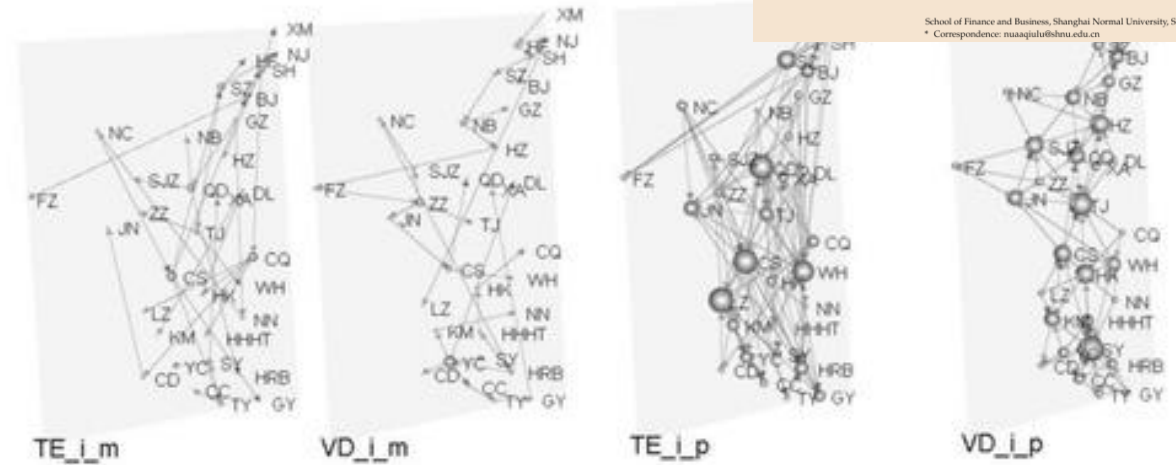
**Spatial Confounding,
Interference,
Endogeneity,**

...

Yes?

**Inevitable when we try to
pin variables to locations.**

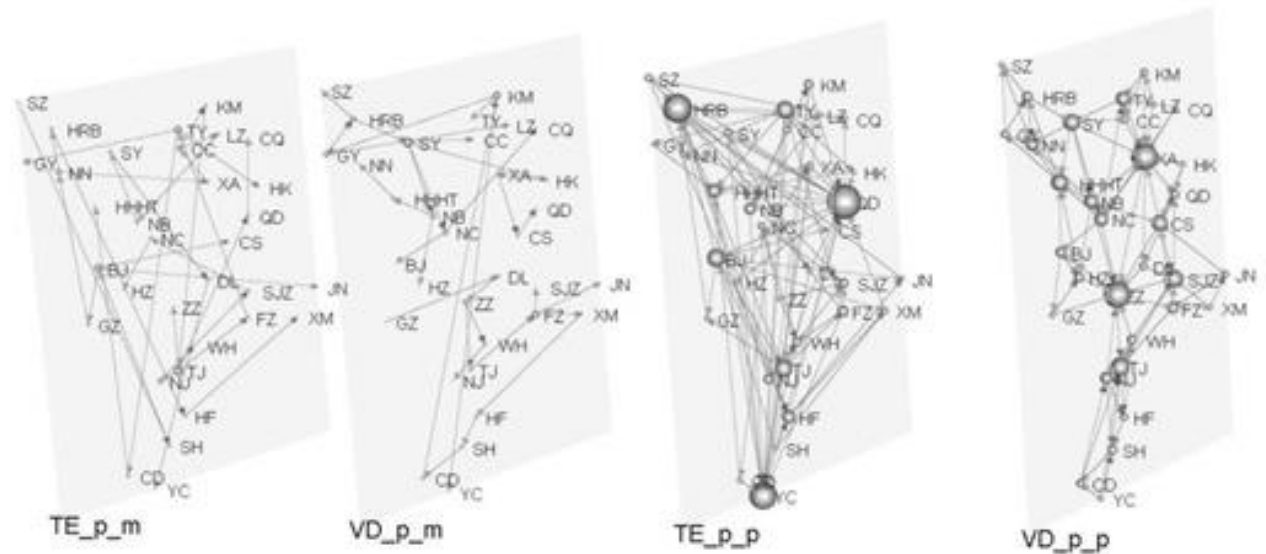
**e.g. for econ/ geographic
networks, earth systems etc.**



(a)

■ Is this a DAG?

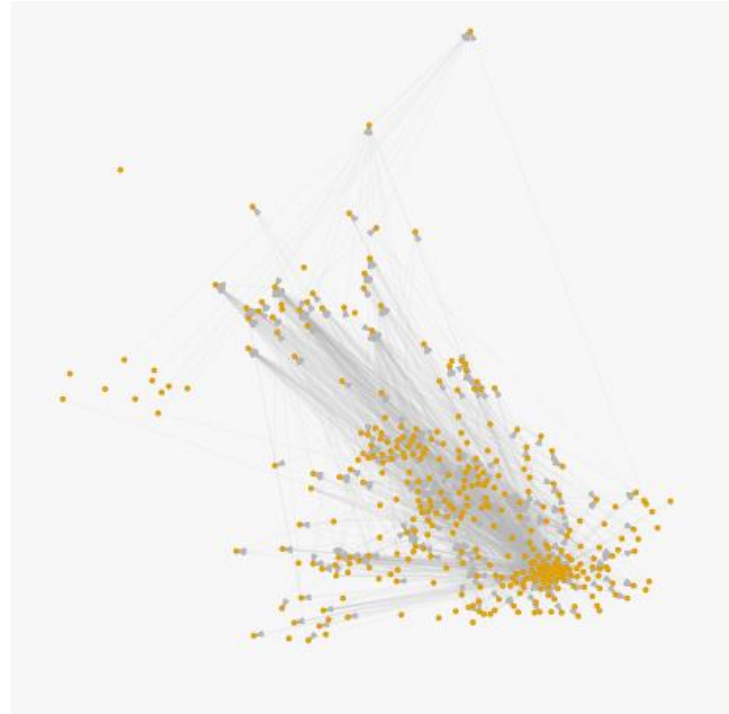
Housing markets.



(b)

■ **Is this a DAG?**
Housing markets.

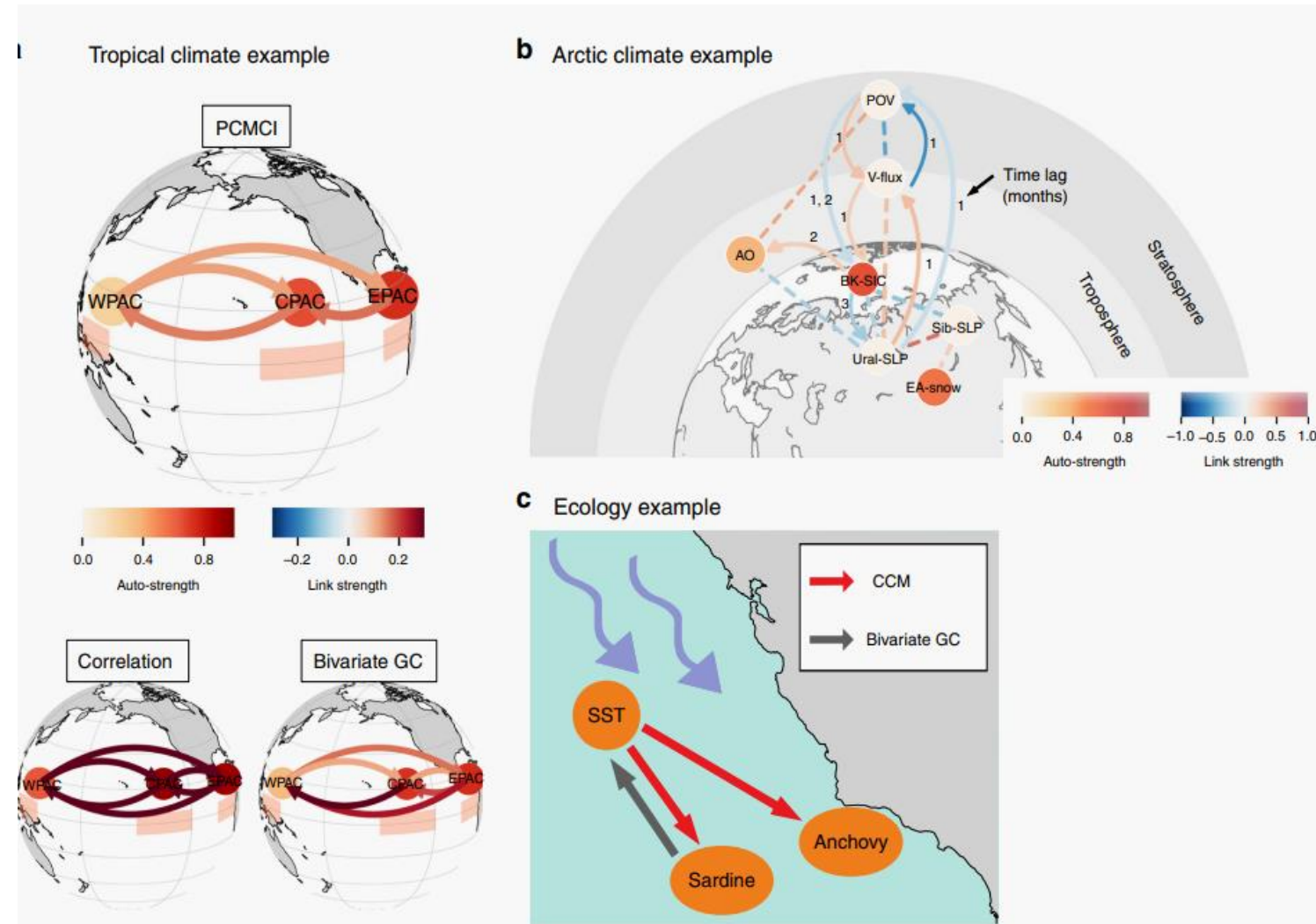
From my own ongoing research.



Inferring causation from time series in Earth system sciences

Jakob Runge^{1,2}, Sebastian Bathiany^{3,4}, Erik Bollt⁵, Gustau Camps-Valls⁶

■ Is this a DAG? Earth systems.



Causal inference from cross-sectional earth system data with geographical convergent cross mapping

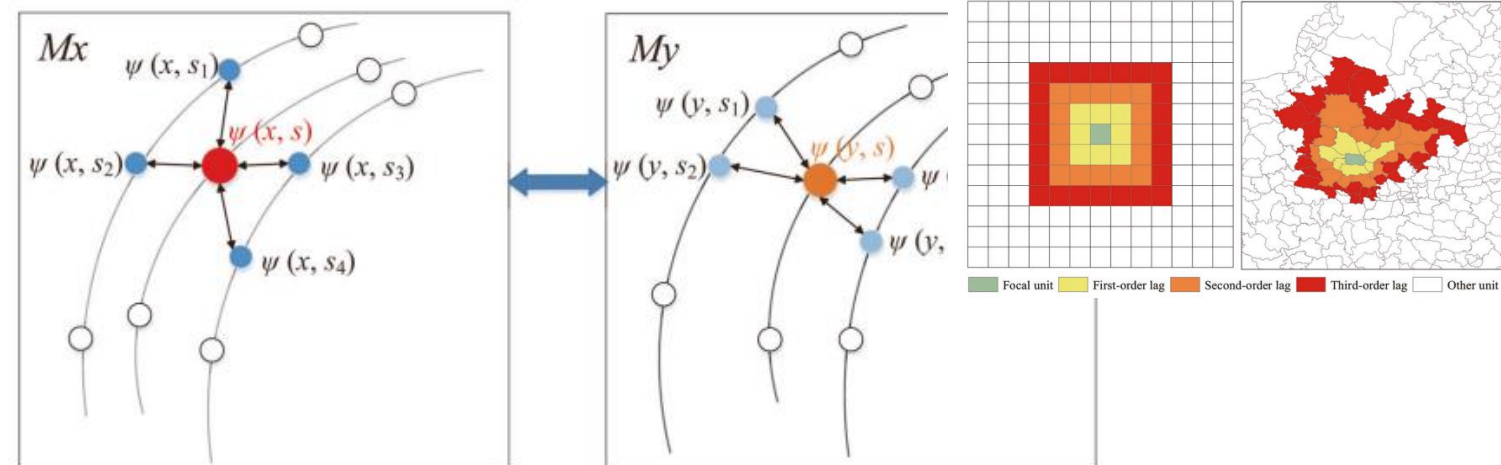
Received: 9 January 2023

Bingbo Gao^{1,2,10}, Jianyu Yang^{1,2,10}, Ziyue Chen³, George Sugihara⁴,

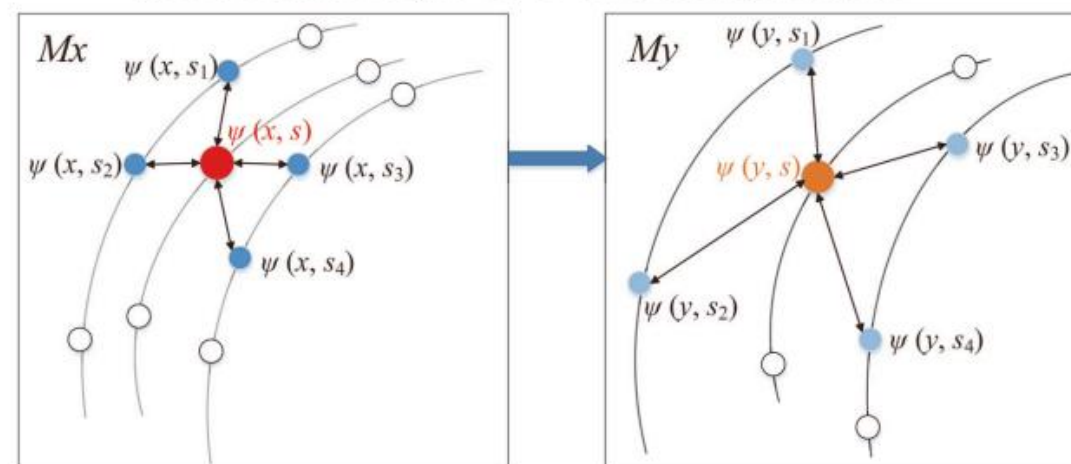
Accepted: 11 September 2023

Manchun Li⁵, Alfred Stein⁶, Mei-Po Kwan^{7,8} & Jinfeng Wang⁹✉

a. The mutual neighbors of reliable prediction

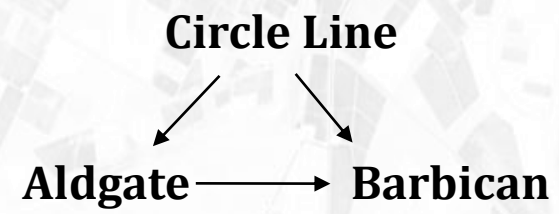


b. The mutual neighbors of unreliable prediction



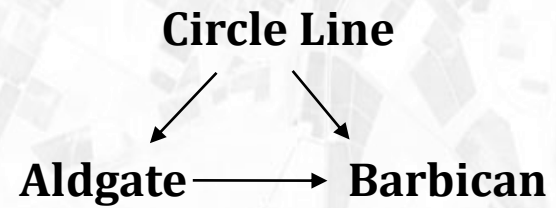
■ Is this a DAG?
Earth systems.

■ **Is this a DAG?**



(Dynamic) Geographic structures.

■ Is this a DAG?



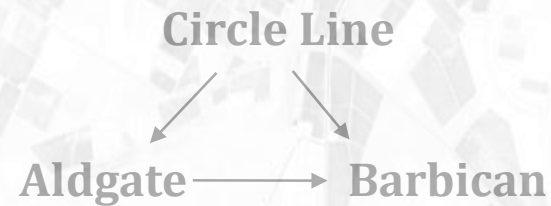
Structures of causal
dependence.

How do we define/measure which is which?

(Dynamic) Geographic structures.

- Statistical causal inference for geographic data.
- Causal models of geographical processes.

■ Is this a DAG?



Structures of causal
dependence.

How do we define/measure which is which?

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Working on:
Spatial Causal Modeling



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