The Issue of Directionality on Mapping Station Points Data in Space and Time

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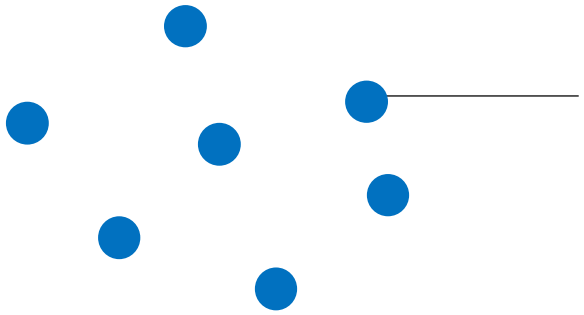
Spatial Points



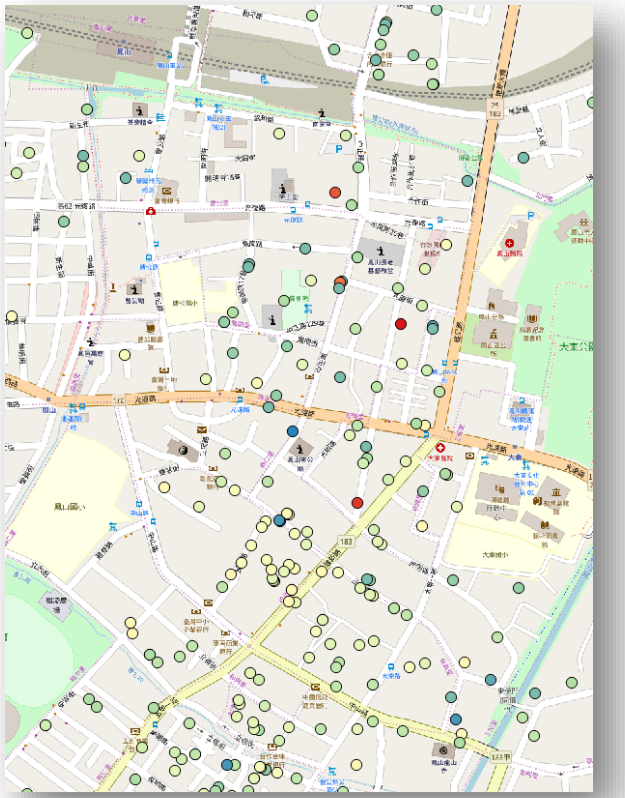
spatial information + attribute information

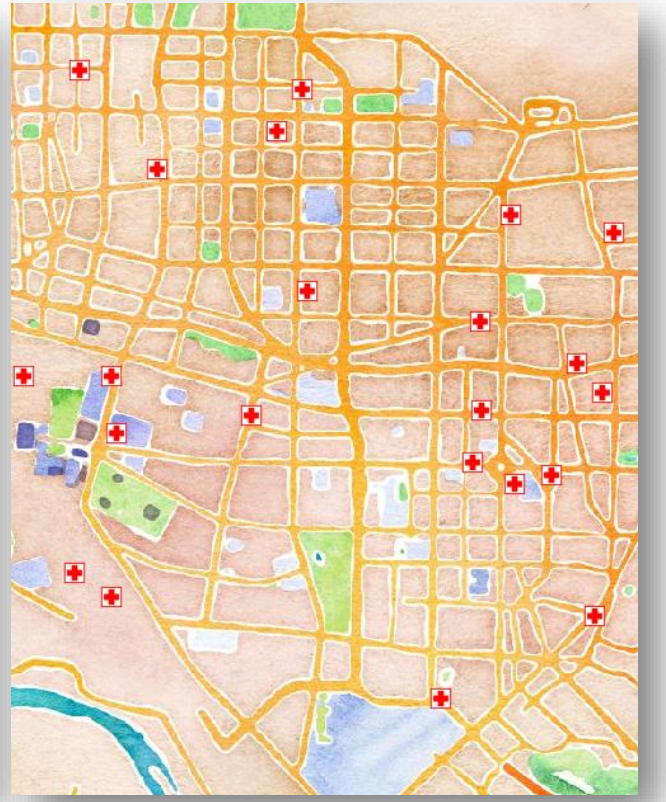
location value

Types of Spatial Points

Event Points

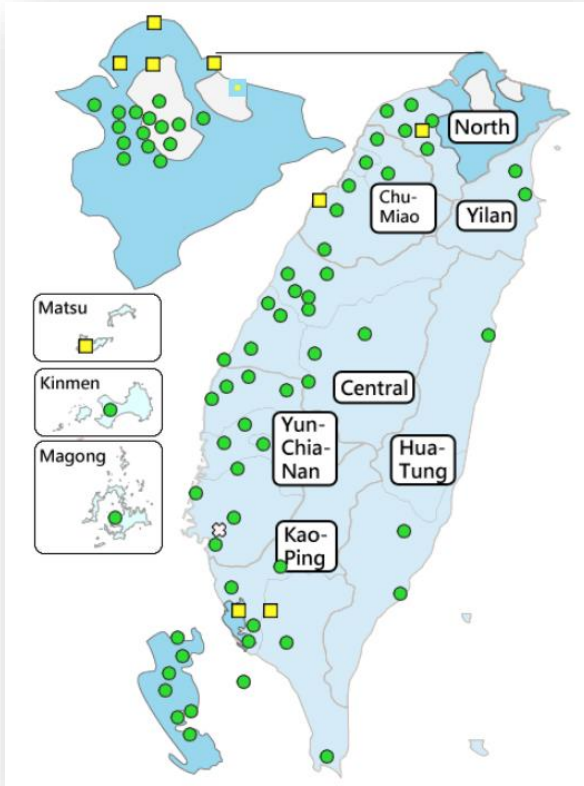
Where events happen?



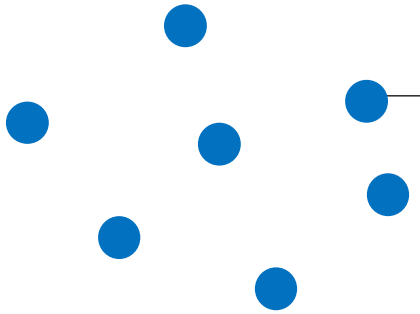


Station Points

What's the observed value?



Spatial Points

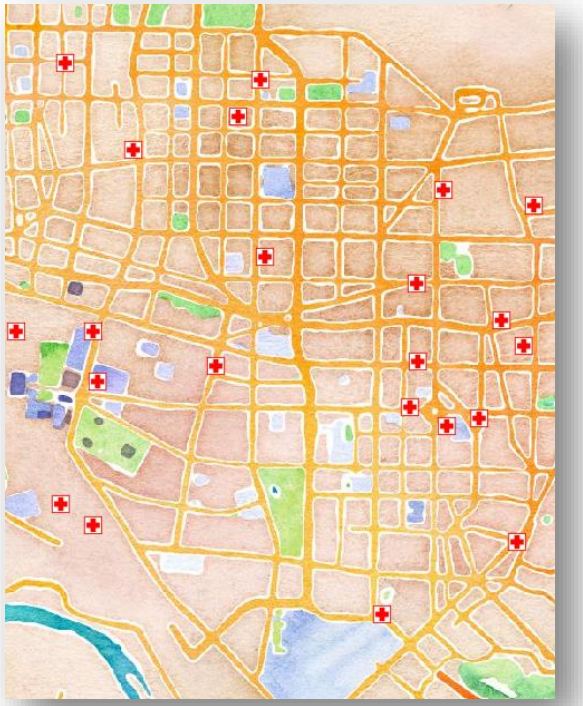


spatial information + attribute information

location value

Event Points locations where events take place

Station Points values of a phenomenon

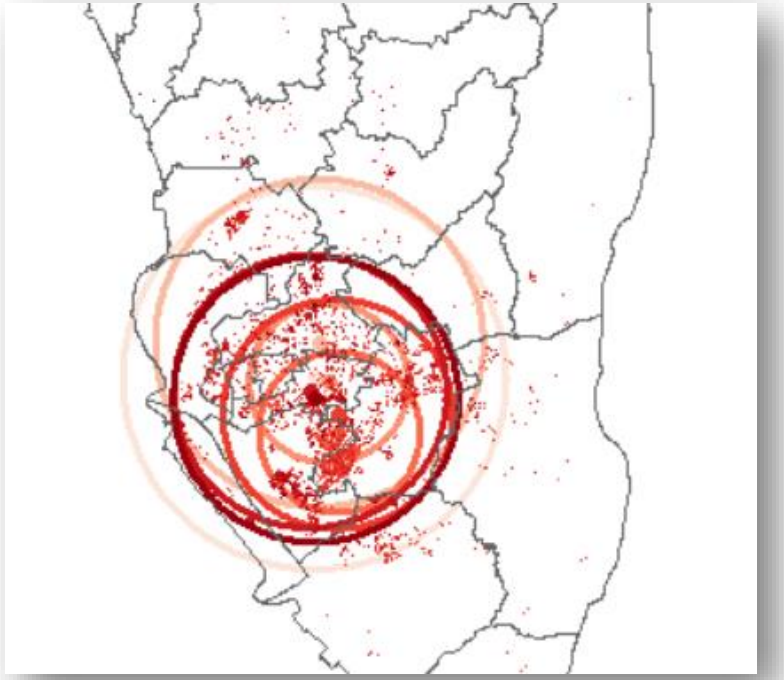


Points and Time

Event Points

new points occur

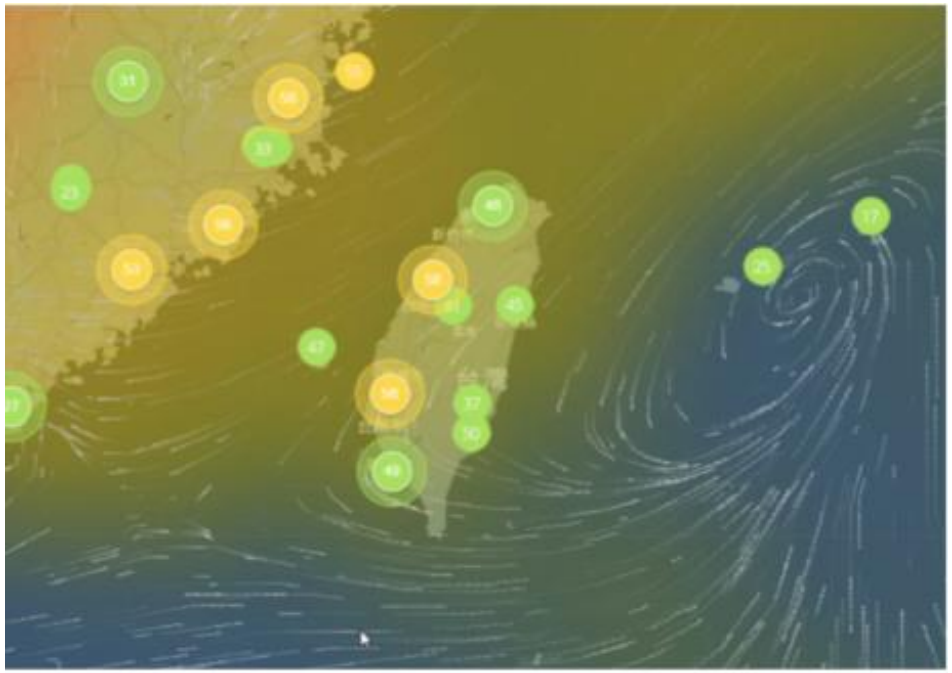
e.g., spread of disease, urban expansion



Station Points

value changes

e.g., air pollution, rainfall



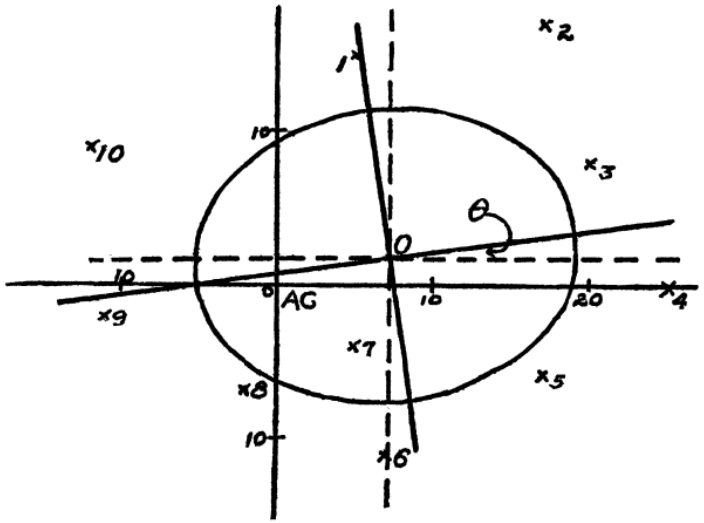
points → detect the direction

Analysis of Event Points

Centrality & Dispersion

Lefever (1926)

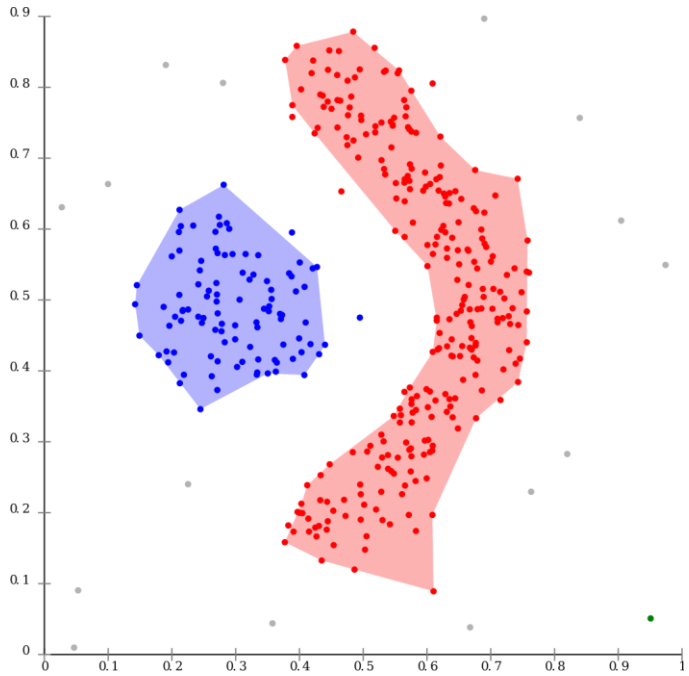
Standard Deviational Ellipse



Cluster

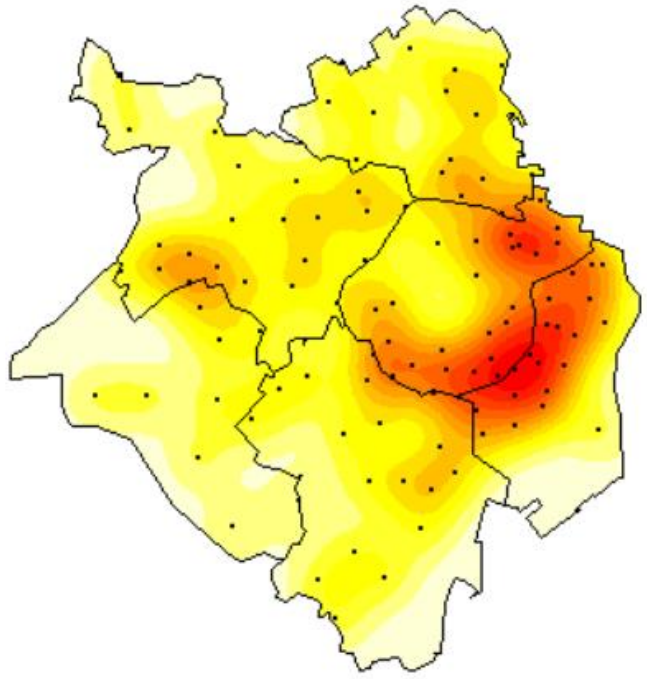
Ester et al. (1995)

DBSCAN



Kelsall and Diggle (1995)

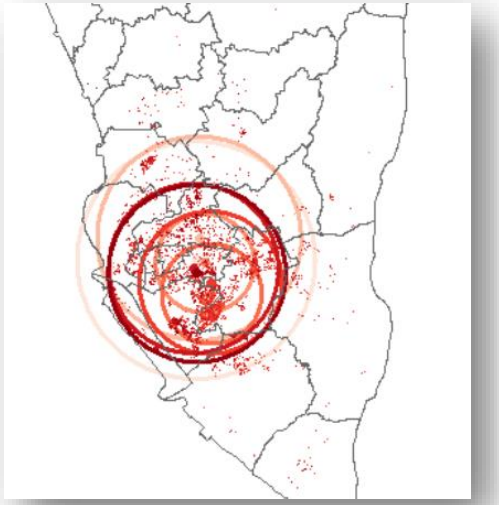
KDE



Analysis of Event Points + Time

Trend

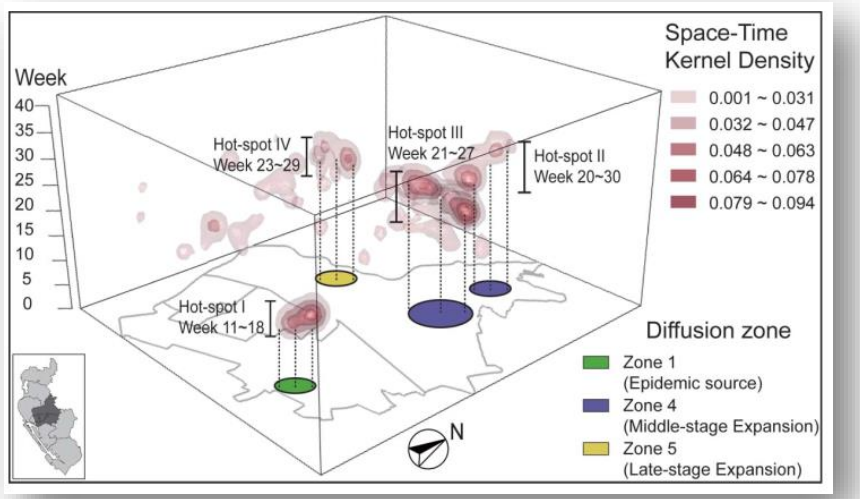
Visualization



Diffusion

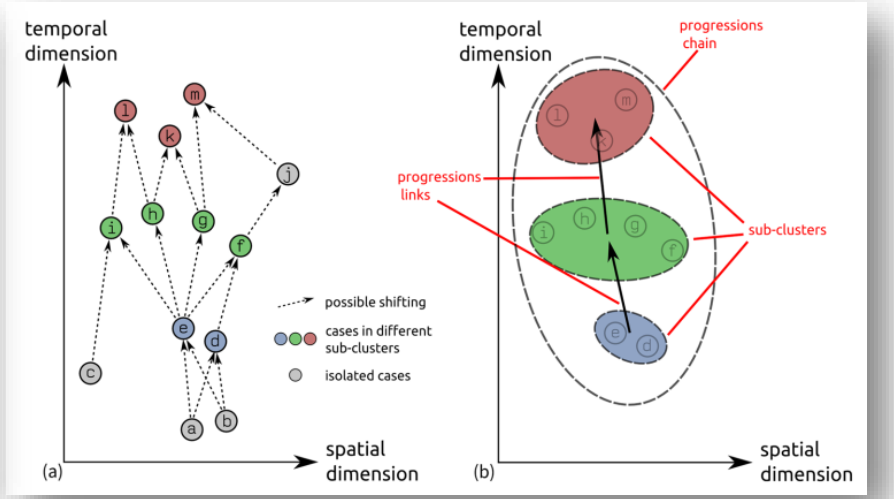
Kuo, Wen,& Sabel (2018)

MST-DBSCAN



Chin et al. (2017)

TaPiTaS

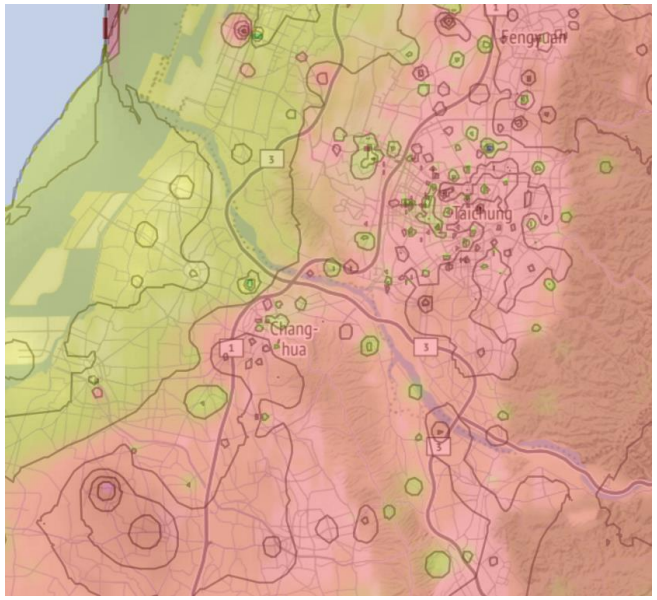


event points with space-time information → direction of movement

Analysis of Station Points: Spatial Interpolation

IDW
(Inverse Distance Weighting)

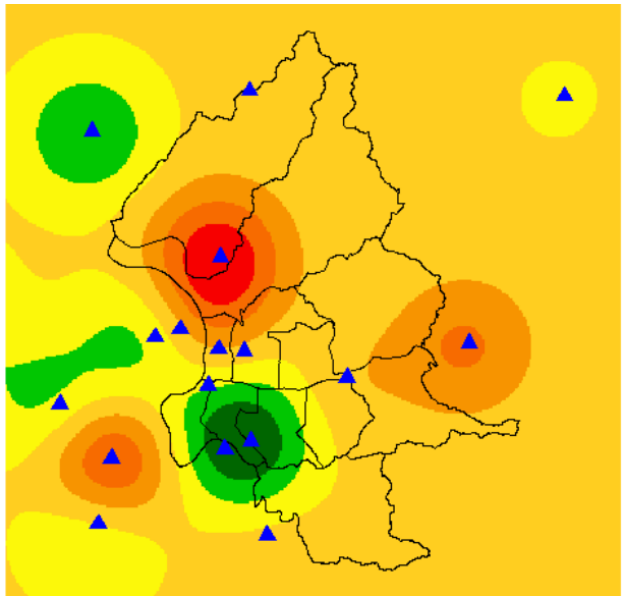
deterministic estimation

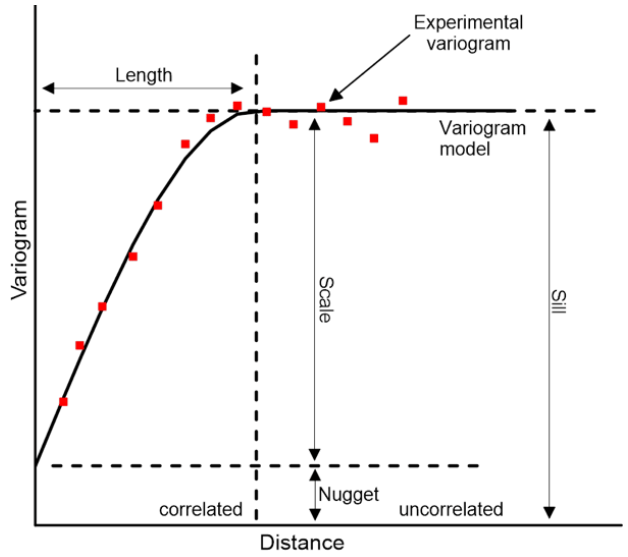


weighted average,
greater weight for closer points

Kriging

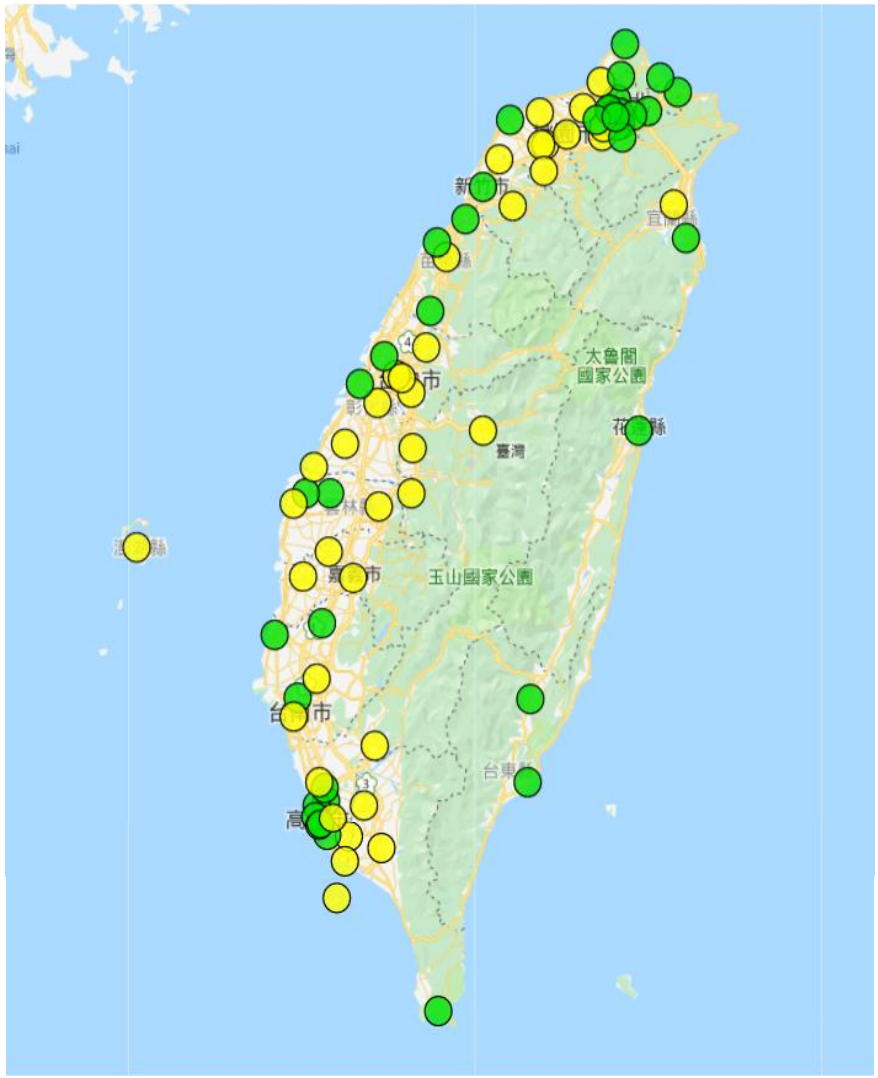
stochastic estimation





geostatistics method based on a **variogram model**

Direction of Station Points?



Values of station points are also affected by directional factors

Find out the underlying structure of trend ?

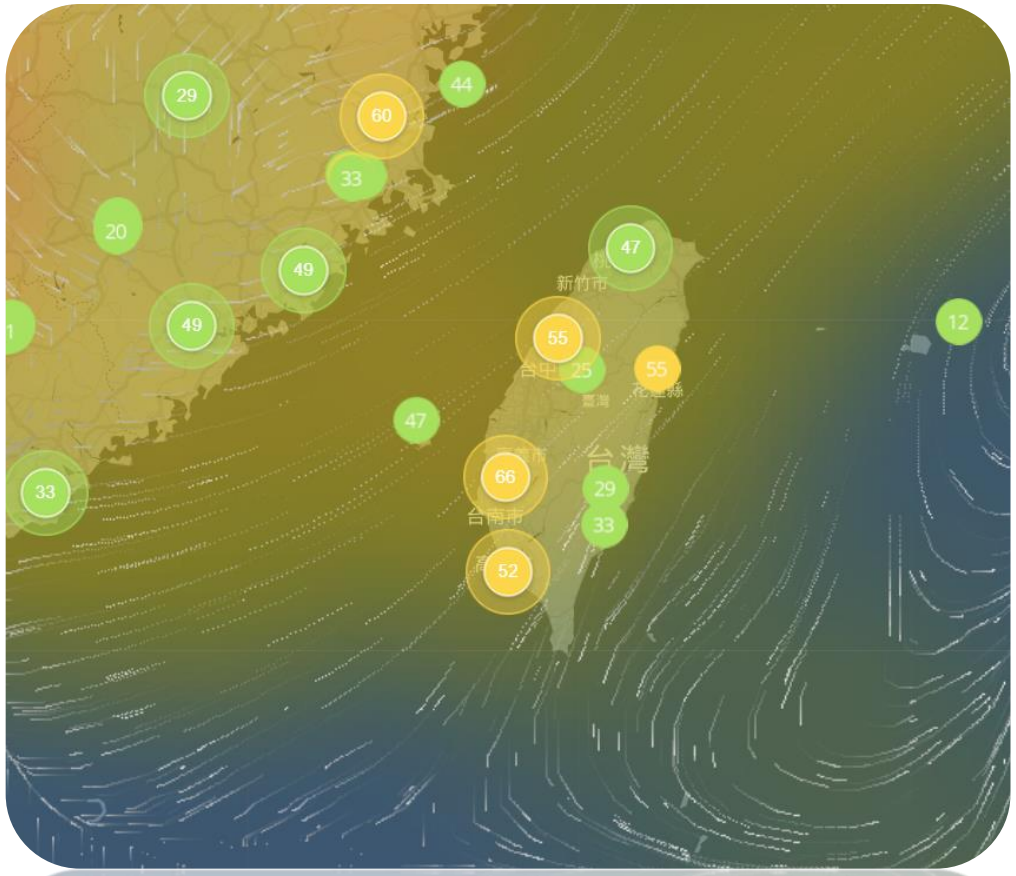
⚠ positions of station points are fixed

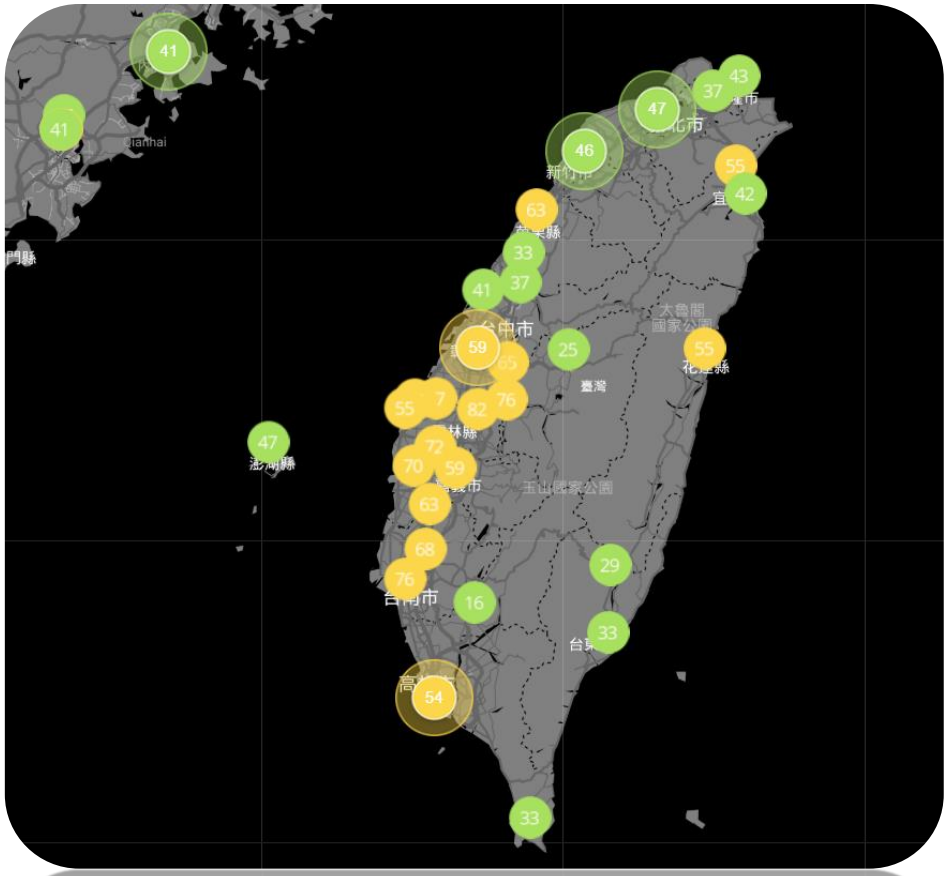
⚠ method for event points can't be applied

→ need other methods
to capture directionality

Capture Directionality

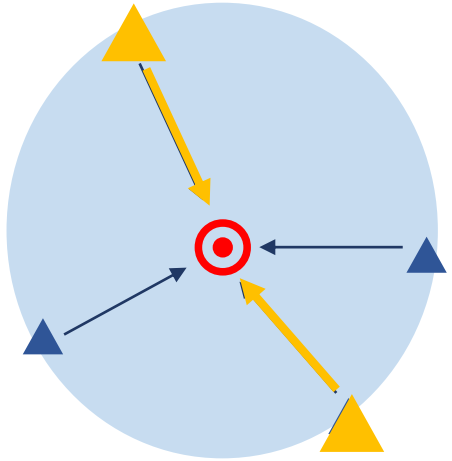
✓ Capture directionality from **station points**





Direction & Spatial Interpolation

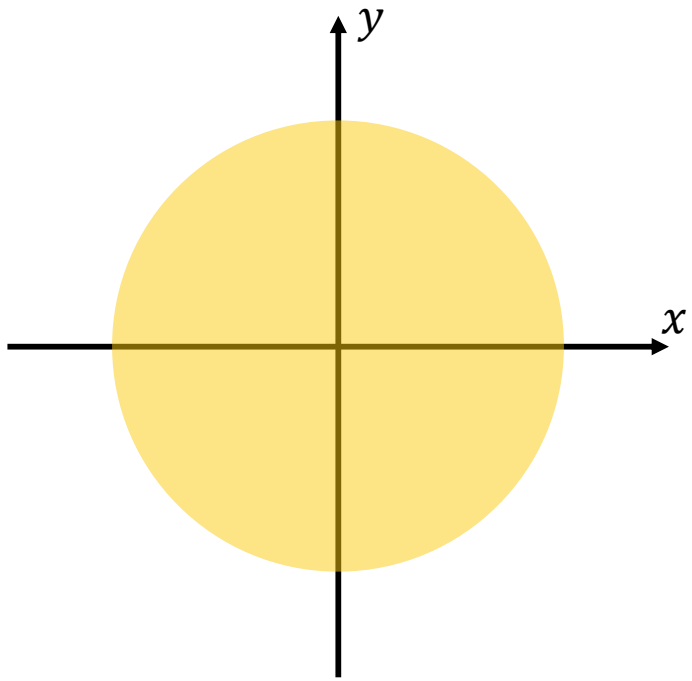
Why is it important to detect directionality ?



Anisotropy

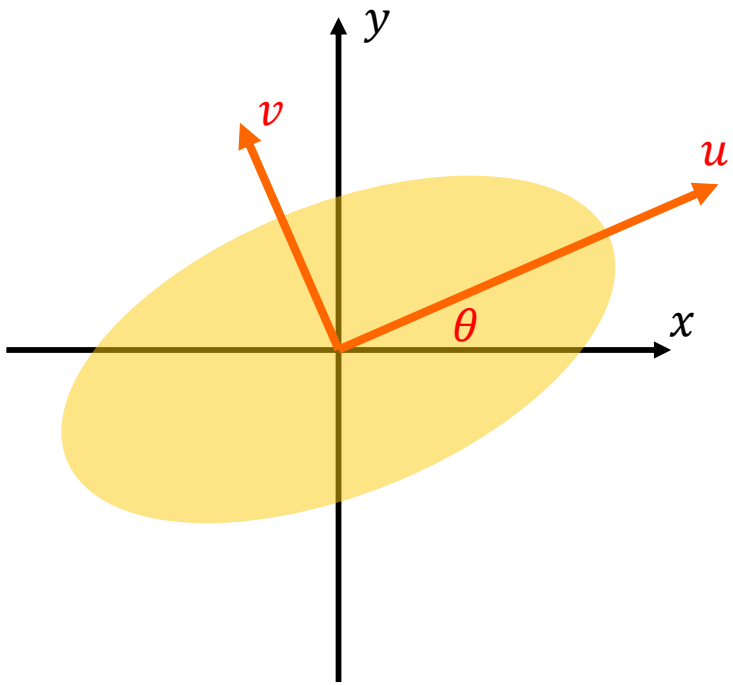
different direction → different affect

isotropy



related to distance only

anisotropy



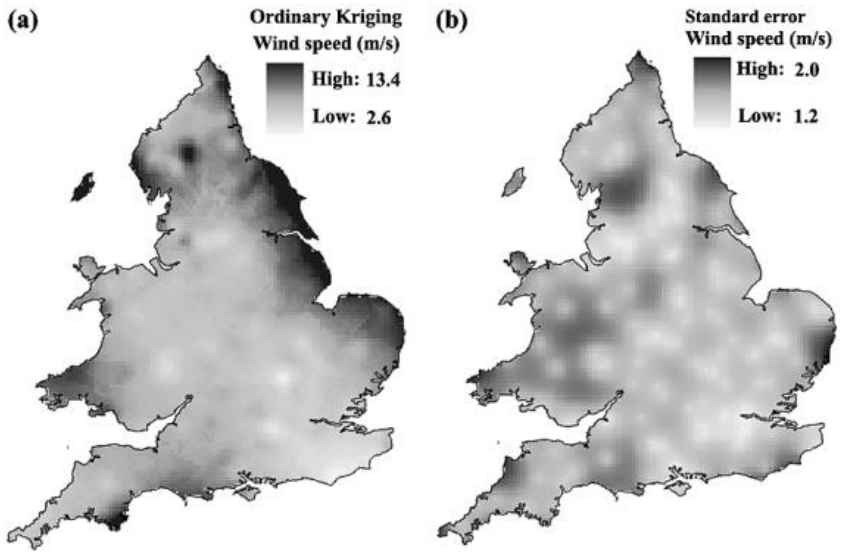
related to distance, angle of rotation,
weighted ratio of long and short axes

Anisotropy Kriging

Luo, Taylor, & Parker (2008)

wind speed

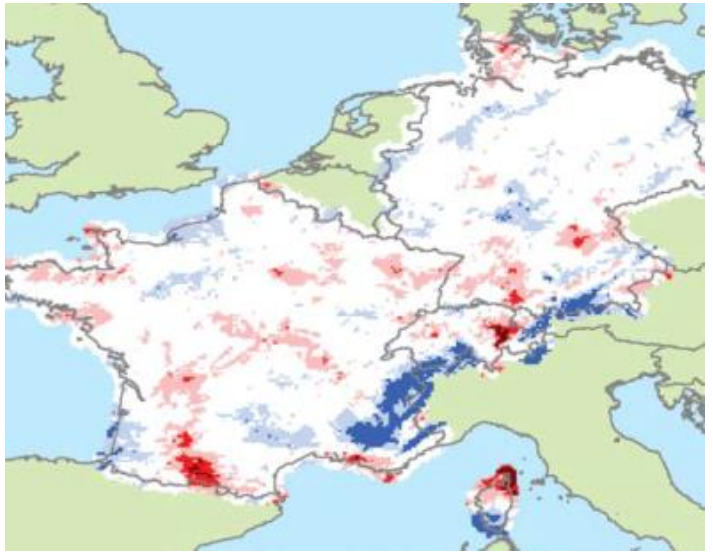
comparison of spatial interpolation methods



Friedland et al. (2016)

wind speed

comparison of isotropy & anisotropy OK



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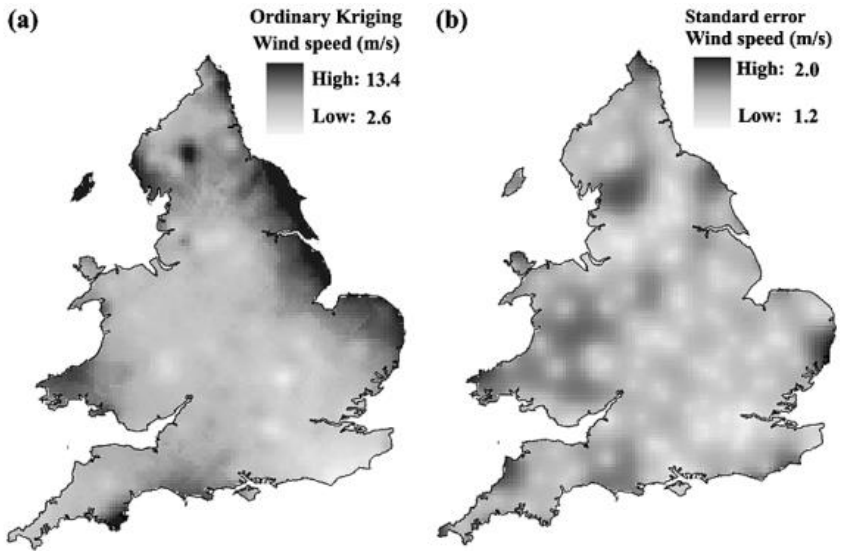

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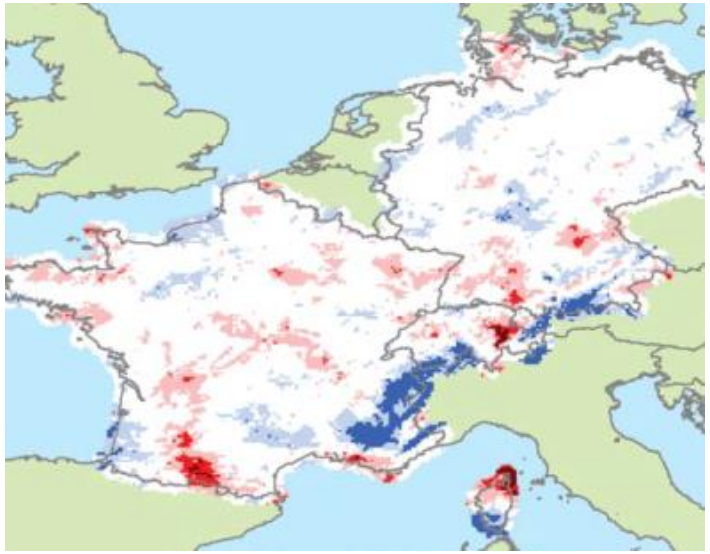
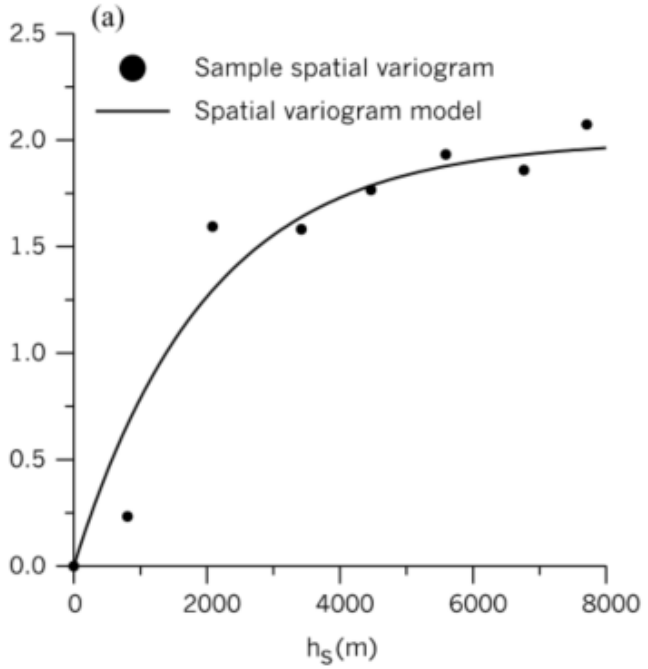


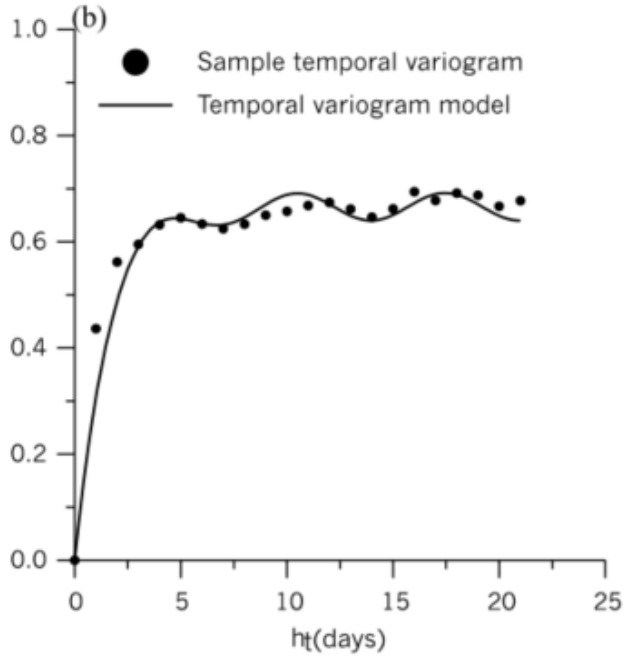
⚠ one direction for the entire study area

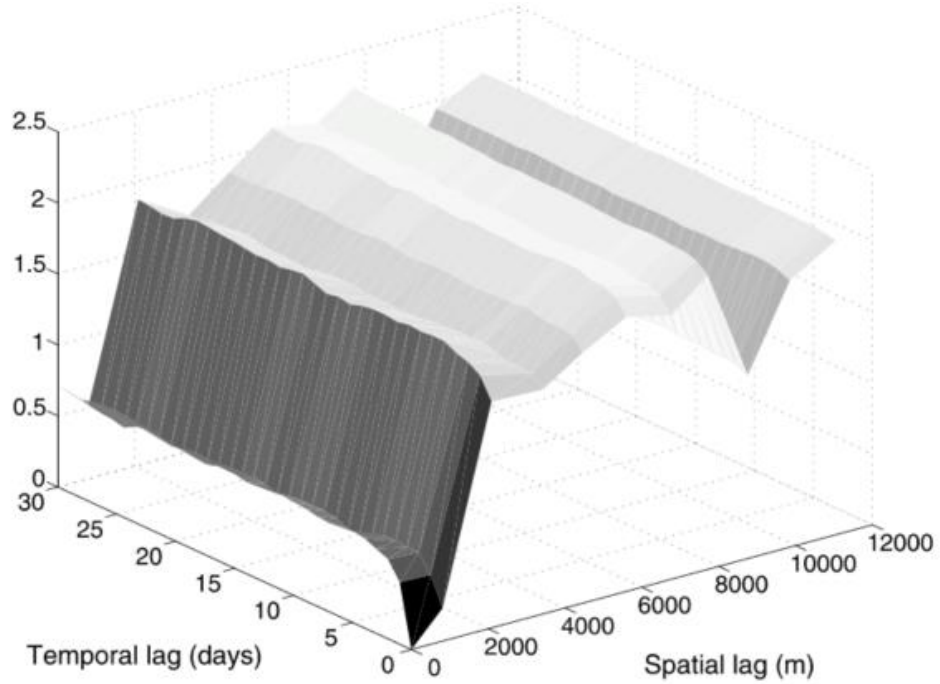
Space-Time Kriging

De Iaco, Myers, & Posa (2002)

space-time Kriging

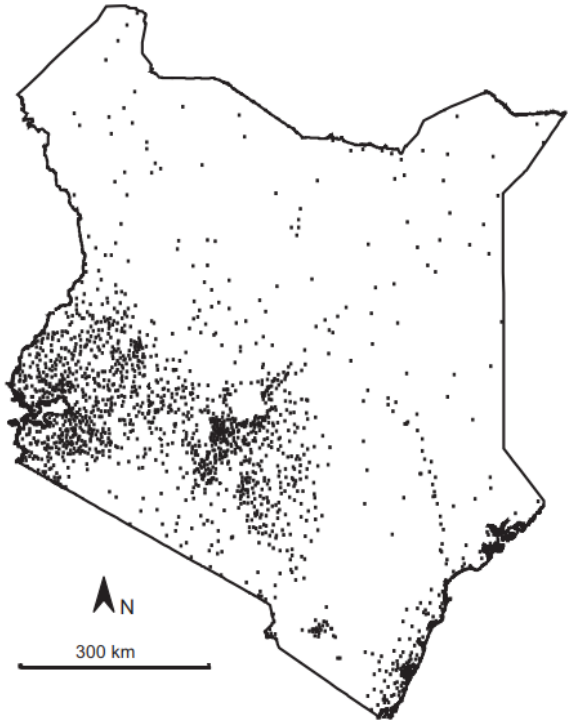




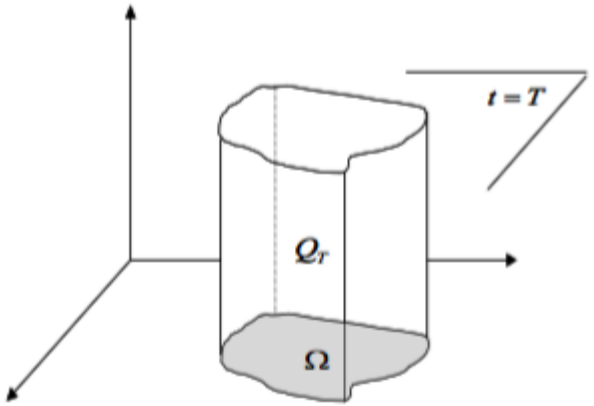


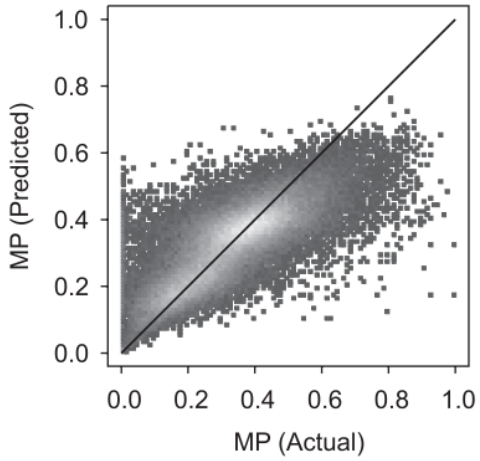
Heterogeneity in Space-Time Kriging

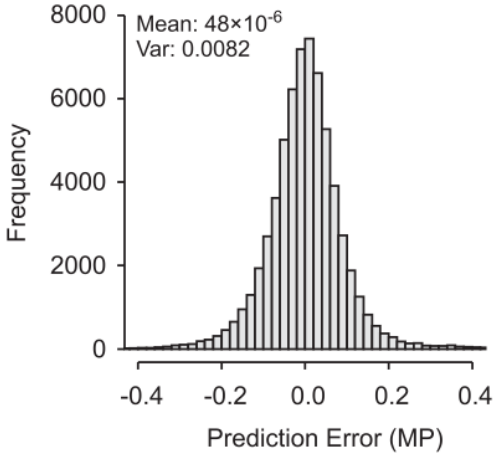
Gething et al. (2007)
local space-time kriging



✓ neighbor







Local space-time ordinary kriging

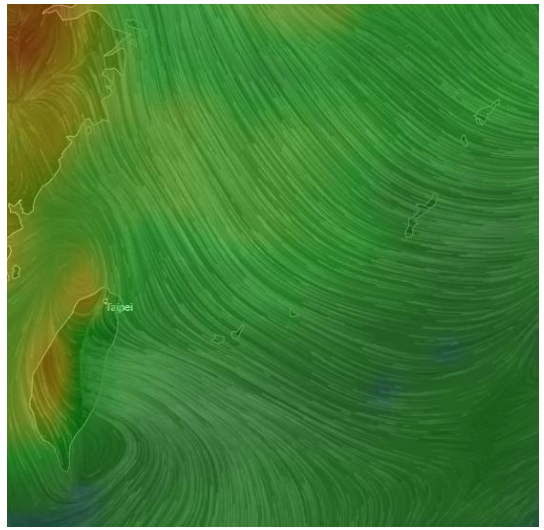
Problem

Space-Time Data

- Time-series data is needed to capture the direction of movement
- spatio-temporal data

Heterogeneity of Anisotropy

- Direction and weighting of anisotropy would be different in space and time
- Spatio-temporal heterogeneity of anisotropy



Heterogeneity of Anisotropy

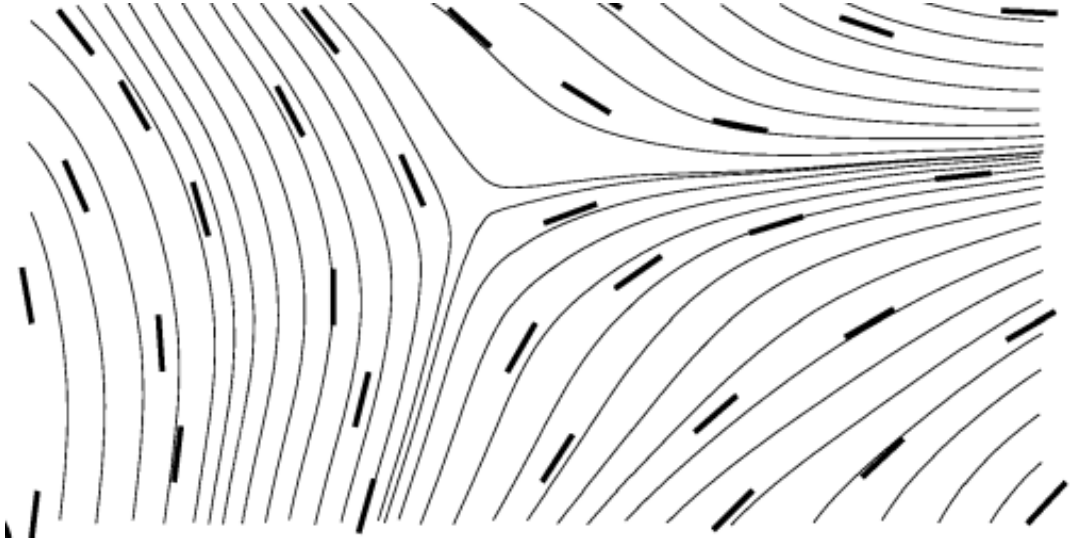
- In past studies, the heterogeneity of directionality has not been solved
- Incorporate the concept of spatio-temporal heterogeneity

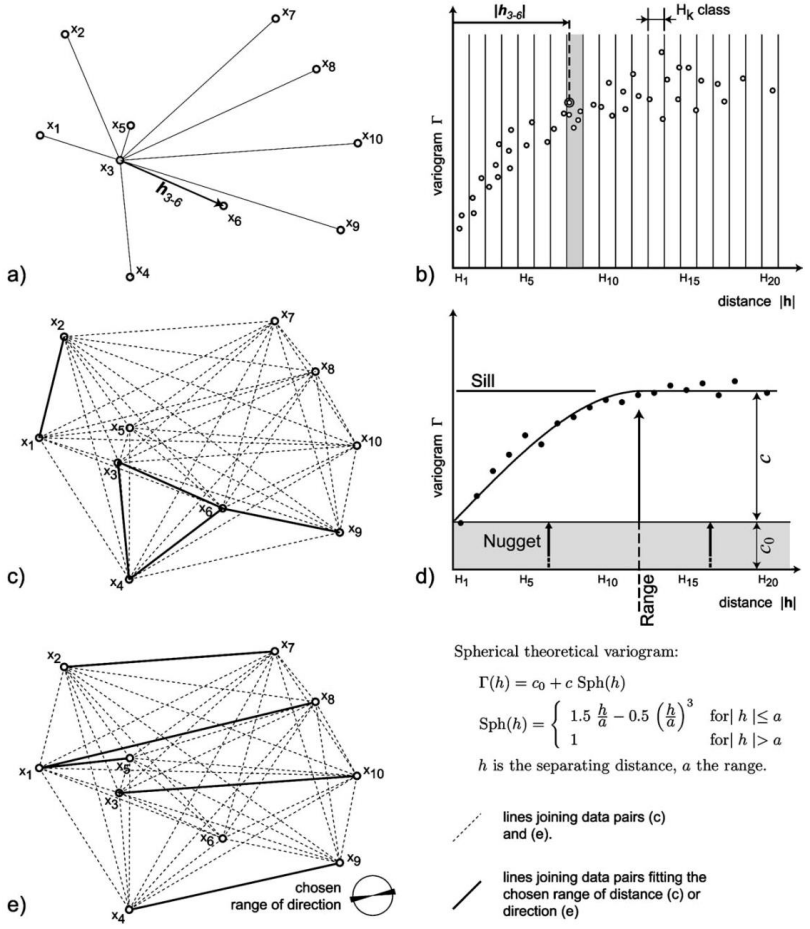
- Find the direction and weighting at each station
- Detect the temporal change of the underlying structure regarding directional factors

Direction Interpolation

Gumiaux, Gapais, & Brun (2003)

interpolation of orientation data





Conclusion

- Observed values of station points are affected by directional factors
- Difficult to understand the background structure regarding directional factors
- To capture underlying directional structure from station points ……

Space-Time Data

Heterogeneity of Anisotropy

Direction Interpolation

Anisotropic Map

Thanks for listening !