Dynamical Markov Modules

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Netsci 2018 – Paris

Algorithms

Louvain

Algorithms

SBM

Louvain

DCSBM

Algorithms

SBM

WalkTrap

Louvain

InfoMap

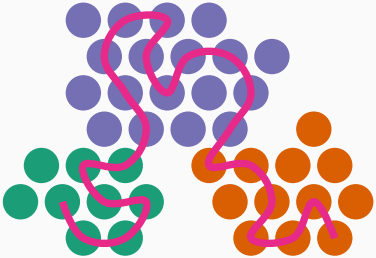
Stability

DCSBM

Projected Markov Chain

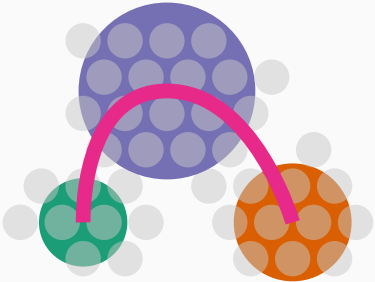
Markov Chain

$$\ldots, x_{\text{past}}, x_{\text{now}}, x_{\text{future}}, \ldots$$



Projection

$$\ldots, Y_{\text{past}}, Y_{\text{now}}, Y_{\text{future}}, \ldots$$

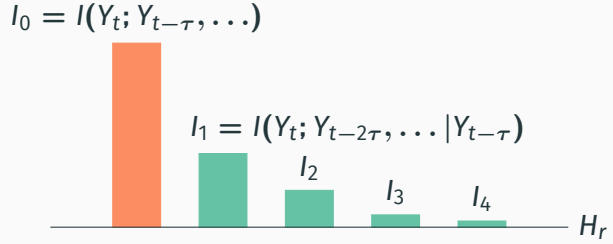


Complexity

Complexity

Memories

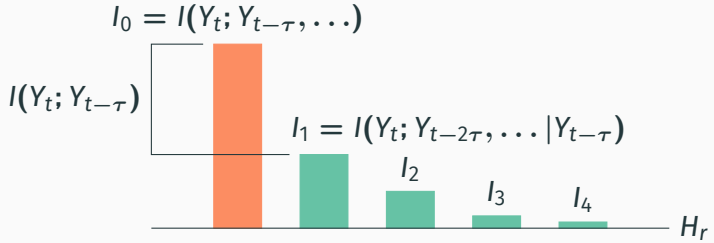
Entrogram



where $I(X;Y) = H(X) - H(X|Y)$ is the Mutual Information

M.F. et al, Journal of Complex Networks, cnx055

Entrogram



where $I(X;Y) = H(X) - H(X|Y)$ is the Mutual Information

M.F. et al, Journal of Complex Networks, cnx055

Ingredients

$$I(Y_t; Y_{t-\tau}) - \alpha H(Y_t)$$

$I(\cdot;\cdot)$: Mutual Information (Markovianity of the projection)

τ : Parameter (timescale selection)

$H(\cdot)$: Entropy (increases with the number of partitions)

α : Parameter (model selection)

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$$I(Y_t; Y_{t-\tau}) - \alpha H(Y_t)$$

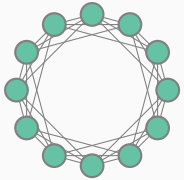
- $I(\cdot;\cdot)$: Mutual Information (Markovianity of the projection)
- τ : Parameter (timescale selection)
- $H(\cdot)$: Entropy (increases with the number of partitions)
- α : Parameter (model selection)

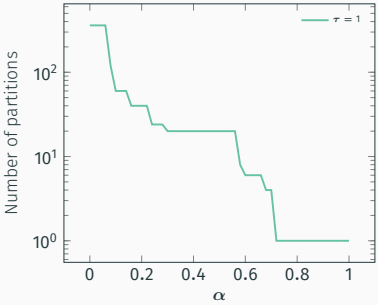
$$I(Y_t; Y_{t-\tau}) \propto -\sum_{rs} e_{rs} \log \frac{e_{rs}}{e_r e_s}$$ †

† in some cases

Examples

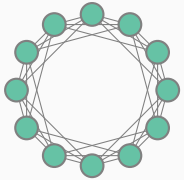
Example 0: One cycle

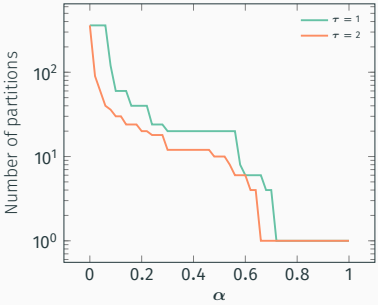




360 nodes, degree = 36

Example 0: One cycle





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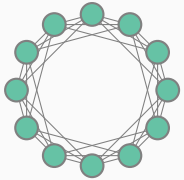

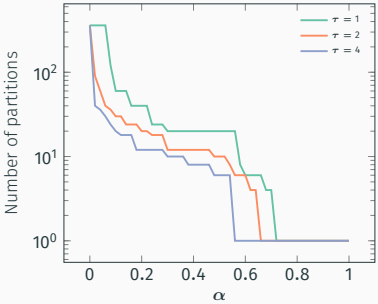

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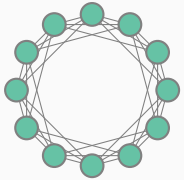

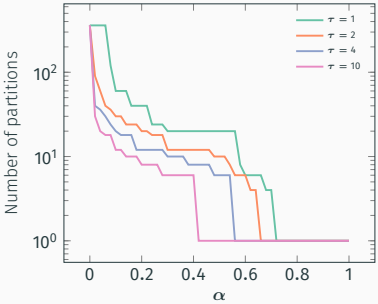

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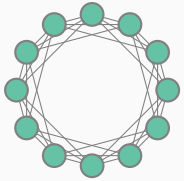

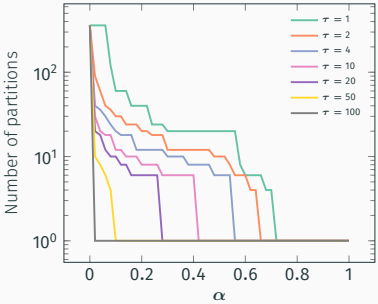

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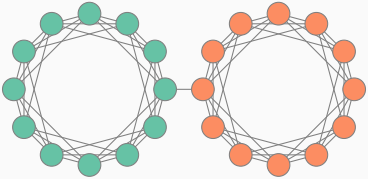
Example 1. Two cycles



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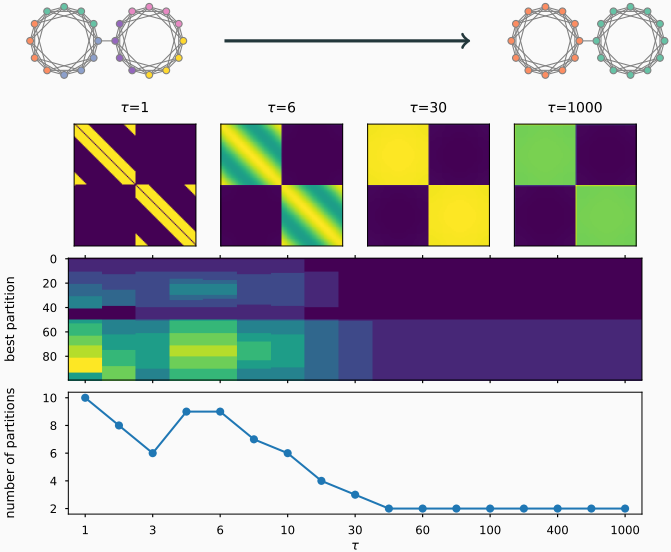
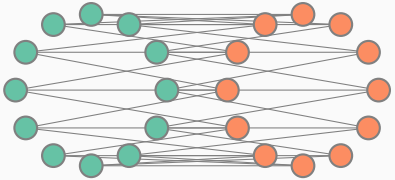
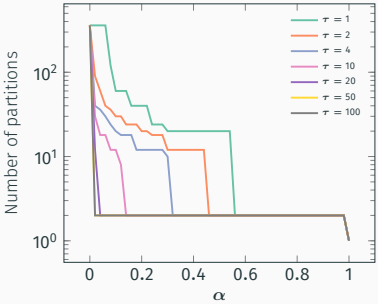


Example 2: More cycles





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Example 3. Ocean buoys

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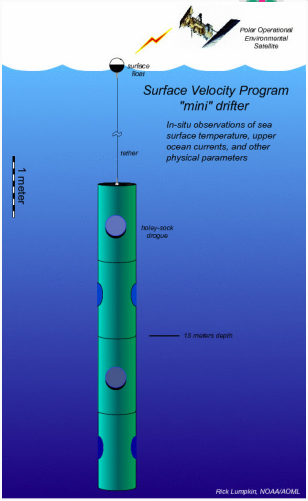
VOS Crew Deploy Next Generation SVP Drifter
Photo by: GDP



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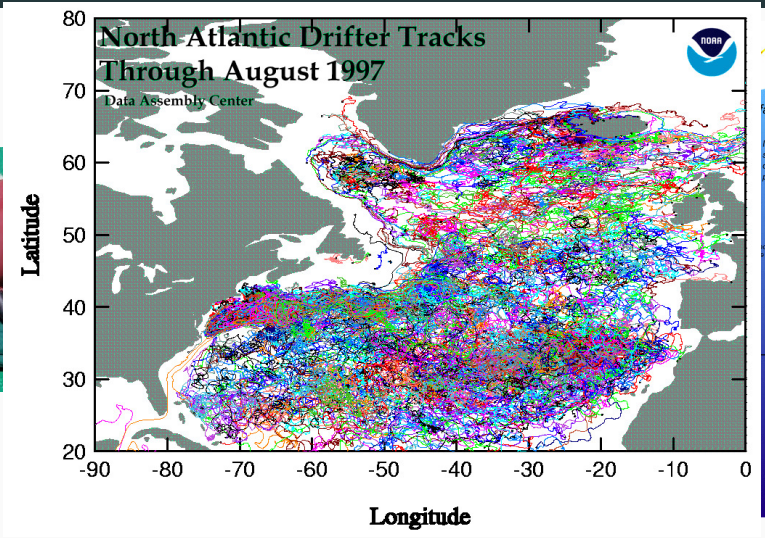
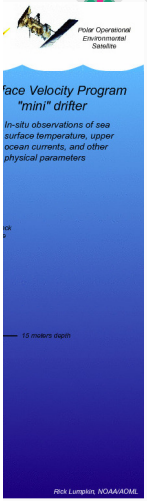
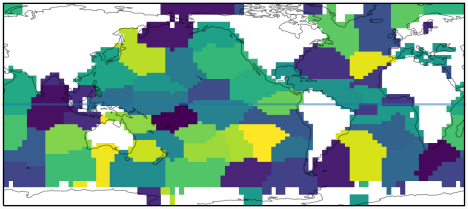




Example 3. Ocean buoys

$\tau = 1$ day



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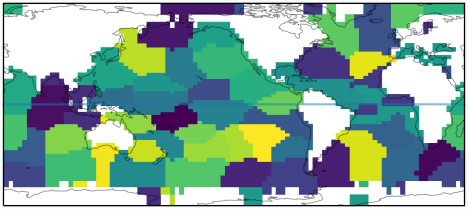
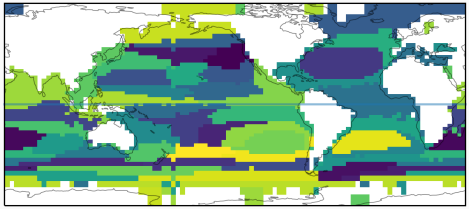


$\tau = 700$ days



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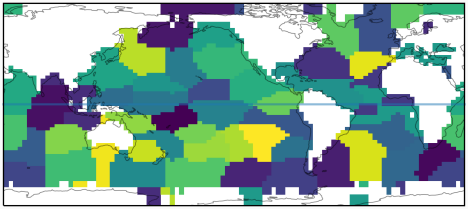

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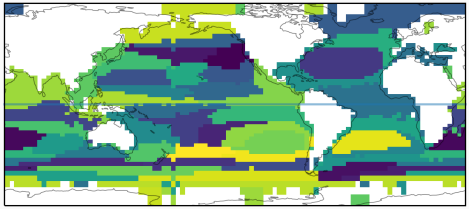

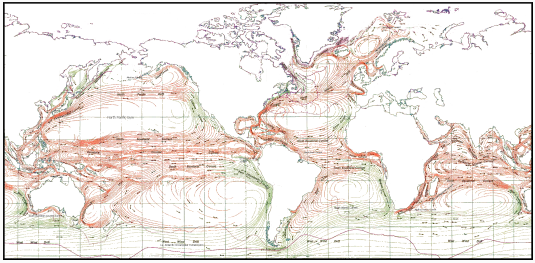

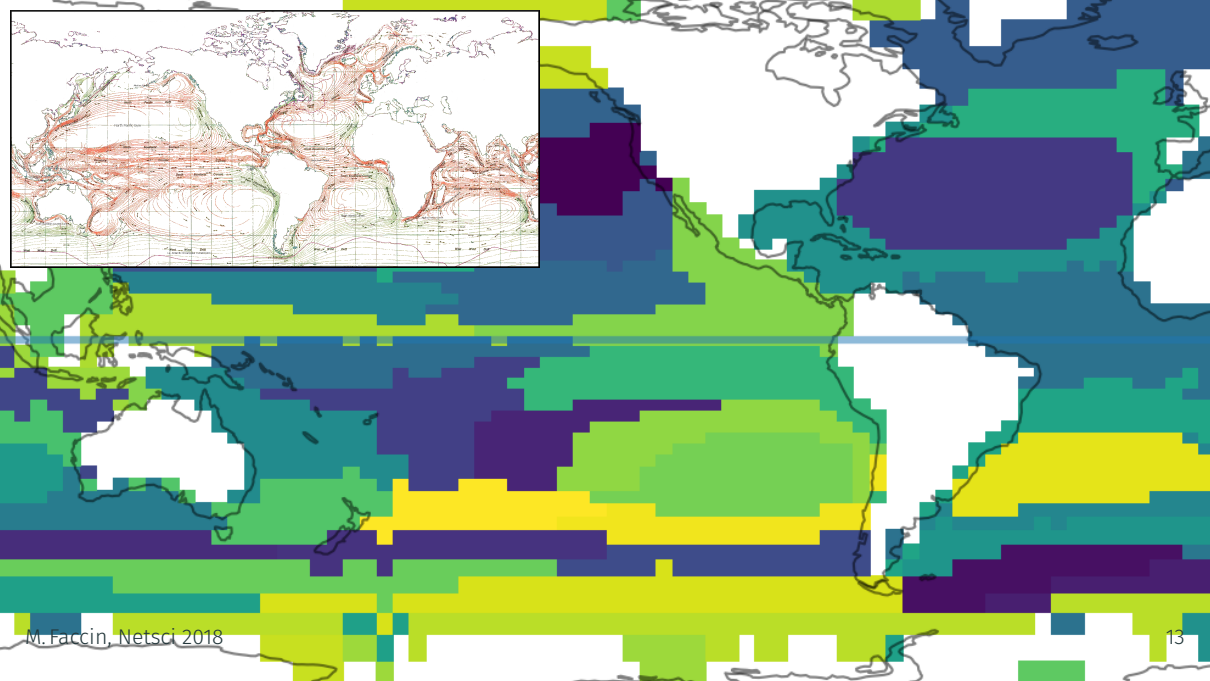

Concluding

- A information theoretical algorithm for block detection
- As a plus: same base as (DC)SBM
- Weighted networks and non-networks (only trajectories)
- Importance of time-scales (controlled by τ)

Questions?

FIG. 172.—FRANKLIN'S CHART OF THE GULF STREAM.

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