Comparison of the Italian and Swedish cattle trade networks

COMPARISON OF THE ITALIAN AND SWEDISH CATTLE TRADE NETWORKS

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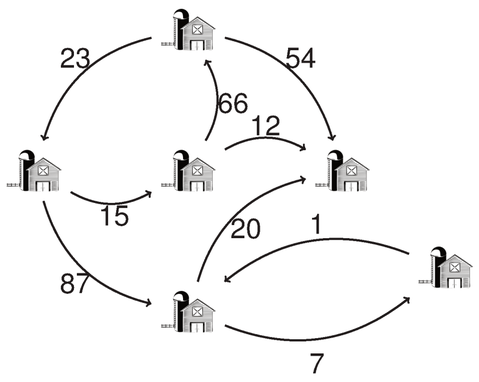
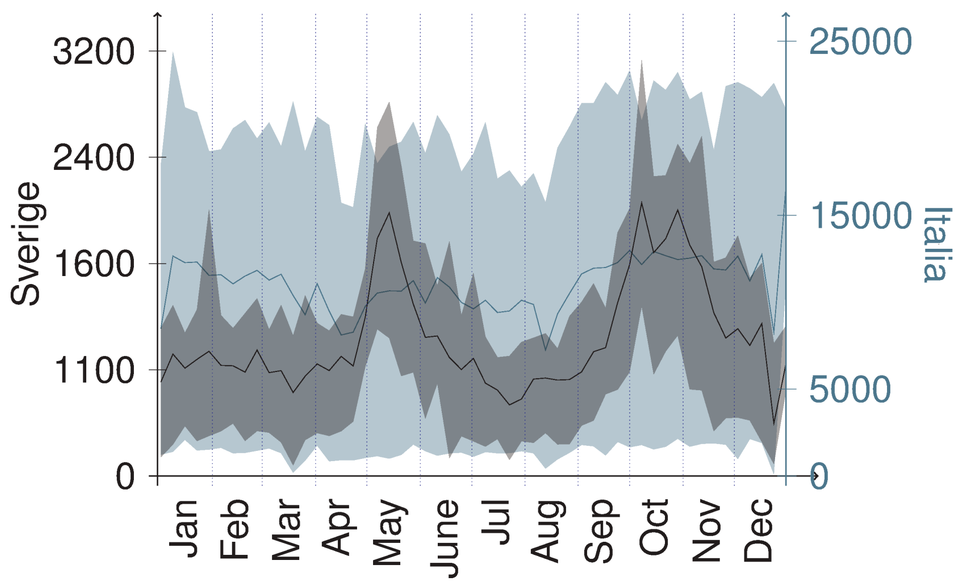
Introduction



# holdings	$1.7 \cdot 10^5$	$2.5 \cdot 10^4$
# batches	$1.7 \cdot 10^6$	$1.7 \cdot 10^5$
# displacements	$6.1 \cdot 10^6$	$8.1 \cdot 10^5$

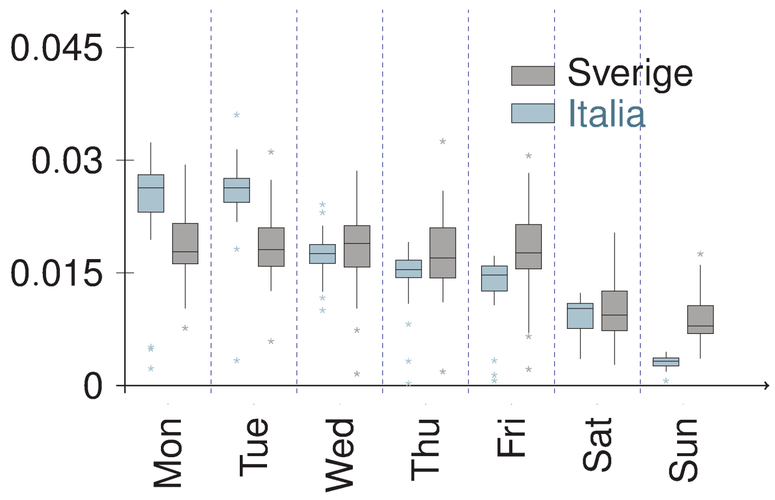
- daily networks of cattle trade movements
- cattle movements are mean of dissemination of infectious diseases (among others Foot-and-Mouth, BVD, TB, etc.)
- understand cattle movements could help in depict the infection risk and to arrange control measure

Mean, min, and max of number of animals moved, $\Delta t = 7$



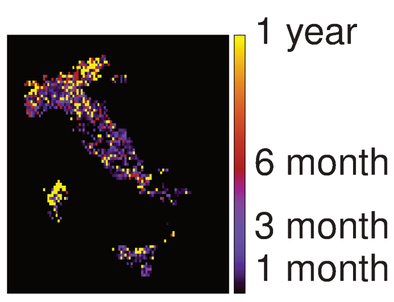
- Italy system is stable in time
- Sweden system shows two peak in spring and fall

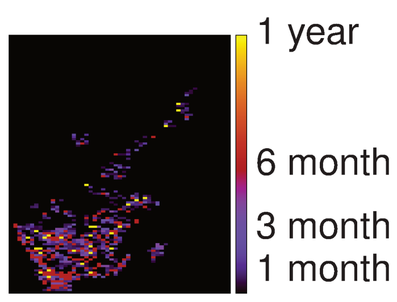
Fraction of farm activity for different week days



- no notable difference among activities in weekdays in Sweden
- Italy seems to have a decreasing activity in weekdays. An artifact of the data reporting or a real feature?

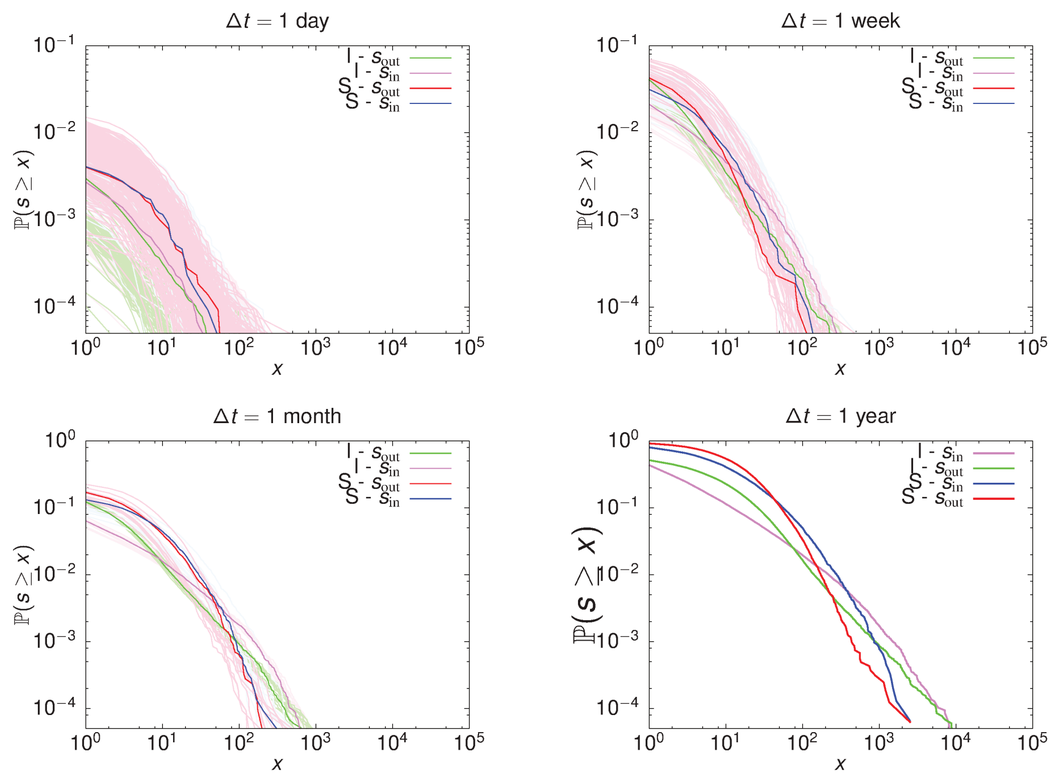
Period of the dominant FFT of the movement temporal series





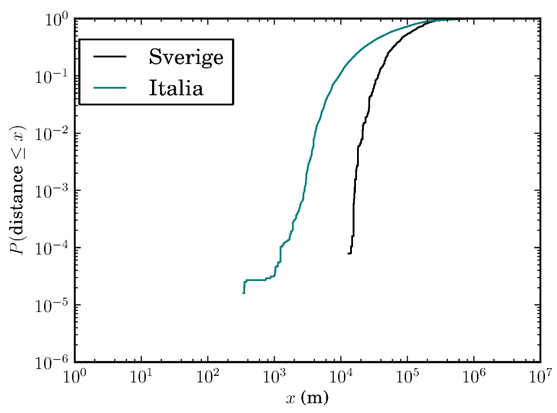
- in Italy the Alpine arc is distinguishable from other region, having an annual dominant period
- overall, in Sweden, the signal has a shorter dominant period

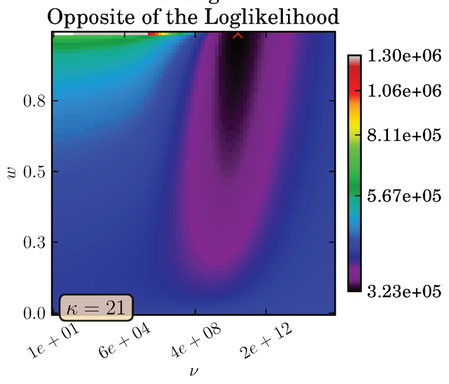
Strength distribution



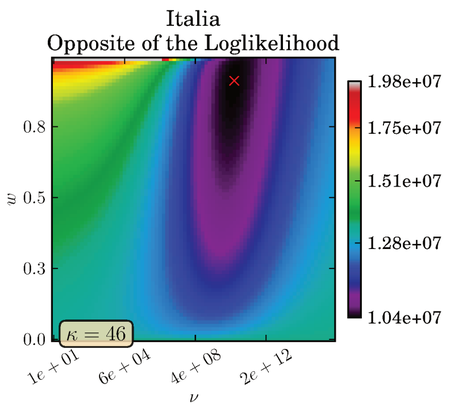
- we say in-strength (out-strength) of a farm the number of bovines moved to (from) that farm
- despite the difference in size, Italy and Sweden share similar behavior even for different time aggregation

Distance distribution and Kernel model





- we fit the distance probability between farm with a mixture model that merge a distance dependent and a mass-action function:
  $\mathbb{P}(d) = we^{-\left(\frac{d}{a}\right)^b} + (1-w)/(N-1)$
- $\nu = a^2\frac{\Gamma(4/b)}{\Gamma(2/b)}$, $\kappa = \frac{\Gamma(6/b)\Gamma(2/b)}{(\Gamma(4/b))^2}$



- the larger is w and the larger is the distance-dependence of connections among farm
- the variance, ν is a measurement of how rapidly the probability of contact decreases with distance
- a low kurtosis, κ, means that contact probabilities are more uniform over some distance and long-distance contacts are rare
- no large differences between parameters estimation. Italian system seems to be more distance independent

Conclusions

- understanding the structure of the cattle trade network is necessary to design an efficient control strategy of an epidemic spreading
- temporal and spatial discrepancies go beyond the trivial effects induced by the different sizes of the two systems
- similarities and differences between the two national system should further explored by simulating disease spreading

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