Studying delays propagations in aeronautical networks through PageRank

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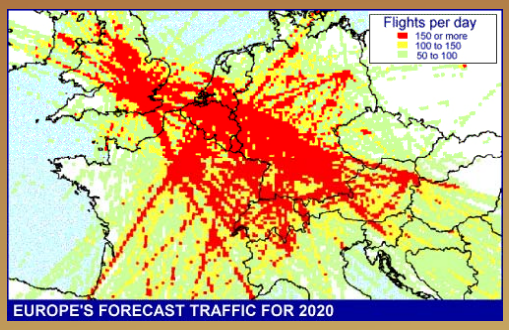
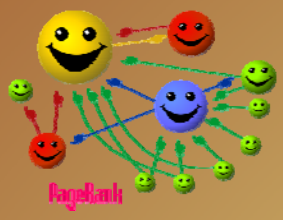
The problem

The air transportation network is clearly a critical infrastructure of our society, and is indeed a complex system created by thousand of element interacting in nonlinear way.
Eurocontrol is forecasting a growth of 100% in the number of flights inside Europe for 2020: this would increase the network congestion up to a unsustainable level.



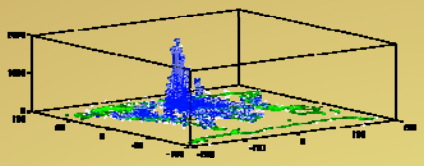
The model



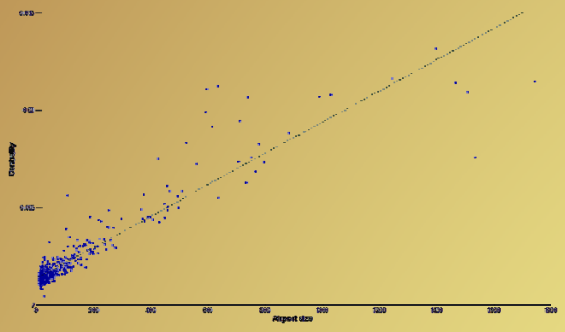
We used a modified Page Rank algorithm to simulate the propagation of *reactionary* delays: that is, situations where a flight is delayed by the previous flight of the same aircraft or crew.

The initial network

The network where agents move has been constructed from the real data of one day of flights. The weight of each link is proportional to the number of flights between the two airports.



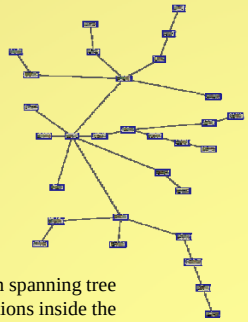
The importance of each airport



Rank	Airport	Centrality
1	Madrid Barajas	0.01093
2	London Stansted	0.00992
3	Munchen	0.00963
4	Oslo	0.00944
5	Barcelona	0.00923
6	Kastrup	0.00908

The centrality of each node represents its criticality: what is the probability for a delay generated in that airport to spread to the whole network. Size is not so important: many small airports have high centrality, while some big airports are very efficient.

This kind of information is of utmost importance for strategic decision taking, as it allows a more rational resources allocation to certain nodes of the system that are acting as bottle necks. At the same time, this is an interesting example of interdisciplinary research, where a physical / mathematical algorithm is applied to a real system, with the aim to improve its efficiency.



Minimum spanning tree of connections inside the European air network.

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