**DESCRIPTION OF TESLA ALGORITHM**

**What is the problem formulation?**

This problem formulation is not focused in a specific field, it raised after the needs of the understanding of the relationships/interactions between the entities of given systems to, in last term, understand the behaviour of the whole systems themselves. And thanks to the recent develops in network recovery algorithms (for simply static cases) the next step was understanding dynamic systems as networks.

To do so, TESLA creators made some assumptions in order to simplify the problem of recovering evolving networks: Lasso regularization and smoothness term (this last one is the boundary between adjacent points).

And applied it to **different examples**: synthetic data (simple birth-death model), U.S. senate network ,author-Keyword academic Social Network and Drosophila melanogaster life cycle.

But **why** do we need to understand relationships between entities of a system?

**Network analysis is useful for detecting anomalies, predicting vulnerability and assessing the potential impact of intervention on different kind of systems.**

**Results**: measure of performance using the synthetic data (precision-recall curve), rest of the cases **to illustrate a promising utility of TESLA.**

Problem formulation:

* Need of understanding relationship/interactions between entities of systems
* Thanks to develops in network analysis that made possible the identification of these needs (understand how the relationships/interactions change over time in different systems) and the creation of the algorithm in last place.

**How did they solve it and what results did they show?**

To fulfil these targets they developed TESLA algorithm: explanation of TESLA here???

Analysing the performance of the algorithm over the synthetic data shows promising results since it **outperforms the static approach** (significantly in high and even precision areas).

Having a look to the Drosophila example, large topological changes can be observed from the temporal rewiring patterns, even showing different interactions in different phases of its life, having an ‘expected’ result that enforces the potential of the algorithm on real world problems.

**Description of algorithm and what type of data I will use.**

\*\* TESLA: from the acronym TESLLOR (temporally smoothed *l*1*-*regularized logistic regression)

* Logistic regression
* Regularized (sparsity)

The lasso regularization is introduced to ensure sparsity in the recovered networks, in order to avoid having highly linked networks due to the consideration of weak links, which importance will be negligible compared with strong links. This also helps us to identify much better the so-called ‘hubs’ (high degree nodes, so with many connections), the most important elements of the network and whose behaviour can affect the whole system.

* Temporary smoothed

This constraint is introduced based on the assumption that the studied systems show a similar distribution in temporary adjacent points, this is that they evolve in a smooth way, with no abrupt changes.

We can find all of these constraints in the algorithm itself

where,

EXPLAIN ALL ELEMENTS IN THE ALGORITHM (MOSTLY LOGISTIC REGRESSION)

The target when applying the logistic regression is to minimize what??????

**Short description why application on finance is a good idea**

As we saw in the problem formulation: **Network analysis is useful for detecting anomalies, predicting vulnerability and assessing the potential impact of intervention on different kind of systems.**

This just sounds like the kind of knowledge that could benefit economy by, from providing a tool to detect critical events that can affect the whole system to the development of techniques to avoid contagion of these events through the network.

Summarizing it provides a potential powerful tool to predict destabilizing events and react them in order to avoid economic crisis like 2008.

\*\* DATA

* Time series of the observed states of the elements forming the network: Stocks. The observed states can be the normalized Close values, so the time series shows the trends or up/down moves of the stocks’ values. [NxP] matrix, N number of samples (or points of the time series), P number of nodes 🡪 columns of the matrix are the time series of each of the nodes.
* Time stamp (ts): [Nx1] matrix where ts(i) is the time stamp/epoch corresponding to the sample I in the data matrix (and ts(N) = T). This way we can split the evolution of the network from 1 (static case, when ts(i) = 1) to N temporal networks. Interpretation of input (show how the vectors/matrices are and explain)
* Sparsity term: , the penalty introduced to enforce sparsity. The higher the penalty, the less connections the network will have. This can be introduced as a scalar (sparsity is the same over time) or as a vector [Tx1] having different sparsity for different epochs.
* Smoothness term: , introduced to enforce similarity between time adjacent points. The higher this penalty, the slower the network will change over time. As the first penalty, this one can be introduced as scalar or vector [Tx1]

**PRESENTATION**

**General overview: First of all define the algorithm (this work is basically the study of the potential the algorithm, the study of its performance in finance and, if necessary, adapting it to this specific field).**

**This algorithm was developed because of the need of…:**

* **Problem formulation and how they solve it???**
* **Then algorithm in depth and data.** Then we have to explain what this algorithm does: which kind of input takes and which kind of output gives. This is because of this need: …
* **Then why application in finance.**

Drawings of all inputs and how they relate to each other.

Flowchart of the algorithm with these inputs and how they shape the data before using the algorithm.