Applications of Network Science in Finance

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The financial crisis cost us $20Tr!
Global banks have paid $321B in fines due to insufficient risk management.

FINED
Regtech is Surging

Organizations are employing software to automate data analytics and data science
The Problem

Current risk management solutions are not able to monitor complex systems. They consider disconnected datasets and **miss important network patterns, connections and anomalies**.
FNA Graph Analytics Platform has 250 graph and machine learning algorithms that allow us to take into account interconnectedness of data.

With a direct bottom line impact.
End-to-end Platform enabling Graph Dashboard in hours

Before

DATA

Ontology Definition

Graph Database

Visualization Solution

Graph Compute Engine

Data Science Software

ETL Software

DASHBOARD

After

DATA

End-to-End Enterprise Solution for Graph Analytics

DASHBOARD
Graph Analytics is Moving to Finance

PayPal has saved more than $700 million with graph based fraud detection

“Goldman Sachs takes a DIY approach to graph analytics”

"Network diagnostics ... may displace atomised metrics such as VaR"
Fedwire Interbank Payment Network (Fall 2001) was one of the first network views into any financial system.

Of a total of around 8000 banks, the 66 banks shown comprise 75% of total value. Of these, 25 banks completely connected

The research was subsequently used e.g. in congressional hearings to showcase the type of information that should be collected by financial institutions after the financial crisis.

Transactions & Similarity Based Networks

**Transaction**: payment, trade, exposure, supply, flow, ...

**Similarity**: correlation, partial correlation, granger causality, transfer entropy, ...

Stavroglou et al (2016)

*Causality Networks of Financial Assets*
Fraud bill $50B per year globally

Existing solutions for fraud detection generate very high number of **FALSE POSITIVES**.

This creates the need for time consuming **MANUAL** processes and high costs.

**REGULATORY** pressure and increased **CYBER CRIME** magnifies the problem.

PayPal has saved more than $700 million with graph based fraud detection
Detect Anomalies in Cyber Networks in Real-time
Identify Patterns of DDoS attacks
Example US Housing: Monitoring a Complex System


Researchers are using network analytics and advanced data modeling to identify weak spots in the system that otherwise might go unnoticed.

This sprawling tree shows housing prices in U.S. markets moving with little correlation in 2000. The tree has gotten shorter and shorter since, indicating higher correlation between markets.
In this example we look at US house prices across states. We see the US states as nodes and strong correlation between house prices as link. In 2000 the tree is very spread out and prices are going slightly up. This is a time when ABS are developed with the assumption that real-estate risk can be diversified across US states.
In 2003 we start to see some strong upward movements in prices in states like Nevada and we see a big cluster of bumper returns in Florida and states that have strong correlations with it.
As we move into 2004, into the peak of the housing bubble we see that most states now have outlier price changes and Nevada for example has an almost 12% rise in house prices in one quarter.
As we move into 2005 we look at the length of the tree. It measures the overall correlations in this system. The shorter (smaller value) the tree, the stronger the correlations. We see that the tree has been getting shorter and shorter. The assumptions behind diversification of ABS getting eroded.
In summer 2007 the housing bubble is over and we see the first negative outlier in Florida. Most of the system has become red, except a green branch on the left.

We also see that the tree has been getting shorter and shorter, reaching new lows each quarter. The system is becoming highly coupled.
In 2009 we reach the peak crisis. The system has become largely red with many central states as negative outliers.

We can look at another metric on the left. Systematic risk measures how much changes in the system are driven by the largest single factor, and how much by idiosyncratic - state level - factors. We see that the system is quickly becoming governed by a single factor affecting all states.
The same dynamics continue with the "double dip" in 2011.
In Spring 2012 we see the first positive outlier in North Dakota, likely drive by the fracking boom. The rest of the system is still mostly negative.
If we fast forward to the latest observation, July 2015, we see a period of positive changes in prices with outliers scattered across the network.

We also see both systematic risk and correlations at their peak. We have not returned to the pre-bubble system state but are in a very risky territory still.
We can see this clearly by looking at the size of the tree.

First in 2010.
Then at the peak of the bubble in 2005.
Then at the peak of the crisis in 2009.
And now.
The tree has shrunk during the whole period. The correlations are now stronger than ever.

Such slow moving change is hard to notice when focusing on daily events. Like in the story of the frog put in water that is gradually heated.
Welcome to the 2016 US Presidential Election Tour

We are delighted to guide you through this dashboard tour, which will only take two minutes. In order to revisit the tour at anytime, click the Tour icon.
Day Before the Election
Let's move to the 7th of November 2016, the day before US presidential election.
Day Before the Election

Markets showed extreme movements with high gains in the equities cluster...
Day Before the Election

...and strong negative movements in 'flight to safety' assets such as Japanese Yen and Gold.
Day of the Election

On the day of the vote, as exit polls started to come in, markets were relatively calm. How to interpret Trump winning the presidency and Republicans taking the congress?
Day After the Election

Let's find it out by moving forward of one day.
Day After the Election

On the day after the vote, the markets had made their mind and we see three strong clusters. Most US equity markets such as Materials and Financial have heavy gains with promises to repeal the Dodd-Frank Act and $1T worth of new infrastructure spending.
Day After the Election

On the downside, we see strong negative movements in the markets for the rest of the world equity markets. A result of ‘America First’. We also see strong negative movements in US and other bond prices as the third cluster.
Day After the Election

We also see strong negative movements in US and other bond prices as the third cluster.
Many Use Cases

- Correlation Analytics
- Supply Chains
- Fraud & AML
- Systemic Risk
- Cyber Security
One FNA Platform

Scriptable

**Graph Analytics Engine**

Configurable

Interactive

Dashboards