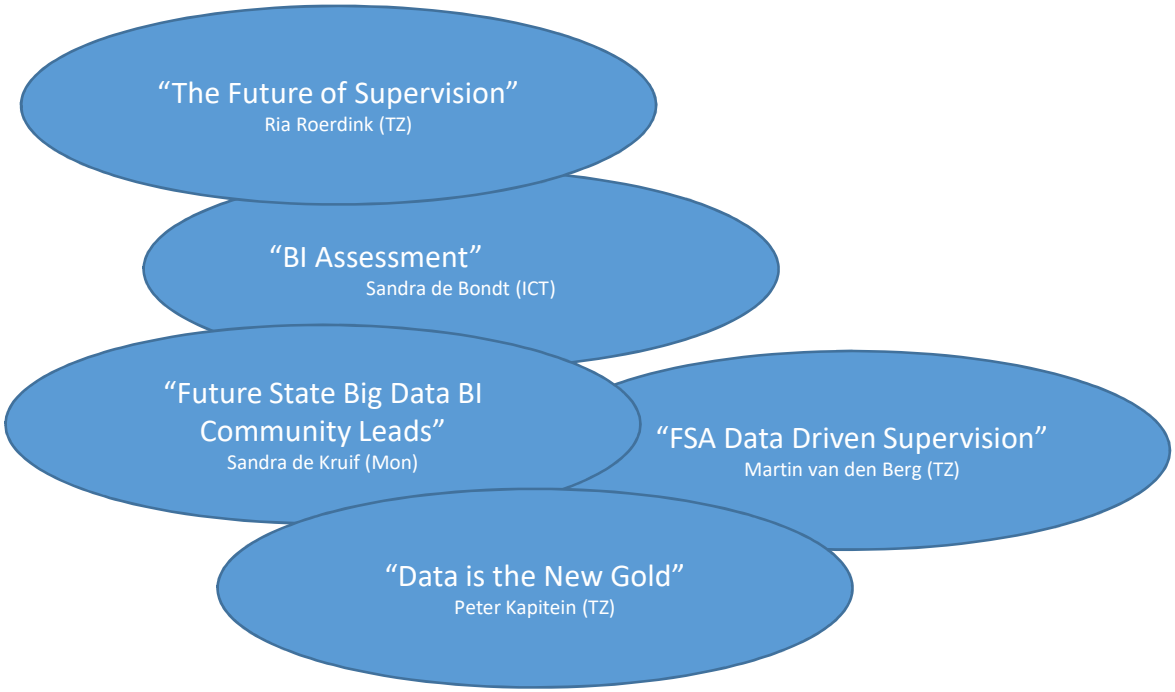
DATA SCIENCE AT THE NETHERLANDS BANK

Building Pathways for Policy Making with Big Data
BI/IFC-BIS Seminar

IMAN VAN LELYVELD

JULY 2018

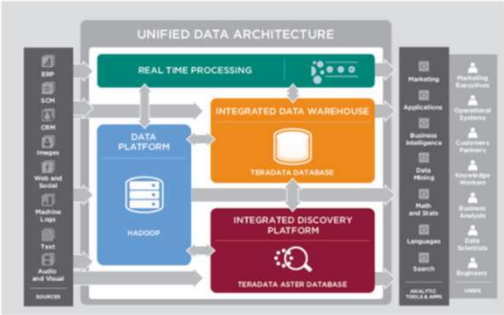
Many Data Science Related Initiatives…



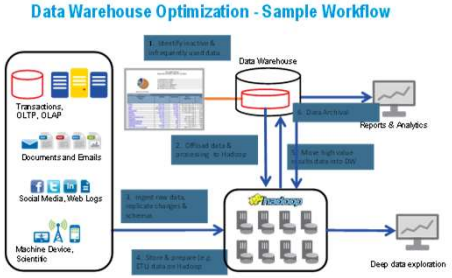
Bank wide programme:
In Charge of Data!

… and out there, there are many different views
So what should we do???!?

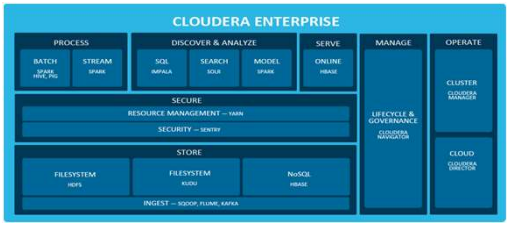
Teradata



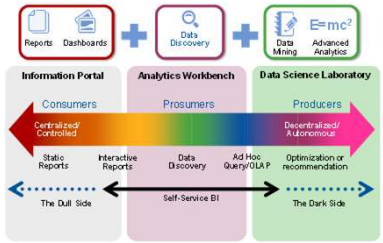
MapR Technologies



Open source big data tooling



Gartner



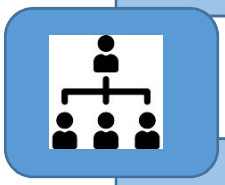
Which elements do we need?

Tooling

- Research Area Network (RAN), Data Platform + Analytical Workspaces/Datalabs/Data science Toolkit, memory/cpu/storage
- Cloud deployment; Data(platform) connectivity, other connectivity (open data, etc..), quick scaling of datalabs
- Open source tooling (e.g. R,python, Git, Neo4J, MongoDB, SQLlight, MySQL, …..)

People

- Appreciation of the scientific method
- Knowledge of statistics (descriptive, explorative, predictive, causal, ...)
- Knowledge of coding in 'interpreter' languages (Python, R, Julia, ...) and support (Anaconda, Jupyter Notebooks, Git, ...)



Organisation

- Decentral vs. Central
- Governance (!!!) – data protection, deployment of analysis (KIV→KII)
- Agile, pilots, data science as a brand
- FTE's

Culture

- Informal: knowledge networks, lunches, seminars
- Creating a community, many already do 'something' with datascience: Get-togethers, what do people need?, datascience 101 sessions, seminar with externals, deep-dive sessies (R, Python, Git, LAMP stack, Neo4J, MySQL, MongoDB, etc..), show preliminary - results

Current tooling is inadequate

- Data not sufficiently standardized
- Data not sufficiently accessible
  - Application Programming Interfaces (API-layer)
- Research Area Network (RAN) too successful
  - Tedious to move information back and forth
  - Is limited in size and computational speed
  - Fails at a basic level (even simple code loops crash for no reason)

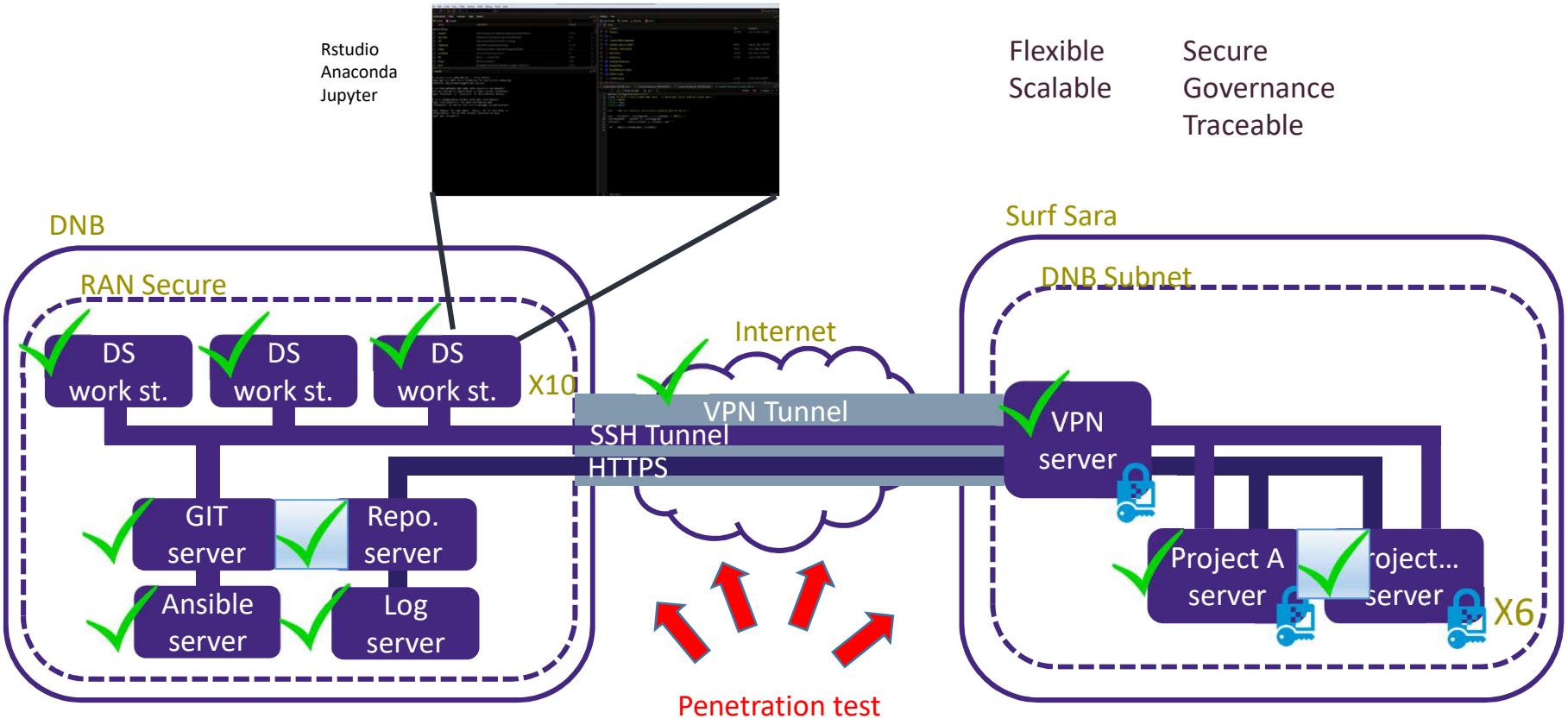
We need a propper analytical workbench … but how ??

Let's just find out!!!

Today’s agenda

1. Bring confidential data to the cloud
2. Deliver 4 Proofs of Concepts
3. Build a Data Science Community

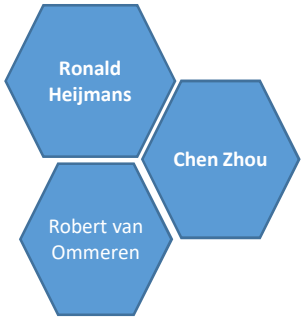
Bringing confidential data to the cloud



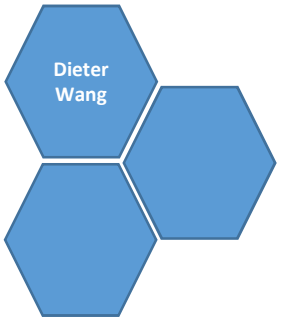
4 Proofs of Concept

1. Credit risk

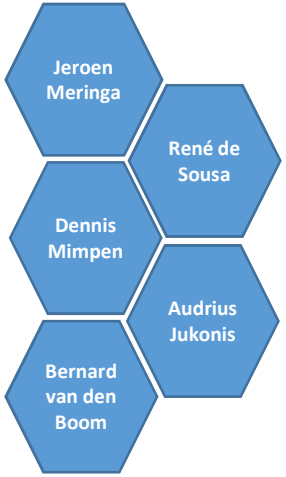
2. CCP Risk Indicators



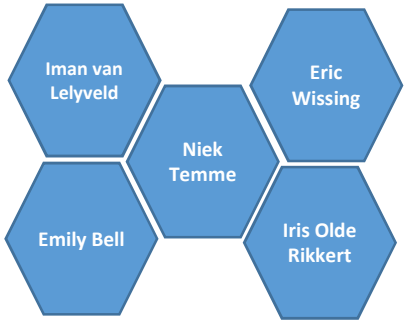
3. CDS Contagion



4. IRS margins



Facilitators



Proofs of concepts I

PoC 1 Credit risk — Pieter van den Berg

Importance

- Credit risk is the largest contributor to overall financial risk and required capital for all of the large banks. Large banks in the NL have permission to calculate minimum capital requirements using internal models.
- Differences between risk estimates of different banks are due to different actual risks and risk management practices (warranted variability) but also due to different default- and loss definitions, modelling methodology, assumptions and other factors such as regulatory add-ons.
- Due to the variety of modelling practices allowed under Basel and the CRR, there is no clear view on what exactly would constitute an acceptable level of RWA variability.
- Explicitly estimating bank-specific effects could lead to a better understanding of the differences between minimum capital requirements of banks.

Analysis

- Get historical loan tape data (100Gbs) in the cloud; at least initially only mortgage data
- Extend existing code base of OSBE/IMK to build simple credit risk / pillar 1 shadow models
- Estimate bank-specific effects
- Compare typical (scorecard) methods with more sophisticated ('machine learning') methods
- Nice to have:
  - Bayesian methods, with Stan or on a tensorflow backend
  - More advanced modelling techniques (state-space/graphical models)

Deliverables

- Replication / extension of current RAN secure RStudio+MonetDB analysis environment in the cloud
- IRB challenger modelling methodology and results
- A better understanding of RWA variability for Dutch banks
- A more generally applicable methodology for risk-corrected RWA benchmarking

PoC 2 EURO CCP — Eric Hogewoning

Importance

- Central Counterparties (CCPs) are becoming more and more important. Post-crisis regulation and technical innovations draw increasing market volume to these central nodes.
- With their increased systemic importance, it is imperative to understand the risks in CCPS. In particular, how CCP transaction data can support the CCP-oversight function.
- In order to have a firm base for data driven oversight/supervision we need to develop risk indicators from transaction and initial margin data.

Analysis

- Take the transaction and initial margin data of EuroCCP for one year.
- Explore the data and develop risk indicators with R.
- Develop a method to set a threshold for medium or substantial change in an indicator with R.
- Write reusable code for the different CCP risk indicators and threshold method.

Deliverables

- A better understanding of the potential of the data for deriving risk indicators
- A selection of risk indicators linked to the Principles for Financial Market Infrastructures
- Know whether it is possible to derive a adequate threshold for medium or substantial risk of the indicators

Proofs of concepts II

PoC 3 Contagion — Dieter Wang

Importance

- Credit Default Swaps (CDS) prices reflect the perceived credit risk of the underlying entity, e.g. a bank. A higher CDS price indicates higher credit risk.
- To understand what drives these prices and risks, researchers usually analyze the role of bank-specific (stock prices, leverage ratio) or economy-wide (stock index, bond yields) variables. However, these variables explain CDS prices very poorly.
- Not only that, the part of credit risk that we cannot explain is not random. Instead, we know that there is another *hidden* variable which failed to include.
- In other words: **Something is driving credit risk, that we cannot explain!**

Analysis

- It is not too surprising, that the bank-specific and economy-wide variables do not explain credit risk of banks very well – we didn't account for *contagion*!
- Thus, we look at the networks between banks based on asset holdings similarity. Why? In case a bank under stress starts a fire-sale of its assets, this network will tell us who´s likely to be affected by the sale (namely those with similar holdings).
- We use the resulting portfolio overlap network to capture how much of this stress or credit risk spills over from one bank to another.
- Lastly, we estimate the importance of the network over time, because contagion is likely to be more important during stress times than calm times.

Deliverables

- We hope to find proof that the portfolio overlap network can capture the hidden part of credit risk that eluded the other variables.
- We would like to see how the importance of the network varies over time.
- Ideally, we can use our resulting model to conduct stress tests in the system. I.e. a dashboard that tells us, how a shock will pass through the banking system.

PoC 4 IRS — Iman van Lelyveld

Importance

- Interest rate derivative markets are a key component in how interest rates are managed by financial an non-financial firms. Daily volume is USD 2.7 trillion.
- Recent regulatory chances force more and more firms to post margin. This reduces counterparty credit risk. But transforms it into liquidity risk.
- Especially for entities that are not used to posting margin (and without access to the discount window == pension funds) this might be an issue
- Moreover, from an FS perspective, the sinkhole effect of unexpected IM calls might be an issue

Analysis

- Collect the data: take IRS data from 3 TRs (DTCC, REGIS, ICE), apply cleaning steps, add auxiliary data, join. We do this for a limited number of days.
- Analyse the data in a mix of Stata, R, Python, Gephi
- Write modular code for the deliverables: community detection, pricing, and stress testing modules.

Deliverables

1. Overview of the Dutch IRS markets How many observations/reporters/contracts do we have? What kind of contracts do these parties trade? Who is buying/selling risks?

2. How does TR reporting match up with prudential reporting Match TR with other prudential data: FINREP/COREP, Basel International Data Hub data

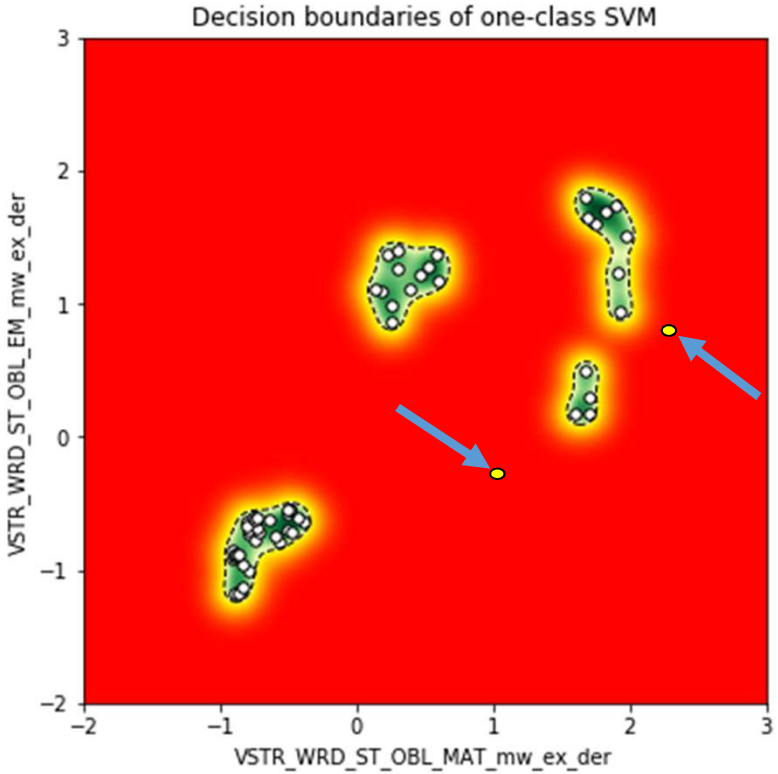
3. How to price IRS with TR data? Given that we don't trust the MtM in the data, we want to price ourselves. What are the options? How can we estimate all of this?

4. How to come to sensible estimate of margin demands? Given the price model, what model can we use to have a simple robust model that can reliably estimate margin demands across the entire market

5. A stress test of the Dutch IRS market Given data, prices and margin demands: how would changing some of the parameters affect a) solvency and b) margin required?

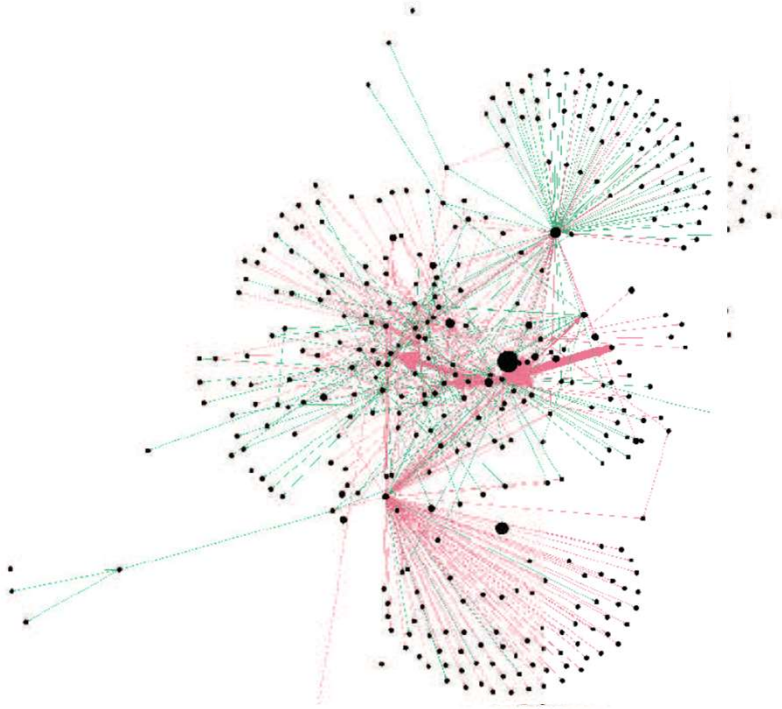
Dazzling Data Science …

Machine Learning



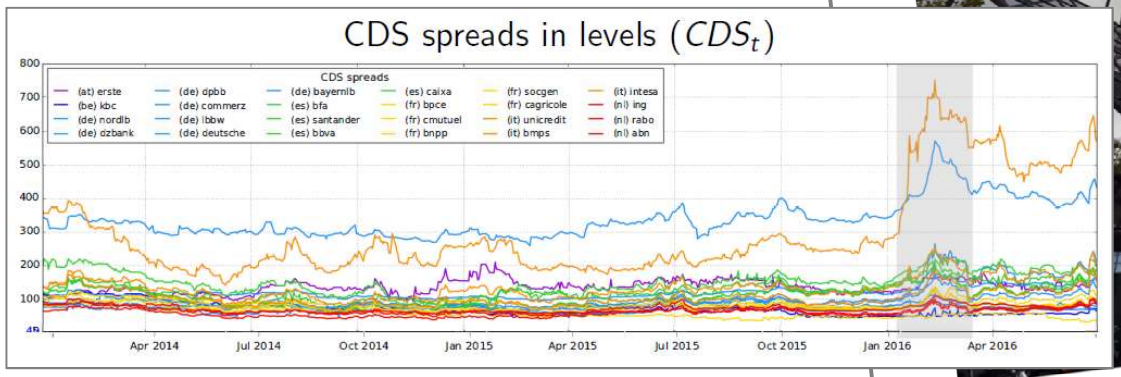
Detecting outliers in regular reporting

Stress testing IRS



How big will margin stress be if interest rates rise?

PoC 3 - Contagion in bank CDS



The Credit Spread is a Puzzle

- Credit Default Swaps (CDS) prices reflect the (perceived) credit risk of the underlying entity (ie. bank)
- To understand what drives these prices and risks, researchers usually analyze the role of *bank-specific* (stock prices, leverage ratio) or *economy-wide* (stock index, bond yields) variables. However, these **structural variables explain poorly**.
- Not only that, the part of credit risk that we cannot explain is not random. Instead, we know that there is another *hidden* variable which we failed to include.
- **Something is driving credit risk, that we cannot explain!**

Main hypothesis

- It is not too surprising, that the bank-specific and economy-wide variables do not explain credit risk of banks very well – we didn’t account for overlapping business models!
- Our hypothesis

  The credit spread puzzle is a result of the commonality in banking business

Why is modelling contagion so difficult?

1. Spillovers and feedback loops are hard to grasp:
   Who will affect whom?

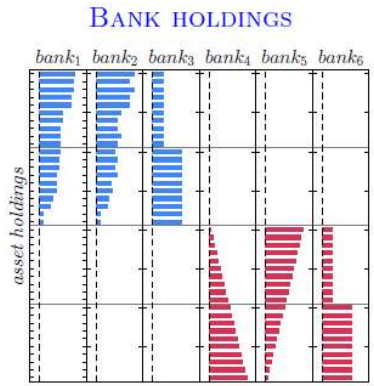
2. Spillovers and feedback loops are nonlinear:
   Small effects can explode!

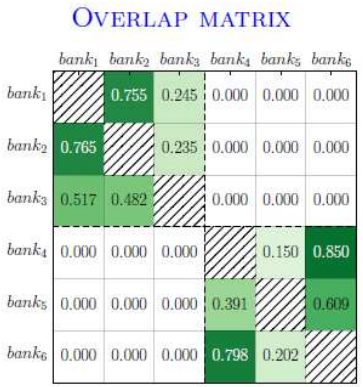
3. Spillovers and feedback loops change over time:
   Calm times vs Calamity times

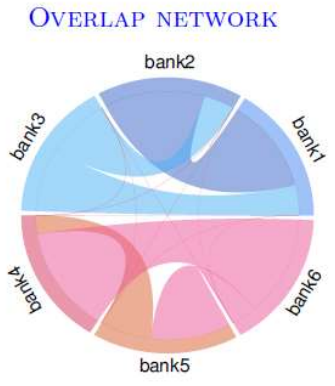
Capturing the underlying network

- Banks with similar business models (holdings) likely affect each other in stress times

➔ What is the portfolio overlap network?

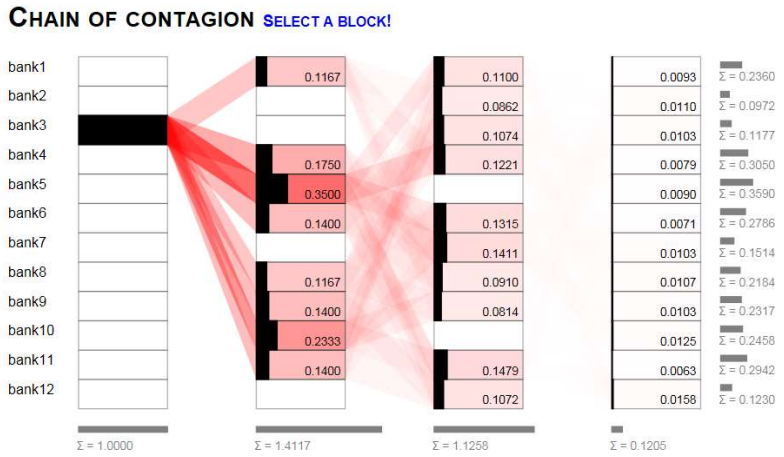






Network stress-testing

- Once the network is available, we can use our model to conduct stress-tests



http://dieter.wang/contagionchain

Why do we need the DataScienceHub?

- **Massive computing needs**
  In the 1.5 years of development, the main bottleneck was computation.
  Old machine: 4 core @2.4GHz, 16GB RAM
  ➔ Not only slow but also crashed
- **Cannot be moved to the cloud**
  E.g. Amazon Web Services, Microsoft Azure, Google Cloud Computing, etc. because of confidential data.

Practical uses and deliverables

- **Knowledge transfer: High-performance computing**
- **Knowledge transfer: Confidential data in the cloud**
- **Dashboard to examine the spillover level in the Eurozone**
- **Same technology can be applied by other central banks.**

How do we work?

- Organisation
  - Sprint: 3 weeks, 2 week break
  - Physical location
- Agile: goals are clear for each PoC
  - Success factors for PoCs as defined in user stories
- Working towards responsible data use
  - Coding Hygiene document
  - GIT: code repository

PoC 1 Credit risk **Pieter van den Berg**

- Opzetten infrastructuur om bestaande functionaliteit bij SuSa te kunnen draaien

PoC 2 EURO CCP **Ronald Heijmans**

- Data geladen
  - 2 miljard transacties
  - Nog enkele kleine technische onvolkomenheden
- Robert van Ommeren (stagiair) is begonnen
  - Onderzoek naar crowded trading

- PoC 3 Contagion Dieter Wang

- Presentaties
  - EUBA
  - World Bank, Fed Board, IMF, OFR
  - FSB Case study

- PoC 4 IRS Iman van Lelyveld
- Prijsmodel werkt:

- Aansluiting met FINREP nog in onderzoek
- Presentatie methodologie bij ECB en ESRB
  - Project met ECB opgestart
- Verdere versterking van het team in bespreking
  - FM en TP_ECFRP

Community

- Python & R lunches
  - Purpose: get to know each other, exchange ideas
  - Frequency: every 6 weeks
  - Big succes: 30 people on average
- Training
  - Overview of training possibilities
  - Open source (Coursera) complemented with bespoke training

Questions?

Our Projects

1. Credit Risk
2. CCP Risk Indicators
3. CDS Contagion
4. IRS Margin Requirements
5. Tekst Analyse Tool Toezicht

What will we deliver to you?

- Deliverables as described in each PoC
  - A presentation at the end of each Sprint
  - Report / dashboard at the last
  - Note: this is PoC, not an implemented product
- Training
  - Applying Python, R and GIT
  - Requirements for better analytical workspace

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Credit Risk: Results and Deliverables

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Results and Deliverables

IRS Margin Requirements: Analysis

I.P.P. va1

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Slide 36

I.P.P. va1 check

Lelyveld, I.P.P. van (Iman) (STAT_OFIS); 17-1-2018

IRS: Results and Deliverables

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