The evolution of model risk management

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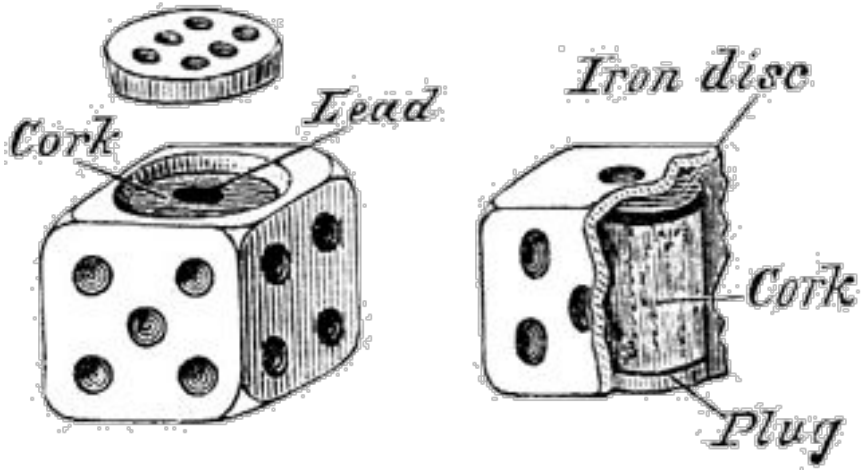
Agenda

- Current state of MRM
- Requirements for technology
  - Data-driven MRM
  - MRM Architecture
- Focus on key challenges
  - Model inventory
  - Business processes
  - ML and AI
- Conclusions

The current state of MRM

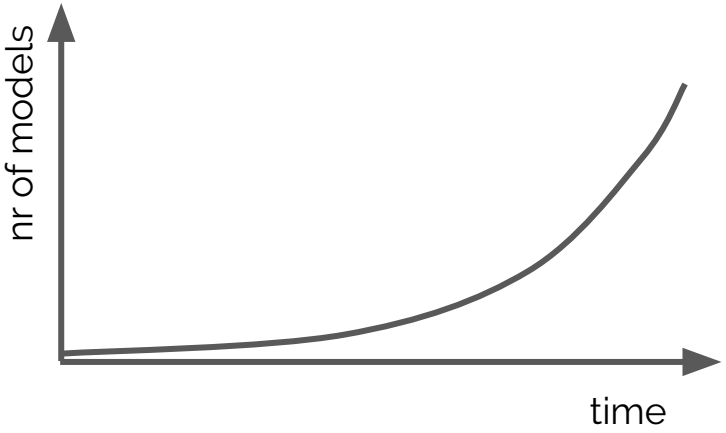
Why we simplify models

Why we validate models



The need for quantification

The number of models in financial institutions increases with 10 – 20 % yearly*



- 100 - 3000 models
- Median duration of a single model validation is >4 weeks**

- **Tiering** (quant. & qual.)
  - materiality
  - risk exposure
  - regulatory impact
- **Qualitative assessments** are fairly stable over time
- **Quantitative assessments** can change quickly and allow for accurate risk management procedures

* See http://www.mckinsey.com/business-functions/risk/our-insights/the-evolution-of-model-risk-management
** See https://www2.deloitte.com/content/dam/Deloitte/dk/Documents/financial-services/deloitte-nl-global-model-practice-survey.pdf

Polling question 1

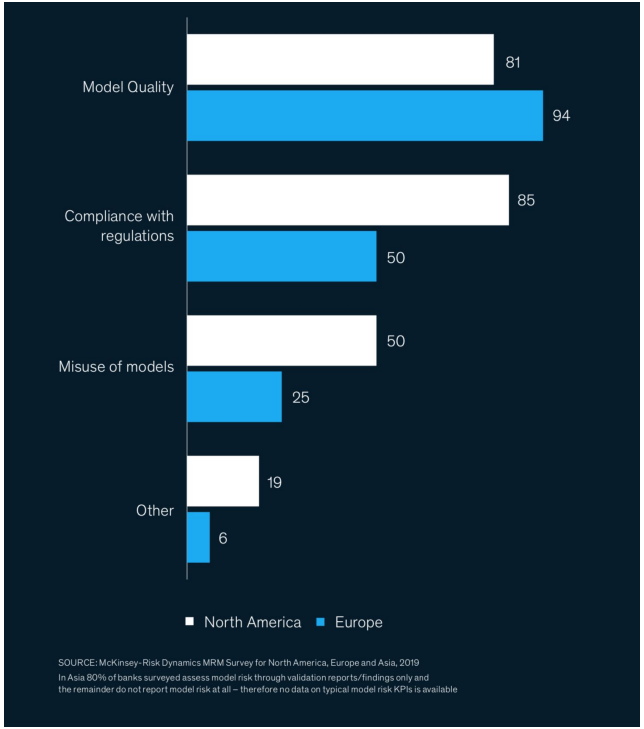
What is the size of your model inventory?

1. less than 50
2. 50-100
3. 100-500
4. 500-2000
5. more than 2000
6. I don't know

Model risk quantification is hard

Model risk is a multi-dimensional concept

- Model quality implies
  - data quality
  - data stability
  - model performance
  - comparison with other approaches
- Compliance with regulations
  - local vs global
- Misuse of models
  - How to detect that a model is not fit for purpose?

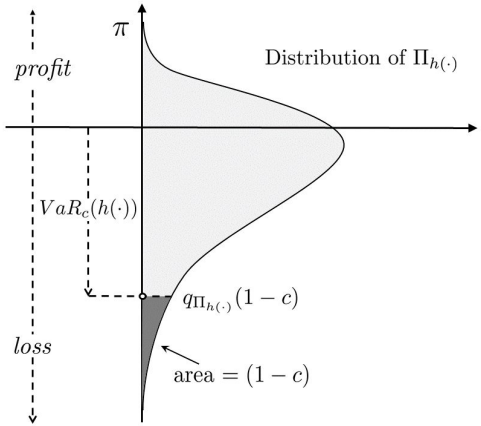


Model risk quantification is hard

Model risk propagates through the model inventory in a non-linear fashion

Example: VaR

- 1% VaR translates to three scenarios / year
- Suppose a IR curve generator is unstable in 0.5% of the cases
- It will impact PnL vectors and shift the VaR



More than regulatory validation

- Introduction of AI implies reputational risk
  - bias
  - fairness
  - explainability

- In the EU - driven by TRIM findings - it is clear that scope of MRM has to increase
  - Model monitoring
  - Better policies for model calibration
  - Data quality

Financial institutions are searching for efficiency

Changing modeling landscape & increased regulatory pressure drive MRM objectives

Challenges

Cost

- increased nr of models
- limits of legacy tech
- competition for talent

Capital

- stricter regulation

Technology

Objectives

Cost reduction

- replace legacy IT systems
- resource planning (tactical and strategic)
- process efficiencies across the organization
- improve model development/monitoring

Capital reduction

- better MRM leading to capital reduction

Turning MRM into a value driver

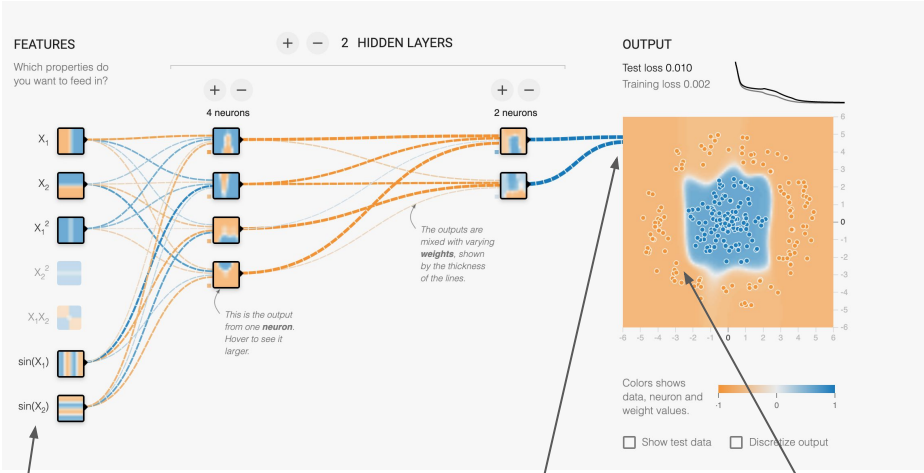
Requirements for technology

MRM has to become data centric

MRM produces data; if we centralize this, it has the potential to transform the business

Analytics related data

- The model execution trace



Model input

Model output

Realization

MRM has to become data centric

MRM produces data; if we centralize this, it has the potential to transform the business

Analytics related data

- The model execution trace
- Data quality metrics
  - normalization
  - interval scale
  - interpretability

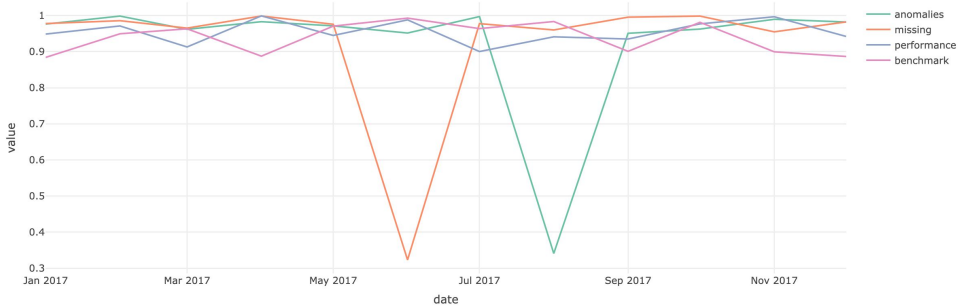
$$Q_{Corr.}(w_I, w_R) := 1 - d(w_I, w_R)$$

MRM has to become data centric

MRM produces data; if we centralize this, it has the potential to transform the business

Analytics related data

- The model execution trace
- Data quality metrics
- Model performance
- Model risk



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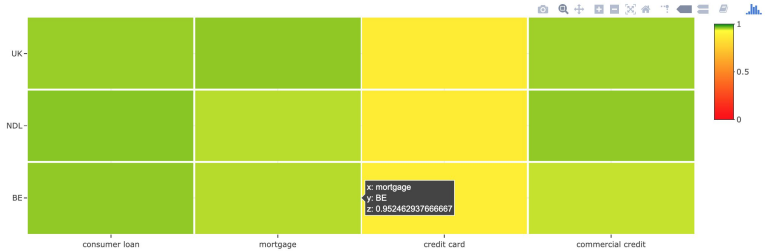


Making this data easily available drives many advantages

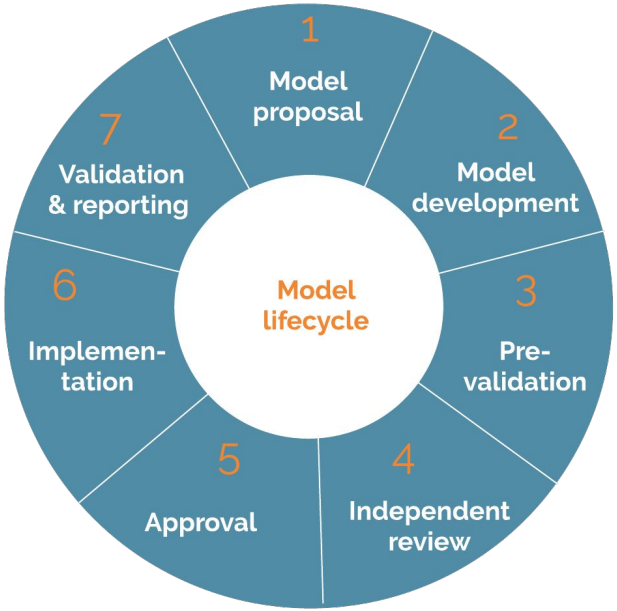
- Increase transparency
  Decision makers can inspect model risk concentration
- Cultural change
  Model risk is well understood through the entire business
- Better models

MRM has to become data centric

MRM produces data that has the potential to transform the business

Process related data

- Model life cycle
  - time per step
  - throughput
  - nr of iterations per model

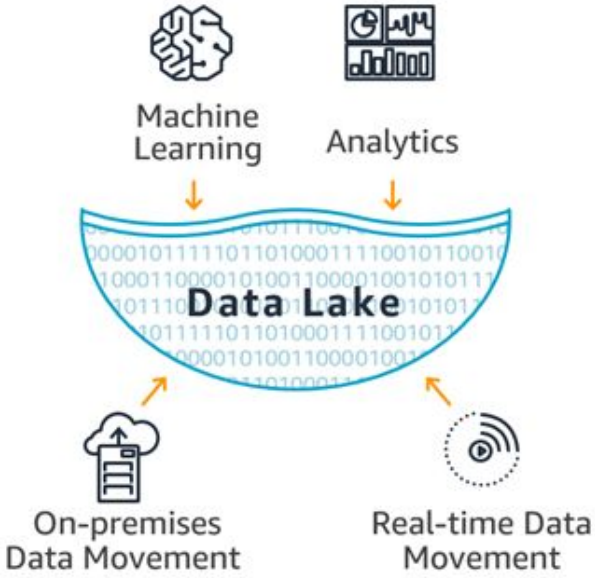


MRM has to become data centric

MRM produces data that has the potential to transform the business

Process related data

- Model life cycle
- Meta-data on data
  - rate of production
  - statistics per dataset
  - number of iterations



MRM has to become data centric

MRM produces data that has the potential to transform the business

Process related data

- Model life cycle
- Meta-data on data

Making this data easily available drives many advantages

- Tactical and strategic resource allocation
- Improve process efficiencies

Technology requirement I

Ability to collect, store and expose all MRM related data

A modular setup

- MRM requires many teams working together on a variety of analytics
  - Model lifecycle crosses lines of defence / teams / geographies
  - Different teams might have different tools
  - Complex authorization requirements

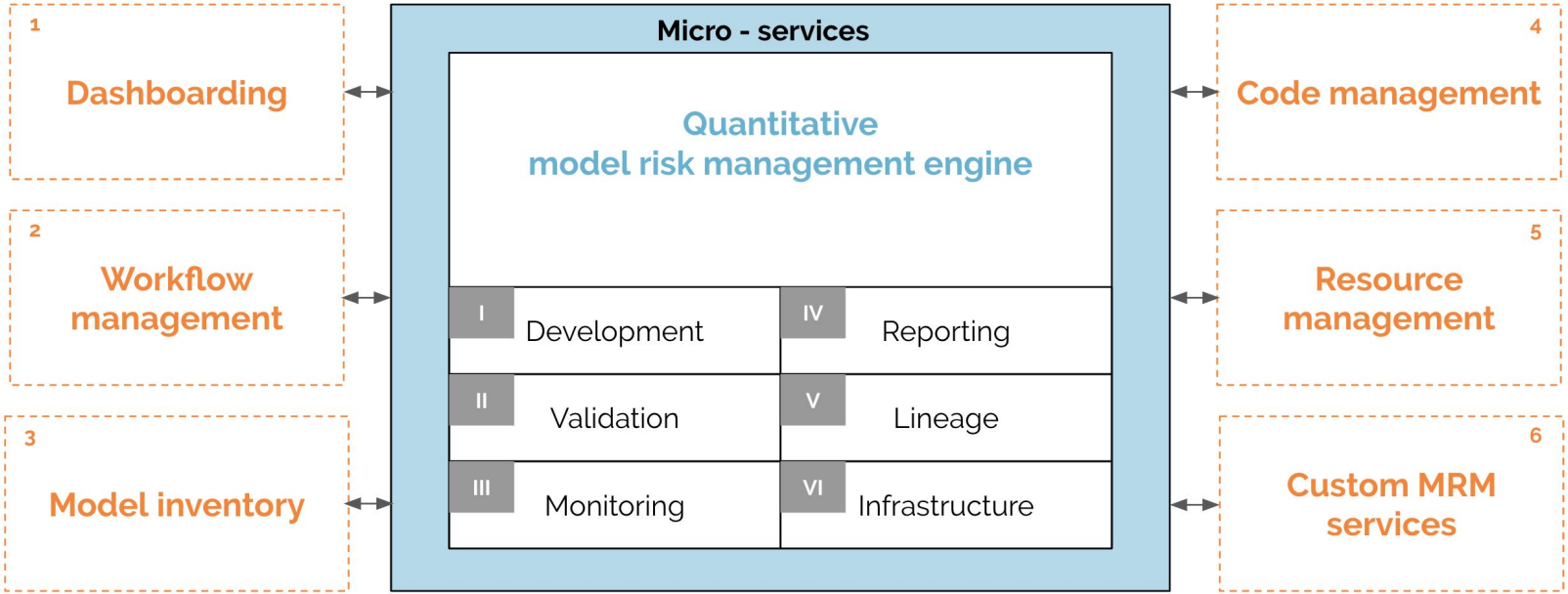
- Analytics might be available across a diverse set of systems
  - Both development and production systems differ
  - Will include legacy, so hard to integrate

- MRM requirements will inevitably evolve over time
  - new regulatory frameworks
  - new model types
  - new business

Technology requirement II

A modular setup with strong integration capabilities

Example architecture



Poll II: Adoption of MRM technology

In 2020, we are planning to introduce following technology into our MRM (select one or more of the below options)

1. No plans to change the technology
2. Planning to evolve the model inventory
3. Plan to implement or evolve a solution for monitoring / backtesting / validation on selected model types
4. Plan to implement an entirely new enterprise model risk management solution

Key focus areas

Model inventory

Some elements

- Model type
- Model owner
- Status
- Model use
- Region
- Business
- Data sources

Model inventory

Some items

- Model type
- Model owner
- Status
- Model use
- Region
- Business
- Data sources

Relationships between model inventory items have to be represented accurately

- study consistency
  - limits
  - regulations
- analyse how limitations propagate
- determine concentration risk
  - dependency on data sources
  - analytics frameworks
  - vendors

Model inventory

RDBMS

Models

Hull-White	123
Black-Scholes	125
Heston	127

Region

UK	205
US	206
BE	207
FR	208

Use

IR trading	333
XVA	334
Equity option trading	335

123	205
123	206
123	207
125	208
127	205
127	208

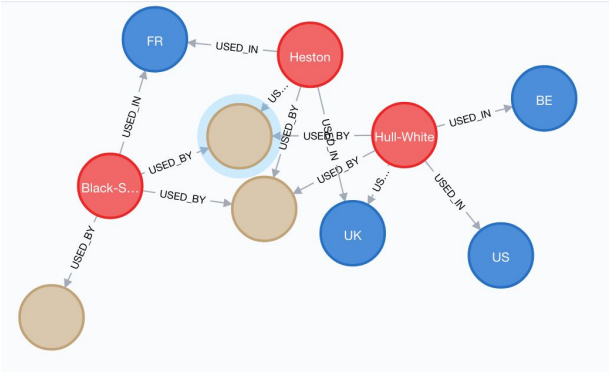
205	333
206	333
208	333
205	334
205	335
207	335
208	335

Traditional relational databases are problematic

- performance (lookup tables)
- unnatural representation
- hard to add fields
- difficult to query

Model inventory

Graph

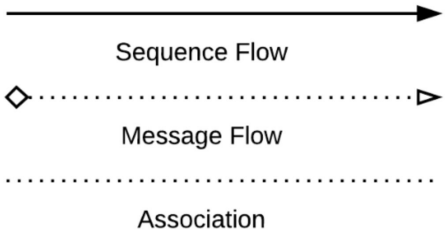


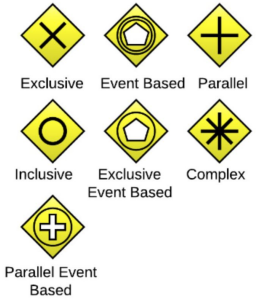
Relationships between objects are represented naturally in graph databases

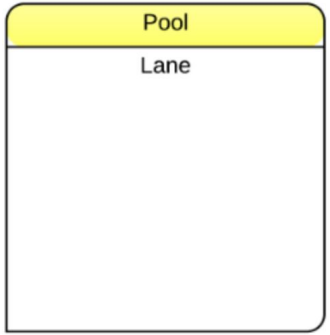
- massive performance gains
- relationships are part of the DB's DNA
- the object model can be modified easily
- specialized query languages are available

Executing business processes

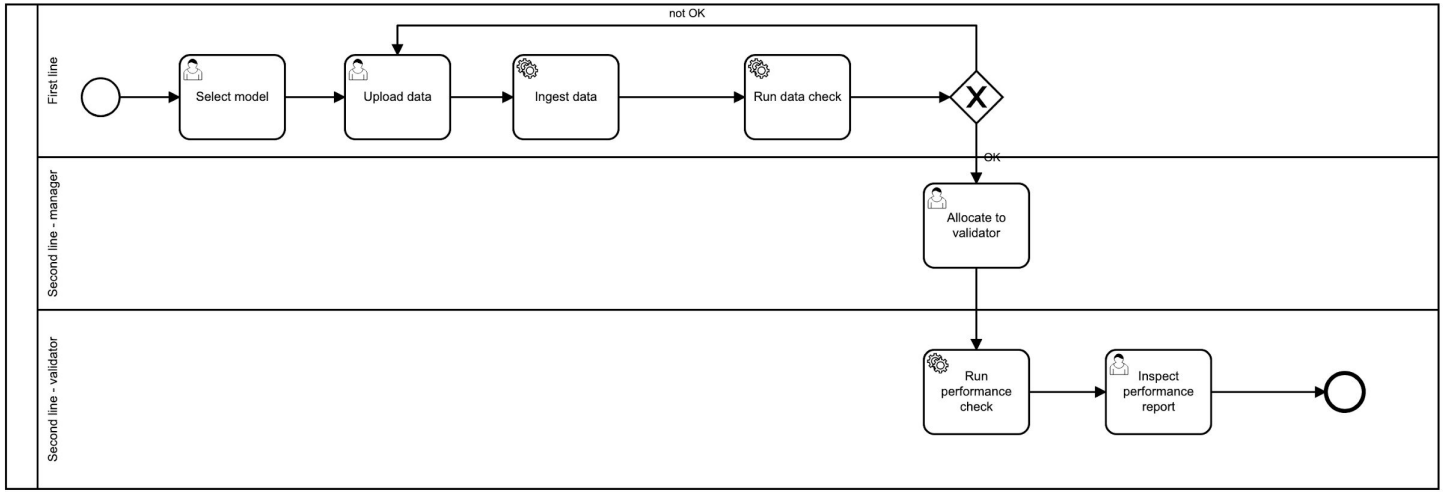
BPMN = Business Process Model and Notation







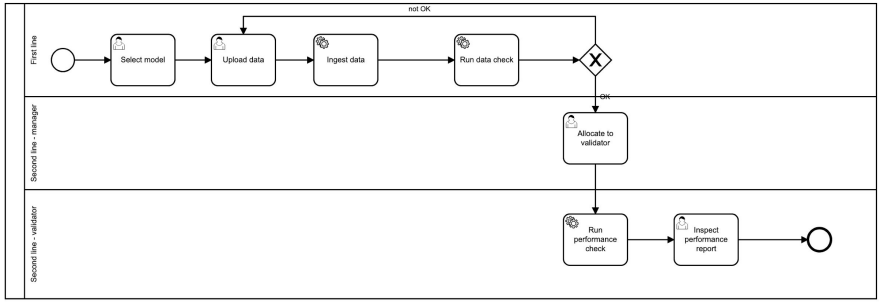
BPMN process example: request for independent review



Executing business processes

1. As a model developer

- structured process
- document repository
- highly automated



Executed process through integrated BPMN engine

2. As a model validator

- responsibility for data is handed off to 1st line
- Focus on SME tasks (rest is automated)
- Share info between lines transparently

3. As a model validation manager

- optimizing resource allocation
- gathering data on the entire process

AI and ML

Where can AI help with MRM?

- data cleaning
- benchmarking
- measuring report quality
- detecting a-typical reports
- model risk quantification
- model issue detection

How to introduce AI in the firm

*Five principles, originally formulated in a paper by Stanford U, UC Berkeley, Google Brain and Open AI**

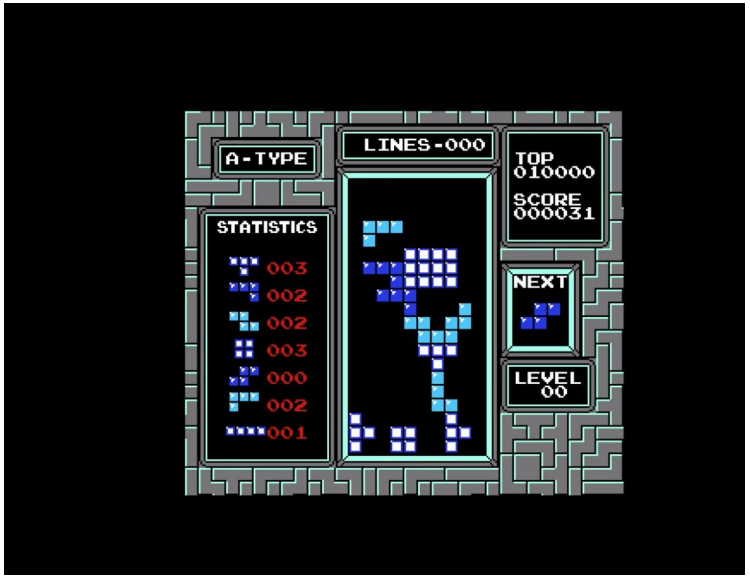
1. Avoid negative side effects

E.g. the AI tries to trigger defaults when loan margin turns negative.

* See https://arxiv.org/abs/1606.06565

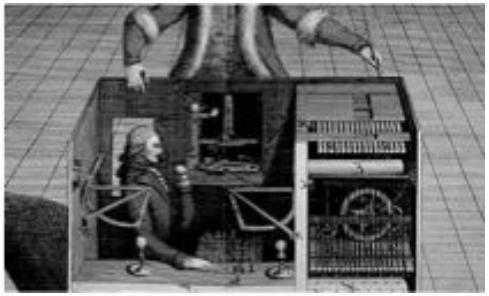
Frameworks - AI safety

2. Reward hacking



Frameworks - AI safety

3. Scalable oversight



If atypical collateral (such as artwork) is encountered, the AI has to reach out to experts if there is too much uncertainty.

Frameworks - AI safety

4. Safe exploration

E.g. AI tries to re-introduce Ninja loans to learn about new possible client segments

Frameworks - AI safety

5. Robustness against distributional shifts

This can be very subtle: “Adversarial examples”*
An example of data hacking

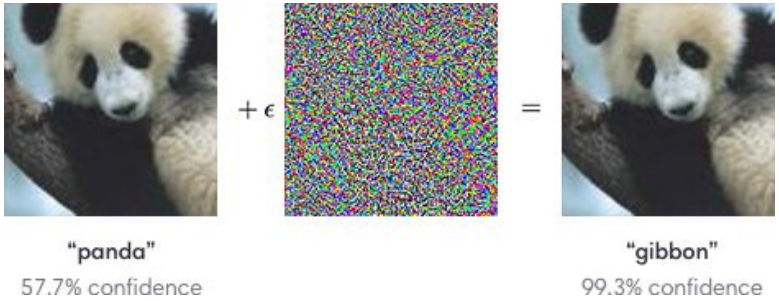
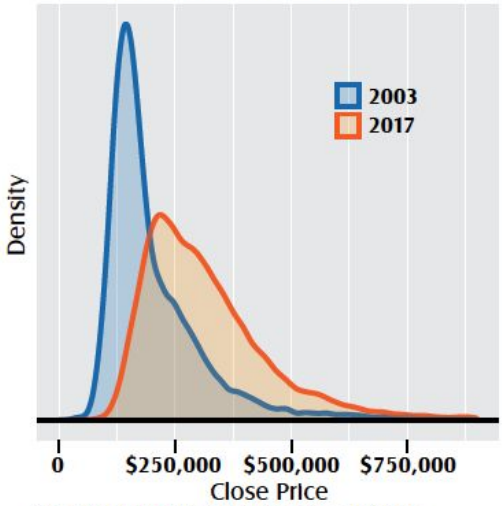


Figure 1. Texas Single-Family New-Home Sales Distribution (by Year)



Note: The probability density functions specify the probability that home sales occur within a particular range of values. The probability is measured by the area under the curve within the range (e.g., within $190,000 and $250,000).
Source: Real Estate Center at Texas A&M University

* See https://arxiv.org/abs/1312.6199

Conclusion

MRM is going through an industrialization phase

Technology is available to support this transition

which will allow for more efficient MRM

allowing institutions to capture the added value of advanced analytics more consistently

Thank you!

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