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AI & ML in Risk Management

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Presentation Structure

- Definitions & Context
  - Machine Learning & Artificial Intelligence
  - Risk Management
  - Where and when
- Applications (Finance industry)
  - Current
  - Projected
- Critique
  - Risks in applying ML and AI

Quickly

More slowly

Let's take a week or two on this

Definitions & Context

- Machine Learning
- Artificial Intelligence
- Risk Management
- Where and when

Machine Learning

- It’s not new!
  - Standard statistics applied
- Common methods
  - Regression in all its forms inc. GLM
  - Decision trees – ditto
  - Clustering
  - PCA

Artificial Intelligence

- It's artificial, but it's not intelligence
  - *Idiot savants*
- Big advances over last few years:
  - Much faster computing power
  - Better deep learning algorithms
  - Lots more data

- Deep learning
  - Layered neural networks

Risk Management

- Are you sure you know what risk management is?
  - Market, credit, operational ?
  - 3 Lines of Defense?
  - Enterprise Risk Management?
- CERA qualification
- ISO 31000

Risk Management =

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Good Management!

Management = people

Q. Where do most losses come from in an organization?

A. People making mistakes or not following rules.

AI and ML have very little to help us with mitigating this risk factor.

AI is maths!

creates a more cost effective representation of X. Suppose that we have N input vectors $X = \{x_1, \ldots, x_N\} \in \mathbb{R}^{M \times N}$ and N output (or target) vectors $\{x_1, \ldots, x_N\} \in \mathbb{R}^{M \times N}$. If (for simplicity) we set biases to zero and use one hidden layer ($L = 2$) with only $K < N$ factors, then our input–output *market-map* becomes

$$Y(X)_j = F^{W,b}(X)_j = \sum_{k=1}^{K} W_2^{jk} f\left(\sum_{i=1}^{N} W_1^{ki} x_i\right)$$
$$= \sum_{k=1}^{K} W_2^{jk} Z_j \text{ for } Z_j = f\left(\sum_{i=1}^{N} W_1^{ki} x_i\right),$$

for $j = 1, \ldots, N$, where $f(\cdot)$ is a univariate activation function.

Because, in an auto-encoder, we are trying to fit the model $X = F^{W,b}(X)$, in the simplest possible case with zero biases, we *train* the weights $W = (W_1, W_2)$ via a criterion function

$$\mathcal{L}(W) = \arg\ \min_W \|X - F^W(X)\|_2^2 + \lambda\phi(W)$$
$$\text{with} \quad \phi(W) = \sum_{i,j,k} \left|W_1^{jk}\right|_2^2 + \left|W_2^{ki}\right|_2^2,$$

where λ is a regularization penalty.

If we use an augmented Lagrangian (as in alternating method of multipliers) and introduce the latent factor Z, then we have a criterion function that consists of two steps, an encoding step (a penalty for Z), and a decoding step for reconstructing the output signal via

$$\arg\ \min_{W,Z} \|X - W_2 Z\|_2^2 + \lambda\phi(Z) + \|Z - f(W_1, X)\|_2^2,$$

where the regularization on W_1 induces a penalty on Z. The last term is the encoder, the first two the decoder.

Where to use it in RM?

Mathematically well-defined problems

Lots of data

Implementable in the organization

Regulatory acceptable

Ethically sound

Application in RM

Current (broad categories):

- Market, credit risk (upside & downside)
- Liquidity, stability
- Compliance (OR type problems)
- Underwriting

Application in RM

Future:

- General improvement in all of the above
  - Better data
  - Better communications to end users
- Integration of silos of application
- Culture
  - Does the firm have the right risk management culture?

Critiques

The future is bright, I love this stuff!

BUT

It's paradoxical:

- Overhyped and undersold
- adopted too quickly and underutilized
- not implemented well

Effective governance is needed

AI – beware the hype

The *deep frontier* generalizes Markowitz's concept by saying that, rather than plotting model mean against model standard deviation, we should plot validation performance against relevant constraints (where the constraints can originate in either implementation or validation). At its core, the deep frontier simply highlights that in Markowitz's approach, the assumption is made that the model is descriptive of the future, whereas the deep frontier demands a focus on validation and out-of-sample performance. (At its simplest, this is given when plotting validation mean against validation standard deviation, a basic data-driven comparison but normally much less clear than Markowitz's model.)

- Lots of ML and AI show improvements over strawman models in finance and banking
- Unfortunately too many of these "strawman" models are still being used

Governance

Has the risk been assessed properly?

- Is it ethical?
- Is the model biased?
- Are applications within risk appetite?

Communications:

- Have senior management, AA, and Board been properly informed (do they know what is exactly being done?)
- Regulatory concerns?

Governance

Who is handling model risk? And how?

Who signs off on an application?

Are the values of the organization affected?

Is there a corporate strategy on this?

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Thank you!

Questions?