

*AI & Machine Learning Applied to Investment
Management: Beyond the Hype*

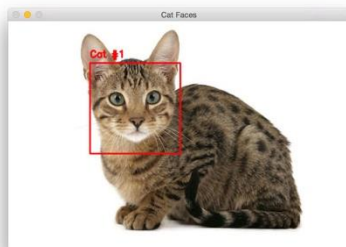
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Automating Optimal Investment Decision Making

From investment discipline to intelligent agents



- A device that perceives its environment and takes actions that maximize its chance of success at some goal
- [T2 sensing its environment and seeking to eliminate Sarah Connor]



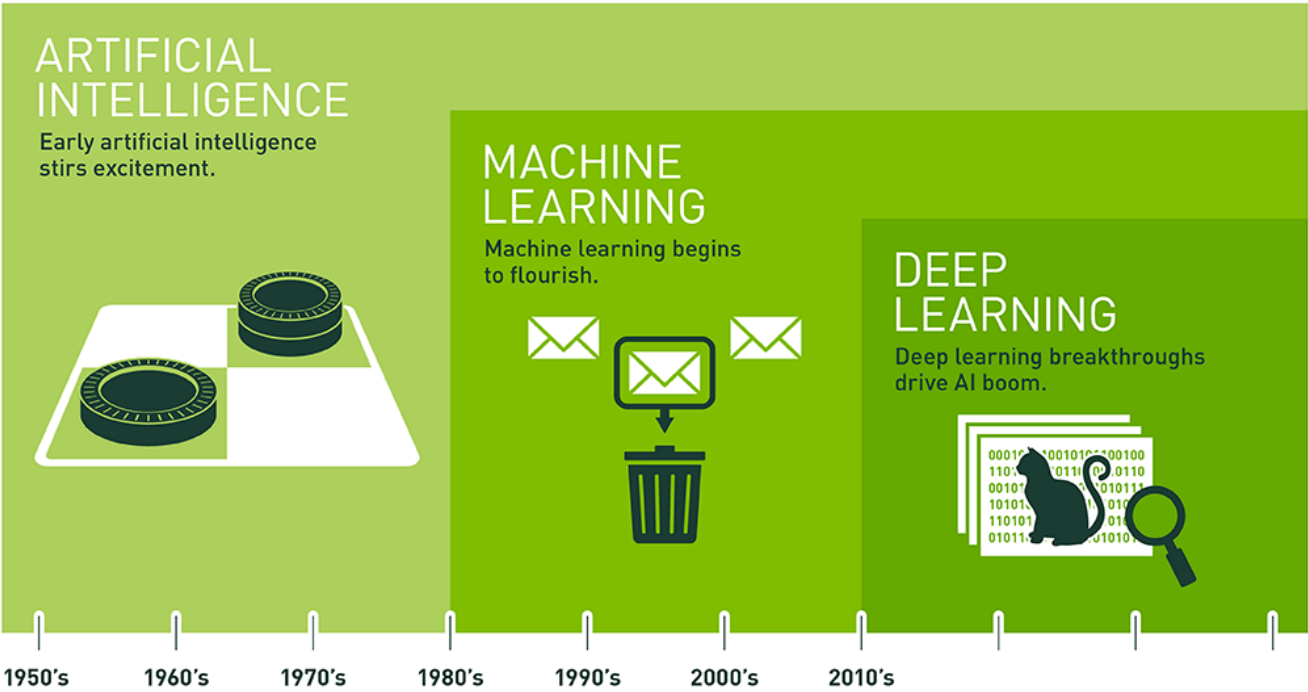
- When we know how a machine does something "intelligent", it ceases to be regarded as intelligent...it's perceived as doing "only" data mining or optimization
- [Face recognition by cameras rarely associated with AI]



- A well structured process in terms of environment: market information & portfolio accounting, buy and sell decisions, risk-return target and restrictions
- [... we'll be mostly talking about quantitative/empirical finance rebranded as AI]

Major Achievements of AI

Ever larger disruptions: games, spam filters and cats!



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Major Goals of AI

Intelligent behaviour by machines

Machine Learning	<ul style="list-style-type: none">▪ Finding patterns, predicting outputs, predicting optimal actions
Reasoning, problem solving	<ul style="list-style-type: none">▪ Optimal decision making under uncertainty
Planning, scheduling	<ul style="list-style-type: none">▪ Find optimal path to achieve a set goal
Natural language processing	<ul style="list-style-type: none">▪ Read and understand human language
Perception	<ul style="list-style-type: none">▪ Use inputs from sensors
Motion and manipulation	<ul style="list-style-type: none">▪ Localization, mapping and motion planning

Major Goals of AI Applied to Investment Management

Focus on machine learning and optimization

Machine Learning	<ul style="list-style-type: none">▪ Learn from data to predict returns or buy/sell decision
Reasoning, problem solving	<ul style="list-style-type: none">▪ Design optimal target portfolio
Planning, scheduling	<ul style="list-style-type: none">▪ Optimal trade scheduling to move from current to target portfolio
Natural language processing	<ul style="list-style-type: none">▪ Most information is already numeric
Perception	<ul style="list-style-type: none">▪ Mostly no need for sensors
Motion and manipulation	<ul style="list-style-type: none">▪ Mostly achieved by book-keeping

Machine Learning vs. Statistics

Both disciplines significantly converged over the past decade

Glossary

Often doing the same things

Naming it differently

Machine learning	Statistics
network, graphs	model
weights	parameters
learning	fitting
generalization	test set performance
supervised learning	regression/classification
unsupervised learning	density estimation, clustering

Market Neutral Long/Short Stock Selection

A simple systematic/automated trading framework to test various methods

Objectives

- Market neutral long/short stock selection
- Maximize Sharpe ratio
- Targeting 10% volatility p.a.

Simulation

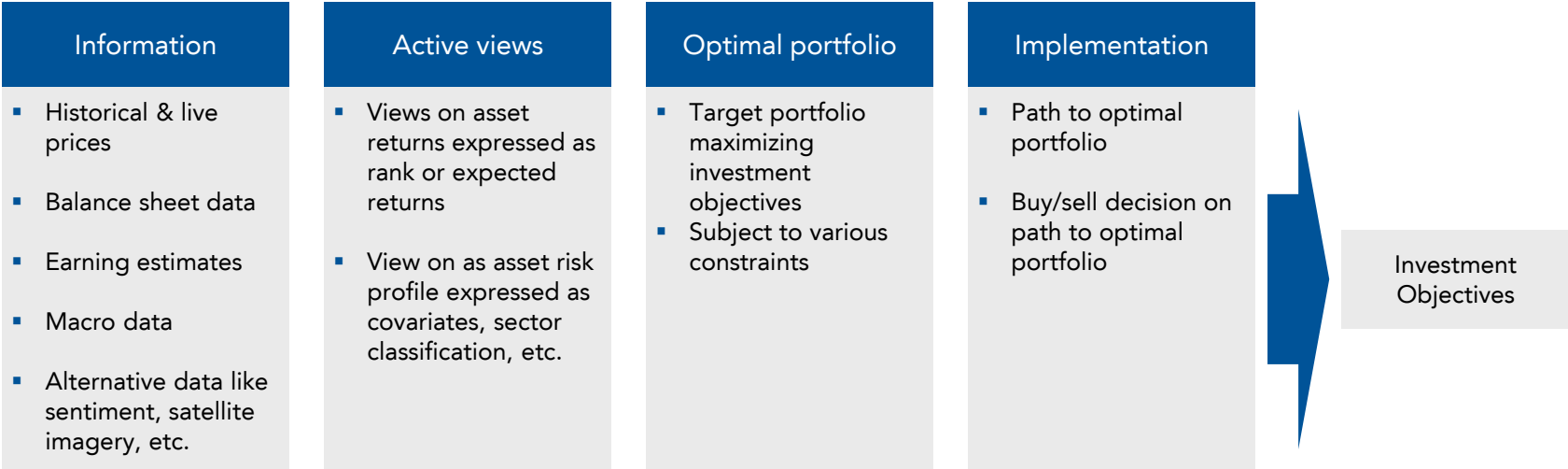
- UK FTSE 100 stocks since early 00', fundamental, price and volume data
- GBP100m trading capital, transaction cost estimates, daily trading
- Rolling forward analysis, 1 year calibration period

Test impact of various ML/AI approaches

- Supervised learning for return forecast
- Unsupervised learning for stock clustering and portfolio construction
- Dynamic programming for optimal trading moving from current to target portfolio

Investment Management Process

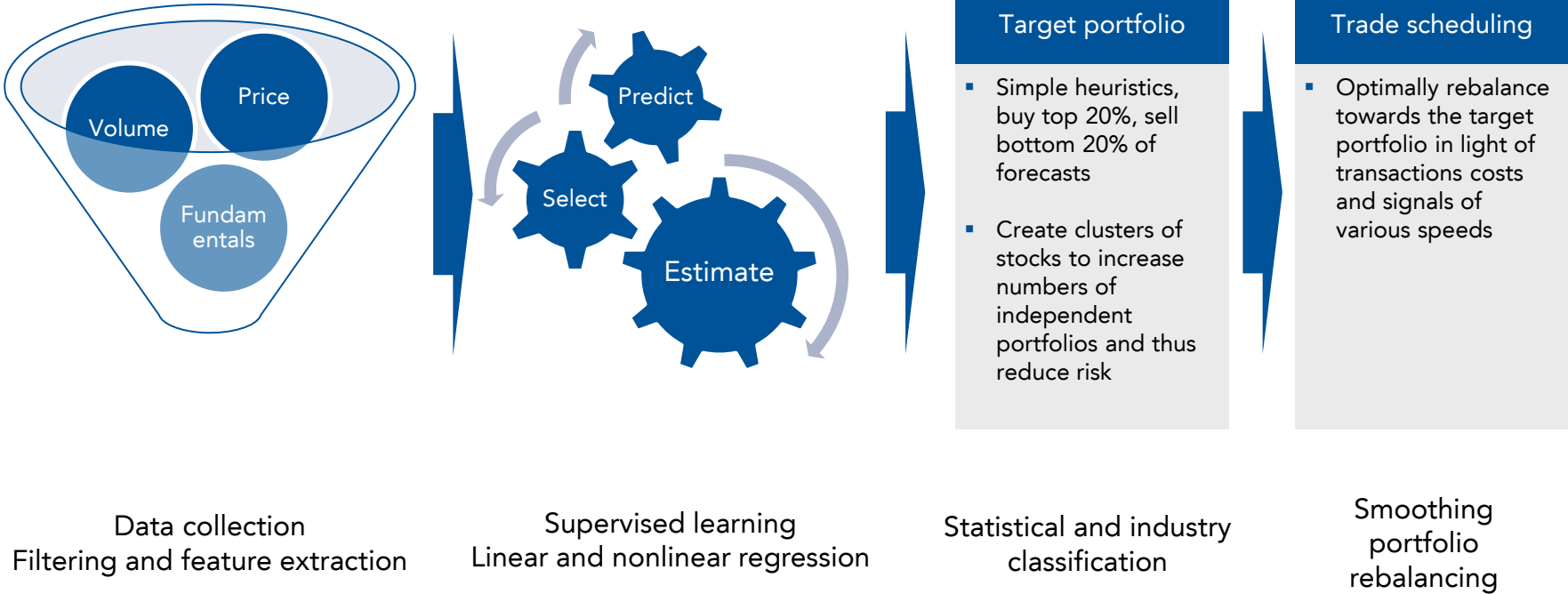
Established and well-defined



Book-keeping and risk reporting: profit & loss, balance sheet, VaR, trade details (costs, implementation, lag)

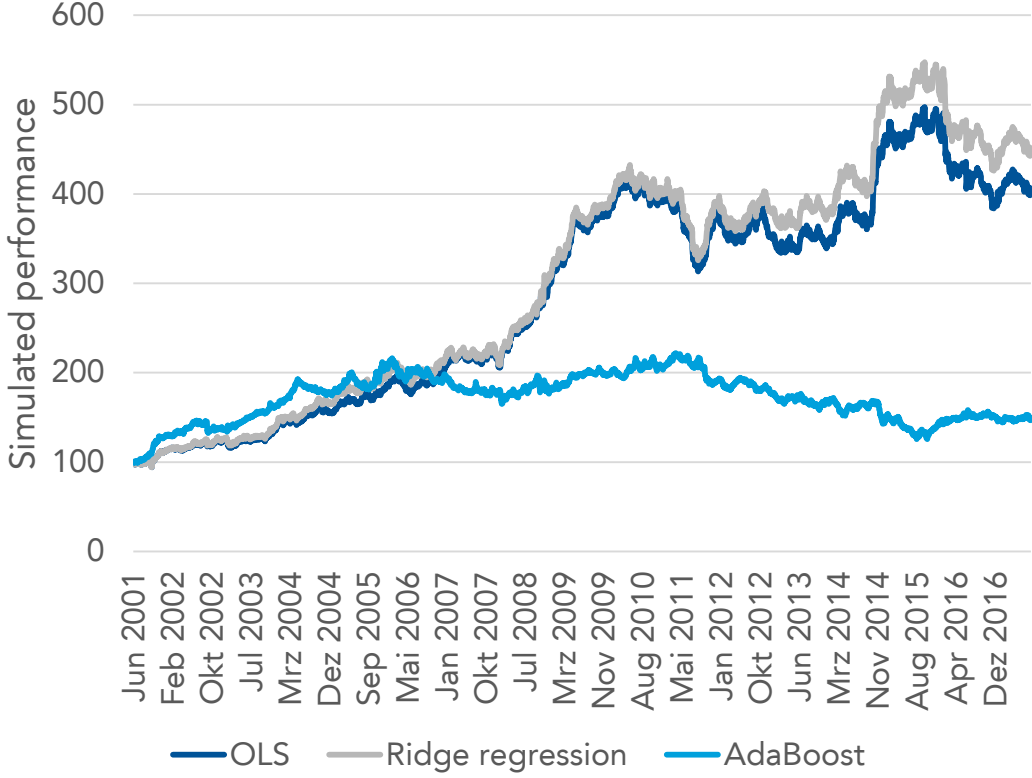
Basic Modelling Framework

Applying AI across the investment process



Supervised Learning

More sophisticated learners do not always perform better

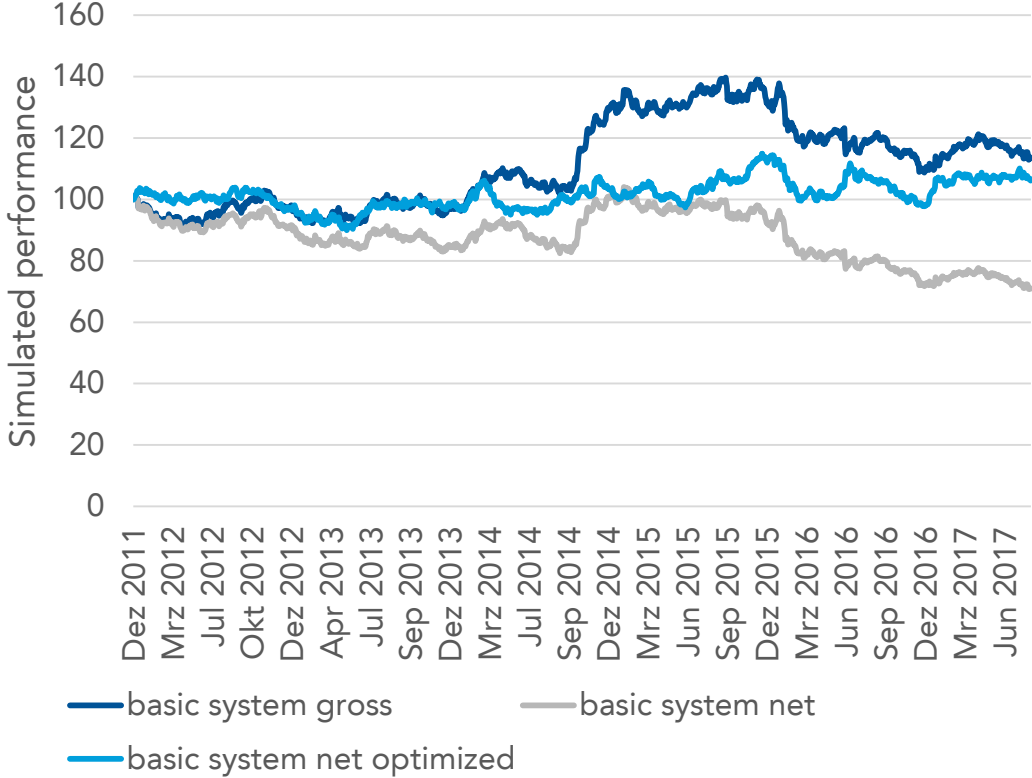


Simulation parameters
GICS sector neutral book
Buy/sell top/bottom 10%
Gross of transaction costs
No trade scheduling

Simulation parameters
Sharpe ratio = 1.0
Realized volatility = 10%
Gross exposure = 2 x
Turnover = 50% daily

Dynamic Programming

Optimal trading towards target portfolio to minimize transaction costs



- Initial ridge regression/sector neutral model gross and net of transactions
- Further optimization of transaction costs through trade scheduling

The Rise of The Machines?



Relax!

Old stuff

- AI has been applied to investment decisions for such a long time that it is seen there as mere optimization, statistics or economic analysis

Noisy & limited dataset

- Classical linear statistical models are most often sufficient to capture the bulk of alphas

Supervision & expert knowledge

- Learning is mostly supervised and requires serious expert knowledge

Industry Outlook

Skynet (Terminator) supposedly became self-aware on August 29th 1997

Machines

- Best at quickly analyzing linear relationships in high dimensions
- Focus on liquid and standardized markets
- Handling of large portfolios and frequent transactions

Humans

- Best at quickly finding complex non-linear patterns in low dimensions
- Focus on specialized and illiquid opportunities
- Handling of bespoke and infrequent transactions

Future

- Shift to automated strategies is already happening
- Driven by investors demand for lower costs and diversifications, e.g. ETF flow
- Driven by regulators; what can be codified can be automated

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