



AI in Investing

Rani Piputri, CFA, CAIA

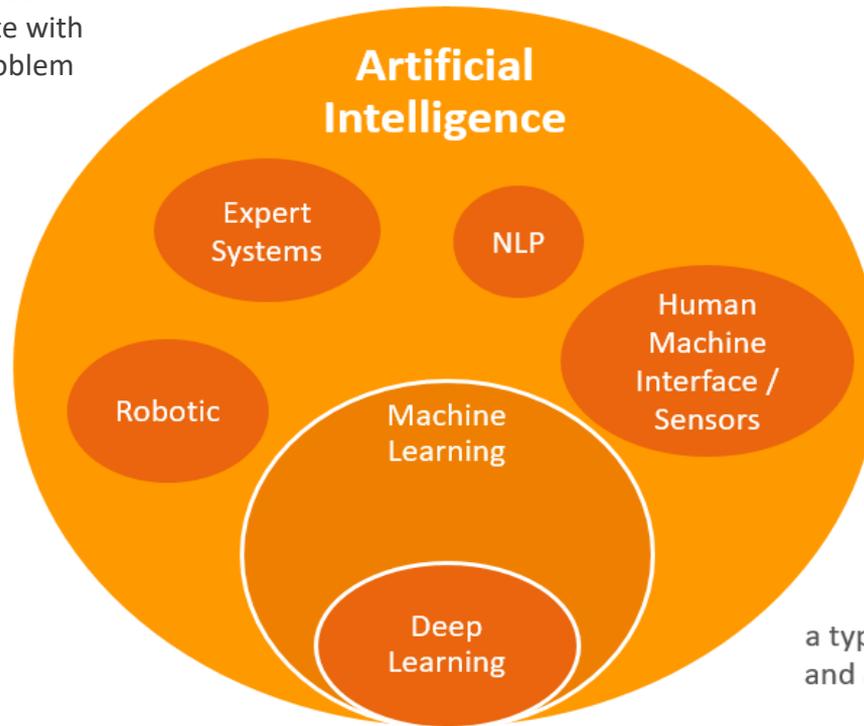
Head of Automated Intelligence Investing
NN Investment Partners

June 2020

What is Artificial Intelligence (AI)?

Artificial Intelligence is intelligence exhibited by machines or software, as opposed to intelligence exhibited by life forms, such as humans and animals.

Machines mimicking cognitive functions that humans associate with the mind, e.g. learning and problem solving



AI is a form of intelligence, a type of technology, and a field of science

AI and Automation

Hardwired
/specific
systems

Adaptive
systems

Human in
the loop

No human
in the loop



Assisted Intelligence

Using data and analytics to drive business insights within existing decisions and actions

Automation

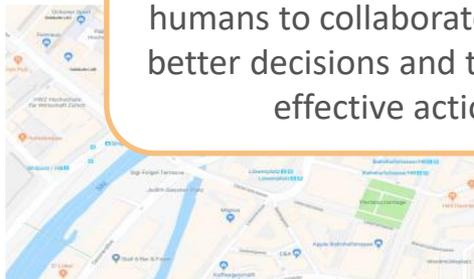
Automating business processes previously performed by humans

Augmented Intelligence

New ways for computers and humans to collaborate in making better decisions and taking more effective actions

Autonomous Intelligence

Systems that are adaptive and can autonomously carry out tasks without human intervention



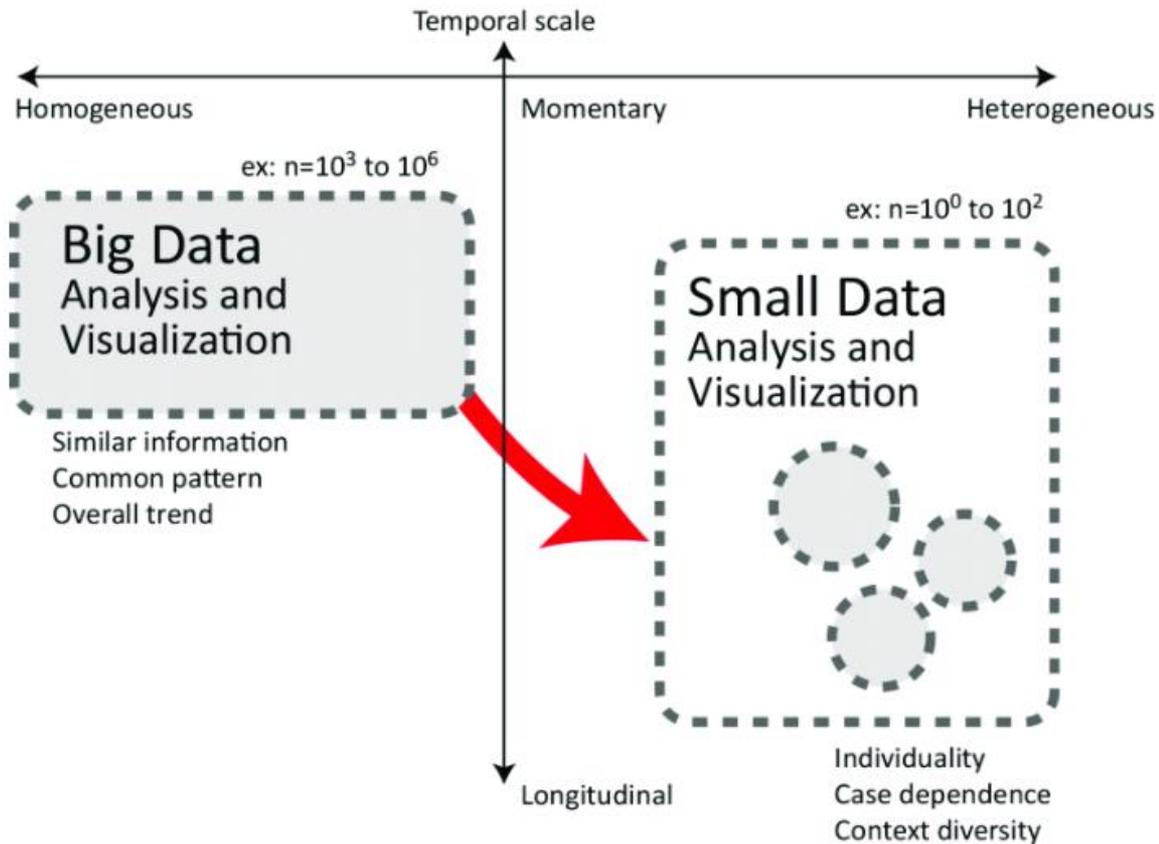
Source: Data Ahead Analytics

AI in Investing – why now?

Niche area becoming mainstream, enabled by:

1. **Big data**: increasing dimension, availability and access of new data / insights
2. Availability and advancement in **tools**: refinements in analytics and forecasting devices
3. Increasingly **complex** investment landscape
 - Discovery of new sources of return
 - Better forecast in anticipating changes in market structure
 - Increasing visibility of non-linear relationships in the market

Big Data



- **Faster and cheaper** to record, store, process and retrieve **more** data.
- The flood of data is generated by **humans** (e.g. social media) and **machines** (e.g. sensors).
- Unstructured data adds richness to structured data.
- Traditional data complemented by alternative data.

Alternative Data

Traditional data like company financial releases or government reports is lagged and difficult to access.



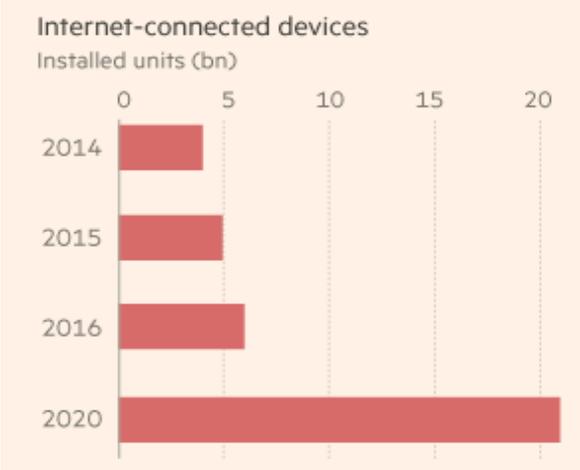
Alternative data is collected from new sources such as web tracking or blogs/tweets which can then be structured and converted into a system of information.



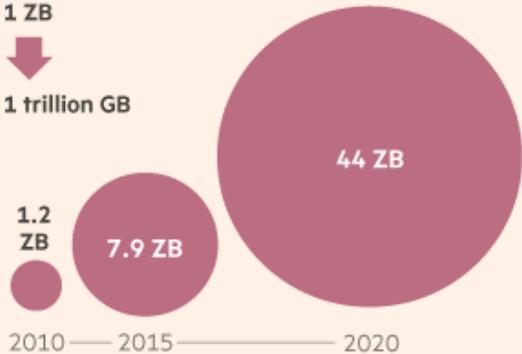
Source: Neudata

Internet of Things

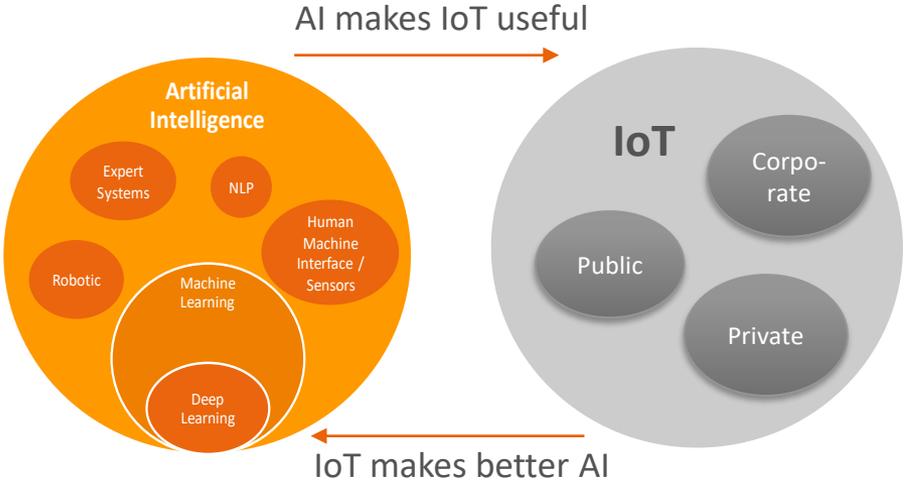
The Internet of things (IoT) is the extension of Internet connectivity into physical devices and everyday objects.



Growth of global data
zettabyte

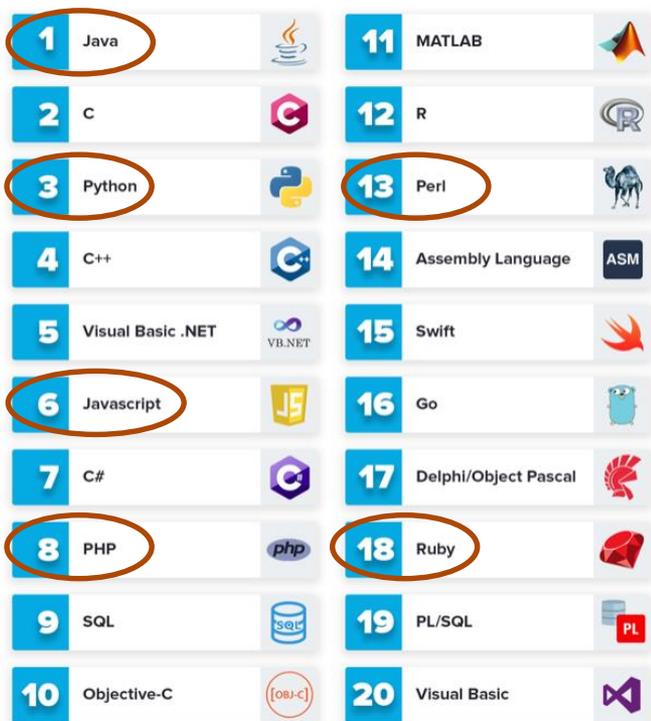


Source: Financial Times



Open Source Technologies

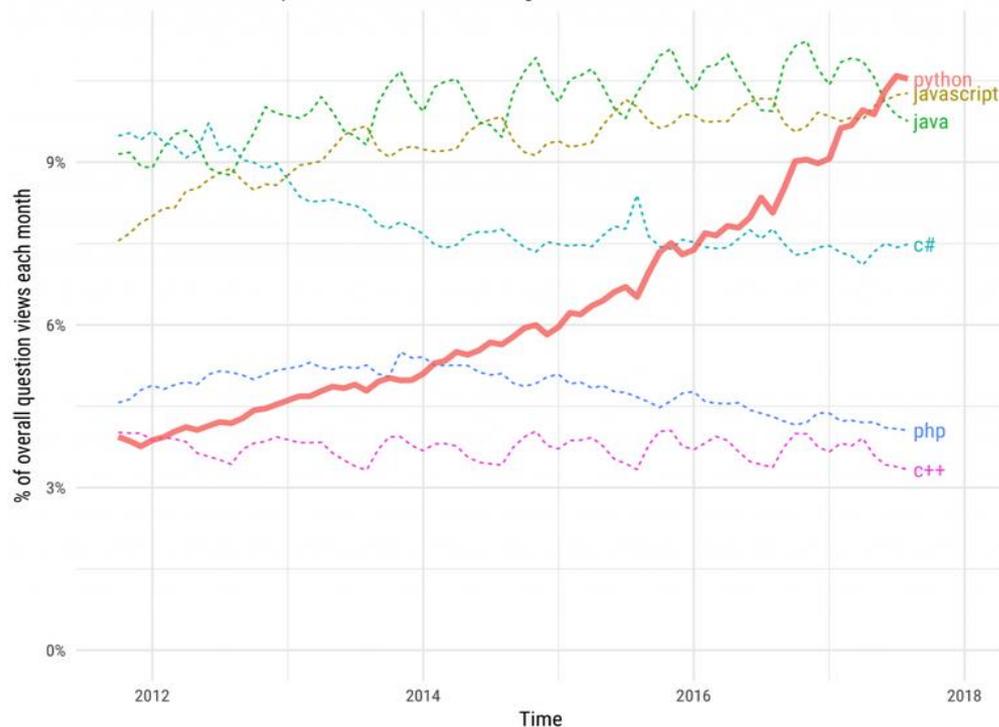
Proliferation of **open source** codes and **free** programming languages propel ability to turn data into information.



TIOBE calculates the rating of a programming language based on the number of hits on popular search engines such as Google, Youtube, Yahoo, Wikipedia, Amazon, Baidu, and Bing. They also consider the number of courses offered, third-party vendors and the number of skilled engineers worldwide. <https://tiobe.com/tiobe-index/>

Growth of major programming languages

Based on Stack Overflow question views in World Bank high-income countries

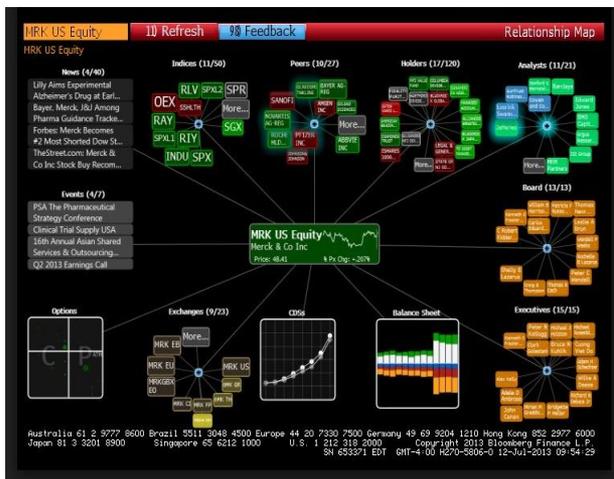


Visits to Python-tagged questions have overtaken Java and JavaScript for the first time.

Analytics and Forecasting

Increasing number of software, systems and APIs for analytics and forecasting

- Improved visualization
- More flexibility and customization
- Faster and intuitive



AI Based Techniques for Investing

AI has developed tools in areas that are relevant for investing:

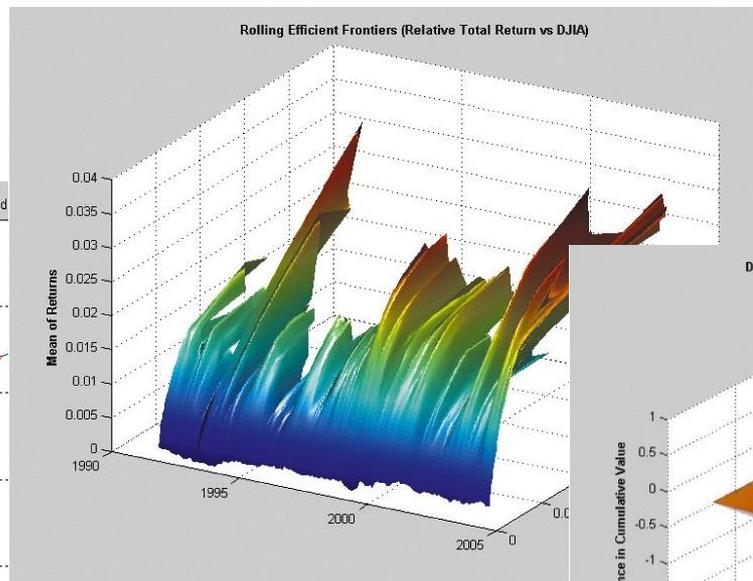
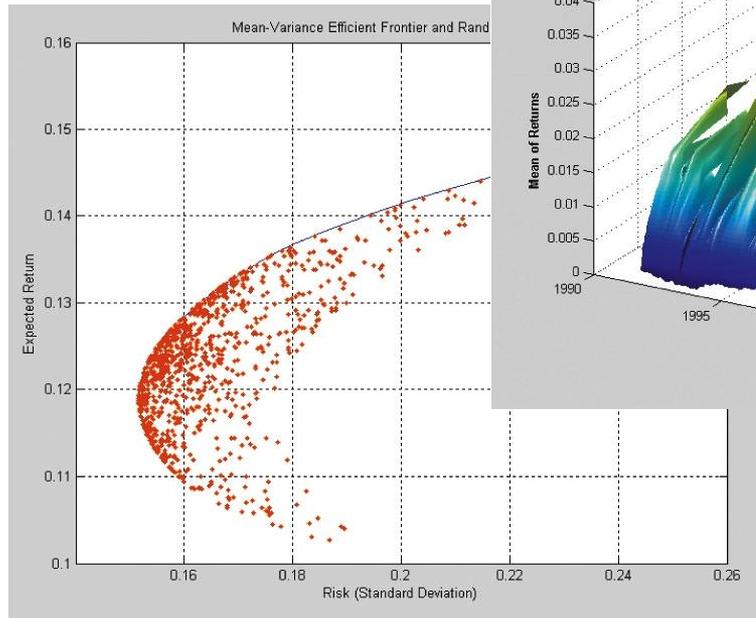
- Search and Optimization
- Classifiers and statistical learning
- Probabilistic methods

Search and Optimization

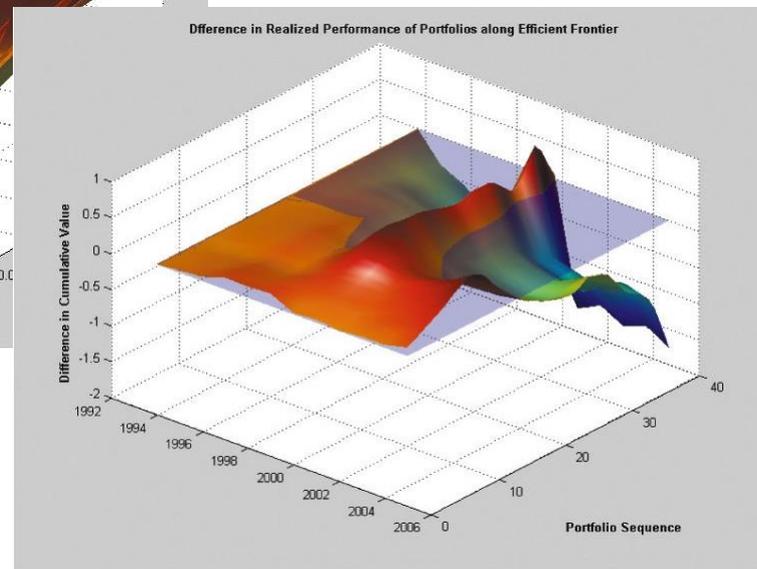
Robust and Faster Portfolio Optimization

... to finding a stable region ...

From mean-variance...



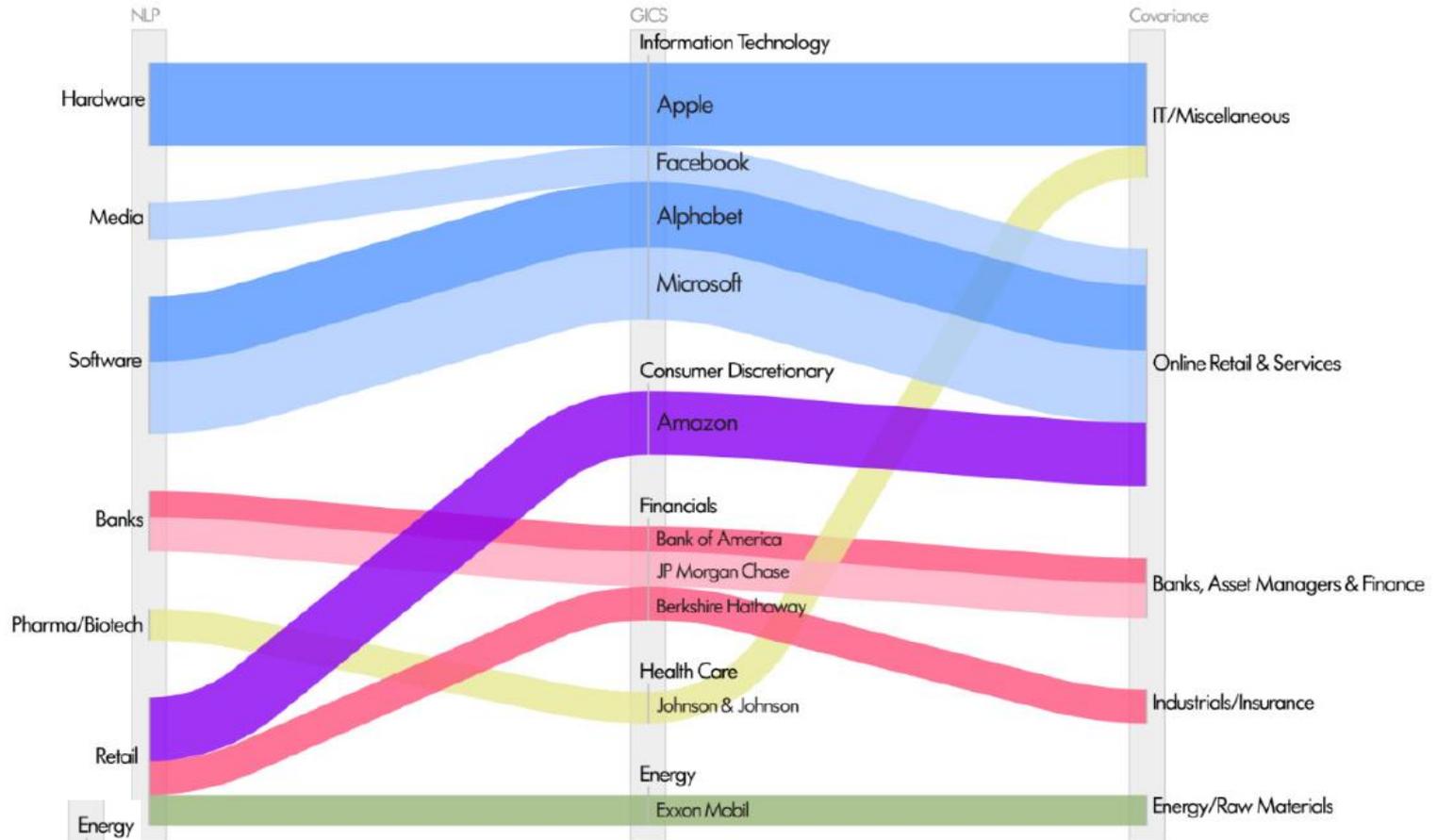
... to portfolio evaluation



Source: Matlab

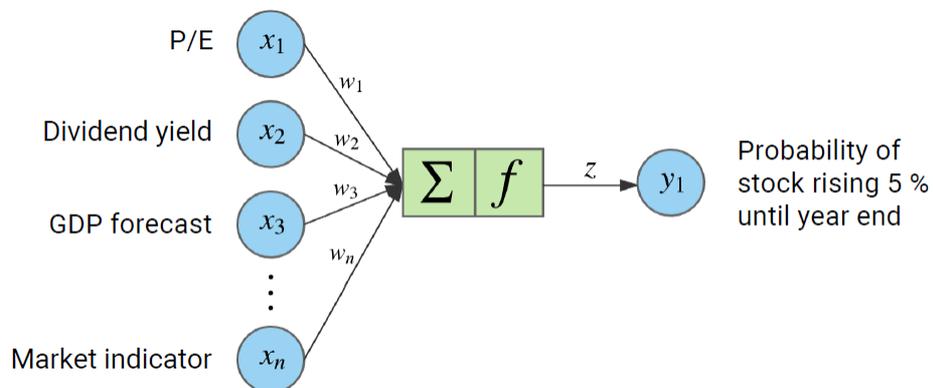
Classifier and Statistical Learning

How 10 largest US companies are categorized according to AI



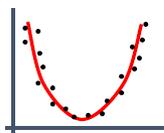
Source: Winton Research

Probabilistic Methods

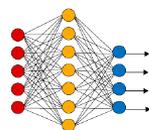


New methods are introduced to explore and generate more accurate economic forecasts.

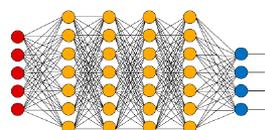
- Machine Learning techniques
→ not without controversies!
- Inspired by non-finance/economic disciplines
 - Evolutionary biology (e.g. survival of a trading strategy)
 - Thermodynamics (e.g. order and disorder of economic systems)



Simple regression model



Simple neural network



Deep neural network

Increasing Complexity in Investing

- In theory we have rational investors and efficient markets. In reality, emotions and irrationality play a large role.
- Market structures change from time to time as the dominance by type of participants or investment themes shift
 - Increasing usage of passive instruments and derivatives
 - Increase in speed of information processing
- Relationships in financial markets are far from linear
 - Interaction among and between corporates, investors and regulators are rarely a straight line
 - Cause and effect in financial markets are bounded by conditionality

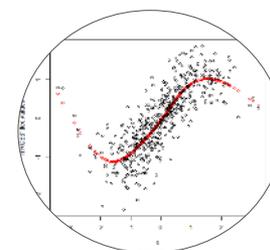


Source: wikipedia, market sentiment



“Watching the ticker tape in 1918”

Source: National Archives and Records Administration

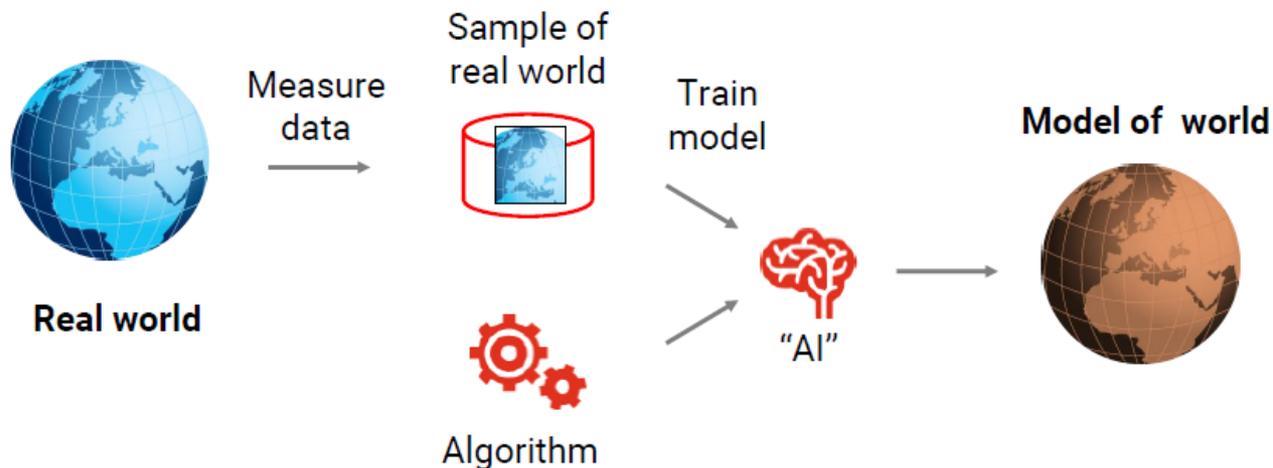


Source: NNIP Research

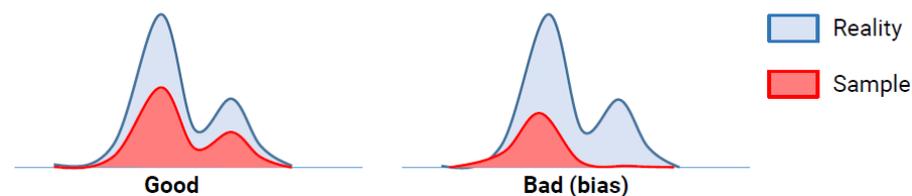
How to bring into practice

AI
in
**Investment
Management**

Understand and Build Data Culture



- The foundation of artificial intelligence is **data**.
- Even perfectly implemented algorithms will fail without the right data.
- Data is not equivalent with 'reality'.



Understand and Build Data Culture

Data is oil, but information is fuel.

Big Data needs refinement to generate added value.

Works with:

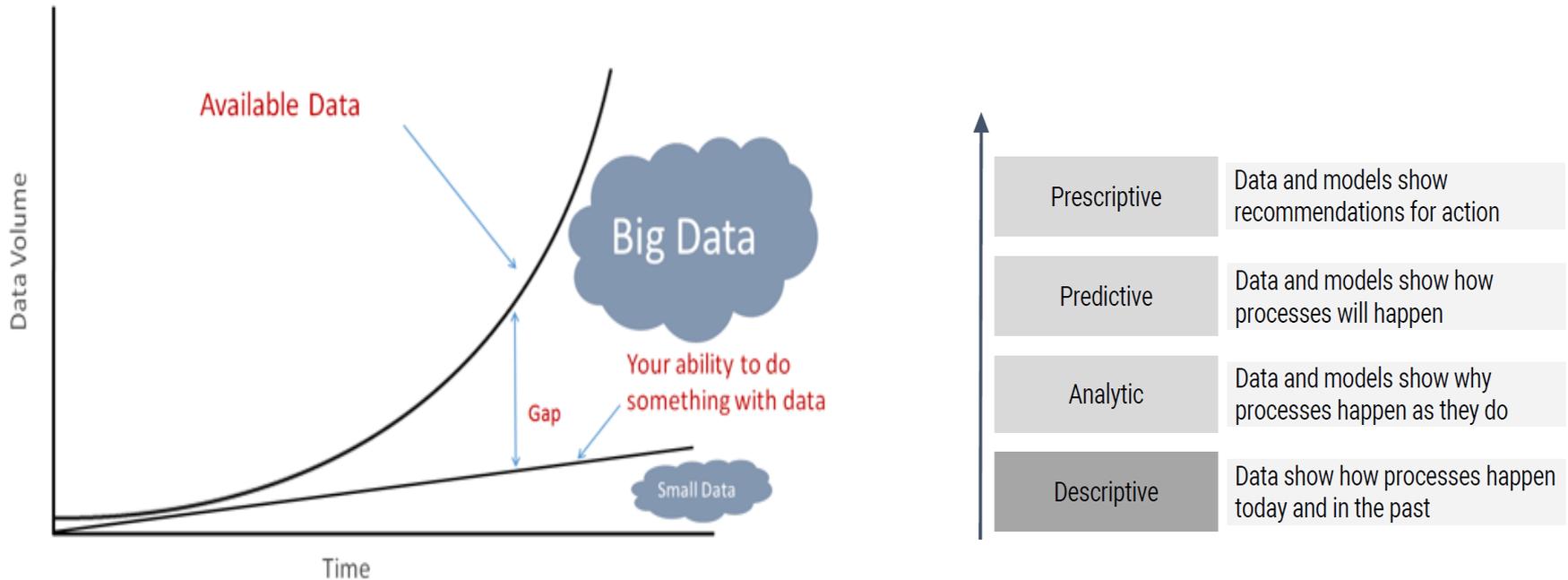
- **Disciplined teams**, in
- **Explorative settings**, where
- Use / **business cases have yet to be identified** / shaped

Otherwise, much effort in data management for minimum return.

Challenges

- **Data acquisition** and heterogeneity : Data are existing, but neither accessible across system boundaries, nor of sufficient quality
- **Data analytics** : Expert knowledge is required to develop effective models with data
- **AI value chain** : Models and software architectures hardly allow dynamic changes and exist in their own silo

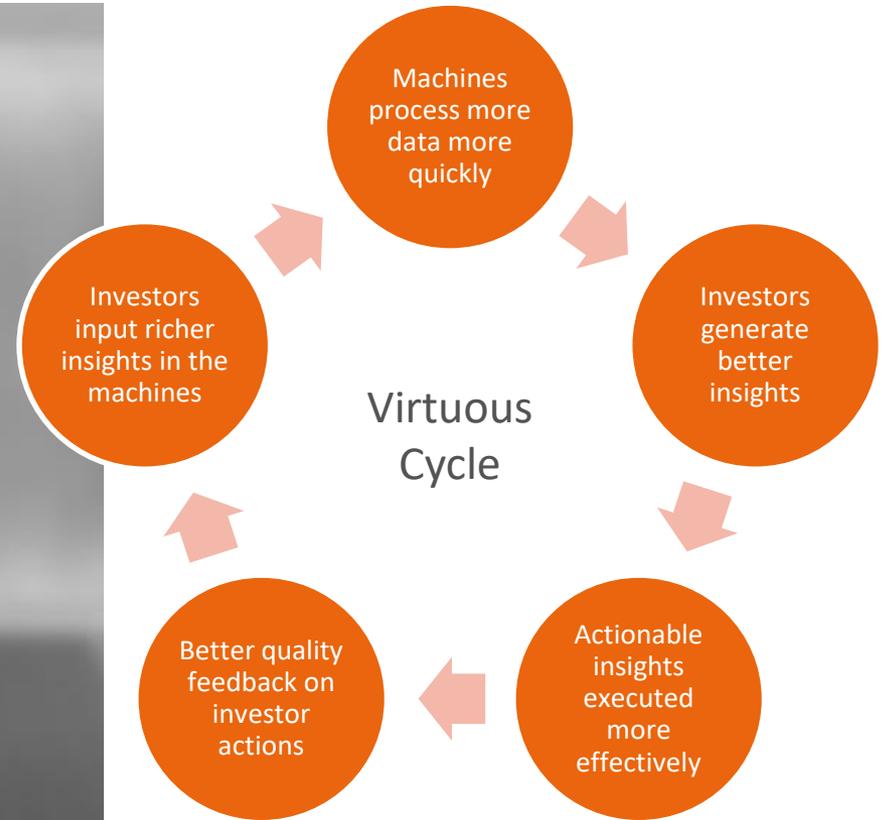
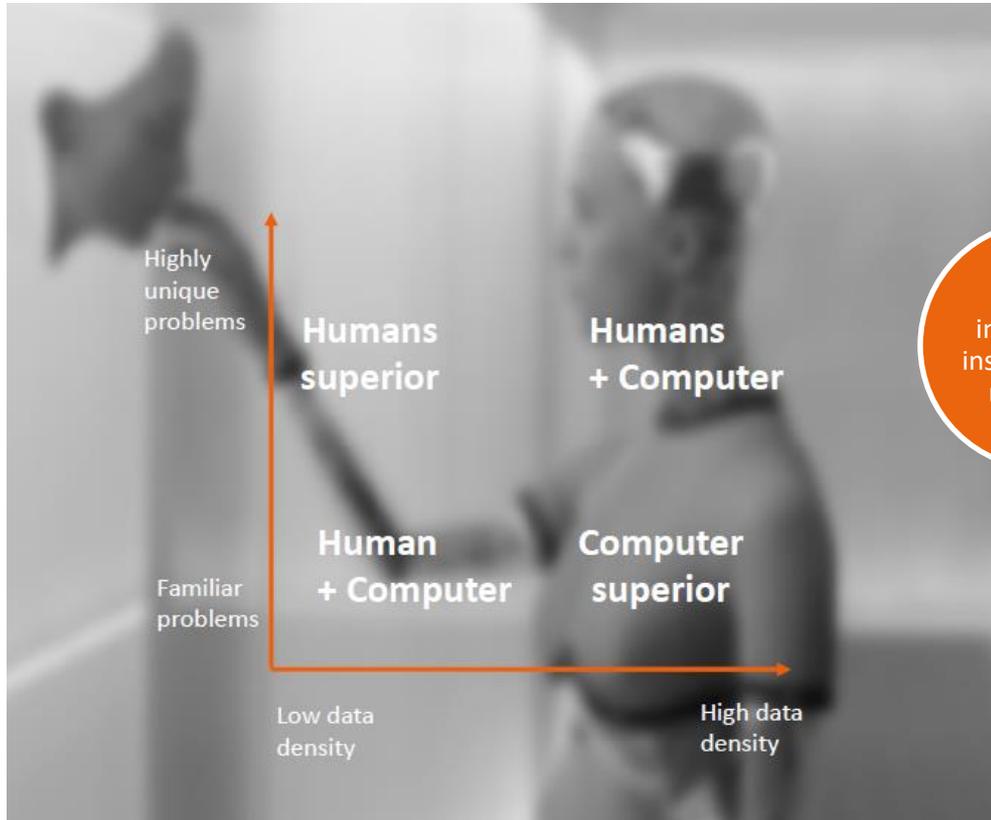
Develop and Stimulate Domain Experts



- Knowledge Gap: The difference between collecting data and understanding data
- Execution Gap: The difference between understanding data and acting on it

Man and Machine

How do man and machine synergize each other?



CONCLUDING REMARKS

- Big Data and Artificial Intelligence are here to stay. They are means for **evolution** - not *revolution* - of investors, investments and markets.
- What does it mean for investment professionals? How to be future proof?
 - Take the driving seat
 - Increase numerical literacy and invest in technological skills & tools
 - **Keep the big picture and the problem at hand**

*AI can only help you solve the problems, if you know how to **identify the problem** and **formulate it in a solvable form**.*

Disclaimer

This document is strictly for professional /institutional investors use only and not for use in public.

This document, including any statements, information, data and content contained therein and any materials, information, images, links, sounds, graphics or video provided in conjunction with this document (collectively “Materials”) are being furnished by NN Investment Partners and/or its affiliates (together, “we”, “us” or “our”) upon request for your general informational purposes only. The Materials are not intended for use by persons in jurisdictions which prohibit or restrict the distribution of the Materials. Under no circumstances should the Materials, in whole or in part, be copied, reproduced, redistributed or shown to any person. The Materials do not constitute a distribution, an offer, an invitation, recommendation or solicitation to sell or buy any securities in any jurisdiction where such activity is not authorised or unlawful or where the person making such distribution, offer, invitation, recommendation or solicitation is not qualified to do so. It is your responsibility to be aware of and to observe all applicable laws and regulations with respect to your dealings in investment products. Without limiting the generality of the above, the funds described are not available for distribution to or investment by US Persons.

We do not provide any legal or tax advice and none of the Materials constitute or should be construed as providing any investment, legal or tax advice. We are not acting as your financial adviser or in a fiduciary capacity in respect of any securities transaction unless otherwise expressly agreed by us in writing. We or our directors or employees do not make any express or implied representations or warranties as to the accuracy, timeliness or completeness of the Materials and nothing shall be relied upon as a promise or representation by us. We or our directors or employees will not be liable or responsible to you or any other parties for any and all liabilities arising directly or indirectly from any reliance on the Materials. We are not responsible for information stated to be obtained or derived from third party sources or statistical service. Certain of the statements contained in the Materials are statements of future expectations and other forward-looking statements. These expectations are based on our management’s current views, assumptions or opinions and involve known and unknown risks and uncertainties. Views, opinions and estimates may change without notice and are based on a number of assumptions which may or may not eventuate or prove to be accurate.

Any past performance, prediction, projection or forecast is not necessarily indicative of future or likely performance. The value of investments and the income from them, if any, may fall as well as rise. Actual results, performance or events may differ materially from those in such statements due to, among other things, (i) general economic conditions; (ii) performance of financial markets, including emerging markets; (iii) interest rate levels; (iv) currency exchange rates; (v) general competitive factors; (vi) changes in laws and regulations; (vii) conditions of the issuers and counterparties of the investments; and (viii) changes in the policies of governments and/or regulatory authorities. If you are unsure of the meaning of any information provided please consult your financial or other professional advisor. We assume no obligation to update any information, including but not limited to forward looking information, contained in the Materials. By accepting delivery of this document, you irrevocably understand, acknowledge, agree and accept the foregoing disclosures.

The Materials have not been reviewed by any regulatory authority in your jurisdiction. Investment involves risk including a possible loss to the principal invested.
Issued by:

NN Investment Partners