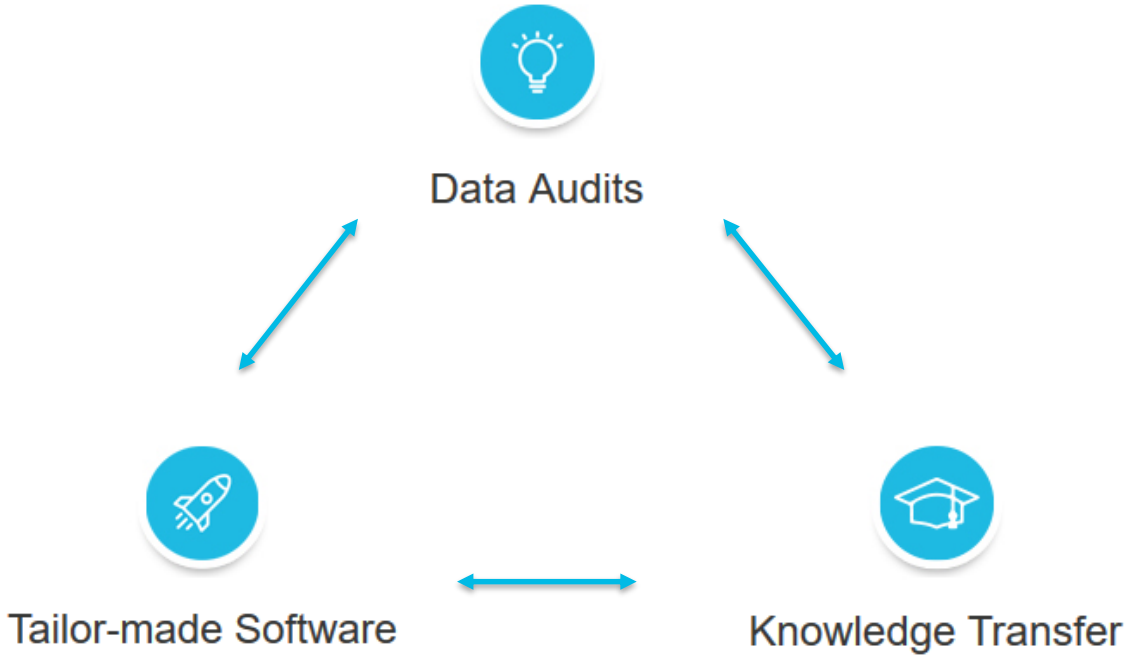
ML²GROW

COMPANY PRESENTATION

What we offer



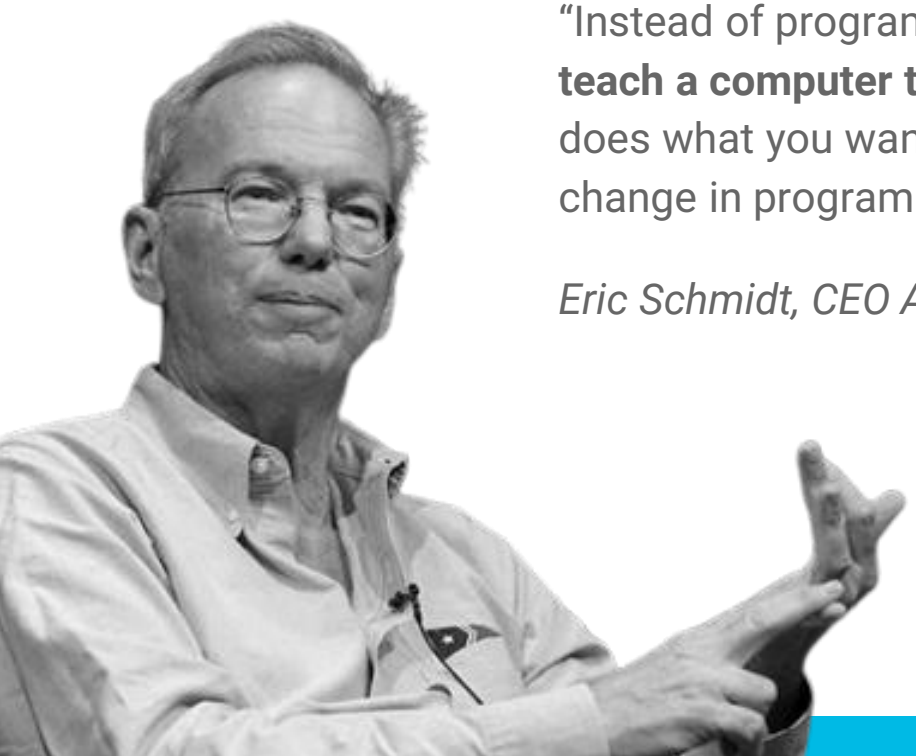
ML²GROW

ADVANCED
MACHINE
LEARNING

ML²GROW

What we believe in

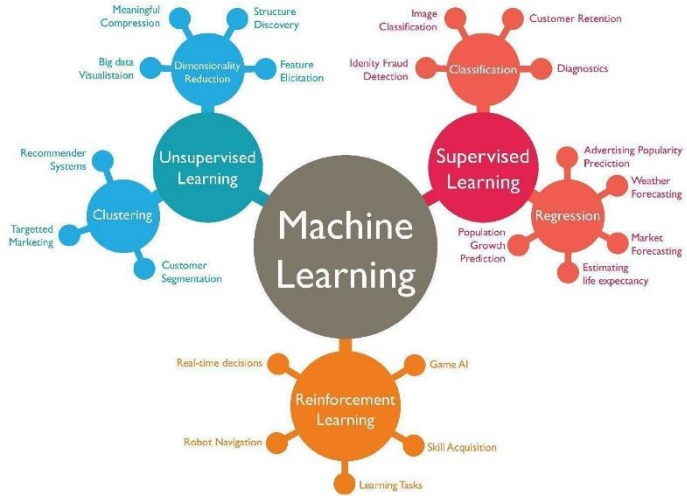
Disruptive technology and a wide field of applications



“Machine learning!”

“Instead of programming a computer, **you teach a computer to learn something** and it does what you want. It's a **fundamental** change in programming.“

Eric Schmidt, CEO Alphabet (Google)

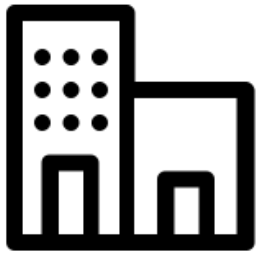


“I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail”

We combine a broad and in-depth knowledge allowing us to find the best approach.

Last 365 days

We talked to…



+- 400 companies about adopting this technology via phone-call > 5 min or reply by mail

In all sectors

+- 150 face-to-face meetings with decision makers of

- Startups
- Small SME's
- Larger SME's
- BEL 20/ Corporates

Why companies in Belgium are struggling to move beyond PoC successes

1) No focus on integration from the start, e.g. assume a perfect technical solution?

How will you change your business process and company culture?

Is it worth it?

Integration first

2) Not realizing it's not only about technology and tools, but also about knowing how to use them:

Know you can (and should) retrain technical personnel to data scientists/machine learning engineers, but how?

Involve experience

Understand you can't learn to drive a car by reading, nor do you judge a surgeon based on the tools they use

Create awareness

General ML solutions are either:

- Not ML
- Not a solution

See the bigger picture

How we create value

Traditional

Machine learning / Our approach

Our journey

ML2Grow is a **spin-off company** of imec & Ghent University relying on decades of experience offering the latest technology

GHENT UNIVERSITY

imec

ML²GROW

ML2Grow was founded in the lap of the **internationally renowned IDLab. Where 300 researchers** push the boundaries of **digital technologies** in close collaboration with industry.

500+ industrial collaborations including ML specific bilateral/licenses to ABB, Intel, John Hopkins, Toyota,…

15+ challenging and inspiring projects, satisfied and returning clients including international firms

In-depth technical knowhow

⇩

+ Application to industry

⇩

+ Intense integration in industry processes = value creation

Our partner

A strategic partnership was created in February 2019 with Invibes Advertising, an advanced technology company specializing in digital in-feed advertisement.

With this partnership, ML2Grow is expanding its AI and machine learning solutions with the full support of a solid established technology group which has a proven track-record in (big) data solutions and products.

"In 2019 we want to focus on data through Artificial Intelligence. ML2Grow will bring the know-how to sustain our development dynamics and continue to compete with web giants."

Nicolas Pollet

CEO Invibes Advertising

Selected portfolio

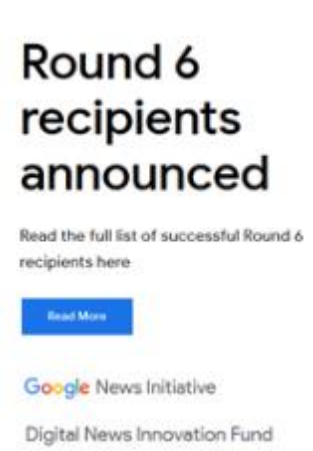
ML2Grow was awarded a Google DNI fund to further develop its technology

The Digital News Innovation Fund (DNI Fund) is a highly competitive European program that's part of the Google News Initiative, an effort to help journalism thrive in the digital age.

The developed solution will automatically adapt the layout of online news stories taking into account the user's profile and context

Added value:

- Address the issue of information overload and attention scarcity
- Retain the user's attention and optimize their experience
- Increasing user engagement



Capacity prediction and resource shortage early warning system

Short description

- The Port of Antwerp is the 2nd largest seaport in Europe
- Brabo trains and provides pilots to service every incoming and outgoing ship

Work performed

- Predictive machine learning models that capture uncertainties in the planning

Added value

- Extend the planning horizon from 20 min to 8 hours
- Avoid expensive capacity shortages
- Reliable simulations of personnel assignments and alternative scenarios

Tracking and anticipating movements of ships in Harbour of Antwerp

Short description

- Port + is the reliable partner in the port communities of Belgium and Zeeland
- AI-based solution to better predict the time of trajectories that ships follow

Work performed

- Develop machine learning models that estimate the time of ship trajectories

Added value

- Deliver accurate information to all actors involved in the harbor
- Removing uncertainty, offering guarantees and looking further into the future
- Avoid ripple effects due to unexpected circumstances (delays)

Development of data-driven fraud detection

Short description

- Ciboris, the Center of Excellence for food chain quality, safety and risk assessment
- Innovation daughter company in the international Primoris Holding

Work performed

- Developing machine learning techniques to detect fraud in the food chain

Added value

- Making efficient use of modern large data-generating analysis tools
- Answering questions about food authenticity is a logical next step in the services Ciboris and Primoris offer)

Custom made churn prediction system of customers

Short description

- HLS is the largest independent distributor of beverages and catering in Belgium
- An detailed product-level analysis of the churn behavior of customers

Work performed

- Custom analysis, development and visualization platform for customer churn

Added value

- Fully integrated in their sales and marketing team workflow
- Weekly report for company representatives indicating potential customers at risk
- HLS' marketing team is using this information to focus on clients of risk by offering personalized promotions and newsletters.

Data-efficient machine learning to optimizing 3D printing

OQTON

Short description

- Oqton wants overcome today's manufacturing challenges with an AI driven factory operating system
- Slide-deck at https://www.ai4growth.be/downloads

Solution based on

- Probabilistic machine learning models
- Multi-fidelity simulation

Large-scale distributed optimization of recipes

Dossche Mills
Since 1875

Short description

- The work revolves around large-scale optimization of recipes via the Google Cloud framework
- Dossche Mills is one of the largest mills in Europe and among the leading manufacturers and suppliers of raw materials for bakeries

Added Value

- Approximately 5 million euros savings per year

Before founding ML2Grow

Healthcare

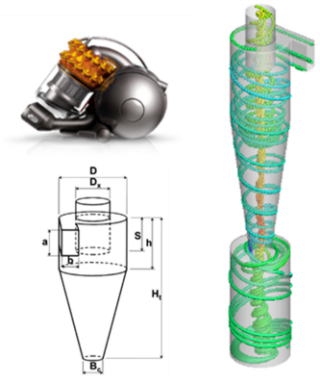
Intensive care unit - mortality and occupancy prediction
Less than 10% of hospital beds, more than 22% of total hospital costs. Challenging to plan, but critical to do so.

Early detection of sepsis
Mortality rate of 30% in US, one of the leading causes of death in Western hospitals. Put forth by multiple experts over the years to be one of the biggest unsolved threats.

At-home detection of sleep apnea (*)
onera
Currently requires overnight stay in hospital and time-intensive annotation by experts.
We developed machine learning algorithms to detect at home using inexpensive skin patch.

Determining the age of a person based on radiogram
Currently time-intensive method with large inter- and intra-observer differences.
We developed powerful deep learning image algorithms to accurately estimate the age.

Engineering



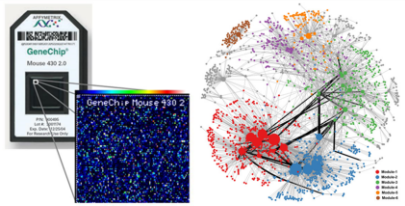
Powerful software for data-efficient machine learning
Gathering data is time-intensive and costly.
We develop powerful models using smart sampling strategies.

Multi-objective optimization
We apply data-efficient machine learning models as surrogates for complex and costly problems.
We create Pareto fronts to model trade-offs and support multiple objectives.

Unique Bayesian optimization framework
We built a framework on top of Tensorflow and state-of-the-art software.
Our framework allows efficient hyperparameter optimization of deep neural networks.

Diverse use cases
Our software has been applied in electronics, multimedia, telecom, photonics, automotive, chemistry, geology and art.

Biotech

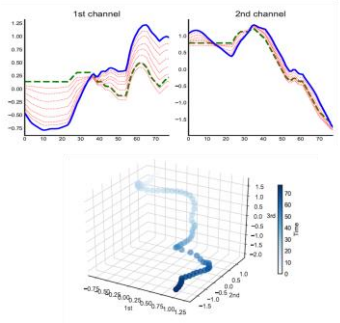


Extract connections from low sample, high dimensional data
We apply powerful ensemble methods to model in challenging settings.
We develop novel methods to extract correlations between entities.

Network visualization
We model connections in the data by using network visualizations.
We optimize predictions by making use of network structure.

Immunology and plant growth applications
By applying the above on gene expression data in immunology and plant science, we are able to generate novel biological knowledge using machine learning, without expert knowledge.

Smart homes and IoT



Non-intrusive load monitoring
We apply machine learning to gain appliance usage insight from aggregated load data.
We develop novel methods to detect events and appliance signatures in time-series data.

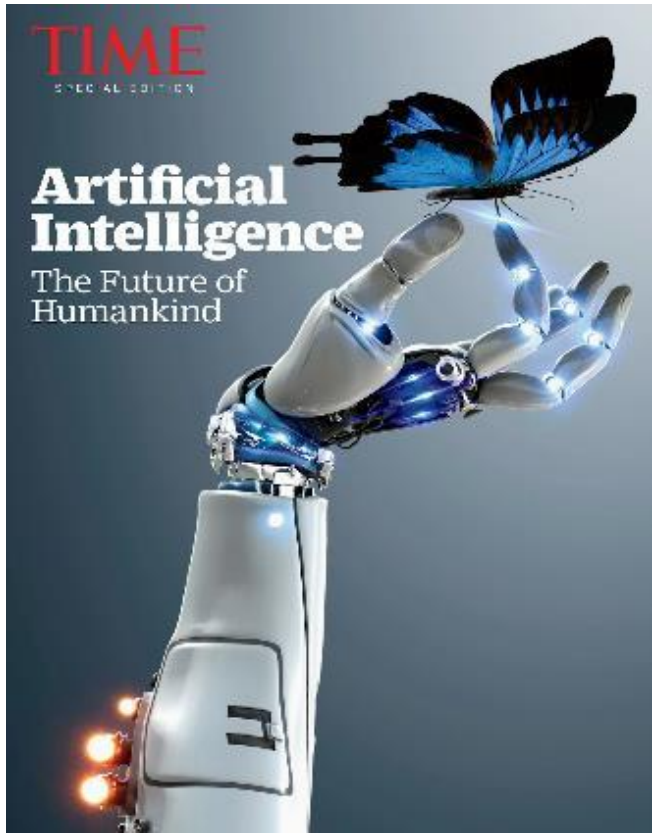
Advanced visualizations using shapelets
3D signatures of events of multiple time-series at important events.
White-box insights using the predictive strength of black-box techniques.

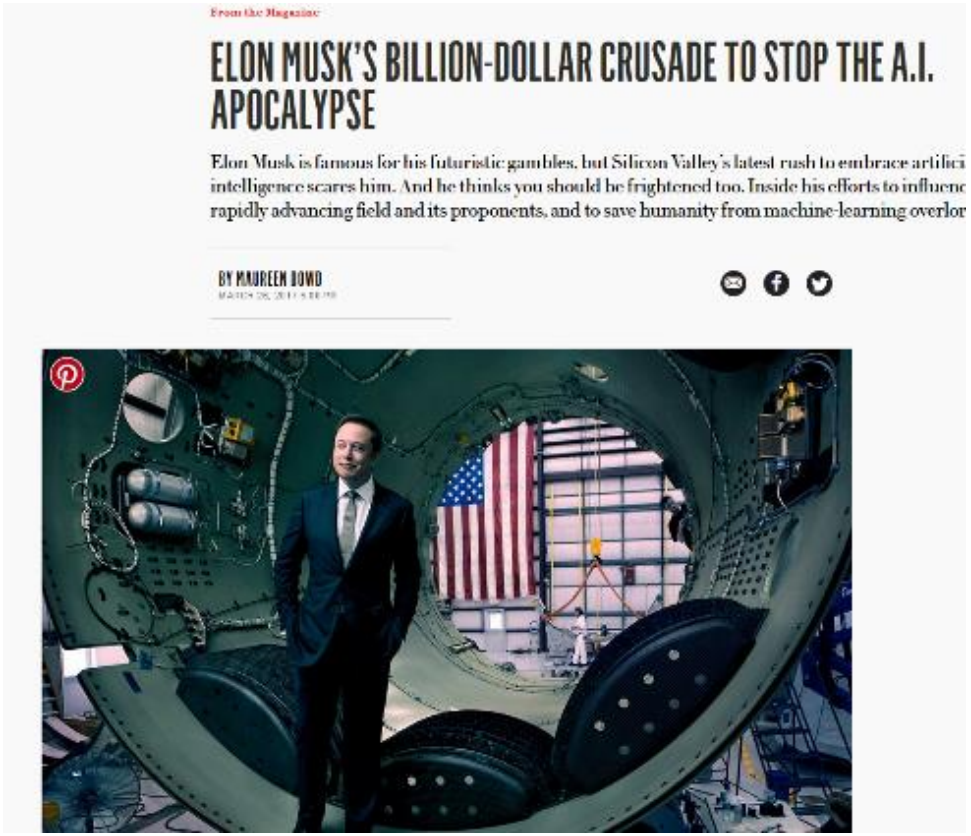
Anomaly detection using sensors in large industrial machines
Predictive maintenance for windmills, compressors and assembly lines.
We apply unsupervised methods which require no ground truth labeling.

Detection using low-energy sensors
Intrusion detection using affordable radar equipment to protect privacy.

What is the essence?

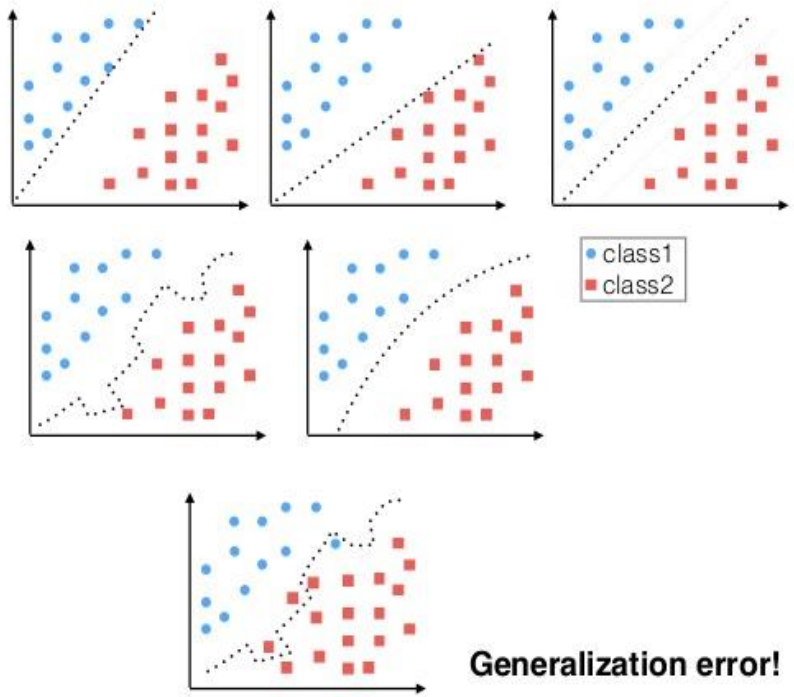
What is everyone talking about?



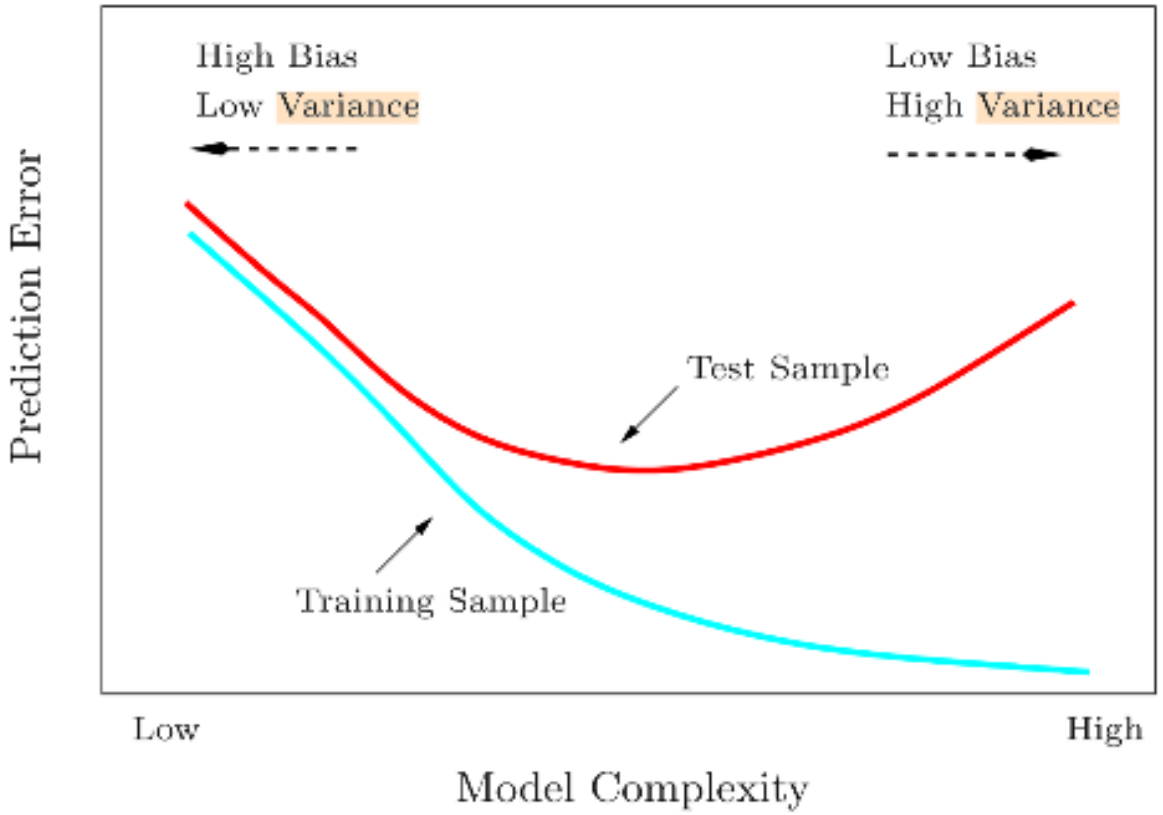


ML²GROW

Machine learning – the art



The problem of overfitting



ML²GROW

‘Machine’ learning?

Incorrect generalization is not only applicable for computers.

Media featured breakthroughs

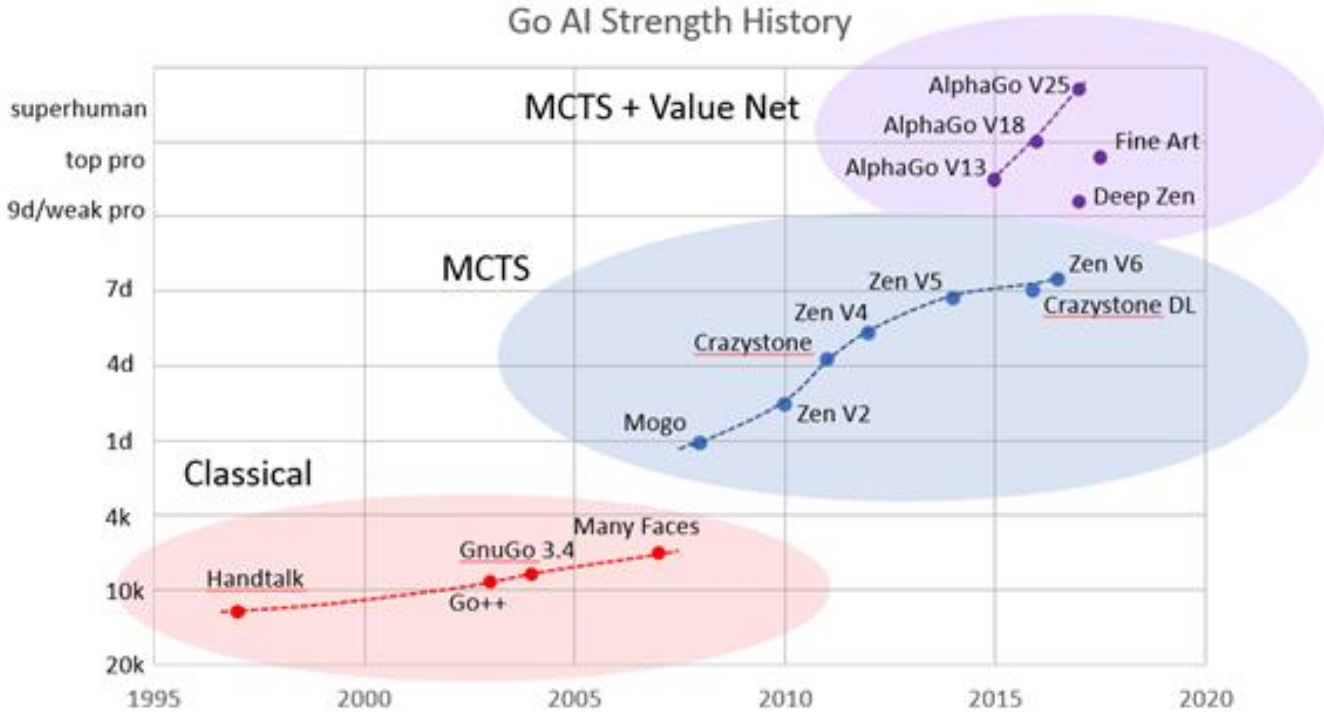
CADE METZ BUSINESS 03.10.16 07:00 AM

IN TWO MOVES, ALPHAGO AND LEE SEDOL REDEFINED THE FUTURE

GEORGIC WOOD FOR WIRED

SEOUL, SOUTH KOREA — In Game Two, the Google machine made a move that no human ever would. And it was beautiful. As the world looked on, the move so perfectly demonstrated the enormously powerful and rather mysterious talents of modern artificial intelligence.

Superhuman tactical insights



SOME OF OUR CLIENTS

THE TEAM

ML²GROW

Team competences

Joachim, CTO

- Multivariate regression & classification, Artificial Neural Networks, Gaussian Processes and probabilistic models, Active Learning, Optimization, clustering, dimensionality reduction
- Scientific computing, software architecture and Cloud Data storage and processing frameworks (RDBMS, Hadoop, Spark, Beam, ..)
- **Main expertise: Probabilistic models, data-efficient machine learning and machine learning via cloud**

Joeri, CEO

- Ensemble learning, Feature Selection, Artificial Neural Networks, Support Vector Machines, Time Series classification & event detection, Deep learning, Sensitivity Analysis, Network analysis, Clustering, Reinforcement learning, Sensor Fusion
- Teacher (Docent) Machine Learning & Algorithms at Ghent University
- Executed and led 10+ European and national machine learning research projects
- Patented ML applications
- **Main expertise: Ensemble theory, applied ML, knowledge transfer**

- Technology stack:
- Vendor independent (AWS/GCP/AZURE).
- In-house typically GCP with standard ML libraries (Python) or R . Knowledge of big data platforms.

Mike, Head of Science

- (Bio)statistics, data visualization, natural language processing (NLP), Artificial Neural Networks, Physics
- Data analytics and big data
- Prior experience as data scientist and project coordinator

Anton, Machine Learning Engineer

- Software development & cloud computing
- Multivariate regression and classification, deep learning, clustering, dimensionality reduction, reinforcement learning

Julie, Data Scientist

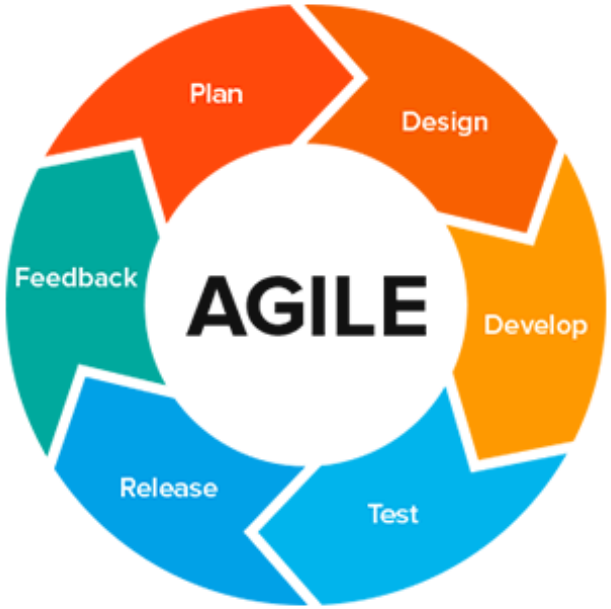
- Multivariate regression & classification, Artificial Neural Networks, Random Forests, Support Vector Machines, Time series analysis, Sensitivity analysis
- Data manipulation and cleaning

SERVICES

Agile AI

ML2Grow believes in an iterative approach to data science

- Raw results can be produced cheaper and faster than polished results
- Raw results convey a lot of information about the problem at hand



Iterative development cycle

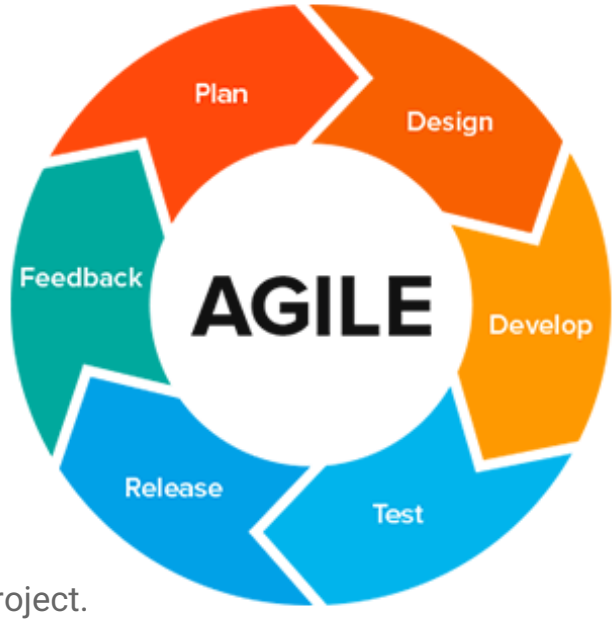
1. Communicate early results with domain experts
2. Interpret observed effects and validate
3. Decide on next steps

This approach improves cooperation and is generates a lot of insights.

Agile AI - project approach

Key features

- Set-up of modular data processing pipes to quickly generate relevant datasets
- Strong focus on data exploration and transformation
- Creation of several key baseline performance measures, both ML and non-ML
- Careful introduction of more powerful models in an iterative approach
- Introduction of stringent feature selection procedures and cross-validation checks to avoid overfitting
- Procedures for data imbalance and data augmentation



This strong iterative procedure allows for **high transparency** to all stakeholders in all stages of the project.

The progress and the success of the project can be **accurately measured** from the start.

Time tracking is **visible** to all stakeholders during all stages of the project.

ML²GROW

1. OPPORTUNITY IDENTIFICATION

ML2Grow's expertise in data science and machine learning transforms your business needs into ML use cases. Via workshops, we create a use case, tailored to your data and existing workflow, with limited risks or costs.

2. DATA AUDIT

To avoid unexpected costs, data audits are of crucial importance. We critically evaluate your data availability, potential and readiness. We identify existing bottlenecks and draft an action plan. We critically evaluate existing solutions or software that are offered to you.

3. DATA ENGINEERING

ML2Grow profiles your business cases We identify, harmonize, deduplicate, characterize and visualize your data.

This process results in a clean data architecture and implementation.

ML²GROW

4. AGILE AI

We develop AI algorithms which solve business needs. Our highly trained and experienced team creates the core of data -driven applications. Via agile methodologies we work in an iterative, transparent and efficient way, together with stakeholders.

5. SOFTWARE DEVELOPMENT

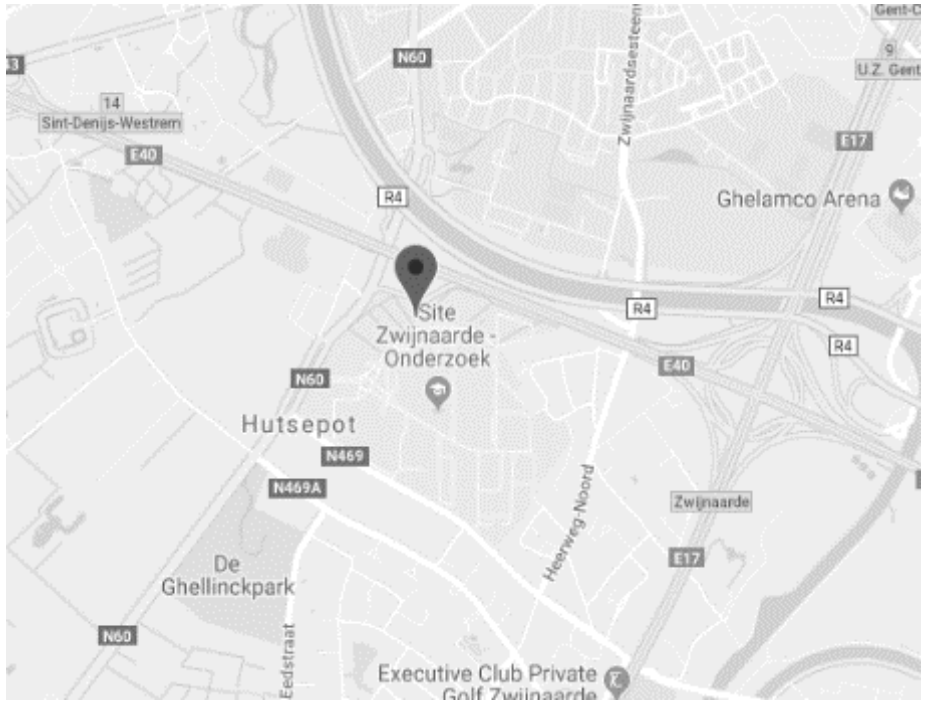
ML2Grow is a trusted partner which combines machine learning with accepted principles of software engineering. All created IP and knowledge is transferred meaning that you become full owner of the developed project code.

6. KNOWLEDGE TRANSFER AND SCIENTIFIC PROJECTS

Our close link to academia and prior experience makes ML2Grow the ideal partner to raise awareness and train personnel. In addition, we frequently participate in high-risk scientific (funded) projects.

Contact

Contact



Contact info

Technologiepark-Zwijnaarde 122, 9052 Gent

+32 474 454 223

sales@ml2grow.com

BE 0676.644.086

Appendix 1: ML2Grow’s training offering

Inspired by the needs of the market

Partially ready, partially under development with an ESF call together with other partners

Training for non-specialists

What → Achieve a basic but correct understanding of the possibilities and shortcomings of AI/ML

To → **C**ommunicate and work with colleagues and clients and have a critical view of on AI products and their limitations

Different from market → Most intro courses are aimed at technical personnel and hands-on or they only focus on the possibilities of AI

How → Ex-cathedra but interactive class, timing between 1 and 2 hours. Either a basic slideset with a focus on real examples of value created by AI or tuned to a specific topic.

Example → At Noordzeedrones, ML2Grow provides such a basic course 6-8 times a year to aspiring pilots to help them evaluate the different tools on the market which 'claim' that AI helps to solve all their problems.

Pricing → Hourly rate + customization and keeping slide-deck up to date time at reduced daily rate.

Inspired by the needs of the market

Partially ready, partially under development with an ESF call together with other partners

Training for specialists

What → Custom-made 'conversion' tracks which aim to efficiently move existing profiles towards a ML/DS profile. E.g. network engineer to ML engineer or software engineer to data scientist

To → Reconvert efficiently existing personnel towards the current market needs in views of the shortage of experienced personnel on the job market

Different from market → There are only general courses available which do not keep into account knowledge/experience of the employee's profile

How → Specific knowledge test, followed by a custom made course track to be followed. Multiple hands-on sessions in the form of coding exercises preceded and followed by a short class

Example → At this moment, no such offering exists on the market. ML2Grow's personnel has prior experience to create such sessions at University level

Pricing → Variable

Teachers

ML2Grow

Joeri Ruyssinck – teaching expertise

2011-2012: Assistant Machine learning courses
2012-2018: Main responsible ML course lab session
2011-2017: Assistant various Bachelor and Master courses

Ghent University: Assistant training (5 full days)
Ghent University: Professor training (3 full days)

2017-2019 (discontinued): Docent Universiteit Gent – 2 bachelor ICT
2016-ongoing : Various guest lectures

PHD Machine learning: specialization ensemble modelling and applied ML

Teachers

In cooperation with MKict

Koen Mertens

Remote sensing courses at Ghent University
Organizer of specialist drone training for agriculture at ILVO

Specialist training for technical staff
Expert speaker in precision agriculture

Recently, teacher at HOGent (several ICT related courses)
Early adopter of deep learning technology at ILVO for drone images

Teachers

ML2Grow

Joachim van der Herten

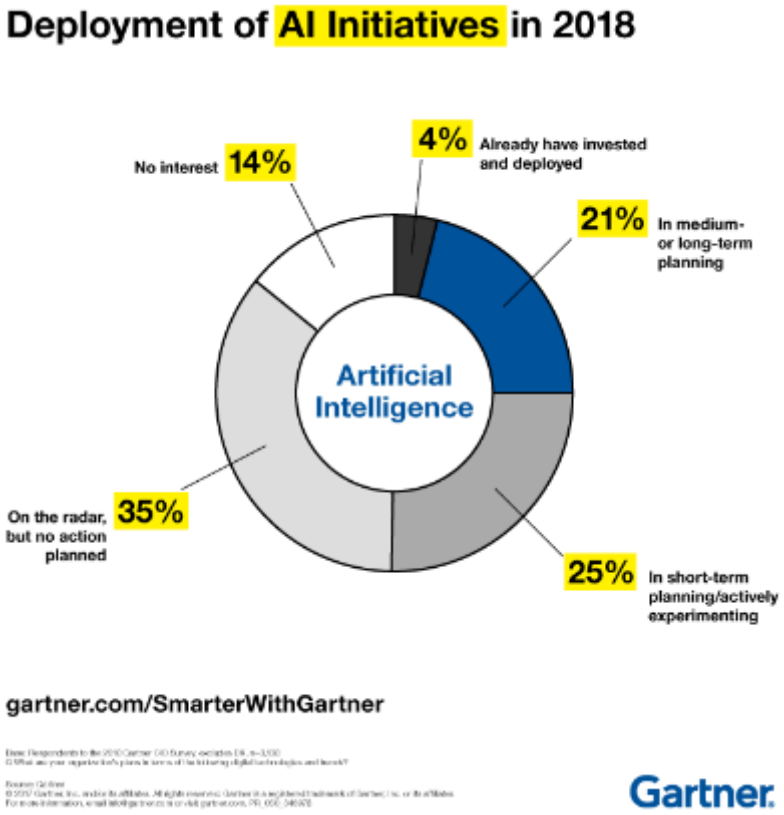
ML cloud computing specialist (Google Certified)
Workshops around automating ML workflows via cloud-platforms

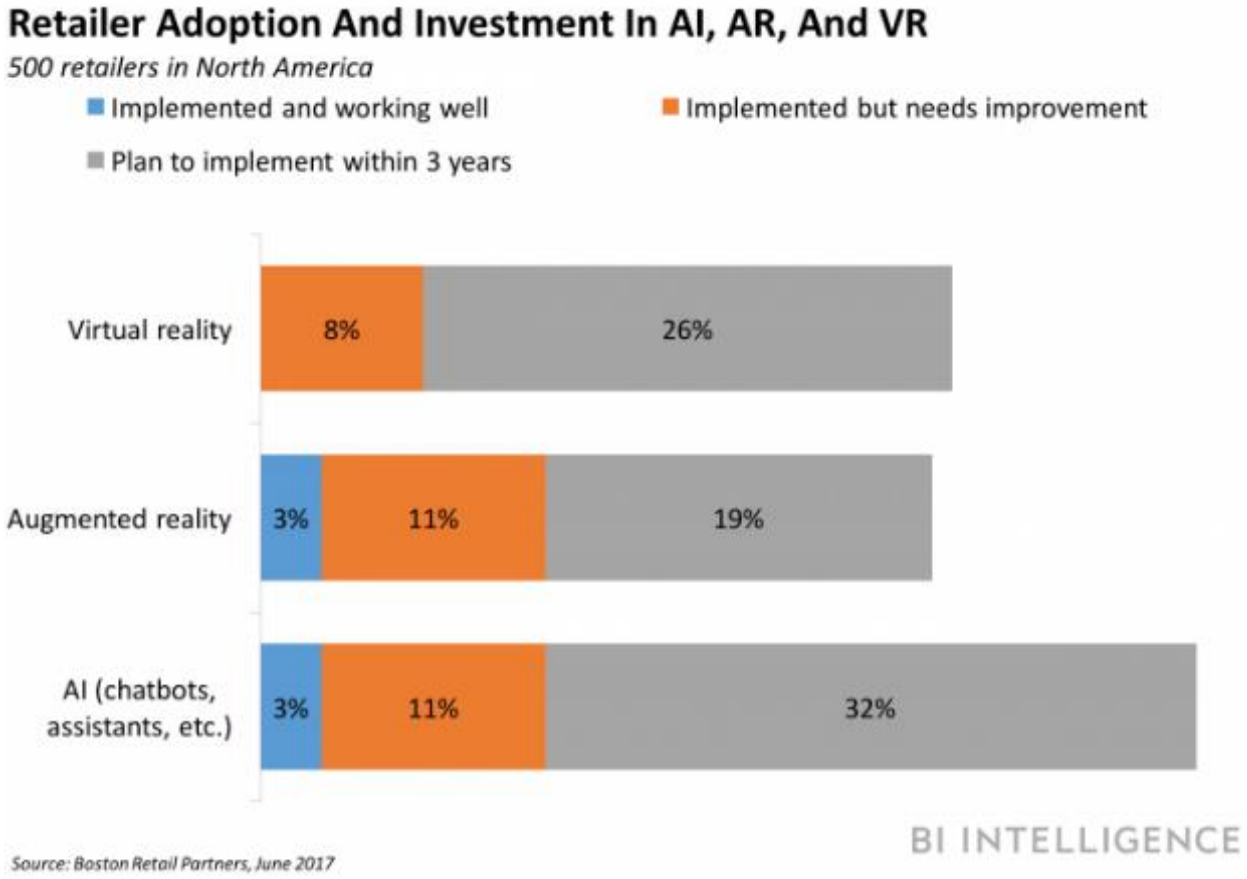
Previous teaching experience as an assistant at Ghent University
Creator of a scalable auto-grading solution (125 students) for ML notebooks (2016-…)

PHD in data-efficient machine learning and Bayesian ML models

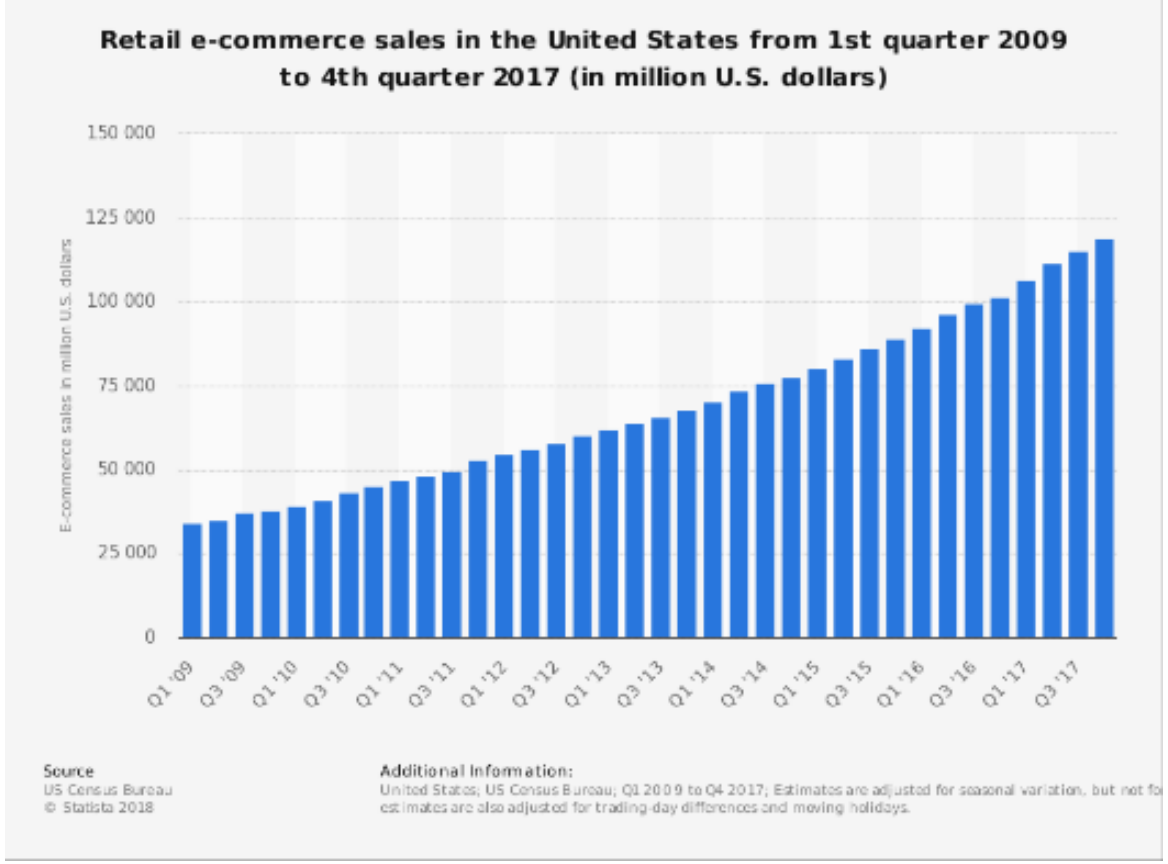
Appendix 2: Recommender and churn technology

Worldwide adoption interest





E-commerce unexpected evolution



	2006	2016	2018	06 - '18
Company	Value ($B)	Value ($B)	Value ($B)	% Change
Sears	$14.3	$0.9	$0.3	-98%
JCPenney	$18.1	$1.7	$1.2	-94%
Nordstrom	$12.4	$7.7	$8.9	-28%
Kohl's	$24.2	$7.1	$11.2	-54%
Macy's	$24.2	$7.1	$9.3	-62%
Best Buy	$28.4	$18.5	$21.4	-25%
Target	$51.3	$31.7	$40.9	-20%
Walmart	$214.0	$243.9	$262.9	23%
AMAZON	**$17.5**	**$474.4**	**$726.3**	**4050%**

Recommender systems I

McKinsey&Company (2013 study)

NETFLIX

75% of all movies and series watched were suggested by a recommender on Netflix. Netflix states their recommender platform saves them up to 1.000.000.000 dollar each year on advertisements

amazon

Amazon stock price from $1.73 (May 97) to $1723.79 (June 2018). Amazon claims that 35% of their sales revenue can be attributed to their recommender systems. In 2016 they attributed 29% increase in total sales to their improved recommender system.

Simple recommender systems easily result in a 3% in sales (2007)

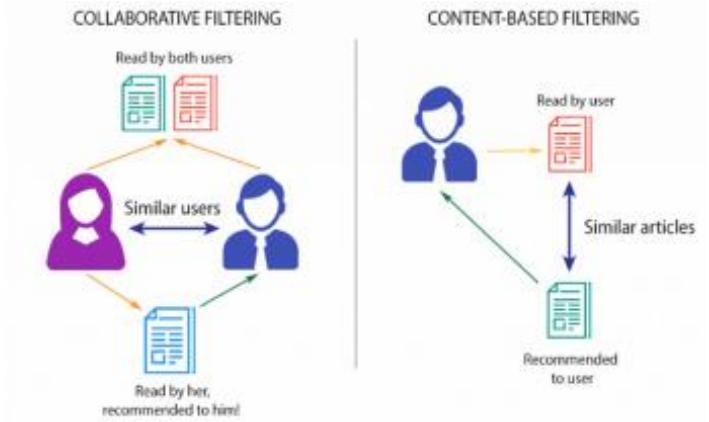
What?

People want to be addressed in a personal way. Recommender systems are algorithms that are able to match identify the products the each specific customer is interested or looking for.
Recommender systems have been key to the success of major companies and are not limited to web shop integration.

How and why?

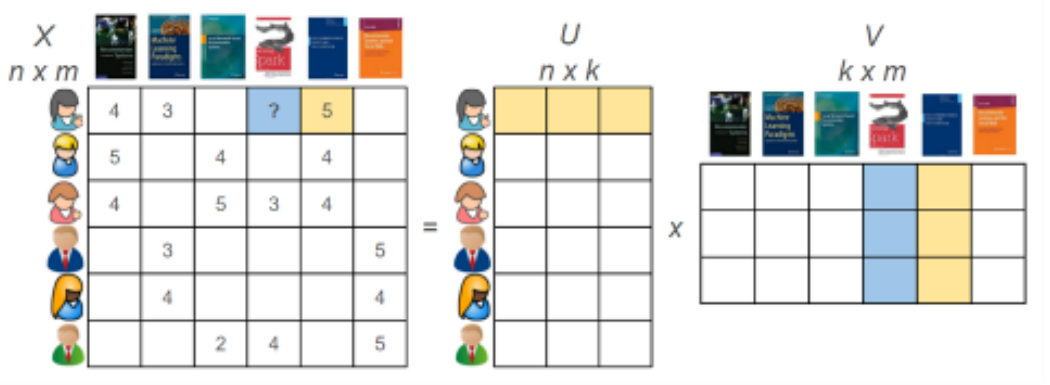
Machine learning uses historical sales data to identify how customers interact with you.
It then uses this global knowledge to accurately predict the behavior of a specific customer.
The extracted knowledge can be used in different ways going from specific reports to support management decisions to fully automated systems that dynamically alter websites.

Recommender systems - types



Netflix prize
1 million dollar
(2009)

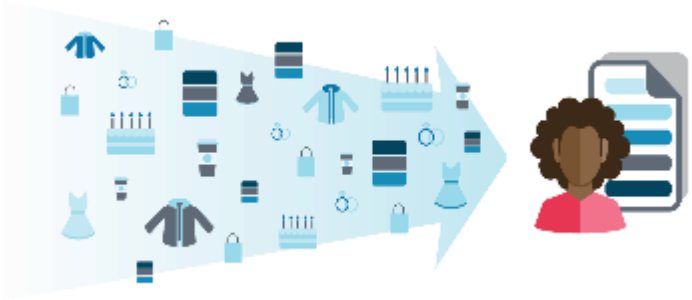
Early popular recommender systems (2000-2005)



Do you still want to buy technology now from ten years ago?
(e.g. Windows Vista [2007] , Nokia E16 [2006])

ML²GROW

Recommenders– part of ML2Grows customer engagement offer



customer data collection

- product recommendations
- customers recommendations
- targeted marketing via newsletters, promotions, actions, ...

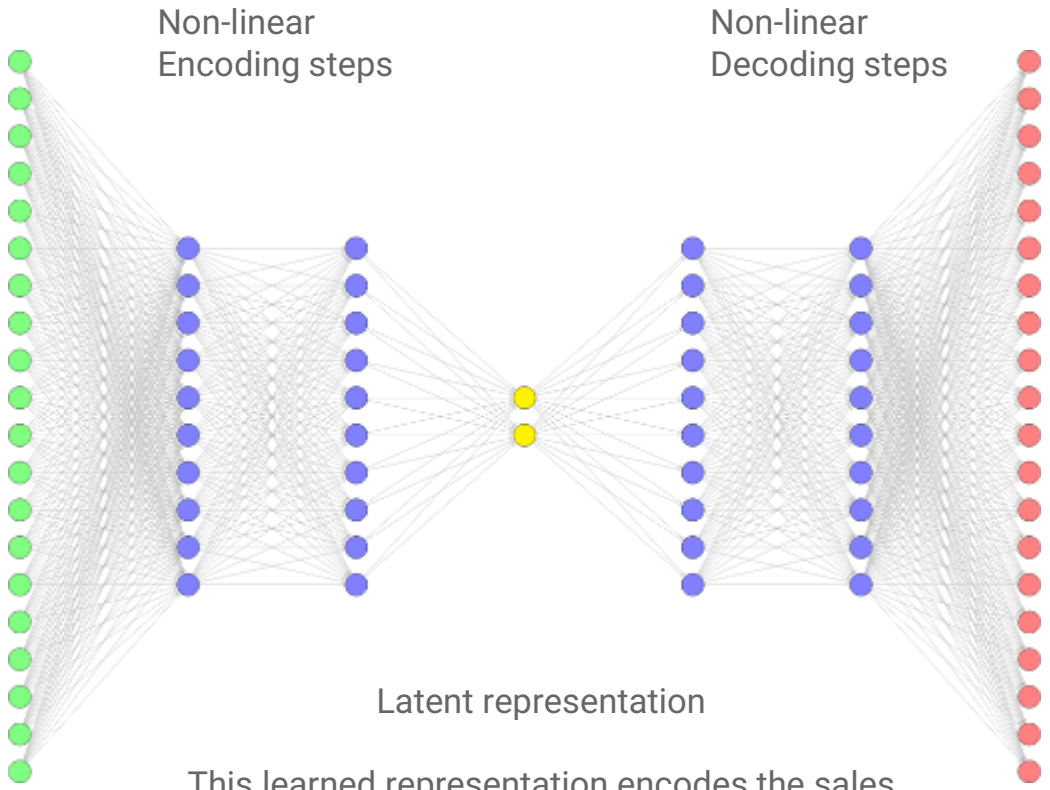
ML2Grow AI engine

- predict customer churn
- prevent customer churn
- increase customer lifetime value
- reevaluate customer investment

ML²GROW

Recommenders– latest and most accurate technology platform

Process sales data into feature representation



This learned representation encodes the sales relationships between customers.

Reconstructed sales data feature representations

DataSet	RMSE
Netflix 3 months	0.9373
Netflix 6 months	0.9207
Netflix 1 year	0.9225
Netflix full	0.9099

Best-in-class collaborative filtering algorithm

Recommender systems – applications

Personalized communication – Marketing decision support

Input for personalized newsletters, promotions, decision support for ‘paper’ folder distribution. Marketing choices based on specific analyses and custom-made interactive visualizations/dashboards

Website integration – classical recommender

Logged in customer receives recommendations based on previous purchases, similar items and previously viewed

Website integration – ‘cold start’ recommender

Logged in customer receives recommendations based on previous purchases, similar items and previously viewed

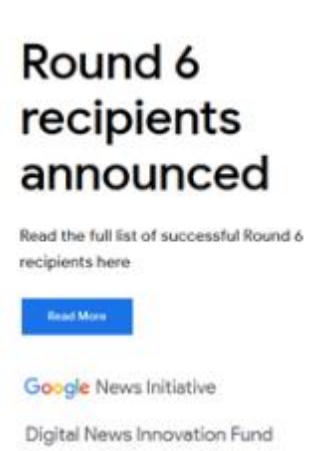
ML2Grow was awarded a Google DNI fund to further develop its technology

The Digital News Innovation Fund (DNI Fund) is a highly competitive European program that's part of the Google News Initiative, an effort to help journalism thrive in the digital age.

The developed solution will automatically adapt the layout of online news stories taking into account the user's profile and context

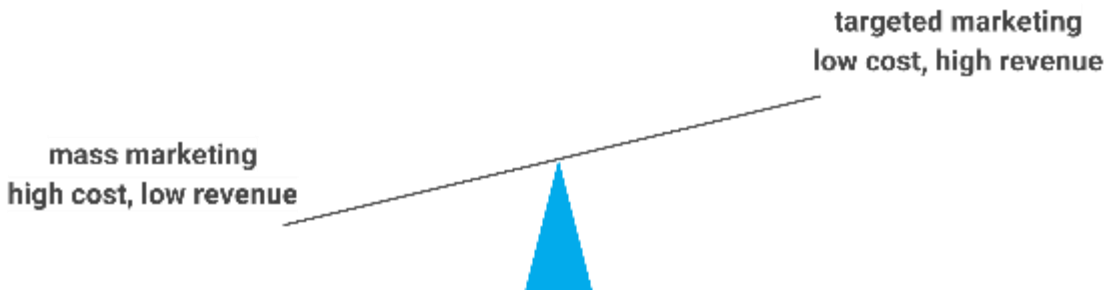
Added value:

- Address the issue of information overload and attention scarcity
- Retain the user's attention and optimize their experience
- Increasing user engagement



Customer churn analysis

5-20% probability selling to **new customer**
60-70% probability selling to **existing customer**



What?

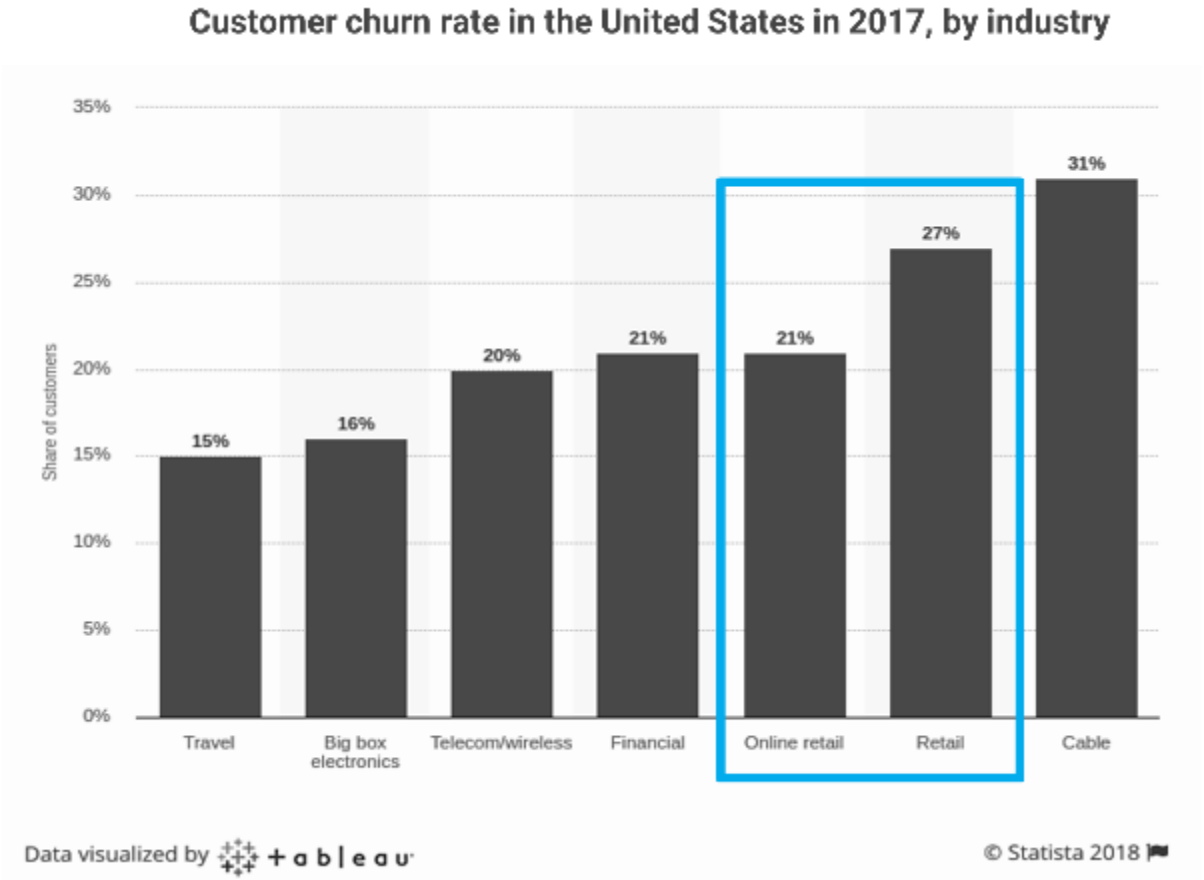
Companies tend to overshoot their efforts to attract new customers while not investing enough to retain their current customer base.
With a growing amount of customers, it becomes increasingly difficult to spend resources on providing promotions or set-up specific communication resulting in a large ‘churn rate’.

How and why?

To effectively deal with customer churn, one needs to focus its efforts to the percentage of customers which have the highest risk of buying from competitors and exiting your customer base.
Similar to recommender systems, machine learning can use historical sales data to identify how customers interact with you.
Using this knowledge, risk profiles can be calculated for each individual customer allowing to focus efforts.
ML2Grows analysis is unique as we offer product level risks %

ML²GROW

Customer churn analysis



Custom made churn prediction system of customers

Short description

- HLS is the largest independent distributor of beverages and catering in Belgium
- An detailed product-level analysis of the churn behavior of customers

Work performed

- Custom analysis, development and visualization platform for customer churn

Added value

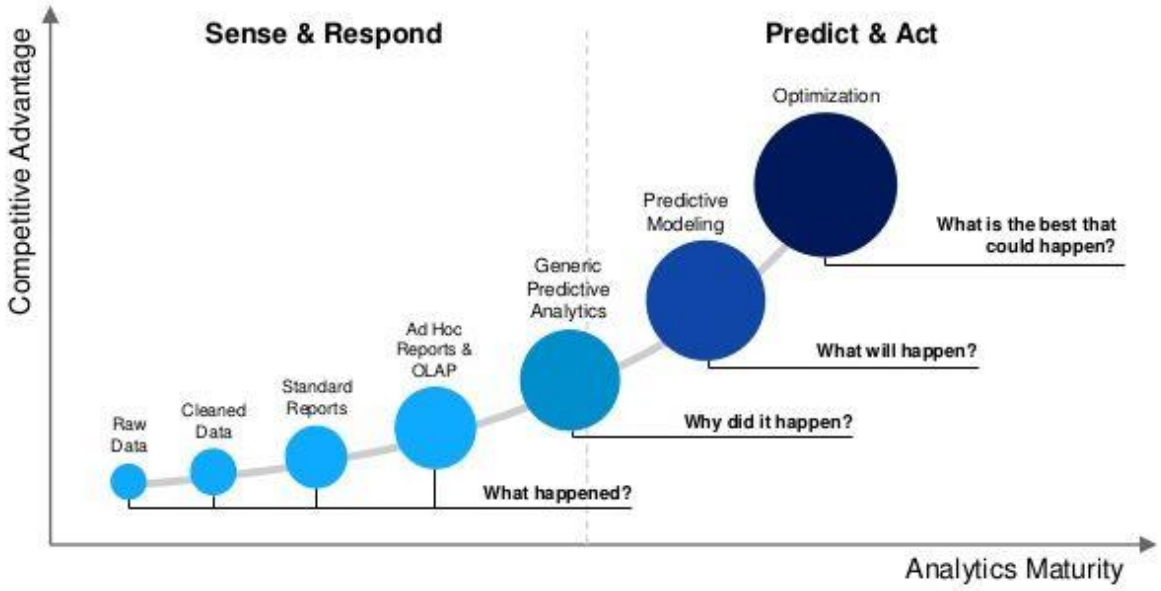
- Fully integrated in their sales and marketing team workflow
- Weekly report for company representatives indicating potential customers at risk
- HLS' marketing team is using this information to focus on clients of risk by offering personalized promotions and newsletters.

MAXIMUM EFFICENCY

94%

PERFECT STOCK ALLOCATION

Stock management



What?

Stock or inventory management is a notoriously hard optimization problem. On the one hand one has limited and expensive stock capacity and an increasing amount of different products, on the other hand customers no longer tolerate (long) waiting times in the age of online shopping.

How and why?

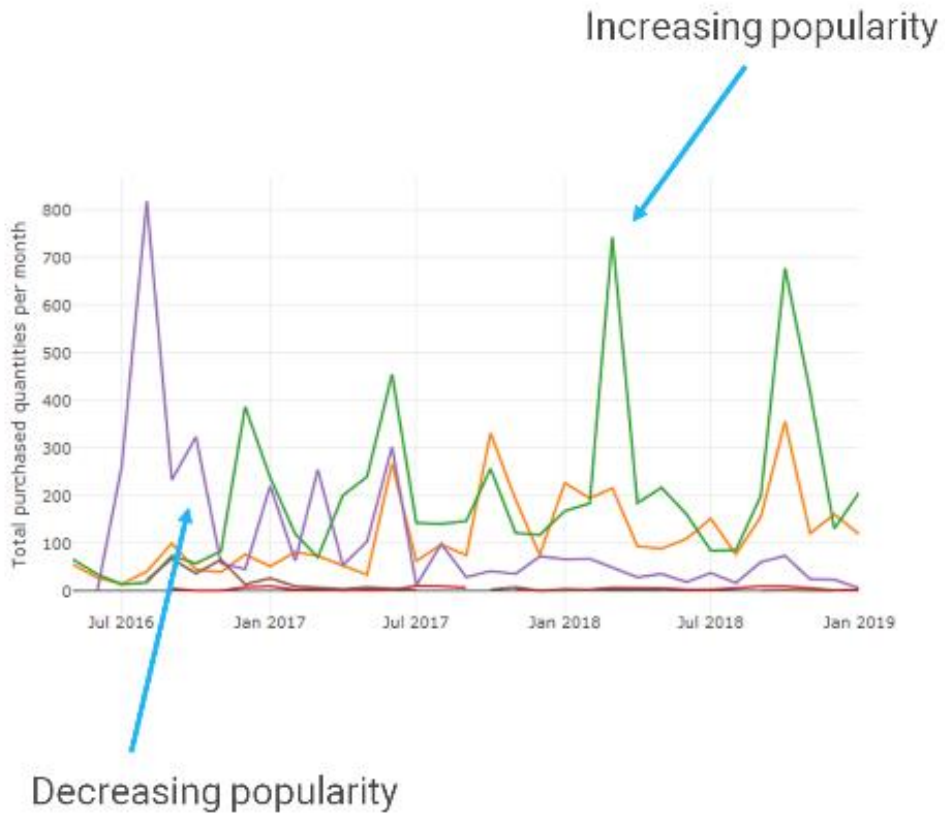
Machine learning models can help to help support decisions on both the supply and demand site.

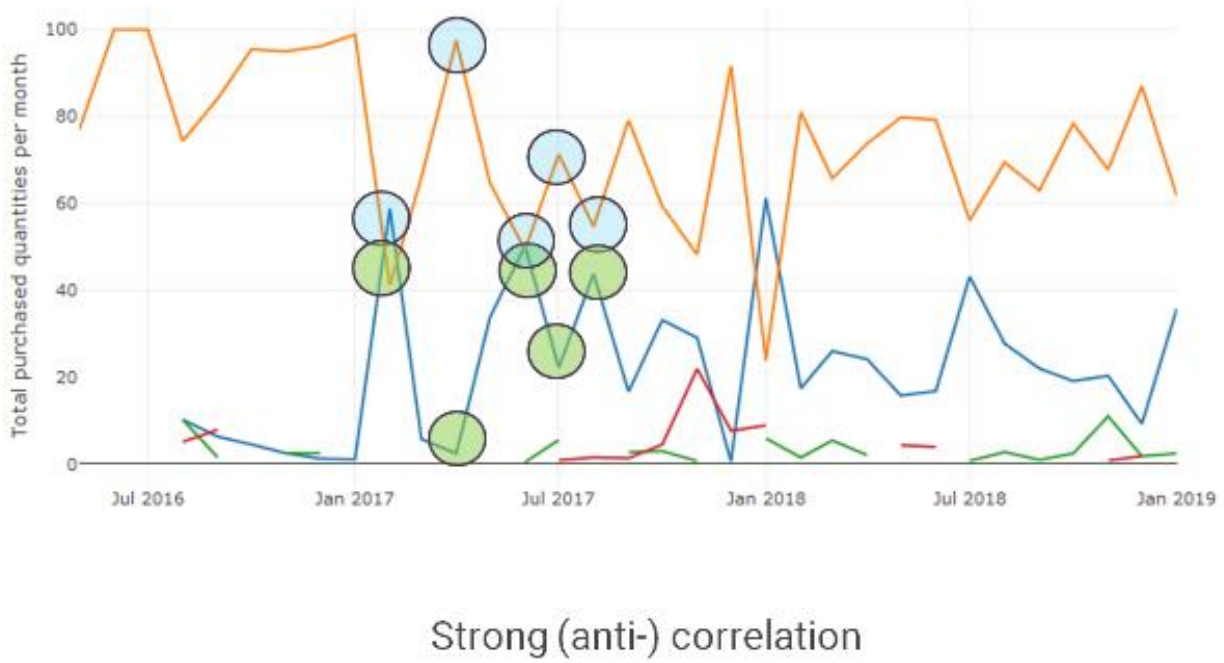
Seasonal/periodic trends in purchases. Identifying similar products and predicting demand curves (on release) over time. Learning geographical differences between physical stores.

Detecting changes in predicted behavior early, can trigger timely responses to avoid running out of stock.

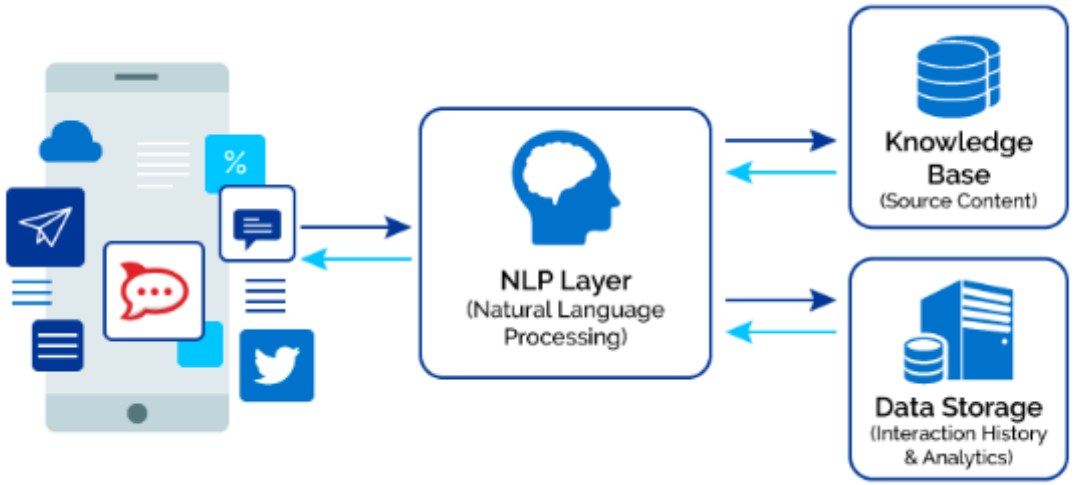
Stock management II

Simple data visualizations in a pre-study show the potential in capturing specific trends





Chatbots



What?

Many companies employ a sizable human workforce which replies to customer questions.

It is known that many of these questions are easy to answer or are the same or can even be found on a F.A.Q. page or other resource.

How and why?

Using machine learning, an intelligent 'chatbot' can be created which learns from historical conversations with clients.

It learns to provide the right answer to either the client directly or to the human operator to free up resources. **This provides 24/24 7 support to the client and reduces personnel time and cost.**

It can also learn the connection between a certain question and relevant items in the knowledge base.

And…

Machine learning is currently replacing many other legacy systems at retailers

- In distribution
- In analyzing marketing decisions and its effects on sales
- Steering and analyzing social media campaigns
- To augment dashboards or othaser business intelligence
- Predicting personnel churn / unavailability

Appendix 3: Machine learning for predictive maintenance

One of the most mature applications of machine learning

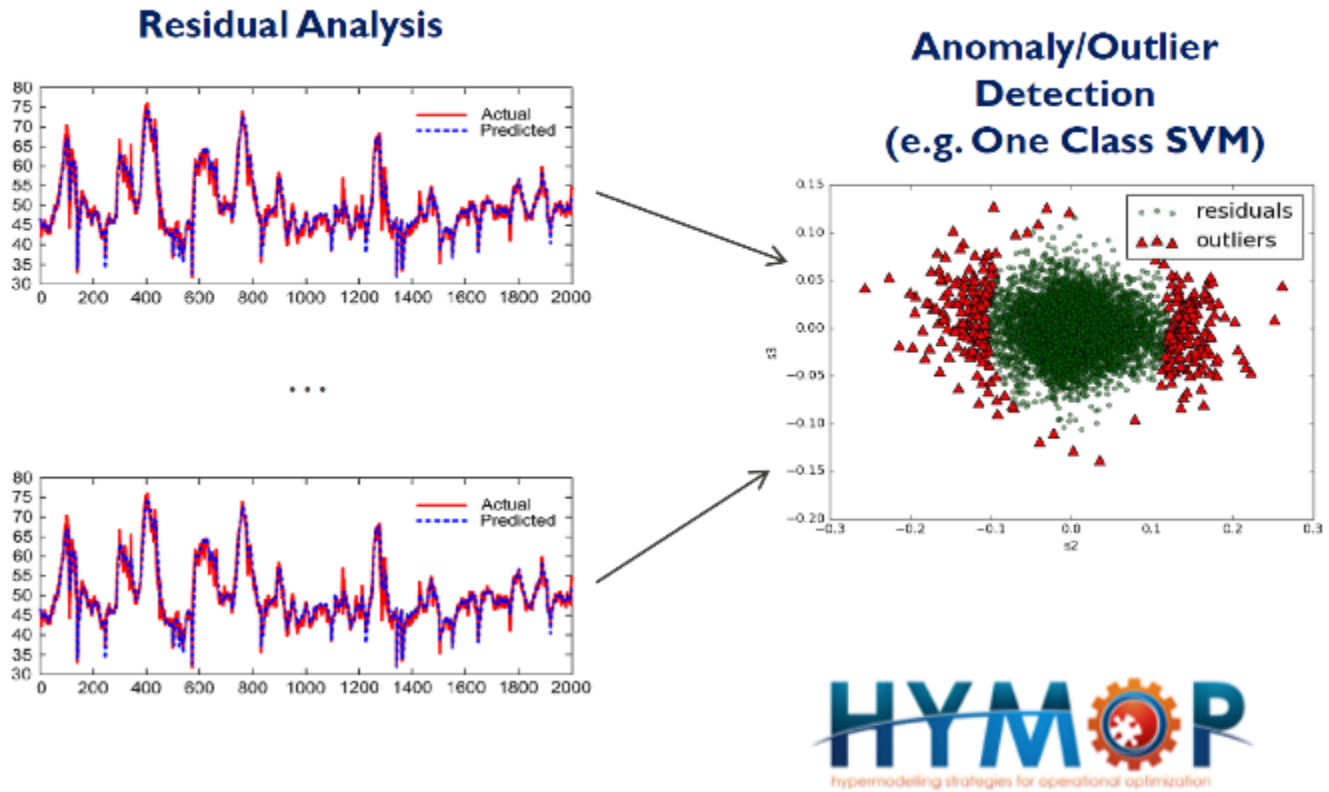
What?

Every machine requires periodic maintenance and is prone to failure.
It is hard to balance the costs of frequent maintenance and planned stops versus the costs of unexpected breakdowns.
Machine learning can be used to move from periodic maintenance to predictive maintenance or to predict wear

How and why?

Early warning of breakdown can lead to a significant reduction in downtime even if it cannot be avoided (e.g. ordering of spare parts)
Early intervention during a breakdown lowers the risk of further damaging the machine and can lead to higher employee safety
Predictive maintenance results in higher uptimes and lower costs.

Sensor fusion techniques can provide a complete picture



- Even in the absence of historical logs of break, unsupervised machine learning techniques yield powerful insights on the operating conditions of your production line or machine (*)
- McKinsey Global Institute estimates that predictive maintenance could globally save manufacturers between **$240 and $630bn by 2025**.

(*) Techniques developed and published by the HYMOP consortium