TOMRA SORTING

TOWARDS A CIRCULAR ECONOMY

TOMRA SORTING SOLUTIONS | RECYCLING

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PETcore presentation

June 2021

4500+
EMPLOYEES GLOBALLY

Publicly listed on Oslo Stock Exchange (OSEBX: TOM)

9.3
BILLION NOK REVENUES IN 2019

TOMRA

TOMRA SORTING SOLUTIONS

FOOD | **RECYCLING** | **MINING**

TOMRA COLLECTION SOLUTIONS

REVERSE VENDING | **MATERIAL RECOVERY**

Circular Economy

Alliance Members Around the World

Officers
Representing each sector of the value chain

lyondellbasell · P&G · VEOLIA

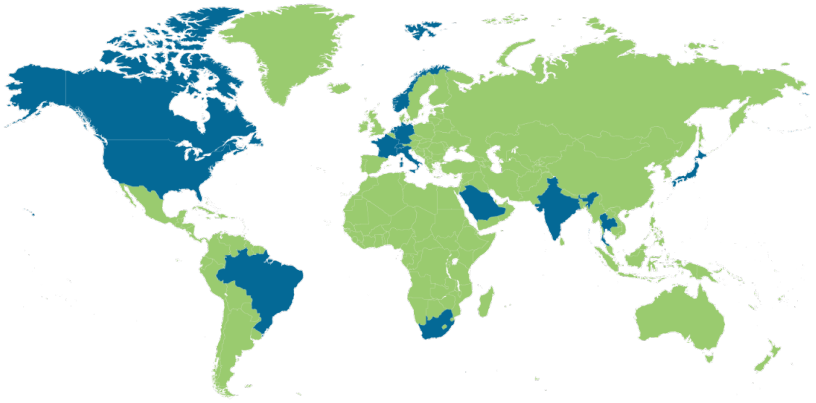
Executive Committee

BASF We create chemistry · Berry · DOW · Chevron Phillips Chemical Company LLC · ExxonMobil · Mitsubishi Chemical Holdings · PEPSICO · sabic · Shell · SUEZ · TOMRA · TOTAL

Board of Directors

Braskem · CLARIANT · covestro · DSM · eni · versalis · Formosa Plastics · Henkel · Mitsui Chemicals · NOVA Chemicals · OxyChem · PolyOne · Reliance Industries Limited · sasol · SCG · Sealed Air Re-imagine · SUMITOMO CHEMICAL · Westlake Chemical

Current membership as of April 24, 2019

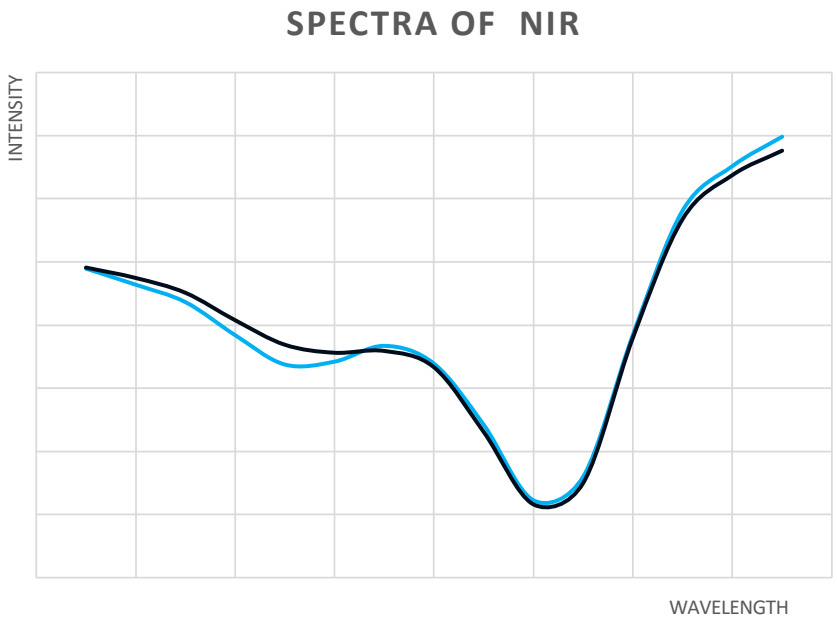


THE FUTURE SENSORS

TODAY
INTO
TOMORROW

NEW TECHNOLOGIES / MOTIVATION

Using a new technology to achieve the high product and customer requirements, which can not be solved using only conventional technology.



PE-HD vs PE-HD Silicon Cartridges

BASIC INFORMATION

Artificial intelligence

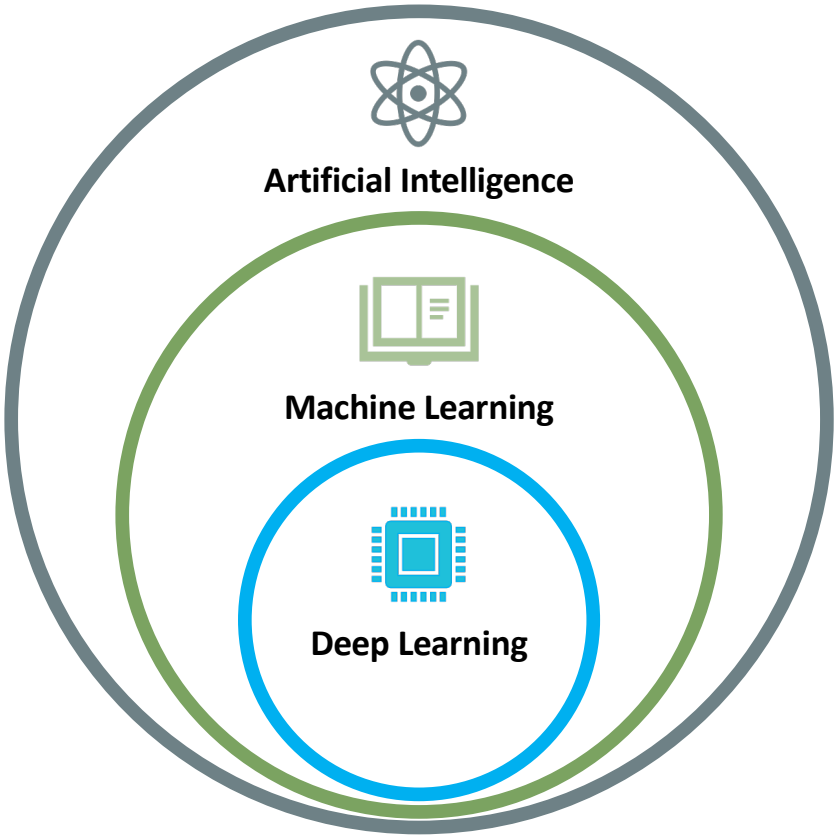
- is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans
- is any **technique** that enables computers to **mimic human intelligence**
- Artificial intelligence is a part of computer science

Machine learning

- Is the scientific study of algorithm and statistical models. Computer systems use to perform a specific task **without** using **explicit instructions.**
- relying on patterns and inference instead Machine learning is a part of artificial intelligence

Deep Learning

- Use **artificial neural networks** which are inspired by information processing and distributed communication nodes in biological systems.
- Deep Learning is a part of machine Learning



DEEP LEARNING

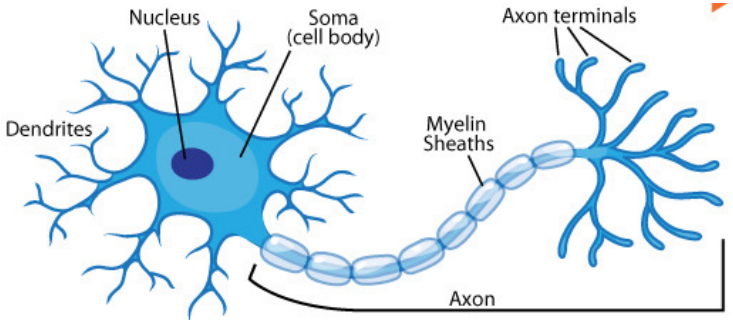
Training a network can be compared to learning a toddler.

By showing an object several times and explaining what it is, the toddler trains himself.

After a while and several trainings it is possible to assign the objects correctly.

This principle is also pursued by Deep learning

DEEP LEARNING



Biological neuron

Deep Learning:
Use artificial neural networks which are inspired by information processing and distributed communication nodes in biological systems (human brain).

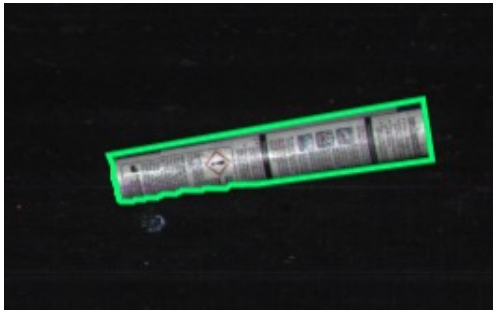
DEEP LEARNING “GAIN”

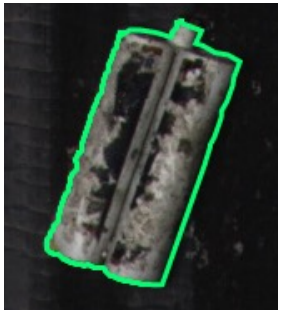
Detection <u>without</u> Deep Learning

- Feature engineering working principle:
  - object characteristics must be defined
    - Shape / Ratio / Filling…

- simple image processing like Object Recognition [feature engineering] solve the problem only seemingly.
- as soon as objects touch, overlap or are deformed, this technique no longer works.
- Technology only works in the parameter specified by humans

- GAIN allows also detection of overlapping, touching, deformed and destroyed objects





DEEP LEARNING-CASE STUDY

Input material	
Input material	PE-HD
Grainsize	> 50 mm
Bulk density	50 - 60 kg/m³

	Input	Recovery Step 1	Recovery step 2
PE-HD silicon cartridge number of pieces	60	58	2

PE-HD silicon cartridge 60 numb. of pieces

Step 1 Recovery of PE-HD silicon Cartridges 96.7%

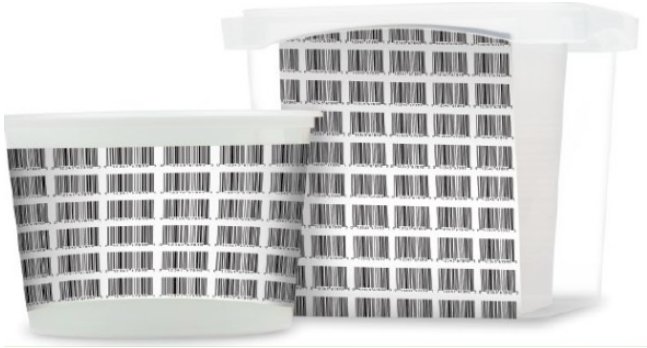
Step 2 Recovery of PE-HD silicon Cartridges 100%

WAT’S NEXT ?

OVERCOMING TODAYS LIMITS – DIGITAL WATERMARKS

- **Holy Grail member from beginning**
- **Improve detection and sorting** of materials, especially of “difficult to sort / recycle” fractions
- Enable **food and non-food** recycling applications, among others
- **Proof-of concept successful** within Holy Grail project
- **Open day events @ TOMRA** in May and October 2019

PIONEER PROJECT



HOLY GRAIL 1.0 - STATEMENT

- **“readable”** digital watermarks have been created
- An open house at TOMRA Sorting Gmbh took place in October 2019 to demonstrate that this project as strengths for going forward
- These promising trials already stated that 90% of hit rate was possible with regular mechanical setup like belt speed at 3 m/s running a mix packaging stream
- Whatever the type of material, flexibles or hard plastics have been tested

AMBITIONS IN HOLY GRAIL 2.0

- Enable and develop a **true circular economy** has high priority in TOMRA
- Identify and evaluate **potential test markets and sites** with project partners – large installed base of TOMRA equipment in different applications and markets (clean/dirty MRF, PRF etc.)
- Establish **dedicated, ringfenced DW project team** (two additional headcount planned) to build, install and support test machines for industrial trials, once funding is secured
- Continue **add-on module development** (connected to standard NIR) based on new specification defined
- Good, established **working relationship** with Digimarc R&D team
- Support **business development** activities, share market knowledge in HG 2.0

Closing remarks

PLASTICS ARE OFTEN WRONGLY COLLECTED AND HIGH AMOUNTS ARE LOST

PRODUCT DESIGN LEADS TO FURTHER LOSSES IN SORTING/RECYCLING

HIGH QUALITY AND QUANTITY RECYCLING WILL BE NEEDED TO SATISFY BRAND OWNER EXPECTATIONS

PRE-INCINERATION PLANTS/MSW PLANTS AS ADDITIONAL IMPORTANT SOURCE FOR FEEDSTOCK OF RECYCLED PLASTICS

NEW TECHNOLOGIES CAN HELP TO IMPROVE PROCESSES AND QUALITY OF RECYCLED FRACTIONS

"Museums of the world save the past, recyclers - the future“

www.tomra.com/recycling