

STRENGTHEN YOUR BUSINESS WITH AI SOLUTIONS



A foreword from the authors

Artificial intelligence has become a buzzword indeed, not only in a business setting but also in public debate. It is used at every turn, often in the context of robotics, but how it really works – and how to differentiate it from unsophisticated functions – seems not yet clear.

Since in NeuroSYS we develop AI-based systems for a variety of industries and use cases, we have, self-righteously, decided to chip in on the topic. However, as it turned out, you cannot say A without saying B when it comes to artificial intelligence. This is how the voluminous publication you are holding in your hands has come into existence.

Just to give you a heads up, the Strengthen your business with AI ebook is divided into three main sections:

- what is artificial intelligence and machine learning,
- their uses – general and in particular industries,
- and how to start an AI project with an external company.

Every topic has been illustrated with examples from our backyard, our case studies mainly.

We hope that this read will leave you with a concrete idea on how to benefit from AI in your business in order to make it stronger and more secure. And lastly, a few words of introduction on how to get ready to start such a project.

Enjoy the read,

NeuroSYS Team

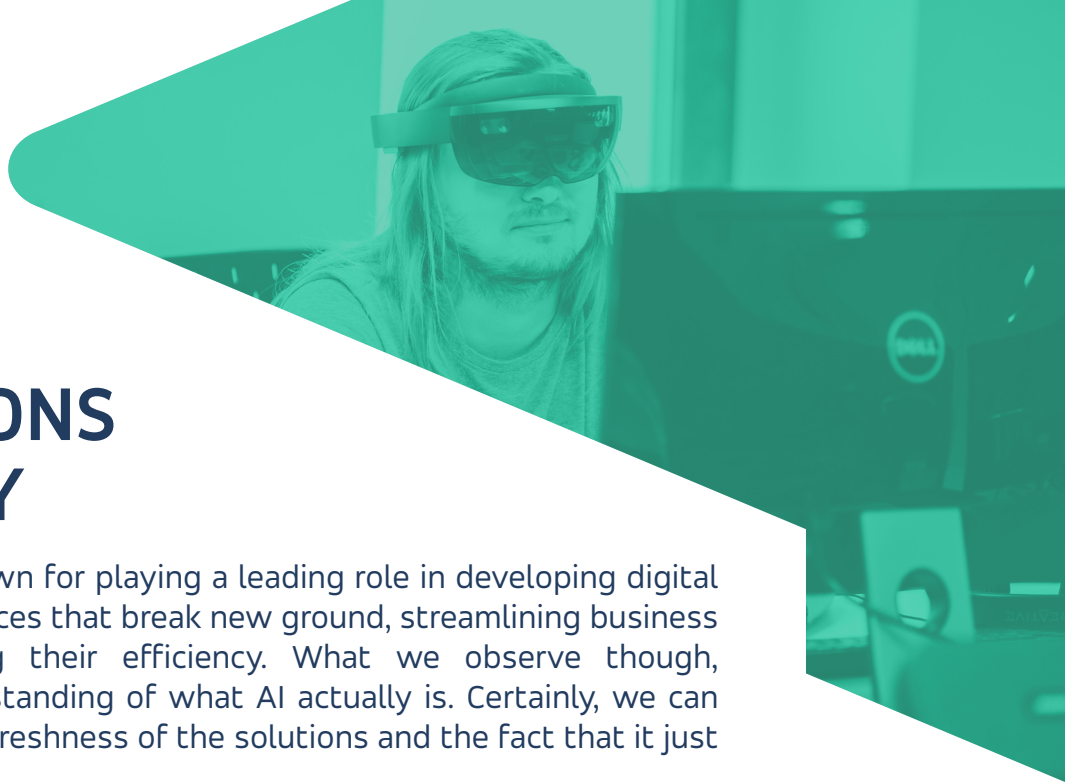
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PART I: ARTIFICIAL INTELLIGENCE EXPLAINED



EXPECTATIONS VS. REALITY

Artificial intelligence is known for playing a leading role in developing digital B2B/B2C products and services that break new ground, streamlining business processes and maximizing their efficiency. What we observe though, is a considerable misunderstanding of what AI actually is. Certainly, we can put it down to the relative freshness of the solutions and the fact that it just enters a lot of life areas.

What Joe Public thinks of AI

People often imagine artificial intelligence to be something out of this world – robots resembling humans to the letter and acting like them, machines taking their jobs, destructive humanoids, or quite the contrary – creatures we can fall in love with. But this vision can't be further from the truth, nowadays at least.

What companies sell as AI

At the same time, what we observe is that a lot of companies sell simple functions of the systems as advanced AI-based decision engines. Whereas they didn't even stand near artificial intelligence algorithms.

What AI actually is

The truth is, artificial intelligence manifests itself in the tools we use in daily life, often not even noticing the fact. Search engines, translation apps, email programs, and smart assistants – all use AI to provide the highest quality of service and the best, seamless experience.

```
Expectations vs. reality

/*
 * Difference between machine learning
 * and AI:
 */

If it is written in Python,
it's probably machine learning

If it is written in PowerPoint,
it's probably AI

});
```

ARTIFICIAL INTELLIGENCE

What people think AI is

What companies sell as AI

What AI really is

ARTIFICIAL INTELLIGENCE IN EVERYDAY LIFE

To be fair, there is a myriad of artificial intelligence applications. As consumers, we come across AI every day, sometimes even not knowing about it. A classic example is **Google Translate**. Only after a neural network model introduction, it has excelled in translation quality.



Google search engine is yet another case. It used to scan websites and provide us with a list of pages, where the searched term appeared. For over a year though, it has been working differently – it tries to answer questions directly, behaving in a human manner. We can still see the search results, as we used to, but often the top result is a straightforward reply. This breakthrough has been possible thanks to natural language processing (NLP) algorithms – searched phrase interpretation and context analysis. Google offers predictive search as well by suggesting to users what they might be looking for.



Recommender systems propose products or services users might like or want to buy, based on their previous choices, behavior, and profiles. The best-known examples are the recommended product lists on Netflix, Spotify, Amazon, and other shopping platforms. You will also find suggested posts and videos on social media platforms, such as Instagram, Facebook, or YouTube.

A particular field of AI, computer vision, is used in **cashierless stores** such as Amazon Go, **Google reverse image search engine**, or **facial recognition and matching** in Google Photos.

Smart assistants, **smart home systems**, **sat-nav apps** (traffic prediction), **email programs** (message and spam filtering, smart replies), and **face detection** used to unlock our smartphones, are just a few more examples of AI usage.





THE ESSENCE OF AI

How to tell AI-powered systems from the rest? The prime objective of artificial intelligence is to solve specific problems that either couldn't have been solved by traditional algorithms or, in most cases, they could have been solved by traditional algorithms but AI ones work way better and can be repurposed successfully.

Their quintessence is to simulate, resemble, or mimic – call it as you like – intelligent, human behavior. The algorithms can learn in time and address issues from a variety of business spheres. Most importantly, they don't have to be sophisticated and visually pleasing – they simply have to work.

THE DIFFERENCE BETWEEN AI, ML, AND DL

Since artificial intelligence and machine learning are often used interchangeably, and deep learning is treated as a separate entity, let's explain these three crucial terms before we move on.



The difference between artificial intelligence (AI), machine learning (ML), and deep learning (DL) equates to the difference between a square and a rectangle. As you can see in the chart below, there is no point in comparing these three terms, since machine learning and deep learning are the subareas of artificial intelligence, while AI is an umbrella term.

■ Artificial intelligence (AI)

It covers every algorithm that is able to solve problems the way humans do. Depending on their capabilities, there are three types of AI to be distinguished. Weak (or narrow) AI implements methods that tackle a single, specific task. This is the only type of AI we have so far and we come across when dealing with AI systems. General AI refers to human-level performance in any task and Super AI has capabilities greater than humans. At the moment, both of them are hypothetical and neither exists.

■ Machine learning (ML)

It integrates a collection of techniques that enable computer systems to improve performance through data processing and analysis. An ML algorithm defines a set of rules (mathematical operations) to be performed on input data, but its parameters are optimized to solve a given task. The operation is based solely on data. ML approaches can be categorized, based on the way they are trained, into supervised, unsupervised, semi-supervised, and reinforcement learning.

■ Deep learning (DL)

It is a specific subset of ML that focuses on complex models (a large number of parameters), usually based on deep neural networks (with plenty of hidden layers). The biggest advantage of DL algorithms is that they usually don't require any feature engineering. They divide input data into numerous layers of abstraction and learn crucial features on their own. However, it comes with a price – we need a huge amount of data to train a deep learning model.

ARTIFICIAL INTELLIGENCE (AI)

Algorithms that solve problems the way humans do

MACHINE LEARNING (ML)

Techniques that improve performance by data processing and analysis

DEEP LEARNING (DL)

Models that learn essential features on their own

PART II: HOW TO PUT AI TO USE

GENERAL AI BUSINESS USES

Let's talk about business now and how to put artificial intelligence to use. We distinguish the following areas for general application of AI and in a moment we will explain how they work in the industry-specific scenarios.



Computer vision

These algorithms detect, recognize, and identify people, places, and other objects in any type of visual content – photos, graphics, or videos. They analyze information quickly and accurately. On a side note, traditional CV algorithms often do the trick, so we use AI only when they go belly up.

It can be used in a variety of industries, such as automotive (self-driving cars), healthcare (cancer diagnosis), and manufacturing (faulty component detection) but also in social media apps (face detection and recognition) and photo editing apps

Natural language processing

With NLP algorithms, machines can identify, understand, and analyze human language. NLP is one of the most challenging branches of AI mainly because human language is full of exceptions and ambiguities. We use irony and humor, and it is often context that plays a major role in understanding the meaning of words and sentences. Not to mention the fact that there are a lot of languages that are subject to different rules and need to be analyzed separately.

NLP is used in sentiment analysis, customer profiling, semantic search (instead of literal understanding), text mining and classification.



Data science

Data science aims at uncovering hidden patterns, relationships, and insights from information that businesses gather every day. In times of increasing volumes of data at hand, it serves a great role in forecasting, risk reduction, and improving operational efficiency.

Data science is eagerly applied in finance (risk analysis, customer profiling), medicine (drug discovery, treatment personalization), manufacturing (predictive maintenance), transportation (traffic management, delivery services), e-commerce (targeted advertising, recommender systems), social media apps (matchmaking, friend/interest suggestions).

Predictive modeling

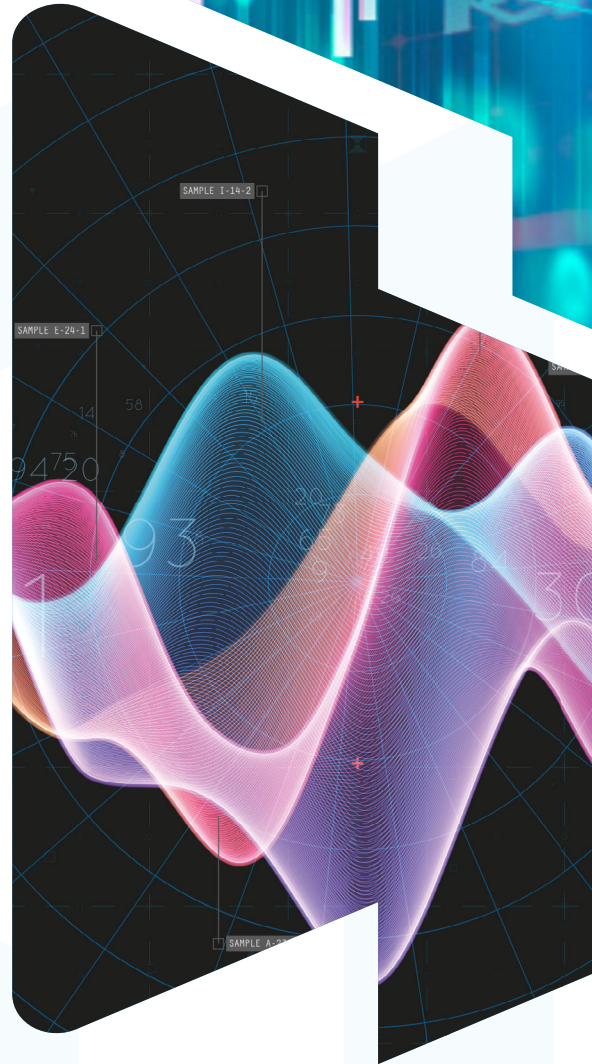
Predictive modeling is used to forecast future events or their outcome, based on what has already happened and what is happening at the very moment. A majority of calculations can happen in real-time, predicting behavior and trends.

Predictive modeling can be used in most industries, such as entertainment (TV ratings), e-commerce (sales volume prediction), banking (risk calculation), and hospitality (guest and order forecasting).

Sound recognition

Sound identification algorithms aim at audio detection, examination, and classification. Simply put, algorithms can analyze sounds the same way they analyze images. One of the most renowned and widely used examples of sound recognition is speech recognition.

Sound recognition is used in speech recognition products, such as personal assistants and speech-to-text apps, as well as music identification applications, security monitoring (glass breaking detection and such), or wildlife observation.



AI IN THE PHARMACEUTICAL INDUSTRY

Challenges

Innovative drug development and manufacturing require extraordinary efforts – and serious risks. Needless to say, the whole process from initial discovery, through long-lasting clinical trials and reviews, to finally getting into the market, takes 10 years at best. While the clinical development time only being 9.1 years*, and costs up to \$2.8 billion**. A substantial part of overall spending covers the inevitable failures, as only a small percentage of new medicines will eventually be authorized for use. Success in this field requires not only large financial resources but also trained scientists, advanced technologies, as well as effective and safe manufacturing processes.

* Clinical development times for innovative drugs, Nature.com, November 10, 2021.

<https://www.nature.com/articles/d41573-021-00190-9>

** Estimated Research and Development Investment Needed to Bring a New Medicine to Market, 2009–2018, JAMA Network, March 3, 2020 <https://jamanetwork.com/journals/jama/fullarticle/2762311>

AI-based solutions

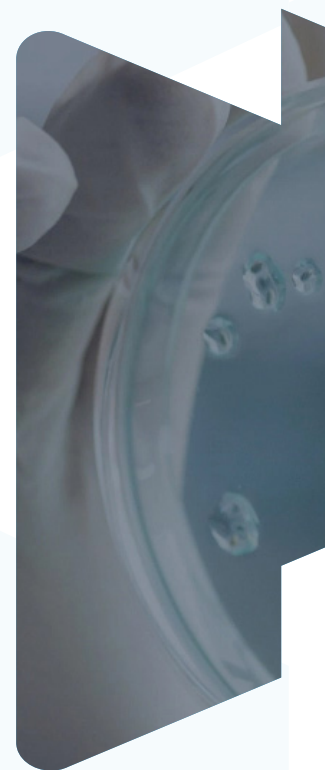
Artificial intelligence algorithm can be applied by pharma in every stage of drug discovery and production process, e.g.:

- Processing and analyzing large datasets in the early stage of drug discovery
- Drug screening to predict physical properties, bioactivity, and toxicity
- Automated chemical synthesis
- Automated sample diagnosis
- Automated microbiological analysis
- Drug repurposing by predicting interactions between medicines and proteins
- Manufacturing and quality control, e.g. elimination of impurities, monitoring of right compound proportions, and adequate packaging
- Classification of clinical documents and patient data

Results

First of all, artificial intelligence adoption has a strong impact on the pharma production process duration. Compared to traditional drug development and manufacturing methods, AI-powered ones are far more efficient and independent of the numerous laboratory specialists available at a given time. Not only can a lot of tasks be automated but also they become reproducible and accurate. It leads to significant savings in the costly process of pharmaceutical research and development.

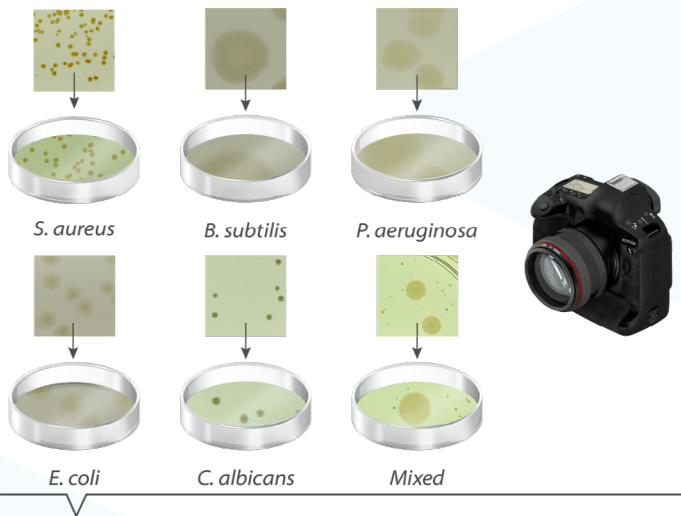
AI employment benefits not only the industry but also patients. Constant system monitoring results in safer drugs, while deep learning mechanisms allow for earlier patient diagnosis.





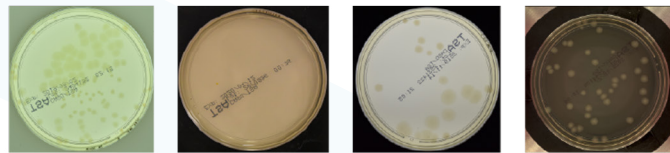
CASE STUDY

AUTOMATED BACTERIA CLASSIFICATION AND COUNTING

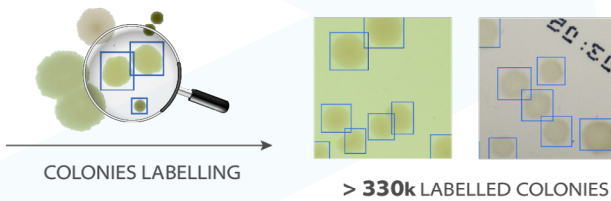


Problem

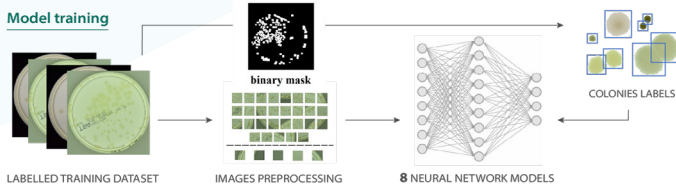
Microbial colony counting and labeling is a fundamental task in microbiology and it is performed manually in most laboratories. This is a demanding, time-consuming, and error-prone process, which requires trained professionals. In our case, there were tens of thousands of samples every month that needed to be analyzed and each sample could contain a thousand strands of bacteria (or be sterile). If bacteria were detected, their colonies had to be counted manually as well.



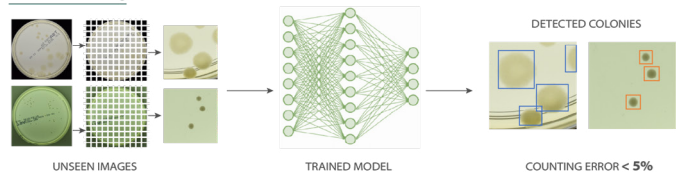
18k PHOTOS IN 4 SETUPS



Deep learning analysis



Model evaluating



Aim

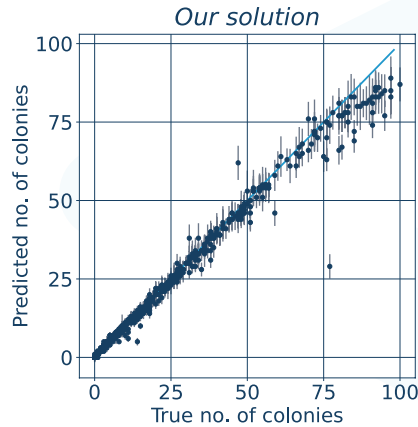
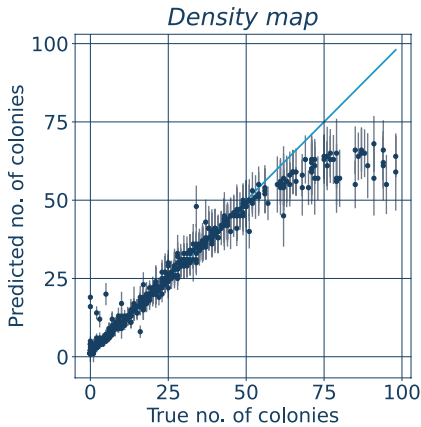
One of our internal R&D projects, partially funded by the National Centre for Research and Development, was to work on a library for automatic identification and classification of bacterial colonies based on RGB images of Petri dishes. The aim was to speed up the process and improve its accuracy.

Solution

Developing deep learning algorithms, we have automated the entire microbial colony classification and counting process based on RGB images and 3D cloud points obtained with a 3D laser scanner. Labeling, photo-taking, counting and classifying colonies, and reporting are performed by machines. Only the edge cases are left for human inspection. The solution can be easily integrated with lab automation software or used as a standalone application.

Methods

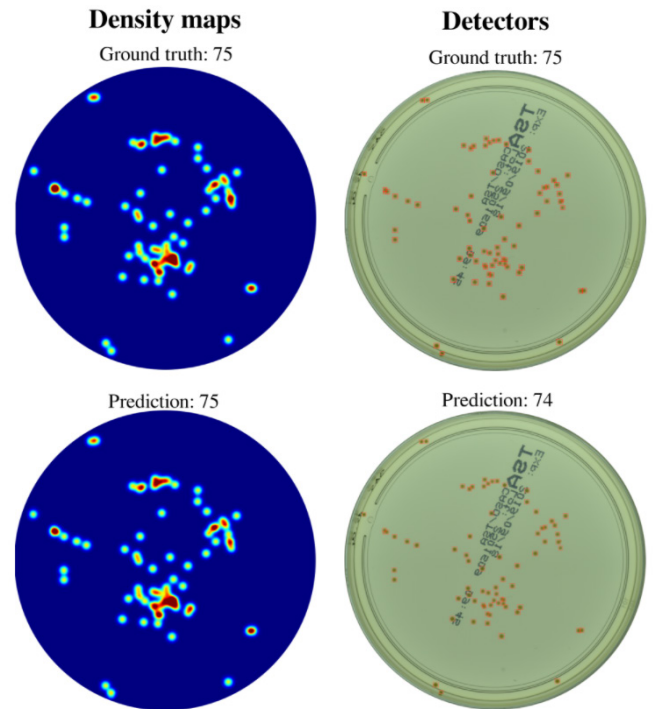
The system is based on **convolutional neural networks** combined with custom image **pre and post-processing** to optimize the localization and identification of microorganisms grown on Petri dishes. In particular, we used: deep neural networks, generative adversarial networks, image processing, object detection, image segmentation, and domain adaptation.



Outcome

- Accurate microorganism classification and high-precision colony counting
- Reduction of microbiological sample analysis time
- Cost minimization – system working 24/7, less staff needed
- Human error cut down
- Laboratory technicians can take on more demanding tasks
- Traceability of processes and automated reporting
- A scalable solution, easily expandable into new tasks and areas

The application areas include but are not limited to the healthcare, pharmaceutical, food, cosmetic, and veterinary industries



R&D projects are co-financed from European Union funds under the European Regional Development Funds as part of the Smart Growth Operational Programme. Project implemented as part of the National Centre for Research and Development: Fast Track.

AI IN THE MANUFACTURING INDUSTRY

Challenges

We are witness to unprecedented changes taking place in the manufacturing industry. There are two main factors contributing to this situation, the massive increase in the amount of data gathered and the expanding computing capacity (and yes, pandemic as well). They influence the way production processes are performed but also help companies with resource management efficiency.

When it comes to high-risk industries, such as mining, mining or petroleum, accidents can lead to far-reaching and severe consequences. To remain competitive in the market, and survive possible crises, manufacturers turn their eyes to production computerization and automation.

AI based solutions

When it comes to manufacturing, every investment in the newest technologies has the potential to return quickly. Artificial intelligence-based solutions apply to the following central areas:

- Automation of production processes in terms of performing simple, repetitive tasks and the most advanced collaboration with humans
- Production planning and inventory management using predictive models
- Predictive maintenance – based on atypical machinery behavior detection and past event analysis
- Machinery event inspection in analog machine parks – cycles, breakdowns, etc.
- Machine-driven quality control and quality assurance
- Data-based resource management, such as energy and water consumption or waste reduction
- Creating digital twins of machinery, production lines, or entire factories to facilitate their management
- Employee training and management
- Workplace safety measures based on AI monitoring taking place in production plants
- Computer vision-based workstation ergonomics improvements
- Entry authorization control



Result

Thanks to the contribution of artificial intelligence, the internet of things (IoT), machine-to-machine communication, and an immense amount of data analysis, it has become possible to manage company resources and plan production more effectively, additionally, accelerate a variety of processes.

Robots take off staff's shoulders mundane and repetitive tasks, often working round-the-clock. In the long run, machines will be able to make more and more crucial decisions independently. The advancement translates into time and cost savings, resulting from fewer downtimes, no necessity for staff training, and finally, higher quality of products.

AI-powered systems can verify the end-product properties, the tasks performed by employees, whether they wear protective equipment. They can also protect no-entry zones, which improves employee safety, productivity, energetic efficiency, and sustainability. Last but not least, AI supports production companies in the event of unexpected circumstances. The symbiosis with AI allows businesses to adjust way quicker to any external changes and, more interestingly, predict them.



CASE STUDY

PERSONAL PROTECTIVE MEASURES CONTROL IN MANUFACTURING

Problem

Working in a production hall usually involves wearing personal protective equipment (PPE), such as safety glasses, hard hats, vests, or masks. Sometimes more than one type of PPE is required. The problem is that employees often forget to wear them, which poses danger not only to themselves but also to the companies they work for. However, punishing workers for negligence in this particular area is demotivating and thus counterproductive.

Aim

We have decided that a straightforward reminder about wearing personal protective equipment could solve the problem. However, instead of delegating people to the task, which would be tiresome for employees and costly for the company, we wanted the process to be automated and thus scalable.

Solution

Facing covid-related challenges, we have built an AI-based system that automatically verifies whether employees wear face masks or not. A camera installed at the entrance to the production hall detects people without face coverage and displays a kind reminder to put the mask on. Also, the system says “Thank you for wearing a mask” to those who wear it already. The aim is to encourage workers to wear PPE and develop this habit in the long run. The system can collect statistics, such as the number of employees not wearing masks and what time of the day is the most sensitive one, to assess progress.

Methods

To build the system, we used: deep neural networks, image processing, and object detection.

Outcome

- Automatic and accurate verification of whether employees wear masks, with no involvement of human resources
- The system can work 24/7, which is particularly important in shift work
- Data collection, analysis, and automated reporting for improved management
- A scalable solution that can work similarly with hard hats, protective glasses, etc.



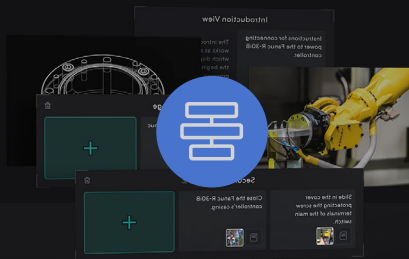
NSFLOW®

Nsflow platform has been created to digitalize industrial processes with **AR and AI**. It is used for:

- Remote collaboration
- Interactive work instructions
- Hands-on training

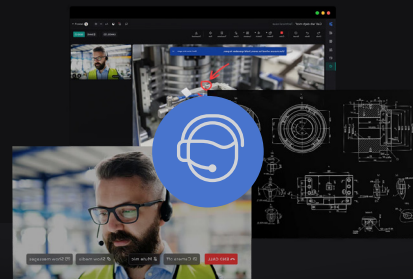
To...

- Retain knowledge
- Automate processes
- Solve problems faster
- Reduce costs of training and service procedures
- Improve product quality
- Promote paperless factory



Digital Workflows

Operation sequences for training and machinery servicing



Remote Support

Consultations with experts

Both modules benefit from augmented reality and AI, among others:



Image processing
(object tracking)



Command
detection



Hand gesture
recognition

NSFLOW®

The app version

Three application versions to choose from:



Out-of-the-box

A predefined version, with built-in native functionalities; it can be used almost immediately



Integration

With internal systems such as SCADA, MES, WMS, ERP, and even a single PLC



Customizations

The platform with new functionalities or modified according to your needs

The fastest way to get Nsflow



SaaS



Platform*

*Out-of-the-box platform, no customisations

Up and running in less than 1 week.

Infrastructure

There are three main options for where the platform could be hosted:



SaaS

Hosted in the cloud, the infrastructure is shared with multiple customers (securely separated)



Private cloud

Hosted in the cloud, but company data is physically separated from other clients' data



On-premises

The platform is hosted on private company servers



Nsflow Box

A plug&play version of the platform – an industrial PC



powered by 

AI IN THE AUTOMOTIVE INDUSTRY

Challenges

The automotive industry encompasses a broad spectrum of companies that are involved in vehicle design, manufacturing, and selling. Automobile manufacturing is the 9th biggest industry by market value ([Yahoo Finance, 2021](#)), globally, followed by auto parts and accessories manufacturing is on the 10th place by employment ([IBISWorld, 2022](#)).

The industry has always heavily relied on innovation – assembly lines, robots, advanced machinery, followed by designing hybrid, electric, and autonomous cars nowadays. The last years have been particularly hard for the auto producers due to Covid-related restrictions – which called for even more alternative manufacturing methods.

Vehicle manufacturers have to deal with complex logistics – car parts are produced and then assembled across different countries, and there is a variety of model variants, depending on particular orders (color, engine power, automatic/manual, extras). The final product has to meet the highest quality and safety standards



AI-based solutions

When it comes to automotive industry, investment in the newest technologies has become a must for companies to survive. Artificial intelligence-based solutions can be exercised in all key areas, such as:

- Production and assembly process automation
- Predictive maintenance – based on atypical machinery behavior detection and past events
- Automated quality control and mounting of vehicle parts
- Work safety measures – workplace accident prevention
- Employee training and management
- Detecting bottlenecks through heatmaps of people and vehicle routes in the production hall
- Operator work analysis and optimization
- Data-based production planning and resource management
- Virtual vehicle prototypes for design stages
- Virtual crash testing
- Tests and simulations run on digital twins
- Intelligent and autonomous car design
- Assistance and road safety systems building

Results

The success of companies in the automotive sector, from manufacturing to car dealing, relies largely on innovation. Modern inventions wouldn't be possible without AI. Intelligent assistant systems mimic human perception, becoming, as Mercedes-Benz calls it, "a thinking partner". Thanks to data analysis from different sources they detect hazards, help to avoid accidents, and even take corrective actions. Autonomous cars will be a natural next step.

When it comes to vehicle production and assembly, robots take on an increasing number of the repetitive tasks, while the intelligent ones assist humans in daily endeavors. AI-powered systems can verify the car part properties, as well as tasks performed by employees, which improves effectiveness, work safety, and product quality. Also, great savings can be achieved through using virtual vehicles for design or testing, before building the costly physical prototypes.

Since the automotive industry relies on the knowledge and skills of its employees and suppliers, and human error can cost a small fortune, AI plays a leading role in employee training and task supervision.

CASE STUDY

A FORKLIFT OPERATOR TRAINING SYSTEM IN A CAR FACTORY

Problem

Forklift driving is an essential skill in car factories. The vehicles are commonly used to load and transfer heavy parts. Forklift operation poses real risks, such as dropping the valuable load, pedestrians being hit by the vehicle, or operators falling. Thus, adequate training is essential to minimize the risk of accidents taking place. The problem is that instructor-led forklift training engages resources and takes a lot of time, even about a week. Instructors have to constantly assess operators' performance and adjust training to their skills. A great many employers require their workers to undergo forklift retraining every year to make sure they still have the necessary skills.

Aim

So far, forklift operator training has been conducted during one-on-one sessions with trainers. Thus, the biggest room for improvement was to replace the live-trainings, at least partially, with the system solutions. The training experience had to be as smooth as the one with experts, ideally with free hands, so trainees could be instructed and perform the tasks simultaneously. The biggest challenge was to supervise training and ensure trainees' safety.



Solution

We have created an automated training system that is to be implemented in multiple factories of one of the leaders in the car manufacturing industry. It trains future forklift operators with the help of augmented reality and artificial intelligence algorithms. Thanks to the new solution, one trainer can now supervise a number of learners at once, helping them in the most demanding tasks only.

The system guides trainees through the whole process with step-by-step instructions. Shows them in detail, in front of their eyes, how to enter a vehicle, get ready to ride, safely join the traffic, carry the load, etc. We have freed workers' hands with AR wearable devices, Microsoft HoloLens 2 goggles in particular, so now they can learn how to perform their tasks more effectively.

The system is able to control employees through sensors and cameras mounted in the maneuvering area and forklifts, images from AR goggles, forklift 3D models, hand tracking, and sound intensity analysis. It also reminds them to wear personal protective equipment.

Methods

To create fully-effective forklift training we used: augmented reality, deep neural networks, image processing, and object detection.

Outcome

- Automated forklift operator training with no or minimal instructor involvement
- System verification of the tasks completion correctness, danger detection, and warning mechanism
- Consistent forklift operating skills across all branches made possible
- Objective skill assessment and examination
- More effective training – trainees can focus on the tasks as long as they need
- Savings of costs and minimizing experts' involvement – more workers can be trained simultaneously
- Data collection, analysis, and automated reporting
- Managers can use training data collectively to optimize learning processes and individually to help particular users
- Training sessions can be recorded for further analysis

The system application areas include all types of machinery training, however, each type has to be designed for the particular setting.



AI IN THE FOOD INDUSTRY

Challenges

The food industry is a diversified network of companies that operate in farming, food production, packaging, transportation, and distribution. It involves not only small, family-run firms but also global food corporations and restaurant chains. The initial stages of the production process are particularly labor-intensive, facing staff shortages in peak season, and heavily dependent on weather conditions, which makes it difficult to plan production in advance. Although mass food production has become highly mechanized, there is still room for automation.

In terms of product quality, the stakes are high. Any aberrations or oversights in the food production cycle can put consumer health at risk. From fresh produce to uncontaminated processed food and correct storage and transport conditions – each stage of the process requires strict control.

AI based solutions

The world population is continuously growing, exceeding 7.9 billion in 2022. Which means the food industry will have to increase efficiency to meet basic human needs. This can be done with robotization and employing AI in various food production stages, such as:

- Smart agriculture – AI in seed selection, soil and crop monitoring (look for robocrops), watering, and fertilizing
- Harvesting, food production, sorting, and packaging robotization
- Automated product security and quality assessment
- Predictive analysis in production planning, also real-time, and revenue forecast
- Data-based management of resources used in production – water, energy, fuel, etc.
- Predictive maintenance of production machinery
- Transportation planning – loading times, routes
- Food waste management systems
- Employee training and management
- No-checkout, staff-free shops
- Recommender systems
- New product development based on consumer interests and trend forecasting
- Introduction of new AI-based recipes



Results

Smart agriculture fosters the food industry development. Through analyzing archival and present data, weather conditions and forecasts, climate changes, product images, samples, and x-rays, learning models can plan production accurately and take countermeasures way before unexpected events, like natural disasters, take place.

The AI-powered decision-making systems help to maximize production and produce quality. At the same time, they minimize waste and costs (e.g. packaging, transportation), increase food production process safety, increase product shelf life, deal with staff shortages, and deal with many more issues. What is particularly important for the next generations to come, produce can also be healthier, thanks to fewer fertilizers and pesticides needed.



CASE STUDY

QUALITY CONTROL AT THE FRUIT SORTING LINE

Problem

In many cases, people still control the quality of the production process manually, especially when it comes to unprocessed goods. The reason is simple – the margin of error is large. There are so many varieties of the same product (deviations in shape, size, color, ripeness, presence of blemishes, leaves, or stem) that traditional computer vision algorithms struggle to cope with the task. On the other hand, building robots that play the testers part is too pricey to be profitable. In effect, human-performed quality control remains time-consuming, error-prone, costly, and potentially fruit damaging.

Aim

Since the industry faces staff shortages and rising labor costs, our goal was to automate the control process to guarantee its consistent quality at the apple sorting lines. As a side effect, we expected a more standardized product, not affected by inspectors' opinions.

Solution

As mentioned before, there is no prototype of an ideal apple – and within their diversity, a lot of them are still marketable. Thus, we knew that comparing images of apples to a master pattern would simply not work. We had to build a quality control system using neural networks.

The solution uses RGB and hyperspectral cameras – and deep learning algorithms. It can examine not only external (with RGB imaging), but also internal (hyperspectral imaging, HSI) properties of apples, such as sweetness, juiciness, or firmness. To achieve the most precise results, all apples have to be evaluated at an invariable camera distance and background color (white in our case). This multi-input method classifies apples by learning what a good apple means – the way humans do. In fact, thanks to HSI technology, the system performs even better.



Methods

In the project, we used: machine learning, deep learning, deep neural networks, convolutional neural networks, image processing, object detection, and image segmentation.

Outcome

- Non-invasive automatic quality control at apple sorting lines, with no human supervision needed
- Excellent model accuracy with a minimal number of samples used
- Fruit assessment based on identical criteria – independent of inspectors' opinions
- Consistent quality, products more reliable for the customers
- Constant, 24/7 productivity
- Data collection available for analysis and further improvements
- A scalable solution that can work in the same manner with other types of fruit, vegetables, fish, etc.





AI IN THE EDUCATION SECTOR

Challenges

Education can take place in different settings, from formal, obligatory schooling to vocational adult learning programs delivered by for-profit institutions. Regardless of the type, education and the approach towards it undergo far-reaching changes, though they might occur a bit more slowly in formal environments. A good example is a growing emphasis put on customized learning and learning paths instead of unified, one-fits-all solutions.

The sector has always relied heavily on a workforce, thus significant teacher shortages have become an issue in many communities. Those who work in the formal education system often complain about being overworked and underpaid, which affects their job satisfaction and teaching effectiveness. When it comes to adult education, frequently conducted in the workplace, instructor-led training (ILT) is time-consuming, costly, and engages experts' time. In all the above cases, technology support is a lifesaver.

AI based solutions

With the increasing global population and lifelong learning trends, education will have to employ more and more technological solutions to meet the growing demand. AI meets the educator and learner needs through:

- E-learning environments and intelligent tutoring systems – for students and future teachers
- Personalized learning in terms of topics and preferred formats
- Assistive technology, e.g. text-to-speech and image-to-speech for learners with vision impairment
- Recommender systems suggesting courses and learning tracks
- Teacher task automation – systems that test learners, grade them, fill documentation, measure progress, identify students with problems
- Back office task automation – automated invoicing, contracting, accounting, information sourcing
- Assessment mechanisms, from reading issues diagnosis, essay grading, to manual task verification
- Augmented/virtual reality courses, also on-the-job, with no instructors
- AI bots for 24/7 assistance
- Engagement mechanisms – automated feedback and appraisal

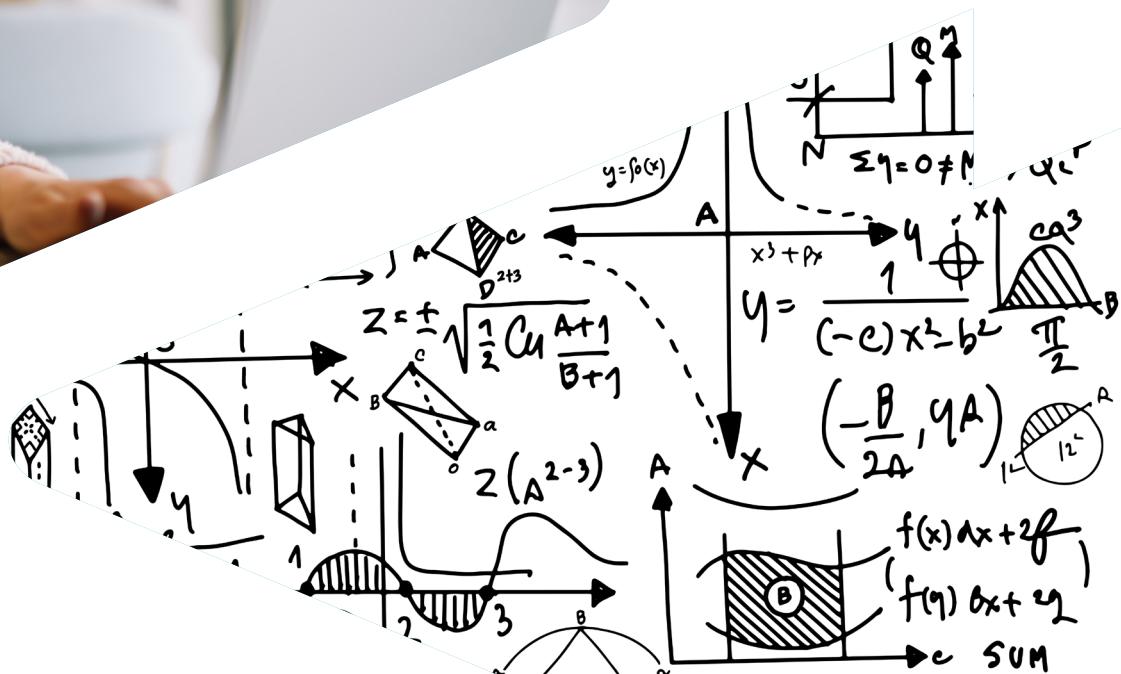


Results

Artificial intelligence is transforming – if not revolutionizing – methods of teaching and learning. And if you think there are isolated cases only, just have a look at Coursera, an online e-learning giant, whose CourseMatch tool automatically matches the online courses with the on-campus ones.

Making learning by doing more available, artificial intelligence helps students learn better, faster, and more effectively. Thanks to task automation educators can devote more time to demanding topics and those learners, who encounter difficulties. Course creators can also easily identify parts that might need improvement.

With speech recognition, computer vision, and natural language processing algorithms the systems can guide learners and assess a variety of their tasks. It is able to score written assignments, diagnose reading/speaking issues, and verify manual task performance – driving down the overall costs.



Product

Samelane learning management system

Problem

Instructor-led employee training, particularly taking place in the classroom, is time-consuming, costly, and hard to keep a tally of. The quality of teaching and knowledge/skills assessment is fully dependent on the very instructor. The more employees there are, the more teaching and managerial staff is needed.

Samelane LMS

Samelane, our learning management system, has been designed to simplify training, manage it and track it, all in one place. Some of its functionalities include:

✓ **Course creation** – easy and intuitive; companies can reuse materials they already have, such as presentations, videos, audio files, text documents, SCORM files

✓ **Course assignment** – the courses can be shared with selected people, departments, or the whole organization

✓ **Recommendation engine** – suggesting courses worth taking

✓ **NLP-based course search engine** – looking for courses and particular course content, present in texts, images, or videos

✓ **Learning automation** – from onboarding to upskilling, training can be fully automated, including reminders, feedback, and grading; learners can access it 24/7 via any device and from every location

✓ **Engagement mechanisms** – quizzes, badges, awards, certificates, gamification

✓ **Evaluation and reporting** – managers can monitor learning progress, completion rate, or evaluation status – on a scale of a single course/employee or entire organization

✓ **Present-day technologies** – Samelane makes use of artificial intelligence, virtual reality, augmented reality, and machine learning. Thus, you can create VR/AR training, use smart search, and automate knowledge sharing, issue detection, and reporting

Samelane



Samelane for Comcast

Samelane is used by Comcast – a major American provider of cable television, entertainment, communication products and services. It provides 24/7 customer support, with thousands of customer service employees (in partner companies) all around the world. Since Comcast customers contact CS directly to solve everyday problems, it is crucial to provide employees with the best training possible.

Before we introduced our learning management system, Comcast had used a simple standard way of classroom training that lacked traceability. LMS allowed the company to get rid of paperwork, automate invoicing and compliance training, increase efficiency and employee satisfaction, and, last but not least, achieve considerable savings.



Samelane for Comcast in numbers:



45,000 users



200,000 e-learning courses completed



400 business units



95% of participants said that LMS has improved their efficiency

PART III: GETTING STARTED

HOW TO START AN AI PROJECT WITH AN EXTERNAL PROVIDER

As you already know how to apply artificial intelligence in your business processes, it's time to discuss how to get the bit between your teeth.

Going straight to the point, we want to make sure you are aware of the fact that artificial intelligence projects are characterized by a high risk. Unlike software development, which can be difficult but still way easier to plan, there are a lot of uncertainties involved in AI implementation, as it belongs to the research domain. Starting an AI project you frequently don't know if your problem can be solved by technology at all, because no one yet has solved it.

Without a doubt, the game is worth the candle. If an AI project is successful – you can boost your business immensely, gain a great advantage over your competition, and create unparalleled products and services. Needless to say, the only way to break new ground is to give it a go.

Encompass unpredictability and minimize the risk

Just as in case of every other innovation, research projects mean we need to confirm our hypotheses first. We must prove that what we want to achieve is in fact achievable.

For this reason, it is practically impossible to determine the time and budget needed for the completion of most AI projects before the kickoff. This generates obvious problems such as how to get your board of directors approve the costs bearing in mind the unpredictability of the outcome.

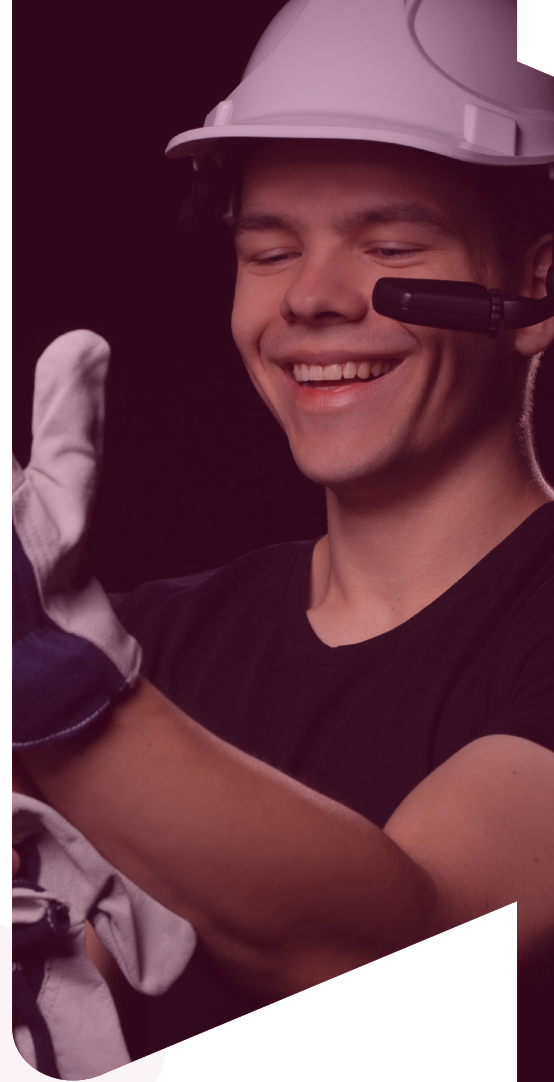
On a side note, it doesn't apply to typical projects that benefit from AI, such as recommender systems, which make use of ready-made tools and libraries, and thus the risk is rather low.



The key is to minimize the risk and costs and make the process as safe as possible. Particularly, when apart from the very project, there is also a question of choosing the right supplier, which always adds to the risk if you are to cooperate for the first time. You might want to paddle your own canoe, but if you don't deal with AI on a daily basis – that might be an arduous task, one would say even impossible. Therefore, most likely you will need to hire AI experts with a research & development team and technical background. So that they can get the monkey off your back.

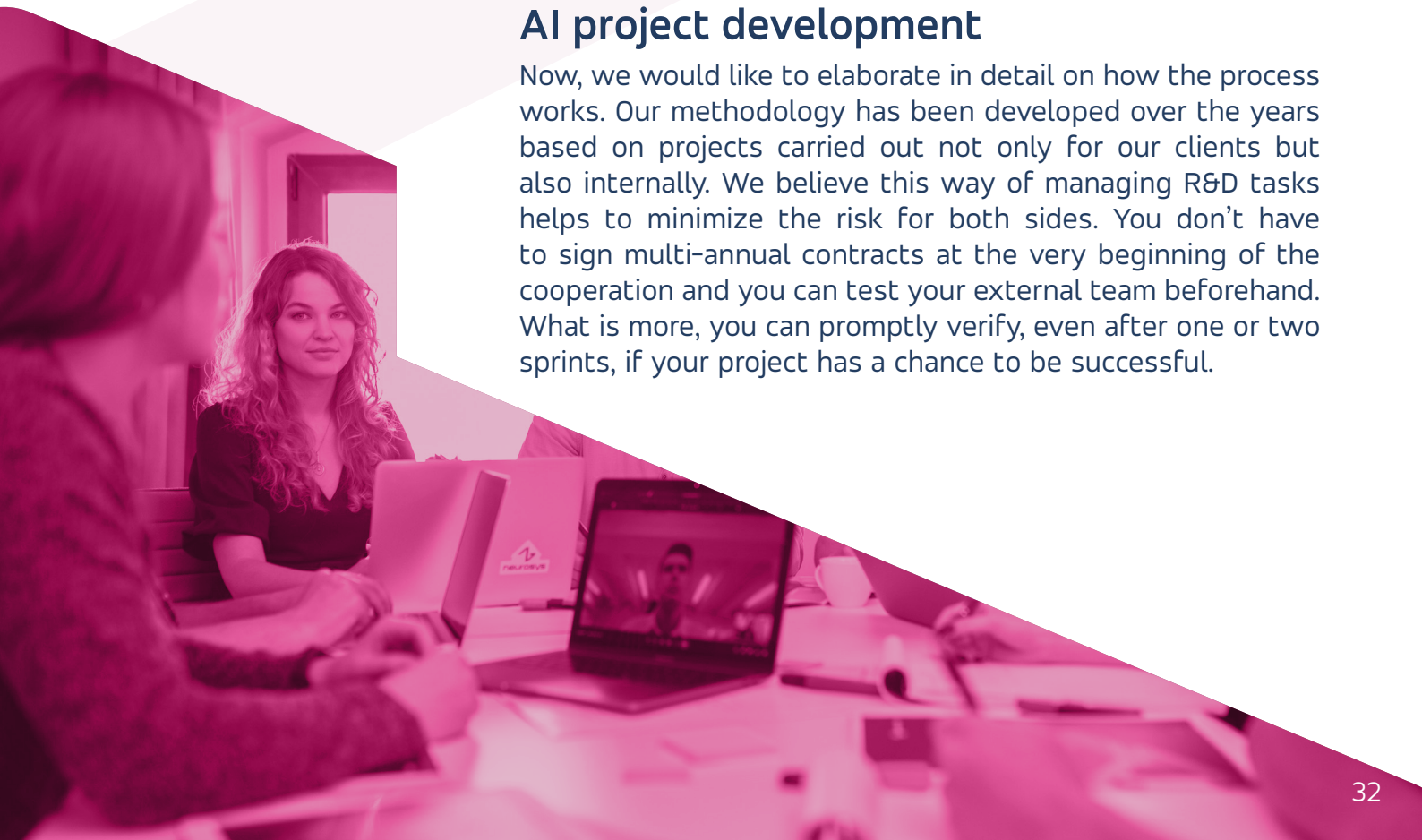
Only to touch briefly upon the subject of supplier verification – a lot of companies say they do AI but in fact, they don't. For this reason, you might want to devote considerable time to double-check your AI company. The fastest and most effective way to proceed, is to make use of AI consultations or development trials if available. In case of no trial offer but a long-term contract served as a starter, you might want to think twice before beginning the cooperation.

Knowing how risky the process is, let's discuss how to make your artificial intelligence project less unpredictable, one step at a time.



Stages of AI project development

Now, we would like to elaborate in detail on how the process works. Our methodology has been developed over the years based on projects carried out not only for our clients but also internally. We believe this way of managing R&D tasks helps to minimize the risk for both sides. You don't have to sign multi-annual contracts at the very beginning of the cooperation and you can test your external team beforehand. What is more, you can promptly verify, even after one or two sprints, if your project has a chance to be successful.



PHASE 1
ANALYZE
THE PROBLEM

Firstly, you diagnose a problem or, as some prefer to call it, a challenge. You have a gut feeling that it can be cleverly solved or things can simply be done better – faster, more effectively, with less human involvement or risk. You come to us to validate your idea.

Since every case is different when it comes to artificial intelligence, we need to learn as much as possible about your organization and its challenges. To achieve that, after signing an NDA, we interview you, collect information, preferably including sample data, and run workshop sessions. Knowing your problem, real data and processes, existing solutions, equipment used, and finally the area that is to be automated, we can propose an initial idea on solving the issue. This stage of the project is free of charge and takes up as little as two days.



PHASE 2
CREATE
A FEASIBILITY
STUDY

Already knowing the problem well, we can proceed further on our own. In phase two, we devote time to verifying the assumptions and ideas that we had come up with in phase one. We conduct a feasibility study to assess if particular algorithms and solutions will work out. At the end of the process, we try to propose a complete, long-term solution. This phase takes about a week.



PHASE 3
DIVIDE IT INTO
SUBPROJECTS

AI projects can last from a few weeks to several months and it is difficult to give the correct estimation with minimal information. To be able to manage such a project effectively, we have to divide it into subprojects that have clear timing, deliverables, and cost estimation. It is important to define the first 1 or 2 sprints during which we can prove the core hypothesis of the project. This way, you know clearly if the path we have taken is correct and has a chance to solve your complex problem.





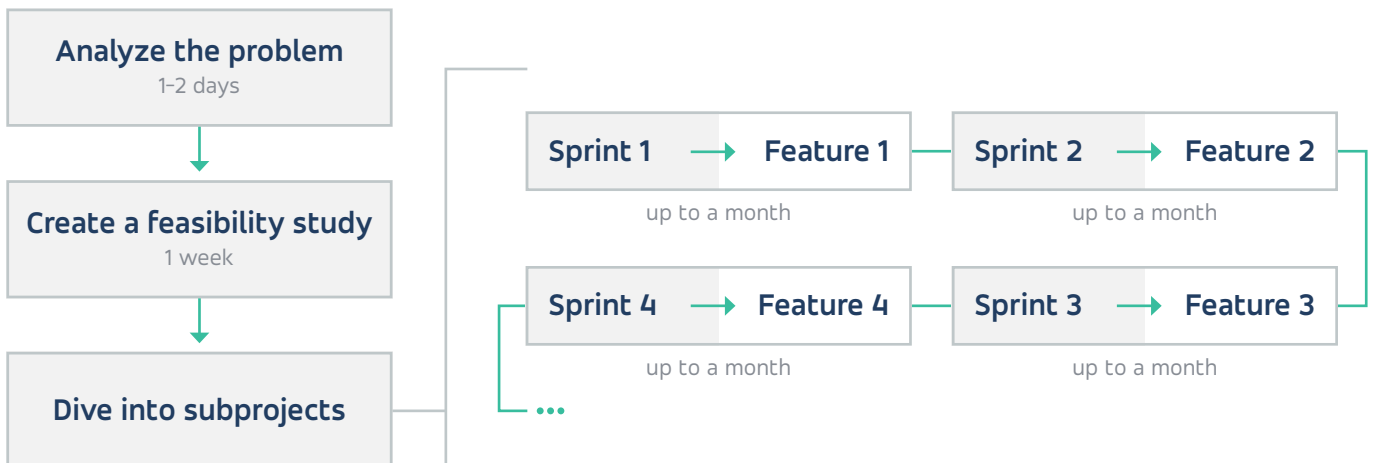
Stages of AI project development

Following this 3-step process, without getting involved in a long-term commitment, you can validate basic assumptions for your AI project, such as, how many training samples are needed, or, how effective the system and its functions will be. In the end, you will learn whether the expected results are likely to be achieved. Moreover, this way you will have a chance to get to know us a little better – if we keep our promises, how responsive we are – and find out for yourself if you like the experience of cooperation.

Based on our so far experience, the key part of each AI project is data – not only its quantity but also the quality. Thus, the initial sprint(s) allow us to realistically evaluate what challenges we will face working with your data – and this bit is particularly important for estimating the project. It can be basic things like mistakes and lack of standardization of data, or more significant problems with gathering real-live datasets.

This way we reduce risk as much as possible for both sides. You don't have to sign long-term contracts with an external provider and we don't have to estimate projects that are highly unpredictable and thus risky. Of course, we won't deliver the full production solution within the first sprint. However, it is definitely worthwhile to verify if the very idea is executable at all – and how long it might take to build a complete system.

Artificial intelligence development process





YOUR DIGITAL TRANSFORMATION PARTNER

WE HELP COMPANIES STREAMLINE THEIR BUSINESS PROCESSES WITH AI AND IT.



ISO 9001:2015
ISO/IEC 27001:2017-06

A few words about us

NEUROSYS in numbers

2010 founded

2 products:
Nsflow & Samelane

Samelane
NSFLOW®

120 employees

12 R&D experts

4 offices in Europe

2 ISO certificates

We specialize in:

AI / Machine Learning
/ Data Science

Software Development

Augmented Reality
App Development

Quality Assurance

UI/UX Design

DevSecOps



About the authors & more

This ebook is an effect of collaborative work.
It wouldn't be possible without:



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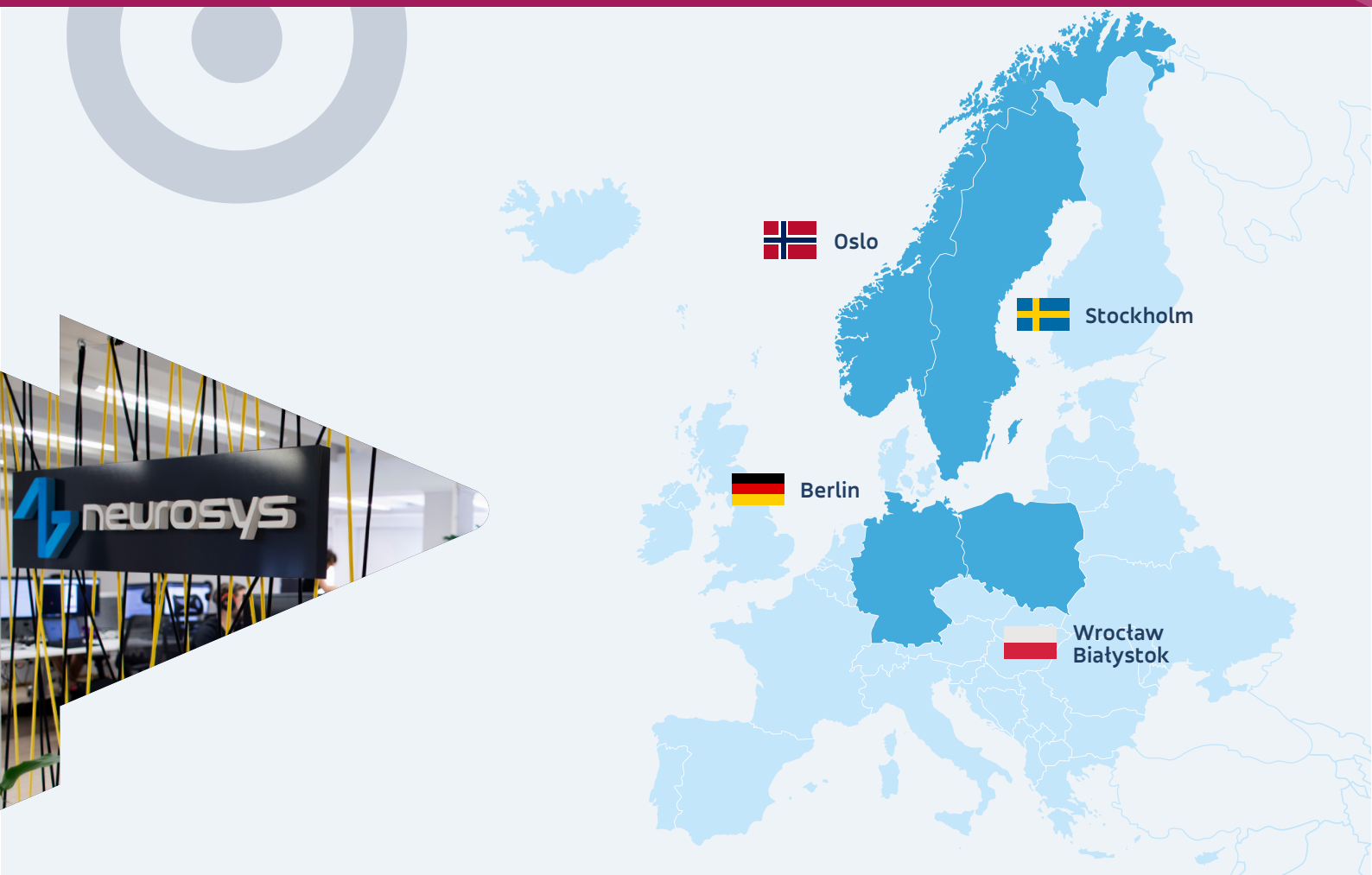


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STAY IN TOUCH WITH US:

