AI4Agri

Developing green and digital skills towards AI use in agriculture

Erasmus+

KA220-VET - Cooperation partnerships in vocational education and training

WP2:

Connecting AI with Agricultural sector: current status and needs assessment

Review on AI and agriculture technology and analysis of farmer-driven innovations and best-practices in AI and agriculture technology

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Validated by Joseph Olugbenga Kayode

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1. Agriculture Policies in the EU

The European Union (EU) has a comprehensive set of agriculture regulations in order to guarantee a steady supply of food, secure farmers' income, and preserve the environment. These policies are constantly evolving to address new challenges and opportunities, and they increasingly recognize the potential technology to transform the agricultural sector (EC,2022).

Common Agricultural Policy (CAP)

The Common Agricultural Policy (CAP) is the cornerstone of EU agriculture policy and has a cross-cutting objective on digitisation, knowledge and innovation which includes investment support for the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). The latest CAP reform, which is in effect from 2023 to 2027, places a greater emphasis on sustainability and innovation and incorporate specific National Strategic Plans.

Sweden's Strategic Plan aims to increase the productivity, viability and competitiveness of the agricultural sector while protecting animal welfare and seeking increased ambition in environmental and climate standards. The strategy also aims to contribute to the development of Sweden's rural areas, to help ensure that these are attractive places to live and work in. The Plan is operating alongside national support schemes, national legislation and with the actions of the Recovery and Resilience Facility, namely the EUR 1.46 billion reserved for the green recovery. Sweden has prioritised the improvement of its knowledge and innovation system in the agriculture sector, with a particular focus on advisory services, knowledge sharing and upskilling. More than 43 000 persons are expected to receive advice, training and knowledge exchange, or participate in innovation groups, which will facilitate the introduction of new technologies and working methods in agriculture.

The Swedish Plan will take full advantage of high-speed broadband that will be brought to sparsely populated areas with the support of the RRF, the European Regional Development Fund (ERDF) and national measures. This will not only help with the implementation of innovative digital solutions, but will also enhance the attractiveness of rural and sparsely populated areas.

2. AI Policies in the EU

The European Union (EU) has been at the forefront of developing policies and regulations on artificial intelligence (AI).

1. White Paper on Artificial Intelligence

In 2018, the European Commission published a *White Paper on Artificial Intelligence*, which set out a framework for the development and use of AI in the EU. The White Paper also called for the development of a new legal framework for AI in the EU.

2. *Regulation on Artificial Intelligence*

In 2021, the European Commission published a proposal for a *Regulation on Artificial Intelligence.* The proposed Regulation would prohibit the development and use of certain high-risk AI applications, such as AI systems that are used for social scoring or that could lead to significant harm to individuals. The proposed Regulation would also require certain AI systems to be subject to prior conformity assessment before they can be placed on the market or put into service.

3. EU AI Act

On Friday, 8 December 2023, the European Union (EU) institutions reached an agreement on the key terms and components of the Artificial Intelligence (AI) Act following months of intense negotiations. The AI Act is a landmark in global AI regulation, reflecting the EU's objective to lead the way in promoting a comprehensive legislative approach to support the trustworthy and responsible use of AI systems. The AI Act follows other major EU digital legislation, such as the General Data Protection Regulation (GDPR), the Digital Services Act, the Digital Markets Act, the Data Act, and the Cyber Resilience Act.

The AI Act is unifying how AI is regulated across the single market of the 27 EU Member States. It also has important extraterritorial implications, as it covers all AI systems impacting people in the EU, regardless of where systems are developed or deployed. Compliance obligations are significant, and largely determined by the level of risk the usage of an AI system poses to people's safety, security, or fundamental rights. Obligations apply along the AI value chain. The AI Act applies a tiered compliance framework. Most requirements fall upon the developers and deployers of AI systems classified as "high-risk", and on general-purpose AI systems (including foundation models and generative AI systems) posing "systemic risks". The agreement currently sets out a phased timeline for enforcement, starting with prohibited AI systems in 2025 and progressively extending to all AI systems by mid to late 2026. There are significant financial penalties for noncompliance.

It is important for business leaders in the EU and beyond to consider the implications of this complex legislation before it comes into effect. This consideration includes understanding how the AI Act interacts with existing and emerging rules and regulations in other jurisdictions, as well as with voluntary AI codes and principles. Businesses and other organizations should ensure they have an up-to-date inventory of the AI systems that they are developing or deploying. They will need to assess whether their systems are subject to compliance obligations and, if so, under which classification. Developers and deployers of high-risk and general-purpose AI systems will also need to ensure that effective AI governance frameworks and compliance systems are in place.

4. EU AI Pact

The AI Pact is a scheme that will foster early implementation of the measures foreseen by the AI Act. Companies will have the opportunity to demonstrate and share their commitment towards the objectives of the future AI Act and prepare early on to be ready for its implementation. More specifically, the Pact will encourage companies to voluntarily communicate the processes and practices they are putting in place to prepare for compliance and ensure that the design, development and use of AI is trustworthy:

- Commitments will take the form of pledges that will be published by the EU Commission.
- The AI Pact will convene key EU and non-EU industry actors to exchange best practices.
- Interested parties will meet in the first half of 2024 to collect ideas and best practices that could inspire future pledges.

In November 2023, the Commission has launched a “call for interest” for organisations willing to get actively involved in the AI Pact. As a next step, the Commission will bring together interested parties, in the first half of 2024, to discuss the ambitions of the Pact and collect preliminary ideas and best practices which could inspire future pledges. Following the formal adoption of the AI Act, the AI Pact will be officially launched and “frontrunner" organisations will be invited to make their first pledges public.

5. The European Data Act and common European agricultural data space

The Data Act aims to maximise the value of data in the economy by ensuring that a wider range of stakeholders gain control over their data and that more data is available for innovative use, while preserving incentives to invest in data generation. The data act should give the users of the connected products and related services the right to access data generated by those products and services. The Data Act entered into force on 11 January 2024, and it will become applicable in September 2025.

The common European agricultural data space will ensure that more data becomes available for use in our economy and society, while keeping companies and individuals who generate data in control. The objective of the agricultural data space is to develop a secure and trusted data space to allow the farming sector to share and access data, improving economic and environmental performance in the field. Production data, supplemented by publicly held data, presents new opportunities for monitoring and optimising the use of natural resources, and contributes to achieving the objectives of the Green Deal and the Common Agricultural Policy.

With the European data act, the European Commission is expected to support the implementation of a common European agricultural data space, facilitating the trustworthy sharing and pooling of agricultural data. The data space should increase the economic and environmental performance of the agricultural sector. This means enabling data sharing as well as practical, fair and clear rules on data use and access. In precision agriculture, internet of things (IoT) analytics of data from connected equipment can help farmers analyse real-time data like weather, temperature, moisture, prices or global positioning system (GPS) signals and provide insights on how to optimise and increase yield. This should improve farm planning and help farmers make decisions about the level of resources needed. It would also protect farmers that use smart agricultural equipment against manufacturers who would use insights into farm yields to speculate on agricultural commodity pricing, essentially using farmers' data against them (Panel for the Future of Science and Technology, 2023).

6. AI testing and experimentation facilities (TEF):

Together with Member States, the Commission is co-funding the TEFs to support AI developers to bring trustworthy AI to the market more efficiently, and facilitate its uptake in Europe. TEFs are specialised large-scale reference sites open to all technology providers across Europe to test and experiment at scale state-of-the art AI solutions, including both soft-and hardware products and services, e.g. robots, in real-world environments.

These large-scale reference testing and experimentation facilities will offer a combination of physical and virtual facilities, in which technology providers can get support to test their latest AI-based soft-/hardware technologies in real-world environments. This will include support for full integration, testing and experimentation of latest AI-based technologies to solve issues/improve solutions in a given application sector, including validation and demonstration.

TEFs can also contribute to the implementation of the Artificial Intelligence Act by supporting regulatory sandboxes in cooperation with competent national authorities for supervised testing and experimentation.

3. Adaptation at National Contexts

Sweden has not yet adapted any EU regulation regarding artificial intelligence. The Swedish Government has stated that it welcomes the Commission's work to create a uniform regulation for AI within the EU and highlights that Sweden must be a leader in taking advantage of the opportunities that the use of AI can provide. The Swedish Government also supports the fact that the proposal is based on human rights, including the right to privacy, freedom of expression, non-discrimination and equality, but also personal integrity, protection of individuals regarding the processing of personal data and information and cybersecurity. Swedish authorities have also recognised the importance to prepare public administration in Sweden for the upcoming EU regulation, since a lack of clear governance and coordination in relation to the regulation could entail that Swedish public administration as a whole will be severely limited in its ability to use AI.

4. National Legislation Frameworks

The use of artificial intelligence (AI) in agriculture is growing rapidly in Sweden, as farmers seek to improve productivity and sustainability. However, Sweden's regulatory landscape for the use of AI in agriculture is shaped by a combination of general laws, specific regulations, and industry guidelines. While there is no overarching legislation specifically dedicated to AI in agriculture, several existing frameworks address relevant aspects of AI adoption and application in this sector.

1. Sweden, National Approach to AI (2018)

In May 2018, the Swedish Government released its national AI strategy National approach for artificial intelligence. This strategy points out the general direction for AI in Sweden in order to create a basis for future policy actions and priorities. In this sense, this strategy serves as a reference for the government to outline forthcoming policy initiatives with the aim to strengthen Sweden's welfare and competitiveness by means of AI. To this purpose, the Swedish strategy focuses on the following priority areas:

- Education and training;
- Research;
- Innovation and use;
- Framework and infrastructure.

In 2018, the Swedish Government set a goal for Sweden to become the global leader within innovation and the use of digital solutions. One of the technologies to achieve this goal is artificial intelligence ("AI"). The Swedish Government commissioned the Public Employment Services, the Swedish Companies Registration Office, the Agency for Digital Government, and the Swedish Tax Agency to promote the use of AI in public administration in 2021. The authorities' report on the assignment, which was published in January 2023, shows that a great demand to provide comprehensive and concrete support in developing and providing guidance for AI solutions has emerged in Sweden, not only in the business sector but also in public administration.

2. Committee directive: Enhanced AI capability in Sweden

On 7 December 2023, the Swedish Government decided to set up a Commission for Enhanced AI capability in Sweden through a Committee directive. This AI Commission will identify needs and propose measures that can help strengthen the development and use of artificial intelligence (AI) in Sweden in a sustainable and safe way. AI has great potential to contribute to increased innovation capacity, higher efficiency, and better competitiveness, but also to more efficient public administration. The purpose of the assignment is to ensure that Sweden, as a leading research nation, advanced industrial nation and ambitious welfare nation, better utilises the opportunities and manages the risks of AI, including helping to identify a niche in AI where Sweden can become an important partner for others.

3. Data Protection Law:

Sweden introduced one of the first data protection laws in the world in 1973 with the introduction of the Data Act (Datalagen). The supervisory authority Datainspektionen was founded the same year. On 1 January 2021, the name was changed to Integritetsskyddsmyndigheten ("IMY"). The GDPR is implemented by the statute Lagen (2018:218) med kompletterande bestämmelser till EU:s dataskyddsförordning. The unofficial English name for this statute is the Act containing supplementary provisions to the EU General Data Protection Regulation. This law is commonly refered to as "The Data Protection Act" (Dataskyddslagen).

4. Environmental Code

The purpose of the Environmental Code is to promote sustainable development. It is applicable to all persons and operators who undertake activities or measures which could impact on the fulfilment of the objectives of the Environmental Code. The scope of the Environmental Code is directly linked to the promotion of sustainable development. The Code is applicable to all activities or measures that are of significance for this purpose to be achieved. It therefore concerns all types of measures and operations that may be of importance to those interests the Code is intended to protect, regardless of whether they are part of a private individual's daily life or are some form of business activity.

Accordingly, AI systems used in agriculture may be subject to environmental regulations, particularly those related to water quality, pesticide use, and soil conservation. Developers and users of AI tools must ensure that their applications comply with environmental standards and minimize potential negative impacts on the environment.

5. Other frameworks

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As stated above, Sweden has not yet enacted specific legislation governing artificial intelligence (AI). However, several existing laws and regulations may be applied to AI systems. These laws address issues such as (1) Ownership/protection[1]; (2) Antitrust/competition laws[2]; (3) corporate governance[3]

5. AI Technologies & Applications in Agriculture Industry

Digitalisation and artificial intelligence for crop morphology measurements

The shape and morphology of plants is related to variety, the underlying genetics and environmental factors (light, temperature, irrigation). Digitalplant phenotyping refers to the use of computers for plant phenotyping where digital sensors are used to measure plant characteristics. One of the most common digital phenotyping methodologies is image analysis, where cameras are used to record images and software is used to automatically extract the measurements from the imagesto access plant morphology (the shape of a plant), in a reproducible and accurate way (Van der Heijden & Polder, 2015).

Currently, many different types of cameras are available for measuring important plant features to characterise plant morphology. The most used camera is the RGB colour camera, which produces images in the visible spectrum, mimicking the human eye. To relate the images to real dimensions, 3D information is often needed, which resulted in RGB camera-based 3D sensors. The Intel Realsense RGBD sensor is an affordable example of a RGB 3D sensor and is often used in horticultural phenotyping, e.g., for tomato fruit detection and counting (Afonso et al., 2020; Fonteijn et al., 2021).

Other examples are LiDAR sensors.

All of these might become low cost because of the development of smart phone camerasfor consumers. In greenhouse crop production, the plants may be intertwined, and so they cannot be easily imaged from all sides. This leads to occlusion and hampers the possibility of imaging important plant traits with a 3D camera. To overcome this problem, more advanced imaging solutions are needed. This can either be achieved by a moving trolley system with a mounted camera, flying drones inside the greenhouse or a robot that scans the plant with a 3D camera from many viewpoints. Using

[1] Computer programs are literary works under the Computer Programs Directive 2009/24/EC, which has been incorporated in the Swedish Copyright Act (1960:729). However, in recital 11 of the Computer Programs Directive, it is stated that only the expression of a computer program is protected, and that ideas and principles are not protected by copyright.
[2] Competition law in Sweden is regulated by the Swedish Competition Act (2008:579), which, through Sweden's membership in the EU, is harmonised with the EU competition law, specifically Articles 101 and 102 of the Treaty on the Functioning of the European Union. Consequently, Swedish competition law is also interpreted in accordance with the European Court of Justice's case law.
[3] In Sweden, the central act regarding corporate governance is the Swedish Companies Act (2005:551). Furthermore, Swedish companies whose shares are listed on a regulated market in Sweden are obligated to apply the Swedish Corporate Governance Code and the regulated market's own rules and regulations. In addition to these, the Swedish Accounting Act (1999:1078), the Swedish Annual Accounts Act (1995:1554), the Swedish Securities Market Act (2007:528), and the Swedish Financial Instruments Trading Act (1991:980) are important regulations in the field of corporate governance. As the legislation is technology-neutral, there are opportunities and flexibility for the use of specific technical solutions in this field.

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artificial intelligence algorithms, the point clouds from different single viewpoints are converted into a robust representation of the crop (Boogaard et al., 2020).

Digitalisation and artificial intelligence for crop physiology performance

Next to plant morphology, plant physiologicalprocesses are important for crop monitoring. In crop production, photosynthesis in the leaves yields important biochemicals, such as sugars, starch, chlorophyll and nutrients, that are transferred to the plant organs, flowers and fruits (Dieleman et al., 2018a). Therefore, measuring the efficiency of plant photosynthesis directly and non-destructively is a desirable way for obtaining information on crop performance and for the early detection of deviations from optimal physiological conditions. Technologies like chlorophyll fluorescence imaging and thermal imaging are promising, especially if they can be applied to other parts of crop canopies, as well as individual leaves. The chemical composition of the crop can be determined by sampling leaves or fruits, sendingthem to a laboratory and waiting for the analysis.

Recent imaging spectroscopy was tested on a laboratory scale, to determine the composition of biochemicals in crops, with promising results (Dieleman et al., 2018b). Imaging spectroscopy is an imaging technique for images taken using many narrow wavelength bands over a range extending across the visible spectrum (from ultraviolet to shortwave infrared) and compared to a standard camera, which only records red, green and blue light. In doing so, it creates an extremely detailed image of the reflection of light on plants or other objects. Imaging spectroscopy provides a lot of information on plant pigments, sugars, proteins, fats and water, as well as their distribution over the leaves or organs. Regions of interest,such as the fruits or leaves, can be automatically extracted from the image. This opens the possibility of using this technique on mobile platforms (Mishra et al., 2020).

Until now, most plant features could only be measured manually, destructively and/or very locally with scarce datapoints. Digitalisation of the measurement and use of modern sensors and camera systemswill help to collect more datapoints. AImethods will largely help in the interpretation of variable data output. AI algorithms will also help to transform and combine the output of multiple sensors into useful information for growers.

Data for autonomous growing and production

Data regarding greenhouse production systems are becoming of increasing importance and are a means of deeper understanding and efficient management of the complex biological dynamic processes. Large and meaningful datasets about all growing aspects are sparse. The greenhouse climate is relatively well-monitored,resulting in a time series with short intervals. However, manual, subjective, time-consuming, often invasive, and costly measurements of traits of crop growth, development, pests, and pathogens result in fragmented weekly or bi-weekly data points (Bouzembrak et al., 2020). This implies considerable data uncertainty as a result of noise, missing data, inconsistent formats, and non-standard collection protocols, among others (Lezoche et al., 2020). Investment into integrating diverse and unstructured data is required before any additional meaningful insights are possible (Osinga et al., 2022).

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Ongoing technological developments, computational power, and high-fidelity sensors offer new opportunities for automated, remote, and non-invasive sensing of growing parameters. The higher spatial and temporal resolution in the measurements and in the growing conditions allows for interpretation of the system's variability at coarser and granular levels and offers opportunities for sufficient information extraction towards more efficient adaptation of horticultural practices. AI and machine learning can deal with the larger datasets and capture the nonlinear relationships present in the heterogeneous data sources in greenhouses.

Deep learning for pest and pathogen management

In the future, the detection of plant pathogens and pests will become extremely important. Unless it is known what a plant is suffering from, nothing can be done about it. The earlier pests and pathogens are identified, the easier it is to control them. Automated systems are starting to play a greater part in this (Polder et al., 2014). Automatic detection of pathogens in plants, as early as possible and without damaging the plant, is an approach that is gaining ever more attention in horticulture. In automatic detection, the basic assumption is that a diseased plant looks different from a healthy one. For example, leaves can have subtle colour differences, which are often invisible to the human eye but can be captured using techniques such as spectral imaging. Spectral imaging, combined with deep learning techniques (described in the previous section), has the potential to become a powerful tool in pathogen detection in greenhouses and vertical farms. Pest detection is often challenging because pests and their eggs are often located underneath the plant canopy and are, therefore, difficult to detect. They are often very small and show a very local distribution. Crops in general might suffer from multiple pests at the same time. Therefore, not only high-resolution detection but also local and organism specific detection is required. High-resolution imaging, in combination with deep learning techniques might have the potential for precision farming in greenhouses and vertical farms. In both cases, large amounts of labelled images are required from different situations (locations, seasons, crop varieties) to sufficiently train the deep learning algorithms.

Digital twins and decision support for market-oriented production

Today's high-tech greenhouses are equipped with different standard sensors for monitoring light, temperature, humidity, and CO2 and for actively controlling different actuators (e.g. lighting, screening, heating, ventilation, cooling, CO2 dosing, fogging, dehumidification, irrigation, and fertiliser dosing) in order to control all growth factors important for crop production at every moment. Today's growers determine the climate, irrigation and crop management strategies based on experience and define the setpoints for climate and irrigation control manually. Actuators then operate based on the setpoints configured in a processing computer, while sensors give feedback on measured data for the control loop (Hemming et al., 2020). The rapid pace of technological advancements, AI, cloud computing, and the uptake of the IoT produces an increasing data stream at high spatial and temporal resolution, almost in real-time. In smart horticulture, the greenhouse grower can monitor and control operations at a distance, based on real-time digital information instead of direct observations and tasks on-site. Large amounts of data can be leveraged for the design and implementation of advanced models, known as digital twins. A digital twin is equivalent to real-life objects mirroring the behaviour and states over its lifetime in a virtual space (C. Verdouw et al., 2021). As a digital representation of actual physical systems and technology integrators, digital twins offer a solution for complex systems analysis and can act as decision support tools (Pylianidis et al., 2021). Digital twins are increasingly adopted in the manufacturing, automotive, and energy industries(Caputo et al., 2019).

Crop health management

Crop health management involves detection and actuation. Detection might be further enriched by prediction but the extreme complexity of weeds, disease and pest dynamics has not resulted in many widespread commercial solutions yet. However, it is on the agenda of many corporations, such as Bayer, which has made large investments to develop prediction tools for mobile telephones (Digital Farming Bayer Global, 2022) since 2017. Smart actuation, by delivering an adjusted spray rate only to places where weeds are located, has recently seen successful solutions with a combination of artificial intelligence and computer vision (https://bluerivertechnology.com). The following examples provide a few representative cases of advanced machines for the delivery of crop protection products or the mechanical removal of weeds, but many more are on the way as new smart machines are continuously emerging.

Planning by producer organisations or cooperatives

Market forecasting Market demand fluctuates quite rapidly, which means that agri-food companies must be one step ahead to act in time. Facing this, companies have been pursuing predictive analytics techniques to improve their supply chains and optimise marketing operations. Due to its ability to effectively discover trends and patterns in large datasets, ML methods allow predictive analysis that can support not only agricultural operations, but also retail (Huber & Stuckenschmidt, 2020). Thus, considering financial constraints to make an accurate market demand forecast, and an automated inventory control system is a game changer for the retail sector. In addition, ML methods can also predict market prices and the tendencies regarding the agri-food sector that will be in the pipeline soon, by understanding the behaviour of market demand. With this, AI-based techniques have become very popular among producer organisations and cooperatives, to efficiently boost supply chain performance, increase productivity and profit, optimise stock management and resource allocation, reduce costs and waste and increase customer satisfaction.

AI in soil and water management and irrigation

Soil and water management has a number of new challenges. Climate change has made the weather more unpredictable and,therefore, forecasting is becoming more difficult. Periods with storms and high rainfall alternate with dry periods. More crop stress, caused by higher temperatures or by excessive rain or floods, is to be expected. Heat resistant varieties are one of the options but intelligent long term (longer than one growing season) water management is another necessity. During summers with high temperatures, flooding and the submergence of crops during longer periods can be detrimental. At the same time, temperatures are higher and more droughts are expected; the crops need more water, either fed by rain or irrigation. Challenges from a crop growth perspective are important, but the role of the agricultural land in groundwater recharge and flood reduction also needs to be optimised as an ecosystem service to society. Using AI, we can combine real-time information from sensors, weather forecasts and crop soil modelling. In addition, spatial information from drones and satellites is accessible. In this way, climate adaptive management becomes feasible by taking into consideration the temporal and spatial variability of the soil and crop status in the field. It allows fast responses and reactsproactively to forecasts. Finally, AI decision support should be a combination of real-time sensors feeding data and imagery into crop growth and soil water balance models for the most optimal decisions. In general,the local level focusses on the farm and crop productivity, while the water resources require a regional dimension at the level of entire river basins and aquifers

National Initiatives:

AI Sweden Start-up Programme (AI Sweden)

The AI Sweden Start-up Programme is aimed at start-up who work with AI or who want to learn more about what AI could be used for. The programme consists of three stages, including learning, connecting, and accelerating. The learning stage included various types of learning content, including courses, workshops, and seminars. The connect stage contain access to the AI Sweden start-up community. And finally, the accelerate step includes full AI Sweden partnership, project access, and engagement, as well access to the Data Factory and testbeds, among other things.

The Data Factory (AI Sweden)

The Data Factory is an initiative launched in 2019 by AI Sweden that supports their partner organisations by enabling them to bring their own challenges to receive support, as well as to take part in existing projects, or experiments in the available testbed environment. The goal of this initiative is to increase the speed of innovation and usage of AI in Sweden, and several projects connected to the Data Factory have already been launched. Some of these include the Road Data Lab which wants to integrate different types of data related to roads in order to add value beyond what any single dataset could provide, and SCAPIS AI platform which aims to create a secure research environment for use of AI on image data from SCAPIS (Swedish CArdioPulmonary bioImage Study).

Edge Learning Lab (AI Sweden)

Edge Learning Lab is a testbed environment located in Gothenburg that enables developers, data scientists, researchers, students, and others to learn about edge learning, including its possibilities and limitations. Its purpose is to speed up the applied understanding of edge learning, including how to use and optimise it across industry, academia, and the public sector.

Swedish AI Start-up Landscape (AI Sweden, RISE & Ignite Sweden)

In 2020, the Swedish AI Start-up Landscape was launched as a joint initiative to pick out the best AI start-ups in Sweden to increase and contribute to the usage of AI while also making it easier for AI startups to access clients, capital, and talent. The chosen AI start-ups together form a landscape that acts as a quality stamp for them while simultaneously providing intel for the innovation ecosystem, investors, the government, and academia. Finally, the initiative is a part of the larger European AI Start-up Landscape which has the same goals but at the European level, and includes other partners such

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as the German Entrepreneurship, German Accelerator, appliedAI, and Hub France IA. As of 2022, Norway and the Netherlands have also joined the landscape.

6. Pedagogical Practices and Trainings

1. Artificial Intelligence' for the Agri & Food sector (NL AIC)

The Dutch AI Coalition (NL AIC) has developed the first AI course for the Agri and Food sector in collaboration with the Top Sector Agri & Food and Groenpact. A free online course that aims to give green entrepreneurs and green students a better understanding of the concept of Artificial Intelligence (AI) and its applications in the sector. The AI course for the Agri and Food sector consists of eleven interactive modules of 8 to 15 minutes with videos showing practical applications of AI in the sector. The course takes about 2.5 hours in total and the modules consist of an alternation of lectures, videos and interactive elements. The course touches on topics such as big data, algorithms and machine learning and focuses on the question: how is all this applied within the industry?

2. Professional training and certification program (AI Farming Technology)

Certified Artificial Intelligence Farming Professional (CAIFP) is a training and certification program for candidates who are already working, want to start a new career or sustainable developer in the agricultural industry. This program does not require any programming or computer science expertise and is designed to introduce the basics to advance level of A.I. and agricultural jobs to anyone whether you have a technical or farming background or not. Each program exam is configured individually, with factors ranging from the following: (i) Number of Multiple Choices questions (50 to 70); (ii) Number of Short essay questions (3 to 5); (iii) Passing score (60%); (iv) Time limit (90 minute); (v) 30 hours of FarmingPractice.

3. Artificial Intelligence for Agriculture Technology and Climate Change (Oxford University)

This course is for professionals in the agriculture, agtech, sustainability/climate change and food value chain sectors who aspire to be pioneers in the application of artificial intelligence (AI) in these domains. The philosophy of the course is based on applying AI techniques to specific problems in agriculture and climate change, and exploring the broader impact of these technologies in the food value chain.
You will gain a unique understanding of applying AI to complex, interdisciplinary problems based on data. The course emphasises AI for Good, and AI with cyber-physical systems, i.e., AI with Edge, systems thinking, and design thinking.

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