How does AI help in restocking supermarkets?

Worksheet AI
Practical assignment Vanderlande

BRAINPORT
EINDHOVEN

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Contents

Worksheets from the Brainport digital library

This worksheet is part of a series of worksheets designed to bring business developments from within the Brainport area into the classroom. The worksheets can be used "as-is" on their own, but can also be used as practical curricular assignments. Its exercises can be done at school with minimal preparation. Each exercise also contains an at-home assignment for students who are home-schooling.

Imprint

This worksheet is also in line with the 'Tech Awareness' project by Brainport Eindhoven, which centres around Brainport's five key technologies. One of those key technologies is Artificial Intelligence (AI). AI is used in things like self-driving cars and trucks (**DAF Trucks**), converting one language to another (Google Translate) or giving instructions (Google Assistant and Siri). It is also used for highly precise positioning (**ASML**). This could aid in things like helping doctors diagnose quicker and better (**Philips**), but also in designing a warehouse in which automatic systems store new products in the right place, and pick them up when needed (**Vanderlande**).

Editorial team and background

The educational material is developed on behalf of Lianne Savelberg-van den Wittenboer, Sr. Project Leader of Education at Brainport Development N.V, in cooperation with Bedrijf in de Klas. If you have any questions or if you'd like to receive the worksheets in an editable format, please contact info@lereninbrainport.nl directly.

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Practical info about the assignment

Theme	AI, programming
Linked subject(s)	Physics, Computer Science, but also Maths and Engineering
Target audience	Senior students in vmbo (pre-vocational education), havo (higher general continued education), vwo (preparatory scientific education) Suitable for other groups as well with some adjustments.
Final terms	Aside from working on cross-curricular themes and the focus on learning and working (vmbo), and the general skills in domain A (havo/vwo), these are more specifically: **vmbo (pre-vocational education)** • Math: Geometry, integrated mathematical activities **havo (higher general continued education)** • Math: Mathematics in technology • Physics: Technical automation / physics and technology / research and design **vwo (preparatory scientific education)** • Computer Science: B1 algorithms • Physics: Research and design
Learning goal(s)	Introduce students to - and have them think critically about - the use of Artificial Intelligence in automating logistical processes.
Guidance	Creative teacher who can think along with realistic case studies.
Duration	Separate exercises of about 1 class period each, but can be extended to a larger (cross-curricular) project.
Equipment	A) How to fill roll cage trolleys • Post-it notes and markers • Timer • Attachment: supermarket answer sheet B) How to stack products as efficiently as possible • Attachment: cage trolleys • Attachment: packages • Scissors • (glue)
Location	For exercise A) it would be helpful (but not essential) if the students are able to visit the supermarket to do their research. The other exercises can be done in class or at home.

Practical and theoretical exercises

Each main assignment is made up of practical and theoretical exercises of various levels. This means you can differentiate according to your class, time, classroom, and available options.

Using these practical exercises you can either continue the theoretical foundation of the subject, or further broaden the exercises into a large project spanning several days, perhaps combined with other subjects. The choice is yours!

All exercises can be complemented with (online) guest lessons, company visits, or they can be used as a starting point for a profile project.

The exercises increase in difficulty

The basic subject matter is the same for each exercise, but they increase from A to ... in difficulty and change from being more practical-based to more theory-based. Exercise A is a practical one: students are introduced to the concept and experience how something works. Exercise D is more theoretical: students do calculations or process more complex information.

The exercises can be easily combined. For instance, you can first use exercise A to introduce students to the concept and then have them go more in-depth with exercise C.

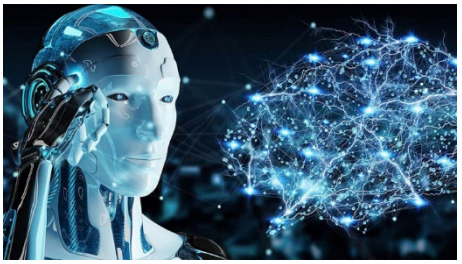
Link to businesses

All assignments and exercises in these work sheets are based on the challenges facing one specific business in the Brainport region. However, other businesses face many of the same challenges. Examples of AI that businesses in the Brainport region work on can be found here[i]:

Are you in touch with a business? Ask them what challenges they face and use a similar assignment from the digital library!

Degree programs in Artificial Intelligence

Do you want to continue studying Artificial Intelligence after secondary school? You can! AI is featured in more and more programs at every level of education. Looking for a specific AI degree program? Check the attachments for your options.



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Background information

The company: Vanderlande

Vanderlande in Veghel (NL) designs, creates and implements systems to sort and transport goods. These goods can be luggage at airports, packages for e-commerce, and postal services, but they can also be products in a supermarket's distribution centre.

Suitcase "rollercoaster" by Vanderlande at Schiphol Airport

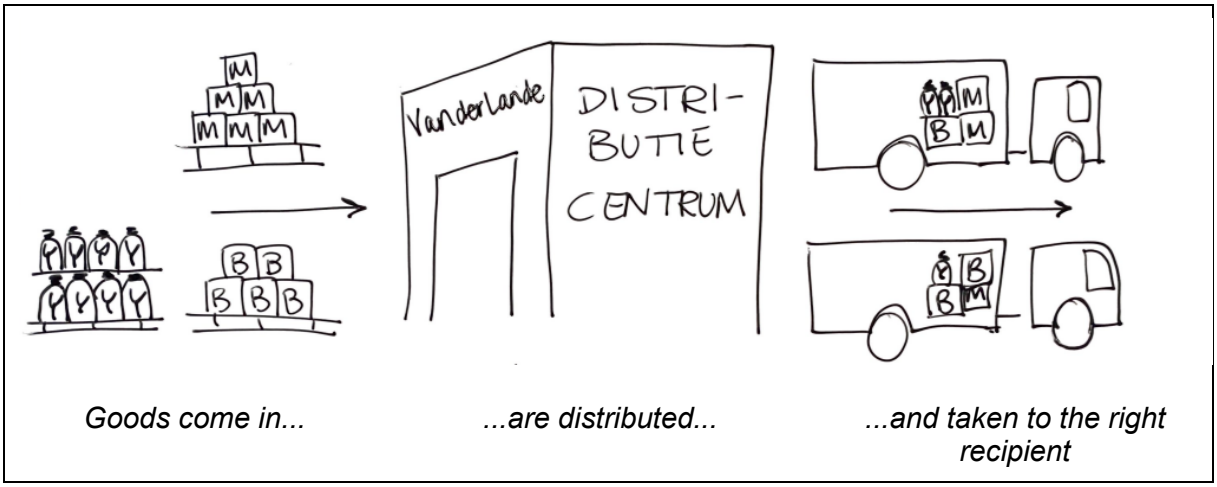
Vanderlande's systems move 4.2 billion pieces of luggage and sort over 39 million packages per day worldwide (425 packages and 117 suitcases per second). Parts are made in Spain, China, the US and The Netherlands, and then transported to project sites all over the world.

You can find Vanderlande systems at over 600 airports, including Schiphol, Heathrow (London) and Hong Kong, but also with parcel couriers such as DHL, e-commerce sites such as Amazon and distribution centres like those for the Jumbo and Albert Heijn supermarkets.

Watch a video about Vanderlande here[ii]

The project: a fully automated distribution centre with AI

A distribution centre is a place where companies collect, distribute and transport goods to other locations.



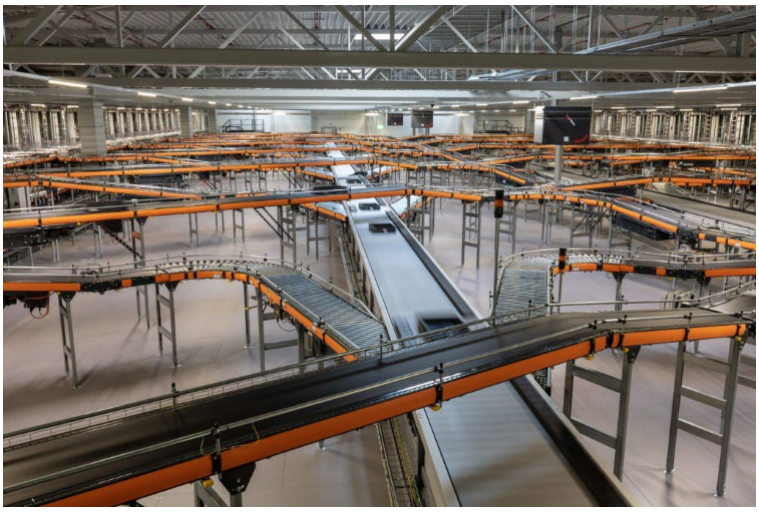
Goods come in... *...are distributed...* *...and taken to the right recipient*

Together with Albert Heijn, Vanderlande developed a distribution centre (DC) in Zaandam that is almost fully automated in terms of intake, storage and distribution of non-perishable products. Trucks loaded with pallets of coffee, biscuits or laundry detergent arrive at the distribution centre. The driver places the pallets at the first station, after which robots will take over the "journey". The products are divided over different trucks in an order that matches the aisle layout in the store. The trucks then only need to drive to the right Albert Heijn location to deliver the stock.

This video shows how the warehouse works[iii]:

There are a few mentions in the video about "smart software" doing things:

- The infeed system sees which products are on the pallet and where the pallet needs to go;
- Smart software calculates how to best stack cage trolleys;
- The stacking order matches the layout of the aisles in store.



This "smart" software uses Artificial Intelligence (AI). AI can simulate various alternatives and learn from the results. This is how you train software to keep making better decisions in unfamiliar situations.

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The assignment: How does AI help in restocking supermarkets?

In this assignment, students discover the role of Artificial Intelligence in restocking Albert Heijn supermarkets. They will be introduced to three AI challenges in the distribution centre that are mentioned in the video:

In **exercise A,** students learn why the **aisle layout in store** matters for the order in which cage trolleys are stacked and why AI is needed to decide what the best order is.

In **exercise B,** students learn how to do different **stackings** and what part AI can play in that.

In **exercise C**, students experience **how an AI can learn** to recognise products and make predictions for new situations.

In **exercise D**, students **discuss** the future possibilities of these types of systems.

The class

Introduction by teacher

- If possible, create a link to previous lessons.
- Tell the students about Vanderlande, distribution centres and their automation (see: background information).
- Explain the overall structure of the assignment.
- You can find supporting visuals for this introduction here:

Vanderlande[iv]

Guided visit in AH distribution centre[iii]

Vanderlande systems in the distribution centre[v]

Jobs at Vanderlande distribution centre[vi]

Execution

The assignments consist of several smaller exercises. These all go together, but can also be done separately. You choose your exercise based on the time you have and what the main area of focus is for your students.

A) How to fill roll cage trolleys as practically as possible

Students do research at supermarkets to see their global layouts. Together with the class they create a general floor plan and a layout of the aisles. They also look in on the loading and unloading for restocking the store and shelves.

What is the best way to stack products onto a cage trolley?

B) How to stack products as efficiently as possible for a supermarket

When stacking the products, you don't only take into consideration the order in store: some products have to be on the bottom and others on top (a crate of bottles on top of a box of crisps isn't practical). The packages also have to fit. Students use a puzzle to figure out, according to certain requirements, how to fit as many products on a cage trolley as possible.

C) How can an AI system learn to recognise products?

You can teach a simple computer program to recognise products by size and colour. But what if there are too many products and the size and colour differ based on how the products are delivered? The program will need to be able to make predictions. Using an online AI training program, students get to see how AI systems learn to recognise products.

D) How will the future of distribution change?

It would be helpful for this exercise to have completed exercises A-C. Students think about the pros and cons of AI in distribution systems: what does that mean for the future of distribution systems? And for the logistics staff? And for other industries that face similar challenges?

At-home assignment

Exercise A can be easily done from home, provided students are allowed to go outside. If not, there's an alternative option in "Tips for the teacher".

Exercises B, C and D can be done from home as well. Students will only need a computer. For exercise B they also need a printer, scissors and possibly glue.

Evaluation

To discuss with students:

- What did they find interesting about the practical assignment?
- How would they potentially encounter the methods from this assignment in their future profession?
- What do the students find interesting about the challenges of automated distribution?
- What do the students find interesting about AI?
- Which topics from the book do they see reflected in this assignment? So why do they learn that?

Tips for the teacher

A) How to fill roll cage trolleys as practically as possible for a supermarket

1. **Think of as many products that are in a supermarket as possible**
    - You can also use folding paper or scraps of paper instead of Post-its. Post-its are just easier to work with. Do make sure the students are able to move around their answers later on, as they still have to categorise them. You can do this online, for example at https://padlet.com.
    - You can choose to let the students work in groups or to create the list with the entire class. If they work in groups, let them think of products in one "product family" so that it doesn't get too broad.
    - Choose which part you have your students do individually, which to do in groups and which to do with the entire class. It's all possible.

Exercises 3 and 4: Supermarket research

- For this exercise, students research the layout of the supermarket and how cage trolleys are unloaded. Ask for the store manager's permission beforehand!

Give the students a short description of the exercise. Include when and how long they are allowed to be in the store to do the assignment. Also include the name of the school and the name and contact details of the respective teacher. This will make shop managers more willing to cooperate and keeps the contact between the school and the supermarket alive for a potential next time!

- If it is not possible to have students visit a supermarket due to permissions, COVID-19 rules, lack of time or some other reason, they can also find information online:
    - Supermarket layout: You can find floor plans online by Googling "plattegrond Albert Heijn" (or any other supermarket).

- Restocking AH (unfortunately this contains ads...):
  https://www.youtube.com/watch?v=PA-MK3Icn0U
  This also shows how a non-automated distribution centre works.
- Stocking shelves at Albert Heijn:
  https://www.youtube.com/watch?v=rm_6DO8z81Y

5-7 - rules that the stacking of products must comply with

You will find these in exercise B.

B) How to stack products as efficiently as possible

- It could be a great help for students if they have some products "live" in class. This will help them learn how size, weight and sturdiness play a part in stacking.
- It works better if you print the boxes on thicker paper.

Use of volume

Students will have to puzzle for this. It does help to do big things first and then fill up the gaps with smaller boxes. In reality of course, that only works from top to bottom. You decide how strict (or realistic) you want to be for this.

They calculate the % by dividing the number of filled squares of the three cage trolleys by 600 and converting that to a percentage.

Stability

You get the most stable trolley by placing the heaviest products (drinks and tins) on the bottom. Calculate the centre of gravity by giving the heavy items a mass 2 per "square" and the lighter items a mass of 1 or ½ (for toilet paper). Definitely do not stack on top of things with loose/uneven top surfaces.

Family grouping

If you look up filled cage trolleys online, you'll see they're not stacked that well in terms of "families". Filling cage trolleys is quite difficult after all. That may well be a good takeaway from this exercise! You decide how strict you want to apply the rules.

Why is AI needed?

AI is needed for stacking because it really is difficult. For each type of product and packaging (which often changes per product), you have to think about what can go on the bottom and what can't. Think of what someone with experience can do and what a layman would do. That's not to follow the rules, but to get a feel for the situation. A normal computer can't get that "feel". An AI system can - eventually!

C) How can an AI system learn to recognise products?

In this exercise, students keep comparing products to create algorithms that the infeed system uses to recognise products. There is an added value for students if you don't do this exercise on paper only, but use real products in class. This allows them to see their shapes in 3D - a lot more fun than images on paper!

The recognition exercise is mainly about things like height, diameters, colour "areas", parts that stick out (caps), etc.

D) How will AI change the future of distribution?

Feel free to choose a different statement here! You can find tips for a good class discussion here[vii].

Broadening the subject

The distribution centre is currently "practically" autonomous. What is needed to make it fully autonomous?

In the video you can see that there is only one manual warehouse activity: the defoiling. Watch the video carefully to see how the employee does that. Describe all the actions the employee takes in as much detail as possible. What would a robot need to be able to do in order to automate that? Why does that require AI?

What other places use AI systems by Vanderlande?

Vanderlande doesn't just make AI systems for automated distribution centres, but also for baggage handling at airports and for parcel shipments. Check the Vanderlande website and choose a video about one of these systems. Why is "smart software" (or AI technology) used here?

What does Vanderlande do with self-driving cars?

Extra: Vanderlande implements AVG systems for many customers: automated guided vehicles. These are self-driving carts that can transport products at airports, in warehouses and in factories. The Brainport digital library also contains an AI worksheet for DAF: "How do trucks drive on their own?" You can apply those same exercises to Vanderlande's AVG systems. If you do, what do you have to watch out for? What's the same? What's different?

Together with businesses

- You can easily combine this exercise with an (online) company visit or a guest lesson by Vanderlande or a distribution centre. Many distribution centres aren't yet as automated as the one in Zaandam. But they do all have some form of automation. How far along are they? Would they also want to change to a fully autonomous system? Why? Or why not?
- You can also use this exercise for a visit to a company with a logistics department: what could they automate (further)? How would AI play a part in that?
- Vanderlande isn't the only company using AI in their processes. Check the other AI worksheets in the Brainport digital library for examples. But also ask another business you're in touch with how they use AI.

A cross-curricular assignment with...

- **Geography / Social Studies**
  As an internationally active business, Vanderlande deals with different cultures. *"Every country has its own customs and traditions, but we respect one another. We strive for one global way of working, but at the same time, we want to comply with the various local laws and regulations as well."* What would that look like in practice?
- **Geography**
  - Albert Heijn's autonomous distribution centre is located in The Netherlands. Which other countries would be interested in such a system? Which countries wouldn't? Why?
  - Vanderlande's systems are used all over the world. How does that work in terms of transport? Where would you put other Vanderlande sites? How does the environment influence the products that Vanderlande makes?
- **Business Economics**
  Vanderlande is a business that invests a large part of its revenue in research and development. This means they are a leader with their technology, but that also costs money. Which choices can a business make in this? What are the pros and cons?
- **Physics** (thanks to the input from the Facebook-group "Vaksteunpunt Natuurkunde"!)
  Niels Arts:
  - Designing a steering system. Sensors, processing and actuators: how do sensors work, how do you detect colour, shape, mass, orientation?
  - Forces and movements. How do you transport items on the belt and how do they safely land in a tray or container? How much power is needed (at least) to drive the belt?
  - Electricity: for this you can look at the switches behind the robots/belts. How do you power an arm or belt? Which components are used and at which voltages?
  - Health and safety: How do you guarantee the health and safety of workers? Which measures are put in place to respond to errors in the process? For example, a package falling off the belt or a bottle of soft drink exploding.

  Anneke Thurlings:
  - Ask students to create a "self-driving" (autonomous) system. Many educational robots are able to drive over a line. How can you use that technology in a distribution centre? What is the part of AI in that?

  Rene van Helden:
  - I was part of the simulation department of this wonderful company a long time ago. I always like to talk a lot about the use of models to make predictions using this company's systems. They build beautiful models to simulate their systems. I loved seeing how many systems don't record where a suitcase or parcel is, but calculate it based on the speed of the conveyor belts and time. Another example is the gradual acceleration of transport trays (bagtrax) using a row of accelerators. Like a particle accelerator.

  Bernard La Rivière:

- Think about visualisation (light, radiation, colour...), sensors and actuators combined with energy conversion, energy loss (friction) on an 8.3 km racetrack, further modelling and making models. Maybe something about the waste (plastic) they use. And math.
- Students can also write a profile paper about AI. You can check out this profile paper (combined with an R&D master's piece) entitled "Understanding Artificial Intelligence" by Finn de Horde, Luke de Jeu, Tony Munzer and Milan La Rivière for inspiration[viii]:

- **R&D**

  Vanderlande wrote two assignments for the Technasium:
  - Design an AGV that can be used in distribution centres
  - Design a sorting unit

  The profile paper mentioned in the physics tips had been combined with a master's piece. That's where you'll find inspiration for a master's piece on AI.

- **Math**

  The entire logistical architecture of a distribution centre is of course based on math. Waiting times, stacking, modelling about what's most efficient, how acute a turn should be, etc. Ask the students to watch the video about the distribution centre and ask them to note down as many mathematical elements from this as they can. Because there is so much, you can also do this at a specific chapter. Take linear equation for example: where could you find a linear correlation here? How do you determine the optimal speed of a conveyor belt? Etc.
- **Visual Arts**

  Design packaging for a product that an AI system can easily recognise. What would be the requirements? (Also see exercise C).
- **Modern Foreign Languages**

  The website www.vanderlande.com is available in various languages. Look at a piece of text on the Vanderlande website in two different languages and translate it into Dutch as literally as possible. Does it say exactly the same? (No!) Why not? What else do you notice about the language used on the website? Have students write their own short text that would fit on the Vanderlande website.
- **Modern Foreign Languages**

  If you go on a company visit, ask if they have any employees from an English, French or German speaking country or work with any. Students that are interested in languages can also prepare questions for those employees.
  Think about things like cultural differences, language barrier, technical jargon, differences in education, etc.
- **Career Orientation**

  Vanderlande has many videos online in which employees talk about their jobs. A really good one is the one where Liselotte talks about being a singer at parties, while working as an Innovation Lead at Vanderlande during the day.

Vanderlande on YouTube[ix]

The video of Liselotte at Vanderlande[x]

For students from a non-Dutch background

- Perhaps the business you visit also has employees that speak Polish, Turkish or Arabic, while you have students that speak those languages. Ask that employee whether they would like to explain to those students, in their own language, what their job entails, how important it is (or not) to speak Dutch, etc.

More information about...

Vanderlande at airports[xi]

Schooltv – how does a Vanderlande luggage robot work? (in Dutch)[xii]

Vanderlande and warehousing[xiii]

Vanderlande and parcels[xiv]

AI in the world *behind* distribution centres

Getting goods and parcels from A to B requires more than just a well-appointed distribution centre. Receiving and processing orders also has an entire (technical) world behind it in which AI plays an increasingly important part. The "AI Course for Everyone" has some good examples of that:

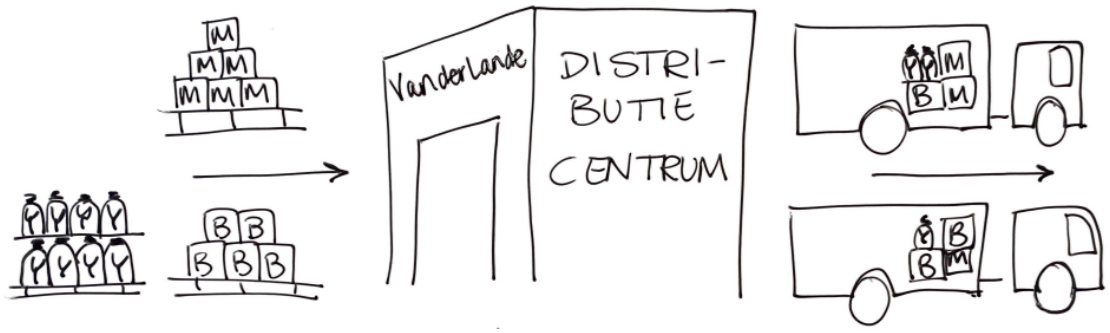
Post NL[xv]

Bol.com[xvi]

Student assignments

General explanation

A distribution centre is a place where companies collect, distribute and transport goods to other locations.



Goods come in... *...are distributed...* *...and taken to the right recipient*

In a distribution centre it's important to use the space as efficiently as possible in order to store as many boxes and packages as possible. Unpacking them, putting them away, picking them up and loading them into the trucks is a tough job. It is difficult to find the staff to do it.

This is why Albert Heijn and Vanderlande, a company from Veghel (NL) that builds sorting systems, developed a fully automated distribution centre where almost every operation in the warehouse is done by machines.

Compare a normal warehouse and Vanderlande's fully automated warehouse:

A normal distribution centre[xvii]

A fully automated distribution centre[xviii]

A) How to fill roll cage trolleys as practically as possible for a supermarket

Inside the distribution centre, robots stack the products onto a trolley in a way that makes it easy to unload in the supermarket. A single trolley contains as many products that are close to each other in-store as possible. This means that stock clerks don't have to run across the entire store when they unload them, which saves time!

In this exercise you look at what the robots in the distribution centre need to consider when preparing the cage trolleys for transportation to the supermarket.

Note: This means you complete exercises 3 and 4 at a supermarket in your neighbourhood!

1. Think of as many products that are in a supermarket as you can:
    - Take plenty of Post-it notes and markers
    - Write as many supermarket products as you can in two minutes (timer!)
    - Ready? Check which products other groups came up with.
    - Start the timer again: add ideas you saw at other groups to your "list" of products (you can peek!)
    - Ready? Take out any Post-its of duplicate products.

2. Organise the Post-its based on product groups:
   Examples of product groups are "fruit and veg", "meat, fish and vegetarian" etc. You can find these on the order pages of the various supermarkets. For example, for Albert Heijn you'll find them here: https://www.ah.nl/producten.

You have now had a good look at the product and product groups in a supermarket. All of these products are brought to the supermarket from a distribution centre.

Complete exercises 3-5 at the supermarket. Use the "Supermarket answer sheet"

! Get permission from the supermarket manager before you start this research.

3. Draw a floor plan of the supermarket:
    - The main product groups must by clearly marked.
    - You can find examples of these plans by doing a Google search for "plattegrond Albert Heijn".
    - You also mark the places where trucks load and unload their stock.

4. Figure out in which order a cage trolley is unloaded in the supermarket.
    - Choose one cage trolley.
    - How many product groups are featured in one trolley?
    - In which order are the products in the trolley?

The products aren't "just" loaded into the cage trolleys. The machines that do this in the distribution centres have rules for that, called algorithms.

5. Write down as many algorithms as you can that a machine uses to determine how to stack products onto a cage trolley: What's on top? What's on the bottom? Why?

    These are algorithms a machine could use to stack products:

    = for example, flat things on the bottom.

Normal software can extrapolate a lot of things, but the calculation program will get very slow if there are too many rules. A normal computer program is also not able to handle new situations. If the product packaging changes, the computer is at a loss.

Artificial Intelligence (AI) can predict the best solution in any new situation by extrapolating previous solutions. With these predictions, AI is able to tackle more complex calculations quicker than normal software.

6. Explain why you need AI for stacking products on cage trolleys and loading up the trolleys.

    You need AI for this, because...

B) How to stack products as efficiently as possible

In the distribution centre, robots prepare the cage trolleys that will be taking to supermarkets by trucks for restocking. This stacking is quite a puzzle: there are many different shapes and sizes of packaging. Closed boxes are easiest to stack, but a cardboard tray with glass jars of baby food makes this job a lot trickier. You also want the boxes (or trays) to be placed on the trolley in such a way that you can unload it from top to bottom, and without having to zigzag through the entire store.

In this video you see what can happen if you don't stack trolleys or pallets properly[xix].

You must keep in mind three things when stacking products:

- **Use of volume** – how can I stack as much as possible onto a trolley?
- **Stability** – how do I make sure that the products and the trolley itself stay stable?
- **Family grouping** – items that are placed together in-store should preferably be on the same trolley, so that you don't have to cross the entire store as you unload.

Tip: maybe someone in your class works as a stock clerk in the supermarket. Perhaps they have any tips or are willing to be a judge for the next exercises!

In this exercise you'll learn about the "stacking challenge" when preparing the cage trolleys. You also think about how a machine could do that automatically.

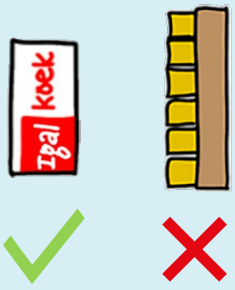
1. Ask your teacher for the "cage trolleys" and "packages" attachments.
   Cut out the **packages**. You should now have one cage trolley and one stack of individual products.

Use of volume

2. Place the packages on the trolley as efficiently as possible: try to get it as full as you can.

Rules for stacking the cage trolley

- Packages have to stay within the blue lines
- can't stick out too far on top
- can't overlap each other
- can't "float"
- you can rotate the package if that is realistic for this product
- (i.e. biscuits, yes, trays of cans, no)
- you can have packages left over



3. Calculate which percentage of space you used on the trolley (there are 200 spaces). Indicate how much % of the cage trolley you managed to fill, who in your class got the highest percentage and what their strategy was:

I filled _____ % of the cage trolleys.
The highest % of the cage trolleys in the class is: _____
They used the following strategy to obtain this:

Use the information in this table for the next exercises:

Packages	Mass (kg)	Stability	Strength
Biscuits	Low	++	+/-
Wine	High	++	+
Drinks in a box	High	++	+
Drinks in a tray	High	-	+/-
Frying oil	High	- -	-
Jars	High	-	+
Tins	High	+	+
Toilet paper	Low	- -	- -

Stability

4. Stack the packages onto the cage trolley again.
   This time, keep in mind the stability: the filled trolley's **centre of gravity** must be as low as possible. Use the data in the table above.

5. Discuss in class how you can take into consideration the trolley's centre of gravity.

When stacking the packages you keep the centre of gravity as low as possible by:

6. Now stack the packages based on the type of products.
   For example, you can't place a box of wine bottles on top of a box of toilet paper.

7. Discuss in class what you take into consideration when stacking the packages.
   Which strategy did you use to fill up the trolley to keep it stable?

When stacking the packages you consider the stability by:

Family grouping

8. Discuss in class which products are generally grouped together in the supermarket. Which product families would you then want to put together on the trolley?

We distinguish the following product families:

9. This time, stack the packages in a way that keeps product families together, and makes it easier to fill the shelves in store without having to walk too far in between.

10. Discuss in class what you took into consideration when stacking the packages. Which strategy did you use to fill up the trolley?

When stacking the packages you consider the product families by:

You see that there are many important aspects to stacking packages onto the trolley. Normal software can extrapolate a lot of things, but the calculation program will get slow if there are too many rules. A normal computer program is also not able to handle new situations, only with situations arising from known circumstances. That is tricky seeing as product suppliers often change the packaging or sizes of their supermarket products.

Artificial Intelligence (AI) can predict the best solution in any new situation by extrapolating previous solutions and learning from them. With these predictions, AI is able to tackle more complex calculations quicker than normal software.

11. Explain why you need AI for automatic product stacking on cage trolleys.

You need AI for automatic product stacking on cage trolleys because:

The Albert Heijn warehouse in Zaandam is not fully autonomous yet. In practice, and even with the help of Artificial Intelligence, not all products can be handled by robots or machines. There are items whose shape or packaging quality risks breakage or falls. We call those "ugly" items.

These items are particularly difficult for machines to handle.

The number of "ugly" articles can make up 10 to 15% of the entire range. Warehouse architects try to reduce the amount of uglies that doesn't fit into their system as much as possible, but they can never get it completely down to zero.

Read the following article on the automated "palletisation" of mixed packages (the automatic stacking of packages containing different products on pallets)[xx].

12. Name at least five "uglies" in the supermarket.

Examples of uglies in the supermarket are:

13. Which solutions does Vanderlande use to stack the packages automatically?

The article mentions the following solutions:

14. Some of the products are still stacked manually.
What would a machine need to be able to do to take over this task?

A machine would have to be able to:

C) How can an AI system learn to recognise products?

You can teach a simple computer program to recognise products by the object's size and colour. But products that are delivered to supermarkets often have different packaging and formats. A normal computer program will not be able to recognise those products. You'll want to avoid the program misidentifying products, or having to have someone present to manually enter which type of product it is.

So you need a program that can predict what the product is based on previous experiences.

Software based on Artificial Intelligence can predict what the new product is. It does that by using algorithms; based on previous "exercises", it calculates what the biggest likelihood is of it being that product. This is how an AI system gets better at learning to recognise new products.

But how does it learn?

This exercise will give you more insight into how AI learns.

1. Examine how the AI program Quick, Draw learns:

   Visit the website https://quickdraw.withgoogle.com/.

   - READ THE PROGRAM'S INSTRUCTION AND EXPLANATION CAREFULLY!
   - Change the program to the language of your choice if need be.
     (Does it not do that on its own and do you really need it? Look up "How to turn on Google Translate".)
   - Start the program: Let's Draw! and follow the instruction.
   - When you're done, choose one of the drawings.
     Google now shows you how it learned to recognise your drawing!

2. In your own words, describe how Artificial Intelligence taught Quick, Draw to recognise drawings.

   Quick, Draw learns how to recognise drawings using AI by:

An AI program can be trained: you take icons and ask lots of people to draw that icon. You feed this information (data) to the AI program. It then calculates which elements of the drawing are important in order to choose the right icon.

Run the Quick, Draw program one more time. But this time, pay close attention to what the program needs in order to guess what you're drawing.

3. Which word did you have to draw? And when did Quick, Draw recognise your drawing?

Word: Drawing at the moment Quick, Draw knew:

4. Which elements in your drawing make Quick, Draw recognise it?
   Give these essential elements a colour in the drawing you made above.

In the "infeed system" at the Zaandam distribution centre (see video[xxi]), the machine uses smart (AI!) software to "see" which products are on the pallet.

5. Below you'll see two products.
   Which elements could AI use to distinguish these two products?

AI could use the following elements: 

6. Draw these products as simplified as possible so that AI can recognise which products they are.

Chopped tomato:	Juice:

7. Make another simplified drawing, but this time for the following products. Mark the distinguishing elements with an arrow.

This is how AI recognises these products:

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8. For each product, indicate how AI is able to distinguish them from one another: which elements does the system take into account?

Elements AI takes into account:

9. Now you get a new product (see image). Indicate which elements it can scan to be able to tell what product it is.

These elements are:

D) How will the future of distribution change?

Using Artificial Intelligence enables further advancements in automation. Where before, machines were only able to take pre-programmed steps, with AI they can now respond to their environment and unexpected situations.

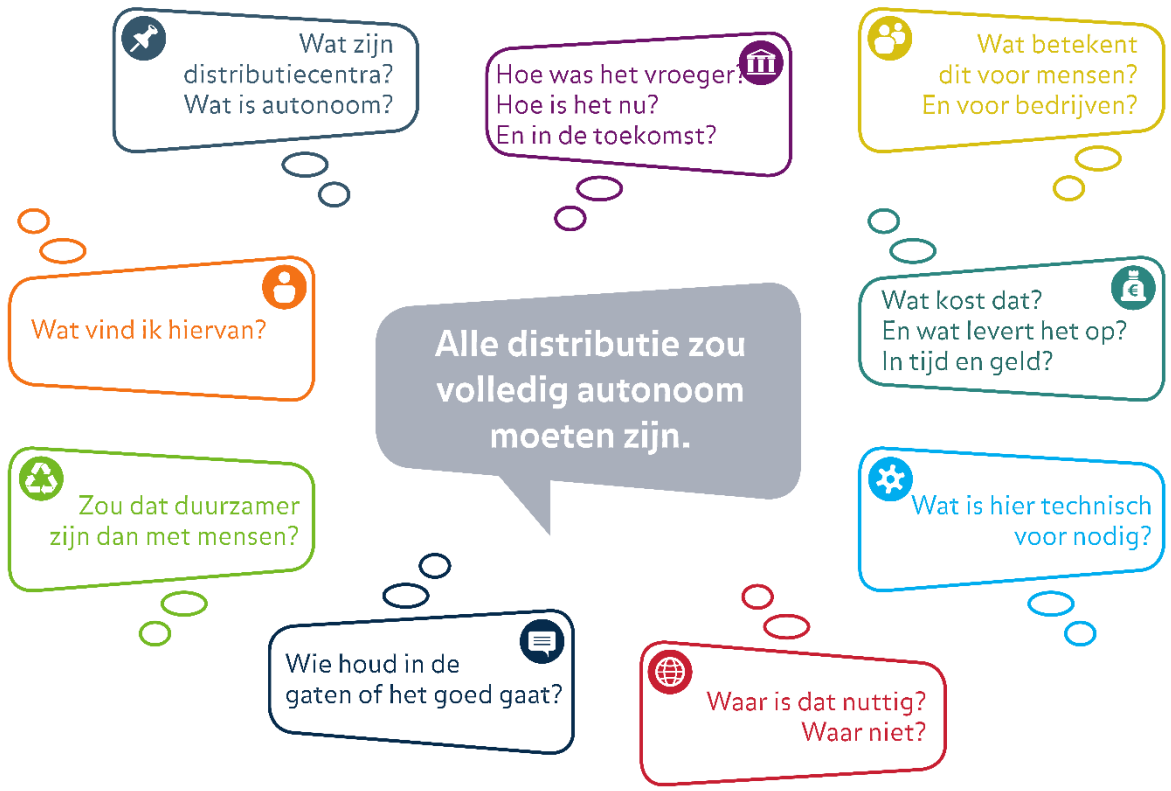
In the distribution centre Vanderlande is developing, AI is key as well. Recognising products, calculating efficient routes to collect products, stacking products on cage trolleys that are then transported by trucks to the supermarkets: you need AI for everything.

But a fully automated distribution centre also means you need less staff. And if this is the start of automation, where does it end? Will supermarket staff become completely obsolete?

Have a class discussion or debate about the following statement:

All distribution should be completely autonomous.

Use the examples below as starting or thinking questions to prepare your viewpoint.



What are distribution centres? What is autonomous?
How was it before and how is it now? And in the future?
What does this mean for people? And for businesses?
How do I feel about this?
What does it cost? What does it gain? In both time and money?
Would that be more sustainable than using people?
Who checks if everything goes okay?
Where is and isn't this useful?
What is needed for this from a technical point of view?

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Attachments

Attachment: Supermarket answer sheet

1. Supermarket floor plan

Pay attention to:

- the most important product groups
- loading and unloading

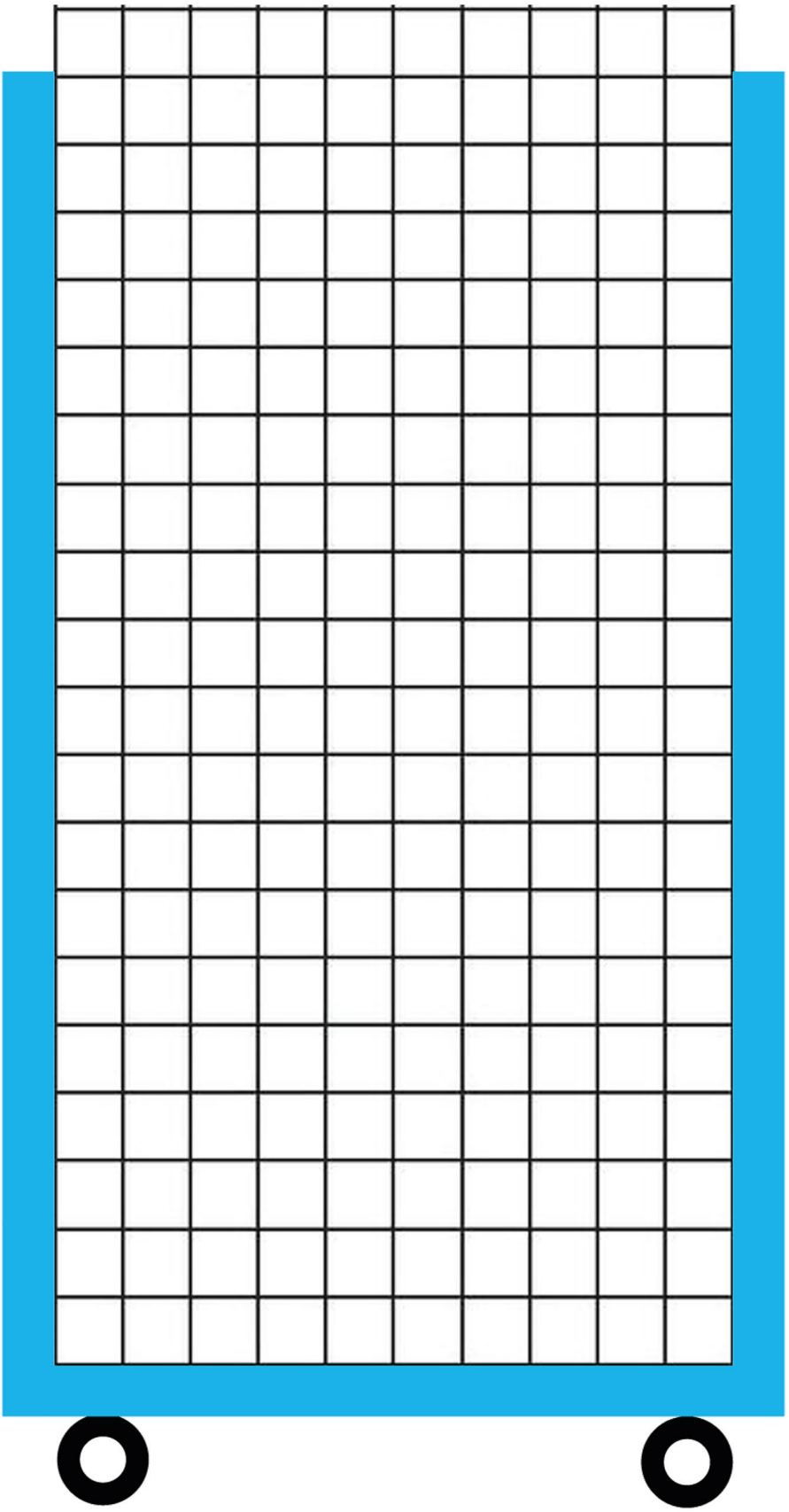
2. In which order are cage trolleys unloaded?

   If possible, take pictures of the products on the trolley

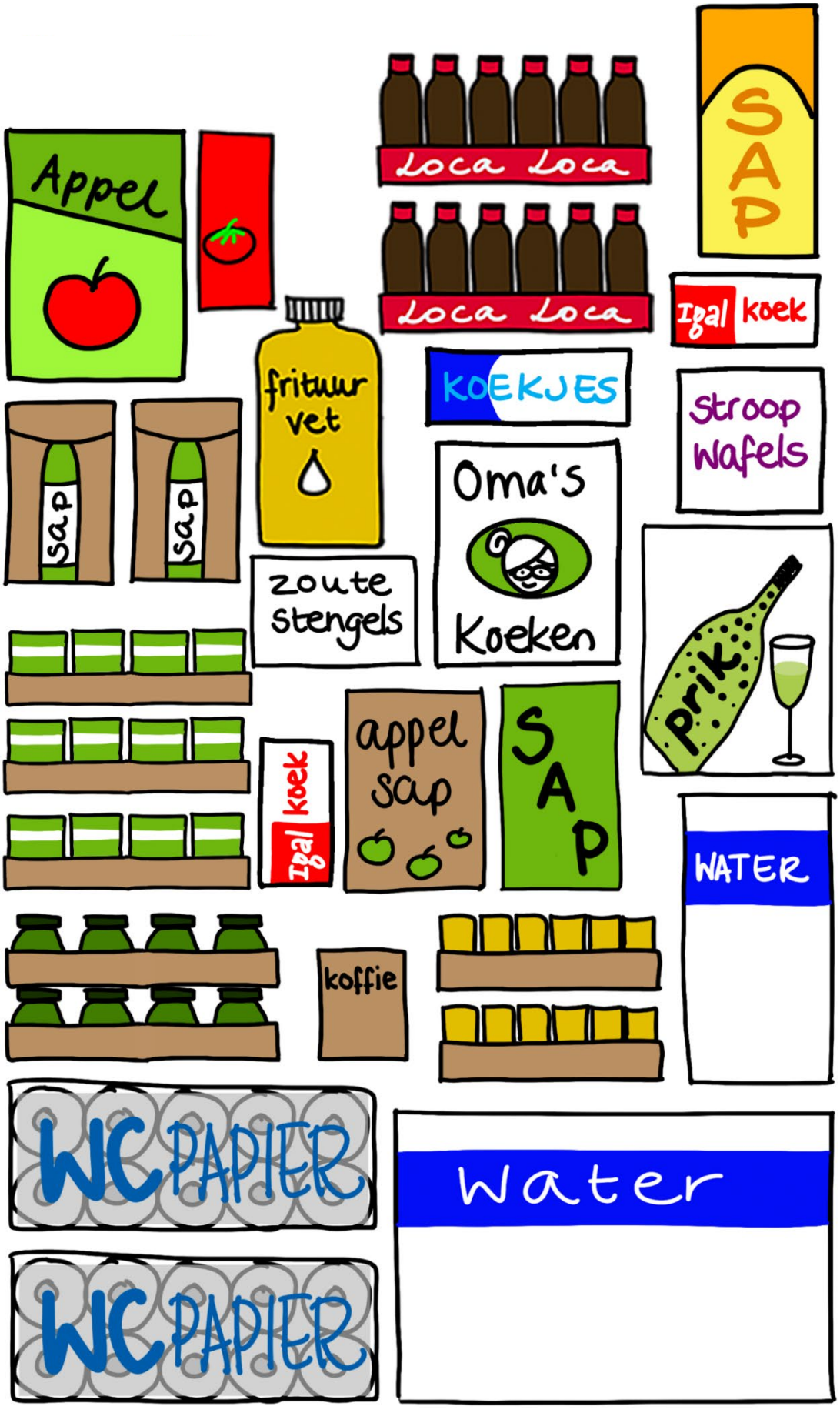
Number of product groups:

Order:

Attachment: cage trolleys



Attachment: packages



Attachment: degree programs with AI

Institute	Program or course	
Summa College and ROC Ter Aa	**Elective program Embrace TEC**[1] A broader elective program centred on Technology, Entrepreneurship and Creativity. This also features AI.	
Summa College	*Software developer, mbo (vocational education) 4*[2]	
Summa College	*Mechatronics mechanic, mbo (vocational education) 4*[3]	
Summa College	*Smart Industry Technician, mbo (vocational education) 4*[4]	
Summa College	*Automotive engineering technician, mbo (vocational education) 4*[5]	

[1] https://www.summacollege.nl/updates/detail/2021/01/06/wil-jij-de-vaardigheden-van-morgen-leren-kies-embrace-tec
[2] https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/software-developer-(bol)
[3] https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-mechatronica-(bol)
[4] *https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-smart-industry-(bbl)*

[5] *https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-automotive-engineering-(bol)*

ROC Ter Aa	*Software developer, mbo (vocational education) 4*[6]	
ROC Ter Aa	*Mechatronics mechanic, mbo (vocational education) 4*[7]	
Fontys	**Degree programs**[8] Bachelor ICT Applied Mathematics Bachelor Engineering Logistics Engineering Automotive Engineering FH Economics: profile Digital & Data FH Economics: digital business concepts AD ICT AD Healthcare Technology	
Fontys	**Minor Embrace TEC** A broader elective program centred on Technology, Entrepreneurship and Creativity. This also features AI. [9]	
Fontys	**ICT: minors for non-Fontys students**[10] Minor Data Driven Business Minor Cyberstars (digital security) Minor Digital Experience Design Minor Digital Marketing Minor EdTech Minor Health TEC	
Fontys	**Hybrid learning spaces / labs** Fontys ICT Innovation Lab, Strijp TQ Fontys at the Brainport Industries Campus (Engineering, Industrial Engineering)	

6 https://roc-teraa.nl/opleidingen/software-developer/
7 https://roc-teraa.nl/opleidingen/monteur-mechatronica/
8 https://fontys.nl/Over-Fontys/Artificial-Intelligence.htm
9 https://fontys.nl/Studeren/Minoren/Embrace-Technology-Entrepreneurship-Creativity.htm
10 https://fontys.nl/Over-Fontys/Fontys-Hogeschool-ICT/Geen-Fontys-ICT-student-maar-toch-een-van-onze-minoren-volgen-Dat-kan.htm

TU/e	**Programs**[11] Bachelor Data Science Master Data Science and Artificial Intelligence Master Data Science and Entrepreneurship	
TU/e	**Face the challenge @ Innovation Space**[12] Challenge-based learning Interdisciplinary projects Individual guidance by teachers, student-mentors and tutors 50% course-specific subjects, 25% general Bachelor College subjects, 25% elective subjects	
TU/e	**SerpentineAI student association**[13] Serpentine is focused on developing Artificial Intelligence. We learn about developing algorithms, with which we compete in AI E-sports competitions. The association connects students, research and industry by sharing our knowledge on state-of-the-art algorithms.	
TU/e	**Fruitpunch AI student association**[14] *Learn how to apply AI by solving real-world challenges* We apply AI for Good in projects like: AI for Wildlife, where we're building an autonomous drone that hunts down poachers in the wildlife reserves of South Africa, AI for Health and AI for Food.	
TU/e	**Tech United student association**[15] Tech United is a multidisciplinary team of students, alumni, PhDs and employees from Eindhoven University of Technology that engage in the development of robotics. Computer algorithms and other disciplines are used to solve problems.	
TU/e	**Blue Jay student association**[16] Drones have the power to extend our senses and actions. We believe technology is here to serve and help people improve their quality of life. At Blue Jay Eindhoven, we are at the forefront by developing a drone that functions indoors and interactive to serve as an assistant for aid workers.	

[11] https://www.tue.nl/en/education/degree-programs/
[12] https://studiegids.tue.nl/verbreding/innovation-space/
[13] https://serpentine.ai/
[14] Fruitpunch AI
[15] Tech United
[16] BlueJay

TU/e	**HART student association**[17] Human augmentation is a field of research that aims to enhance human abilities through medicine or technology. This vast field has numerous applications ranging from prosthetic exoskeletons and glasses to organ replacement.	
TU/e	**URE student association**[18] The team stands for technological innovation, teamwork and a passion for engineering. Using a combination of the engineering skills of all the members and some help from our dear partners, we are able to build a high-tech, revolutionary electric (and autonomous) Formula-style race-car every year.	

[17] https://teamhart.nl/
[18] https://www.universityracing.nl/

Attachment – Links used in QR codes

[i] https://www.instagram.com/brainporteindhoven/guide/ai-artificial-intelligence/17939865835446145/

[ii] https://youtu.be/6NyhcNNI_1k

[iii] https://www.youtube.com/watch?v=FwagVpkDKtQ

[iv] https://youtu.be/6NyhcNNI_1k

[v] https://www.vanderlande.com/warehousing/innovative-systems/

[vi] https://youtu.be/849qnkltvjs

[vii] https://onderwijstips.ugent.be/nl/tips/discussie-modereren-de-klas-en-online/

[viii] https://brainporteindhoven.com/fileadmin/user_upload/Onderwijs/Brainport-Eindhoven_PWS-Understanding-Artificial-Intelligence.pdf

[ix] https://www.youtube.com/user/Vanderlandetube/playlists

[x] https://youtu.be/rTEoYauUPto

[xi] https://www.vanderlande.com/airports/

[xii] https://schooltv.nl/video/hoe-werkt-een-bagagerobot-jouw-koffer-van-incheckbalie-tot-vliegtuig/

[xiii] https://www.vanderlande.com/warehousing/

[xiv] https://www.vanderlande.com/parcel/

[xv] https://www.youtube.com/watch?v=d2PNJ0AKdUk&list=PLbfgFDlJp-TCeJarp-s1DkWzTn22wBFdk&index=2

[xvi] https://www.youtube.com/watch?v=_uFvLr7Cmfs&list=PLbfgFDlJp-TCeJarp-s1DkWzTn22wBFdk&index=1

[xvii] https://youtu.be/H0PEWwcSVoc

[xviii] https://www.youtube.com/watch?v=FwagVpkDKtQ

[xix] https://youtu.be/rHpPri2CO4c

[xx] https://www.warehousetotaal.nl/werkvloer/meerdere-oplossingen-voor-mixed-palletiseren/81877/

[xxi] https://youtu.be/FwagVpkDKtQ?t=35